THE APPLICATION OF COST-EFFECTIVENESS ANALYSIS TO DISEASE CONTROL PROGRAMMES IN DEVELOPING COUNTRIES, WITH SPECIAL REFERENCE TO MALARIA CONTROL IN NEPAL

ANNE JANE MILLS

Thesis submitted to the University of London in fulfillment of the requirement for the degree of Doctor of Philosophy in the Faculty of Medicine

Evaluation and Planning Centre, London School of Hygiene and Tropical Medicine, Keppel St, London WC1.

August 1989

BLANK
IN
ORIGINAL

ABSTRACT

The aims of this research study are three-fold:

1. to explore the relevance of recent developments in the methodology of cost-effectiveness analysis to disease control programmes in developing countries and specifically to malaria control in Nepal;

2. to apply cost-effectiveness analysis to the malaria control programme in Nepal in terms both of (a) the cost-effectiveness of various malaria control strategies and (b) the cost-effectiveness of the malaria control programme as a whole, in order to refine a methodology capable of more general application to disease control programmes in developing countries;

3. to assess whether policy-relevant conclusions can be drawn from the application of cost-effectiveness analysis to the malaria control programme in Nepal.

The thesis is structured as follows. After the first introductory chapter, Chapter 2 reviews the literature on the cost-effectiveness analysis of disease control programmes, considering first the methodology of cost-effectiveness analysis, then its application to disease control programmes in first developed and then developing countries, and finally its application to malaria control. Chapter 3 briefly describes the epidemiology of malaria and policies and strategies of control before considering the history of malaria control in Nepal, present malaria control strategies and economic characteristics of the control programme.

In Chapter 4, objectives and methods are presented for the study of malaria control in Nepal with a description of the theoretical framework of the analysis followed by a description of the various sub-studies, comprising a cost analysis, an effectiveness analysis and two surveys of malaria patients. The findings are presented in three chapters. The first (Chapter 5) presents the results of an analysis

of the recurrent expenditure of NMEO (Nepal Malaria Eradication Organization) districts. The second assesses the internal efficiency of the Nepalese malaria control programme, considering first vector control strategies and second case detection and treatment strategies. The following chapter (Chapter 7) presents results relating to the desirability of malaria control (as opposed to other investments).

These results are discussed in Chapter 8 in terms both of the application of the cost-effectiveness methodology and of the findings in Nepal. Chapter 9 then draws out the implications of the findings for malaria control policies and strategies in Nepal. In Chapter 10, conclusions are drawn relating to the three aims of the research study identified above and recommendations are given. Finally, Chapter 11 draws out the implications of this study for further research.

CONTENTS PAGE

Annexes

LIST OF TABLES PAGE

LIST OF FIGURES PAGE

LIST OF MAPS

ACKNOWLEDGEMENTS

I would like to acknowledge the following help which made this research possible.

The staff of the Nepal Malaria Eradication Organisation (NMEO) and Integrated Community Health Services Development Project (ICHSDP) supplied the accounting data, some of which required many hours of painstaking transcription from Nepali into English. They also answered patiently many detailed questions about resource use. Thanks are particularly due to Dr M B Parajuli, formerly Chief of the NMEO, Mr S L Shrestha, formerly Deputy Chief of the NMEO, Dr B B Karki, Deputy Director of the ICHSDP, and to the Regional Malaria Officers of the East, Central and West Regions, District Malaria Officers of Morang, Ilam and Rupandehi, and District Health Officers of Saptari and Parsa.

The NMEO and ICHSDP also made possible the patient survey. I am most grateful for the advice given on the design and implementation of the survey by Dr M. B. Parajuli, Mr S. L Shrestha and Dr B. B. Karki. I would also like to acknowledge the assistance of the Regional Malaria Officers, the District Malaria Officers and District Health Officer of the six districts involved in the survey and all the staff of the unit offices and health posts who collected the data. I am grateful for assistance in coding and analysis given by the headquarters staff of the NMEO and am particularly indebted to Mr R G Vaidya, Head of Entomology, who organized and supervised coding and data analysis.

The household survey was carried out by New Era, a Nepali non-profit-making nongovernmental research and training agency under contract to the Overseas Development Administration. Thanks are due to the staff of New Era and particularly to R P Shrestha, formerly Executive Director, New Era, who supervised the survey, and T N Rajbanshi, who carried it out. I owe a considerable debt to Hilary Dimond who cleaned and edited the data set, transferred it to a mainframe, did the preliminary analyses and organized the data set in a way that much facilitated further analysis.

All the field work including the patient and household surveys was financed by the Overseas Development Administration of the British Government as part of a larger economic study of malaria.

The analysis of the patient survey and alternative methods of malaria control draws on discussions with Dr M Colbourne, formerly Department of Tropical Hygiene, LSHTM, who was associated with the early fieldwork of the economic study of malaria.

I am most grateful to my supervisor, Professor David Bradley, for his advice and to Professor Patrick Vaughan for constant encouragement and for facilitating the completion of the thesis.

I am indebted to Patrick Corran for wide-ranging support, including assisting my initial faltering steps to make myself computer-literate and writing a conversion programme for Nepali dates. Finally both he and Anthea Mills have provided the help with child care which has enabled this research to be finalised.

1. INTRODUCTION: THE APPLICATION OF COST-EFFECTIVENESS ANALYSIS TO DISEASE CONTROL PROGRAMMES.

Disease control programmes have for long been a feature of the health sectors of developing countries. Indeed in some countries, of which a prime example is Nepal, disease control programmes preceded the extension of general health services to the population and were the first health programmes to reach into people's homes. Some early successes, for instance yaws control in Africa and malaria control in South East Asia in the 1940's and 1950's, encouraged the emphasis on disease control programmes. As a result, a sizeable proportion of health sector expenditure was, and often continues to be, spent on disease-specific programmes, despite attempts to integrate these into general health services.

There has also for long been an interest in the economic impact of tropical diseases. A classic epidemiological study of malaria in the Punjab published in 1911 commented on its economic effects:

> "The autumn of 1908 in the Punjab was characterised by an epidemic of extraordinary severity. The effects of this epidemic were first prominently brought before the public by a sudden disorganisation of the train service due to "fever" among the employees at the large railway centre, Lahore.......At Amritsar, a city of 160,000 inhabitants, it is stated that almost the entire population was prostrated and the ordinary business of the city disrupted. For many weeks labour for any purpose was unprocurable and even food vendors ceased to carry on their trade" (Christophers 1911).

A review by Prescott (1979) of studies on the benefits of malaria control lists the earliest economic study as dating from 1916: it studied the effect of malaria on 74 tenants on a Louisiana plantation. The earliest developing country study published was by Sinton in 1935, which put together a mass of (largely anecdotal) evidence dating from the nineteen hundreds onwards on the economic consequences of malaria in India.

The motivations of such studies were mixed. Partly they were genuinely humanitarian and philanthropic, though often commercial interests or the economic interests of the colonial power were also involved. Behind publication often lay a motive of propaganda - to stimulate the authorities to take action - rather than of informing an academic or research community. There was therefore a clear tendency for evidence on the economic consequences of disease to be exaggerated and to be insufficiently based on empirical data.

This exaggeration was one reason for growing disillusionment with studies of the economic impact of disease. Other reasons were methodological difficulties. The main theme of these early studies was the impact of disease on production since diseases such as malaria, at times of epidemics, had an obvious impact on the ability of a household to produce for its own survival and on the ability of a country to expand production and raise its level of economic development. The value of lost production was therefore seen as the main economic cost of disease, and a theoretical rationale was later provided by Mushkin and others in the form of human capital theory, where programmes such as health and education are viewed as investment in people which enables them to be more productive and to increase their material well-being (Mushkin 1962). Productive benefits (plus other benefits such as averted medical care costs) could therefore be set against control costs in order to assess the desirability of public health programmes.

Health economists are now retreating rapidly from this theoretical approach to benefit valuation. It has been severely criticised as ignoring the value of improved health per se (ie the consumption as opposed to the investment value of health); as not necessarily reflecting either individuals' or society's valuation of improved health; and as biasing choice towards programmes benefiting the most productive members of society. The application of the theory can also be criticised for its tendency to base estimates of production gains on the existing earnings of individuals, ignoring whether these reflect their social productivity or whether the productivity of additions to the labour force will be the same as that of existing members of the labour force.

However, the approach to benefit valuation that is proposed in the place of the human capital approach, namely the willingness-to-pay approach, also has both theoretical and practical difficulties. Usually the willingness-to-pay is defined to be that of the consumer, although in principle a willingness-to-pay approach does not automatically imply consumer sovereignty (Drummond 1981). Consumer valuations can be questioned on a number of grounds, including the ability and desire of consumers to make such judgements (Mooney 1977), and the desirability of accepting valuations that will be based on a distribution of income and wealth that may not be considered equitable.

There is the further difficulty of eliciting valuations in the frequent absence of prices for the output of the health sector. Valuations can be based either on observing behaviour or on questionnaires. Valuations based on behaviour - for instance the costs individuals are willing to incur in order to avoid a health hazard - will be affected by whether or not the individual accurately perceives the risks (though this does not undermine the approach for Mishan: Mishan 1971). Questionnaires are extremely difficult to phrase appropriately and simply, and respondents may deliberately overstate their valuations. Questionnaires in general are fraught with difficulties in developing countries (Campbell, Streatha and Stone 1979) though one attempt has been made to ask willingness-to-pay questions (Birdsall 1987).

Proponents of the application of economic evaluation techniques have now therefore largely retreated from the use of cost-benefit analysis to assess public sector health programmes, preferring instead cost-effectiveness analysis. In its simplest form, cost-effectiveness involves the choice of either the strategy that achieves a given health objective at least cost, or that maximises the achievement of a health objective for a given fixed budget. In contrast to cost-benefit analysis, where the emphasis is usually placed on whether a health programme is worthwhile compared to other health programmes or completely different uses of the resources, cost-effectiveness analysis focuses attention on the particular health strategies chosen to reach health objectives. It has therefore introduced an emphasis on internal efficiency which is welcome given the evident inefficiencies of many parts of countries' health sectors. Health policies and strategies have tended to be technologically-driven, if constrained by absolute resource limitations, and in the past have largely neglected considerations of cost-effectiveness.

The increasing interest in cost-effectiveness analysis has been matched by theoretical developments which make it a more flexible and sophisticated technique. These theoretical developments are increasingly being adopted in cost-effectiveness studies done in developed countries, but have been little employed in developing countries.

Most cost-effectiveness studies in developed countries have evaluated strategies for the care of chronic conditions and the desirability of new medical procedures or therapies. Not surprisingly, given the structure of developed country health systems, the emphasis has been on the medical care sector rather than the broader health sector.

In developing countries, perhaps surprisingly, most attention has been paid to the cost-effectiveness of immunization and family planning programmes. This emphasis probably results on the one hand from the interest shown by international agencies responsible for supporting these programmes in the use of cost-effectiveness analysis as an aid to policy making and management, and on the other hand from the relative ease of applying cost-effectiveness analysis to programmes such as these where units of output are relatively easily defined.

In contrast, the cost-effectiveness of disease control programmes (excluding the strategy of immunization) is surprisingly little studied, with a few exceptions such as diarrhoeal diseases. Partly this reflects the continuing influence of the past emphasis on cost-benefit analysis (studies are still being done, for example, to explore the effects of schistosomiasis on work output). Partly it also reflects the decreasing international emphasis given in recent years to disease control programmes in favour of the promotion of primary health care, since international agencies are often the sponsors of economic evaluation studies.

Yet disease control programmes are a major consumer of resources in many developing countries. In terms of the criteria suggested by Williams (1974) for the selection of issues worthy of economic evaluation, a disease control programme such as malaria control:

- involves decisions on sizeable amounts of resources;

- is the concern - or is influenced by - a variety of government departments, raising issues of co-ordination of policy amongst them;

- has objectives which may not be shared by all these departments (for example the objectives of the malaria control department may not be of interest to the agriculture and irrigation departments and may even clash with their own objectives);

- faces clear choices between control strategies or between different mixes of strategies;

- employs technology that is reasonably well understood (in terms of the association between inputs and outputs) if only in comparison with many other health technologies.

Disease control programmes, and malaria control programmes in particular, thus seem a suitable choice for the application of cost-effectiveness analysis. The volume of resources at stake means improvements in efficiency could lead to savings or the transfer of resources for other uses within the programme; and the choice of strategies is not strictly determined by technological considerations, providing scope for other considerations to enter the decision-making process.

The aims of this research study are three-fold:

1. to explore the relevance of recent developments in the methodology of cost-effectiveness analysis to disease control programmes in developing countries and specifically to malaria control in Nepal;

2. to apply cost-effectiveness analysis to the malaria control programme in Nepal in terms both of (a) the cost-effectiveness of various malaria control strategies and (b) the cost-effectiveness of the malaria control programme as a whole, in order to refine a methodology capable of more general application to disease control programmes in developing countries;

3. to assess whether policy-relevant conclusions can be drawn from the application of cost-effectiveness analysis to the malaria control programme in Nepal.

The remainder of this thesis is structured as follows. Chapter 2 reviews the literature on the cost-effectiveness analysis of disease control programmes, considering first the methodology of cost-effectiveness analysis, then its application to disease control programmes in first developed and then developing countries, and finally its application to malaria control. Chapter 3 briefly describes the epidemiology of malaria and policies and strategies of control before considering the history of malaria control in Nepal, present malaria control strategies and economic characteristics of the control programme.

In Chapter 4, objectives and methods are presented for the study of malaria control in Nepal with a description of the theoretical framework of the analysis followed by a description of the various sub-studies of costs and of effectiveness and of two surveys of malaria cases. The findings are presented in three chapters. The first (Chapter 5) presents the results of an analysis of the recurrent expenditure of districts where malaria control is provided by the vertical programme, the National Malaria Eradication Programme (NMEO). The second assesses the internal efficiency of the Nepalese malaria control programme, considering first vector control strategies and second case detection and treatment strategies. The following chapter (Chapter 7) presents results relating to the desirability of malaria control (as opposed to other investments which would also improve health).

These results are discussed in Chapter 8 in terms both of the application of the cost-effectiveness methodology and of the findings in Nepal. Chapter 9 then draws out the implications of the findings for malaria control policies and strategies in Nepal. In Chapter 10, conclusions are drawn relating to the three aims of the research study identified above. Finally, Chapter 11 draws out the implications of this study for further research.

2. REVIEW OF THE LITERATURE ON THE COST-EFFECTIVENESS OF DISEASE CONTROL PROGRAMMES

This review defines its sphere of interest as disease control programmes. By this is meant a health sector activity, project or programme which has the objective of reducing the incidence, prevalence or mortality of a disease. Often this will be a preventive programme, such as immunization or vector control, but not always. For example in the case of schistosomiasis, mass treatment is a serious alternative to preventive measures as a means of reducing prevalence and mortality. However, activities which provide curative treatment but do not have the ultimate aim of influencing the level of disease are excluded from the scope of this review. So are programmes such as general primary or secondary care which are not targeted at specific diseases. This distinction is relatively easy to make in the context of developing countries, where reducing disease levels is usually of high priority in health planning. In developed countries, the health sector as a whole is more focused on personal health care and on meeting the needs of individuals, and tends to pay relatively less attention to systematic disease control programmes. It is therefore not always easy to draw a distinction between activities that primarily respond to the health needs of individuals and those that have broader objectives.

2.1 Theoretical developments in cost-effectiveness analysis

Cost-effectiveness analysis is said to have originated in the US Department of Defense in the early 1960's, though the initial use and author of the term have not been traced (Crosse 1967). The reason for its development was the difficulty of applying the technique of cost-benefit analysis because of the problem of valuing military programme objectives in monetary terms. Since this problem is encountered also in other fields of public expenditure, the use of cost-effectiveness analysis spread rapidly. For example the Overseas Development Administration of the UK Foreign and Commonwealth Office published in 1972 a guide to project appraisal in developing countries and noted that:

> "A major problem arises in relation to projects whose benefits cannot be satisfactorily valued in monetary terms. Typical

examples in the social field are public health projects and projects designed generally to improve amenities. The role of social cost benefit analysis in relation to this type of "social" investment is as a tool in the identification of the least cost method of achieving the desired objective. Moreover by enabling costs to be evaluated on a consistent basis social cost benefit analysis enables due consideration to be given to the implications for economic policy of particular objectives. At the margin choices have to be made and a consistent evaluation of the costs of alternative choices is evidently of great assistance to rational decision making" (Overseas Development Administration 1972).

As initially applied, cost-effectiveness analysis usually compared the cost of one or more interventions with its health effects, producing a ratio such as cost per life saved. In contrast, cost-benefit analysis placed a value on lives saved and on resource consequences of interventions, enabling costs and benefits to be compared in monetary terms.

Recently the distinction between cost-effectiveness and cost-benefit analysis has been blurred by development and categorization of various types of economic evaluation (see Figure 2.1). "Consequences" has been adopted as the generic term for the results of interventions, to avoid the confusion caused by the term "effects" and "benefits", and also to avoid using the term familiar to economists of "output" which clashes with epidemiologists' definitions. Where there is no evaluation of alternatives or of both costs and consequences, the evaluation can only be partial. Full economic evaluations are classified as:

cost-minimization analysis: where the alternatives produce identical health outcomes and the analysis can focus on identifying the least-cost alternative;

cost-effectiveness analysis: where the costs of the alternatives are compared to a single, common measure of health effect, which the alternatives may produce to different degrees;

cost-utility analysis: where the health status change is weighted in terms of its utility (to individuals or society) and the cost and utility of alternatives are compared;

Figure 2.1: The distinguishing characteristics of economic evaluation of health programmes

Are both costs (inputs) and consequences (outputs) of the alternatives examined?

		NO		YES
		Examines only consequences	Examines only costs	
Is there comparison of two or more alternatives?	NO	PARTIAL EVALUATION 1A Outcome description	 1B Cost description	PARTIAL EVALUATION 2 Cost-outcome description
	YES	PARTIAL EVALUATION 3A Efficacy or effectiveness evaluation	 3B Cost analysis	FULL ECONOMIC EVALUATION 4 Cost-minimization analysis Cost-effectiveness analysis Cost-utility analysis Cost-benefit analysis

Source: Drummond, Stoddart and Torrance (1987) cost-benefit analysis: where both costs and consequences are valued in monetary units.

Both costs and consequences can be subdivided into various elements (see Figure 2.2), discussed in greater detail below. While cost-effectiveness analysis may end in a simple division of costs by units of health effect, it may also net out against costs those elements of benefits that can easily be valued in monetary terms. In this way, the previous clear distinction between cost-benefit analysis and cost-effectiveness analysis has been blurred.

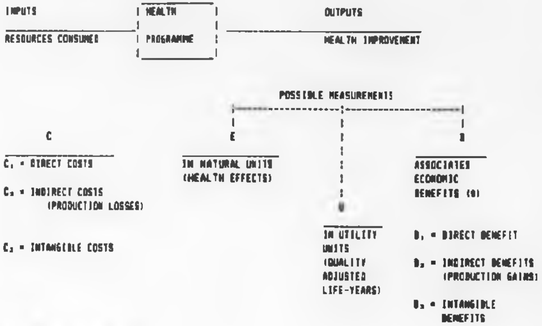
Costs

Figure 2.3 describes in more detail the currently accepted classification of the cost of programmes. The generally recommended viewpoint of any economic evaluation is that of society as a whole (though analyses may explore the particular implications for agency or household budgets). Thus the cost elements comprise those of operating the particular programme incurred by the health sector; those borne by households (eg home care, time lost from work because of the treatment) and those borne externally to the health sector (eg possibly schools in the case of child health programmes).

The origins of economic evaluation are rooted in welfare economics theory. Cost-benefit analysis can be seen as a technique for identifying potential Pareto improvements, that is situations where the maximum total sum of money that the gainers from a project would be prepared to pay to ensure that the project is undertaken exceeds the minimum total sum of money that the losers from it would accept as compensation to allow it to be undertaken (Drummond 1981). Cost-effectiveness analysis does not permit this judgement to be made since benefits are not valued, but is based on Paretian principles to the extent that the prices used to value the resources used by programmes are assumed to have welfare significance.

Resources used should therefore be valued using prices which reflect their social opportunity cost. If markets function efficiently (ie there is perfect competition and no external effects) prices should reflect social opportunity cost. Although these conditions are not

Figure 2.2: Components of economic evaluation



<u>COMMON FORMS OF ANALYSIS</u>

1. COST ANALYSIS: C_1, $C_1 + C_2$

2. COST-EFFECTIVENESS ANALYSIS (CEA): $(C_1+C_2)/E$; $(C_1-B_1)/E$; $(C_1+C_2-B_1-B_2)/E$

3. COST-UTILITY ANALYSIS (CUA): $(C_1+C_2)/U$; $(C_1-B_1)/U$; $(C_1+C_2-B_1-B_2)/U$

4. COST-BENEFIT ANALYSIS (CBA): $B_1+B_2-C_1-C_2$; $(B_1+B_2)/(C_1+C_2)$

ALSO SOMETIMES INCLUDES CONSIDERATION OF C_3 AND B_3

Source: Drummond and Mills (1987)

Figure 2.3: Types of cost relevant to the economic evaluation of health programmes

Costs		
I. Organizing and operating costs within the health care sector (e.g. health care professionals' time, supplies, equipment, power and capital costs)		Direct costs
II. Costs borne by patients and their families		Direct costs
Out-of-pocket expenses		Direct costs
Patient and family inputs into treatment		Direct costs
Time lost from work	Indirect costs	
Psychic costs	Indirect costs	
III. Costs borne externally to the health care sector, patients and their families		

Source: Drummond and Stoddart (1985)

always met in developed countries, analysts generally make the assumption that the divergences are not great and use market prices when they are available. Thus shadow pricing is only necessary for resources which are not purchased (eg the time of volunteers).

In contrast, in developing countries analysts start from the assumption that market prices are unlikely to reflect social opportunity cost. Firstly, the domestic price structure may be distorted by measures such as tariffs, subsidies, import licensing and excise taxes which shelter the domestic economy from international competition, and by an acute shortage of foreign exchange. These distortions may mean that goods produced domestically could have been purchased from abroad at lower real cost by using domestic resources to produce exports and exchanging them for the foreign products. The domestic price thus exaggerates the opportunity cost of the goods.

Secondly, the existence of a large pool of unemployed or underemployed labour, together with rigidities in the labour market which influence wage levels, can mean that wage rates do not reflect the opportunity cost of employment. A health programme might be able to employ unskilled labourers without a corresponding decrease in output from their previous occupations because they were unemployed. If they were previously subsistence farmers, their opportunity cost would be greater than zero but might still be less than the market wage.

The recommendation of economic evaluation methodologies concerned with the developing country context (Overseas Development Administration 1972, Squire and Van der Tak 1975) is therefore to use a system of shadow (efficiency) prices when valuing costs and consequences. For goods that are traded internationally, the use of "border" or "world" prices (the price at which a good can be bought on the world market and transported to the border) is suggested; labour is valued at its domestic opportunity cost; and the domestic value of non-traded goods and services (including labour) are translated by various procedures into world prices.

Non-traded goods can make up a large proportion of total costs and the translation into world prices may have to use short-cuts (such as the "standard conversion factor": Squire and Van der Tak 1975).

Alternatively, non-traded goods can be valued at their domestic price and the world price of traded goods translated to rough domestic equivalent prices through the use of a shadow exchange rate (Weiss 1978). The use of a shadow conversion factor and shadow exchange rate are essentially equivalent. Less approximate methods than the standard conversion factor are usually, however, recommended, such as roughly disaggregating the production costs of non-traded goods into traded and non-traded components, and then applying a conversion factor to the non-traded residual.

More basic differences exist in economic evaluation methodology between developed and developing countries than arise in shadow (efficiency) pricing practices alone. Indeed, the practice of cost-benefit analysis in developed and developing countries has diverged to the extent that the "traditional" and "new" approaches are now distinguished (Irvin 1978, Ray 1984). The traditional approach gives priority to efficiency - whether a project will lead to a net gain in social welfare - leaving to one side equity issues on the grounds that these can be dealt with separately by the goverment. In effect, this assumes that income gains are of equal value regardless of to whom they accrue (Ray 1984). In addition, the traditional approach is not concerned to break down income into its investment and consumption components, because capital markets are assumed to be efficient and therefore investment is equally as valuable as present consumption at the margin. Even if there are distortions, again these should be the focus of separate government action.

The "new" approach, drawing on recent work on growth and development, recognizes the economic circumstances in developing countries where income disparities are likely to be very wide, markets poorly developed, and consumers poorly informed. It argues that the social valuation implicit in the traditional approach does not have to be followed; instead countries may choose different fundamental objectives. In particular, decision makers may wish to use cost-benefit analysis to place greater weight on investment than implied by the traditional approach, or to incorporate the objective of redressing poverty and economic inequality.

If so, the valuation of costs and benefits will differ, and will be based on shadow (social) prices which reflect a country's preference for savings versus consumption, and/or for benefiting some income groups more than others. In the case of savings, developing countries facing a serious shortage of savings for public or private investment may wish to bias project selection by using a "savings premium" that weights costs and consequences that produce savings more heavily than those that increase consumption. In the case of income distribution, the value of project costs and consequences accruing to different income groups could be adjusted by use of a consumption weight which reflects the value decision-makers place on reducing inequality.

Irvin (1978) summarized the features of the now-accepted approach to cost-benefit analysis in developing countries:

"i) productive efficiency for all traded goods is taken as determined independently of the domestic consumption pattern;

ii) interpersonal utility comparisons are firmly re-established via the principle of social valuation of consumption benefits to different groups;

iii) the present method, by articulating crucial macro-planning variables in micro-level selection criteria, lays claim to playing a central role in the overall planning process."

In theory at least, therefore, the approach to costing adopted when evaluating health programmes in developing countries should differ from that adopted in developed countries.

A further difference can arise from differences in the availability of expenditure information, usually the starting point for cost analysis. In developing countries, information systems vary considerably in their sophistication. Expenditure may not be disaggregated by geographical area let alone by health institution or programme (Kaewsonthi and Harding 1984). Different budgets may fund the same institutions, making it difficult to calculate total expenditure. Communications and accounting difficulties may mean that expenditure records of local institutions are not kept up to date and actual expenditure may not be known until many months after the end of the financial year. Hospital accounts are usually not disaggregated by individual department and it is usually necessary, for instance, to apply estimation procedures to separate inpatient from outpatient expenditure (Heller 1975).

However some problems in the collection of cost data are common to both developed and developing countries, particularly the problem of joint costs. In the health sector, resources frequently serve more than one programme and may need to be divided up in order to distinguish the total cost of a particular programme. Alternative methods of cost allocation include:

- if one of the programmes is clearly pre-eminent, the whole cost of the shared resources could be attributed to that and any contribution the resources may make to another programme ignored;

- if one of the programmes is clearly dominant, but has been modified to permit other programmes to use the shared resources, the additional cost of the modifications could be attributed to the subsidiary programme;

- if the programmes cannot clearly be divided into main and subsidiary, total costs could be divided pro-rata with some measure of workload or throughput;

- the fixed cost element could be left unallocated and variable costs attributed to the programme which gives rise to them. This procedure will not produce an estimate of the total cost of programmes.

Consequences

Figure 2.4 indicates the main elements of consequences. Category 1, changes in physical, social or emotional functioning, is often referred to as health effects. Its specification here in rather broader terms reflects the frequent concern of developed country analysts with the evaluation of treatments for chronic conditions, where little may be done about the underlying condition but treatment may permit patients to lead more or less satisfactory lives. The measure used as an indicator of physical, social or emotional functioning may be specific to the disease in question (eg number of cases of malaria prevented) or broader

Figure 2.4: Types of consequence relevant to the economic evaluation of health programmes

<u>Consequences</u>

I. Changes in physical, social or emotional functioning (effects)

II. Changes in resource use (benefits)

For organizing and operating services within the health care sector
- For the original condition } Direct benefits
- For unrelated conditions }

Relating to activities of patients and their families
- Savings in expenditure or leisure time } Direct benefits
- Savings in lost work time } Indirect benefits

III. Changes in the quality of life of patients and their families (utility)

Source: Drummond and Stoddart (1985)

(eg number of deaths prevented). The broader the measure, the more possible it is to use cost-effectiveness analysis to compare a variety of health programmes, but the greater the danger of distorting the comparison by ignoring other health outcomes or qualitative dimensions of the health outcome chosen. For instance most diseases cause not only mortality but also morbidity, and the severity of morbidity will differ between diseases.

In developed countries, while information on health effects of interventions may be less than would be desired, it is usually possible to piece together a picture, if only from a literature review (Drummond 1987). In developing countries, evidence is much scarcer and epidemiological studies or clinical trials rare. Therefore measures of intermediate output are often used as proxies for health effects (eg "fully immunized children" in place of "cases averted" or "deaths averted").

The misleading nature of a single measure of health effect has led some theorists to propose the use of multiple measures and others the development of a health index. Multiple measures simply list dimensions of quality of life or health. For example the Nottingham Health Profile, used recently to evaluate heart transplants in the UK (Buxton, Acheson, Caine, Gibson and O'Brian 1985), measures quality of life along six dimensions: physical mobility, pain, sleep, energy, social isolation and emotional reactions. In a study of a variety of mixes of interventions aimed at improving maternal health in Narangwal, India, the health indicators used were deaths averted, days of illness averted, extra centimeters of growth at 36 months, and increase in psychomotor scores over the first 3 years of life (Kielmann and associates 1983).

Such multiple measures are difficult to interpret when one intervention performs better on some dimensions and worse on others. A health index, by incorporating multiple measures in one index (Torrance 1976), resolves this problem at the expense of sometimes questionable judgements on how to combine the measures. Chapalain (1978), for example, simply added deaths and cases of handicap avoided by alternative interventions to reduce perinatal mortality, implicitly weighting them equally. A slightly more sophisticated type of health index is that proposed by the Ghana Health Assessment Project Team

(1981). This uses estimates of incidence, case fatality and duration and extent of disability to calculate the number of healthy days of life lost because of a particular disease. While incidence, case fatality and duration of disability can, in principle at least, be measured, the extent of disability is assessed subjectively by equating "total" disability with death, and the absence of disability with health, and then placing different degrees of disability between these points. For instance one day of leprosy is counted as 75% of a healthy day.

This procedure leaves plenty of scope for disagreement. In the application of the healthy days of life lost concept to an evaluation of the Onchocerciasis Control Programme in West Africa, Prost and Prescott (1984) assumed that blindness results in complete disability and thus is equivalent to death, though they note it could be worse than death because the community has to support the consumption of a non-productive blind person. In reworking their figures, Evans and Murray (1987) pointed to evidence that blind people were active both socially and economically and considered that a year of blindness is worth 0.5 of a healthy year.

The Ghana Health Assessment Project Team method values individuals in direct proportion to their expectation of life at their current age. It therefore biases the selection of projects toward those that favour younger age groups since they have the greatest number of healthy days to lose (it is interesting to note that one of the precursor indexes which confined itself to mortality only, took years of life lost between the ages of 1 and 70 to avoid over-estimating the value of an infant death which would often be replaced by another birth - Romeder and McWhinnie 1977). It has recently been argued that the concept of healthy days of life lost should incorporate a different weighting for age preference, and should also incorporate time preference (Barnum 1987). Barnum points out that the timing of health effects over individuals' life-spans has implications for their economic contribution. He therefore weights healthy days of life lost by productivity weights for each age group. He also argues that the concept of time preference, normally applied in economic evaluations to both costs and consequences, should be incorporated in the indicator by applying a discount rate to the time-stream of healthy days of life.

Barnum shows that weighting for productivity and discounting can potentially influence the choice of priorities and programmes.

If a measure of health effect or a health index is weighted by utility weights which reflect the relative value of one health state compared to another (consequence type 3 in Figure 2.4), this turns the analysis into a cost-utility analysis. Cost-utility analysis can be seen as a special case of cost-effectiveness analysis (and was at first treated as such) but is now considered a distinct technique (Torrance 1985). It could be argued that the measure healthy days of life lost incorporates utility weights in its assessment of disability relative to death, but little emphasis was placed on seeking public or individual values. Utility weights may be devised either from the general public (in which case it may be possible to use pre-existing surveys) or may need to be specific to the condition under consideration, in which case a special survey may be required. It can be argued that for planning decisions, the relevant values are those of the general public, though patients' valuation of the changes in quality of life may also be valuable if the general public lacks information on the condition in question and also as an aid in clinical decision-making (Drummond 1987). An extensive review of the determination and measurement of health state utilities is given in Torrance (1985) and a critical examination of the assumptions underlying them in Loomes and McKenzie (1989).

The most commonly used measure in cost-utility analysis is the quality-adjusted life year (Drummond, Stoddart and Torrance 1987). Here the life extension gained is adjusted by utility weights which reflect the relative value of the quality of the life extension. While years of life gained are discounted, it is usually argued that a year of life gained is of equal value regardless of who receives it. The method therefore implicitly biases project selection against age groups who have the fewest years of healthy life to gain (ie the elderly). As with any measure, however, a different weighting for age preference and indeed for other preferences (eg sex, social class, occupation: Charny, Lewis and Farrow 1989) could be incorporated.

The quality-adjusted life year has not so far been employed in economic evaluations of developing country health programmes. One reason may be its greater relevance to chronic diseases than to many acute communicable conditions where individuals, after a relatively brief spell of illness, either die or return to complete health. However there are some communicable diseases that have long-lasting effects (eg schistosomiasis, onchocerciasis) and chronic diseases (eg cardiovascular disease, cancers) are of increasing importance in the health sector of those countries where the incidence of communicable diseases is decreasing. Another reason for the neglect of the quality-adjusted life year in developing country economic evaluation studies is likely to be the unavailability of information on the preferences of the general public for different health states and the difficulties of obtaining it. It would seem to be highly dangerous to transfer the utility weights of, say, a sample of the Canadian public to a developing country setting. A special survey would therefore be necessary, probably in each country, with extensive evaluation to check its sensitivity to racial, socio-economic and cultural differences.

Torrance (1985) has suggested the circumstances when cost-utility analysis is appropriate:

> "when quality of life is <u>the</u> important outcome, when quality of life is <u>an</u> important outcome, when the programme under evaluation affects both morbidity and mortality and you wish to have a common unit of outcome that combines both effects, when the programmes being compared have a wide range of different kinds of outcomes, and when you wish to compare a programme to others that have already been evaluated using CUA. Cost-utility analysis is inappropriate or unnecessary when the effectiveness data for final health outcomes is not available, when the effectiveness data show that the programmes being compared are all equally effective, when quality of life is important but it can be captured by a single variable measured in easily understood natural units, or when it is clear that the extra cost of obtaining and using utility values connot change the results".

The final type of consequence listed in Figure 2.4 is changes in resource use. A health programme (eg immunization) may produce savings for the health sector and for individuals in terms of the savings in resources that would otherwise have been used to treat and care for the sick. This could clearly be a significant consequence of preventive programmes in developed countries where health services are universally accessible. In developing countries its inclusion in an analysis is more controversial because it may bias the analysis in favour of areas already well served with health facilities. To avoid this, the importance of the equity objective may need to be explicitly acknowledged, by giving greater weight to health consequences experienced by more deprived population groups (Mills 1985).

The inclusion of the final category listed under changes in resource use, savings in lost work time, is controversial. There are several arguments here. In a cost-benefit analysis (not the main focus of this review), if the willingness-to-pay approach is used to value health consequences, it may be that individuals would take time savings into account in their valuation; including them also as a separate category could thus involve double counting (Drummond 1981) though Torrance (1985) denies this. Even when health consequences are not being valued, the inclusion of savings in lost work time biases evaluations in favour of individuals or groups that participate in the work-force (Drummond and Stoddart 1985). There is clearly a dilemma: countries may be crucially dependent on the wealth created by those members of the population who work, and individuals may place a high value on their ability to earn their living and support their families, but it may not be considered ethically defensible to give such groups priority in access to health care.

A further problem relates to the measurement of time savings. In a subsistence economy, where many productive activities are undertaken collectively by the household, the effect of the illness of a household member on productive time may be minimized by reallocation of responsibilities within the household. If there is spare time within the household at that period of the year, the actual time lost may be leisure time, or it may be time spent on childcare or housework (Rosenfield, Golladay and Davidson 1984).

The scheme of consequences of Figure 2.4 is demanding in terms of information. It requires information not only on the relationship between the actfvities of the health programme and health consequences but also on treatment patterns prior to the introduction of the health programme and the behaviour of individuals after its introduction. To obtain information on health consequences, randomized controlled trials are frequently recommended in both developed and developing country settings (Tugwell, Bennett, Sackett and Haynes 1985). Alternatives in decreasing order of preference are cohort studies and before and after studies, case-control studies, and descriptive studies. Tugwell et al suggest assessing "community effectiveness" (how well an intervention with potential for reducing illness will work when applied in the community) on the basis of efficacy (assessed by clinical trials), screening and diagnostic accuracy, health provider compliance, patient compliance, and coverage of the target population (dependent on availability and acceptability of effective health services). These would ideally be combined to assess community effectiveness using a multiplicative conditional probabilities model but in the absence of the necessary information, a simple multiplication formula is used, which assumes that all the factors are independent.

This approach is clearly useful for assessing interventions targetted at individuals; its relevance is less clear to, for instance, environmental health measures. However it provides a valuable emphasis on the importance of the behaviour of providers and patients, in addition to clinical efficacy, as determinants of effectiveness. In some sample calculations, Tugwell et al found that patient and provider compliance appeared to be the major limiting constraints to community effectiveness for some interventions.

In the developing country setting, where relevant epidemiological data are often unavailable, analysts have recommended major data collection efforts. Barnum (1987), for example, calls for an international effort to collect consistent and accurate epidemiological information, stating that:

> "the technology of cost-effectiveness analysis and sector evaluation, whether for single or multiple diseases, has outrun the epidemiological basis for analysis".

Rosenfield, Golladay and Davidson (1984) recommend focussing on the household when considering the social and economic consequences of disease. They suggest

> "a number of methods for data collection and analysis ranging from small samples of intensive case studies to subsequent larger-scale representative surveys in a given region..... The survey .... should capture information on mortality, morbidity, acute and chronic disability (over as long a time period as possible), functional disability and compensation in the household due to disease (how roles, time allocation and other resource

expenditures change). .....A particularly important task is to develop methods for assessing the severity or functional effects of morbidity and impairment related to the prevalent tropical diseases. These methods should be capable of being reliably applied in large-scale representative household surveys, both prospective and retrospective types. Multiple indicators of health outputs could be used to evaluate the effectiveness of interventions, methods and activities".

Needless-to-say, the funds necessary for such surveys are usually not available, and previous experience of large scale surveys has not always been happy (Barnum 1987).

In evaluating the effect of a health programme on communicable, especially vector-borne, diseases, a model of the mechanism by which the disease spreads can be valuable. Such models exist, for instance, for schistosomiasis (Rosenfield, Smith and Wolman 1977) and malaria (Molineaux and Gramiccia 1980).

Putting costs and consequences together

As indicated in Figure 2.2, cost analysis, cost-effectiveness analysis and cost-utility analysis may be more or less comprehensive in terms of the types of cost and consequence included. The main options concern whether indirect costs and indirect benefits are added to direct costs and direct benefits, and whether in cost-effectiveness and cost-utility analysis, costs are simply divided by the chosen measure of health effect or utility, or whether those benefits that can be valued (ie direct benefits and possibly indirect benefits) are subtracted from costs.

However the calculations are formulated, certain procedures are recommended (Drummond, Stoddart and Torrance 1987):

Discounting: individuals and society have a positive rate of time preference, therefore both costs and consequences should be discounted. How to determine the discount rate is controversial. In traditional analysis, the market interest rate is used for reference, but this is likely to indicate the discount rate appropriate for inter-generational comparisons only under very unrealistic assumptions (Ray 1984). Developing countries may select a discount rate (the accounting rate of interest) which reflects their preference for investment rather than consumption, and for consumption accruing to low rather than high income groups. Since all economic evaluations in a particular country should use a common discount rate, in practice analysts are advised to first investigate whether an agreed rate exists before estimating their own (Overseas Development Administration 1972).

Incremental analysis: in comparing alternatives, one may be both cheaper and more effective. More often, it will be cheaper but less effective. An incremental analysis is then required (Drummond, Stoddart and Torrance 1987) to compare the incremental costs of the other alternative (costs of option 2 minus option 1) with its incremental effects (effects of option 2 minus option 1). This provides evidence of the cost of seeking greater effectiveness and leads to the question: is it worth it?

Sensitivity analysis: The variables in economic evaluation studies are rarely estimated with absolute certainty or precision. Therefore it is desirable to test the sensitivity of the conclusions to plausible changes in the values of the main variables by re-working crucial elements of the analysis using different assumptions (Drummond, Stoddart and Torrance 1987).

In addition, distributional issues should be explored in quantitative or qualitative terms (Klarman 1982). They often cannot be explicitly incorporated in the analysis (perhaps because they involve transfer payments or because making a judgement on weighting for equity considerations may seem excessively arbitrary). However, most public programmes, whatever their objectives, have distributional consequences (Weisbrod 1977).

While putting costs and consequences together may be a simple arithmetical calculation, various forms of modelling have been suggested. For example, cost considerations can be incorporated into a disease transmission model, to trace the cost and health consequences over time of particular interventions. Other possibilities include linear programming which can be used, for instance, to identify the allocation of resources that would maximise given objectives subject to various resource constraints, and simulation models whch can help to study the effects of alternative policies on target variables (Carrin 1984).

International comparisons

In the developing country literature, there has been a recent trend toward identifying optimal health strategies by putting together the results of economic evaluation studies from a wide range of countries and time periods. To evaluate such attempts later in this review, it is useful here to identify the main influences on costs and consequences which will cause them to vary.

Barlow and Grobar (1985) give a useful summary of why the prices of inputs in relation to the official exchange rate (and hence costs) can vary substantially from one country to another. The factors include:

- differences between countries in the rates of taxation or subsidy;
- differences in the degree of competition in the national market (prices are likely to be higher where there is a greater degree of monopoly);
- differences in market demand (larger demand may mean a higher price);
- differences in supply conditions (labour inputs or inputs which are produced using labour-intensive technology are likely to be relatively cheap in economies with abundant labour relative to capital);
- differences in the ratio between the general price level and the official exchange rate (the degree of currency over-valuation).

In addition, if the studies being compared date from different years, price indices need to be used to convert costs to a common year. This conversion is not straightforward because the price indices commonly available are often not sensitive to the changing price levels of health service inputs.

Finally, there are a number of influences on both costs and consequences that are specific to the particular programme being evaluated (Mills and Drummond 1987, Barnum 1982, Tugwell et al 1985). The effectiveness of a programme depends on factors such as delivering an efficacious drug or vaccine, patient and provider compliance and population coverage. These can vary considerably between different social, cultural and organisational settings, resulting in different levels of effectiveness for the same intervention. The costs of a programme also depend on a number of local factors, including the scale of the programme, population density and whether a new programme can be added to an existing infrastructure and can take advantage of existing under-utilised resources.

Standardised methodology

As indicated in this review of methodology, a reasonably standard approach to cost-effectiveness and cost-utility analysis has now developed, though the literature demonstrates a considerable diversity of practice. Several analysts, concerned with the lack of uniformity, have suggested that economic evaluation methodology be standardised (Russell 1986, Barlow and Grobar 1985). Barlow and Grobar for instance, propose that an international agency engaged in health activities should design a standardised form on the lines of that shown in Table A5.1 and promote its use in disease-control projects.

2.2 Application of cost-effectiveness analysis to disease control programmes in developed countries

This section reviews the application of cost-effectiveness analysis (including cost-utility analysis) to disease control programmes in developed countries. Many studies do not adhere closely to the terminology and methodological approaches reviewed above (for instance Cretin (1977) calls his study "cost/benefit analysis of treatment and prevention of myocardial infarction" but calculates a cost-effectiveness ratio: dollars per added year of life). In particular, studies frequently term themselves "cost-benefit analysis" when only programme costs and the consequences in terms of saved treatment costs are considered. This review includes such studies but excludes those where an attempt is made to place a value on health itself, for instance by using the human capital or willingness-to-pay approach. This section reviews first the topics covered by studies, secondly their methods and finally their findings.

Topics

A starting point for a review of the topics chosen for analysis is provided by Warner and Hutton (1980) who reviewed cost-benefit and cost-effectiveness studies on health care topics (ie personal health care) published between 1966 and 1978. They classified studies by the three broad categories of prevention, diagnosis (including screening) and treatment. When they analysed the balance of studies between these areas and over time, they found the following picture:

% of studies on:	1966-73	1974-78
prevention	44.7	22.0
diagnosis	18.8	30.9
treatment	36.5	47.2
total	100.0	100.0

They comment that the early CBA/CEA literature concentrated relatively more on health programmes with the characteristics of public goods - especially communicable disease control - than individual patient care. They ascribe the increased emphasis on diagnosis (primarily screening) and treatment to the expansion of technology and concerns of cost. Indeed in the treatment category, evaluation of medical procedures predominated, with a recent emphasis on equipment (mainly CT scanners). They noted that although the literature covered a vast array of disease problems, a few accounted for a large share of the literature: cardiovascular disease (especially hypertension), cancers (especially screening), mental illness, drug abuse and alcoholism, renal disease, communicable diseases (mainly prior to 1974) and birth defects (more recently).

A more recent review (Drummond 1985) confirms that the majority of economic evaluations of health programmes undertaken in industrialised countries are of alternatives in therapy. A large proportion of these concern "high technology" medicine in the fields of chronic renal failure, coronary care and neonatal intensive care.

Figure 2.5 sets out a framework for reviewing the topics and choices considered in the disease control field. It classifies broad strategies as prevention (aimed at the individual or at the environment), diagnosis

Figure 5.1: Relationship between district-level expenditure and district population-at-risk

Strategy	Choice of: sector	intervention/ technique	delivery strategy	target group	place of intervention	time of intervention
Prevention - aimed at individual	Motorcycle helmet laws Distribution of fluoride tablets at school	Alternatives for reducing perinatal mortality and morbidity Value of hypertension screening	Alternatives for providing dietary advice to control cholesterol levels in children Strategies for hepatitis B vaccination Improving compliance with hypertension therapy	Choice of target group for hypertension screening and treatment; for hepatitis B, influenza and pneumococcal pneumonia vaccination; for screening for Down's syndrome and cervical cancer	Work-place based fitness programme Work-place based hypertension screening and treatment	Hypertension treatment v. cardio-vascular disease treatment Antepartum treatment of Rh immunisation v later treatment
- aimed at environment	Water fluoridation Research priorities into environmental causes of cancer Lowering aflatoxin tolerance levels					
Diagnosis		Which test for breast cancer	Delivery strategy for screening for neural tube defects; for asymptomatic bacteriuria; for asymptomatic colon cancer	When to screen - eg. for Down's syndrome, neural tube defects	Location of screening for asymptomatic bacteriuria	Frequency of cancer screening tests
Treatment		Alternatives for treatment of end-stage renal failure; of cardio-vascular disease; of duodenal ulcers.			Location of treatment for renal disease, mental illness, epilepsy	

and treatment. The alternatives that studies may evaluate are classified as choice of: sector, intervention or technique, strategy for delivering that intervention or technique, target group, place of intervention and time of intervention. Studies which illustrate this range of strategies and choices have been noted on the figure, in order to indicate the nature of the choices evaluated by studies.

Since the focus of this review is on disease control, it is perhaps not surprising that prevention features large, though most studies are concerned with strategies aimed at individuals rather than the environment. A few are concerned with strategies that are implemented outside the health sector, such as motorcycle helmet laws (Muller 1980) and giving fluoride tablets to children at school (Stephen and Campbell 1978). Many are concerned with the choice of intervention or technique. For instance Chapalain (1978) reviewed the cost-effectiveness of seven programmes for reducing perinatal mortality and morbidity in France (including rubella vaccination, improved antenatal care, better supervision of labour, resuscitation in the labour room and the creation of neonatal resuscitation centres). Stason and Weinstein (1977) examined a number of issues concerning the detection and treatment of hypertension. They defined four questions for analysis (identified in Drummond, Stoddart and Torrance 1987): the desirability of treatment of hypertension as opposed to treating the cardiovascular morbidity that would otherwise arise; the efficiency of treating hypertension as opposed to using the resources in any other way; the choice among programmes aimed at different age, sex and pre-treatment diastolic pressure groups; and the choice between screening programmes to detect hypertension and improved efforts to manage known hypertensives.

Given agreement that a particular disease should be controlled by means of a particular intervention (or only one means may be available), choice of delivery strategy is of relevance. For example Berwick, Cretin and Keeler (1981) compared three approaches to providing dietary advice designed to control chlorestarol levels in children. The approaches were universal screening plus dietary counselling in 10-year-olds, targeted screening with dietary counselling for those 10-year-olds with a family history of early coronary disease, and population-wide intervention through a mass-media campaign or school education. Mulley, Silverstein and Dienstag (1982) examined the cost-effectiveness of three strategies for the use of Hepatitis B vaccine: vaccinating everyone, screening everyone and vaccinating those without evidence of immunity, and neither vaccinating nor screening but passively immunizing those with known exposure.

Compliance is a problem with many screening programmes, either with the screening programme itself or with subsequent treatment. It has been a particular concern of hypertension treatment programmes because of the side-effects of treatment. Using a delivery strategy that improves compliance has been evaluated by Mitchell, Drummond, Haynes, Johnston and Gibson (1983).

Because of the cost of extending new technologies to everyone, the choice of target group has been of interest, either as a central concern or as a side issue, as in the studies cited above of hypertension treatment and screening, control of chlorestarol levels and the use of Hepatitis B vaccine. Similar choices of target group selection (those at high risk versus widening the population covered) are evident in other studies of vaccination policy, for example for influenza (Helliwell and Drummond 1987) and pneumococcal pneumonia (Willems, Sanders, Riddiough and Bell 1980) and in studies of screening policy (Drummond and Mills 1987).

The place of intervention has been increasingly of concern since certain locations such as school and work offer captive populations and thus potentially high coverage at low cost. For example Shephard (1985) evaluated a fitness programme for company employees and Logan, Milne Achber, Campbell and Haynes (1981) compared the cost-effectiveness of screening and treatment of hypertension using nurses at the worksite or regular community-based care by physicians.

Finally, time of intervention is often a central issue in disease control programmes since primary prevention (eg immunisation) or secondary prevention (eg screening) can be compared to the alternative of later treatment. Timing has therefore entered into many of the studies mentioned already. Other studies include Torrance and Zipursky (1984) who considered the cost-effectiveness of antepartum prevention of Rh immunisation (an alternative to postpartum or post-abortion treatment).

Very few published studies of preventive strategies aimed at modifying the environment were located. The greatest number concern the issue of water fluoridation, comparing dental care costs with and without fluoridation (for example Fidler 1977). Pollution control has also been an issue (Lave and Seskin 1978). Despite widespread public concern about cancer-inducing toxic substances and occupational hazards, there is relatively little analysis of the cost-effectiveness of control measures (Warner 1979). One interesting study (Weinstein 1983) assesses research priorities to identify preventable causes of cancer, proposing a quantitative approach to priority setting based on decision analysis and cost-effectiveness analysis, and illustrating the approach by comparing the value of research into dietary beta-carotene (thought to reduce the risk of cancer) with carcinogen bioassays of high-volume industrial chemicals such as *p*-dichlorobenzene. Another diet-related study is that by Dichter and Weinstein (1984) on the cost-effectiveness of lowering the aflatoxin tolerance level.

Much of the literature in this field is unpublished (in official documents) or semi-published. A very useful article (Graham and Vaupel 1981) summarises the results of 57 lifesaving programmes falling under five US agencies concerned with the environment (eg traffic safety, environmental protection). Very few were the responsibility of the Department of Health and Human Services. Most analysed measures to improve transport safety and reduce pollution.

The strategy of diagnosis is most clearly relevant to disease control when used in screening programmes. Drummond and Mills (1987) provide a useful review of issues that arise in screening programmes, covering many of the choices in Figure 2.5. For example, studies have evaluated which test or combination of tests is most cost-effective (Simpson, Chamberlain and Gravelle 1978 and Mooney 1982 in the case of breast-cancer screening).

Delivery strategy is an important consideration in encouraging take-up of a screening programme. For example Hagard, Carter and Milne (1976) proposed adding a publicity campaign to a screening programme for antenatal detection of neural tube defects. Perhaps the most famous example of delivery strategy issues comes from an evaluation of screening for asymptomatic cancer of the colon (Newhauser and Lewicki 1975). Six sequential tests for each patient were advised to minimise the cases missed, and while the average cost per case detected over the six tests was $2500, the incremental cost per case of the sixth test was $47m. Both delivery strategy and place were evaluated in a study of alternative methods of screening school children for asymptomatic bacteriuria (Rich, Glass and Selkon 1976). One method involved supervised collection at schools of urine samples and the other the self-administered home use of dipslides.

As discussed above in relation to prevention, one of the most crucial issues in screening is whom to screen, for instance for Down's Syndrome and neural tube defects. Drummond and Mills (1987) review this issue. Time of intervention is relevant in terms of when and how frequently to screen. Eddy (1980) considered how frequently to carry out a variety of cancer screening tests.

Few studies considering the strategy of treatment are highly relevant to disease control, except in the sense that in the case of chronic diseases, treatment can slow down or prevent progression to more serious states of ill-health. Innumerable studies of treatment for end-stage renal failure have been done, evaluating hospital dialysis, home dialysis and transplantation (for example Ludbrook 1981, Stange and Summer 1978). Choices in treatment for coronary care, especially surgical interventions, have had similar attention (Weinstein, Pliskin and Stason 1977). Culyer and Maynard (1981) evaluated the choice of drug therapy or surgery for duodenal ulcer treatment.

Place of care is a frequently evaluated choice because of the cost of institutional care. Applications include hospital or home renal dialysis (referred to above), community-oriented or hospital-based treatment for mental illness (Weisbrod, Test and Stein 1980, Mangen, Paykel, Griffith, Burchell and Mancini 1983) and the location of epilepsy clinics (Kriedel 1980).

From this review of the subjects of economic evaluation studies relevant to disease control in developed countries, four conclusions can be drawn. Firstly, most attention has been paid to preventive strategies aimed at individuals and delivered via health care facilities.

Secondly, immunisation and screening have been the prime approaches to disease control evaluated, with little attention paid, for instance, to health education, dietary change or manipulation or modification of the environment. Thirdly, choice of the appropriate target group, place of intervention and time of intervention have been seen to be of major importance. Finally, those diseases of greatest interest have been non-communicable, chronic conditions such as renal failure, coronary disease, mental illness, neo-natal conditions and birth defects, which are often expensive to treat and/or prevent. Communicable diseases rarely feature in recent literature with a few exceptions such as hepatitis B, influenza, syphilis and (very recently) Aids.

Methods

Methodological issues arising from the developed country literature are reviewed here under the headings type of study, cost assessment, assessment of consequences, and comparison of costs and consequences.

Type of study: Warner and Hutton (1980) note an increasing tendency towards cost-effectiveness analysis. Between 1966 and 1973, cost-effectiveness studies made up 42.1% of total cost-benefit and cost-effectiveness studies published, but in 1974 to 1978, 53.2%. More recently, cost-utility analysis has increasingly been adopted. As notable, however, has been the number of so-called cost-benefit studies which compare the costs of a programme with its consequences in terms of reduced need for treatment. This is particularly evident in the disease control literature, no doubt because the treatment costs averted by a preventive programme are considered an important consequence when health budgets are under strain and new expenditure needs to be strongly justified.

Related to this point is the limited focus of many studies. While it is generally accepted that a true economic evaluation should take a societal perspective (Drummond and Mills 1987), many studies restrict themselves to costs and consequences that fall on the health sector's budget.

Cost assessment: where resources used in health programmes carry a price, the market price has been used unadjusted. Inputs of patient, family or volunteer time often have an opportunity cost, but this is rarely priced. One exception is the study by Logan et al (1981) where wages were used to value lost leisure-time (some of the treatment took place after work). Drummond, Stoddart and Torrance (1987) question this valuation on the grounds that leisure time in the early evening may actually be valued more highly than work-time.

Placing a value on resources used jointly is a continual problem, especially since hospital accounting systems are rarely helpful in identifying the resources used in a particular activity. Culyer and Maynard (1981) cope with this problem by using a variety of methods to calculate the cost of surgery for duodenal ulcer.

Assessment of consequences: perhaps the most important methodological issue in the assessment of consequences is the availability and reliability of medical evidence. Developed countries are relatively well supplied with published data on clinical aspects of health care interventions but this often does not provide the necessary information for an economic evaluation. Culyer and Maynard (1981) point out, for example, that few clinical trials include broad assessments of the patient's (or his family's) functioning. Evaluations of public health measures particularly suffer from lack of good evidence on effectiveness since prospective controlled studies are hard to design and manage (Drummond 1985).

Studies use a variety of measures of health effect, usually specific to the health intervention being evaluated (eg reduction in diastolic blood pressure for a hypertension treatment programme; number of cases of breast cancer detected for a breast cancer screening programme). Increasingly, however, they are using quality-adjusted life-years (sometimes in addition to more programme-specific measures) to permit comparison to be made with other, perhaps very different, health programmes. Sometimes the utility weights are obtained in an apparently arbitrary manner (for instance Stason and Weinstein (1977) concluded one year on hypertension treatment was equivalent to 0.99 quality adjusted life years). Other studies have used published results of surveys of health state utilities (for instance Willems et al (1980) used the results of Bush, Chen and Patrick (1973)). Yet others have done their own assessments of health state utilities: Boyle, Torrance, Sinclair and

Horwood (1983) used the preferences of a local random sample of parents with school-aged children to value the life years gained by a neonatal intensive care programme.

One issue that has arisen in the assessment of consequences concerns the boundaries of the analysis. If a programme permits people to live longer and to die of another disease, should the cost of treating that disease be included in programme costs? Stason and Weinstein (1977) included the cost of treating noncardiovascular disease in future years in the cost of the hypertension programme they evaluated. Willems et al (1980) allowed for a similar effect in their evaluation of vaccination against pneumococcal pneumonia. Drummond, Stoddart and Torrance (1987) argue that such consequences can be safely ignored if they are not closely linked to the programme being evaluated and will occur some distance into the future. They point out that a decision has always to be made on the boundaries of an economic evaluation.

As mentioned above many studies place particular emphasis on the consequence of health service costs averted. This leads to the problem of assessing the value, in their alternative use, of the resources saved. For example, fluoridation might lead to lower dental caries, but how would dentists use the time they would otherwise have spent treating dental caries and what would be the benefits of the extra services they performed?

Comparison of costs and consequences: cost-effectiveness studies, instead of simply dividing programme costs by health effects (or quality adjusted life years in the case of cost-utility analysis) are increasingly netting out savings in treatment costs and the value of indirect benefits (savings in work time) from programme costs. Discounting is generally employed, using discount rates ranging up to 10% but commonly 5% or 7%. In some studies, the conclusions are shown to be sensitive to the choice of discount rate. Distributional issues are present in most studies, but rarely drawn out clearly. An exception is the study by Rich et al (1976) where the cheaper test was found to be less effective than its alternative for lower social class children.

Findings

It is difficult to summarise the findings from a wide range of often very disparate studies. This section therefore summarises some of the evidence on immunisation and screening and draws on published reviews of findings for screening and for a variety of programmes which have been evaluated using cost-utility analysis.

Evaluations of the traditional childhood vaccines generally find that they are efficient uses of resources. For example, studies of measles vaccination in the US argue it has saved far more than it has cost (Warner 1979). As, however, the incidence of communicable diseases declines, vaccination can become more questionable. Stillwell (1976), for example, argued that BCG vaccination in schools would eventually become uneconomic when compared to the cost of treatment.

In the case of newer vaccines which tend to be more expensive, evaluations often find that their use is clearly justified only in high risk groups. This was so in the case of influenza vaccine (Helliwell and Drummond 1987), Hepatitis B vaccine (Mulley et al 1982) and vaccination against pneumococcal pneumonia (Willems et al 1980).

The results of a review of screening programmes in the Developed Commonwealth (Drummond and Mills 1987) indicated that for some screening programmes (for instance screening for PKU, cervical cancer and syphilis), savings in health service costs alone were sufficient to offset the programme cost. For a few others (mass miniature radiography and screening for congenital toxoplasmosis) programme costs considerably exceeded health service savings. For yet others, especially screening for Down's syndrome, the balance of benefits and cost depended on the selection of the target group. In general, while targeting may be worthwhile, it can also be costly to identify and reach high risk groups.

As Mulley et al (1982) point out, new health programmes are rare that actually save resources, though it is notable that of the 57 options for environmental protection measures reviewed by Graham and Vaupel (1981), 13 involved no net additional costs per life or life-year saved, of which only one fell within the health sector (genetic screening), the others involving transport safety measures, fire prevention or pollution reduction. However, creation of savings or zero net costs should not be the only criterion for programme choice from society's point of view because it ignores the value that society would place on the value of health improvement per se. Table 2.1 presents the results of a North American review of cost-utility studies, which ranks them in terms of net health care costs per QALY gained, and Table 2.2 presents a similar, British summary. Such results enable policy makers to ask how much it is worth spending and to assess programme expansion in the light of these results. For example some well established programmes (for instance dialysis) are relatively expensive per quality-adjusted life year gained when compared to newer programmes which have yet to gain widespread acceptance as a routine health service activity. It had been argued that the antepartum anti-D programme was too expensive, but the evaluation showed it gave relatively good value for money compared with other programmes.

It remains to ask, however, what has been the influence of economic evaluation studies on policy makers. Recently analysts have became increasingly concerned about the weakness of the link between study results and their implementation (Drummond and Hutton 1986, Ludbrook and Mooney 1984). Problems include the lack of interest of analysts in policy change, lack of awareness and interest of policy-makers in study results, the political framework of policy-making, the potential threat to professional expertise and the practical and methodological problems of the evaluations (Drummond and Mills 1987).

2.3 Application of cost-effectiveness analysis to disease control programmes in developing countries

This section reviews the application of cost-effectiveness analysis to disease control programmes in developing countries. As with the developed country literature, it can be difficult to draw the boundaries of the review in terms of the definition of both disease control and cost-effectiveness analysis. Studies have been classified as disease control if their prime focus is on reducing the incidence, prevalence or mortality of one or more diseases rather than on the delivery system. They have also been included if they look both at programme (control) costs and health effects. Studies that look only at programme costs or

Table 2.1: Comparative cost-utility results for selected health care programmes

Programme	Reported cost/QALY(a) gained in US $ (year)	Adjusted(b) cost/QALY(c) gained in US $ 1983
Hospital haemodialysis	40,200 (1980)	54,000
Continuous ambulatory peritoneal dialysis	35,100 (1980)	47,100
School tuberculin testing programme	13,000 (1968)	43,700
Coronary artery bypass surgery for single vessel disease with moderately severe angina	30,000 (1981)	36,300
Neonatal intensive care, 500-999gm	19,600 (1978)	31,800
Estrogen therapy for post-menopausal symptoms in women without a prior hysterectomy	18,160 (1979)	27,000
Treatment of mild hypertension (diastolic 95-104 mm Hg) in males age 40	9,880 (1976)	19,100
Treatment of severe hypertension (diastolic > 105 mm Hg) in males age 40	4,850 (1976)	9,400
T4 (thyroid) screening	3,600 (1977)	6,300
Neonatal intensive care, 1000-1499 gm	2,800 (1978)	4,500
Coronary artery bypass surgery for left main coronary artery disease	3,500 (1981)	4,200
Antepartum anti-D	1,220 (1983)	1,220
Postpartum anti-D	<0 (1977)	<0
PKU screening	<0 (1970)	<0

(a) These studies use similar, but not identical, methods. Generally, costs are not health care costs; however, discount rates and preference weights are not completely consistent. Difference in methods should be considered when comparing the relative cost-utility.
(b) QALY denotes quality-adjusted life-year.
(c) Adjusted to 1983 dollars according to the US Consumer Price Index for Medical Care for all urban consumers. Source: US Bureau of Labor Statistics, Monthly Labor Review.
Source: Torrance and Zipursky (1984)

Table 2.2: Approximate NHS cost per QALY gained for some selected activities

Activity	Cost per quality adjusted life year gained (£ 1985)
Hospital haemodialysis	15,000
Heart transplantation	8,000
Coronary artery bypass for double vessel disease and moderate angina	4,000
Kidney transplantation	3,000
Coronary artery bypass for left main vessel disease and severe angina	1,000
Total hip replacement	800
Pacemaker for heart block	700
GPs counselling patients to stop smoking	< 200

Source: Williams (personal communication) at disease consequences (ie "cost of disease" studies) are therefore excluded, as are cost-benefit analyses. In the developing country context, unlike the developed country literature, cost-benefit analyses have been concerned primarily with benefits in the form of productivity gains rather than averted health service costs. Studies on malaria are excluded here, since they are the subject of the following section.

Topics

Most developing country economic evaluations are directed at disease control rather than diagnosis and treatment (unless these are part of a curative strategy for disease control). This bias reflects both the origin of the studies (most are done by developed country economists and are commissioned by international agencies) and the more purposeful direction of national health policy in developing countries. It is also, of course, a reflection of the disease burden in developing countries and the availability of the technology (if not the resources or management skills) to reduce the burden.

There has been over time a change in the attention paid to different diseases. Early studies were primarily on malaria, with other parasitic diseases, mainly schistosomiasis, later receiving attention. Most recently, immunisable diseases, and to a slightly lesser degree diarrhoeal diseases, have received the greatest attention from analysts (or perhaps more accurately from their commissioning agencies).

Figure 2.6 presents a similar framework for reviewing the subjects of studies to that employed in Figure 2.5 for developed countries. An extra set of boxes has been added, to allow for studies that compare the alternatives of prevention and treatment for controlling a particular disease (while some developed country studies compare prevention with treatment, the latter aims merely to treat cases that come to the health service rather than to use treatment as a strategy for disease control).

It is convenient to review the choices that the developing country literature considers by broad disease category. The review therefore commences with parasitic diseases and then considers in turn immunisable diseases, other communicable diseases, non communicable diseases and studies not specific to any single disease category.

Figure 2.6: Framework for reviewing cost-effectiveness studies of disease control programmes in developing countries

	Choice of:					
Strategy	sector	intervention/ technique	delivery strategy	target group	place of intervention	time of intervention
Prevention - aimed at individual		Comparison of vaccines; value of additional vaccines Comparison of vaccination with other health programmes Comparison of control methods for diarrhoeal disease; TB Ways of reducing vit. A deficiency	Mass campaign v. fixed routine immunisation strategies; size of clinics	Target group for immunisation; for chemotherapy for schisto control	Fixed v. mobile immunisation clinics; rural v. urban locations Hospital v. clinic treatment of diarrhoea	Immunisation v. treatment for immunisable diseases
- aimed at environment	Water supply and irrigation design for schistosomiasis control Vitamin A fortification of MSG	Molluscides for schistosomiasis control Imagicides v. larvicides for filariasis control				
Diagnosis		Choice of test for hepatitis B and hypo-thyroidism				
Treatment	Use of mass media for ORT messages Commercial sales of ORT	Comparison of drugs for schisto. and other parasitic disease control Comparison of TB drugs	Alternative ways of teaching ORT	Targeting treatment for schisto. and filariasis	Home v. clinic teaching of ORT Inpatient v. out-patient TB therapy	
Prevention versus treatment		Alternatives for schisto. and and filariasis control Alternatives for reducing infant and child mortality; child or general morbidity and mortality		Choice of age-groups for TB control		

The literature on parasitic diseases has been comprehensively reviewed by Barlow and Grobar (1985). The greatest number of studies relate to schistosomiasis control. Many of these examine only one option (for instance mollusciding or chemotherapy) and thus can draw no firm policy conclusions on their own other than to ask: is the cost worthwhile? The more sophisticated studies evaluate a mix of control measures. For instance Jordan (1977) compared the costs and effects (in terms of case-years prevented) in three areas, one receiving molluscicides, another water supplies and the third chemotherapy. A more elaborate study, by Rosenfield, Smith and Wolman (1977) in Iran, developed a transmission model to predict the impact of control on schistosomiasis and used it to compare the costs and effects of four alternative approaches: molluscicides, chemotherapy, physical destruction of snail habitats and a combination of measures. Bekele (1980) also used a transmission model and exploited it to consider in much greater detail the costs and effects of combinations of control measures (chemotherapy, mollusciding, water supplies).

The technology of schistosomiasis control has been transformed in recent years by the development of new drugs that are safe to use for mass chemotherapy. Since available drugs bear different prices and involve different treatment regimes, they are an obvious subject for economic evaluation. Several studies have looked at choice of drugs, for example Korte, Schmidt-Ehry, Kielmann and Brinkman (1986) and Saladin, Saladin, Holzer, Dennis, Hanson and Degremont (1983). Prescott (forthcoming) investigates the further issue of whether drugs should be given to everyone, to high risk groups only, or to those identified by screening to be infected.

In the case of schistosomiasis, therefore, control choices have involved both measures directed at the environment (mollusciding, water supplies, irrigation engineering) and at individuals (mass treatment). Choices have involved not only sector (the health sector versus other sectors in the case of water supplies and irrigation engineering) but also control technique and target group (mass or selective chemotherapy).

Choice of drug for mass chemotherapy has also been evaluated for ankylostomiasis and ascariasis (Sinniah and Sinniah 1981 and Sturchler, Stahel, Saladin and Saladin 1980) and for trichuriasis (Sinniah and Sinniah 1981). The cost of mass chemotherapy has been considered for Bancroftian filariasis but with no comparison (except the implicit "do nothing").

Two final examples of cost-effectiveness analysis of parasitic disease control are worth mentioning. Rao, Chandrasekharan, Kaul, Narasimhan and Sharma (1980) applied a number of control measures for Brugian filariasis in different areas, including imagicides, imagicides plus selective or mass treatment, mass or selective treatment only, and larvicides. They evaluated their cost and impact on prevalence rates. Prost and Prescott (1984) evaluated the cost-effectiveness of the Onchocerciasis Control Programme in West Africa, which employs larvicides and imagicides. In order to be able to evaluate whether onchocerciasis control was worthwhile, they compared it with cost-effectiveness ratios from two measles immunisation programmes.

Unlike parasitic diseases, which have more often been the subject of cost-benefit than cost-effectiveness analysis, most analysts of immunisable diseases employ cost-effectiveness analysis. Immunisation lends itself more than do other health programmes to assessing effectiveness since the link between inputs (immunisation) and effects (prevention of disease) is reasonably well understood. In addition, the idea of comparing alternatives, if only the costs of fully immunising a child at different health centres, has been well established by the publications of the Expanded Programme on Immunisation (EPI) of WHO.

Immunisation cost-effectiveness studies can be divided into those that use a measure of intermediate output (usually fully immunised child) and those that use a measure of health effect (usually case or death averted). The former group of studies usually concentrate on the internal efficiency of immunisation programmes. One important issue has been the relative merits of fixed and mobile immunisation strategies. For example Creese (1984) looked at the relative cost-effectiveness of fixed, outreach and mobile immunisation clinics in Brazil, and Creese and Dominguez-Uga (1987) at the cost-effectiveness of the routine vaccination services and national campaign in Colombia. Another issue has been the appropriate size of fixed clinics: a number of EPI - commissioned studies have looked at how costs per fully-immunised child vary by health centre (Creese, Sriyabbaya, Casabal and Wiseso 1982, Robertson, Davis and Jobe 1984). Choice of target group has also been considered (should a new immunisation programme immunise only newborns or also the backlog of older children: Barnum 1980).

Choice of place of intervention is implicit in the debate over whether the delivery strategy should be fixed or mobile. It also emerges as an issue in a cost-benefit analysis of measles immunization in Zambia (Ponnighaus 1980) which is of interest here because one of the questions investigated was whether measles immunization should be confined to areas with a 24 hour electricity supply (because maintaining the cold chain was difficult and costly in the absence of electricity).

Those immunization studies that use a measure of health effect in the cost-effectiveness ratio usually seek to tackle the question: is the EPI programme (or vaccination against one or more diseases) worthwhile compared to other uses of the resources? Robertson, Foster, Hull and Williams (1985) calculated the cost per case and death prevented by the various vaccines in the Gambian EPI programme. They compared these with each other, with similar results from other countries and with other health interventions. Barnum, Tarantola and Setiady (1980) similarly calculated cost per case and death prevented for each of the vaccines used in Indonesia but compared them with treatment costs, thus considering choice of time of intervention. Shepard, Sanoh and Coffi (1986) analysed measles vaccination only in the Ivory Coast and like Robertson et al (1985) compared their results to those from other countries in order to consider the value of the programme.

Other communicable diseases that have been studied include diarrhoeal diseases, tuberculosis and hepatitis B. Of these, diarrhoeal diseases have been the most analysed. Choices considered have been of intervention, of place of intervention and of sector. Phillips, Feachem and Mills (1987) reviewed the potential cost-effectiveness of six strategies for controlling diarrhoeal diseases - vaccination against rotavirus diarrhoea, measles and cholera, breast-feeding promotion, improved weaning practices and improved personal hygiene - as an input to international policies on diarrhoeal disease control strategies. Horton and Claquin (1983) compared the cost-effectiveness of the provision of treatment for diarrhoea at a large "Western-style" treatment centre and a smaller treatment centre staffed by paramedics. Lerman, Shepard and Cash (1985) analysed total expenditure on diarrhoea treatment for under fives (by health centre, hospital and families) noting the extensive use of ineffective or marginally effective medications. Finally, a number of studies of the cost-effectiveness of oral rehydration therapy (ORT) have been done (reviewed in Shepard, Brenzel and Nemeth 1986). The approaches to delivering ORT studied included health education via the mass media, care in health facilities and by outreach workers, home visits and making ORT available through commercial outlets. Unfortunately, most of the approaches have data from only one site, making it difficult to compare approaches.

Two studies on tuberculosis are of particular interest. Feldstein, Piot and Sundaresan (1973) developed a resource allocation model to study the optimum allocation of resources among various tuberculosis control approaches, including treatment, vaccination and chemoprophylaxis, in the Republic of Korea. Barnum (1986) considered both choice of drug and place of treatment in a comparison of the cost-effectiveness of a short-course tuberculosis treatment regimen using rifampicin or ethambutol with long course regimens based on thiacetazone and isoniazid, and involving different combinations of inpatient and outpatient care.

The final communicable disease considered here is Hepatitis B. McNeil, Dudley, Hoop, Metz, Thompson and Adelstein (1981) developed a quantitative model to assess the value of screening for hepatitis B surface antigen as a means of reducing serum hepatitis amongst recipients of blood transfusions. The choice of either second-generation (counterimmunoelectrophoresis) or third-generation (radioimmunoassay) tests was considered and the model was applied to Indian data.

Few strategies for the control of non-communicable disease have been analysed. One study, similar to that on hepatitis B, reviewed the cost-effectiveness of several tests for screening for hypo- and hyperthyroidism in India, suggesting that the results should be compared with the cost-effectiveness of iodine supplementation in order to determine optimal policies towards subclinical thyroid disease (Thompson, McNeil, Ganatra, Larson and Adelstein 1981). Another disease resulting from a nutritional deficiency, xeropthalmia, was the subject of a cost-benefit analysis in the Philippines (Popkin, Solon, Fernandez and Latham 1980), though a subsequent correspondent in the journal pointed out that a cost-effectiveness framework would have been more appropriate and re-calculated the figures (Fowler 1982). Three different strategies designed to eliminate vitamin A deficiency were analysed involving choices of sector and intervention: mass distribution of vitamin A capsules, vitamin A fortification of monosodium glutamate and a primary health scheme.

Studies not specific to the disease groupings considered above form a disparate set of analyses, their main common feature being their focus on infant and child diseases. Almroth, Greiner and Latham (1979) compared the cost of breastfeeding a child with artificial feeding, commenting on the likely health consequences of each. Barnum (1980) examined the choice of intervention (immunisation, ORT, low technology water supplies) to combat communicable childhood diseases in Kenya. In a more elaborate study in Colombia, a non-linear resource allocation model was developed to provide a framework for deciding how to allocate resources amongst programmes aimed at reducing infant and child mortality (Barnum, Barlow, Fajardo and Pradilla 1980). The programmes included health promotion, latrines, well-baby clinics, antenatal iron supplements, inpatient care and institutional deliveries. Grosse (1980) presented a cost-effectiveness model which estimated deaths and days of incapacity for a number of interventions including health centres, village health workers, nutritional programme, immunisation, sanitation, malaria control and combinations of these, applied within a variety of budget constraints.

Finally, a major epidemiological study in Narangwal, India, which also had an economic component, investigated amongst other questions whether a programme which combined nutrition and infection control was more cost-effective (in terms of a variety of health indicators) than nutrition and infection control programmes conducted separately (Kielmann and associates 1983). The services were targeted on mothers and children.

What conclusions can be drawn from this review of the subjects of developing country economic evaluation studies? Firstly, the majority are concerned with evaluating new policies and strategies either in the abstract (prior to their introduction) or as pilot projects. Several consequences follow from this, including lack of consideration of alternative strategies, lack of investigation of the routine operations of the health sector and lack of accurate cost and effectiveness data (a problem considered further below). Secondly, because many of the studies were commissioned by international agencies, they address the concerns of those agencies and thus tend to follow international health policy fashions rather than national needs. This is exemplified by the recent emphasis on evaluating diarrhoeal disease control and measures to increase child survival. Thirdly, the range of diseases which have been the subject of a reasonable number of cost-effectiveness analyses is extremely limited, being confined to schistosomiasis, immunisable diseases and possibly diarrhoeal diseases. Even with these diseases, conclusions on the cost-effectiveness of the programme in question relative to other programmes can only be made on the basis of cross-country comparisons: in no country have a sufficient number of different studies been done to assist choices between different diseases or health programmes. Choices within programmes have been rigorously analysed by relatively few studies which are scattered in terms of both disease/programme and country. The only country where a number of studies have been done on one disease is St Lucia (population 140,000) and schistomiasis.

Methods

Type of study: cost-effectiveness studies have appeared only in the last 10 years, and have been the preferred analytical technique only for the last few years. No study has adopted the Drummond and Stoddart framework, netting out either or both direct and indirect benefits against programme costs. Two recent studies mention the possibility of so doing (Shepard, Sanoh and Coffi 1986, and Shepard, Brenzel and Nemeth 1986). Difficulties include those of projecting the likely use of curative facilities in the absence of the preventive programme (in countries where health services are not universally accessible) and the need to retain consistency of practice with other studies when policy conclusions are drawn on the basis of comparison of results from a number of studies.

The study by Barnum, Tarantola and Setiady (1980) of immunisation in

Indonesia does juxtapose the cost per death and per case prevented with the cost of treating one case. However the calculation assumes all cases would receive treatment: an implausible assumption, not reflecting the likely actual impact of the immunisation programme on health sector expenditure. Other studies which consider treatment costs averted do so as part of a cost-benefit analysis, where health effects are not retained in physical units but converted to a monetary value through the human capital approach.

Although cost-effectiveness analysis is a technique for the comparison of alternatives, remarkably few studies do so, often because a cost analysis is attached to an epidemiological trial of the efficacy of a drug, insecticide or molluscicide, or because only one strategy was employed in the programme under study and analysts felt unable to project the costs and consequences of alternative strategies. There is therefore an implicit comparison with doing nothing or an explicit comparison with results from other studies in other countries. Rarely is there a discussion of the problems of international comparisons (Barlow and Grobar (1985) is an exception) except occasionally to note the problems of using exchange rates to convert overvalued currencies.

As in the case of the developed country literature, few studies take a social perspective, most considering only those costs and savings that fall on the government. For instance the Narangwal study (Kielman and associates 1983) notes that the project appears to have caused a reduction in household expenditure on private practitioners but does not include this as a resource-saving consequence. Nor does it, in common with many other studies, draw out any distributional implications from this effect.

Cost assessment: programme costs calculated in studies are frequently incomplete. A review by the Population, Health and Nutrition Department of the World Bank (World Bank 1983) summarises the principal problems as omissions and under-estimation, mishandling of capital/recurrent costs, absence of shadow pricing, inadequate treatment of joint cost allocation and lack of cost models. Inputs not paid for are frequently not costed, although they are likely to have an opportunity cost (eg airtime on the government-owned radio station in The Gambia, not costed in Shepard, Brenzel and Nemeth 1986). Some studies of the effectiveness of drugs or chemicals calculate only a drug or material cost, excluding the delivery cost.

Certain costing problems frequently arise. One is whether or not to allow for the full cost of expatriates in programme costs. If fully costed, they can take up a sizeable share of total costs and some studies calculate instead or in addition the local cost if technical assistance were to be withdrawn.

Another is the problem of joint costs. This frequently arises in the analysis of immunisation programmes and different approaches have been adopted. Robertson et al (1985), for example, allocated EPI costs (excluding vaccines which were directly allocated) to the various diseases in proportion to actual vaccination contacts. This provides no idea of the cost implications of adding or subtracting a vaccine from the programme. In contrast, Barnum et al (1980), in evaluating the expansion of a programme of smallpox and BCG immunisation to include DPT, calculated the costs of operating the BCG and DPT programmes separately and also calculated the cost of adding DPT to an existing BCG programme and vice versa. Similarly, Phillips et al (1987), in considering the costs of introducing new rotavirus diarrhoea and cholera vaccinations, undertook an incremental analysis. It was assumed the vaccines would be added to existing immunisation programmes and the calculation allowed for the nature of the new vaccine (injectable or oral), whether it must be delivered on its own or in a dose with other vaccines, and whether or not it would be administered at an age when children attended for other vaccinations.

An alternative approach was adopted by Shepard, Sanoh and Coffi (1986) in focusing on measles alone of the EPI diseases, on the grounds that it was the leading cause of reported morbidity. For this reason and others (for instance the more stringent cold chain requirements of measles vaccine and the greater difficulty of recruitment of children at the age the vaccine is given), 75% of EPI costs were allocated to measles. This contrasts with the Robertson et al (1985) approach which would have produced a figure of 17%.

No cost-effectiveness study located employed the full Squire and Van der Tak methodology for shadow pricing (one cost-benefit analysis has done chemicals calculate only a drug or material cost, excluding the delivery cost.

Certain costing problems frequently arise. One is whether or not to allow for the full cost of expatriates in programme costs. If fully costed, they can take up a sizeable share of total costs and some studies calculate instead or in addition the local cost if technical assistance were to be withdrawn.

Another is the problem of joint costs. This frequently arises in the analysis of immunisation programmes and different approaches have been adopted. Robertson et al (1985), for example, allocated EPI costs (excluding vaccines which were directly allocated) to the various diseases in proportion to actual vaccination contacts. This provides no idea of the cost implications of adding or subtracting a vaccine from the programme. In contrast, Barnum et al (1980), in evaluating the expansion of a programme of smallpox and BCG immunisation to include DPT, calculated the costs of operating the BCG and DPT programmes separately and also calculated the cost of adding DPT to an existing BCG programme and vice versa. Similarly, Phillips et al (1987), in considering the costs of introducing new rotavirus diarrhoea and cholera vaccinations, undertook an incremental analysis. It was assumed the vaccines would be added to existing immunisation programmes and the calculation allowed for the nature of the new vaccine (injectable or oral), whether it must be delivered on its own or in a dose with other vaccines, and whether or not it would be administered at an age when children attended for other vaccinations.

An alternative approach was adopted by Shepard, Sanoh and Coffi (1986) in focusing on measles alone of the EPI diseases, on the grounds that it was the leading cause of reported morbidity. For this reason and others (for instance the more stringent cold chain requirements of measles vaccine and the greater difficulty of recruitment of children at the age the vaccine is given), 75% of EPI costs were allocated to measles. This contrasts with the Robertson et al (1985) approach which would have produced a figure of 17%.

No cost-effectiveness study located employed the full Squire and Van der Tak methodology for shadow pricing (one cost-benefit analysis has done so (Knudsen 1981) and a case-study of domestic water supply (Porter and Walsh 1978) was employed to demonstrate the application of the ODA-recommended methodology to cost-effectiveness analysis, though without using any indicators of health effects). Indeed virtually all studies employ market prices and actual foreign exchange rates. A very few mention the possibility of a shadow wage and foreign exchange rate and Horton and Claquin (1983) used a shadow exchange rate but not a shadow wage rate. No study discusses or uses world prices and conversion factors. In this sense, practice in the health sector can be seen to be considerably out of step with economic evaluation practices in other sectors.

Assessment of consequences: assessment of health effects is a major problem in all studies. Those that can rely on an epidemiological study are very rare. The Narangwal study (Kielman and associates 1983) was based on prospective longitudinal field experiments yet because of its cost and complexity, such a study is unlikely to be repeated. More limited studies are more common (for example of the effectiveness of a drug or insecticide) but may not provide the information required for an economic evaluation. For example indicators of effectiveness used are often parasite prevalence in the case of a drug, or vector densities in the case of an insecticide, not the cases of clinical disease or deaths prevented required for the economic evaluation.

In the absence of good epidemiological data on health indicators, economic evaluation studies have had recourse to a number of different approaches. Household surveys of programme take-up (for instance of ORT use or immunisation status) may provide the basis for projecting health impact. A few countries - for instance The Gambia and Bangladesh - have areas where disease patterns have been intensively studied by epidemiologists, providing at least base-line information. Many studies match utilisation data with international estimates of efficacy (of a drug or vaccine) and case fatality rates. Others use intermediate measures of outcome such as "fully immunised child".

A final strategy used has been a survey of expert opinion. For instance Grosse (1980) relied on a literature review to identify the link between a variety of health programmes and delivery system components and changes in disease-specific morbidity and mortality. Barnum et al

(1980) used the Delphi technique, surveying the views of international experts, to identify the effects of alternative combinations of maternal and child health services on child survival.

The difficulties and dangers of extrapolating from limited data are indicated by two studies of the Onchocerciasis Control Programme in West Africa. Evans and Murray (1987) reworked the figures of Prost and Prescott (1984) and produced cost-effectiveness ratios that were 8 to 22 times as costly per unit of health effect. The main reasons for these differences were different values for the population at risk, the incidence and prevalence of onchocercal blindness and the years of healthy life lost due to blindness.

In terms of the measures of health effect used, a few recent studies have used "healthy days of life lost" (for example Prost and Prescott 1984 and Shepard, Sanoh and Coffi 1986). A few others have used multiple measures (Grosse 1980, Kielman and associates 1983). Most use either one indicator relevant to the disease under study (eg case years of schistosomiasis prevented) or one or two indicators relevant to a number of diseases (deaths prevented, cases prevented). The deficiencies of this approach are exemplified by studies of immunisation. For example the following cost-effectiveness ratios for the immunisation programme in Brazil can be calculated from Creese (1984):

Cost-effectiveness ratio	Immunisation against: measles	polio
cost per death averted	$ 108	$2128
cost per disability averted	$6667	$ 286
cost per case averted	$2.14	$ 212

Choice between these programmes requires a trade-off between large reductions in mortality and small reductions in disability from measles vaccination, and the opposite for polio vaccination. A further problem of many studies and exemplified in this one is that the relevance of these ratios to policy makers is unclear: numbers of deaths, disabilities and cases are presented as the consequences of spending $1m on either polio or measles vaccination but is this a realistic choice for policy makers?

Other difficulties result from the use of a single measure of effectiveness to evaluate very different strategies. For example, cost-effectiveness studies of schistosomiasis control have frequently used cost per case year prevented to compare the strategies of chemotherapy, mollusciciding and water supplies. Yet water supplies have far broader benefits than schistosomiasis control alone. Numerous studies use reduction in infant or child mortality to compare very disparate interventions (eg Walsh and Warren 1979).

No study has used "quality adjusted life years". Interestingly, Feldstein, Piot and Sundaresan in 1973 recognised that relative social values needed to be placed on the different effects of health programmes and reviewed alternative approaches to establishing relative social value weights, including the literature that led later to the development of quality of life measures. No analyst concerned with developing countries seems to have taken this further in the succeeding 15 years.

Concern amongst developed country analysts with the subsequent health experiences of survivors is of relevance to developing countries: is a child saved from one illness more likely to die from another illness? Only Shepard, Sanoh and Coffi (1986) have allowed for this, arguing that children who would have died from measles but are saved by vaccination face higher mortality than other children of the same age. They therefore adjusted their calculation of healthy days of life saved to allow for this.

As mentioned earlier, no cost-effectiveness study has concerned itself with indirect benefits (the value of productivity gains). While cost-benefit analyses are not the subject of this review, it is relevant to note here that the methods used in these studies to measure and value productivity gains are usually extremely weak. In principle gains in productive time should be carefully measured and valued at their marginal product (Mills 1985). In practice, arbitrary and often exaggerated assessments are made of days of work lost due to illness and these are multiplied by the average or minimum wage regardless of the relationship between wages and marginal product and the likely change in marginal product as available labour time increases. Indeed, the discredit that has been attached to the human capital approach partly stems from the crude way in which it has been applied and may help to explain why indirect benefits are not discussed in cost-effectiveness studies.

Studies which adopt a more sophisticated approach are very rare. A model study is that by Conly (1975) which explored the economic consequences on households of malaria. Instead of assessing days of work lost and their value, it looked directly at indicators of production, comparing households with much malaria and those with little malaria. It did not look, however, at the cost of control.

Comparison of costs and consequences: neither discounting nor sensitivity analysis have been consistently employed in studies. The importance of discounting when comparing alternatives with very different time horizons was shown by Cohn (1972) in a comparison of malaria eradication and control strategies. Variations in the discount rate affected the choice of strategy because the higher the discount rate, the less weight is given to the future continuing costs of control.

Incremental analysis is largely absent, even when studies appear to offer a good opportunity. Barnum (1986) for example, when estimating the costs and effects of alternative regimes for tuberculosis treatment, presented only average costs per unit of effect for the seven alternatives. Yet it seems from the text that some options had lower costs and lower effectiveness and others higher costs and higher effectiveness, providing the ideal opportunity for incremental analysis. Another example where incremental concepts are relevant but not used is the immunisation study by Robertson et al (1985) which divided costs between all diseases (including diptheria, pertussis and tetanus although these are prevented by one combined vaccine). A more relevant approach would have been to regard some vaccines as the main justification for the vaccination programme and others as optional add-ons, thus analysing their incremental costs and effects. McNeil et al (1981) and Thompson et al (1981) are unusual in calculating incremental cost-effectiveness ratios, in both cases for one diagnostic test over another.

Findings

As in the case of the developed country literature, it is difficult to summarise findings from a wide range of studies. This section therefore relies for quantitative results on those studies which have tackled the lengthy and time consuming task of analysing and presenting results in as consistent a fashion as possible, by selecting similar ratios and translating them to a common currency and year. This has been done for parasitic diseases by Barlow and Grobar (1986), for oral rehydration therapy for diarrhoeal diseases by Shepard, Brenzel and Nemeth (1986), for immunization by Phillips, Feachem and Mills (1985) and for a variety of health interventions by Cochrane and Zachariah (1983). These results are reproduced in Annex 5 and summarized here in order to provide a basis for later comparisons with similar ratios for malaria control.

Summaries of the findings of cost-effectiveness studies on parasitic diseases (excluding malaria) are presented in Table A5.2 for annual cost per person protected and Table A5.3 for cost per case year prevented. Only two studies of parasitic disease control projects produced a cost per death averted. Since they were both of malaria, they are considered later.

The measure "cost per person" shows an enormous range, even for the same disease (for example schistosomiasis). However, while it gives some indication of the level of resources required, especially if compared to annual health expenditure, it is not particularly helpful given the vagueness of the term 'protection'.

"Cost per case-year prevented" is more useful and suggests there are big differences between different control measures - for instance chemotherapy and vector control in the case of schistosomiasis. Bekele (1980), on the basis of looking at combinations of control measures for schistosomiasis, concluded that the gains from simultaneously operating several control measures rather than chemotherapy alone did not justify the additional cost. Unfortunately most studies do not study combinations of methods and so cannot provide further evidence on this conclusion.

Table A5.3 demonstrates the enormous differences in the cost-effectiveness of similar techniques in different locations. For instance costs (1984 prices) of vector control (mollusciciding) to reduce schistosomiasis prevalence varied between $9.29 per case-year prevented (Iran) and $84.23 (St Lucia).

A variety of reasons could account for these differences, including on the cost side differences in input prices, different combinations of inputs and different environmental circumstances and on the effectiveness side, differences in vectors or vector behaviour, differences in the compliance of the population or the efficacy of control measures. Differences in cost, appropriately standardised, have been little investigated. An exception is Jobin (1979), who has compared the cost of mollusciciding per 100m^3 treated and per km^2 in a number of schistosomiasis control projects (see Table A5.4). He concluded that costs were generally related to simple geographical parameters such as volume of snail habitat and distance between habitats. Rainfall patterns and the cost of chemicals (which take up very different shares of programme costs) can also be important.

Data on variation in effectiveness is available from the second set of results discussed here, from oral rehydration therapy projects (see Table A5.5). Cost per child per year varied by a factor of 20, deaths averted per 1000 children also by a factor of 20 and cost per death averted by a factor of about 65. These differences are accounted for by the very different approaches employed by different projects (for instance repeated home visiting by nurses in Egypt as opposed to primarily mass media in The Gambia) and very different use rates achieved for oral rehydration therapy. In contrast, comparison of costs per fully immunised child from immunisation programmes (Table A5.6) shows only a four-fold difference, probably because the technology is reasonably standard, known to be effective if properly administered, and not dependent on patient compliance once a child is contacted (Mills and Drummond 1987).

Further evidence on the importance of delivery strategy is available, particularly from immunisation programmes. Evidence is accumulating that mobile campaign-type strategies appear to offer a cheap way of achieving high levels of coverage in the short term, though they do not necessarily offer a comparable range of services to that of fixed services. Moreover, campaigns are difficult to sustain in the long term and may become increasingly costly as coverage from fixed centres improves (Creese and Dominguez-Uga 1987).

In terms of service integration, there is now considerable evidence that bringing the provision of different services together can produce benefits both in increased effectiveness and reduced costs, providing that the efficiency of the newly integrated services can be maintained. However, there is less evidence on whether integration is more appropriate for some services (eg for general child care) than others (eg for vector-borne diseases).

There has recently been interest in ranking health interventions in terms of cost per death averted, which provides an indication of best-buy programmes, assuming that reduction in mortality is an adequate proxy for national health objectives. Table 2.3 reproduces one such comparison, shown in common 1984 dollars, adapted from Cochrane and Zachariah (1983). The general impression from this and other, similar tables is that "primary health care" interventions, for instance immunisation and oral rehydration, represent good buys and that control of vector-borne diseases and especially water supplies are not such good investments in terms of mortality reduction. However, while the reliability of estimates for immunisation is reasonably good, there are very few estimates of deaths averted by parasitic disease control programmes. Barlow and Grobar (1986) list only two, both for malaria, and only one of these has much foundation in reality. There is therefore a large gap in the literature regarding the cost-effectiveness of vector control projects in terms of reducing mortality.

To summarize: sufficient evidence has been collected from developing country economic evaluation studies to indicate that certain interventions, particularly those falling under primary health care, are highly cost-effective. However they also indicate that costs, effectiveness, and cost-effectiveness vary widely, between countries, diseases and programmes, for reasons that are not well understood. Moreover, the evidence on the cost-effectiveness of parasitic disease control projects is particularly poor.

What has been the impact of economic evaluation studies on policy

Table 2.3: Cost per death prevented through different health interventions

Author	Intervention	Country	Cost per death prevented($1984)
Shepard (1982)	Measles immunization (includes all joint costs of a programme of polio, DPT, BCG and tetanus)	Ivory Coast	$529
Barnum et al (1980)	Total immunization programme	Indonesia	$163
	BCG programme only		$558
	DPTT programme only		$169
	BCG added to existing programme		$127
	DPTT added to existing programme		$97
Barlow (1976)	Mass vaccination	Morocco, 1971	
	BCG		$41
	DPTT		$64
	Polio		$1,859
Barnum (1980)	Immunization Total	Kenya	$107
	DPT, TT, BCG only		$344
	Measles only		$63
	Polio only		$7,972
	DPT, TT, BCG		$87
	Measles added to existing programme		$33
	Polio added to existing programme		$712
	New births only		$88
Barnum & Yaukey (1979)	Health programme separate	Nepal	$695
	Integrated with family planning		$371
Faruquee & Johnson (1982)	Nutrition programme prenatal	Narangwal, India	$9
	Health care - infant		$27
	- child		$33
Barlow (1976)	Hospital	Morocco, 1971	
	Large		$4,460
	Medium		$4,770
	Small		$3,990
Horton & Claquin (1982)	Hospital treatment of diarrhoea	Bangladesh	
	Sotaki		$202
	Matlab		$1,362 - $1,459
Prescott (1980)	Malaria eradication (spraying and drugs)	Bangladesh	$1,014 - $31,463
Walsh & Warren (1979)	Mosquito control - malaria (infant & child)	Cross-country analysis	$820
	Community water supply, sanitation		$4,930 - $5,890
	Selective primary health care		$275 - $340

Adapted from Cochrane and Zachariah (1983). Costs of original sources converted to US$ 1984 by multiplying by ratio between US GNP deflators for year of study and 1984 (ratios from Barlow and Grobar 1985).

making? This question is clearly not easy to answer. In terms of impact on national decision-makers, the answer is likely to be very little because few studies have been oriented to their concerns. In terms of international health policy, there is some evidence that economic evaluation results (for instance on primary health care, immunisation and diarrhoeal diseases) have had some influence. An unfortunate consequence of the interest of policy-makers in such studies has, however, been the simplistic application of cost-effectiveness analysis to justify policies formulated on other grounds rather than to assist in making policies.

2.4 Application of cost-effectiveness analysis to malaria control programmes

In order to review a reasonable number of studies, the criteria for inclusion of studies in this section are rather more lax than in previous sections. In particular, cost analyses (producing, for instance, a cost per person protected) are included. In addition, the method of measurement and valuation of direct and indirect benefits (averted treatment costs and productivity gains) used in cost-benefit studies is reviewed, since it is of relevance to the subsequent case-study.

Topics

Figure 2.7 provides a framework for reviewing the subjects analysed by malaria control studies. Table 2.4 lists, in alphabetical order by author, those studies reporting a cost-effectiveness ratio. It briefly indicates the group or area studied, the purpose of the study and the control methods involved.

Most studies are concerned with choices of strategies for prevention. Although case detection and treatment are, together with vector control measures, an important part of the preventive activities of national malaria control programmes, economists have paid little attention to them. Griffith (1961) reviewed the costs of a number of national malaria eradication campaigns, his main aim being to estimate the financial implications of moving from the attack phase, where spraying was the main strategy, to surveillance including case detection and making? This question is clearly not easy to answer. In terms of impact on national decision-makers, the answer is likely to be very little because few studies have been oriented to their concerns. In terms of international health policy, there is some evidence that economic evaluation results (for instance on primary health care, immunisation and diarrhoeal diseases) have had some influence. An unfortunate consequence of the interest of policy-makers in such studies has, however, been the simplistic application of cost-effectiveness analysis to justify policies formulated on other grounds rather than to assist in making policies.

2.4 Application of cost-effectiveness analysis to malaria control programmes

In order to review a reasonable number of studies, the criteria for inclusion of studies in this section are rather more lax than in previous sections. In particular, cost analyses (producing, for instance, a cost per person protected) are included. In addition, the method of measurement and valuation of direct and indirect benefits (averted treatment costs and productivity gains) used in cost-benefit studies is reviewed, since it is of relevance to the subsequent case-study.

Topics

Figure 2.7 provides a framework for reviewing the subjects analysed by malaria control studies. Table 2.4 lists, in alphabetical order by author, those studies reporting a cost-effectiveness ratio. It briefly indicates the group or area studied, the purpose of the study and the control methods involved.

Most studies are concerned with choices of strategies for prevention. Although case detection and treatment are, together with vector control measures, an important part of the preventive activities of national malaria control programmes, economists have paid little attention to them. Griffith (1961) reviewed the costs of a number of national malaria eradication campaigns, his main aim being to estimate the financial implications of moving from the attack phase, where spraying was the main strategy, to surveillance including case detection and

Figure 2.7: Framework for reviewing studies on the cost-effectiveness of malaria control

	Choice of:					
Strategy	sector	intervention/ technique	delivery strategy	target group	place of intervention	time of intervention
Prevention - aimed at individual			Comparison of case detection and treatment approaches	Case detection and treatment v. mass drug administration to selected groups	Case detection and treatment at home, clinic, volunteer's home, hospital	
- aimed at environment	Design and management of water resource projects Use of fish	Comparison of insecticides Comparison of insecticides and environmental management	Comparison of insecticide dosages and coverage			Number and timing of spray-rounds of insecticide
Diagnosis			Diagnosis through malaria clinic or central laboratory			Presumptive and radical treatment versus radical treatment alone
Treatment		Oral versus injectable drugs	Various means of delivering treatment Use of PHC network		Treatment at home, clinic or hospital	

Table 2.4: Description of studies of malaria control reporting a cost-effectiveness ratio

Author (date)	Group or area studied	Purpose of study	Control methods involved
Barlow (1968)	Sri Lanka: actual data 1947-66; projected data 1976-77	Assess economic impact of malaria eradication	Insecticides, case detection and treatment, surveillance
Bruce-Chwatt & Archibald (1959)	Western Sokoto, Nigeria, 130,000 people	Compare comparative value of 3 insecticides to control malaria	DDT, PHC, dieldrin; alternative dosages and spray cycles
Bruce-Chwatt (1987)	Non-specific	Assess cost of chemotherapy	Chemotherapy
Cohn (1973)	India, 1950-71	Review costs and benefits of malaria control programme	Insecticides, case detection and treatment, surveillance
Gandahusada et al (1984)	3 areas, each c. 50,000 pop., in Central Java, Indonesia, 1980-2	Evaluate full and selective coverage of residual fenitrothion	Insecticides: alternative dosages and coverage
Griffith (1961)	Greece, 1958, national programme	Assess cost of malaria eradication	Surveillance
	Thailand, 1960, field trials	" "	Surveillance, spraying
	Indonesia, 1961, national programme	" "	Spraying; spraying and surveillance
	Ceylon, 1960, national programmes	" "	Spraying and surveillance
	Taiwan, 1956 and 1960, national programme	" "	Spraying; spraying and surveillance; surveillance
	India, 1961, national programme	" "	Spraying; spraying and surveillance, surveillance.
Hedman et al (1979)	Mining town in Liberia, pop. 16,000, 1976/7	Evaluate programme	DDT spraying, larvicide measures, chemotherapy

continued

Table 2.4: Continued

Author (date)	Group or area studied	Purpose of study	Control methods involved
Jeffrey (1984)	Non specific, 1984	Assess cost of chemotherapy in PHC	Chloroquine
Kaewsonthi and Harding (1984)	Thailand, 2 zones, pop. 1.3m and 0.5m, 1980-1	Assess cost and performance of surveillance	Case detection and treatment activities
Molineaux and Gramiccia (1980)	Garki district, Kano State, Nigeria, 1969-79	Assess effectiveness of control measures	Various combinations of insecticide, mass drug administration, larviciding
Ortiz (1968)	Paraguay, 1965-72, national programme	Projection of cost of eradication programme	Insecticides, case detection and treatment
Sharma (1986)	Kheda district, Gujarat, India, 1985	Compare chemical and environmental control methods	Spraying with DDT and malathion; environmental management
Walsh and Warren (1979)	Non-specific	Identify priority primary health care interventions	Vector control

treatment, epidemiological investigation, protective measures against malaria importation and transmission, and entomological vigilance and focal vector control.

The main concern of this analysis was to ensure adequate financial resources were made available for the crucial phase of surveillance. The analysis was also intended to promote the usefulness of cost analysis of programmes - though this seems to have fallen on deaf ears. While several subsequent studies have costed an entire package of malaria control measures in order to proceed to a cost-benefit analysis (eg Barlow 1968, Cohn 1973, Ortiz 1968) no other study was located that attempted a comparative cost analysis until Kaewsonthi and Harding (1984).

The Kaewsonthi and Harding study had a number of objectives, including to develop a methodology for assessing the cost-effectiveness of malaria surveillance and monitoring processes, to produce results of use to programme managers and to strengthen research capabilities in health economics. Although the aim of the research was to compare the cost-effectiveness of surveillance processes within an area and between areas, this aim was rejected because it was argued that it was impossible to achieve unless the processes were real alternatives and not complements; had the same target and achieved the same level of effectiveness; and operated in the same environmental conditions. It was considered that these conditions were not met. The research therefore concentrated on assessing the unit cost and performance of surveillance processes. Comparisons involved different delivery strategies for surveillance activities (active case detection, malaria clinics, volunteers etc), different places for making contact with potential cases (patient's home, malaria clinic, volunteer's home, hospital etc) and different target populations (the whole population for routine activities, mass drug administration for selected groups).

No other study has gone into preventive measures aimed at individuals in such detail. A few other strategies have been evaluated, but with only partial cost or effectiveness information. For example there is now considerable interest in the potential of bed nets impregrated with insecticide and partial coating (Schreck and Self 1985). Historical data from the Tennessee Valley Authority indicates that parasitaemia rates in the late 1930s were far lower in houses that had been screened against mosquitos as opposed to unscreened houses (Cooney and Brooks 1986).

Most of the attention of analysts has been directed to preventive measures aimed at the environment. The use of residual insecticides has been extensively evaluated in terms of their insecticidal properties, safety, and required dosages and frequency of application. Rarely do such studies consider their impact on the incidence of malaria or their cost over and above that of the insecticide alone. A rare study which included cost considerations is that by Gandahusada, Fleming, Sukamto, Damar, Suwarto, Sustriayu, Bang, Arwati and Arif (1984), which compared alternative dosages and coverage of fenitrothion, incorporating parasitological, entomological and cost studies.

Comparisons of insecticides usually consider insecticide cost alone. An exception is Phillips and Mills (1986) who compared the operational (delivery) costs of three insecticides in Nepal (DDT, malathion, bendiocarb), concentrating on costs associated with transporting the insecticides and delivering them to the walls of houses.

Because of vector resistance to insecticides and their foreign exchange cost, there has been renewed interest in environmental management and modification. This was the subject of a meeting of the WHO/FAO/UNEP Panel of Experts on Environmental Management for Vector Control (PEEM) in 1986 which reviewed a number of case studies (PEEM 1986). Most compared environmental management approaches with chemical control. Few had data on the effectiveness of the alternative approaches, instead comparing the cost of achieving control (the level of control usually being unspecified) using different methods. For example Sharma (1986) projected the costs of achieving control by chemical or environmental management methods in Kheda District, Gujarat, basing his calculations on estimated chemical control costs and a pilot project of environmental management.

Extensive comparisons were made from the experience of the Tennessee Valley Authority, covering a wide range of environmental management techniques (Cooney and Brooks 1986). Some approaches had been built into the engineering design, others involved later modifications to that design, and yet others required annual activities. Further comparisons were quoted at the PEEM meeting from mosquito control in coastal salt marshes in the US. For example the Public Health Study Team report (1976) compared impounding and dike maintenance with larviciding. Finally, the cost of the use of fish as part of an integrated approach to control was compared to the savings from reduction in larviciding it made possible in a study in California (Lichtenberg and Getz 1985). All these studies took vector control (at an unspecified level) as their objective and compared alternative means of achieving it. Reduction in the nuisance of mosquitos was as much the purpose of vector control as reduction in disease transmission.

Although diagnosis is a central activity of malaria control programmes, little attention has been paid to the costs of alternative patterns of organisation, though this was one of the issues implicitly included in the study by Kaewsonthi and Harding (1984) since they compared malaria clinics (where parasitology is carried out immediately) with other methods of case detection where parasitology is centralised.

Similar comments apply to treatment. While choices certainly exist with respect to choice of drugs and place of treatment, these have not been evaluated except by Kaewsonthi and Harding (1984). Two studies have, however, documented the cost consequences of poor prescribing practices: Guyer and Candy (1979) in a comment on the widespread and unnecessary use of injectable antimalarial therapy in the Cameroon and Barnett and Creese (1980) in a study of the treatment provided for common diseases, including malaria, in a sample of clinics in Ghana. Several studies have estimated the cost of including chemotherapy for malaria in primary health care (eg Jeffery 1984).

Two conclusions can be drawn from this review of the subjects of cost and cost-effectiveness studies of malaria control. Firstly, no study has compared the value of malaria control with the value of other health programmes in terms of preventing morbidity and mortality. A cost per infant and child death averted by malaria control was shown in Table 2.3 but the empirical basis of that estimate is very speculative. Secondly, very few studies have adequately explored the innumerable choices concerning the strategies and organisation of malaria control.

Methods

Type of study: no study has attempted a full cost-effectiveness analysis, incorporating complete costing and effectiveness measures. Gandahusada et al (1984) come closest although the costs appear incomplete, and Kaewsonthi and Harding (1984), while employing a cost-effectiveness framework, concentrated on cost analysis and unit cost measures. Other studies focus on either costs or effectiveness, or are primarily concerned with vector rather than disease control. Several cost-benefit analyses have produced a single cost-effectiveness ratio (Cohn 1973, Barlow 1968) but its policy implications are not drawn out.

Costs: Many of the comments in the review of the developing country literature apply also here. Costs are often incomplete and shadow pricing is not employed. The only example of a careful dissection of programme costs is Kaewsonthi and Harding (1984). Their task of identifying the costs of operational activities was much hampered by an accounting system that was not disaggregated by type of activity (spraying, case detection etc). Much time and effort was therefore spent developing means of allocating expenditure to activities and investigating the sensitivity of the results to the various formulae used. This study is the only one which investigated time and financial costs of patients and their relatives and friends.

Consequences: a variety of means have been used to obtain information on health effects. Historical (retrospective) studies such as those by Barlow (1968), Cohn (1973) and Kuhner (1971) project cases and deaths with and without control. Most studies of this type estimate cases and deaths without control on the assumption that levels prior to control would have remained the same in the absence of control. Barlow (1968) was able to draw on much more sophisticated analyses of the effect of malaria control on mortality rates in Sri Lanka.

Studies based on epidemiological trials (for instance Gandahusada et al 1984, Molineaux and Gramiccia 1980) use the indicators of the trials. Gandahusada et al (1984) had to use the slide positivity rate rather than malaria incidence because the blood examination rate varied by time and place. Molineaux and Gramiccia (1984) monitored malaria incidence. The US studies of vector control used various measures of the vector population (for instance mean number of mosquitos per light trap night: DeBord, Carlson and Axtell 1975 and Serhan, Howitt, Moore and Mitchell 1981).

Two non-field-based studies looked only at health effects, not at other consequences or programme costs, and are considered here because effects are measured in ways that would adapt well to economic evaluation studies. The Ghana Health Assessment Project Team (1981) used census data, death certificates, inpatient and outpatient statistics and special surveys to estimate the number of healthy days of life lost from various diseases. Malaria was assumed for analytical convenience to be a single life-time disease, with high mortality in late infancy and early childhood followed by recurring disability from clinical attacks throughout the rest of life. Ojo (undated) applied the Tugwell, Bennet and Sackett (1985) approach to estimating the community effectiveness of vector control, chemoprophylaxis and treatment, deriving the weights for the various components of community effectiveness from a literature review.

Kaewsonthi and Harding (1984) used indicators of performance: for example effectiveness (the extent to which a target - eg speed of treatment - is met), time taken, performance (degree to which a task is successfully completed) and relative contribution to surveillance. In order to relate performance to costs, they calculated unit costs based on measures of intermediate output (slides taken, positive cases detected etc).

Although no cost-effectiveness study includes consideration of direct and indirect benefits as categories of consequence, their use in cost-benefit studies of malaria is reviewed here since it is of relevance to the later case study. Table 2.5 summarises the main approaches to the measurement and valuation of direct (treatment costs saved) and indirect (production gains) benefits adopted in cost-benefit studies. A few other relevant studies are also included; those which measure days of disability lost and those which attempt to assess the "cost"of malaria, without considering control. A more extensive theoretical and empirical review of the effect of malaria control on the supply of labour has been included in Section 3 of Annex 1.

Table 2.5: Measurement and valuation of direct (treatment costs saved) and indirect (production gains) benefits from malaria control (a)

Author (date)	Group/area studied	Valuation of treatment costs	Disability days/episode	Method of valuation of days lost
Barlow (1968)	Sri Lanka	Reduction in public and private treatment costs assumed to increase saving and investment: values used not stated	Not stated: based on malariologists' opinions and data from household survey of morbidity	Based on estimated elasticity of output with respect to skilled and unskilled labour
Bhombore et al (1952)	3 villages in India	Annual per family expenditure on malaria compared pre and post spraying in sprayed and control villages	Not reported in study	Wage rate for hired labour
Cohn (1973)	India	Not valued due to lack of data but considered to be sizeable	Discussed but not quantified	Discussed but not valued
Conly (1975)	Area of Paraguay	Not discussed	5.4 days (from survey)	Not valued directly
Cooper (1979)	Thailand	50% treated x cost of treatment	15 days	Marginal product of labour taken to be 0.6 of average product
Ghana Health Assessment Project Team (1981)	Ghana	Not valued	1 days	Not valued
Khan (1966)	East Pakistan	Estimated private expenditure per case	10 days (disability) plus 10 (debility)	'Average product of labour'
Kuhner (1971)	Thailand	Not valued	15 days	Marginal product of a labour year
Livadas and Athanassatos (1963)	Greece	Cost of anti-malarials, private medical care of 1/4 of cases and hospitalisation of 1/40 of cases	6 days	Daily wage
Mason and Hobbs (1977)	Area of El Salvador	Not valued	3.9 days (P.falciparum); 3.4 days (P.vivax) (from survey)	Not valued
Miller (1958)	20 West African men	Not valued	6.3 days (from survey)	Not valued
Niazi (1969)	Iraq	Cost of drugs for all cases; of hospital care for 3 days for 10% of cases	7 days	Daily wage

Table 2.5: Continued

Author (date)	Group/area studied	Valuation of treatment costs	Disability days/episode	Method of valuation of days lost
Ortiz (1968)	Paraguay	Not assessed	44 days	Assumed value of output per man day by agricultural sector
Quo (1959)	Philippines	Not known	7 days	Minimum weekly wage
Ramaiah (1980)	India	Total cases x unit cost of out-patient, hospital and private care		Per capita income, adjusted for age/sex differences and employment rates
Rao & Bhombore (1956)	Tract in Mysore state, India	Not assessed	6 days	Daily wage
Sabera (1977)	Sri Lanka	90% of cases x OP cost; 10% of cases x hospital cost for 3 days	5 days	Average earning capacity of self-employed rural farm hand
Russell and Menon (1942)	2 Indian villages	Reported payment for treatment and religious ceremonies	Per person over 21: 9.7 days (village 1), 20.7 days (village 2) (from survey)	Reported earnings losses
San Pedro (1967/8)	Philippines	Estimated cost of OP care (doctor, lab tests, drugs) x number of cases	3 days (disability) plus 30% loss in working efficiency for 6 weeks	Legal minimum wage for agricultural workers
Sinton (1935/6)	India	Discussed. Average cost per case x no. of cases	7 days (disability) plus 10% loss in working efficiency	Average monthly wage rate weighted for different earnings by sex
Van Dine (1916)	Louisiana, USA	Not assessed	6.43 equivalent adult days per case plus 25% loss of working efficiency in crop season	Days lost reduced to days actually required but not available because of malaria for crop production (amounting to 1.1 effective labour days per case) and valued in terms of loss of cotton.
Wright (1971)	Indonesia	67% of cases x chloroquine cost; 33% x clinic cost; 6% x hospital cost for 5 days	6 days	Employed (61%) x daily wage; underemployed (30%) x .5 of wage; unemployed (9%) not valued.

(a) These studies which estimate the 'burden of disease' treat these as 'costs'; those which assess the value of control treat them as "benefits" (averted costs).

By no means all studies attempt an assessment of the cost of treatment without control and of the likely savings with control. A few studies, for instance Bhombore, Brooke-Worth and Nanjundiah (1952) compare actual expenditure before and after and with and without malaria control (though they appear to derive their information from a single survey, requiring a period of recall of up to 2 years). Most studies estimate treatment costs on the basis of assumptions on the proportion of cases treated and the unit cost of treatment. Common shortcomings are to exaggerate the likely proportion of cases receiving treatment, and to assume that eradication is instantaneous and completely effective, thus implying zero treatment costs with control.

A notable point from Table 2.5 is the enormous variation in days of disability per malaria episode assumed (or measured) in the various studies. Since days of disability lost will depend on such factors as the parasite species, immune status of the population, frequency of attacks per individual and whether or not the episode is treated, comparison between the studies must be undertaken cautiously. However, it is notable that those studies which measure days of disability from their own surveys (eg Conly 1975, Mason and Hobbs 1977, Miller 1958) tend to find lower values than the other studies which rely on estimates, suggesting a tendency of the latter studies to exaggerate.

Most studies assume that days of disability equal days of productive labour lost. Van Dine (1916), however, converts days of disability into equivalent labour days, taking account of important factors such as varying labour force participation rates, seasonality of labour demand, debilitating effects of disease and the time spent by family members in caring for the sick.

Most of the methods of valuation of days of work lost due to morbidity and debility are based on some estimate of the average wage, adjusted or unadjusted. For example Bhombore et al (1952) multiplied the disability days reported in their survey by the prevailing wage rate for hired labour; Sinton (1935) multiplied days of work lost by the average monthly wage rate (weighted to allow for differing male and female earnings); Quo (1959) used the minimum weekly wage; San Pedro (1967-8) the legal minimum wage for agricultural workers; Niazi (1969) a "daily wage"; Khan (1966) the "average product of labour"; and Ortiz (1968) the assumed output per man day in various agricultural sub-sectors. The only substantially different approach was adopted by Kuhner (1971) who used the marginal product of a labour year, estimated from an assumed Cobb-Douglas production function for the agricultural sector. With this specification, the marginal product of labour is equal to a constant fraction (the labour elasticity of output) of its average product. A time series of the average product was used to derive the marginal product, using two plausible values for labour elasticity (0.4 and 0.5).

Most of these studies value years of life lost due to mortality in a similar fashion, basing the estimate on the average or minimum wage, or annual per capita income. The main exception is Quo (1959) who multiplied the number of deaths by $1,500, the value placed on death by the Philippines Civil Code.

A notable exception to the above methodology which bases estimates of loss on the product of the number of days of work lost and their value is the study by Conly (1976) which looked directly at the economic consequences of malaria in terms of, for instance, land area cultivated, crop selection and harvest quantities. Households were studied for a two year period and differences in malaria incidence between groups of households and between years one and two permitted a comparison of indicators of household production between groups of households experiencing different levels of malaria. The value of the loss due to malaria was not, however, compared with the cost of control, as in the cost-benefit analyses.

No cost-benefit study is entirely convincing in its estimate of the output loss due to morbidity, debility and mortality caused by malaria, and most estimates are implausible. The main problems are:

- indirect benefits are not completely specified or explored: some analysts include all three causes of loss (morbidity, debility, mortality), others only one or two;

- the empirical basis for estimating length of illness, degree of disability and debility, and mortality rates is extremely weak: most estimates are guesses;

- the empirical basis for quantifying time lost from work is also extremely weak: most studies assume that days of illness are equivalent to productive days lost, ignoring issues of the seasonality of labour demand, sex and occupational differences in work patterns, substitution for the labour of the sick person by other household members;

- virtually all studies assume that the value of the lost output is equivalent to some measure of the average wage, ignoring issues such as whether the wage reflects productivity, whether an average measure is appropriate when sizeable increments of labour may result from control programmes and in labour surplus economies, and the variations of productivity by sex and occupation.

Indirect benefits discussed so far are those relating to the labour supply of individuals. The relationship between malaria and economic development is much broader than that stemming from the effects of malaria on individuals. Some of these broader effects can be taken into account within the micro-analytical framework of cost-benefit and cost-effectiveness analysis. For example if malaria control permits migration to land previously unoccupied because of malaria and which is more fertile than land presently occupied, then estimates can be made of the increased marginal product of labour resulting from migration. More often, however, the effects of malaria control are likely to be so far-reaching that the partial equilibrium framework of cost-benefit analysis is inappropriate and a macro-framework required.

Within the constraints of cost-effectiveness analysis, while it is possible to take account of indirect benefits affecting individuals, it is impossible to take account of the interaction of the variety of other economic variables that will affect overall national income. Nonetheless, it is important for a cost-effectiveness analysis to acknowledge these broader interactions even if they cannot be neatly quantified. Annex 1 therefore summarises the likely relationship between malaria, malaria control and economic development, reviewing both theoretical issues and empirical evidence.

Comparison of costs and consequences: studies permit a number of comparisons to be made of the annual cost per person protected of single or combined control measures, but very few produce ratios of cost per case or death prevented. The US studies of vector control alternatives usually present estimates of cost per acre or per unit reduction in vector populations rather than per person. Only Kaewsonthi and Harding (1984) employ sensitivity analysis and no study attempts incremental analysis. A resource allocation model to help identify most effective intervention strategies has been proposed (Parker 1983) but not tested with real data.

Findings

Table 2.6 summarises the results of those studies that have produced cost-effectiveness ratios expressed in the form annual cost per person protected, cost per case prevented, or cost per death averted, in US $ of 1984. These results should be treated with some caution because the source documents often provide inadequate information for judging the quality of the cost and effectiveness estimates. In particular, cost estimates are liable to be incomplete, for instance omitting capital costs, administrative overheads and private costs. In addition some estimates come from particular small-scale trials (eg Gandahusada et al 1984, who compare full and selective coverage of residual fenitrothion spraying) and some from national malaria control programmes using a combination of strategies (eg Kaewsonthi and Harding 1984, who analyse data for Thailand). A final reason for cautious interpretation relates to the malaria situation at the time of the study. Some estimates are based on the cost of a research programme assessing the feasibility of establishing control in a previously uncontrolled situation (eg Molineaux and Gramiccia for the Garki area in Nigeria), some on the costs of maintaining control in areas where control has been established for some time (eg Kaewsonthi and Harding for Thailand) and some on the costs of the entire control programme over a considerable period of time, including both the attack and maintenance phases (eg Cohn for India and Barlow for Sri Lanka).

Griffith (1961) concludes from his review of national programme costs that these range from $0.01 to $0.48 ($0.03 to $1.56 in $ 1984). It is interesting to note that these are not very different from more recent estimates for national programmes using combined strategies (eg Thailand). As might be expected, however, recent vector control costs,

Table 2.6: Cost-effectiveness ratios of malaria control projects ($1984)

Country	Control method	Annual cost per person protected	Cost per case prevented (a)	Cost per death averted	Reference
LDCs	Drugs	0.07(b)	-	-	Bruce-Chwatt (1987)
LDCs	Drugs	0.07(b)	-	-	Jeffrey (1984)
Taiwan	Surveillance	0.10	-	-	Griffith (1961)
Thailand	Drugs, vector control	0.16	-	-	Kaewsonthi and Harding (1984)
India	Surveillance	0.19	-	-	Griffith (1961)
Thailand	Surveillance	0.20	-	-	Griffith (1961)
Thailand	Spraying	0.20	-	-	Griffith (1961)
Taiwan	Combined methods	0.26	-	-	Griffith (1961)
India (Kheda)	Environmental management	0.27	-	-	Sharma (1986)
India (national programme)	Spraying and surveillance	0.29	-	-	Griffith (1961)
	Spraying	0.39	-	-	Griffith (1961)
Greece	Surveillance	0.41	-	-	Griffith (1961)
Indonesia	Spraying	0.42	-	-	Griffith (1961)
Ceylon	Spraying and surveillance	0.43	-	-	Griffith (1961)
Taiwan	Spraying	0.43	-	-	Griffith (1961)
Indonesia	Spraying and surveillance	0.49	-	-	Griffith (1961)
Thailand	Drugs, vector control	0.61	-	-	Kaewsonthi and Harding (1984)
India (Kheda)	Spraying	0.63	-	-	Sharma (1986)

continued

Table 2.6: Continued

Country	Control method	Annual cost per person protected	Cost per case prevented (a)	Cost per death averted	Reference
Taiwan	Spraying and surveillance	1.25	-	-	Griffith (1961)
LDCs	Surveillance, vector control	1.47	-	-	Smith (1985)
Indonesia	Vector control	1.57	75.00	-	Gandahusada et al (1984)
Nigeria (Sokoto)	Spraying	1.63	-	-	Bruce-Chwatt & Archibald (1959)
LDCs	Vector control	2.97	-	892.20	Walsh & Warren (1979)
Indonesia	Vector control	4.05	92.10	-	Gandahusada et al (1984)
Liberia	Drugs, vector control	6.64	12.30	-	Hedman et al (1979)
India	Vector control	-	1.08	-	Cohn (1973)
Paraguay	Vector control	-	53.77	-	Ortiz (1968)
Nigeria (Garki)	Drugs, vector control	-	233.15	-	Molineaux and Gramiccia (1980)
Sri Lanka	Vector control	-	-	69.95	Barlow (1968)

Source: Barlow and Grobar (1985); references cited in table.

(a) Annual costs divided by annual number of cases (deaths) prevented, or total cost during project life divided by number of case-years (deaths) prevented during project life.

(b) Drug costs only

expressed per capita of the population protected, are considerably higher than their 1960s counterparts, reflecting both the increased cost of insecticides and a switch to more expensive insecticides.

The range of influences on the ratio 'cost per case prevented' makes it difficult to draw conclusions from the figures in Table 2.6. The higher the initial incidence, the greater will be the potential reduction in incidence on application of a control measure. This helps to account, for instance, for the very low cost per case prevented in India and per death prevented in Sri Lanka. Other influences will be the characteristics of the vector and environment as expressed in the basic case reproduction rate (helping to account for the high cost in the Garki project, Nigeria where control measures had to be applied intensively to be effective) and population density (helping to account for the relatively cheap control in the Liberian project where a mining town was the location of control efforts).

The results of cost-effectiveness studies of vector control through environmental management were reviewed by the meeting of the Panel of Experts on Environmental Management for Vector Control (PEEM 1986). Conclusions were difficult to draw because of the lack of consistency of the expressions of cost and effectiveness. However it appeared that environmental management has been proved to be cost-effective for vector control in many circumstances in the US. Whether this conclusion applies widely elsewhere is uncertain: in the US, objectives of level of control are as much influenced by mosquitos as pests than as disease vectors; environmental management has other virtues besides vector control, notably its value for recreational purposes and environmental safety; and studies indicate its value is site-specific, depending on the vector, nature of the environment and size and location of breeding sites, and on the degree of malarial endemicity.

2.5 Conclusions

What conclusions can be drawn from the review in this chapter that are relevant to the design of a study on the cost-effectiveness of malaria control? In terms of topic, there is great need for a study of routine control operations, to investigate the costs and effectiveness of alternative control measures and alternative ways of delivering them.

The value of malaria control *per se* is an important question but given the difficulty of answering it (even if reasonable estimates could be produced for malaria control, there is a lack of similar studies on other health programmes to which malaria control could be compared), it should probably remain a subsidiary question.

Such a study of routine malaria control operations needs to be tied closely to the issues and choices facing policy-makers. Only one study of malaria control so far, that by Kaewsonthi and Harding (1984), has attempted this. It also needs to evaluate not only existing strategies but also the costs and consequences of incremental changes to them, since incremental change is the reality of decision-making.

In terms of methodology, there is now a well developed approach to cost-effectiveness analysis of health programmes in the developed country literature which has yet to be fully applied in the developing country context. Similarly, the practices of economic evaluation in other sectors in developing countries have yet to be fully applied in the health sector. In detail, a study should incorporate the following methodological features:

- attempt to apply the Drummond and Stoddart (1985) approach to the assessment of costs and consequences;

- analyse the total costs of control measures, accounting for all resources used and including consideration of the resources of private households;

- consider the relevance of the three categories of consequence (health effects, direct and indirect benefits, changes in utility) quantifying them where possible and if not possible, developing proxy measures;

- include consideration of the extent to which the time costs of illness are compensated for by reallocation of tasks within the household;

- shadow price those costs and consequences expressed in monetary terms;

- apply discounting, sensitivity analysis and incremental analysis where relevant.

2.5 Summary

This chapter has reviewed the literature on the cost-effectiveness of disease control programmes. It first examined theoretical developments in cost-effectiveness analysis and defined the various types of economic evaluation. It then considered costs, categorising them as those borne by the health sector, by households and by agencies external to the health sector. Resources used should be valued using prices which reflect social opportunity cost, which may require shadow pricing. The differences between the evaluation methodology in developed and developing countries were reviewed with comments on the derivation of efficiency and social prices in developing country methodology. Practical costing problems reviewed included lack of information and analysis of joint costs.

Consequences were categorized as changes in physical, social or emotional functioning, changes in resource use and changes in quality of life. The definition and measurement of the first category, health effects, were discussed, including the use of health indices such as 'healthy days of life lost'. The indicator 'quality-adjusted life years' was briefly discussed, with comments on why it had not yet been used in developing country studies. The pros and cons of including changes in resource use as a category of consequence were reviewed, including the danger of biasing programme selection in favour of areas already well-served with health facilities, and the difficulties of measuring and valuing productive time lost in a subsistence economy where production is organized within the household.

Finally, the review of methodology commented on the procedure to be used in putting costs and consequences together, notably the use of discounting, incremental analysis, sensitivity analysis and examination of distributional issues. The section ended with a comment on the reasons why costs and consequences of a particular programme may vary between areas and countries.

The second main section of the review examined the application of cost-effectiveness analysis to disease control programmes in developed countries. In terms of topics studied, it was concluded that most attention had been paid to preventive strategies aimed at individuals and delivered via health care facilities; that immunisation and screening had been the prime approaches to disease control evaluated and that those diseases of greatest current interest to evaluators were non-communicable, chronic conditions. In terms of methods used, cost-effectiveness analysis was increasingly popular but few studies took a societal perspective; few studies considered or used shadow pricing; health indices and the 'quality-adjusted life year' were increasingly popular as indicators of health consequence; and many studies placed particular emphasis on the consequence "health service costs averted". In terms of findings, there was good evidence that the traditional vaccines were well worth while, though the use of the newer, more expensive vaccines might only be clearly justified in high risk groups. Some screening programmes produced net savings; for others, the balance of benefits and costs depended on the selection of the target group. Ranking of programmes in terms of cost per quality adjusted life year indicated that some well-established programmes were relatively expensive compared to newer programmes yet to achieve widespread acceptance. The section concluded with a comment on the influence of economic evaluation studies on policy-makers.

The third main section of the review examined the application of cost-effectiveness analysis to disease control programmes in developing countries. From a review of the topics evaluated, it was concluded that the majority of studies were concerned with evaluating new policies or strategies rather than routine activities; that they responded to international health policy fashions rather than to national needs; and that the range of diseases evaluated was extremely limited. In terms of methodology, virtually no cost-effectiveness study had included consideration of direct or indirect benefits; few compared alternative strategies other than an implicit 'do nothing'; few took a social perspective; costs were frequently incomplete and shadow pricing rarely used; assessment of health effects was often inadequate, with most studies using indicators of intermediate output; and neither discounting, sensitivity analysis or incremental analysis had been consistently employed. In terms of findings, it was concluded from a review of parasitic diseases control projects that there were large differences in cost-effectiveness between different control measures and that the cost-effectiveness of similar techniques in different locations could vary enormously. Similar variations had been found in other programmes, for example oral rehydration therapy. Comparisons of cost per death prevented by different programmes suggested that primary health care interventions represented good value for money, but information was too scanty to draw conclusions on the cost-effectiveness of parasitic disease control programmes.

The final section of the review examined the application of cost-effectiveness analysis to malaria control programmes. In terms of topics, it was concluded that no study had compared the value of malaria control with the value of other health programmes in preventing morbidity and mortality, and that virtually no study had adequately explored the innumerable choices concerning the strategies and organisation of malaria control. In terms of methods, no study had attempted a full cost-effectiveness analysis; only one had examined costs carefully; indicators of health effects were frequently unsatisfactory; and no cost-effectiveness study had included consideration of direct and indirect benefits.

Since cost-benefit analyses of malaria control had assessed direct and indirect benefits, those studies were reviewed. It was concluded that indirect benefits were rarely completely specified or explored; that the empirical basis for estimates was extremely weak; and that virtually all studies assumed that the value of the lost output was equivalent to some measure of the average wage, ignoring issues such as whether the wage reflected productivity and whether an average measure was appropriate when sizeable increments of labour might result from control programmes in labour surplus economies. A brief comment was made on the relationship between malaria, malaria control and economic development, and further discussion included in Annex 1.

The findings of all studies that produced a cost per capita, per case prevented or per death prevented were presented and reasons for the variations discussed.

The review in this chapter was used to draw conclusions relevant to the design of a study on the cost-effectiveness of malaria control. In particular, it was concluded that a study should focus on routine operations and alternative strategies; should attempt to answer questions of relevance to policy-makers; should undertake a complete cost analysis; should include consideration of the extent to which time costs were reduced by reallocation of tasks within the household; and should use shadow pricing, discounting, sensitivity analysis and incremental analysis where relevant.

3. THE EPIDEMIOLOGY OF MALARIA AND MALARIA CONTROL POLICIES AND STRATEGIES

3.1 The characteristics of malaria

From the point of view of an economic evaluation, malaria has a number of important characteristics. Malaria is the result of infection with parasitic protozoa of the genus Plasmodium transmitted by female mosquitos of the genus Anopheles. Infections in man are caused by four species of the parasite: P.falciparum, P.vivax, P.malariae and P.ovale. The life cycle of all species of human malaria parasites is essentially the same, comprising an exogenous sexual phase with multiplication in certain Anopheles mosquitos and an endogenous asexual phase with multiplication in the human host.

The clinical course of malaria consists of bouts of fever accompanied by other symptoms such as headache, nausea and vomiting and alternating with periods that are symptom-free. Other consequences of infection include anaemia, splenomegaly and complications resulting from involvement of the brain, liver and kidney. The clinical severity of malaria varies considerably depending on the species and strain of the parasite and the immune status of the human host. The severest form is due to P.falciparum, which is associated with a high fatality rate in non-immunes. Malaria due to P.vivax and P.ovale is less severe and rarely fatal. However vivax malaria, if untreated, can often result in relapses, causing anaemia and debility. P.malaria produces the least severe form of infection.

Only certain species of anopheline mosquito are important vectors of malaria under natural conditions. The inherent susceptibility of Anopheles to infection with human plasmodia varies somewhat in relation to the species and strain of malaria parasite. In addition, numerous external factors such as temperature and humidity influence the development of the mosquito and malaria parasite within it. The various species of Anophelines have well defined behaviour characteristics, including favoured breeding places, feeding habits (source of blood, time of feeding) and resting habits.

Natural transmission of malaria infection occurs through exposure to the bites of infective female Anopheline mosquitos. It depends on the presence of and relationship between the vertebrate host (man), agent (parasite), vector (mosquito) and the environment. Sex and age are not important influences on infection in themselves except that the dangerous first infections are more likely to be in the young and sex and age may be related to behavioural practices that affect the risk of infection. Certain genetic characteristics appear to affect human response to infection (for example sickle cell trait). In addition, populations exposed continually to intense malaria in highly endemic areas develop a degree of immunity to infection.

In any geographical area, there are usually only a few anopheline species that are important vectors. Conditions that determine importance include vector density, feeding habits, and length of life, which varies according to temperature and humidity. In particular, development of plasmodia in Anopheles does not occur below a certain minimum temperature. Temperature, however, is only one environmental influence on transmission. Humidity affects mosquito survival and rainfall influences breeding places (both creating and destroying them). Sanitation, housing and occupation can affect vector/man contact. Migration can transfer malaria from one location to another.

Malaria is described as epidemic when there are periodic or occasional sharp increases in the amount of malaria in a given indigenous community and endemic when there is a constant incidence of cases over a number of successive years. Endemic areas can be classified as hypoendemic, where there is little transmission, mesoendemic, with varying intensity of transmission depending on local circumstances, hyperendemic, where transmission is intense but seasonal, and holoendemic where there is an even higher perennial transmission resulting in a considerable degree of immune response in all age groups, particularly adults. The levels of endemicity are formally described by the prevalence of parasites in children aged 5 - 9 years.

3.2 Malaria control policies and strategies

Russell (1952) classified the measures for prevention of malaria in individuals and for larger scale control of the disease as follows:

- measures to prevent mosquitos from feeding on man;
- measures to prevent or reduce the breeding of mosquitos by eliminating collections of water or altering the environment;
- measures to destroy the larvae of mosquitos;
- measures to destroy adult mosquitos;
- measures to eliminate malaria parasites in the human host.

In general, the relevance of these methods depends on the various epidemiological types of malaria and the specific locations in which they are to be applied. In addition, combinations of measures, rather than a single measure alone, are often necessary for control.

Protection against bites

Measures that protect against the bites of mosquitos include bed-nets (which may be impregnated with insecticide); protective clothing; repellents applied to the skin, clothing or bed-nets or released into the air; screening of houses; and siting of houses.

Reduction and elimination of breeding sites

These measures can be permanent or temporary. Permanent measures include filling waterlogged areas, drainage and the construction of deep ponds to retain water. Temporary measures include water management, for instance keeping the shore-line of reservoirs clear of vegetation and varying the water level to destroy larvae, sluicing and flushing streams using sluice gates in dams, intermittent drying of irrigated fields, ponds and water containers, and clearing vegetation round and in breeding places where vector species dislike breeding places exposed to sunlight, or growing trees if they dislike shade.

Anti-larval measures

Some of the above measures will destroy mosquito larvae (eg flushing). In addition there are measures which act directly on the larvae. These include petroleum oils which are applied to the surface of water and kill larvae by suffocation or poisoning and other larvicides such as

Paris green which are poisonous to larvae. Larvivorous fish have also been used where conditions are favourable.

Control of adult mosquitos

Residual insecticides are the most commonly used means to control adult mosquitos. They are sprayed on the preferred resting places of mosquitos, normally the inside walls of houses. The most commonly used insecticides are DDT, malathion and fenitrothion. They may be formulated in various ways, including solutions, emulsions, water-dispersible powders, and granules. An alternative or complement to residual spraying is space spraying of fast-acting compounds.

Genetic control, which reduces the reproductive potential of insects, has been explored but is still primarily the subject of research rather than practical application.

Chemotherapy and chemoprophylaxis

Drugs may be used to prevent transmission or to prevent parasites growing once they are inoculated. They may be used by individuals to protect themselves or as part of a community-wide control programme. While mass chemoprophylaxis has been tried (eg mass distribution of chloroquine to school children), the most widespread use of drugs is to treat diagnosed cases and thus prevent further transmission. Chemotherapy then forms part of a system of case detection and treatment, often involving an active search for infected people, presumptive treatment of suspected cases, and radical treatment of confirmed cases. An alternative or complement to this process is mass drug administration.

3.3 The history of malaria and malaria control in Nepal

The history of malaria and malaria control in Nepal can be divided into three periods, the first up to the late 1950s before the introduction of residual spraying, the second between the late 1950s and early 1970s when eradication was attempted and the third, from the early 1970s to the present, when the aim was control.

Period I

During the first period, the country could be divided into the following areas on the basis of their malaria characteristics (see Map 3.1):

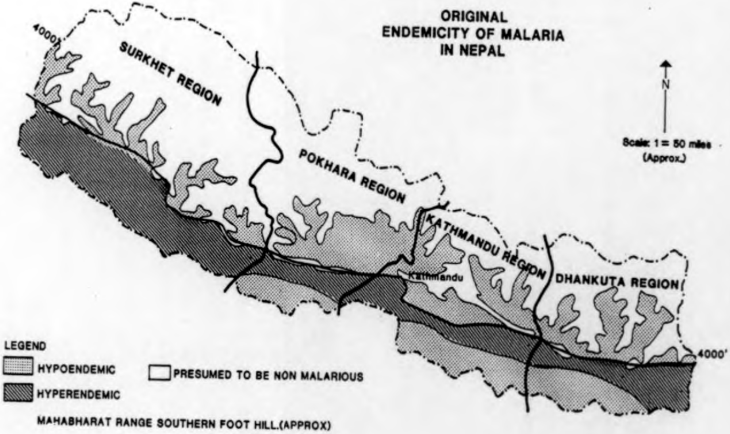
- the southern edge of the outer Terai which was flat, cultivated and with relatively limited malaria, though it was liable to more severe outbreaks from time to time. A.culcifacies was the suspected vector, and A.annularis later implicated. This area was classified as hypoendemic.

- the northern forested edge of the Outer Terai, the lower forested slopes of the Churia and Siwalik hills (below 2000 feet), the Inner Terai and lower forested slopes of the Mahabarat range. This area was intensely malarious, the main vector being A.minimus. It was classified as hyperendemic.

- the area north of the Mahabarat range. In the cultivated valleys between 2000 and 4000 feet, there was some transmission of malaria at a low level, mainly by A.fluviatilis. These areas were classified as hypoendemic.

- parts of the country above 4000 feet where there was little or no transmission of malaria. A.maculatus was later found to be a possible vector here.

Since malaria was known to be prevalent and eradication was initially the objective, there was probably seen to be little point in obtaining accurate and representative parasite rates for the pre-control situation. It is therefore not surprising that the only country-wide information located was as shown below. No population base was available for these rates, and incidence could therefore not be calculated. In the hyperendemic areas P.falciparum was found to be the most common parasite and in hypoendemic areas, P.vivax.



Map 3.1: The original endemicity of malaria in Nepal

Parasite rates pre-spray

Area (Year of survey)	Hyperendemic areas(a) IPR (%)(b)	CPR(%)(c)	Hypoendemic areas(a) IPR (%)	CPR(%)
North central (1959)	29.0-34.6	23.2-40.0	0.0-0.8	0.7-2.2
South central (1959)	9.4-34.4	21.8-50.7	0.5-1.1	0.5-1.1
East zone (1962-4)	20.5-41.6	20.9-50.1	0.2-3.9	0.2-4.3
West zone (1963-5)	11.0-85.1	11.7-70.4	0.0-4.6	1.3-7.8

(a) Classified on the basis of spleen rates
(b) Infant parasite rate
(c) Child parasite rate
Source: NMEO 1970

An earlier survey done in the Rapti Valley (Central Inner Terai) during 1956-7 found that the infant parasite rate was 63%, child parasite rate 57-77%, and child spleen rate 92%. Transmission was perennial, with a peak in the second quarter of the year (NMEO 1966). Supplementary information on this area is provided by a much earlier survey done in Makwanpur and Chitwan by Major Phillips of the Indian Military Services (Phillips 1925). The people in the area were made up of different tribal groups: Tharus, an indigenous race, Rai Dhanwars, of hill origin but who had been settled in the area for some time, and Kumalaya, who were recent migrants. Phillips found differing levels of morbidity and mortality amongst these groups, the Tharus being the least susceptible to malaria and the Kumalaya the most.

A survey of 436 Tharu children showed that 85% had enlarged spleens. Phillips commented that these disappeared with adolescence. Amongst the Rai Dhanwar, former migrants, 65% of 105 children had enlarged spleens, but spleens were not palpable in the majority of children after the age of 12 years. The recent migrants from the Hills seemed to be most susceptible to malaria, suffering both child and adult deaths. For example Phillips estimated a general mortality rate in children of around 43% in migrants and 17% in Tharus. One group of settlers he described as 'doomed to extinction'.

This information suggests that in this particular part of the Inner

Terai, malaria may have had the characteristics of holoendemicity: high spleen rates in children but low in adults for the indigenous population.

Unfortunately this is the only evidence that could be located on the morbidity and mortality caused by malaria before control began. It is not known to what extent it is representative of the Inner Terai as a whole, nor is there similar information available for hypoendemic areas. In the hyperendemic areas, it is likely that immunity in adults gave some considerable degree of protection to indigenous farmers, though at the expense of infant and child mortality. New settlers, both adults and children, seem to have been at high risk of illness and death. In hypoendemic areas, the relatively low infant and child parasite rates and predominant species (P.vivax) suggest that malaria prevalence in adults was relatively low and symptoms milder. Repeated relapses may have caused severe debility in a small proportion of the population. Occasional epidemics, causing morbidity and mortality, are likely to have occurred.

Period II

The second period started when it was shown that residual spraying of DDT inside houses stopped the transmission of malaria in a pilot project in the Rapti Valley in 1956-8. Similar success was obtained by pilot projects in other parts of Nepal. This suggested that malaria eradication was feasible and a nationwide campaign was started, with cooperation from USAID and WHO, based on DDT spraying followed by surveillance. Spray coverage was achieved in 1960-62 in the Central and West zones, in 1964 in the East, and 1965-6 in the Far West.

The campaign had rapid results. Transmission in the A.minimus area fell to a very low level. The combination of DDT spraying and clearing of the forest by settlers which destroyed breeding places resulted in the virtual elimination of A.minimus (none have been found in recent years). In other areas malaria transmission was much reduced but not completely interrupted. In the cultivated areas of the Terai an unexpected vector A.annularis was identified. It is now resistant to DDT; malathion may reduce transmission but does not stop it. Over a wide area, including the A.minimus area, scattered transmission continued at a low level due to A.fluviatilis, which was susceptible but not completely controlled by DDT due to its exophilic habits.

Data on annual parasite incidence was only collected once surveillance systems had been set up. The earliest data for the whole country is for 1968. By then only a few thousand cases were being detected and this level was maintained for several years. However, there seemed little prospect of a complete interruption of transmission and in the early 1970s USAID support was withdrawn as part of a global policy since malaria eradication no longer appeared feasible. The objectives of the programme were changed, with control becoming the immediate objective. Programme activities were withdrawn from hills in the West where there was little malaria and because of operational difficulties and staff shortages.

Period III

The reduction in funding for the programme, together with large scale movements of population, often settling in temporary houses which were difficult to spray (Shrestha undated), contributed to an increase in cases to nearly 15,000 in 1974. Further contributory factors were problems encountered by malaria control in India, leading to a considerable number of imported cases. Extra funds and insecticide were obtained for the Nepal programme and the increase in cases was contained, the level remaining at around 12,000 until the early 1980s when it rose slightly, and markedly in 1984 and 1985 to around 42,000 cases in 1985. The main cause was an epidemic in the Far West. Subsequently, the level dropped to around 37,000 cases in 1986 and 27,000 in 1987. The majority of cases are now concentrated in the West and Mid/Far West Terai (HMG/WHO/USAID/ODA 1986).

A combination of malaria control and economic development has produced wide ranging changes in the ecology of the Terai, affecting vector habitats. A.minimus breeds in partially shaded, slow flowing water with marginal vegetation. Its disappearance in the very similar, adjacent Nainital Terai has been attributed to deforestation and cultivation (Chakrabarti and Singh 1957) and it is likely that similar influences were at work in the Nepal Terai. In Nepal it has been noted that the density of A.fluviatilis is reduced as trees are cut and its breeding places (similar to those of A.minimus) exposed to sunlight, though recently A.fluviatilis has been recorded breeding in clear ponds with vegetation in the plain cultivated Terai (Shrestha undated). In contrast, the density of A.annularis appears to have increased, possibly because of the expansion of irrigation and perhaps because DDT spraying has reduced its natural predators and competitors (White 1982).

3.4. Present malaria control strategies in Nepal

The aims, objectives and strategies of malaria control at the time of this research were summarized in the Nepal Malaria Eradication Organisation (NMEO) Plan of Action (NMEO 1984/5). The objectives were as follows:

Immediate	:	to prevent mortality and further reduce morbidity due to malaria;
	:	to maintain the achievements made so far.
Intermediate	:	to reduce malaria incidence to such a low level that the Primary Health Care System would be able to take over the maintenance of the achievements in confirmation to the HMG's strategies of HFA 2000.
Long Term	:	to control malaria effectively so that it may not hinder socio-economic development and ultimately eradicate it from the country;
	:	to integrate all anti-malaria field operations with the PHC system as soon as the latter becomes ready to absorb such activities.

Malaria control operational strategies

Malaria control operational strategies consist of case detection through various mechanisms, slide examination, treatment of confirmed positive cases, and spraying with residual insecticides. These activities are common to both unintegrated districts, where malaria control is carried out by the National Malaria Eradication Organization (NMEO) and integrated districts, where malaria control is one of a number of services provided by the Integrated Community

Health Services Development Project (ICHSDP). The activities of each strategy are described briefly below. They represent the approaches in general use at the time of the study (1983-5): experiments were and are being made with alternative approaches and these are described in Chapter 9.

(a) Case detection

Active Case Detection (ACD). At the time of this study, throughout the whole malarious area of Nepal with the exception of the hill districts of the mid-western and western regions where anti-malaria operations were withdrawn in 1971 due to their high cost, house to house visits took place monthly to collect blood smears from all people with a present or past history of fever and from those who had recently returned from areas in India where malaria prevalence was high. In the NMEO districts, house to house visits are carried out by malaria field workers (MFW) supervised by unit office staff. In the ICHSDP districts, village health workers (VHW) do the house-visiting, supervised by health post staff.

Activated Passive Case Detection (APCD). Cases detected by MFWs and VHWs outside their normal schedule of visits are termed APCD.

Passive Case Detection (PCD). There are four PCD mechanisms:

> **PCD (H):** All health institutions (hospitals and health posts) are encouraged to collect slides which are then sent to a malaria laboratory.
>
> **PCD (V):** In NMEO districts, volunteers have been recruited and supplied with the means to take blood smears and give presumptive treatment.
>
> **PCD (M):** Cases detected by malaria offices at any level (unit, district, region, headquarters), are termed PCD (M).
>
> **PCD (MC):** At some main hospitals, malaria clinics have been set up to receive any attender to the hospital complaining of

fever. Blood slides are taken and examined on the spot, and radical treatment provided immediately to positive cases.

Mass Blood Survey (MBS): Case detection through MBS takes two forms. In contact surveys, a number of blood slides are collected from the immediate family and close neighbours of a positive case. A mass blood survey is conducted if a sudden outbreak of malaria occurs or if active malaria transmission is suspected.

Follow-up: Slides are taken monthly for 12 months from all diagnosed cases, to screen for relapses.

(b) Parasitology

All slides are examined in malaria-specific laboratories, usually at district level, the exceptions being the malaria clinics which have their own microscopists and some temporary laboratories that are established in unit offices during the peak of the transmission season. Positive slides are notified to unit offices/health posts.

(c) Treatment

Presumptive treatment is given to all people from whom blood slides are collected except those attending malaria clinics. Presumptive treatment consists of 600mg chloroquine for adults and appropriate dosages for younger age groups.

Radical treatment is given to confirmed cases. P.vivax and indigenous P.falciparum cases receive 1500 mg chloroquine (900 mg if presumptive treatment was given within the previous 7 days), and 75 mg primaquine (adult dose) on 5 consecutive days. The only exception is radical treatment for cases detected at malaria clinics where a two day treatment is given of 1200 mg chloroquine and 60 mg primaquine. P.falciparum cases that are classified as Imported A (ie imported from India) receive 1000 mg sulphadoxine, 50 mg pyrimethamine and 45 mg primaquine (adult dose) in a single dose.

Mass drug administration is occasionally done, consisting of 600 mg chloroquine and 45 mg primaquine (adult dose).

(d) Spraying with residual insecticides

In general, spraying is considered to be required whenever the village-level Annual Parasite Index (API) minus imported A cases exceeds 0.5 in the Terai and 1.0 in Hill areas. Focal spraying should be carried out during the transmission season in un-sprayed villages where two or more indigenous cases are detected. Due to financial and supply constraints, these rules have often not been followed precisely.

Malathion, at a dosage of 2 gm of active ingredient (a.i.) per sq metre, is the insecticide of choice in the outer Terai where A.annularis is considered the main vector, since this vector has been shown to be resistant to DDT.

DDT, when available, is used in the moderate receptive areas of the forest and forest fringe in the Terai, Inner Terai and hill valleys where A.fluviatilis and A.maculatus are the vectors, and in some areas of the outer Terai where A.annularis has not yet been implicated as a vector.

Spraying practices are modified in the light of the quantity and type of insecticide available at any particular time. In 1984, two rounds of malathion were sprayed but only one round of DDT (1.5 gm a.i./sq m.) due to shortage of DDT. In 1985, Ficam took the place of DDT in the East, Central and West Regions.

Support programmes

The above operational strategies are backed up by support programmes for health education, entomology, training and research.

Health education. The aim of the health education programme is to inform communities of the objectives, methods and benefits of malaria control. The programme also supports the activities of the volunteers.

Entomology. The entomology programme investigates the ecology, density and behaviour of vectors in different ecological strata in order to provide guidance to control operations.

Training. The Research and Training Centre, Hetauda organizes basic and refresher courses for malaria control staff. In addition, regular seminars and workshops on specific topics are held.

Research. A number of field research projects are under way, supervised and carried out by staff from the Research and Training Section of the NMEO headquarters (NHQ) and from the Research and Training Centre, Hetauda.

Organizational structure

In 1984, the NMEO conducted malaria control activities in 26 districts (made up of 40 political districts), containing 6.2m people. The districts are divided into four Regions: the East, Central, West and Mid-West (including the Far-West). Within each district, unit officers are responsible for the malaria control activities within the unit boundary (approximately 50,000 population). Each unit is divided into localities (approximately 8000 population) each containing one malaria field worker. The organizational structure of the NMEO is shown in Figure 3.1.

For some time, integration of malaria control activities with other Ministry of Health activities has been a policy objective of the Ministry of Health. In 1974, 6 districts were integrated and in 1983, a further 8 districts. Malaria control in these 14 districts, population approximately 3m, is now the responsibility of the ICHSDP. At district level, malaria control is the responsibility of the district health officer, assisted by a malaria assistant. Health posts carry out malaria control activities within their area. Each health post area is divided into a number of vaks, with one village health worker per vak. Very recently (1988), integration has been pursued on a much larger scale.

Unit officers and health post staff carry out case detection and

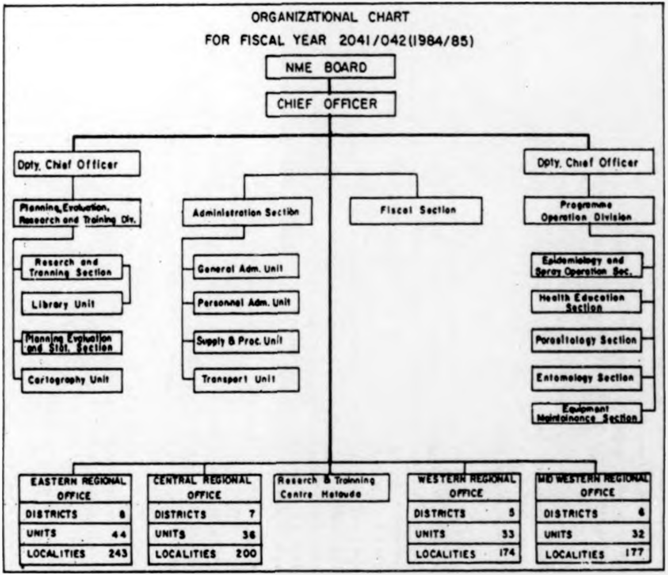


Figure 3.1: Organizational structure of the NMEO

treatment activities, sending slides to the laboratories in the district malaria offices and district health offices. When spraying is required, temporary staff are recruited to work as sprayers, but the staff for direct supervision are drawn from the health posts and unit offices, and the training is done by these staff at their place of work. District and regional officers also supervise spraying activities. Figure 3.2 shows the operational activities carried out by the field units and staff of the NMEO and ICHSDP.

3.5 Economic characteristics of the Nepalese programme

The cost of malaria control

Malaria control has traditionally represented about 20-25% of Ministry of Health recurrent expenditure (WHO 1982). It is thus a major consumer of health sector resources. Table 3.1 shows the annual cost of the malaria programme from its inception in the mid 1950s to 1985/6, including funds from both internal and external sources. External sources have funded and continue to fund insecticides, drugs, equipment and vehicles, while the government finances local costs (mainly salaries). Between 1955 and 1985, around 56% of costs have been locally financed, and the rest externally financed. This balance is heavily dependent on the usage of insecticide, which takes up the great majority of external assistance.

Table 3.1 suggests that the total annual cost of control in 1980 prices has varied surprisingly little between 1965/6, when total coverage was achieved, and the present. Expenditure declined to a low point in the early 1970s but had to be rapidly increased to keep a resurgence of malaria in check. A similar pattern can be seen in the early to mid 1980s though it is slightly distorted by the two-yearly consignments of USAID commodities. Given the current mix of malaria control strategies, an annual cost (1980 prices) of Rs 40m-50m seems to be the consequence.

In order to investigate further the economic characteristics of the control programme, a summary is presented here of 1984 costs by budget code and programme (taken from Mills 1987). While information is

Figure 3.2: Operational activities carried out by field units and workers

FIELD UNITS/ WORKERS	OPERATIONAL ACTIVITIES								
	House Visiting	Blood slide collection	Slide examination	Treatment		Case investigation	MBS	Follow-up	Spraying
				Presumptive	Radical				
NMEO districts									
Unit office									
- MFW	+	ACD/APCD	−	+	−(1)	−	−	+	−
- Malaria assistant/ inspector	−	PCD (M)	−	+	+	+	+	−	+
Volunteers	−	PCD (V)	−	+	−	−	−	−	−
Malaria clinic	−	PCD (MC)	+	−	+	+	−	−	−
Hospital/ health post	−	PCD (H)	−	+	−	−	−	−	−
ICHSDP districts									
Health post									
- VHW	+	ACD/APCD	−	+	−	−	−	+	−
- Health post-in-charge/ AHW	−	PCD (H)	−	+	+	+	+	−	+
Hospital	−	PCD (H)	−	+	−	−	−	−	−

(1) In some areas, MFWs may do some of the radical treatment

Table 3.1: Expenditure on malaria control 1955 to 1985

Year	HMG Expenditure	USAID Financial aid	USAID Commodities	WHO Expenditure	Other Expenditure (a)	ICHSDP (b)	Total Expenditure	GDP Deflator (c)	Cost 1980 prices
1955-8			108,000	1,947,200		N/A	2,055,200	23.0	8,935,652
1958/9	42,310	126,929	120,412	33,210		N/A	324,861	23.0	1,455,917
1959/60	364,453	1,093,339	1,106,130	320,525		N/A	2,884,447	24.0	12,018,614
1960/1	397,703	1,193,110	1,207,047	349,767		N/A	3,147,627	25.3	12,440,983
1961/2	577,300	1,732,100	1,752,420	507,003		N/A	4,568,823	25.5	17,920,874
1962/3	828,014	2,486,441	2,515,485	728,916		N/A	6,559,656	26.9	24,385,337
1963/4	1,132,400	3,397,470	3,437,156	995,909		N/A	8,963,105	28.7	31,230,330
1964/5	1,602,474	4,807,422	4,863,577	1,409,325		N/A	12,683,798	30.6	41,447,054
1965/6	2,106,154	6,034,240	6,104,847	2,274,441		N/A	16,999,882	33.3	51,050,454
1966/7	4,573,694	6,087,590	6,158,707	4,022,420		N/A	20,842,430	38.4	54,277,131
1967/8	5,449,634	6,905,137	6,985,755	1,603,213		N/A	20,983,741	36.3	57,806,134
1968/9	5,051,881	6,663,313	6,741,142	1,991,929		N/A	20,447,390	40.1	50,864,154
1969/70	6,441,645	6,441,645	3,040,000	1,081,232		N/A	17,004,622	42.9	41,502,616
1970/1	6,406,130	6,406,130	1,988,296	1,870,891		N/A	16,671,443	45.9	36,321,226
1971/2	4,899,353	6,119,216	2,982,449	1,430,824		N/A	15,431,901	47.3	32,625,303
1972/3	5,981,253	4,703,000	2,100,000	1,746,786		396,041	14,927,079	53.3	28,007,277
1973/4	12,323,317	3,576,704		2,107,124		407,159	18,504,304	51.4	36,000,593
1974/5	20,210,126			349,900	4,435,200	417,745	25,413,051	62.2	40,856,996
1975/6	54,040,163			2,546,250		1,509,907	58,104,329	79.7	73,000,176
1976/7	37,925,754		11,375,000	3,404,375		1,673,657	51,458,702	80.1	64,240,053
1977/8	27,075,044		20,000,000	1,624,000	2,472,000	1,727,172	53,008,216	77.1	68,419,626
1978/9	27,739,401		20,000,000	3,000,000	1,743,084	1,761,819	53,245,204	84.5	63,012,075
1979/80	28,905,600		20,000,000	2,000,000		1,807,626	52,713,106	92.9	56,741,772
1980/1	23,771,281		33,500,000	3,030,000		1,854,624	61,164,705	100.0	61,164,705
1981/2	23,627,904		19,324,440	1,990,442		1,902,845	46,845,631	107.9	43,415,784
1982/3	35,285,734		773,720	11,007,136		1,952,318	49,018,909	118.0	41,541,448
1983/4	30,111,786		25,651,650	1,900,730		5,223,079	62,886,245	132.5	47,461,694
1984/5	40,500,000		3,752,000	2,587,512		5,350,079	52,189,271	139.1	37,526,435
1985/6	40,500,000		23,901,500	2,941,900	23,120,730	5,490,210	95,300,360	147.7	64,482,302
Total Rs	448,730,540	67,774,116	229,250,644	56,519,029	31,189,934	31,561,082	865,014,845		1,105,938,764
Total $1980									99,494,229

N/A=Not Applicable

(a) Includes UNDP and ODA expenditure.

(b) Estimated on basis of per capita cost of Rs 1.13 (derived from Gilles 1987 and HMG/AID/WHO 1975).

(c) From Shrestha (1974) for 1955-9 and International Statistics Yearbook for remainder.

readily available for national and regional levels (NMEO only), this detail is only available for five districts:

- + Morang (NMEO, East region, Outer Terai);
- + Rupandehi (NMEO, West region, Outer Terai);
- + Ilam (NMEO, East region, Hill);
- - Saptari (ICHSDP, East region, Outer Terai);
- - Parsa (ICHSDP, Central region, Outer Terai)

The share of regional and national costs that can be attributed to these districts was estimated according to the method described in Annex 2.

Distribution of costs by budget code

Table 3.2 shows the distribution of costs by budget code in 1986 for all five districts, two NMEO regions, and NMEO headquarters. Perhaps the most striking feature of Table 3.2 is the small share of capital in total costs. In the 5 districts, the range is from less than 1% to around 4%. Rent, although shown as a recurrent item, should be added to this as representing the value of the services of buildings. Even so, the share of capital is less than 4% except in Saptari where rent alone takes up 5%. The figures reflect the absence of capital items at district level, especially vehicles. In NMEO districts, vehicles are kept at Regional level, and this is reflected in the capital share at the two regions (15-18%, or 22% including rent). The capital share is also a relatively low proportion of HQ costs even if external assistance is excluded from total costs.

Within recurrent costs (excluding WHO support), virtually all are incurred by the government except in sprayed districts. Labour takes up the largest share of recurrent costs except in Parsa where insecticide takes the lion's share. Indeed all district shares are heavily affected by the amount of spraying: insecticide takes up 10% of total costs in Morang, 36% in Rupandehi and 70% in Parsa. After labour costs and insecticide, the next largest share of recurrent costs goes to DA/TA (per diem and travel allowances). Other items are very low or insignificant, including drugs. Externally donated drugs, Fansidar and primaquine, take up less than 0.05%. The low proportion

Table [illegible]: Distribution of costs (a) by budget code, [illegible]

Code No	Description	[illegible] %	[illegible] %	Ilam %	Kap[illegible] %	Parsa %	East Region %	West Region %	[illegible] %
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	Office goods	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	Fuel, [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	Fuel, other purposes	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	Clothes	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
7.5.1	Supplies	0.5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
8.1	Encouragement prizes	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0
8.3	Drugs	3.4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
9	Contingencies	*.*	0.0	*.*	[illegible]	*.*	1.0	1.0	[illegible]
10.1	Furniture	*.*	*.*	*.*	0.0	0.0	0.0	0.0	0.0
10.2	Vehicles	0.0	0.0	0.0	0.0	0.0	0.0	0.0	*.*
10.3	Machinery, equipment	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.3
Total government recurrent		87.6	62.1	[illegible]	[illegible]	[illegible]	[illegible]	82.1	56.9
	Drugs	*.*	*.*	*.*	*.*	*.*	0.0	0.0	0.0
	Insecticides	[illegible]	35.9	0.0	0.0	69.8	0.0	0.0	0.0
	Measles	0.4	0.4	0.0	0.0	2.0	0.0	0.0	0.0
	WHO HQ support	0.0	0.0	0.0	0.0	0.0	0.0	0.0	38.1
Total external recurrent		10.2	36.3	*.*	*.*	71.7	0.0	0.0	38.1
Total recurrent		97.7	98.4	[illegible]	96.6	95.9	84.6	82.1	95.0
Capital:	Vehicles	0.0	0.0	0.0	2.0	0.3	13.3	16.4	3.6
	Microscopes	0.5	0.5	0.4	0.8	0.2	2.1	1.4	0.9
	Sprayers	1.7	1.1	0.0	0.0	3.6	0.0	0.0	0.0
	Other	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.5
Total capital		2.3	1.6	0.4	3.4	4.1	15.4	17.9	5.0
Total cost		100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

. Cost less than 0.05%

(a) Recurrent costs represent recurrent expenditure; capital costs represent the annuitised value of the capital stock.

taken up by fuel costs again reflects the limited use of motorised transport.

Distribution of costs by programme

Table 3.3 shows the distribution of costs in 1984 by programme for the 5 districts, 2 Regions and NMEO headquarters plus the Research and Training Centre (RTC). In all five districts, the distribution of costs by programme depends vitally on whether or not spraying takes place in the district. Where it does not (Ilam and Saptari) administration takes approximately 11%, parasitology 8-11%, with surveillance (including health education in the case of Ilam) taking the balance. In sprayed districts, the spraying programme is the largest, reducing the proportion of the other programmes significantly except in Morang where only limited spraying took place.

The programme shares in the two NMEO regions are very similar, administration being the largest programme, followed by entomology and parasitology. At the NMEO headquarters, administration is also the largest programme, though followed by research and training. The great majority of research and training costs is accounted for by WHO assistance (50%) and by the expenditure of the Research and Training Centre (40%).

It is of interest to note the proportion of resources in ICHSDP districts devoted to malaria control. In Saptari, malaria absorbs 22% of the regular budget expenditure of the district public health office and 11% of the regular budget expenditure of health posts. In Parsa, these proportions are 25% and 14%. It was impossible to calculate the proportion that malaria control absorbs of total district resources since allowance cannot be made for resources received in kind by the other programmes.

3.6 Summary

This chapter has reviewed the epidemiology of malaria and malaria control policies and strategies in order to provide a background to the research. The characteristics of malaria were summarized and control measures briefly described. The history of malaria and

Table 3.3: Distribution of costs by programme, 1984

	Surveillance	Parasitology	Health education	Spraying	Administration	Entomology	Research and training
	%	%	%	%	%	%	%
Morang	62.5	5.4	11.5	14.6	6.2	0.0	0.0
Rupandehi	39.1	7.0	4.7	45.4	3.8	0.0	0.0
Ilam	68.0	5.7	15.5	0.0	10.9	0.0	0.0
Saptari	78.2	11.1	0.0	0.0	10.7	0.0	0.0
Parsa	10.4	2.1	0.0	86.2	1.4	0.0	0.0
East Region	12.3	14.0	4.0	7.8	41.9	20.1	0.0
West Region	10.9	14.3	4.2	9.3	42.3	19.0	0.0
NMEO NHQ+RTC	4.2	2.4	3.6	2.8	54.2	3.1	29.7

malaria control in Nepal was then outlined. From the early 1970's to the early 1980's, around 12,000 cases occurred a year. This figure increased to a peak of 42,000 cases in 1985 and subsequently fell to 27,000 in 1987.

Present malaria control strategies in Nepal were described in some detail. Case detection was carried out by active case detection (house-to-house visits by malaria field workers and village health workers) and by a variety of passive methods. These included PCD (H) (case detection by health institutions), PCD (V) (case detection by malaria volunteers), PCD (M) (case detection by malaria offices), and PCD (MC) (case detection by malaria clinics). In all case detection strategies except PCD (MC), a blood slide was taken and presumptive treatment given. Slides were examined in malaria laboratories and positive cases traced and given radical treatment. In malaria clinics, the blood slide was examined and radical treatment given immediately. Chloroquine was used for presumptive treatment; chloroquine and primaquine for radical treatment for P.vivax and indigenous P.falciparum: and sulphadoxine, pyrimethamine and primaquine for imported P.falciparum.

Spraying of radical insecticides was used wherever the API minus imported A exceeded a given level. Malathion was used where A.annularis was considered the main vector, and DDT elsewhere. Shortage of insecticide severely limited the amount of spraying.

Operational strategies were backed up by support programmes for health education, entomology, training and research.

The Nepal Malaria Eradication Organization (NMEO) was responsible for control activities in 26 districts covering 6.2m people. The Integrated Health Services Development Programme (ICHSDP) was responsible for malaria control in 14 districts covering 3m people. Malaria control strategies used by the two organizations were similar, though the NMEO employed single-purpose workers and the ICHSDP mainly multi-purpose workers.

The economic characteristics of the malaria control programme were briefly described. Malaria control absorbed 20-25% of Ministry of

Health recurrent expenditure. Capital took up a very small share of total costs and labour a very large share of recurrent costs except in sprayed districts. In unsprayed districts, the administration programme absorbed approximately 11% of total costs, parasitology 6-11% and surveillance the balance. In sprayed districts, the spraying programme was the largest.

4. A STUDY OF THE COST-EFFECTIVENESS OF MALARIA CONTROL IN NEPAL

4.1 Objectives of the study

As stated earlier, the objectives of this research study are to:

- explore the relevance of recent developments in the methodology of cost-effectiveness analysis to disease control programmes in developing countries and specifically to malaria control in Nepal;

- apply cost-effectiveness analysis to the malaria control programme in Nepal in terms both of
  - (a) the cost-effectiveness of various malaria control strategies and
  - (b) the cost-effectiveness of the malaria control programme as a whole

  in order to refine a methodology capable of more general application to disease control programmes in developing countries;

- assess whether policy-relevant conclusions can be drawn from the application of cost-effectiveness analysis to the malaria control programme in Nepal.

The review in Chapter 2 has identified the current state of cost-effectiveness methodology and current good practice. This chapter considers how this can be applied to malaria control in Nepal, the data requirements and how the data can be and was obtained. In developing an appropriate methodology, three major areas must be tackled: the conceptual framework for the analysis; the methodology of the cost analysis; and the approach to the assessment of effectiveness. These three areas are considered in turn below, and are followed by a description of the methods used to obtain information relevant to the cost-effectiveness study from malaria patients.

4.2 Framework for the analysis

The conceptual framework for the analysis, based on ideas presented in Drummond and Stoddart (1985), is shown in Figure 4.1. It sets out those

Figure 4.1: Framework for the cost-effectiveness analysis of malaria control

Costs

I Costs to the government of malaria control (ie costs of the NMEO and costs of malaria control borne by the ICHSDP and other Ministry of Health services).

II Costs borne by patients, their households and community members:
- payments for treatment and transport to obtain treatment;
- loss of time for the patient during the illness prior to cure and for relatives who look after the patient (time may be diverted from household activities, work outside the home and leisure);
- time and money costs of preventive actions taken by households and communities.

Consequences

I Cases of illness and death averted (through preventive strategies); reduction in length of illness and secondary transmission prevented (through curative strategies).

II Savings in resource use:
- savings in government resources that in the absence of curative or preventive malaria control strategies would be spent on treatment of cases;
- similar savings in individual or household expenditure on treatment and travel;
- savings in lost work time.

III Changes in the quality of life to patients and their households and to the whole community as a result of malaria control.

Source: adapted from Drummond and Stoddart (1985) costs and consequences relevant to a cost-effectiveness analysis of malaria control. The costs of malaria control are made up of two main categories: those falling on the government and those falling on the patient, his/her family and the community. Consequences are of two main types. The first is the immediate health effect of prevention or cure of malaria, namely cases prevented, illness curtailed and any secondary cases prevented through prompt treatment. The second is any savings in resource use to the government or individuals and households: for instance savings in government and household expenditure on treatment as a result of preventive strategies for malaria. The inclusion of savings in lost work time as a category of this type of consequence is controversial as discussed earlier, not least because it may bias evaluation in favour of individuals or groups that participate in economic activity. Moreover, in a country such as Nepal, obtaining a value for lost work time is both conceptually and methodologically difficult. However, since the surveys described later in this chapter throw some light on the magnitude of lost work time and its implications for households, this category of consequence is retained.

The third type of consequence listed is change in the quality of life for patients, households and the community. This consequence adjusts the health consequence by some measure of its value to individuals. For example, 10 days of illness resulting from infection with P.falciparum might not be considered as equivalent to 10 days of illness resulting from infection with P.vivax, because of differences in both the severity of the illness and the risk of serious complications. Adjustment to health consequences to allow for the severity of the illness or quality of life are most commonly made for health programmes which treat chronic conditions where the quality of life following treatment is an important consideration. In the case of a malaria control programme, where the health consequence, cases averted or reduction in days of illness, consists of change in an acute illness of relatively short duration, quality of life is a much less important consideration. Two features do, however, deserve mention, though they are difficult to quantify. Firstly, prompt treatment of P.vivax malaria prevents relapses and consequent anaemia and debility which affects the quality of life. Secondly, there may be a reduction in the fear of malaria amongst the whole community as a consequence of the malaria control programme. In Nepal, it is frequently said that the severely malarious areas of the

Terai were much feared by Hill dwellers and travellers prior to malaria control; thus malaria control has given rise to a community-wide benefit affecting not merely the inhabitants of malarious areas but also those who travel through them.

Integral to a cost-effectiveness analysis is the comparison of alternative ways of achieving an objective. In the case of malaria control, this comparison is particularly complicated, for two main reasons. Firstly, malaria control is usually conducted through a mix of strategies some of which are primarily preventive (vector control), some curative (various treatment regimes) and some both preventive and curative (case detection and treatment). The health consequences are thus heterogeneous: both cases prevented and cases cured. Secondly, because of the process of malaria transmission, one case cured or prevented may prevent also further cases. Thus a dynamic view should ideally be taken of health consequences.

Cost-effectiveness analysis investigates alternative ways of achieving an objective, and objectives and choices can be specified at different levels. In the case of malaria control, the following different levels can be distinguished, involving objectives and choices of increasing specificity:

(1) the objective of improving health (choice of malaria control versus other means of health improvement);
(2) the objective of malaria control (choice of vector control versus case detection and treatment and various mixes of both);
(3) the objectives of (i) vector control and (ii) case detection and treatment (choice of strategies for each);
(4) the objective of delivering a pre-determined strategy (choice of means of blood slide examination, choices of different mixes of staff for various activities, choice of organizational pattern etc).

The importance of these levels is at the same time conceptual, relevant to policy and practical. If decision-makers want to choose between investing a given sum of money in malaria control rather than another health programme, then the objective is at the first level, that of improving health, and the measure of health consequence used must be one that is common to many different health programmes, for instance increasing years of healthy life.

If decision-makers are more concerned with how to maintain malaria control, then the objective is at the second level, and the measure of health consequence used must be relevant to comparisons between, for example, case detection and treatment on the one hand and vector control on the other.

Practical considerations, however, affect the extent to which these two types of analysis can be done, for the nature of the association between resources invested and improvement in health or prevention of malaria is difficult to specify. This is particularly true in Nepal, where malaria control has contributed to population redistribution and consequent environmental changes which mean that the consequences of removing preventive measures are difficult to determine. Because of the difficulties of assessing effectiveness in terms of change in health, analysis often concentrates on evaluating alternatives to achieve the third and fourth levels of objective. At the third level, the objectives are stated separately, not requiring choice between them. For instance, if the objective is that of detecting and treating cases, the measure of health consequence used would be cases detected and treated. At the fourth level, the desirability of malaria control and of existing control strategies is taken for granted, and emphasis placed on discovering the least cost way of delivering the components of a control strategy, for instance examining a blood slide or spraying a house.

Assessing cost-effectiveness in terms of health impact is, however, extremely important. For instance, there is little point in minimizing the cost of an ineffective control strategy. Thus in the cost-effectiveness analysis here, an attempt is made to produce information relevant to all four levels of objective. The choices to be evaluated are therefore :

Level 1: choice of malaria control versus other health programmes;
Level 2: choice of vector control versus case-detection and treatment as means of malaria control;

Level 3: choice of means of case-detection and treatment, including case detection by active and passive methods and use of anti-malarial drugs);

: choice of means of vector control, including alternative insecticides and environmental management;

Level 4: choice of ways of organizing an activity, for instance district versus peripheral laboratories, integrated versus unintegrated patterns of organization.

While these choices have been specified in terms of 'either/or', it is also important to look at a mix of strategies, and particularly at choices 'at the margin': for instance, given an existing mix of strategies, at where additional resources might be put.

The cost-effectiveness analysis required the collection of data firstly on financial and economic aspects of malaria control activities (both government and non-government) and secondly on the effectiveness of malaria activities in controlling malaria. The methodology adopted for these components of the analysis is described below.

4.3 Sub-study no.1: cost analysis

Cost information was required on the costs of malaria control falling both on the government and on households and individuals. Household cost information was obtained as part of the surveys of malaria patients and households described later. This section therefore deals with the analysis of costs to the government.

The aims of the cost analysis were:

(i) to identify the resources used with the objectives they served;
(ii) within each main objective, to allocate resources used to operational activities.

The cost analysis of government malaria control activities was divided into two parts. In the first part, the geographical distribution of NMEO expenditure on malaria control was analysed, in order to look at the proportion of expenditure absorbed by different geographical areas and the relationship of expenditure to population covered and cases treated. This analysis was limited by the availability of financial information to NMEO districts only, and to recurrent not capital expenditure. The more detailed information required for the cost-effectiveness analysis was produced by undertaking in depth cost analyses in five districts. Cost analysis was done with the aid of a micro-computer and spreadsheet programme (Lotus 123). The methodology of the cost analysis is described in detail in Annex 2. The approach adopted is summarized here, firstly for the analysis of the geographical distribution of NMEO resources, and secondly for the detailed analysis in five districts.

Analysis of the geographical distribution of NMEO resources

The aim of this analysis was to compare the resources used in malaria control between NMEO districts. All resource use, therefore, needed to be allocated to districts. Total resource use (excluding capital) was calculated by adding together for each district:

- actual district expenditure;
- an estimate of the cost of the drugs used;
- an estimate of the cost of insecticide used;
- a share of regional expenditure;
- a share of National Headquarters (NHQ) and Regional Training Centre (RTC) expenditure.

Malaria statistics are reported for years of the Gregorian calendar not financial years. In order to use comparable financial information, expenditure in 2039/40, 2040/1 and 2041/2 (July to December) was converted to equivalent expenditure for 1983 and 1984 by analysing the proportion of financial year expenditure disbursed in the first 6 months (July to December) and adding it to the last 6 months' expenditure of the previous financial year.

Drugs and insecticide purchases and donations are reflected in NHQ accounts, but their supply date may bear little relationship to when they are used. Expenditure on drugs and insecticides was therefore subtracted from NHQ expenditure and added in at district level by multiplying quantities used (kilos of insecticide and quantities of drugs obtained by multiplying numbers of cases by drug dosages) by the estimated price paid (see Annex 2 for details of how prices were calculated).

Different districts are likely to make different claims on regional and NHQ resources depending on their size and the severity of their malaria situation. It is thus necessary to share out the costs of NHQ and regional offices to districts. This was done by taking NHQ and Regional expenditure by programme (surveillance, parasitology, health education, spraying, administration, entomology, research and training) and apportioning each programme to districts according to various criteria (see Table A2.4 in Annex 2). For instance spraying expenditure was distributed in proportion to the population sprayed, and surveillance expenditure in proportion to an index giving equal weight to population and number of cases.

Analysis of government malaria control costs in five districts

The second part of the cost analysis involved the following sequence of steps:

- five districts were selected for the analysis;
- a comprehensive listing was made of all government resources used for malaria control in the five districts, their appropriate regions, the RTC and NHQ, including both capital and recurrent inputs and externally donated items;
- resource use was analysed by the purposes it served. In NMEO districts, regions and NHQ, this analysis was based on the programme budget structure;
- a share of regional, NHQ and RTC costs by programme was allocated to the district programmes;
- within each programme, resources were allocated to operational activities;
- resources valued in financial prices were converted to economic prices to obtain a true measure of the opportunity cost of the resources used;
- the cost of each operational activity was divided by measures of output, to produce unit costs.

Choice of districts. The choice of districts was governed by the need to obtain a representative selection of districts but also tempered by practical considerations. In order to match government with private expenditure, it was convenient to select districts where the patient survey (described below) had investigated private expenditure. Thus Morang in the East, and Rupandehi in the West were selected. A hill district, Ilam, was then added. Two ICHSDP districts were selected, Saptari and Parsa, on the basis of availability of financial and malaria data and accessibility. The location of the districts are shown in Map 4.1. They cover the main characteristics considered to influence the costs of malaria control, namely:

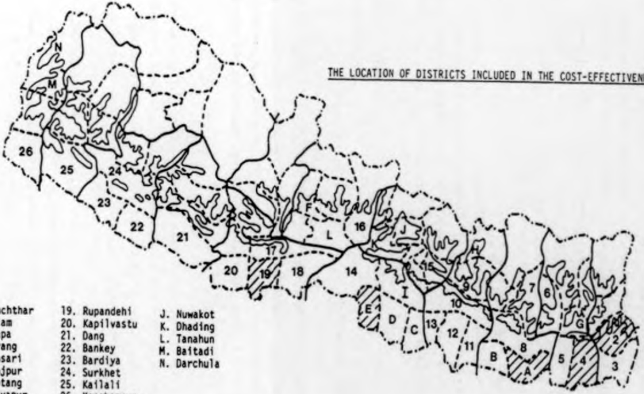
- terrain (Terai and Hill; East and West Terai);
- receptivity (low and moderate);
- vector (A. annularis and A. fluviatilis);
- species (differing proportions of P. vivax and P. falciparum);
- malaria incidence (relatively low API to relatively high API);
- classification of cases (high proportion of imported cases to low proportion);
- organizational pattern (integrated and non-integrated).

Listing of resources used. In order to obtain information on resource use, information available at NMEO and ICHSDP headquarters was collected, and visits were made to all five districts and to the two NMEO regional offices (East and West). The cost of drugs and insecticide was estimated on the basis of quantities used and replacement prices. The main capital assets were valued at replacement cost and converted to an annual cost.

Since the NMEO is a single-purpose organization, all resource use serves the purposes of malaria control. In the ICHSDP districts, however, malaria control is only one of a number of activities carried out. A malaria budget does exist, but this funds only supplies for treatment and spraying, and the regular budget funds staff costs and other development budgets fund some supervision costs. Resources used by malaria control were thus estimated by identifying actual resources used where possible (for instance drugs and insecticides, salaries of malaria assistants and microscopists) and elsewhere estimating the proportion of staff time, or building space etc, used by malaria control. In this way, ICHSDP district malaria costs were identified. It did not prove

Map 4.1: Location of the districts for the cost-effectiveness study

THE LOCATION OF DISTRICTS INCLUDED IN THE COST-EFFECTIVENESS STUDY



1. Panchthar
2. Illam
3. Jhapa
4. Morang
5. Sunsari
6. Bhojpur
7. Khotang
8. Udayapur
9. Ramechhap
10. Sindhuli
11. Dhanusa
12. Mahottari
13. Sorlaki
14. Chitawan
15. Kobhre
16. Gorkha
17. Palpa
18. Nawalparasi
19. Rupandehi
20. Kapilvastu
21. Dang
22. Bankey
23. Bardiya
24. Surkhet
25. Kailali
26. Kanchanpur

A. Saptari
B. Sirha
C. Rautahat
D. Bara
E. Parsa
F. Kaski
G. Dhankuta
H. Dolakha
I. Makwanpur
J. Nuwakot
K. Dhading
L. Tanahun
M. Baitadi
N. Darchula

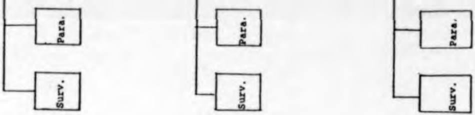
Districts included in the cost-effectiveness study possible, however, to estimate the share of ICHSDP headquarters' resources consumed by malaria control.

Resource use by purpose. Within the overall objective of malaria control, a number of sub-objectives can be specified, for instance surveillance, spraying etc. Such sub-objectives can be identified with programmes. Indeed, the NMEO has implemented a programme budget system whereby the budgets and financial accounts for malaria control are sub-divided into a series of programmes, each of which has a different purpose, although each serves the main purpose of malaria control. Such a programme budget structure much facilitated the cost analysis.

Figure 4.2 shows the programme budget structure at different management levels, and more details on the activities funded by each programme are given in Annex 2, Table A2.1. Some adjustments needed to be made to the allocation of expenditure between programmes. For instance, the salary of the district malaria officer was paid from the surveillance programme although he was responsible for all programmes. Such misallocations were adjusted, based on discussions with the districts. ICHSDP districts did not use the programme budget structure, and resource use by programme was estimated.

Distribution of NHQ, RTC and regional costs to districts. NHQ, RTC and regional costs by programme were allocated to districts according to the criteria shown in Table A2.4 in Annex 2. Programme costs thus comprise three elements: district level costs, regional overheads and NHQ and RTC overheads.

Allocation of resources to operational activities. A number of operational activities were defined, which are carried out under the umbrella of various programmes (see Figure 4.3). Operational activities are the basic elements of malaria control, such as case detection and slide examination. They are provided by the surveillance, parasitology, health education and spraying programmes. The two other programmes, research and training, and administration, provide support but are not themselves responsible for operational activities. (Entomology is also a support programme but its prime purpose is to support the spraying programme and so was subsumed within that at district level). Research and training was kept in the analysis as a support programme, but the



Key: Surv = Surveillance Para = Parasitology Educ = Education
Spray = Spraying Admin = Administration Ento = Entomology
R & T = Research and Training.

Figure 4.2: The programme budget structure of NHQ, Region and district levels

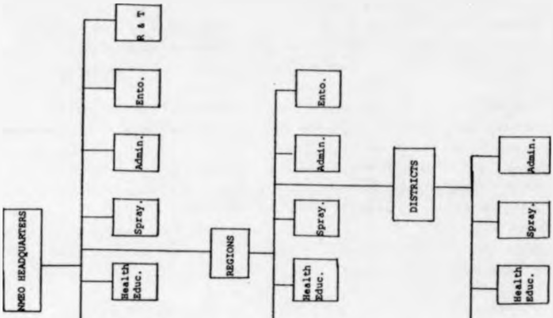


Figure 4.3: Operational activities funded by programmes

Programme	Operational activities
Surveillance	Active case detection Activated passive case detection Passive case detection (hospital) Passive case detection (malaria office) Passive case detection (malaria clinic) Mass blood survey Radical treatment and investigation
Parasitology	Slide examination, district and unit laboratories Slide examination, malaria clinic
Health education	Passive case detection (volunteers) Community education
Spraying	Spraying

administration programme was distributed to the other programmes in proportion to their total cost. The spraying programme finances only one operational activity (spraying). The health education programme finances primarily PCD (V), but also community education activities. The cost of the latter could not be separated out so is included in the cost of PCD (V). The surveillance and parasitology programmes finance several activities, so the costs of the surveillance programme were distributed between the various forms of case-detection and radical treatment, and the costs of the parasitology programme between the district laboratory and malaria clinic. The costs of case detection and radical treatment cannot easily be distinguished from each other, since certain costs are joint. A particular problem arises from the use of MFWs for radical treatment in some districts. The views of district and unit officers were relied on to estimate the proportion of time spent on different operational activities within the same programme.

Conversion of financial prices to economic prices. The appropriate concept for valuing resources in an economic analysis is that of social opportunity cost - the value to society of a particular resource in its next best alternative use, or what has to be given up by using the resource in its current activity. Financial prices (prices actually paid) may not accurately reflect social opportunity cost and where necessary are adjusted to produce 'shadow' or 'accounting' prices. The method adopted is described in Section 6.4 of Annex 2. In brief, traded goods and services are valued at world (border) prices, that is the price prevailing on the world market, and the prices of non-traded goods and services are adjusted by use of conversion factors so that all goods and services are valued in terms of a common yardstick.

Calculation of unit costs. The costs of the operational activities were divided by appropriate measures of output to produce unit costs. Measures of output were specific to each programme, and included cases treated in the surveillance programme, slides examined in the parasitology programme, and houses sprayed in the spraying programme.

Accuracy of the cost analysis. The method of cost analysis described here may produce certain inaccuracies:

- programme budgeting has only recently been introduced into the NMEO, and until 2041/2 (1984/85) there was no requirement to report expenditure by programme. Malaria staff accepted that a particular bill might be charged against a programme that had funds remaining rather than against the correct programme;
- when joint costs have to be divided between activities, there is inevitably some uncertainty over the precise division;
- drugs and insecticides have been costed on the basis of numbers of cases and kilos of insecticides used. To the extent that wastage or losses of supplies occur, this is likely to be an underestimate of actual costs.

The great majority of costs, however, are salary costs. These are the easiest to account for accurately by programme, and thus serious misallocation between programmes is unlikely. Distribution of staff time between operational activities in the surveillance programme is more speculative, but if this has been done correctly, misallocation of other inputs will have little effect on unit costs.

4.4. Sub-study no.2: effectiveness analysis

The information on effectiveness required for the cost-effectiveness analysis is defined by the measures of effectiveness needed to answer the questions posed. The measures of effectiveness required differs, as discussed above, depending on the level of the choice being considered. A distinction is commonly made between two types of measure:

- measures of activities (or intermediate output);
- measures of final output.

Choices at the first and second levels discussed above require measures of final output, whereas choices at the third and fourth levels require measures of intermediate output.

Measures of final output relevent to malaria control are:

- number of days of healthy life gained;
- change in annual parasite index (API);

- cases cured;
- cases prevented.

Measures of intermediate output are specific to particular strategies, and include:

Case detection	- population covered; - number of slides collected; - annual blood examination rate (ABER); - number of houses visited; - number of cases detected.
Treatment	- number of cases given presumptive treatment; - number of cases given radical treatment.
Spraying	- number of houses protected; - number of people protected; - reduction in vector densities.
Environmental management	- number of ponds cleared; - number of people protected; - reduction in vector densities.

Information on final output measures: the majority of final output measures are not readily available from the routine information systems of the NMEO and ICHSDP. Indeed the only measure readily available and likely to be accurate is that of 'cases cured'. Even in the case of this measure, however, there is some scope for inaccuracy since records report the number of cases given radical treatment and the number that relapsed (in the case of P.vivax) or recrudesced (in the case of P.falciparum). The head-count of numbers treated is likely to be accurate since a record is kept of every patient, but individuals not successfully treated, who relapse or recrudesce, are likely to be underestimated since this statistic relies firstly on identifying the case and secondly linking it to the earlier episode.

The API is routinely reported, but its accuracy depends on whether it is representative by time and place. Annual blood examination rates are relatively high in NMEO districts, for example averaging 16.2% in the

East, 19.6% in the Centre, 16.9% in the West and 14% in the Far-West in 1984. However, whether they are representative is unknown.

Annual blood examination rates are much lower in ICHSDP districts, ranging in 1984 between 0.5% and 13.7%, with an average for all 14 integrated districts of 6.7%. Malaria staff of both the NMEO and ICHSDP felt that coverage was poor and cases missed. Therefore the API is likely to be a poorer indicator of malaria incidence, and of changes in incidence from one year to the next, in ICHSDP than in NMEO districts.

The two other measures of final output, number of days of healthy life gained and cases prevented, are far more difficult to estimate since quantifying them requires an answer to the question of how malaria would respond to a cessation of a particular strategy or of the control programme as a whole, or to the replacement of one strategy by another.

Estimates of the likely malaria incidence in the absence of a control programme are difficult to base on an empirical study. Even if control measures were stopped in one area of Nepal as an experiment, any results would not necessarily be applicable to the rest of Nepal given the varying epidemiology of malaria over Nepal. Most economic studies of malaria attempt to quantify cases prevented by reference to the situation before the control programme was introduced. However in Nepal there are good reasons for arguing that the pre-control situation is not likely to re-appear:

- the original, extremely efficient vector in hyperendemic areas, A.minimus, appears to have been virtually eliminated;

- significant environmental changes have occurred, most notably a reduction in the area under forest and an increase in the cultivated area;

- substantial population movements have increased population density in the Terai;

- the population now has much greater access to private treatment facilities, including drug stores.

Overall, these points suggest that incidence is now likely to be less in the absence of control that it was pre-control. However, two factors complicate the assessment. Firstly, the Nepal malaria situation is highly dependent on the Indian malaria situation, itself unpredictable. Epidemics in the Indian Terai could spread to Nepal (and have done so in the past but intensification of control efforts in Nepal have contained the epidemic).

Secondly, the spread of chloroquine-resistant strains of malaria parasite from India to Nepal has implications for the case fatality rate. Without resistance, cases are likely to rise but the risk of deaths will continue to be relatively small. With resistance, deaths are likely to increase in the absence of proper treatment. Even if the government reaction is to expand treatment facilities, resistance to fansidar (the drug of choice with chloroquine resistance) is likely to develop, resulting in the use of much more expensive and complicated-to-administer drugs, and again in increased deaths.

Assessing the relative effectiveness, in terms of cases prevented, of one strategy over another is in principle more susceptible to empirical investigation. Comparative data is collected by the NMEO on malaria incidence in sprayed and unsprayed areas, but given that areas selected to be sprayed are those anticipated to present control problems, most assessments of the NMEO's spraying programme have felt that few conclusions on the effectiveness of spraying can be drawn from this data. Moreover, while assessment of the effectiveness of one control measure over another is always difficult, it is particularly difficult in Nepal because the incidence of malaria is relatively low. Control strategies are aimed primarily at maintaining this low level rather than producing a significant reduction in cases. The number of cases prevented is thus somewhat hypothetical, and no strategy is likely to produce a large decrease in cases, making detection of its actual effect difficult.

Complementing the cost-effectiveness study by a field survey of the effectiveness of various malaria control strategies would have been prohibitively expensive and time consuming, and possible trials were in any case being discussed and planned by the NMEO. It was decided in this study, therefore, to rely on the existing information system of the NMEO and ICHSDP, on various existing reports and on informed speculation for evidence on the effectiveness of malaria control in terms of final output measures.

Information on intermediate output measures: the routine information system produces relatively promptly virtually all of the measures of intermediate output listed earlier. In general, standards of data collection for specific activities seemed relatively high, and the activities of field staff were regularly checked by their supervisors. There are therefore good grounds for believing that the information is reasonably accurate.

Major problems arise with respect to only one indicator, namely reduction in vector densities. While routine entomological work is carried out, much of the field data is not easy to interpret. For example White (1982) reports that:

"Although three-fourths of the people living in the NMEO programme area are not protected by house-spraying, nearly all the entomological studies have been conducted in sprayed villages. The available data from sprayed villages are insufficient for computation of vectorial capacities and receptivity to malaria for the years since 1974, and there is virtually no information on which to base estimates of the malariogenic potential in unsprayed situations".

Finally, this research encounters problems of data availability that are common to any study of a routine programme, namely that empirical data is available for only those control strategies that are actually employed. This is a particular problem in the case of assessing the cost-effectiveness of environmental management, a control strategy that the NMEO has only recently begun to consider seriously, but also applies to possible variants of existing control strategies. Thus assessment of the effectiveness of various control strategies has to be based not only on empirical data from Nepal but also on published evidence from elsewhere and consideration of its relevance to Nepal.

4.5 Sub-study no.3: patient survey

The cost-effectiveness analysis framework adopted in the research required information on the number of days of illness and incapacity caused by malaria, on the use made of sources of treatment other than those offered by the NMEO/ICHSDP, and on the expenditure of malaria patients on treatment. This information is not routinely produced by the NMEO information system, though some relevant information is collected but not analysed via the SF5 form which is filled in for each malaria case identified and reports the result of the investigation of the circumstances surrounding each case as well as brief personal characteristics of the patient.

Since every case identified is visited and investigated, an economical means of collecting the additional data required for the cost-effectiveness analysis was to add on a brief, extra form to the SF5 enquiry. This form (the ESM1 form) inquired about number of days of work and school lost as a result of malaria, about use made of various sources of treatment, and about private expenditure on treatment. NMEO districts were stratified by geographical region and one district chosen at random from the East, Central, West and Mid-West Terai, and from the Hills. To these five districts was added one ICHSDP district. In order to minimise the effort required to obtain the information, the ESM1 form was filled in at the same time and by the same malaria worker as the SF5 form.

The ESM1 form was used in the districts for between 4 and 12 months, depending on the district. Information on 3253 malaria cases was obtained and analysed together with selected items from the SF5 form. The data was coded and entered into dBase II by NMEO staff, and cleaned and edited by the author. The cleaned data set was then transferred to SPSS/PC and analysed by the author. The ESM1 forms (in Nepali and in an English translation), together with a list of items of information on the SF5 form, are reproduced in Annex 3.

4.6 Sub-study no.4: household survey

The main virtues of the above study were its geographical spread and number of cases included. Both these virtues were possible because the survey was tagged on to an existing data collection system. However, precisely for this reason, the number of additional questions that could be asked was limited, and questions had to be very simple. Moreover, the use of malaria workers to collect the data introduced the possibility of biasing the responses.

Therefore a second, in depth survey in two small geographical areas using specially trained interviewers was also set up. The objectives of this survey were much broader than to provide information for the cost-effectiveness analysis alone. However, detailed questions were asked about time and income losses resulting from malaria and about the use of curative services and this information is used later in this thesis. The methodology of the study is therefore reported briefly here.

The aim of the survey was to find out the economic implications of malaria at the level of the household in terms of the present impact of malaria on household activities; the implications for households of any future increase in the incidence of malaria, and patients' behaviour with respect to treatment. The main topics on which information was collected were:

- the amount and type of sickness caused by an episode of malaria;
- the number of days of disability and debility per case of malaria;
- the socio-economic and personal characteristics of malaria patients;
- what household activities were not done because of malaria, and whether they were postponed, done by other people, or not done at all;
- any financial and economic losses arising from the effect of malaria on household activities;
- the patient's choice and use of public and private treatment facilities;
- private expenditure on curative and preventive care for malaria.

Because the incidence of malaria at the time of the survey was relatively low (maximum API of 5 per 1000), it was not feasible to study all or a random sample of households in an area and expect to obtain a sufficient number of households with a malaria case. Therefore the following approach was adopted:

- two districts, and one malaria unit in each of the districts, were selected in order to ensure a sufficient number of accessible cases, a mix of both P.vivax and P.falciparum infections, a mix of imported and indigenous cases, and a range of economic circumstances (household income, predominant crops, etc);

- all malaria cases diagnosed by the NMEO in these two units were to be interviewed, as soon as possible after diagnosis and also a fortnight later, when a household questionnaire was also administered;
- for each malaria case, a neighbourhood control was identified, matched for age-group and sex but free from malaria for the previous month;
- the survey was carried out for 12 months, in order to pick up seasonal variations in malaria transmission and economic activity.

Survey activities were organised and implemented by a Nepali survey organisation (New Era), supervised by the author. Specially trained interviewers were used, who lived in the malaria units where the survey was located. Data was coded and entered into dBase III by New Era, and subsequently edited and cleaned in London and transferred to a mainframe computer. Statistical analysis was done using SPSS. Information on 867 malaria cases and 867 controls was analysed. The questionnaires used are reproduced in Annex 4.

4.7 Summary

This chapter has outlined the methodology of the study of the cost-effectiveness of malaria control in Nepal. It considered the conceptual framework for the analysis, the data requirements and how to obtain the data.

The conceptual framework was based on Drummond and Stoddart (1985), classifying costs as those falling on the government and on patients and households, and consequences as health effects, savings in resource use (both expenditure and time), and changes in quality of life. Four levels of objective and choice were distinguished: objective of improving health (choice of malaria control versus other means of health improvement); objective of malaria control (choice of vector control versus case detection and treatment and various mixes of both); objectives of (i) vector control and (ii) case detection and treatment (choice of strategies for each); objective of delivering a pre-determined strategy.

Data collection activities could be grouped into four sub-studies. These were the cost analysis, the effectiveness analysis, the patient survey and the household survey.

The aims of the cost analysis were to identify resources used with the objectives they served and to allocate resources used to operational activities. The cost analysis was divided into two parts. In the first part, NMEO recurrent expenditure by district was analysed and related to population covered and cases treated. In the second part, an in-depth study was done of malaria control costs in three NMEO districts and two ICHSDP districts. Resources valued in financial prices were converted to economic prices and costs analysed by programme and activity.

In the effectiveness analysis, measures of output required were defined and how to obtain them discussed. The 'number of cases cured' could be obtained from programme data but it was not known what proportion of total cases were being detected. The difficulties of estimating 'cases prevented' were discussed, together with the difficulties of mounting a field study. Information on intermediate measures of output were available from programme data.

The patient survey was set up to collect information on the number of days of work and school lost as a result of malaria, the use made of various sources of treatment and private expenditure on treatment. Information on 3253 malaria cases in six districts was collected by malaria workers. This information was analysed with information from the SF5 form, a routine form which described the epidemiological characteristics of each case.

The household survey was set up to obtain more detailed and accurate data than could be obtained through the patient survey. Its aim was to investigate the economic implications of malaria at the level of the household in terms of the impact of malaria on household activities and patients' behaviour with respect to treatment. All malaria patients in two geographical areas were to be interviewed together with a neighbourhood control for each patient. Data on both the individual and their household were obtained. Information on 867 cases and 867 controls was analysed.

5. RESULTS OF THE STUDY I: THE RECURRENT EXPENDITURE OF NMEO DISTRICTS

In this chapter, the results of the sub-study on the recurrent expenditure of NMEO districts is reported. Particular attention is paid to the relative costliness of different districts, to the distribution of resources between districts and to the determinants of district expenditure.

5.1 Per capita expenditure

The recurrent expenditure of NMEO districts, regions, NHQ and RTC was analysed for 1983 and 1984 (Tables A5.7 and A5.8). Districts integrated in 1983 were excluded from the calculations. Table 5.1 shows total district expenditure per capita in 1983 and 1984 (columns 1 and 2). Total district expenditure is made up of district-level expenditure, the value of insecticides sprayed, the value of drugs used, a share of NHQ and RTC expenditure, and a share of regional expenditure, and has been divided by district population-at-risk.

The column on per capita expenditure for 1983 shows a three-fold difference between the lowest cost district (Morang) and the highest (Udaipur). In 1984, although district-level expenditure increased, insecticide expenditure decreased especially in the East and mid West and the range between the lowest and highest cost districts increased. In general, Hill districts have higher expenditure for a given level of activity than other districts. This relationship is obscured in columns 1 and 2 of Table 5.1 because Hill districts have fewer cases and a less severe malaria situation, and therefore receive fewer funds for treatment (drugs) or spraying. In order to look in more detail at cost variations between districts, it is therefore useful to analyse expenditure on the malaria control infrastructure alone, by distinguishing between fixed expenditure (district-level expenditure) and variable expenditure (drugs and insecticide). This division is approximate since included in district-level expenditure are some items that vary in the short-term in response to changes in the level of activity (e.g. minor supplies and DA/TA for radical treatment, wages of spraymen and DA/TA for spraying). However the great majority of district-level expenditures are consumed by salaries, and these do not

Table 5.1: Analysis of NMEO district recurrent expenditure per capita in 1983 and 1984

District	Per capita expenditure (Rs) 1983 (1)	Per capita expenditure (Rs) 1984 (2)	1983: Per capita fixed costs (a) (3)	1983: Per capita variable costs (b) (4)	1984: Per capita fixed costs (a) (5)	1984: Per capita variable costs (b) (6)	Geographical location (7)
Morang	4.05	3.76	2.40	0.81	2.51	1.40	Outer Terai
Sunsari	4.51	4.23	2.74	0.80	2.88	1.40	Outer Terai
Jhapa	4.95	4.72	2.91	1.14	3.08	0.71	Outer Terai
Ilam	11.32	10.65	8.35	1.20	8.74	0.19	Hill
Panchthar	9.45	13.32	7.08	0.19	10.81	1.29	Hill
Bhojpur	10.99	11.06	8.67	0.24	9.49	0.10	Hill
Udaipur	11.07	11.50	7.95	2.20	8.45	1.57	Inner Terai
Dhankuta	11.55	10.35	9.40	0.12	8.51	0.10	Hill
Eastern region	6.15	6.06	4.09	0.95	4.43	0.47	
Ramechhap	8.94	12.12	7.36	0.12	10.10	0.13	Hill
Sindhuli	11.04	10.74	8.21	1.11	8.36	0.46	Inner Terai
Mahottari	6.61	8.37	3.18	2.35	3.13	4.12	Outer Terai
Dhanusha	11.08	11.36	3.14	6.64	3.39	6.71	Outer Terai
Sarlahi	5.07	6.30	2.98	1.92	3.13	2.17	Outer Terai
Chitwan	5.57	5.68	3.55	1.02	3.98	0.65	Inner Terai
Kavre	6.68	7.09	5.20	0.15	6.27	0.16	Hill
Central region	7.86	8.58	3.98	3.70	4.10	3.14	
Rupandehi	6.57	7.45	3.34	2.01	3.64	2.44	Outer Terai
Gorkha	6.36	7.08	4.05	0.17	5.43	0.11	Hill
Palpa	7.00	7.63	5.43	0.12	5.90	0.14	Hill
Kapilvastu	6.43	6.43	3.54	1.67	3.50	1.56	Outer Terai
Nawalparasi	6.53	6.64	3.39	2.01	3.55	1.91	Outer Terai
Western region	6.54	6.07	3.03	1.45	4.11	1.52	
Surkhet	10.75	8.68	7.27	1.66	6.04	0.13	Inner Terai
Dang	6.00	6.60	4.52	1.07	5.11	0.10	Inner Terai
Banke	6.29	5.40	3.36	1.71	3.60	0.53	Outer Terai
Bardiya	5.16	4.90	3.30	0.45	3.45	0.33	Outer Terai
Kailali	7.03	5.90	3.65	2.12	3.77	0.78	Outer Terai
Kanchanpur	10.07	8.01	5.13	3.43	5.13	0.95	Outer Terai
Mid west region	7.42	6.44	4.30	1.08	4.53	0.40	
NATIONAL MEAN	6.99	7.05	4.04	1.76	4.31	1.46	
MEAN OF DISTRICTS	7.85	7.90	5.07	1.43	5.51	1.01	
RANGE	4.04-11.07	3.76-13.32	2.40-9.40	0.12-6.64	2.51-10.81	0.10-6.71	
SD	2.46	2.66	2.20	1.34	2.55	1.47	

(a) Expenditure financed from district budget
(b) Expenditure on drugs and insecticides

change in the short-term in response to an increased level of spraying or of cases.

Columns 3 to 6 of Table 5.1 therefore show per capita expenditure for 1983 and 1984 divided into fixed and variable components, and the geographical location of each district is indicated. Per capita fixed expenditure at district level varies more than four-fold between the lowest and the highest cost districts. Per capita fixed expenditure is highest in Hill districts, partly because staff allowances are higher but also presumably because unit offices have to cover a scattered population and long distances. However it is not clear why per capita fixed expenditure in the Hills of the East Region should be almost double the expenditure of the two hill districts of the West region, Gorkha and Palpa, and Kavre in the Central region.

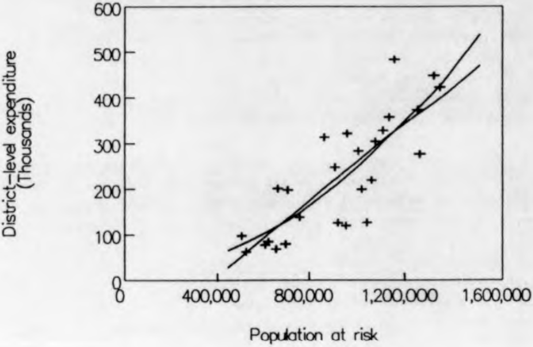
Of the Inner Terai districts, two (Udaipur and Sindhuli) have costs close to those of Hill districts, while Chitwan has costs close to those of Outer Terai districts, with Dang and Surkhet falling somewhere in-between. In the Outer Terai districts, per capita fixed expenditure increases from East to West.

Per capita variable expenditure tends to show a reverse pattern. It is low in Hill districts, where no spraying takes place and cases are relatively few, and high in the Outer Terai districts, especially where spraying with malathion is concentrated, for instance Mahottari, Danusha and Rupandehi.

On average around 70% of district-level expenditure is fixed - a relatively high proportion. This figure is as high as 98% in a district such as Panchtar where no spraying takes place, and as low as 32% in a district such as Danusha with extensive spraying of malathion.

Geographical location, number of cases and presence or absence of spraying are therefore the main influences on expenditure. Figure 5.1 plots district-level expenditure against district population-at-risk. Although there is a certain minimum level of expenditure associated with a district regardless of population size, the rate of increase of expenditure as the district population increases appears to be essentially constant.

Figure 5.1: Relationship between district-level expenditure and district population-at-risk



The curved line represents the quadratic equation:

$$DLE = 28790 - 0.0244 \times POP + 2.43 \times 10^{-7} \times POP^2$$

$$r^2 = 0.680$$

The straight line represents the equation

$$DLE = -160172 + 0.42 \times POP$$

$$r^2 = 0.669$$

5.2 Distribution of expenditure by geographical area, management level and type of expenditure

It is of interest to look at the distribution of expenditure, to assess which geographical areas absorb the bulk of expenditure and the proportion of expenditure absorbed by management levels above the district. Districts cannot simply be classified by level of receptivity, since many districts contain areas of both low and moderate receptivity. A crude geographical classification has thus been used, categorizing districts as mainly Outer Terai (low receptivity), mainly Inner Terai (moderate receptivity) and mainly Hill (low receptivity). Around 65% of expenditure was absorbed by 13 Outer Terai districts, 17% by 5 Inner Terai districts, and 18% by 8 Hill districts (Table A5.9).

Since expenditure on insecticide can make up such a large proportion of total expenditure, it is useful to analyse it further. Spraying records distinguish quantities sprayed in terms of the receptivity of the area. In 1983, 56% of expenditure on insecticides went on low receptive areas, and 44% on moderate receptive areas. In 1984 the figures were 80% and 20%. This pattern may appear paradoxical, since the bulk of expenditure is going on areas where there is relatively less risk of malaria resurgence. There are two explanations: firstly, malathion is sprayed in low receptivity areas only due to resistance of the vector (A. annularis) to DDT and is considerably more expensive than DDT per head of the population sprayed; secondly stocks of DDT were very short in 1984 and thus only one third of the 1983 quantity was sprayed.

Another analysis of interest is the distribution of expenditure by management level and type of expenditure (Table A5.10). On average, NHQ and RTC expenditure amounted to 11-12% of total expenditure (range 8-16%) and Regional expenditure 6% (range 4-8%). Drugs were a very insignificant proportion of total expenditure, amounting to 1-3% only. As might be expected, insecticide expenditure varied enormously, from 0% of expenditure to 59%. A reduction in insecticide expenditure between 1983 and 1984 is evident: from an average of 23% of total expenditure in 1983 to 19% in 1984. The reduction occurred only in the East and mid-West Regions and was particularly marked in the latter.

5.3 Expenditure per unit of output

It is desirable to express district expenditure in terms of some appropriate measure of output. Unfortunately, as discussed in Chapter 4, there is no simple measure that encompasses both the curative and preventive objectives of the malaria control programme. Two simple unit costs are calculated here and shown in Table 5.2: district-level expenditure per slide and total district expenditure per case.

District-level expenditure per slide provides evidence of the cost of maintaining the case detection and treatment network in different districts. All district-level expenditure is averaged out over the number of slides, so included in expenditure is any district-level expenditure on spraying (spraymen and supplies). This, however, is a relatively small proportion of total district-level expenditure and should not therefore unduly distort the comparison of unit costs across districts. Insecticide and drugs have been excluded.

Columns 1 to 4 of Table 5.2 show district-level expenditure per slide and slides per 1000 population (to give an indication of the level of activity) for 1983 and 1984. As indicated in earlier analyses, Hill districts tend to have the highest unit costs. It might be expected that the greater the number of slides per 1000 people the lower would be the cost per slide because a large proportion of expenditure is likely to be fixed in relation to the level of activity. However Figure 5.2, which plots district-level expenditure per slide against slides per 1000 population for 1983, does not show a clear relationship, probably because other factors (such as geographical location) obscure the pattern.

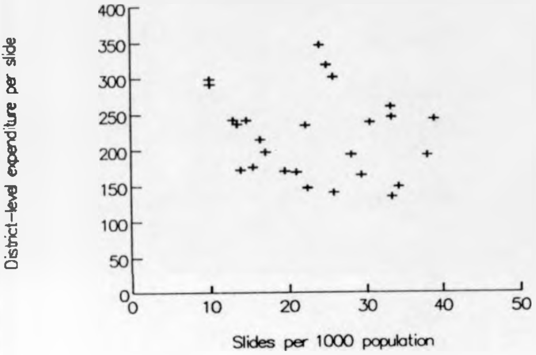
Columns 5 to 8 of Table 5.2 show total expenditure per case detected and treated (total district expenditure divided by total district cases). This unit cost is slightly misleading, in that the more cases that are detected, the better (i.e. lower) appears cost per case. This result is paradoxical from the perspective of malaria prevention since a district that is failing to control malaria may reduce its costs per case. This problem arises because malaria control has dual objectives - both prevention and treatment - but these elements cannot be separated and in this unit cost all expenditure, rather than expenditure on treatment

Table 5.2: Recurrent expenditure per slide and per case, 1983 and 1984.

District	(----1983----) Dist.-level expenditure per slide (Rs) (1)	Slides per 1000 pop (2)	(----1984----) Dist.-level expenditure per slide (Rs) (3)	Slides per 1000 pop (4)	(----1983----) Expenditure per case (Rs) (5)	Cases per 1000 pop (6)	(----1984----) Expenditure per case (Rs) (7)	Cases per 1000 pop (8)
Morang	13.90	173	15.05	159	3,761	1.47	2,494	1.51
Sunsari	15.51	177	17.51	163	3,133	1.44	2,934	1.44
Jhapa	9.99	292	11.56	267	3,015	1.30	3,100	1.40
Ilam	24.12	346	20.11	311	9,554	1.19	7,057	1.34
Panchtar	25.00	301	34.04	317	2,204	4.51	2,090	4.63
Bhojpur	33.30	260	35.33	249	2,457	4.47	3,134	3.31
Udaipur	34.99	310	24.05	360	7,000	1.50	3,229	3.56
Dhulang	39.00	243	55.37	154	5,326	2.21	5,043	2.05
Eastern region	17.31	236	20.05	231	3,560	1.73	3,069	1.90
Ramechhap	50.09	193	44.93	225	6,066	1.11	9,202	1.31
Sindhuli	33.42	246	30.49	274	5,220	3.11	1,915	5.63
Mahottari	13.45	236	14.30	216	3,101	3.06	1,963	4.26
Dhanusa	13.90	242	15.11	224	3,109	5.02	2,109	5.39
Sarlahi	9.97	299	12.37	253	2,543	3.31	2,057	3.06
Chitwan	14.69	242	16.31	239	3,400	1.64	1,695	3.35
Kavre	22.10	235	26.76	234	2,220	3.01	2,299	3.43
Central region	15.65	249	17.79	235	2,625	3.00	2,093	4.10
Rupandehi	19.57	171	17.02	214	2,209	3.97	1,261	5.95
Gorkha	29.30	165	33.00	170	2,142	3.97	1,620	4.32
Palpa	20.11	193	26.40	223	2,190	3.20	1,546	4.94
Kapilvastu	16.50	215	15.07	230	2,321	3.77	1,204	5.34
Nawalparasi	17.10	197	19.07	200	2,724	2.40	1,720	3.04
Western region	20.45	180	19.44	212	2,326	3.01	1,413	4.93
Surkhet	30.49	239	34.34	199	3,995	2.69	1,346	6.45
Dang	33.45	135	32.07	159	5,070	1.34	1,328	4.07
Banke	20.99	170	18.12	199	7,530	0.83	933	5.06
Bardiya	23.39	147	22.46	153	9,514	0.94	1,202	4.00
Kailali	25.09	141	33.46	161	3,200	3.14	950	6.16
Kanchanpur	34.34	149	32.29	159	4,632	3.10	659	12.17
Mid west region	27.97	156	30.76	169	4,757	1.56	990	6.51
NATIONAL MEAN (a)	19.03	212	20.33	212	3,019	2.33	1,672	4.22
MEAN OF DISTRICTS	23.45	220	25.13	221	4,173	2.32	2,502	4.30
RANGE	9.97-39.00	141-346	11.56-55.37	153-360	2142-9514	0.54-5.02	659-9202	1.34-12.17
SD	8.57	57	10.45	55	2,355	1.12	1,995	2.25

(a) Includes expenditure on treatment of cases at HQ

Figure 5.2: Relationship between district-level expenditure per slide and slides per 1000 population, 1983



only, is distributed to cases. However, the cost per case is useful if interpreted as showing the magnitude of malaria control expenditure in relation to the number of cases occurring. As demonstrated in Figure 5.3 which plots expenditure per case against cases per 1000 population for 1983 and 1984, there is a very strong relationship between these two variables, indicating how expensive a case detection and treatment system can become when malaria incidence falls to very low levels. For example Bardiya in 1983 had the lowest number of cases per 1000 population (0.54) and one of the highest costs per case (Rs 9,514).

A comparison of the 1983 and 1984 figures for the mid West region emphasizes the responsiveness of unit costs to a change in the level of activity, for the rise in cases in 1984 dramatically reduced the cost per case. It is clearly important to distinguish those areas where the high cost of a case detection and treatment system may be worthwhile because of the risk of resurgence, from those where a rapid and sizeable increase in cases is not likely and the malaria control infrastructure imposes continuing high fixed costs with little return in terms of cases detected.

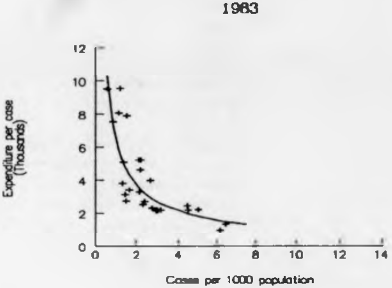
5.4 The effect of expenditure on malaria incidence

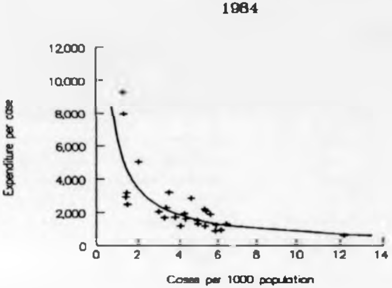
It would be desirable to use the information presented in this chapter to examine the relationship between levels of expenditure and levels of malaria. However, it is clear from the analysis that any relationship is likely to be extremely complex and affected by factors that cannot easily be included in the analysis such as climatic conditions and the malaria situation across the border with India. Moreover malaria incidence in any one year is influenced not merely by the expenditure of that year but also of preceding years. Thus not merely cross-sectional but also time series data is required to examine the relationship.

However, information has been presented here for two years and between those two years there was a marked change both in expenditure patterns and in malaria incidence. It is thus worth doing a simple comparison, shown in Table 5.3, of changes in total expenditure and insecticide expenditure and changes in indigenous cases.

Between 1983 and 1984, malaria incidence rose slightly in the East,

Figure 5.3: Relationship between expenditure per case and cases per 1000 population for 1983 and 1984.





1983 (upper): The line represents the empirically fitted equation

$$EPC = 6369 \times CASES^{-0.7786}$$

$$r^2 = 0.65$$

1984 (lower): The line represents the empirically fitted equation

$$EPC = 6508 \times CASES^{-0.8882}$$

$$r^2 = 0.69$$

Table 5.3: Relationship between change in expenditure and change in number of cases, 1983 to 1984

District	API(minus imported A) 1983	API(minus imported A) 1984	Change in API 1983-4	Change in indigenous cases 1983-4	Total Expenditure 1983	Total Expenditure 1984	Change in expenditure 1983-4	Change in insecticide exp. 1983-4
Morang	0.42	0.43	0.01	11	1,960,021	1,895,487	(64,534)	(189,502)
Sunsari	0.51	0.48	(0.03)	(21)	1,419,436	1,355,420	(64,016)	(121,457)
Jhapa	0.22	0.25	0.03	25	2,224,088	2,186,803	(37,285)	(176,256)
Ilam	0.78	0.64	(0.14)	(15)	716,556	700,184	(16,372)	(60,129)
Panchtar	2.60	2.80	0.20	19	778,134	1,027,457	249,322	0
Bhojpur	0.97	1.14	0.17	9	882,078	965,143	83,066	(4,183)
Udaipur	1.62	3.28	1.66	104	1,427,704	1,423,958	(3,746)	(198,920)
Khotang	0.12	0.12	0.00	2	799,618	883,521	83,903	0
Eastern region	0.51	0.64	0.13	134	10,207,635	10,436,973	229,338	(760,535)
Ramechhap	0.19	0.14	(0.05)	(6)	758,232	844,652	86,420	0
Sindhuli	1.96	5.31	3.35	454	1,406,211	1,413,304	7,093	(84,706)
Mahottari	1.82	2.47	0.65	251	2,368,051	3,072,566	704,515	672,026
Dhanusha	3.30	3.58	0.28	156	4,693,876	4,949,646	255,770	113,213
Sarlahi	1.24	1.72	0.48	177	1,894,164	2,100,646	206,482	112,199
Chitwan	0.54	1.91	1.37	377	1,581,100	1,655,563	74,463	(182,893)
Kavre	1.27	1.41	0.14	17	652,622	786,250	133,628	0
Central region	1.76	2.57	0.81	1,436	13,354,256	14,822,626	1,468,370	710,670
Rupandehi	2.07	4.47	2.40	955	2,455,921	2,909,664	453,744	198,501
Gorkha	0.85	1.57	0.72	141	1,398,410	1,560,956	162,546	(15,393)
Palpa	0.51	1.07	0.56	67	972,462	1,074,265	101,803	0
Kapilvastu	1.77	3.98	2.21	639	1,963,803	2,023,543	59,740	(25,154)
Nawalparasi	1.11	2.41	1.30	420	2,151,017	2,263,006	111,989	(14,775)
Western region	1.42	3.06	1.64	2,222	8,942,413	9,832,234	889,821	143,100
Surkhet	2.26	5.87	3.61	470	1,363,401	1,179,891	(183,510)	(192,601)
Dang	1.04	4.47	3.43	906	1,888,882	1,887,641	(1,241)	(275,338)
Banke	0.64	5.47	4.83	926	1,242,493	1,111,460	(131,033)	(235,004)
Bardiya	0.48	3.95	3.47	683	1,837,016	1,827,895	(9,121)	(124,036)
Kailali	1.45	5.50	4.05	996	1,749,413	1,530,435	(218,978)	(320,739)
Kanchanpur	1.90	11.96	10.06	2,071	2,010,113	1,673,362	(336,751)	(491,091)
Mid west region	1.23	6.09	4.86	5,972	9,290,318	8,417,684	(872,634)	(1,647,689)
TOTAL (a)				9,744	41,795,029	43,509,927	1,714,898	(1,554,364)

(a) Includes expenditure on treatment of cases at HQ

slightly higher in the Central Region, doubled in the West, and rose very sharply in the mid West. Insecticide use decreased markedly in the East and mid West and increased slightly in the Centre and West. Expenditure excluding insecticide increased slightly.

A marked reduction in insecticide use was thus accompanied by very little change in malaria incidence in the East (except in Udaipur) and by a very marked increase in the mid West, suggesting that spraying has more importance in the West than the East. Other factors, however, such as the Indian situation, were undoubtably important, and more detailed studies would be required for any firm conclusions to be drawn.

In the Centre, where insecticide expenditure slightly increased and incidence rose over the Region as a whole, there was a more varied pattern at district level. In the three districts where insecticide expenditure increased, there was only a slight increase in the API. In two where it fell, there was a more marked increase. In the West, however, no such clear pattern emerges. Very slight decreases in insecticide expenditure in three districts were accompanied by an approximate doubling of incidence, and in Rupandehi, incidence doubled despite a 25% increase in spraying.

5.5 Analysis of the main influences on district cost per capita

It is clear that from the analysis in this chapter that a variety of factors affect the cost of malaria control. The following variables seem to be the most important influences:

- population size of districts
- terrain (Outer Terai, Inner Terai, Hill)
- region (East, Central, West, mid-West)
- number of cases per 1000 population
- number of slides per 1000 population
- insecticide type (DDT, Malathion)
- proportion of the district population sprayed.

In order to attempt to disentangle the influence of these variables, a multiple regression analysis was carried out with district cost per capita as the dependent variable and the above variables as independant variables. Approximately three quarters of the variation in cost per capita could be explained by these variables. However, the extent of the correlation between the independent variables was such that it would be unwise to attempt to quantify the contribution of any particular independent variable. The multiple regression therefore added little to the findings already presented.

5.6 Conclusions

A number of conclusions can be drawn that are relevant to considerations of efficiency and of alternative malaria control strategies.

- The cost of malaria control varies widely across the country, for reasons often not associated with the vulnerability or receptivity of the district to malaria. The case detection and treatment network is particularly expensive in Hill districts which are classified as low receptive.

- Considerable resources are being absorbed by areas of low receptivity in the Outer Terai because the resistance of A. annularis to DDT requires the use of malathion where spraying is considered necessary.

- Regional and national levels absorb around 17-18% of total NMEO recurrent expenditure: a relatively high proportion, though technical skills and back-up are concentrated at these levels and the NMEO headquarters provides support also to the ICHSDP.

- External assistance (drugs, insecticides and WHO technical assistance) makes up approximately 25% of total recurrent expenditure.

- Residual spraying adds significantly to malaria control costs even in terms of insecticide alone (excluding operational costs of spraying).

- Further investigation is required of the relationship between levels of spraying and levels of malaria, to see whether more economical use can be made of insecticide.

- A relatively high proportion of district-level expenditure is fixed, resulting in high costs per unit of activity in districts with relatively few cases.

5.7 Summary

This chapter has examined the recurrent expenditure of NMEO districts in terms of per capita expenditure; expenditure by geographical area, management level and type of expenditure; and expenditure per unit of output.

1983 per capita expenditure showed a three-fold difference between the lowest and highest cost districts. When expenditure was disaggregated into fixed and variable components, per capita fixed expenditure varied more than four-fold between the lowest and highest cost districts and was highest in Hill districts, lowest in Outer Terai districts and in between for Inner Terai districts. In Outer Terai districts, per capita fixed expenditure increased from East to West. Per capita variable expenditure showed a reverse pattern, being highest in Outer Terai districts especially those where malathion was sprayed. On average around 70% of district-level expenditure was fixed.

The 13 Outer Terai districts absorbed around 65% of expenditure compared to 17% for Inner Terai districts and 18% for Hill districts. A high 56% of insecticide expenditure in 1983 and 80% in 1984 went on low receptive areas, primarily because vector resistance to DDT in these areas required malathion to be sprayed rather than the cheaper DDT. On average, NHQ and RTC expenditure absorbed 11-12% of total expenditure, drugs only 1-3%, and insecticide 0-59%.

An analysis of district-level expenditure per slide confirmed that Hill districts tended to have the highest unit costs. District-level expenditure per case was highly correlated with the number of cases. For example, the rise in cases in 1984 sharply reduced the cost per case. It was concluded that it was important to distinguish those areas where the high fixed costs of a case detection and treatment system were worthwhile from those where it was not.

An attempt to compare change between 1983 and 1984 in the number of cases, total expenditure and insecticide expenditure was inconclusive. In some areas a marked reduction in insecticide use was accompanied by very little change in malaria incidence and in others by a marked increase in cases. It was concluded that a variety of factors affected malaria control costs, some of which could be examined (e.g. population size, terrain, region, cases and slides per 1000 population, insecticide type, proportion of the population sprayed) but others which were less amenable to analysis over a short time period (climatic conditions, malaria prevalence in adjoining areas of India).

A variety of conclusions were drawn from the analysis in the chapter, notably that the cost of malaria control varied widely across the country, for reasons often not associated with malaria risk;, that the case detection and treatment network had high fixed costs and thus was very expensive if malaria incidence was low; and that spraying and particularly the use of malathion considerably increased district costs.

6. RESULTS OF THE STUDY II: THE COST-EFFECTIVENESS OF MALARIA CONTROL STRATEGIES

In this chapter, the results are presented of a detailed analysis of the costs and cost-effectiveness of malaria control strategies in the following districts:

- Morang (NMEO, East region, Outer Terai);
- Rupandehi (NMEO, West region, Outer Terai);
- Ilam (NMEO, East region, Hill);
- Saptari (ICHSDP, Eastern region, Outer Terai);
- Parsa (ICHSDP, Central region, Outer Terai).

In order to be able to include the overhead costs of regional and national management levels, NMEO expenditure at the national level (NHQ and Regional Training Centre), and East and West regions has also been analysed. A similar analysis of ICHSDP overhead costs was not possible.

The results are presented first for vector control strategies and second for case detection and treatment strategies. Within each section, costs to the government are considered first and then costs to individuals. Analysis of case detection and treatment mechanisms is done first for all case detection mechanisms taken together (but excluding volunteers) since this permits a comparison between non-integrated and integrated districts. Subsequently the costs of the various NMEO case detection mechanisms are disaggregated and compared.

6.1. Vector control strategies

Costs to the government and cost-effectiveness estimates

In 1984, the only routine vector control method used was residual spraying. This was therefore the only method that could be rigorously costed, though the potential costs of alternative vector control methods are considered below in Chapter 9.

In looking at the costs of spraying per unit of output, it is important firstly to distinguish between fixed and variable costs, and secondly to distinguish between the costs of spraying different insecticides since both chemical and operational costs are likely to be different.

The division of costs between fixed and variable components gives a feel for how costs are likely to change as the level of spraying increases or decreases. What is considered fixed depends on the time-frame: in the long run (over several years) all costs, including those of vehicles and spraying supervisors, could adjust to a changed level of output. Here, however, it seems sensible to take a time-span of about one year, and to regard the costs of the spraying programme at NHQ and Regional levels to be fixed, except for the fuel used for dumping insecticide. At district level, some costs would not be incurred in the absence of spraying (salaries of spraymen, insecticides, sprayers etc.) and some costs represent time diverted from case detection and treatment (supervision by unit and district officers). Thus all costs at district level can be regarded as variable, except for spraying's share of administrative overheads.

Table 6.1 shows 1984 spraying costs in NMEO districts. These represent the cost of delivering one cycle of DDT (in Morang and Rupandehi) and 2 cycles of malathion. The table distinguishes between fixed and variable cost components and DDT and malathion areas. In Rupandehi, in order to divide costs (excluding insecticide) between malathion and DDT areas, it has been assumed that the costs of delivering these insecticides to the wall of a house are proportional to the distribution of sprayman days between insecticides. Thus non-insecticide expenditure has been distributed to malathion and DDT spraying in proportion to the number of sprayman days (22% to DDT, 78% to malathion).

Table 6.1 shows that in DDT areas, fixed costs make up around 25% of total costs, and in the one malathion area, 17%. The majority of fixed costs are incurred at regional level, though NHQ fixed costs are also sizeable. Overall, fixed costs are relatively low.

The most immediately accessible indicators of the level of output of the spraying programme are population covered and houses sprayed. The figures in Table 6.1, together with information from Parsa, have therefore been used to calculate spraying costs per house and per capita (see Table 6.2). The DDT unit costs refer to one cycle of spraying, and

Table 6.1: Costs of spraying in NMEO districts distinguished by fixed and variable components.

	Morang DDT (Rs)	<-----Rupandehi---------> DDT (Rs)	Malathion (Rs)
Fixed			
district			
- spraying	0	0	0
- administration	15,294	8,575	30,404
- total (% of fixed)	15,294(14%)	8,575(13%)	30,404(13%)
region			
- spraying	56,928	22,142	78,503
- administration	10,037	10,135	35,931
- total (% of fixed)	66,965(61%)	32,277(50%)	114,434(49%)
NHQ			
- spraying	5,744	3,628	12,864
- administration	22,463	20,269	71,862
- total (% of fixed)	28,207(25%)	23,897(37%)	84,726(37%)
Total fixed (% fixed)	110,466(100%)	64,749(100%)	229,564(100%)
(% of total)	(25%)	(21%)	(17%)
Variable			
- wages	30,876	36,245	128,506
- insecticide	259,096	194,140	922,766
- sprayers	27,433	6,035	21,398
- other district	13,550	6,123	21,709
- fuel for dumping	3,093	1,412	5,005
Total variable	334,048	243,955	1,099,384
(% of total)	(75%)	(79%)	(83%)
Total	444,514	308,704	1,328,948
	(100%)	(100%)	(100%)

Table 6.2: Spraying costs per house and per capita per cycle

Cost component	Morang DDT(a) (Rs)	<---Rupandehi-----> DDT(b) (Rs)	Malathion(c) (Rs)	Parsa Malathion(d) (Rs)
(Number of houses)	(7,329)	(5,112)	(12,684)	(17,698)
Per house fixed				
- district	2.09	1.68	2.40	1.50
- region	9.14	6.31	9.02	N/A
- NHQ	3.85	4.67	6.68	N/A
- total	15.08	12.66	18.10	N/A
Per house variable	45.58	47.72	86.67	123.70
Total district fixed plus variable	47.67	49.40	89.07	125.21
Total per house cost	60.66	60.38	104.77	N/A
(Population)	(40,221)	(30,819)	(84,663)	(130,195)
Per capita fixed				
- district	0.38	0.28	0.36	0.20
- region	1.66	1.05	1.35	N/A
- NHQ	0.70	0.78	1.00	N/A
- total	2.74	2.11	2.71	N/A
Per capita variable	8.31	7.92	12.99	16.82
Total district fixed plus variable	8.69	8.20	13.35	17.02
Total per capita cost	11.05	10.03	15.70	N/A

(a) 1.5 gm of a.i. per sq.m. 1984; one cycle only
(b) 1.5 gm of a.i. per sq.m. 1984; one cycle only
(c) 50% at 1 gm of a.i. per sq.m.; 50% at 2 gm; two cycles
(d) 2 gm of a.i. per sq.m.; two cycles

the malathion costs have been averaged over the output of both cycles. The unit costs therefore represent a cost per cycle and would need to be multiplied by two to give an annual cost. 'Houses' rather than total buildings (houses plus structures) has been used as the unit of output in order to approximate costs per household. The table has been laid out so that comparison can be made both for district-level costs between NMEO and ICHSDP districts, and for total costs between NMEO districts alone. In Parsa, the spraying programme's share of administration costs has been treated as fixed, and all other costs as variable.

DDT costs per house and per capita are very similar in Morang and Rupandehi, at around Rs 8 per capita per cycle taking district costs only. Malathion costs in Rupandehi are 60% higher, and in Parsa, more than double. The reasons for the difference between the Rupandehi and Parsa malathion unit costs can best be explored by disaggregating the unit cost:

Cost component	Rupandehi (Rs per capita)	Parsa (Rs per capita)
District - fixed	0.36	0.20
Variable - malathion	10.90	14.14
- other	2.09	2.68
Total	13.35	17.02

As explained in the footnotes to Table 6.2, Rupandehi used an average dose of 1.5 gm ai per sq.m. (50% at 1 gm and 50% at 2 gm) and Parsa, 2 gm. However, Parsa's insecticide cost is slightly less than would be expected from the dosage, suggesting either that there was less wastage or less strict adherence to dosage in Parsa. Parsa's district overhead costs were less, but non insecticide variable costs more.

When comparing DDT and malathion, this analysis shows how important it is to take into account all aspects of the insecticides including the dosage required and their persistence. The border prices used in this analysis to value insecticide are quite similar for DDT (Rs 34.96/kg) and malathion (Rs 35.24/kg). Malathion, however, is double the cost of DDT when the quantity used per house or per capita per cycle is considered. For example, the insecticide cost per capita was Rs 6.44

for DDT in Morang, Rs 6.30 for DDT in Rupandehi, Rs 10.90 for malathion in Rupandehi, and Rs 14.14 for malathion in Parsa.

Moreover, the length of time for which the insecticide remains effective should be taken into account. This can be done by calculating a cost 'per month of protection'. If we assume that DDT confers protection for 6 months, malathion at 1 gm a.i. per sq.m. for 2 months and malathion at 2 gm for 3 months (based on Fontaine 1978), then total unit costs are:

DDT:	Rs 1.76 per person per month of protection (average of Morang and Rupandehi costs)
Malathion:	Rs 6.28 per person per month of protection (Rupandehi costs, protection estimated at average for 1 gm and 2 gm, ie 2.5 months).

In order to include consideration of Parsa where malathion at 2 gm of a.i. per sq.m. was sprayed, costs at district level can be calculated:

DDT:	Rs 1.41 per person per month of protection
Malathion:	Rs 5.34 per person per month of protection (Rupandehi)
	Rs 5.67 per person per month of protection (Parsa)

These costs can be used to explore the trade-off between the increased period of protection resulting from a higher dosage and the increased cost. If Rs 13.35 (Rupandehi) protects for 2.5 months and Rs 17.02 (Parsa) protects for 3 months, then the extra half month's protection is gained at an incremental cost of Rs 3.67. Whether this cost is worthwhile can only be judged in terms of the additional cases prevented, which will be influenced by the length of the transmission season, and whether protection is required beyond 3 months, in which case it may be more economical to repeat the spray cycle rather than extend the duration of its effect.

Ficam (bendiocarb) was sprayed in place of DDT in 1985. Information was therefore not available for this study on the actual costs of spraying

Ficam (other than the purchase and freight costs), but a comparison can be made with DDT and malathion on the basis of plausible assumptions.

A recent study (Phillips and Mills 1987) compared the operational costs for DDT, malathion and Ficam. Only those costs likely to differ between the insecticides were calculated. The operational costs per structure of Ficam (excluding insecticide) were very close to those of DDT. Here, therefore, the cost of spraying Ficam is taken to be the difference between the total variable cost per house and per capita and the insecticide cost for DDT. Information on quantities sprayed and houses and population covered for Ficam is taken from 1985 statistics for Morang (1 cycle) and Rupandehi (2 cycles). Only variable costs have been calculated since fixed costs for Ficam were not known. They would not change the ranking of insecticides.

Table 6.3 shows the resulting unit costs. The higher cost of the first cycle of Ficam in Rupandehi is explained by greater quantities of insecticide used per house. Ficam is over twice as expensive per house or per capita per cycle as DDT, and 23% per house and 31% per capita more expensive than malathion. The difference between the per house and per capita comparisons stems from differing average household sizes in the Ficam and malathion areas.

The next step in this analysis should be to move from indicators of level of activity as units of output to indicators of change in health status. If there are grounds for believing that the interventions being compared are similarly efficacious (as, for example, in the case of the different insecticides compared above which have been field-tested in Nepal and found to be effective in killing mosquitoes), then indicators of activity, adjusted for the period of residual action of each insecticide, are adequate measures of output.

However, these units of output do not permit comparisons to be made between alternative vector control methods or between vector control and other control methods such as case detection and treatment. For these comparisons, an indicator of output such as cases prevented is required.

Unfortunately, there is very little evidence in Nepal on the effectiveness of spraying in terms of cases prevented. On the whole,

Table 6.3: Comparison of the variable costs per cycle of DDT, Malathion and Ficam

		Insecticide	
	DDT (a)	Malathion (a)	Ficam (b)
Cost per house per cycle (Rs)			
Morang	45.58	-	97.23
Rupandehi	47.72	86.67	132.56 (c) 106.97 (d)
Cost per capita per cycle (Rs)			
Morang	8.31	-	17.22
Rupandehi	7.92	12.99	22.09 (c) 16.97 (d)

(a) Variable costs only (taken from Table 6.1).

(b) Assuming non-insecticide variable costs per house and per capita are the same as DDT. Quantities and coverage taken from 1985 spraying cycles.

(c) First cycle

(d) Second cycle

spraying has continued on the assumption that it must be effective, as it was initially in controlling malaria in the 1950s and 1960s, rather than on the basis of good evidence about continuing effectiveness. Successive reviews of the control programme have compared the timing and level of cases between sprayed and unsprayed areas but have been unable to draw conclusions because the comparison has not formed part of a carefully designed study: for example those areas sprayed are those where transmission is expected to be more intense and thus they are not necessarily comparable to unsprayed areas, and the normal case detection system has been relied on to indicate number of cases.

Reviews have also looked at the trend of malaria incidence over the transmission season in relation to the timing of spray cycles, a frequent comment being that insecticide was applied too late to stop transmission (HMG/WHO/USAID/ODA 1984). Perhaps the most detailed review, though still relying on programme data, was done by the 1988 external review team (HMG/WHO/USAID/ODA/JICA 1988). It comments that:

> "On a village by village assessment of spraying, it is apparent that certain insecticides, applied in a timely manner, impact on malaria transmission whereas in the same districts others appear to have little effect on transmission. Any one of several factors can be responsible for failure of an applied insecticide (vector resistance or behaviour, timing of application etc.). From..... Unit data in the Far Western Region two trends can be observed. First, summer application of DDT had some dampening effect on malaria case incidence in the early summer but a sharp build up is noted starting in mid June. Second, insecticide application for the Autumn is just before or right at peak transmission. Upon comparison of data from sprayed and unsprayed areas of Kailali district similar trends are observed. The effect of DDT in the summer cycle, however, is somewhat limited, if at all. Ficam application in the autumn cycle has a more pronounced effect on the reduction of malaria transmission relative to the unsprayed areas where transmission continues at a fairly high level for an additional 2 months. Nevertheless, Ficam application was somewhat after the main peak of malaria transmission. Application of effective insecticides 4 to 6 weeks earlier is indicated in most of the Far West Region to prevent the build up in transmission. Similar trends are observed in other regions but in depth analysis was not possible due to time limitations."

In 1987, because of concern that the effectiveness of spraying was not known, two small scale studies were set up in the Central and Western Regions, one locality being sprayed and another unsprayed in each region (Webber 1987). Parasitological results from a mass blood survey and serological profiles were used to check the localities were comparable.

A comparison of cases in the 2 localities in the Central Region showed no marked difference between the sprayed and unsprayed areas, suggesting that surveillance alone might have been sufficiently effective. In the Western Region study, the trend of cases from one small area which was sprayed in August showed that by September residual spraying was having no effect, possibly because the vector was exophilic and exophagic.

Another reason for a lack of impact of spraying can be local customs, especially those of replastering houses twice a year and sleeping outside. In the patient survey, 65% of households whose house had recently been sprayed said they had replastered since then. In 5 out of the 6 districts in the survey, the majority of male malaria patients slept outside, and only a slightly lower proportion of women.

It is clearly difficult to generalize about the effectiveness of residual spraying. If properly applied, in some areas it can be highly effective, in others not effective due to vector or human behaviour or unnecessary because of local influences on transmission (for example transmission occurring in forest areas not in the sprayed, settled villages). Not infrequently, factors to do with the application of insecticide (especially timing of spray cycles) have reduced any potential effectiveness. It is clearly very important to distinguish between the effectiveness of residual insecticide spraying under ideal conditions and under normal programme and field conditions.

Because no clear-cut conclusions are possible on the effectiveness of spraying, no further calculations of cost-effectiveness are made here, discussion on the relative cost-effectiveness of alternative vector control and alternative malaria control methods being delayed to Chapter 8.

Costs to individuals

Unlike case detection and treatment strategies, residual spraying requires little action by individuals and thus imposes few costs on them. Those costs that may arise stem less from the active participation of householders than from the unwanted side-effects of spraying. The main activity required of households is to vacate their houses and remove foodstuffs and utensils for 3 hours. The time (and hence cost) implications of this are likely to be insignificant.

Potential side-effects differ between insecticides. DDT and Malathion seem not to have caused ill-effects amongst the population at large, though in 1985 there were a few reports that children were occasionally affected to a minor extent by Ficam, but only if they returned to their houses too early or instructions to sweep up and burn residues were not followed (Phillips and Mills 1987). Domestic birds and animals are occasionally affected by insecticides.

A more serious problem from the perspective of malaria control is the smell and residue left by the spraying of insecticides which may lead households to refuse to allow their houses to be sprayed or to replaster soon after spraying. This appears to be mainly a problem with Malathion. In contrast, Ficam lacks both smell and residue.

Finally, spraying confers some benefits to householders, in reducing the nuisance effect of insects and killing bed bugs (until they develop resistance).

None of these costs or benefits are readily quantified or valued. Since they are likely on the whole to be insignificant, no attempt at quantification or valuation is made. However, they may be of some importance in influencing compliance and thus coverage rates.

6.2 Case detection and treatment strategies: costs to the government

Costs per capita

Case detection and treatment strategies financed by the NMEO surveillance programme (ie excluding malaria volunteers) are considered here as a whole, and in the following section are analysed individually. Case detection and treatment strategies provide protection to the whole population, so it is appropriate to express the cost as a cost per head of the population covered. Table 6.4 shows the per capita cost of case detection and treatment, listing the share of administration separately. Since the cost of management levels is not available for ICHSDP

Table 6.4: Cost per capita of case detection and treatment at district level

	Morang (Rs)	Rupandehi (Rs)	Ilam (Rs)	Saptari (Rs)	Parsa (Rs)
Case detection and treatment:					
- case detection and treatment costs	2.26	2.99	7.47	0.67	0.91
- administration costs	0.14	0.11	0.88	0.08	0.01
Total cost	2.40	3.10	8.35	0.75	0.92

districts, Table 6.5 shows per capita costs by management level for NMEO districts only.

In Table 6.4, there is a striking difference between the per capita cost of case detection and treatment in NMEO and ICHSDP districts. NMEO costs in Morang are more than double and in Rupandehi, more than triple the costs in Saptari and Parsa. Administration allocated to case detection and treatment takes up a relatively small share in the four districts, and the difference between them lies in the cost of the case detection and treatment network.

In ICHSDP districts, case detection is only one of 8 tasks of a VHW, and so the cost is likely to be significantly less than in an NMEO district where the MFW spends all his time on case detection. Moreover, in ICHSDP districts, treatment is carried out when required, using staff time diverted from other activities. Thus the nature of the costs in the two patterns are different: in ICHSDP districts, costs per capita will respond to changes in the number of cases, whereas in NMEO districts, they will largely remain fixed due to the high proportion of labour costs in total costs. This issue is investigated further below in relation to the cost of case detection and treatment per unit of intermediate and final output (costs per slide and per case).

In Ilam, an NMEO hill district, per capita costs are around three to four times as great as the NMEO Terai districts. This partly reflects higher rates of pay and allowances for staff in Hill districts, and partly the costs of maintaining a case detection and treatment network in a difficult terrain, with a scattered population. Ilam's share of regional and NHQ costs is relatively high on a per capita basis because administration is the largest programme at regional and national levels, and this is allocated to Ilam on the basis of its share of expenditure and thus reflects its high costs.

Case detection and treatment costs per slide and per case (excluding parasitology)

Since case detection and treatment strategies are directed towards the taking of blood slides and detection of malaria cases, the most appropriate indicators of activity are slides taken and cases detected

Table 6.5: Cost per capita by management level of case detection and treatment in 3 NMEO districts

	Morang (Rs)	Rupandehi (Rs)	Ilam (Rs)
Case detection, treatment (including administration)			
- district	2.40	3.10	8.35
- regional share	0.21	0.30	0.45
- NHQ share	0.27	0.36	0.70
Total	2.88	3.76	9.51

and treated. Table 6.6 therefore shows the cost of case detection and treatment, expressed as per slide and per case, for the five districts. This cost excludes parasitology and in NMEO districts, health education. It thus represents the cost of district, unit office and health post staff and supplies required for detection and treatment. The costs of parasitology, of health education and of the various case detection methods used by the NMEO surveillance programme are analysed in subsequent sections.

To look first at the three NMEO districts, cost per slide is very similar between Morang and Rupandehi, but almost double in Ilam. Because Ilam has very few cases, Morang not many, and Rupandehi a lot, costs per case detected show a very different pattern. Morang cost per case is almost triple that of Rupandehi, and Ilam more than ten times higher. Virtually all costs can be regarded as fixed: the variable items such as drugs and forms take up only 5% of total costs. Therefore unit costs at different output levels show a direct (inverse) relationship with output. The high cost of a surveillance system when incidence is low is evident.

As discussed earlier, the integrated districts, Saptari and Parsa, do not have the same high fixed costs because time is diverted from other activities when necessary. Cost per slide in Saptari is very similar to that in Morang and Rupandehi, and in Parsa it is lower. However, the slide positivity rate is much higher as might be expected when surveillance staff have other responsibilities and are less inclined to probe for fever episodes. Whether a slide is taken or not will then depend more on the patient, and a higher proportion of slides are likely to be positive. Thus the costs per case in Saptari and Parsa are higher than that of Rupandehi, though below that of Morang.

It is interesting to contrast the cost per capita in the two ICHSDP districts shown in Table 6.4 with the costs per slide and per case shown here. Costs per capita were two to three times higher in the two NMEO Terai districts than in the two ICHSDP Terai districts. However relatively fewer slides are taken and cases detected in the ICHSDP districts, so despite their relatively low proportion of fixed costs, their costs per slide are very close to Morang and Rupandehi, and per case lower than Morang but higher than Rupandehi.

Table 6.6: Case detection and treatment (CD & T) costs per slide and per case

Cost component	Morang (Rs) (a)	Rupandehi (Rs) (a)	Ilam (Rs) (a)	Saptari (Rs) (b)	Parsa (Rs) (b)
(Number of slides)	(76,192)	(74,340)	(17,596)	(19,345)	(24,094)
District:					
- CD & T	11.78	12.09	21.28	11.55	8.91
- administration	0.69	0.42	2.49	1.43	0.11
- total	12.47	12.51	23.77	12.98	9.02
Region:					
- CD & T	0.33	0.34	0.16	N/A	N/A
- administration	0.45	0.50	0.97	N/A	N/A
- total	0.78	0.84	1.13	N/A	N/A
NHQ:					
- CD & T	0.17	0.24	0.12	N/A	N/A
- administration	1.01	1.00	1.63	N/A	N/A
- total	1.18	1.24	1.75	N/A	N/A
Total cost per slide	14.43	14.59	26.65	N/A	N/A
(Number of cases)	(615)	(1556)	(67)	(297)	(296)
District:					
- CD & T	1460	578	5588	752	725
- administration	85	20	654	93	9
- total	1545	598	6242	845	734
Region:					
- CD & T	41	16	43	N/A	N/A
- administration	56	24	253	N/A	N/A
- total	97	40	296	N/A	N/A
NHQ:					
- CD & T	21	11	33	N/A	N/A
- administration	125	48	427	N/A	N/A
- total	146	59	460	N/A	N/A
Total cost per case	1788	697	6998	N/A	N/A

(a) Cost of the surveillance programme which covers ACD and PCD except volunteers. Health education and parasitology excluded.

(b) Cost of case detection and treatment, excluding parasitology.

A most important consideration is the efficiency of the case detection system in terms of the proportion of total cases detected. Unfortunately, total cases are not known, and could not be investigated within the scope of this study. Further investigation of this issue would be well worth while, since it might change the relative cost-effectiveness of NMEO and ICHSDP districts.

Parasitology

Table 6.7 shows the cost of parasitology expressed as a cost per slide. This represents the cost of slide examination, excluding the cost of transporting the slide to the laboratory which is included within the case detection and treatment cost. In the two NMEO districts with a malaria clinic, Morang and Rupandehi, the cost of both clinic and district laboratories are included. This is disaggregated in Table 6.9.

Costs per slide are similar in all districts, being Rs 1.74 to Rs 2.03 except in Morang which is significantly cheaper. In NMEO districts, regional and NHQ costs make up 20-37% of total costs per slide. This high overhead cost probably reflects the emphasis given to cross-checking the performance of district laboratories. Calculation of the regional and national costs of cross-checking and expressing them per positive slide erroneously classified at district level as negative would help to establish the optimum level of quality control. If the unit cost exceeded the cost per case detected through case detection activities, it could be argued that the level of cross-checking should be decreased, and vice versa if the opposite were found.

Health education

In NMEO districts, the health education programme finances the support to volunteers and community education on malaria. In the cost analysis (see Annex 2) costs paid by other programmes but belonging to health education were transferred, so the cost of the programme shown here is higher than that shown in the NMEO accounts. The cost of community education could not be separated out, so all programme costs are attributed to PCD (V).

Table 6.7: Parasitology costs per slide

Cost component	Morang (Rs)	Rupandehi (Rs)	Ilam (Rs)	Saptari (Rs)	Parsa (Rs)
(Number of slides)	(80,071)	(83,450)	(20,606)	(19,345)	(24,094)
District:					
- parasitology	0.97	1.95	1.54	1.63	1.78
- administration	0.08	0.08	0.20	0.20	0.02
- total	1.05	2.03	1.74	1.84	1.80
Region:					
- parasitology	0.35	0.40	0.16	N/A	N/A
- administration	0.05	0.10	0.08	N/A	N/A
- total	0.40	0.50	0.24	N/A	N/A
NHQ:					
- parasitology	0.10	0.12	0.06	N/A	N/A
- administration	0.12	0.20	0.13	N/A	N/A
- total	0.22	0.32	0.19	N/A	N/A
Total cost per slide	1.67	2.85	2.17	N/A	N/A

Table 6.8 shows the cost per slide and per case of case detection through PCD (V). The figures show large variation, with Rupandehi being particularly low in terms both of cost per slide and per case. The Ilam cost per slide is mid-way between Rupandehi and Morang, but is very high when expressed per case because of the low number of cases in Ilam. Around 80% of programme costs are incurred at district level, a slightly lower proportion than in the surveillance programme (Table 6.6).

These unit costs cannot be directly compared with the costs of case detection in the surveillance programme because the latter programme provides radical treatment for cases detected through PCD (V). In the section below, therefore, an attempt is made to separate the costs of the various case detection mechanisms and of radical treatment, in order to be able to make an appropriate comparison between case-detection mechanisms.

6.3 Comparison of case detection and treatment mechanisms

Costs to the government and cost-effectiveness estimates

The discussion above of the cost of case detection and treatment mechanisms lumped all mechanisms (except volunteers) together. It is important, although difficult, to look separately at each mechanism. Two important points, however, must be made.

Firstly, of the case detection mechanisms only PCD (V) has its own accounts. Thus the costs of the surveillance programme have to be broken down by case detection method. Many of the costs are joint between the methods, so the allocation of costs is to some extent arbitrary. The method used is described in Annex 2. The costs can only be approximations, representing the right order of magnitude but not necessarily the exact cost.

Secondly, comparison between each other and between districts of the unit costs of different case detection methods is complicated by the fact that they do not operate independently of each other. The yield of ACD for example, will be affected by whether a PCD volunteer is available in the neighbourhood. In recent years, the PCD network in NMEO districts has been much expanded and this is reflected in an

Table 6.8: Costs per slide and per case of case detection through PCD (V).

Cost component	Morang (Rs)	Rupandehi (Rs)	Ilam (Rs)
(Number of slides)	(3879)	(9110)	(3010)
District:			
- health educ.	42.24	11.77	28.26
- administration	2.73	0.47	3.46
- total	44.97	12.24	31.72
Region:			
- health educ.	2.33	0.98	0.39
administration	1.79	0.56	1.34
- total	4.12	1.54	1.73
NHQ:			
- health educ.	3.94	1.30	1.31
- administration	4.00	1.11	2.26
- total	7.94	2.41	3.57
Total cost per slide	57.03	16.19	37.02
(Number of cases)	(145)	(752)	(21)
District:			
- health educ.	1130	143	4050
- administration	73	6	496
- total	1203	149	4546
Region:			
- health educ.	62	12	56
- administration	48	7	192
- total	110	19	248
NHQ:			
- health educ.	105	16	188
- administration	107	13	324
- total	212	29	512
Total cost per case	1525	197	5306

increasing proportion of cases being detected through PCD rather than ACD mechanisms. Information from the patient survey suggests that there can be very little difference in the number of days between the start of the fever and slide collection for the different slide collection mechanisms. In Rupandehi, for instance, the mean time-lag for ACD was 8.0 days (SD 7.5) and for all PCD 7.1 days (SD 6.7), with PCD (MC) having the shortest delay (mean of 6.6 days, SD 6.3) and PCD (H) the longest (mean of 9.1 days, SD 7.4). The distribution of the time-lag between start of the fever and slide collection was positively skewed. A logarithmic transformation was therefore applied and a geometric mean calculated. For Rupandehi, the geometric mean time-lag for ACD was 6.2 days, for all PCD 5.5 days, for PCD (MC) 5.2 days and for PCD (H) 7.2 days (these differences were not significant at the .05 level).

Data from the household survey gives a more mixed picture. In Nawal Parasi, as in Rupandehi, the time-lag between the start of the fever and slide collection was only slightly longer for ACD (mean of 8 days, SD 9.3) than for all PCD mechanisms (7.3 days, SD 7.8), and the time-lag for PCD (V) was shorter (6.5 days, SD 6.4) and for PCD (H) longer (10.5 days, SD 10.7). However in Dhanusa, PCD mechanisms consistently showed a significantly ($P < .05$) shorter time-lag (mean of 4.1 days, SD 6.9) than ACD (6.0 days, SD 6.6).

In summary, it appears that there is a tendancy for the delay between the start of the fever and slide collection to be least for PCD mechanisms, notably for PCD (MC) and PCD (V). However, the differences are relatively small, suggesting that the population cannot be distinguished clearly into two groups, one which waited for an ACD worker and the other which used PCD mechanisms. Thus there is likely to be interdependence between ACD and PCD mechanisms, the one being affected by the other. In particular, the better the PCD network, the lower is likely to be the yield of ACD.

In the household survey, all patients who did not visit a PCD mechanism were asked whether they knew where they could get free treatment. In the area studied in Dhanusa district, 73% did know, their main reasons for not attending a PCD mechanism being that the malaria field worker visited (34%), and that they waited for the malaria field worker (37%). A related reason was that a malaria volunteer visited the patient (4%).

In the area studied in Nawal Parasi, 59% of non-attenders at PCD places of treatment knew where to get free treatment, their reasons for not attending being similar (MFW visited 32%, waited for MFW 29%, malaria volunteer visited 8%). Only 11% of all cases surveyed in Dhanusa and 15% in Nawal Parasi did not know where to get free treatment for fever.

Information about sources of treatment for malaria thus seems to be relatively well disseminated in these areas. It seems likely that the ACD mechanism is used if an MFW happens to arrive at the house in the first few days of the illness, if he is known to be due to come, or if the patient's symptoms are particularly mild. Otherwise a PCD mechanism is used. Only 5% of patients in Dhanusa and Nawal Parasi said PCD mechanisms were too far to visit.

Despite this interdependance between the various types of case detection mechanism, it is nonetheless still useful to look at their unit costs, to assess their order of magnitude and potential for expansion. The costs of surveillance in the two ICHSDP districts are already approximations because of the problem discussed earlier of identifying malaria control costs. It was therefore felt not to be worthwhile to attempt to break down the ICHSPD cost data further, to distinguish the costs of ACD and PCD (H) and radical treatment. This section therefore considers the cost of case detection mechanisms in NMEO districts only.

Table 6.9 compares the cost to the NMEO of ACD/APCD and Follow-up, PCD (V), PCD (MC), PCD (M) and PCD (H). Since the claim these methods make on administration at all levels is assumed to be proportional to their costs, administration costs can safely be ignored in this analysis. Programme expenditure at Regional and NHQ levels does differ between PCD (V) and all other mechanisms, but these costs were explored in the previous section, are a relatively small proportion of total costs and for simplicity are ignored here. Moreover, the relatively higher regional and national costs of the health education programme can partly be attributed to community education activities rather than to the PCD (V) network per se.

The costs included under each heading in Table 6.9 need some explanation. Radical treatment costs are for the moment omitted. ACD/APCD/Follow-up includes the cost of MFWs, supplies and laboratory

Table 6.9: Comparison of cost to the NMEO of case detection methods

Case detection method	Morang (Rs)	Rupandehi (Rs)	Ilam (Rs)
ACD/AFCD/Follow-up			
% of total slides	87%	85%	84%
Cost/slide:			
- case detection	9.41	6.72	15.22
- parasitology	0.91	1.72	1.54
- total	10.32	8.44	16.76
% of total cases	56%	42%	65%
Cost/case			
- case detection	1546	493	4598
- parasitology	149	126	465
- total	1695	619	5063
PCD (V)			
% of total slides	5%	11%	15%
Cost/slide:			
- case detection	42.24	11.77	28.26
- parasitology	0.91	1.72	1.54
- total	43.15	13.49	29.80
% of total cases	19%	33%	24%
Cost/case:			
- case detection	1130	143	4050
- parasitology	24	21	220
- total	1154	164	4270
PCD (MC)			
% of total slides	4%	2%	
Cost/slide:			
- case detection	2.13	9.82	
- parasitology	2.54	11.63	
- total	4.67	21.45	
% of total cases	2%	19%	
Cost/case:			
- case detection	477	44	
- parasitology	569	52	
- total	1046	96	

(continued)

Table 6.9: Continued

Case detection method	Morang (Rs)	Rupandehi (Rs)	Ilam (Rs)
PCD (M) (a)			
% of total slides	2%	12%	2%
Cost/slide:			
- case detection	0.90	0.83	1.96
- parasitology	0.91	1.72	1.54
- total	1.81	2.55	3.50
% of total cases	15%	4%	9%
Cost/case:			
- case detection	13	9	89
- parasitology	13	19	70
- total	26	28	159
PCD (H) (b)			
% of total slides	1%	1%	<1%
Cost/slide:			
- case detection	14.76	9.90	80.65
- parasitology	0.91	1.72	1.54
- total	15.67	11.62	82.19
% of total cases	7%	3%	2%
Cost/case:			
- case detection	312	106	686
- parasitology	19	18	13
- total	331	124	699

(a) Only drugs and supplies costed
(b) Costs to the NMEO only.

examination. PCD (V) includes the cost of the health education programme as described earlier, plus laboratory examination. PCD (MC) includes the cost of the malaria clinic in terms of staff, supplies and equipment. Unlike the others, PCD (M) and PCD (H) are not fully costed. PCD (M) is assumed to be a virtually cost-less addition to the work of the unit staff, requiring only drugs and supplies. For PCD (H) no attempt was made to assess the hospital's costs: the cost shown is purely that incurred by the NMEO in supporting PCD (H).

MFWs (through ACD, APCD and Follow-up) account for 85% of slides, but 42-65% of cases. PCD mechanisms, in contrast, pick up relatively more cases than slides. The main impression from the unit cost data is that the same mechanism can have widely differing costs depending on the level of use. For instance both PCD (V) and PCD (MC) in Rupandehi appear as very low cost ways of detecting cases. Yet the cost per case in Morang is roughly ten times higher. Rupandehi had on average 0.4 volunteers per 1000 population and Morang 0.2, and Rupandehi volunteers on average took more slides than Morang volunteers. Thus accessibility and use of volunteers was clearly less in Morang. In addition, support costs were greater because the whole of the cost of the MFW for health education was allocated to PCD (V), whereas in Rupandehi, half of the time of this worker was said to be used for radical treatment. In Ilam, volunteers were clearly working as an important supplement to the ACD system, with a cost per case detected that was significantly lower than ACD.

Malaria clinics appear to be a cheap way of obtaining and examining slides, the relatively high cost of slide examination as compared to district laboratory costs being offset by the low case detection cost. In terms of cost per case detected, malaria clinics performed well. The performance of the malaria clinics in Rupandehi owe much to their location: in two urban centres adjacent to areas with many cases.

PCD (M) is clearly well worthwhile. PCD (H) also is relatively cheap from the NMEO's point of view, though relatively few cases are detected.

Radical treatment and investigation of cases detected through ACD/APCD and Follow-up, PCD (V), PCD (M) and PCD (H) is done by unit offices, and in malaria clinics by their staff at the time of case detection. The total costs of case detection and treatment are shown in Table 6.10. For the malaria clinic, the cost of radical treatment is purely the cost of drugs, since all other malaria clinic costs have been attributed to case detection. For all other mechanisms, however, the cost represents the activities of the unit offices in radical treatment and investigation. This analysis accentuates the difference between the cost per case of malaria clinics and all other mechanisms.

A fair comparison must take account of costs other than those falling on the government, namely the opportunity cost to volunteers of spending time on malaria case detection, and any difference in costs to individuals arising from different mechanisms. These differences may stem from a propensity to pay for private sources of treatment and losses due to inability to work through illness that differ between the case detection mechanisms. Inclusion of these costs in the cost of case detection mechanisms is important not only in the comparison of case detection mechanisms but also in the comparison of this strategy of malaria control with that of vector control, since more cases of malaria are likely to occur with the former than the latter strategy, thus imposing greater costs on individuals.

Costs to individuals

(a) Costs to volunteers

The costs to volunteers of slide collection and giving presumptive treatment will depend primarily on the extent to which these activities are compatible with their main occupations and the amount of time required. Little information is available on the occupations of volunteers. In a hill district, Bhojpur, the following information was available in the 1984 Annual Report:

Teacher	36
Farmer	11
Official	19
Merchant	5

From visits to volunteers in the Terai, it appeared that quite a large proportion were merchants, often drug sellers. Acting as a volunteer

Table 6.10: Cost per case of case detection and radical treatment

Case detection method	Morang (Rs)	Rupandehi (Rs)	Ilam (Rs)
ACD/APCD/Follow-up			
Cost per case:			
- detection	1695	619	5063
- radical treatment	364	172	1253
- total	2059	791	6316
PCD (V)			
Cost per case:			
- detection	1154	164	4270
- radical treatment	364	172	1253
- total	1518	336	5523
PCD (MC)			
Cost per case:			
- detection	1046	96	
- radical treatment	2	2	
- total	1048	98	
PCD (M)			
Cost per case:			
- detection	26	28	159
- radical treatment	364	172	1253
- total	390	200	1412
PCD (H)			
Cost per case:			
- detection	331	124	699
- radical treatment	364	172	1253
- total	695	296	1952

may well bring them a commercial advantage. In addition, the volunteers visited seemed not to find the duties required onerous. The number of slides per volunteer per year is low (35 in Morang, 57 in Rupandehi, 50 in Ilam in 1984), so little time is required. For all these reasons, no opportunity cost is attributed here to volunteers' time. Even if it were, the effect would be insignificant. For example, 50 slides a year, at 10 minutes per slide, gives a total of 8 1/2 hours per year, or one day's work.

(b) Costs to individuals: private expenditure associated with treatment

Expenditure by individuals which is associated with treatment for the malaria episode may have a number of causes:

- purchase of drugs, special foods etc;
- consultations with private practitioners;
- travel costs of visiting a PCD mechanism or private practitioners.

In addition, individuals detected through a particular method may be more or less likely to spend money on drugs, medical advice etc. For instance malaria patients may have to spend money on transport in order to reach a PCD post. Travel to PCD (H) or PCD (MC) will make other forms of care (drug sellers, private practitioners) more accessible and thus may encourage private expenditure on medical fees and drugs.

Information on expenditure on fees, drugs and laboratory examinations, special food, sacrifice and worship, and travel by malaria cases detected through different case detection mechanisms was collected in both the patient and the household survey. Their findings are rather different and so both are discussed here.

The results of the patient survey were reported in detail in Mills and Colbourne (1985) and are summarized here. Two districts are common to that analysis and this one, namely Morang and Rupandehi. Table 6.11 thus shows mean expenditure by type of expense and case detection method for these two districts.

There are a number of problems with using this data in this analysis.

Table 6.11: Private expenditure (Rs) per malaria case in Morang and Rupandehi, as identified by the patient survey

		Morang			Rupandehi		
		Mean	SD	n	Mean	SD	n
Fees:	ACD	5.73	15.56	120	0.49	3.16	566
	APCD	5.94	16.46	48	0.56	4.87	171
	PCD(V)	5.00	16.92	30	0.27	2.61	434
	PCD(MC)	-	-	0	3.71	9.10	404
	PCD(M)	5.57	13.27	60	0.52	3.01	100
	PCD(H)	2.86	10.69	14	0.54	3.69	46
	MBS	33.33	57.74	3	0.50	2.74	30
	Follow-up	0.56	2.32	36	0.00	0.00	54
	ALL (a)	4.95	14.60	359	1.50	5.49	2022
Drugs:	ACD	81.18	136.02	148	19.13	52.68	566
lab	APCD	44.94	73.34	62	22.02	58.02	171
exams	PCD(V)	65.20	173.21	35	24.10	72.51	434
	PCD(MC)	-	-	0	34.12	51.25	404
	PCD(M)	58.33	111.02	72	30.23	98.33	100
	PCD(H)	48.84	62.99	19	8.20	13.01	46
	MBS	170.00	286.85	4	13.37	37.29	30
	Follow-up	9.32	17.35	38	4.15	10.21	54
	ALL (a)	60.31	117.55	443	22.25	57.58	2022
Special:							
foods	ACD	8.48	25.93	120	4.36	21.06	566
	APCD	2.76	10.95	49	6.56	46.93	171
	PCD(V)	2.90	7.67	30	2.03	9.65	434
	PCD(MC)	-	-	0	7.62	24.02	404
	PCD(M)	12.50	38.35	59	5.62	17.17	100
	PCD(H)	12.50	46.77	14	6.28	14.44	46
	MBS	0.00	0.00	3	4.77	13.99	30
	Follow-up	3.83	12.56	36	1.50	6.53	54
	ALL (a)	7.10	25.12	359	4.38	22.01	2022
Sacrifice:							
&	ACD	9.99	34.07	121	0.60	4.78	566
worship	APCD	5.29	16.90	49	0.20	2.05	171
	PCD(V)	0.00	0.00	30	1.06	8.04	434
	PCD(MC)	-	-	0	0.75	6.85	404
	PCD(M)	8.61	30.98	59	0.63	4.04	100
	PCD(H)	0.71	2.67	14	0.41	2.52	46
	MBS	0.00	0.00	3	0.00	0.00	30
	Follow-up	1.11	6.67	36	0.19	1.36	54
	ALL (a)	5.88	24.84	360	0.61	5.57	2022

(continued)

Table 6.11: continued

		Morang			Rupandehi		
		Mean	SD	n	Mean	SD	n
Travel:	ACD	5.53	26.86	148	1.17	7.71	566
	APCD	2.42	6.82	62	1.19	6.31	171
	PCD(V)	0.77	2.86	35	2.03	24.65	434
	PCD(MC)	-	-	0	4.91	7.54	404
	PCD(M)	10.03	31.05	73	0.99	3.55	100
	PCD(H)	1.42	4.78	19	0.13	0.88	46
	MBS	0.00	0.00	4	0.00	0.00	30
	Follow-up	0.79	3.59	38	0.20	1.37	54
	ALL (a)	5.63	31.37	444	1.98	19.92	2022
Total expenditure: (b)	ACD	113.86	177.48	120	26.97	62.15	566
	APCD	64.79	88.71	48	30.57	96.53	171
	PCD(V)	80.63	202.07	30	30.93	93.88	434
	PCD(MC)	-	-	0	53.23	67.85	404
	PCD(M)	84.95	133.04	59	39.19	99.03	100
	PCD(H)	58.07	76.63	14	18.39	25.12	46
	MBS	261.67	380.60	3	18.63	39.66	30
	Follow-up	16.17	29.69	36	6.04	11.82	54
	ALL (a)	82.65	146.08	358	31.59	73.60	2022

(a) Includes PCD (unspecified) not shown separately
(b) Includes 'other' expenditure not shown separately

Source: Mills and Colbourne (1985)

Firstly its reliability is unclear, especially for Morang where reported expenditures seem extremely high (though one reason for this is that the survey found that higher levels of expenditure were in general associated with imported cases, which made up a high proportion, 64%, of the Morang cases in contrast to 18% in Rupandehi). Secondly, it is not possible to distinguish travel expenditure to a PCD mechanism from travel expenditure to other places of help, and thus to include in the PCD cost an allowance for transport. Thirdly, the mean disguises a very wide range, as indicated by the standard deviation.

The distribution of the data is highly positively skewed, with some very high values which inflate the arithmetic mean. For example the arithmetic mean for all case detection mechanisms in Rupandehi was Rs 31.59 and the geometric mean, Rs 7.44. Since the Morang data has some particularly extreme values, logarithmic transformation and calculation of the geometric mean reduces the differences between Morang and Rupandehi. For example the geometric mean for all case detection mechanisms in Morang was Rs 14.34, only double Rupandehi's geometric mean as compared to the more-than-four-fold difference between the arithmetic means.

Despite these problems with the data, some interesting impressions can be gained from Table 6.11. In Morang, the arithmetic mean expenditure of individuals detected through ACD is more than if they are detected through PCD, especially on drugs. The geometric mean shows a less marked pattern indicating that the ACD arithmetic mean is influenced by some particularly high spenders. This may reflect a preference for self-treatment as opposed to seeking advice from the malaria service. Not surprisingly, the reverse is true for travel expenses: individuals attending PCD (M) spent double those detected through ACD. Unfortunately no information is available on PCD (MC) attenders.

In Rupandehi, the picture appears very different from Morang. Individuals attending PCD mechanisms, especially those attending PCD (MC), spend higher sums than those detected through ACD. PCD (MC) attenders stand out as spending significantly more ($P < .05$) than all other types of case. In particular they spent more on fees, drugs and laboratory examinations, special foods and travel, perhaps because of the close geographical proximity of malaria clinics to commercial sources of treatment. Total expenditure by PCD (MC) cases is double that of ACD cases. Cases detected through other PCD mechanisms show a less clear pattern, total expenditure falling somewhere between ACD and PCD (MC) except PCD (H). In both districts PCD (H) attenders spend relatively low sums. As might be expected since some may be symptomless, follow-up cases spend least.

The data from the household survey shows a very different picture. In the survey area in Dhanusa, only 4% of patients incurred expenditure on treatment but in Nawal Parasi, 45%. These compare with 70% of patients found to have incurred expenditure by the patient survey in Rupandahi and Morang, and 76% in Bara, 60% in Sarlahi and Bhojpur and 47% in Dang, the other districts covered by the survey. Part of the explanation for the low proportion incurring expenditure on treatment in Dhanusa is likely to lie in the relative isolation of the area (far from private sources of treatment) and in intensive malaria control activities (because of persistent and relatively high levels of transmission) which made the inhabitants more aware of and thus more likely to use the free malaria treatment services.

The amounts spent found by the surveys are also rather different. Of those patients who paid for treatment, the mean (standard deviation) was Rs 56 (Rs 126) in Dhanusa and Rs 35 (Rs 78) in Nawal Parasi. These compare with figures from the patient survey of Rs 46 (Rs 85) in Rupandehi, Rs 123 (Rs 164) in Morang, Rs 49 (Rs 119) in Sarlahi, Rs 91 (Rs 157) in Dang, Rs 91 (Rs 118) in Bara and Rs 119 (Rs 193) in Bhojpur.

Although these amounts seem on the face of it to differ considerably, they are reasonably consistent for similar districts such as Dhanusa, Nawal Parasi, Rupandehi and Sarlahi, all NMEO districts in relatively well-developed areas of the Outer Terai. Morang is the only Outer Terai NMEO district which has very different figures, and during the survey malaria staff in Morang did warn that in their opinion expenditure was being exaggerated.

An analysis by case detection mechanism of the data on expenditure from the household survey is shown in Table 6.12. In the survey area in Nawal Parasi, patients detected through PCD mechanisms spent more than ACD cases, and those detected by malaria volunteers the most. The data from

Table 6.12 Private expenditure per malaria case by case detection mechanism in the survey areas in Dhanusa and Nawal Parasi, as identified by the household survey

Case detection mechanism	Dhanusa (Rs)			Nawal Parasi (Rs)		
	Mean	SD	n	Mean	SD	n
ACD	1.3	7.9	59	12.5	27.3	58
APCD	1.4	6.8	34	18.8	34.6	23
PCD (V)	0.0	0.0	3	22.8	80.9	116
PCD (M)	0.0	0.0	5	15.3	24.3	42
PCD (H)	-	-	0	1.0	1.7	3
PCD(all)(a)	2.9	33.3	235	19.7	68.1	170

(a) Includes PCD (Unclassified)

Dhanusa suggests a similar pattern, though is unhelpful for the various PCD mechanisms because the great majority of PCD cases were not classified by case detection mechanism. The difference in magnitude in the figures between Tables 6.11 (patient survey) and 6.12 (household survey) stems more from the differing proportions of patients who spent nothing than from the differing expenditures of those who spent something.

How can this information be used in the cost-effectiveness analysis? Both surveys suggest that the extent to which patients seek sources of treatment other than those offered by the NMEO and ICHSDP differs considerably between districts, and also, though to a lesser extent, the sums paid. It therefore seems best to use data relating to the two districts studied for the cost-effectiveness analysis, even though there are grounds for supposing that the way in which this data was collected may have biased the sums reported upwards.

Mean private expenditure per case for each case detection method, as identified by the patient survey for Rupandehi and Morang, is therefore added to the government cost per case of case detection and treatment. The resulting sums are shown in Table 6.13.

The inclusion of private costs associated with treatment does not alter the ranking of methods by cost per case, though in Rupandehi the distance between PCD(MC) and other mechanisms is narrowed.

(b) Costs to individuals: days of work lost

A cost is incurred by individuals if malaria prevents them from carrying out their normal activities and loss of earnings or production results. However there may be no, or a lesser loss to the household if other, underemployed household members replace the ill person; or no, or a lesser loss to society if the work that would have been done by the patient outside the household is done instead by a previously under-occupied worker. This loss, if it exists, affects the choice of case detection method if use of one case detection method rather than another leads to a longer period of illness.

The information collected on likely production losses by the patient and

Table 6.13 Government and private costs of case detection and treatment

Case detection method	Cost per case (Rs) (a)	
	Morang	Rupandehi
ACD/APCD/Follow-up		
- government cost/case	2059	791
- private cost/case (b)	81	25
- total	2140	816
PCD (V)		
- government cost/case	1518	336
- private cost/case	77	29
- total	1595	365
PCD (MC)		
- government cost/case	1048	98
- private cost/case	N/A	51
- total	N/A	149
PCD (M)		
- government cost/case	390	200
- private cost/case	81	37
- total	471	237
PCD (H)		
- government cost/case	695	296
- private cost/case	55	17
- total	750	313

(a) Private expenditure has been roughly converted to economic prices by applying a conversion factor of 0.95.

(b) Weighted mean for ACD, APCD and Follow-up.

household surveys was rather different. Since information for the patient survey was collected by malaria workers as part of their routine activities, it was not possible to enquire in detail about the impact of illness on household economic activities. Instead, information was simply sought on whether the patient regarded himself or herself as 'normally working', and how many days of work were lost as a result of the episode of malaria. Similar information was sought about school attendance. In contrast, the household survey enquired in detail about both total and partial incapacity caused by malaria, about whether the illness imposed an extra burden of work on household members and if so, who did this work and whether any problems resulted. Households were also asked directly whether they experienced any loss of cash income as a result of the illness, and whether they thought it likely that household production would be affected. The results are reported here in turn from the patient and household surveys.

Information from the patient survey of mean days of work lost and mean days of school lost by case detection method for those who declared themselves to work or attend school in Rupandehi and Morang is shown in Table 6.14. On average, 8.3 days of work were declared to have been lost in Rupandehi and 14.5 in Morang as a result of the malaria episode. This period in Rupandehi matches reasonably well the time-lag between start of the fever and presumptive treatment, which averaged 6.3 days. The same is not true, however, for Morang, where the mean time-lag between start of the fever and presumptive treatment was 6.6 days.

Differences in days of work lost between case detection methods are relatively small in Rupandehi, but cases attending malaria clinics seem to have a particularly short period of incapacity. Conclusions are difficult to draw for Morang because the figures span a very wide range and the sample size is small for several of the mechanisms. However, there is little difference in days of work lost between ACD and all PCD mechanisms.

Because of the skewed distribution of days of work lost, a logarithmic transformation was done and geometric means calculated. This procedure produces slightly lower means for Rupandehi but does not change the conclusion that there are no significant differences in days of work lost between case detection methods. For Morang, because there are some

Table 6.14: Mean days of work and school lost by case detection method, Morang and Rupandehi

Case detection method	Rupandehi			Morang		
	Mean	SD	n	Mean	SD	n
<u>Days of work lost per worker</u>						
- ACD	8.8	6.8	407	15.3	22.6	88
- APCD	8.9	6.3	138	12.3	17.2	42
- PCD(V)	9.1	7.5	368	24.6	44.2	20
- PCD(MC)	7.3	6.8	279	-	-	-
- PCD(M)	9.3	5.0	85	16.4	23.5	45
- PCD(H)	9.6	5.5	34	9.4	9.4	12
- MBS	9.9	7.7	23	90.0	0.0	1
- Follow-up	5.6	3.8	44	5.5	8.2	27
- All PCD (a)	8.2	6.5	1090	15.1	23.8	155
- All	8.3	6.6	1564	14.5	22.9	271
<u>Days of school lost per school attender</u>						
- ACD	9.2	5.7	45	22.9	37.1	16
- APCD	8.3	5.6	16	4.0	4.4	5
- PCD(V)	11.0	7.1	26	6.0	1.4	2
- PCD(MC)	7.1	6.8	97	-	-	-
- PCD(M)	8.0	6.9	9	10.7	10.0	9
- PCD(H)	6.3	1.5	4	4.7	4.6	3
- MBS	14.0	10.8	4	-	-	-
- Follow-up	4.8	3.3	4	12.5	17.7	2
- All PCD (a)	8.0	6.8	164	9.1	9.1	24
- All	8.3	6.7	217	14.5	24.5	42

(a) Includes PCD (Unclassified)

Source: Mills and Colbourne (1985)

particularly extreme values, the geometric mean of days of work lost for all case detection mechanisms (5.9 days) is lower than that of Rupandehi (6.7 days). The conclusion stands, however, that there is no significant difference in days of work lost between ACD and all PCD mechanisms in Morang.

As was apparent from the review in Chapter 2 of previous studies of malaria which have estimated the likely economic loss resulting from malaria, the traditional, crude approach is to estimate a total cost by multiplying days of work lost (or merely days of illness) by some measure of the minimum or average wage. If this approach were to be adopted using the data from the patient survey, estimates could be made in the following way.

The survey form did not specifically enquire about lost wages, but in Rupandehi this information was recorded for 1228 of the 1579 cases 'normally working'. It is highly unlikely that such a high proportion of patients were wage labourers, and the majority of sums implied a wage per day of Rs 15. It appears that this wage may have been used as a means of valuing days of work lost; it is also a reasonable reflection of local wage levels. Therefore Rs 15 per day could be used as a basis for valuing days of work lost. Since the main period of malaria transmission occurs during and immediately after the monsoon, when farmers are busy planting and caring for crops, it can be argued that this figure need not be adjusted for seasonal under-employment. Although the age and sex pattern of malaria cases was analysed in the patient survey (see Mills and Colbourne 1985), it would seem to be placing excessive emphasis on crude figures to make further adjustment to the value of days lost for age or sex. Therefore Rs 15 per day could be taken as the average cost (financial prices) per day lost by workers due to malaria, resulting in a total loss per episode of malaria of Rs 125. 82% of patients declared themselves to work in Rupandehi, therefore this sum could alternatively be expressed as Rs 103 per malaria case.

The patient survey of malaria cases also provides information on the proportion of malaria patients attending school. In total in the 6 districts studied, 24.5% of patients were aged 5-14 years, and 38% of these normally attended school. This average conceals a large difference between males and females (49% of males and 23% of females attending school) and districts (from 7% attending school in Saptari to 36% in Morang and 43% in Rupandehi). Table 6.14 showed the mean days of school lost per school attender in Rupandehi and Morang, the figures reflecting fairly closely the pattern for each district shown by days of work lost. While illness can have an effect on school performance, it is not clear how to value that effect. Therefore the existence of a cost arising from school absence is noted here, but no attempt at valuation is made.

The household survey provides the data required to consider both the reliability of the above data on days of work lost and the appropriateness of the assumption that all days of work lost result in a cost. Mean days unable to work per worker infected were 3.8 (SD 3.2) in Dhanusa and 9.3 (SD 7.2) in Nawal Parasi. Per person unable to work (ie excluding those who lost no days) these figures were 4.7 (SD 3.0) days and 10.3 (SD 6.9) days. The mean days partially disabled per worker infected were 0.99 (SD 2.1) in Dhanusa and 2.5 (SD 4.6) in Nawal Parasi. On these days, those partially disabled worked on average 280 (SD 104) minutes as opposed to a normal day of around 470 minutes in Dhanusa, and in Nawal Parasi, 205 (SD 111) minutes in contrast to a normal day of around 540 minutes.

This information from the household survey provides further evidence that the information on days of work lost from the patient survey is the correct order of magnitude. The difference in mean days unable to work between Dhanusa and Nawal Parasi is quite large, but this variability is repeated in the 6 districts covered by the patient survey. While mean days of work lost in Rupandehi were 8 days as reported above, the other districts surveyed had figures of 6 days (Sarlahi), 8 days (Bhojpur), 12 days (Dang), 13 days (Bara) and 15 days (Morang).

Patients who were economically active were asked in the household survey whether anyone did extra work because of the malaria episode, only 38.5% responding yes in Dhanusa and 88.1% in Nawal Parasi. The great majority of episodes of malaria required assistance from only one person (83% in Dhanusa and 73% in Nawal Parasi), and the source of help was primarily the household (82% of helpers in Dhanusa and 88% in Nawal Parasi). Only 10% of helpers in Dhanusa and 5% in Nawal Parasi were hired labourers. In Dhanusa, males and females were represented amongst the helpers in roughly equal numbers, though in Nawal Parasi, 80% were female. In both districts, the majority of female helpers were aged between 25 and 44 years, though male helpers in Dhanusa were mainly in the age range 15 to 54 and in Nawal Parasi, 35 upwards. On average, total hours of help provided per episode of illness where help was required was 33 hours (SD 31) in Dhanusa and 38 (SD 46) in Nawal Parasi (approximately 4 days in both districts).

Where the malaria patient was a small child, the parents were asked whether any household member had to spend extra time in child care because of the illness. 80% of parents in Dhanusa and 94% in Nawal Parasi said yes. The carer was primarily the mother (89% of carers in Dhanusa and 83% in Nawal Parasi), and a mean of 4.9 (SD 3.3) days of extra care per child requiring extra care were provided in Dhanusa and 11.7 (SD 10) days in Nawal Parasi. Per child infected, these means are 3.9 (SD 3.5) and 10.9 (SD 10.1) days. The majority of carers spent from 1 to 6 hours per day looking after the child. In both districts, 69% of carers were able to do their normal activities as well. Of those who could not, 36% in Dhanusa and 56% in Nawal Parasi received help, predominantly from other household members.

All households where help was required, whether this was because of a child's or adult's illness, were asked whether providing the help caused any problems. 75% of households in Dhanusa and 50% in Nawal Parasi said no. Of those families which had encountered problems, economic activities which suffered were mainly agriculture in Dhanusa and to a lesser extent domestic work, and agriculture, domestic work, and animal husbandry in Nawal Parasi.

Those patients in households where no help was provided during the episode of malaria were asked why not. In Dhanusa, the main responses were no-one available (39%), help not needed (36%), availability of many household members/servants (24%), others could not do the patient's work (17%), and night fever (6%). In Nawal Parasi, 50% said that help was not needed, 27% that no-one was available, and between 7% and 10% gave each of the other reasons.

For the few households who hired labour to provide help, the mean cost was Rs 73 (SD Rs 47) in Dhanusa and Rs 74 (SD Rs 63) in Nawal Parasi.

Per person infected, this translates to means of Rs 1.6 and Rs 3.1.

All households were asked whether the illness had caused any loss of cash income other than payments for hired labour and medical care. 9% in Dhanusa and 20% in Nawal Parasi said yes, the main reasons being that the patient could not work as a wage labourer (92% in Dhanusa and 63% in Nawal Parasi) and that the patient could not do other types of work (25% in Nawal Parasi). Mean cash lost per household losing was Rs 169 (SD Rs 156) in Dhanusa and Rs 138 (SD Rs 162) in Nawal Parasi. Translated into a mean per person infected, these figures convert to Rs 14 (SD Rs 65) and Rs 27 (SD Rs 90).

Patients were also asked whether they thought the malaria episode would affect production. 72% in Dhanusa and 71% in Nawal Parasi said no. 23% in Nawal Parasi said production would be affected because they could not cultivate their crops. This reason was also given by 7% in Dhanusa, further reasons being that agricultural implements were not made (5%) and that vegetables and wood were not sold (7%).

In summary, the great majority of households coped with the consequences of the malaria episode by drawing on household reserves of labour, primarily of adults rather than children. For 75% of households in Dhanusa the illness of a working household member caused no problems. This proportion was 50% in Nawal Parasi, perhaps because of the longer mean period of illness. In Dhanusa, 91% of households experienced no cash loss (excluding hired labour and medical care costs) because of the illness and in Nawal Parasi, 80%. Over 70% of households in both districts did not think household production would suffer. If the financial losses that were reported are expressed per case of malaria, they represent a mean of Rs 16 in Dhanusa and Rs 30 in Nawal Parasi. This contrasts with a figure of Rs 103 if the crude approach to valuation is taken of multiplying days of work lost by the local wage rate.

The first estimate is likely to be an underestimate because the value of the non-financial production losses of the minority of households experiencing them are excluded; the second an over-estimate since it takes no account of the availability of spare capacity with the household.

The sample size of the household survey is too small to permit a detailed analysis of losses by case detection mechanism. Moreover, as discussed later, the period of work lost is influenced by factors such as the species mix of cases, the delay between start of the fever and presumptive treatment and whether or not the patient has had previous episodes of malaria, all of which vary by district. Since the data in the household survey are not from Rupandehi or Morang, the districts being analysed here in the cost-effectiveness study, the data on days of work lost per worker by case detection mechanism from the patient survey are taken, but multiplied by the loss found by the household survey, expressed as a mean per worker per day of complete disability. This approach makes the assumption, probably realistic, that the factors mentioned above as affecting the illness episode affect the length of disability (ie number of days) rather than the severity of each day of illness.

The result of this calculation is a mean loss per worker per day of complete disability from the household survey of Rs 4.6 (Dhanusa) and Rs 3.7 (Nawal Parasi), rounded to Rs 4. This needs to be converted to a loss per person with malaria. In Rupandehi, 82% of malaria patients stated that they worked and in Morang, 79%. This gives a loss per malaria patient per day of Rs 3.3 in Rupandehi and Rs 3.2 in Morang. This loss, multiplied by the days of work lost by case detection mechanism, is added to the cost per case of various case-detection methods in Table 6.15.

As with the inclusion of expenditure by individuals, inclusion of losses due to inability to work does not change the ranking of methods and, indeed, increases the cost per case of malaria clinics by less than for other methods.

Speed of treatment

A final consideration in comparing case detection methods is the speed with which confirmed cases receive radical treatment. The longer the delay, the more likely that the initial case will lead to the infection of others. Table 6.16 shows mean days from start of fever to radical

Table 6.15: Costs of case detection and treatment including value of losses due to inability to work (a)

Case detection method	Morang (Rs)	Rupandehi (Rs)
ACD/APCD/Follow-up		
- total cost per case of treatment	2140	816
- value of days of work lost (weighted mean)	37	26
- total cost per case	2177	842
PCD (V)		
- total cost per case of treatment	1595	365
- value of days of work lost	71	27
- total cost per case	1666	392
PCD (MC)		
- total cost per case of treatment	N/A	149
- value of days of work lost	N/A	22
- total cost per case	N/A	171
PCD (M)		
- total cost per case of treatment	471	237
- value of days of work lost	47	28
- total cost per case	518	265
PCD (H)		
- total cost per case of treatment	750	313
- value of days of work lost	27	29
- total cost per case	777	342

(a) Value of days of work lost has been converted to economic prices by multiplying by the conversion factor for unskilled labour of 0.9.

Table 6.16: Number of days from start of current fever to radical treatment, and from slide collection to radical treatment, by case detection mechanism.

	Morang Mean (days)	Morang SD	Morang n	Rupandehi Mean (days)	Rupandehi SD	Rupandehi n
Start of fever to radical treatment:						
- ACD	30.3	18.9	147	19.4	14.4	570
- APCD	30.1	19.4	62	17.3	11.1	173
- PCD(V)	28.5	12.9	35	16.4	8.6	435
- PCD(MC)	-	-	0	6.8	6.7	402
- PCD(M)	19.8	15.0	70	15.8	8.1	100
- PCD(H)	30.2	11.6	18	22.7	12.3	47
- MBS	24.0	11.3	2	21.4	21.8	30
- Follow-up	29.7	20.8	34	15.7	12.0	55
Slide collection to radical treatment:						
- ACD	23.4	16.4	147	11.4	12.4	570
- APCD	23.2	16.8	63	9.5	7.4	173
- PCD(V)	21.6	11.0	35	8.9	5.7	435
- PCD(MC)	-	-	0	0.3	2.6	393
- PCD(M)	12.9	12.3	71	8.4	6.0	100
- PCD(H)	25.3	10.7	18	13.6	9.3	47
- MBS	11.7	5.5	3	13.6	19.6	30
- Follow-up	21.9	16.2	38	12.1	12.7	58

Source: Mills and Colbourne (1985)

treatment, and from slide collection to radical treatment, by slide source, for Morang and Rupandehi.

The two districts differ in the speed with which cases receive radical treatment, but both display similar patterns. PCD cases in general are treated more quickly. Mean days for PCD (V) reflects well on the support provided to the volunteer system. PCD (M) may be relatively fast because cases live near the malaria unit office. PCD (MC) is very fast because immediate radical treatment is usually given. Why PCD (H) is relatively long is not clear, unless couriers collect slides less frequently than from other PCD mechanisms.

In general, therefore, the PCD mechanisms perform well in terms of the speed with which cases are detected and treated.

6.4 Summary

This chapter has analysed the cost and cost-effectiveness of malaria control strategies, facilitating a comparison of alternatives both within and between strategies. It has analysed costs both to the government and to malaria patients and their households.

With respect to the strategy of spraying, fixed costs made up 25% of total costs for DDT, and 17% for malathion. The district cost per capita per cycle was around Rs 8 for DDT and Rs 13 to Rs 17 (depending on the dosage) for malathion. Total costs per capita per cycle were Rs 10-11 for DDT and a minimum of Rs 16 for malathion. Because of the differing persistence of DDT and malathion, the difference between them was increased when a cost per person per month of protection was calculated: Rs 1.41 for DDT and Rs 5.34 to Rs 5.67 for malathion (district costs).

A rough estimate of the cost of spraying Ficam indicated that it was over twice as expensive per capita as DDT, and a third more than malathion.

No cost of spraying per case prevented could be calculated because of the absence of reliable data on the effectiveness of spraying. However, what data existed was reviewed and it was concluded that if insecticides were properly applied, spraying could be highly effective in some areas and ineffective in others because of human or vector behaviour or unnecessary because of local influences on transmission. Not infrequently, poor application practices had reduced any potential effectiveness.

The cost and effectiveness of case detection and treatment strategies were analysed first for all case detection strategies taken together (excluding volunteers) in integrated and non-integrated districts, and subsequently for each case detection strategy in non-integrated districts.

The district cost per capita of case detection and treatment was Rs 0.75 and Rs 0.92 in the two integrated districts (Saptari and Parsa), and Rs 2.40, Rs 3.10 and Rs 8.35 in the three non-integrated districts (Morang, Rupandehi and Ilam). Costs were low in integrated districts at least partly because manpower was diverted to malaria control when required; total costs thus changed as the number of cases changed whereas in non-integrated districts virtually all costs were fixed.

District costs per slide taken (excluding parasitology) were Rs 9.02 (Parsa), Rs 12.98 (Saptari), Rs 12.47 (Morang), Rs 12.51 (Rupandehi) and Rs 23.77 (Ilam). District parasitology costs per slide were around Rs 1.80 in integrated districts and Rs 1.05 to Rs 2.03 in non-integrated districts.

District costs per case (excluding parasitology) were Rs 734 in Parsa, Rs 845 in Saptari, Rs 598 in Rupandehi, Rs 1545 in Morang and Rs 6242 in Ilam. Since virtually all costs in non-integrated districts were fixed, unit costs at different levels of output showed a direct (inverse) relationship with output. In integrated districts in contrast, unit costs remained more stable as cases increased. Thus in terms of cost per case, the integrated districts fell within the range of costs of the non-integrated districts, rather than outside it as with the cost per capita indicator. The question of whether there was any difference between integrated and non-integrated districts in the proportion of all cases detected could not be answered.

Before costs in non-integrated districts were disaggregated by case detection mechanism, the interdependence of the yields of the mechanisms was discussed. Based on survey data, it was concluded that the ACD mechanism was used if an MFW happened to arrive at a house in the first few days of the illness, if he was known to be due to come, or if the patient's symptoms were particularly mild. Otherwise a PCD mechanism was used.

PCD (H) and PCD (M) represented relatively low cost additions to the work of units whose prime function was not case detection. Therefore only ACD/APCD/Follow up (all done by MFWs), PCD (V) and PCD (MC) were discussed in detail. District costs of case detection through ACD/APCD/Follow up were Rs 1695 (Morang), Rs 619 (Ilam) and Rs 5063 (Ilam); of PCD (V) were Rs 1154 (Morang), Rs 164 (Rupandehi) and Rs 4270 (Ilam) and of PCD (MC) Rs 1046 (Morang) and Rs 96 (Rupandehi). The same mechanism could therefore have widely differing costs, depending on the level of use, but in each district malaria clinics were consistently the cheapest followed by volunteers, and ACD etc consistently the most expensive. Adding the cost of radical treatment accentuated the difference between the cost per case of malaria clinics and all other mechanisms.

Costs to individuals were explored in terms of costs to volunteers, costs of private expenditure associated with treatment and costs of days of work lost.

Costs to volunteers appeared to be insignificant and so were not quantified.

Costs of private expenditure were available from both the patient and household surveys. They suggested that the extent to which patients sought sources of treatment other than those offered by the NMEO and ICHSDP differed considerably between districts and, though to a lesser extent, the sums paid. Mean expenditure per patient paying for treatment was Rs 46 in Rupandehi and Rs 123 in Morang, with 70% of patients in both districts incurring some level of expenditure. In Rupandehi, individuals attending PCD mechanisms, especially PCD (MC), spent more than those detected through ACD. The reverse was true in Morang except for PCD (M). The addition of mean private expenditure per case for each case detection method to the government cost did not alter the ranking of methods by cost per case.

The cost of days of work lost is conventionally calculated by multiplying days lost by some measure of the average or minimum wage. The patient survey found that on average 8.3 days of work were lost in Rupandehi and 14.5 in Morang per worker, with little difference between case detection mechanisms. Multiplying days of work lost by the unskilled wage would result in a loss of approximately Rs 103 per malaria case in Rupandehi.

The validity of this approach was checked by using data from the household survey on changes in time allocation patterns of households in response to the illness of a household member. The great majority of households coped with the consequences of the malaria episode by drawing on household reserves of labour, primarily of adults rather than children. For 75% of households in Dhanusa the illness of a working household member caused no problems. This proportion was 50% in Nawal Parasi, perhaps because of the longer mean period of illness. In Dhanusa, 91% of households experienced no cash loss (excluding hired labour and medical care costs) because of the illness and in Nawal Parasi, 80%. Over 70% of households in both districts did not think household production would suffer. If the financial losses reported were expressed per case of malaria, they represented a mean of Rs 16 in Dhanusa and Rs 30 in Nawal Parasi, contrasting with the figure of Rs 103 if the crude approach to valuation was taken.

Because the crude approach seemed likely to produce a gross over-estimate of loss, the loss found by the household survey was used to value the days of work lost found by the patient survey in Rupandehi and Morang. This was added to the cost per case of the case detection mechanisms. The complete (government and private) cost per case detected was therefore estimated to be in Rupandehi, Rs 171 for PCD (MC), Rs 265 for PCD (M), Rs 342 for PCD (H), Rs 392 for PCD (V) and Rs 842 for ACD/APD/Follow-up. In Morang, the estimates were PCD (M) Rs 518, PCD (H) Rs 777, PCD (V) Rs 1666 and ACD/APCD/Follow up Rs 2177. The attractiveness of PCD mechanisms over ACD was emphasized by their shorter time-lags between start of fever and radical treatment and slide-collection and radical treatment, producing a not easily quantified benefit in terms of a reduced probability of secondary cases.

7. RESULTS OF THE STUDY III: THE DESIRABILITY OF MALARIA CONTROL

Figure 4.1 in Chapter 4 set out a framework for the cost-effectiveness analysis of malaria control. The preceding chapter (Chapter 6) has analysed the cost of the malaria control strategies in use in Nepal in 1984 and quantified their cost-effectiveness in terms of intermediate outputs such as houses sprayed, slides taken and cases detected. In this chapter, the consequences of malaria control activities as laid out in Figure 4.1 are estimated and matched against the control costs in order to produce cost-effectiveness ratios that can help in determining whether malaria control is worthwhile per se (rather than which activities are the most efficient means of malaria control, which was the theme of the previous chapter).

In Figure 4.1, consequences were listed as:

- cases of illness and death averted;
- savings in resource use:
  - savings in government resources that in the absence of purposeful curative or preventive malaria control strategies would be spent on treatment of cases;
  - similar savings in individual or household expenditure;
  - savings in lost work time;
- changes in the quality of life.

These are considered in turn below. The discussion is conducted in terms of the three districts, Morang, Rupandehi and Ilam, for which most data are available.

7.1 Cases and deaths prevented

It is most accurate to regard the entire malaria control programme as directed towards the prevention rather than treatment of malaria, and thus to use 'cases prevented' as the output measure. Quantifying this measure requires an answer to the question of how malaria incidence would respond to a cessation of the programme. Most commonly this question is answered by reference to the situation before the control programme was introduced. As discussed in Chapter 4 section 4.4, there are good reasons for arguing in Nepal that the pre-control situation is not likely to re-appear because of changes in vector species, the environment, population distribution and access to private sources of treatment. However, in the absence of any experimental withdrawal of control activities, it is extremely difficult to estimate the cases currently being prevented by the control programme.

Since the likely course of events if the control programme is withdrawn is so unclear, the figures presented here on likely cases and deaths must be considered as highly speculative. They do, however, give an idea of the orders of magnitude involved. The approach adopted is to assume that present malaria control activities are adequate to maintain incidence at current levels. Cases (deaths) prevented are then cases (deaths) without the programme minus cases (deaths) with the programme.

Estimates of cases without the programme need to acknowledge the different vulnerability of different geographical areas to the resurgence of malaria. Table 7.1 defines five topographical and malariological belts in Nepal, based on their malaria vulnerability, receptivity and risk. Of the three districts considered here, all contain a mix of low receptive and moderately receptive areas. In Morang and Rupandehi these are cultivated plain Terai and Inner Terai; in Ilam, Upper Valleys and Inner Terai. Cost-effectiveness estimates have been made separately for areas of low and moderate receptivity. In addition, low and high estimates have been made. The low estimate is based on the API in districts (distinguished by level of endemicity) with the highest incidence in 1985 and 1986, when there was a considerable increase in transmission, and assumes that these represent a level that other districts of similar receptivity might reach without control. The high estimate for areas of moderate receptivity is based on information from other countries in South-East Asia on levels of malaria where control is ineffective. For low receptivity areas the high estimate has been set at a level that gives the same ratio between the high and low estimate as that of moderate receptivity areas. These assumptions produce estimates of APIs of 10 and 40 in areas of low receptivity and 60 and 250 in areas of moderate receptivity. Since a certain level of malaria exists even with the control programme, the actual 1984 cases are subtracted from the estimates of cases obtained from these APIs to produce the numbers of cases prevented.

Table 7.1: Provisional stratification of malaria vulnerability, receptivity and risk in five topographical and malariological belts of Nepal.

Area	Type and endemicity of original malaria	Transmission season (months)	Vulnerability	Receptivity	Malaria risk (minimal<low<medium<high<maximal)
Cultivated plain terai	Stable hypoendemic	I-XII	+	+	Low without control of A.annularis Minimal with effective control of A.annularis by means of house-spraying or anti-larval measures
Forested plain terai	Stable hyperendemic	I-XII	+	(+++) ++	(Maximal if A.minimus returns) Moderate without control of A.fluviatilis. Low with effective control of A.fluviatilis by means of house-spraying.
Inner terai (including foothills up to 1000m)	Stable hyperendemic	I-XII	+	++	Low to moderate without control of A.maculatus and especially A.fluviatilis. Low with effective endophilic anopheline control by means of house-spraying.
Mountains & upper valleys (1000-2000m)	Unstable hypoendemic	Variable, from VI-VIII to IV-X	+	+	Low to moderate without control of A.fluviatilis and especially A.maculatus. Minimal with effective control of A.fluv. where necessary by means of house-spraying, plus measures to reduce A.mac. vectorial capacity by means of house-spraying, zooprophylaxis or lowering output from breeding-sites.
High Himalayas	Malaria-free	None	+	Nil	Absent

Footnote: ¹It should be noted that the level of malaria risk may rise as a result of unusual climatological conditions, environmental factors and influx in parasite carriers.

Source: White (1982)

Estimating deaths prevented by the programme is even more speculative. In Nepal, the case fatality rate (CFR) pre-control is thought to have been around 1%. Since then, both public and private sources of treatment have proliferated so 0.5% is used here as a low estimate. To allow for the likelihood of deaths arising from increased chloroquine resistance, 2% is used as an upper estimate. In 1984, no deaths were said to have resulted from malaria so this CFR is applied to the unadjusted numbers of cases.

Estimates of cases and deaths prevented represent the level at which cases would eventually stabilize without the programme. The time profile of the increase of cases and deaths is thus not addressed in these calculations since it would add unnecessary sophistication to what are fairly crude calculations.

Only the effects of the control programme on malaria have been considered here. Other benefits include its effects on the control of other vector-borne diseases such as Japanese B encephalitis and filariaris, and the reduction of nuisance insects such as bed bugs.

7.2 Resource use consequences of malaria control: consequences for government resources

If the malaria control programme were to cease, a proportion of the malaria patients would seek treatment at government facilities. Estimating the total cost of treatment requires assumptions on the proportion of patients that would seek treatment and the cost of treatment.

In the absence of any better basis for estimation, it is assumed that the proportion of cases seeking treatment would be the same as the present proportion of cases detected through PCD mechanisms. The cost of outpatient treatment is taken to be the mean of the cost per suspected case of detection and presumptive treatment in Saptari and Parsa (see Tables 6.6 and 6.7), namely Rs 13. It is further assumed that a proportion of cases equivalent to four times the number of deaths would be admitted to hospital, at a cost per person of Rs 300 (approximate cost, taken from Phillips 1985). These assumptions produce a cost for the government of treating the cases that would present in the absence of malaria control, which can be viewed as the savings for the government created by malaria control.

7.3 Resource use consequences of malaria control: consequences for household expenditure

Current situation

In Chapter 6, data on household expenditure on treatment by case detection method was reported. It appeared that despite the universal availability of free malaria treatment services, a considerable proportion of malaria patients chose to visit and pay for other sources of treatment. This pattern of behaviour is of considerable importance when considering the likely implications of cessation of control. The use and cost of these services is therefore considered here before making the assumptions necessary for the cost-effectiveness analysis. Information on these topics from the household survey relates to two small and relatively isolated areas whereas data from the patient survey covers a large number of cases in 6 districts of diverse characteristics. Therefore the latter data is of greatest use in considering the patterns and determinants of use of sources of treatment and so is discussed here.

Table 7.2 shows the number of visits made by each patient to sources of help before receiving presumptive treatment. The proportion making no visits ranged from 23% in Bara to 53% in Dang. One visit was made by between 32% in Morang and Bhojpur and 67% in Bara. Relatively few patients made more than one visit except in Morang and Bhojpur. Patients with P.falciparum infections were more likely to make any visit, and more likely to make more than one visit, than P.vivax cases.

Information was also collected on the source of help. The proportion of all patients who visited a hospital ranged from 1% in Sarlahi to 13% in Morang. Fewer visited a health post. Virtually no-one said they visited a community health leader or a community health worker (presumably because they were largely absent in the districts studied), or an ayurvedic practitioner. A considerable proportion, ranging from just under 20% of all patients in Dang and Bhojpur through approximately 30% in Rupandehi, Sarlahi and Morang to 47% in Bara, visited a private

Table 7.2: Number of visits per case to sources of help prior to presumptive treatment: patient survey

	District						Total
	Dang	Rupandehi	Sarlahi	Morang	Bhojpur	Bara	
Visits per person							
No visits	193	756	66	194	64	12	1285
column percent	52.6%	36.7%	39.1%	43.4%	40.8%	23.1%	39.5%
1 visit	143	1101	87	141	50	35	1557
column percent	39.0%	53.4%	51.5%	31.5%	31.8%	67.3%	47.9%
2 visits	26	167	14	72	37	5	321
column percent	7.1%	8.1%	8.3%	16.1%	23.6%	9.6%	9.9%
3 visits	5	36	2	30	6	0	79
column percent	1.4%	1.7%	1.2%	6.7%	3.8%	0.0%	2.4%
4 visits	0	1	0	10	0	0	11
column percent	0.0%	.0%	0.0%	2.2%	0.0%	0.0%	.3%
Total	367	2061	169	447	157	52	3253
column percent	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Missing:0

practitioner. Drug sellers were also frequently visited: 13% of cases in Dang visited a drug seller, between 20 and 30% in Bhojpur, Bara and Sarlahi, and around 40% in Rupandehi and Morang. Finally, visits to a faith healer showed considerable variation, from a low of 2% in Rupandehi, 4% in Bara and 6% in Sarlahi, to 13% in Dang, 15% in Morang and 31% in Bhojpur. Figure 7.1 shows how total visits were distributed between sources of help in each district. Use of malaria services is not shown here because the question asked about visits made before receiving presumptive treatment.

Table 7.3 shows the distribution of the total amount spent by each patient by district. A considerable proportion spent nothing: 24% in Bara, around 30% in Rupandehi and Morang, around 40% in Sarlahi and Bhojpur and 53% in Dang. Of those who spent something, the majority stated that they spent under 30 rupees but a small proportion quoted considerable sums, some so high that their accuracy seems questionable (for instance Rs 1200 spent by one case in Dang on sacrifice and worship). Because of the skewed distribution, geometric as well as arithmetic means were calculated. Average expenditure was as follows:

<u>Total expenditure per case</u>

District	Median (Rs)	Arithmetic mean (Rs)	Standard Deviation	n	Geometric mean (Rs)
Dang	0.0	42.3	116.3	363	4.7
Rupandehi	10.0	31.6	73.5	2030	7.5
Sarlahi	4.0	29.0	94.9	168	5.1
Morang	25.0	82.7	146.1	358	14.3
Bhojpur	10.0	69.7	159.0	153	9.3
Bara	20.0	69.9	110.1	51	14.8
All survey districts	10.0	41.0	98.7	3123	7.7

The geometric means show that differences between the districts still persist even when the effect of the skewed distribution is reduced by log transformation.

The greater the number of days off work, the more was spent on treatment. Mean expenditure is shown below for Rupandehi, categorized

Figure 7.1: Distribution of total visits between sources of help, by district

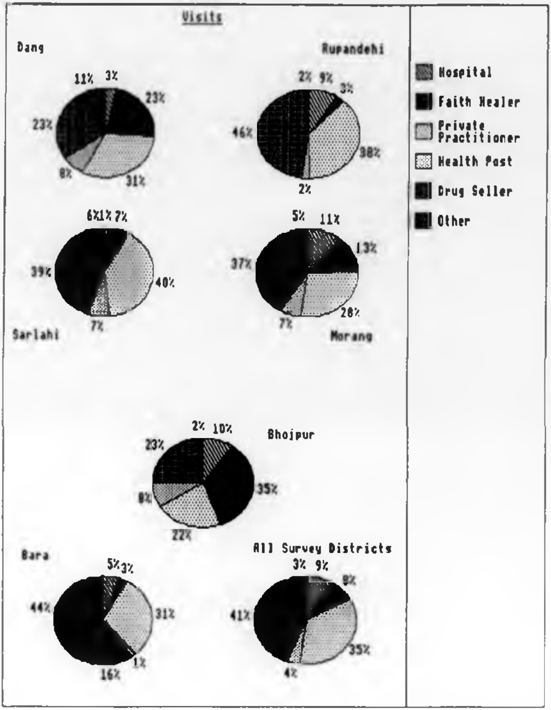


Table 7.3: Distribution of patient expenditure on treatment, by district: patient survey

	District						Total
	Dang	Rupandehi	Sarlahi	Morang	Bhojpur	Bara	
Total expenditure on illness							
No expenditure	194	650	68	117	63	12	1104
column percent	53.4%	32.0%	40.5%	32.7%	41.2%	23.5%	35.4%
Rps 1-9	16	336	28	25	10	9	424
column percent	4.4%	16.6%	16.7%	7.0%	6.5%	17.6%	13.6%
Rps 10-19	33	264	16	25	12	4	354
column percent	9.1%	13.0%	9.5%	7.0%	7.8%	7.8%	11.3%
Rps 20-29	17	192	14	27	6	5	261
column percent	4.7%	9.5%	8.3%	7.5%	3.9%	9.8%	8.4%
Rps 30-39	16	125	8	17	8	1	175
column percent	4.4%	6.2%	4.8%	4.7%	5.2%	2.0%	5.6%
Rps 40-49	8	88	8	17	5	2	128
column percent	2.2%	4.3%	4.8%	4.7%	3.3%	3.9%	4.1%
Rps 50-99	36	221	18	38	21	4	338
column percent	9.9%	10.9%	10.7%	10.6%	13.7%	7.8%	10.8%
Rps 100-199	21	100	5	47	12	6	191
column percent	5.8%	4.9%	3.0%	13.1%	7.8%	11.8%	6.1%
Rps 200-299	10	25	1	16	6	4	62
column percent	2.8%	1.2%	.6%	4.5%	3.9%	7.8%	2.0%
Rps 300 and over	12	29	2	29	10	4	86
column percent	3.3%	1.4%	1.2%	8.1%	6.5%	7.8%	2.8%
Total	363	2030	168	358	153	51	3123
column percent	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Missing:130

by number of days not worked. The geometric mean shows a smoother and less exaggerated but nonetheless similar pattern.

Mean expenditure by days not worked (Rupandehi)

Days not worked	Arithmetic mean (Rs)	Standard Deviation	n	Geometric mean (Rs)
0	9.8	25.7	53	1.3
1-4	17.0	31.5	335	4.3
5-9	21.3	41.9	638	5.6
10-14	32.3	58.7	321	9.3
15-19	67.8	148.3	114	14.3
20-24	62.8	106.5	54	21.3
25-29	56.7	48.9	13	34.9
30+	64.3	85.4	33	25.7

Similar information for the other districts showed that high mean total expenditure was associated with cases who had 15 or more days off work. High expenditure per patient also seemed to be associated with classification, with imported cases spending more than indigenous cases.

Expenditure on drugs and laboratory examinations took up the largest share of total expenditure, with a mean expenditure per patient of Rs 16.9 in Dang, Rs 22.2 in Rupandehi, Rs 13.4 in Sarlahi, Rs 60.3 in Morang, Rs 34.0 in Bhojpur and Rps 40.9 in Bara. Expenditure on sacrifice and worship was relatively high in Bhojpur (mean of Rs 23.5), Bara (mean of Rs 10.4) and Dang (Rs 17.9) but not in other districts. While considerable sums were spent by a few individuals on fees, special foods and travel to obtain care, mean expenditure per patient on these items was low in all districts. Figure 7.2 illustrates how mean total expenditure was divided between the various types of expenditure in each district.

In conclusion, despite the comprehensive malaria service presently offered in the districts studied, a substantial proportion of malaria patients sought help from some other source of care, whether to obtain a type of care not available from the malaria service (for instance the services of faith-healers), to supplement the care offered by the malaria service, or in ignorance of the existence of the malaria

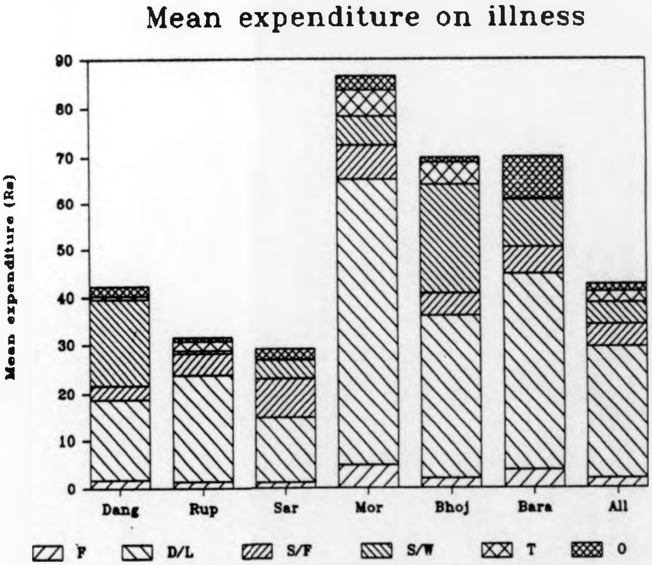


Figure 7.2: Mean expenditure on treatment, by type of expenditure and district

service. As a consequence, substantial sums of money were spent: a total of around Rs 128,000 by the 3123 individuals in the survey for whom this information was available. Recourse to these other sources of treatment seemed to be particularly associated with lengthy periods of disability, though it is unclear whether this was because patients delayed obtaining treatment from the malaria service because they were treated (ineffectively) elsewhere, or whether it was the long period of illness that led them to consult private sources of treatment. Imported cases were also more likely to purchase care, possibly because they had to seek treatment when away from home, or they may have had greater access to cash to pay for treatment than indigenous cases.

Assumptions for the cost-effectiveness analysis

It can therefore safely be concluded that the increased number of malaria cases resulting from the cessation of control is likely to lead to substantial private expenditure on treatment. It is assumed for the moment that mean private expenditure per case on treatment will remain at the same level. This will be an underestimate if patients make more use of private facilities as may happen, for example, if public facilities become overburdened by malaria cases.

7.4 Resource use consequences of malaria control: consequences for lost work time

Current situation

In Chapter 6, days of work and school lost were discussed in relation to case detection method. Here, a fuller presentation of that data is given in order to investigate in more detail the influences on days of work and school lost. This will enable a more informed judgement to be made on how days of work and school lost might be affected by the cessation of malaria control.

For those who stated they normally worked, Table 7.4 shows days not worked by district. The variation between districts is considerable and 3 districts in particular stand out. Sarlahi and Bhojpur both have a relatively high proportion of cases (around 30%) who lost no days.

Table 7.4: Number of days not worked by district

	District						Total
	Dang	Rupandehi	Sarlahi	Morang	Bhojpur	Bara	
Days not worked due to illness							
0 days	26	54	42	62	40	6	230
column percent	8.3%	3.4%	29.2%	22.9%	30.3%	14.0%	9.3%
1-4 days	33	338	33	45	21	1	471
column percent	10.5%	21.5%	22.9%	16.6%	15.9%	2.3%	19.0%
5-9 days	75	642	28	51	33	10	839
column percent	24.0%	40.9%	19.4%	18.8%	25.0%	23.3%	33.9%
10-14 days	73	323	26	28	11	12	473
column percent	23.3%	20.6%	18.1%	10.3%	8.3%	27.9%	19.1%
15-19 days	46	114	8	25	13	4	210
column percent	14.7%	7.3%	5.6%	9.2%	9.8%	9.3%	8.5%
20-24 days	29	54	3	11	7	0	104
column percent	9.3%	3.4%	2.1%	4.1%	5.3%	0.0%	4.2%
25-29 days	12	13	2	5	1	2	35
column percent	3.8%	.8%	1.4%	1.8%	.8%	4.7%	1.4%
30 days and over	19	33	2	44	6	8	112
column percent	6.1%	2.1%	1.4%	16.2%	4.5%	18.6%	4.5%
Total	313	1571	144	271	132	43	2474
column percent	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Morang also had a relatively high proportion who lost no days (23%) but also had 16% who lost over 30 days. The averages are as follows:

Days of work lost

District	Mode	Median (days)	Mean (days)	Standard deviation	% losing no days	n
Dang	10.0	10.0	12.1	9.6	8.3	313
Rupandehi	5.0	7.0	8.3	6.6	3.4	1571
Sarlahi	0.0	4.0	6.1	7.6	29.2	144
Morang	0.0	7.0	14.5	22.9	22.9	271
Bhojpur	0.0	5.0	7.6	9.6	30.3	132
Bara	10.0	10.0	13.4	10.9	14.0	43
All survey districts	5.0	7.0	9.4	10.6	9.3	2474

The mean days lost is thus 9.4 (range by district 6.1 - 14.5).

Mean days lost was calculated for a variety of sub-groups of the survey population. This approach was preferred to multiple regression because of concerns over data quality and the high correlation between a number of the independent variables. Where appropriate, geometric means are given in addition to arithmetic means because of the skewed distribution of days of work lost. Since cases from Rupandehi predominate in the sample, the means for Rupandehi are reported here. In general, despite the variation in mean days lost between the districts, the means for the population sub-groups behave consistently across the districts. A comment is made below only when this is not so.

Age: Mean days lost varied little with age, except to rise amongst those aged 65 years and over.

Sex: Mean days lost was virtually identical for males and females, being 8.3 for males (SD 6.8) and 8.5 for females (SD 6.1) in Rupandehi.

Visits per patient and total expenditure per patient: As might be expected, mean days lost increased as visits per patient and total expenditure per patient increased. For example, mean days lost was

6.8 (SD 4.7) in Rupandehi for those cases who spent nothing, and 9.2 (SD 7.2) for those who spent Rps 1 and over. An even sharper difference was evident in Morang, where the figures were 5.5 (SD 8.1) and 18.1 (SD 25.7). Equivalent geometric means for Morang were 2.45 and 8.02.

Source of slide: As shown in Chapter 6, mean days lost showed little variation by source of slide.

Species and classification: In Rupandehi, mean days lost for P.vivax cases was 7.9 days (SD 6.1) and for P.falciparum, 10.9 days (SD 8.1). After log transformation, this difference was found to be significant ($P < 0.001$). This pattern was mirrored in the other districts, with the exception of Sarlahi. Indigenous P.vivax cases in Rupandehi had a mean days lost of 7.9 (SD 5.8) and imported A P.vivax of 8.3 (SD 7.7). Similar figures for P.falciparum were 11.9 days, SD 8.6 (indigenous) and 9.6 days, SD 7.0 (imported A). This pattern was not repeated in all districts. In Morang, mean days lost by indigenous P.vivax was 8.5 (SD 13.2) and by imported A P.vivax 15.3 (SD 26.2). In the case of P.falciparum, both Morang and Dang show a reverse pattern to Rupandehi, though few cases are involved.

Number of days from start of fever to slide collection: As might be expected, mean days of work lost increased as the number of days between the start of the fever and slide collection (i.e. presumptive treatment) increased. In Rupandehi the figures were as follows:

<u>Mean days of work lost by days from start of fever to slide collection (Rupandehi)</u>

Days from start of fever to slide collection	Arithmetic mean days lost	Standard deviation	n	Geometric mean days lost
0 - 2	5.3	4.2	215	4.0
3 - 5	6.2	4.0	573	5.3
6 - 8	8.2	5.3	361	7.2
9 - 11	9.9	4.1	164	9.1
12+	15.4	10.0	245	12.6

A similar pattern was apparent for mean days lost by the number of days between the start of the fever and radical treatment.

Number of days from slide collection to radical treatment: Mean days lost increased as the number of days between slide collection and radical treatment increased, though within a more restricted range than the figures above. For a time lag of 7 days and less, mean days lost in Rupandehi was 7.4 (SD 5.7), for 8 - 14 days, 9.3 (SD 7.4), for 15-30 days, 9.8 (SD 6.7) and for over 30 days, 10.1 (SD 7.1).

Presence of previous fever: In Rupandehi, mean days lost for those who had not had a previous fever was 8.3 (SD 6.1) and for those with a previous fever, 8.8 (SD 7.8). In Morang these figures were 6.9 (SD 7.6) and 16.7 (SD 25.2). The more detailed information below on days lost by number of days between the previous and current fever shows a clear pattern.

<u>Mean days of work lost by days between current fever and previous fever (Rupandehi and Morang)</u>

Days from previous to current fever	Rupandehi Mean days lost	Rupandehi Standard deviation	Rupandehi n	Morang Mean days lost	Morang Standard deviation	Morang n
< 8 weeks	10.2	7.6	103	12.9	13.8	57
8-24 weeks	8.0	6.8	166	20.1	24.1	68
24-52 weeks	9.0	10.7	91	22.4	36.9	54
> 1 year	8.0	5.6	64	7.7	13.4	27

Attention was drawn earlier to the unusually large proportion of Morang cases who lost over 30 days' work. The above figures support earlier comments on possible confusion between previous and current episodes. Mean days lost in Morang is much closer to the experience of other districts for those cases who have not had a previous fever or where the fever was more than one year earlier. Thus it seems that some of the longer periods of days lost may result from individuals who either have had a new infection soon after a previous infection, or a relapse. In some cases, days lost may not therefore relate only to the current episode of fever.

For all those who stated they normally attended school, Table 7.5

Table 7.5: Number of days of school lost by district

	District						Total
	Dang	Rupandehi	Sarlahi	Morang	Bhojpur	Bara	
Days of school lost due to illness							
0 days	4	11	1	9	0	0	25
column percent	7.3%	5.0%	16.7%	21.4%	0.0%	0.0%	7.6%
1-4 days	4	33	2	7	2	0	48
column percent	7.3%	15.1%	33.3%	16.7%	33.3%	0.0%	14.6%
5-9 days	13	104	3	6	1	1	128
column percent	23.6%	47.7%	50.0%	14.3%	16.7%	100.0%	39.0%
10-14 days	19	45	0	5	2	0	71
column percent	34.5%	20.6%	0.0%	11.9%	33.3%	0.0%	21.6%
15-19 days	6	10	0	5	0	0	21
column percent	10.9%	4.6%	0.0%	11.9%	0.0%	0.0%	6.4%
20-24 days	5	10	0	1	0	0	16
column percent	9.1%	4.6%	0.0%	2.4%	0.0%	0.0%	4.9%
25-29 days	1	1	0	3	1	0	6
column percent	1.8%	.5%	0.0%	7.1%	16.7%	0.0%	1.8%
30 days and over	3	4	0	6	0	0	13
column percent	5.5%	1.8%	0.0%	14.3%	0.0%	0.0%	4.0%
Total	55	218	6	42	6	1	328
column percent	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

shows days of school lost. The distribution shows a not dissimilar pattern to days of work lost, though the small numbers make conclusions more difficult. Morang in particular again showed a relatively high proportion with no days lost and with more than 30 days lost. The averages by district were as follows:

<u>Days of school lost</u>

District	Mode (days)	Median (days)	Mean (days)	Standard deviation	% losing no days	n
Dang	10.0	10.0	11.6	7.9	7.3	55
Rupandehi	5.0	7.0	8.3	6.6	5.0	218
Sarlahi	0.0	4.5	4.2	3.2	16.7	6
Morang	0.0	7.0	14.5	24.5	21.4	42
Bhojpur	3.0	7.5	9.7	8.4	0.0	6
Bara	7.0	7.0	7.0	0.0	0.0	1
All survey districts	10.0	7.0	9.6	11.0	7.6	328

These averages are close to those for days of work lost, with a similar pattern of variation between the districts. Sarlahi, for example, is again the lowest, Dang is one of the highest, and Morang again has the most extreme distribution.

Mean days of school lost was analysed by the same categories as days of work lost. Results are again reported here for Rupandehi, the numbers for the other districts usually being too small to permit conclusions to be drawn.

Age and sex: Mean days of school lost varied little by age or sex.

Visits per case and total expenditure per case: No relationship was apparent between mean days of school lost and number of visits for treatment or expenditure on treatment.

Source of slide: Mean days of school lost showed slightly more variation by source of slide than mean days of work lost. If all PCD categories are grouped together, the mean days of school lost is 9.2 (SD 5.7) for ACD and 8.0 (SD 6.8) for PCD.

Species and classification: In Rupandehi, mean days of school lost for P.vivax cases was 8.0 (SD 6.6) and for P.falciparum, 10.8 (SD 6.9) (this difference was tested using a log transformation but was not significant). Mean days of school lost were similar for indigenous (7.9 days) and imported P.vivax (8.7 days) in Rupandehi. The numbers of imported P.falciparum cases were too small for conclusions to be drawn for Rupandehi. For the sample as a whole, mean days of school lost for indigenous P.falciparum was 12.8 (SD 8.8) and for imported A P.falciparum, 8.6 (SD 6.7).

Number of days from start of fever to slide collection: Mean days of school lost tended to increase as the number of days between the start of the fever and slide collection increased. In Rupandehi, the results were as follows:

Mean days of school lost by days from start of fever to slide collection (Rupandehi)

Days from start of fever to slide collection	Arithmetic mean days lost	Standard deviation	n	Geometric mean days lost
0-2	6.7	5.1	32	5.3
3-5	5.4	2.4	59	4.9
6-8	7.8	7.9	66	6.2
9-11	9.8	1.7	20	9.7
12+	14.4	7.6	39	11.8

A similar pattern was apparent for mean days lost by the number of days between the start of the fever and radical treatment, though with a wider range of mean days lost. For a time lag of 0-7 days, mean days lost in Rupandehi was 6.2 (SD 7.3), and for a time-lag of over 30 days, 17.1 (SD 7.3).

Number of days from slide collection to radical treatment: Mean days of school lost in Rupandehi increased as the time-lag between slide collection and radical treatment increased. For a time lag of 0-7 days, mean days of school losr was 7.2 (SD 6.5), for 8-14 days, 9.7 (SD 6.5) and for 15-30 days, 11.2 (SD 6.8).

Presence of previous fever: In Rupandehi, mean days of school lost for those who had not had a previous fever was 8.4 (SD 6.8) and for those with a previous fever, 9.0 (SD 6.8). Other districts showed a greater difference. In Morang, for example, the means were 9.2 (SD 11.0) for those without a previous fever and 16.7 (SD 28.1) for those with a previous fever.

What can be concluded from this data on days of work and school lost? Information obtained in the patient survey on number of days of work lost was expected to be approximate. Indeed, the distribution of days of work lost was extremely wide, with a small minority of patients reporting very large numbers of days (maximum days reported were 48 in Dang, 90 in Rupandehi, 60 in Sarlahi, 180 in Morang, 60 in Bhojpur and 45 in Bara).

However on the whole, mean days not worked varied in the expected directions when analysed above for various sub-groups of patients and behaved consistently across the districts. Moreover, while the mean days not worked of 9.4 days appears high, it is not inconsistent with the mean days from start of fever to presumptive treatment of 7.6 days. Information on days lost appears therefore good enough for general conclusions to be drawn, even if there are some inaccuracies.

Two factors appear to influence strongly mean days of work lost. Firstly, on average P.falciparum cases lost 40% more days than P.vivax cases. Secondly, the longer the periods between the start of the fever and presumptive and radical treatments, the more days of work were lost. The relationship between days of work lost and the classification ot the patient is less clear. In Rupandehi, imported P.falciparum cases lost on average fewer days than indigenous P.falciparum, but the figures were very similar for P.vivax. It might be suggested that imported P.falciparum infections are less severe because these individuals are more likely to have had malaria before, but it is not clear why this argument does not apply also to P.vivax infections.

Days of work lost varied considerably between the districts, for reasons that are in general unclear. However, Dang had both a longer-than-average mean days of work lost and a mean time-lag from start of fever to slide collection that was the longest of all the NMEO districts. Thus delay in receiving treatment may help to account for the higher mean days of work lost. This explanation may also hold for Bara though the number of cases is too small to draw firm conclusions. The only other district that varied markedly from the survey mean was Morang. Here the mean days of work lost seems to have been biased by confusion between current and previous episodes.

Days of school lost showed a very similar pattern to days of work lost, with a virtually identical mean and standard deviation. Days lost by species and time-lag between start of the fever and treatment also behaved in a similar fashion. P.falciparum cases on average experienced a mean number of days of school lost which exceeded P.vivax cases by 35%.

The above analysis is more difficult to do using the data from the household survey because some of the sample numbers in the population sub-groups are small. For example, too few P.falciparum cases occurred in Dhanusa to analyse days not worked by species. In Nawal Parasi, however, mean days not worked per person infected were 8.9 (SD 6.4) for P.vivax cases and 11.5 (SD 9.7) for P.falciparum cases, or about 30% more, thus confirming the conclusion from the patient survey (though the difference here was not significant).

The implications of these findings are that household resource costs stemming from the period of disability caused by malaria will increase if the proportion of P.falciparum infections increases and if case detection is less rapid. The first of these eventualities is already occurring and this trend is likely to strengthen as chloroquine resistant strains of malaria become more established in Nepal. The likelihood of the second eventuality depends on the extent to which Nepal can maintain its current, relatively efficient case detection mechanisms. Given the greater time-lag between infection and treatment that seems to occur in integrated districts, increased integration may well lead to greater household resource costs. So may cessation of formal malaria control activities.

Assumptions for the cost-effectiveness analysis

In order to calculate the value of the lost work time which would result from the cessation of malaria control, it is necessary to make assumptions on the proportion of malaria patients engaged in economic activity, the mean days lost per case and their value. Given the uncertainties surrounding the assumptions, it was decided to err on the side of caution. In low receptive areas, it is assumed that the great majority of cases would continue to occur in the working population, so the current proportions of patients engaged in economic activity in Morang, Ilam and Rupandehi are used (79%, 86% and 82%). In moderately receptive areas, since the probability of children being infected is greater, it is assumed that 70% of cases would be engaged in economic activity with the low case estimate, and 50% with the high case estimate.

It is further assumed for the moment that the current pattern of days of lost work per case would continue. This implies that the withdrawal of malaria-specific case detection and treatment services would not increase the delay before treatment and thus increase days of illness and days of work lost per case. This assumption is later relaxed.

At present, the pattern of transmission is scattered, with few households experiencing more than one case at a time or in a short period of time because of rapid case detection and treatment. This situation would be likely to change in the absence of a control programme and cases could cluster in households, producing an effect that would be greater than the sum of days lost multiplied by the current mean daily loss since the capacity of the household to cover for illness would be reduced, and this would be most likely to occur at times of peak labour demand because of the coincidence of periods of intensive agricultural activity and peak malaria transmission. Lost days are therefore valued at Rs 8 per worker, double the value estimated in Chapter 6, to allow for the likely clustering of cases in households. No adjustment is made for seasonal unemployment since the peak of malaria transmission coincides with busy periods in the agricultural cycle, but Rs 8 is multiplied by the conversion factor of 0.9, giving Rs 7.2, to convert it to an economic price.

As the analysis of data from the patient survey suggests, the resulting value of total days lost will be an underestimate if the species mix changes since P. falciparum cases appear to lose more days of work than _P. vivax_ cases. It will also be an underestimate if increased chloroquine resistance results in lengthier periods of illness or more severe illness, and if the withdrawal of control activities lengthens the period between the onset of the fever and treatment.

Deaths from malaria give rise to a loss of the earnings the individual would otherwise have earned over his or her remaining lifetime. In order to calculate these losses, assumptions are required on the average age of death, years of life remaining at that age, annual earnings and on a discount rate. At an API of 250 per 1000, the high estimate for moderately receptive areas, the first attack of malaria, that most likely to be fatal, will occur by the age of 4 and at an API of 62, the lower estimate for moderately receptive areas, by the age of 16 years. Therefore it is assumed that the mean age of death will fall in the age groups 1-4 and 15-19 for the low and high case estimates for moderately receptive areas. For low receptive areas, the low estimate is based on the current situation where the first attack occurs in teenagers and young adults. So 25-29 is taken to be the age group containing the mean age of death for the low case estimate, and 20-24 for the high estimate. Life tables (Central Bureau of Statistics 1977) were used to estimate years of life remaining at these ages.

The permanent removal of a household member from the workforce is likely to have more severe consequences on household labour supply and productivity than the temporary removal due to a short period of illness. It is therefore assumed that the dead household member would have been fully employed for 7 months of the year (the period of peak labour demand) and partially employed for the remainder of the year. The value of a day of full employment is taken to be Rs 15 (the wage for agricultural labour) and its value at slack periods of the year 40% of that, namely Rs 6. The weighted average is thus Rs 11.25 and is multiplied by 312 working days in the year and by the conversion factor of 0.9 to give annual earnings of Rs 3200. A discount rate of 12% is used. It is assumed, somewhat arbitrarily, that a child becomes productive at the age of 15. Because of the sweeping assumptions necessary to estimate the value of lost work days, it was not thought to be worthwhile to introduce such refinements as adjusting values for age or sex differences in productivity.

7.5 Changes in the quality of life

If the cessation of malaria control were to lead to a high incidence of malaria and, with increased chloroquine resistance, to an increased risk of death, the quality of life of the population of the Terai would suffer. There is no obvious way of placing a value on this consequence but an approximation can be made to a quality of life measure by translating the numbers of cases and deaths into 'healthy days of life'. This has the advantage that it incorporates both cases and deaths in one measure, but the disadvantages that days of illness and days of death are treated as equivalent and that only individuals who are actually infected are counted.

It can be argued that society is not indifferent as to <u>when</u> days of healthy life are saved - sooner rather than later. Thus the measure 'discounted days of healthy life gained' has also been calculated, with days discounted at 12% per annum.

Barnum (1987) argues for calculating also the measure 'discounted productive years of life lost', including only years of life lost in productive ages and weighting the years for variations in productivity over a person's life-time. Since the production consequences are taken into account separately here (as a resource saving consequence) this measure is not used.

7.6 Cost of control

The estimates of the cost of control are based on cost figures presented earlier for Morang, Rupandehi and Ilam. Saptari and Parsa have been omitted because cost data is incomplete with respect to overhead costs and private costs. Since surveillance costs are largely fixed with respect to the level of activity, they have been distributed between low and moderate areas in proportion to the population distribution. In order to distribute the cost of spraying between these areas in Rupandehi, insecticide costs have been calculated directly since data are kept separately for low and moderate areas. Other spraying costs have been distributed in proportion to the distribution of sprayman days.

7.7 Cost-effectiveness estimates

Table 7.6 presents the results of the cost-effectiveness calculations. Information on private costs and days of work lost was not available for Ilam so information from the patient survey for an adjacent hill district, Bhojpur, was used.

The first four cost-effectiveness ratios (C I, C II, C III and C IV) illustrate the resources required to prevent cases and deaths but cannot on their own imply anything about the relative value of preventing malaria - this requires a comparison with similar ratios from other health programmes to see whether the cost per case, death and healthy day of life gained from malaria control is more or less than that from other health programmes. These figures have not been located for Nepal, but a comparison is made with ratios from other countries in Chapter 8 below. It is useful to note here, however, the difference in the ratios between low and moderately receptive areas, and between the Terai and Hill. Relatively greater value (in terms of cases and deaths prevented) is obtained in moderately receptive areas and in the Terai since the cost of control is not proportional to the risk of malaria - in particular, the surveillance network is more expensive in the Hills and spraying is expensive in low receptive areas where A. annularis is the vector.

The cost-effectiveness ratio C V suggests that present government control costs are not matched by savings in government treatment costs that would be incurred in the absence of control except with the high case estimate and high case fatality rate in moderately receptive areas in the Terai. This suggests that malaria control cannot be justified, as might be expected, by savings in government treatment costs alone.

If, however, private treatment costs are added to government treatment costs, net savings result (ratio C VI) at a level of cases between the low and high estimates. Inclusion of the value of lost work days makes a dramatic difference (ratio C VII). Net savings result even

Table 7.6: Cost-effectiveness calculations

	Morang		Ilam		Rupandehi	
	Low receptive	Med. receptive	Low receptive	Med. receptive	Low receptive	Med. receptive
Population	308,033	115,547	42,707	22,961	231,467	159,326
%	77%	23%	65%	35%	59%	41%
A. COST OF MALARIA CONTROL (Rs)						
To NMEO						
-surveillance cost	1,213,032	360,655	420,397	225,599	963,475	663,190
-spraying cost	0	444,514	0	0	1,328,948	308,704
-total cost	1,213,032	805,169	420,397	225,599	2,292,423	971,894
To households						
-treatment (a)	45,882	13,906	3,642	2,185	42,418	26,868
-lost work days (b)	24,083	7,299	1,294	776	34,621	21,929
-total cost	69,965	21,205	4,936	2,961	77,039	48,797
Total cost	1,282,997	826,374	425,333	228,561	2,369,462	1,020,691
B. CONSEQUENCES						
I. Cases						
Cases without control						
-low estimate (c)	3,890	6,935	428	1,378	2,315	9,560
-high estimate (d)	15,561	28,897	1,711	5,740	9,259	39,832
Cases 1984	584	177	55	33	1,433	895
Cases prevented						
-low estimate	3,306	6,758	373	1,345	882	8,665
-high estimate	14,977	28,720	1,656	5,707	7,826	38,937
II. Deaths						
Deaths without control						
-low estimate cases, .5% CFR	19	35	2	7	12	48
-low estimate cases, 2% CFR	78	139	9	28	46	191
-high estimate cases, .5% CFR	78	144	9	29	46	199
-high estimate cases, 2% CFR	311	578	34	115	185	797

Table 7.6: continued

	Morang: Low receptive	Morang: Med. receptive	Ilam: Low receptive	Ilam: Med. receptive	Rupandehi: Low receptive	Rupandehi: Med. receptive
III. Healthy days of life						
Savings in healthy days of life (e)						
-low estimate cases,.5% CFR	309,329	616,922	29,303	113,303	151,109	787,210
-low estimate cases,2% CFR	1,013,495	2,173,706	100,031	422,253	581,905	2,933,092
-high estimate cases,.5% CFR	1,207,016	2,043,319	120,157	525,269	690,312	3,667,027
-high estimate cases,2% CFR	4,420,170	10,119,965	474,060	1,970,951	2,565,009	13,690,591
Savings in discounted healthy days of life (f)						
-low estimate cases,.5% CFR	106,150	201,780	9,237	30,036	42,123	214,975
-low estimate cases,2% CFR	200,010	513,136	20,446	92,606	146,040	644,151
-high estimate cases,.5% CFR	450,035	854,150	30,202	130,326	203,675	926,521
-high estimate cases,2% CFR	1,140,642	2,167,290	115,030	391,177	619,344	2,736,564
IV. Savings in resources (Rs)						
Government treatment (g)						
-low estimate cases,.5% CFR	39,732	75,428	3,544	11,030	19,652	116,554
-low estimate cases,2% CFR	106,255	194,033	10,061	35,396	59,233	200,023
-high estimate cases,.5% CFR	160,232	307,228	14,663	40,036	101,973	505,962
-high estimate cases,2% CFR	434,334	811,302	43,932	147,794	267,297	1,107,060
Private treatment (a)						
-low estimate cases,.5% CFR	159,754	530,960	29,295	105,643	70,040	600,731
-low estimate cases,2% CFR	159,754	530,960	29,295	105,643	70,040	600,731
-high estimate cases,.5% CFR	1,176,662	2,256,367	130,141	440,390	616,396	3,059,046
-high estimate cases,2% CFR	1,176,662	2,256,367	130,141	440,390	616,396	3,059,046
Lost workdays (h)						
-low estimate cases,.5% CFR	703,003	1,403,792	73,604	232,255	347,069	1,616,670
-low estimate cases,2% CFR	2,314,277	4,133,494	242,093	774,582	1,250,924	5,379,313
-high estimate cases,.5% CFR	3,370,029	3,672,207	302,499	507,017	1,599,201	4,150,751
-high estimate cases,2% CFR	9,401,607	10,191,313	976,137	1,882,010	5,243,419	13,144,730
Total savings						
-low estimate cases,.5% CFR	1,002,569	2,010,171	106,522	349,756	430,361	2,413,955
-low estimate cases,2% CFR	2,600,206	4,150,466	282,208	915,501	1,308,996	6,340,066
-high estimate cases,.5% CFR	4,621,723	6,245,001	447,305	1,005,043	2,324,571	7,723,739
-high estimate cases,2% CFR	11,012,593	13,259,043	1,150,210	2,479,082	6,127,111	17,390,044

Table 7.6: continued

	(--------Morang--------)		(--------Ilam--------)		(-------Rupandehi-------)	
	Low receptive	Mod. receptive	Low receptive	Mod. receptive	Low receptive	Mod. receptive
C. COST-EFFECTIVENESS RATIOS (Rs)						
I. Cost per case prevented (i)						
-low estimate cases	388	122	1,141	170	2,620	118
-high estimate cases	86	29	257	40	382	28
II. Cost per death prevented (j)						
-low estimate cases,.5% CPR	66,001	23,031	198,034	33,101	204,734	21,354
-low estimate cases,2% CPR	16,500	5,951	49,703	8,295	51,184	5,339
-high estimate cases,.5% CPR	16,500	5,719	49,703	7,963	51,184	5,125
-high estimate cases,2% CPR	4,125	1,430	12,426	1,991	12,796	1,281
III. Cost per day of healthy life gained (k)						
-low estimate cases,.5% CPR	4.44	1.34	14.40	2.02	15.60	1.30
-low estimate cases,2% CPR	1.27	0.30	3.90	0.54	4.07	0.35
-high estimate cases,.5% CPR	1.01	0.29	3.32	0.44	3.43	0.28
-high estimate cases,2% CPR	0.29	0.08	0.90	0.12	0.92	0.07
IV. Cost per discounted day of healthy life gained (l)						
-low estimate cases,.5% CPR	13.09	4.10	46.05	7.41	56.25	4.75
-low estimate cases,2% CPR	4.57	1.60	14.95	2.47	16.22	1.50
-high estimate cases,.5% CPR	3.05	0.97	11.13	1.75	11.63	1.18
-high estimate cases,2% CPR	1.12	0.30	3.90	0.50	3.83	0.37
V. Net savings in government curative and preventive costs (n)						
-low estimate cases,.5% CPR	(1,174,100)	(720,740)	(416,852)	(213,761)	(2,272,771)	(855,340)
-low estimate cases,2% CPR	(1,107,577)	(611,157)	(409,530)	(190,203)	(2,233,190)	(691,072)
-high estimate cases,.5% CPR	(1,045,600)	(487,942)	(405,533)	(175,984)	(2,183,450)	(463,952)
-high estimate cases,2% CPR	(779,500)	6,193	(376,465)	(77,085)	(2,025,130)	215,166
VI. Net savings in total curative and preventive costs (n)						
-low estimate cases,.5% CPR	(960,228)	(212,693)	(391,200)	(110,303)	(2,244,349)	(201,477)
-low estimate cases,2% CPR	(893,705)	(94,103)	(383,063)	(86,745)	(2,204,760)	(30,009)
-high estimate cases,.5% CPR	65,100	1,754,520	(379,232)	270,241	(1,609,473)	2,564,226
-high estimate cases,2% CPR	351,272	2,240,654	(349,965)	364,400	(1,451,109)	3,247,345
VII. Total net savings (o)						
-low estimate cases,.5% CPR	(201,228)	1,103,797	(310,810)	131,175	(1,931,101)	1,393,264
-low estimate cases,2% CPR	1,396,498	4,032,092	(143,084)	646,900	(908,466)	5,319,375
-high estimate cases,.5% CPR	3,337,926	5,419,427	21,973	857,283	(44,891)	6,703,040
-high estimate cases,2% CPR	9,720,796	12,432,600	724,070	2,250,441	3,737,649	16,370,153
VIII. Net savings per case prevented (p)						
-low estimate cases,.5% CPR	(60.86)	175.16	(853.02)	90.12	(2,141.69)	160.08
-low estimate cases,2% CPR	422.30	596.62	(383.74)	518.90	(1,007.39)	613.93
-high estimate cases,.5% CPR	222.07	100.70	13.26	150.21	(5.72)	172.15
-high estimate cases,2% CPR	649.59	431.90	437.60	394.38	470.94	420.43
IX. Net savings per death prevented (q)						
-low estimate cases,.5% CPR	(10,345)	34,139	(149,822)	17,591	(166,858)	39,149
-low estimate cases,2% CPR	37,949	39,070	(16,721)	24,933	(21,179)	37,023
-high estimate cases,.5% CPR	42,901	37,509	2,560	39,069	(978)	33,657
-high estimate cases,2% CPR	31,260	30,513	21,177	19,602	20,293	30,549

Table 7.6: continued: Notes

(a) Based on mean private expenditure of Rs 82.7 (Morang), Rs 69.7 (Ilam), Rs 32.6 (Rupandehi) multiplied by conversion factor of 0.95.

(b) Based on proportion of cases working and lost work days of 79% and 14.5 (Morang), 86% and 7.6 (Ilam), 87% and 6.3 (Rupandehi) multiplied by mean daily loss of Rs 4 and conversion factor of 0.9.

(c) Assuming API of 10 in low and 40 in moderate receptivity areas.

(d) Assuming API of 62 in low and 250 in moderate receptivity areas.

(e) Assuming death to occur in age-groups 1-4 and 15-19 for high and low case estimates for moderate areas, and 20-24 and 25-29 for low receptive areas.

(f) Discount rate of 12%.

(g) Assuming proportions seeking treatment of 43% (Morang), 24% (Ilam), 50% (Rupandehi), and treatment cost of Rs 13 for cases and Rs 300 for four times the number of deaths multiplied by conversion factor of 0.95.

(h) Loss for cases based on proportion of cases working as in (b) for low receptive areas and 70% for low estimate and 50% for high estimate, moderate receptive areas times loss per day of Rs 6. and loss for deaths based on average daily wage throughout year of Rs 11.25 times conversion factor of 0.9 and days worked per year of 312.
Lifetime earnings based on (e) above and discounted at 12%.

(i) Total cost of control divided by cases prevented.

(j) Total cost of control divided by deaths prevented.

(k) Total cost of control divided by days of healthy life gained.

(l) Total cost of control divided by days of healthy life gained discounted at 12%.

(m) Government treatment costs without control minus government cost of control.

(n) Total treatment costs without control minus total curative and preventive cost of control.

(o) Total resource costs without control minus total cost of control.

(p) Total resource costs without control minus total cost of control, divided by cases prevented.

(q) Total resource costs without control minus total cost of control, divided by deaths prevented.

assuming low incidence except with the low case fatality rate in low receptive areas and with either fatality rate in the expensive areas of the low receptive Terai where malathion is sprayed (Rupandehi) and the low receptive hill (Ilam). This result indicates that in narrow terms, considering only the resources used in malaria control and the resources that malaria control creates in terms of avoided treatment costs and productivity losses, malaria control can be justified. However, the ratio omits the value of preventing illness and saving life per se. It thus under-estimates the value of malaria control and does not provide an answer to the question of whether one should invest in malaria control as opposed to some other service.

The final two cost-effectiveness ratios, C VIII and C IX, divide net savings by cases and deaths, producing a net saving per case and per death. These figures suggest considerable potential benefits to individuals from preventing malaria.

Given the large number of assumptions necessary to produce the cost-effectiveness ratios, it is clearly important to test the sensitivity of the conclusions to variations in key assumptions. Table 7.6 itself incorporates some sensitivity analysis by using low and high case estimates and case fatality rates. In addition, the effects of changing the following assumptions were tested:

- halving the value of a day of work lost and of the annual loss due to death;
- doubling the cost of private treatment; assuming all cases receive government outpatient treatment; and doubling the government inpatient cost;
- doubling days of work lost per case;
- discount rates of 5% and 8%.

The effects of changing assumptions were as follows.

Cases prevented: The cost-effectiveness ratios are highly sensitive to assumptions on the number of cases prevented, as indicated by the range in cost per case prevented (C I).

Case fatality rate: Varying the case fatality rate has a large effect on the indicators healthy days of life and lost workdays. For example, 'savings in healthy days of life' (B III) are almost quadrupled by changing the case fatality rate from 0.5% to 2%, and lost work days trebled. Since lost work days are by far the greatest component in 'savings in resources' (B IV), 'total net saving' (C VII) and 'net savings per case and death' (C VIII and C IX) are very sensitive to variations in the case fatality rate.

Value of days of work lost: Halving the value of days of work lost has relatively little effect. Only one of the values in 'total net savings' (C VII) is switched from positive to negative (low receptive area of Ilam, high case estimate and low case fatality rate). 'Net savings per case and death prevented' are roughly halved but again, only one value switches from positive to negative.

Treatment costs: Assuming 100% seek government outpatient treatment and the cost of government inpatient treatment is doubled has the effect of approximately doubling savings in government treatment costs. This is sufficient, however, only to switch one value in C V, 'net savings in government treatment costs', from negative to positive (moderately receptive area of Ilam, high case estimate and high case fatality rate). In conjunction with the doubling of private treatment costs, the effect is to switch the values of C VI, 'net savings in total treatment cost', from negative to positive for all moderately receptive areas and low case estimates. Thus net savings occur whatever the case estimate and case fatality rate in moderately receptive areas but not for low receptive areas of Rupandehi or Ilam where control is costly, or the low receptive area of Morang and the low case estimate.

Work days lost per case: Doubling the work days lost per case has little effect because total work days lost are dominated by those resulting from death. In the ratio C VII, 'total net savings', only two values switch from negative to positive.

Discount rate: A reduction in the discount rate to 5% increases savings in discounted healthy days of life and in the value of lost work days by about 50%, thus affecting both the ratio C IV, 'cost per discounted day of healthy life gained', and C VII, 'total net savings' and consequently C VIII and C IX. The cost per discounted day of healthy life gained is thus considerably lower, and all values of 'total net savings' (C VII) became positive except the low receptive area of Ilam and Rupandehi with a low case estimate and low case fatality rate. With a discount rate of 8%, these areas with a low case estimate and high case fatality rate are also negative.

In conclusion, the sensitivity analysis indicates that the most important assumptions are those relating to the incidence of malaria in the absence of malaria control and the case fatality rate. Any cost-effectiveness ratio that includes a variable that depends on the days of life saved by preventing deaths (eg days of healthy life gained, lost work days saved) is dominated by the assumptions on deaths. Thus the assumptions on the period of incapacity of each case or its value are of little importance. Even halving the estimated value of the annual loss due to death has little effect.

The cost of malaria control is such that even if all cases received treatment at government expense, only in the moderately receptive areas with a high case estimate and high case fatality rate would treatment costs exceed the current costs of control. Superficially this might indicate that a curative rather than preventive strategy was worthwhile. However the ratio 'net savings in government treatment costs' (C V) ignores firstly the sizeable sums that individuals may spend on treatment, and secondly the cost to individuals in the form of lost production.

In terms of the economic analysis the results of the sensitivity analysis are reasonably reassuring: the exact values of the economic parameters (number of days lost per case, value of days lost per case and per death, value of treatment cost) are of less importance than the epidemiological parameters. Of all the economic parameters, that whose value appears to be the most important is the discount rate, though it affects only some of the cost-effectiveness ratios.

7.8 Summary

This chapter has provided the assumptions which, when matched with the cost analysis, enabled an assessment of the desirability of malaria control to be done. The framework of Figure 4.1 was used to assess the consequences of malaria control, namely cases and deaths averted, savings in resource use and changes in the quality of life.

The number of cases in the absence of malaria control was difficult to assess and was speculatively put at minimum and maximum APIs of 10 and 60 for low receptive areas and 60 and 250 for moderately receptive areas. The case fatality rate was put at 0.5% and 2%.

Consequences for government resources stem from treatment demands for cases that would arise in the absence of malaria control. It was assumed that the proportion of cases seeking government treatment would be the same as the present proportion of cases detected through PCD mechanisms; that the cost of outpatient treatment was Rs 13; that inpatient cases would equal four times the number of deaths; and that the cost of inpatient treatment was Rs 300.

Consequences for individuals stem from the costs of private treatment and of days of work lost that would arise in the absence of malaria control. Data from the patient survey was used to examine the influences on private expenditure and days of work and school lost in order to assist speculation on how these might change if the malaria control programme were to cease. The most important findings on private expenditure were that a substantial proportion of malaria cases currently sought help from non malaria service sources of care and spent substantial sums of money. Use of these other sources of treatment was particularly associated with lengthy periods of disability and with imported cases.

In the case of days of work and school lost, it was found that there was a strong association with the species of parasite, P. falciparum cases losing significantly more days of work than P. vivax cases, and that the longer the periods between the start of the fever and presumptive and radical treatments, the more days of work and school were lost.

The assumptions made for the cost effectiveness analysis were that mean private expenditure per patient would remain at the current level; that the current proportions of patients engaged in economic activity would persist in low receptive areas but would be reduced to

70% and 50% in moderately receptive areas, low case estimate and high case estimate respectively, due to the increased numbers of children infected; that the current pattern of days of lost work per case would continue; and that the value of each day lost would be Rs 7.20, double the current value, due to multiple cases within households which would limit their capacity to cope with the workload of sick members.

The value of the loss of production due to deaths was estimated by making assumptions on the average age at death for each API level and using life tables to estimate years of life remaining at those ages. Based on assumptions on the value of a day of full employment and on labour demands through the year, the value of a year's work was put at Rs 3200. It was assumed that a child became productiven at age 15, and the value of years of life lost was discounted at 12%.

Changes in the quality of life that would result from the cessation of malaria control could not be valued, but a proxy quality of life measure was used in the form of the indicators, 'healthy days of life lost' and 'discounted healthy days of life lost'.

Estimates of the cost of control were based on the cost analysis in Chapter 6 for Morang, Rupandehi and Ilam. Costs were distributed between low and moderately receptive areas of each district.

Nine cost-effectiveness ratios were calculated:

- cost per case prevented;
- cost per death prevented;
- cost per day of healthy life gained;
- cost per discounted day of healthy life gained;
- net savings in government curative and preventive costs;
- net savings in total curative and preventive costs;
- total net savings (including value of days of work lost);
- net savings per case prevented;
- net savings per death prevented.

The first four could not on their own imply anything about the relative value of preventing malaria since they required a comparison with similar ratios from other programmes. Present government control costs were not fully matched by savings in government treatment costs except with the high case estimate in moderately receptive areas in the Terai. If private treatment costs were added, net savings resulted at a level of cases between the low and high estimates. Inclusion of the value of lost work days resulted in net savings in virtually all areas.

The relevance of these various cost-effectiveness ratios to policy-makers was discussed. An extensive sensitivity analysis indicated that the most important assumptions were those relating to the incidence of malaria in the absence of malaria control and the case fatality rate. The exact values of the economic parameters were much less important.

8. DISCUSSION

8.1 Research objectives and methods

Chapter 1 listed the following aims of this research study:

1. to explore the relevance of recent developments in the methodology of cost-effectiveness analysis to disease control programmes in developing countries and specifically to malaria control in Nepal;

2. to apply cost-effectiveness analysis to the malaria control programme in Nepal in terms both of (a) the cost-effectiveness of various malaria control strategies and (b) the cost-effectiveness of the malaria control programme as a whole, in order to refine a methodology capable of more general application to disease control programmes in developing countries;

3. to assess whether policy-relevant conclusions can be drawn from the application of cost-effectiveness analysis to the malaria control programme in Nepal.

The following chapter takes up point number 3, so this chapter concentrates on whether the research has been able to achieve aims one and two.

The recent developments in the methodology of cost-effectiveness analysis have been found to be applicable to malaria control, though no attempt has been made to apply cost-utility analysis through use of an output measure such as quality adjusted life years. The methodology of the main components of the evaluative framework are considered in turn below.

Cost analysis

The cost analysis proved quite feasible, though was much assisted by the programme budgeting system used by a number of NMEO regions and districts. Accurate costing would have been far more difficult in the absence of such a system. The joint nature of costs in integrated districts was the main costing problem encountered, to which there was no easy solution.

Effectiveness analysis

The greatest methodological problem was posed not by the cost analysis but by the absence of good evidence on the effectiveness of alternative malaria control strategies or of the programme as a whole. Since it was beyond the scope of the research to mount a trial of alternative strategies, programme data and the views of experts as expressed in the External Reviews had to be relied on for evidence of effectiveness. Two main strategies were used to cope with the consequential poor evidence on effectiveness. For the comparison of alternative ways to achieve a programme objective (eg vector control, or case detection and treatment) measures of intermediate output were used, such as houses sprayed or cases detected. This approach is valid where this measure is common to the alternatives being compared and there is good reason to believe that it is a reliable proxy for a final output measure. For example in the case of spraying, it is known that both DDT and malathion are effective in killing susceptible and exophilic mosquitoes if properly applied; thus the measure 'houses sprayed' is a reasonable proxy indicator of output for the purpose of comparing insecticides so long as allowance is made for the differing periods of time over which they are effective.

For the analysis of the desirability of malaria control, the approach adopted to cope with the shortcomings of the effectiveness data was to estimate minimum and maximum levels of cases in the absence of control, in the expectation that the true value lay somewhere between these. This was admittedly guesswork, but it made it possible to explore the extent to which conclusions on cost-effectiveness were likely to be sensitive to the precise assumptions adopted on the likely level of malaria in the absence of control.

A final short-coming of the effectiveness analysis is that the effect of malaria control activities on diseases other than malaria has been ignored. These other diseases include viral encephalitis, leishmaniasis and filariasis. Although they do exist in Nepal, malaria presents the most serious problem and is taken to be the main raison d'etre of the control programme. Given the uncertainties over its effect on malaria, there seems to be little point in speculating on its effect on other diseases, about which even less is known.

Resource saving consequences

The cost-effectiveness analysis was able to estimate the value of the resource saving consequences included in the evaluative framework, namely savings in public and private treatment costs and savings in lost work time. The inclusion of both of these items can be controversial. In the context of a developed country, where all who need treatment are likely to obtain it, few question the relevance of averted treatment costs to a cost-effectiveness analysis. In a developing country, however, treatment may be confined to particular diseases, population groups or geographical areas. The inclusion of treatment savings can thus bias analyses or programme choice in favour of particular programmes or particular geographical areas.

In the comparisons undertaken within the context of this analysis, this type of bias was not a problem. For example, no cost-effectiveness ratios were available for other health programmes in Nepal to which malaria control might be compared, and no conclusions were drawn on the geographical scope of the malaria control programme that would be affected by differences in private treatment practices between areas. Indeed, inclusion of averted treatment costs is of value in seeing whether these alone are sufficient to offset the cost of control activities. Finally, given that alternative malaria control strategies and alternative case detection and treatment strategies have different consequences for the number and duration of cases of malaria, it is important to take into account their differing consequences in terms of treatment costs.

Controversy over the inclusion of savings in lost work time as a consequence has two sources: concern that it biases investment decisions in favour of programmes that improve the health of the workforce as opposed to children or the elderly; and concern that extremely crude measures are used to value days of work lost. The analysis here copes with these concerns in several ways. Firstly, a very broad definition of work was used in the surveys, encompassing not merely paid employment but also unpaid work within and outside the household, including childcare, housework and food preparation. Moreover, no arbitrary definition of the workforce was used: malaria cases were asked whether they considered themselves to work, according to the definition of work outlined above. Account was therefore taken of the work contribution of both children and the elderly. Secondly, the household survey was designed to explore the mechanisms within the household which determined whether the illness of a family member was translated into a loss of income or production. The resulting estimates of loss were much lower than if estimates had been based on the number of days of disability multiplied by a daily wage.

Finally, while it is recognised that households and society value the extension of life and improvement in quality of life as benefits in their own right and not merely as means to improvement in economic circumstances, in a poor subsistence economy, people themselves place a high priority on improving their economic circumstances. It was clear from discussions with villagers on the consequences of malaria that concerns about inability to work and earn a living were not concerns imposed by the preconceptions and framework of the research but reflected real local concerns.

Two resource-saving consequences occasionally included in cost-benefit analyses of malaria control programmes have been ignored in this analysis. They are the averted funeral expenses which result from saving lives (included by Rao and Bhombore 1956) and the value of the calories that an episode of fever consumes (included by Barnum 1978, Wright 1977 and Ramaiah 1980). The first has been excluded here because malaria control merely postpones death, the second because the empirical basis for estimating a value appears to be very shaky.

Quality of life

Since an assessment of the utility of malaria prevention to individuals in terms of the improvement in the quality of life was not possible within the scope of the fieldwork, the second-best solution adopted here was to use the measure 'healthy days of life lost' as a proxy and as a convenient way of amalgamating both cases and deaths in one measure. It is recognised, however, that such a measure incorporates assumptions on the relative weight to be given to days of illness versus days of death and to different age-groups. Indeed, the cost-effectiveness calculations showed clearly the extent to which the measure favours programmes which prevent deaths rather than episodes of illness.

Putting costs and consequences together

In putting costs and consequences together, a variety of ratios were calculated, ranging from a simple control cost per case averted to net savings per case averted. This approach both facilitates a discussion of the relevance of different measures to different sorts of decisions and different decision-makers and assists comparisons with other cost-effectiveness studies which on the whole calculate a less comprehensive range of costs and effects.

In valuing costs and consequences, the decision was taken to adopt economic pricing, adjusting for the extent to which prices diverged from the true social opportunity cost of goods and services, but not social pricing on the grounds that this had not been used in economic appraisals in Nepal, for instance in those conducted by the World Bank, and that there was virtue in consistency of practice. Similarly the approach to economic pricing and discounting used drew on the practice of the World Bank and Asian Development Bank in Nepal.

The analytical framework

The final issue that needs to be tackled in considering the appropriateness of the cost-effectiveness methodology in evaluating malaria control in Nepal is the relevance of the analytical framework. Cost-effectiveness analysis, like cost-benefit analysis, is rooted in partial equilibrium theory. Mishan (1982) warns his readers as follows:

> "Let me remind the reader again that the context of a cost-benefit analysis is that of partial equilibrium analysis, one in which we concentrate on the valuation of several items on the assumption that the effects of consequent changes in the prices of all but the most closely related goods or bads may be neglected as we vary the amounts or introduce any one of these several items".

In the case of the evaluation of the costs and benefits of endemic disease control projects, there seems to be general agreement that a macro focus is appropriate. This has been argued by Barlow (1967) with reference to malaria control in Sri Lanka, by Newman (1965) for malaria in Sri Lanka and Guyana and by Weisbrod, Andreano, Baldwin, Epstein and Kelley (1973) for schistosomiasis in St Lucia. Newman, for example, argues that:

> "In both Ceylon (Sri Lanka) and British Guiana (Guyana), the removal of malaria here is estimated to have resulted in an acceleration of the crude rate of natural increase by 0.7% per year. When one disease assumes such a major role, its eradication can no longer be treated as a marginal change. The whole of the demographic systems and hence the whole of the social and economic systems, were previously geared to a heavy loss of life in order to come to terms of equilibrium with the disease. Its eradication thus implies that we must analyse whole new systems; in economic terms, we must then deal with general equilibrium analysis and not ... partial equilibrium analysis .... which is quite valid for relatively minor diseases."

Weisbrod et al (1973) comment, however, that:

> "the consequences of structural change are very difficult to deal with empirically, given the current state of knowledge. General equilibrium theory in the social sciences exists at a level of abstraction which as yet has relatively little operational value".

Barlow, despite epidemiological and economic data that were relatively good for a developing country, still had to make many assumptions on the initial effects of malaria control and on relationships between variables in his model, and some of his assumptions were severely criticized.

This methodological issue is not a major problem for that part of the cost-effectiveness analysis that is concerned with the evaluation of alternative malaria control strategies, since achievement of a certain level of malaria control is taken as given. It is a problem, however, in assessing the desirability of malaria control _per se_. The methodology employed in Chapter 7 assumed that the consequences of complete loss of control would be of the same nature as those from a much smaller number of cases, namely health consequences, resource costs stemming from treatment costs and loss of work time, and reduction in the quality of life. This approach, however, ignores two possible further consequences of loss of control, namely abandonment of land by farmers and the interaction of this effect and that of loss of work time with a number of other economic variables to an extent that has ramifications throughout the economy.

The consequences of abandonment of land would be the loss of the marginal product of farm land and settlers in malarious areas, net of any gain in the marginal product from the new activities of migrants and any gain in output from new uses to which the abandoned land might be put, for example forest products if forestry were to be developed.

If it is thought that loss of control of malaria is likely to have widespread ramifications throughout the economy of Nepal, then a macro analytical framework would be appropriate to evaluate this situation. The ideal analytical approach would be to simulate the economy of Nepal, using a macro-economic model of the main relationships such as that devised by Barlow (1967) (see Annex 1). The main changes induced by loss of control would be fed into the model (any change in fertility and mortality rates, change in quantity and quality of labour inputs, change in consumption and savings rates, change in availability and quality of land) in order to see their collective effect on per capita income over time. The information required on the immediate effects of loss of control would be largely the same as in the micro model, but the relevant variables would be allowed to interact with other economic variables in the model to determine in the long run the impact of non-marginal changes in labour supply, land and possibly population numbers on per capita income.

Very little guidance is available in the literature on what might be the consequences of complete loss of control. The references cited above were all examining the consequences of moving from a position of no control to one of control or eradication, at a time when the countries concerned were far less developed than they are now. No study seems to have considered in detail the economic consequences of loss of control in the 1980s. The cost-benefit analyses of malaria control reviewed in Chapter 2 all confined themselves to loss of work time and treatment costs, ignoring any other possible consequences.

It is thus possible only to speculate on the consequences of loss of control in Nepal. Since the 1950s, much of the Terai has been opened up to external influences, with a considerable growth in agriculture, commerce and minor industry. Improvements in communications have made previously isolated areas accessible. If malaria incidence were to rise considerably, the population now has access to sources of treatment, both government and private, and the level of awareness of malaria seems quite high. There is therefore no longer the same fear of malaria that was reported to be a reason for the under-population of the Terai in the 1950s. Thus there seems to be little reason to suppose that the return of malaria would lead to the widescale abandonment of the settlements that have taken place in recent years.

This view is supported by the absence of alternative means of livelihood for the settlers. Cultivable land is in extremely short supply in Nepal, with what land there is remaining to be exploited being in the malarious parts of the Terai. Moreover, in terms of the more intensive exploitation of existing agricultural land, again the potential lies primarily in the Terai where average holdings are much larger than in the Hills but average farm output is little greater (Mills 1988). Employment opportunities are relatively limited, whether in rural or urban areas.

A final reason for assuming that a resurgence of malaria would not force farmers off the land is that it is difficult to envisage that the government could stand by and allow an epidemic of malaria to continue without mobilizing at least treatment, if not control activities. Similarly, if malaria began to affect the viability of industrial and commercial enterprises, employers would presumably see it to be in their interest to provide treatment. This speculation supports the assumption, made earlier, that loss of control would not significantly increase the period between onset of the fever and treatment.

If abandonment of land is not likely and treatment services are mobilized during epidemics for priority groups, then there is less reason to suppose that the resurgence of malaria would have wide-ranging economic effects. Those most vulnerable to malaria, small-scale subsistence farmers, produce little for sale and thus a fall in their production and consumption is unlikely to have any major effects on marketed agricultural production or agricultural exports.

These points lead to the conclusion that loss of control of malaria would be unlikely to lead to major consequences that are not taken into account in the cost-effectiveness framework used here.

8.2 Validity of data

The validity of the data used in the cost-effectiveness analysis is considered here under three headings: the programme cost data, the effectiveness data, and the evidence on household resource costs.

Programme cost data

The main shortcomings of the data on the costs of the malaria control activities of the NMEO and ICHSDP can be summarized as follows:

- a comprehensive analysis of costs in all districts was possible for only NMEO districts, and only for recurrent not capital costs. In addition, since many districts did not report expenditure according to a programme budget format, it was not possible to do any detailed analysis of costs by programme or activity for all districts;

- because of resource limitations, the detailed analysis required for the cost-effectiveness study could only be done for three NMEO districts and two ICHSDP districts. While this was adequate to draw overall conclusions, it has left unanswered some detailed questions on why costs and cost-effectiveness vary between districts. In particular, a more extensive analysis of the costs of integrated districts would have been desirable given the speed with which the government is now pursuing integration;

- however, costs of integrated districts were much more difficult to analyse because of the joint nature of activities in integrated districts and the multiple sources of funding and multiple budgets for malaria control. Far more estimation procedures had to be used than in NMEO districts. Moreover, the accounting system at ICHSDP headquarters was so complex that it was impossible to disentangle headquarters costs associated with malaria control from those associated with other programmes;

- the costs of drugs and insecticides were estimated on the basis of quantities used rather than quantities supplied, thus excluding the costs resulting from wastage. Although enquiries were made in the study districts about supplies, stock levels and wastage, it proved very difficult to put any figures on these. Underestimation of the cost of drugs will have very little effect on costs since drug costs are an insignificant proportion of total costs. The same is not true of insecticides, but spraying is anyway the most expensive malaria control strategy so underestimation would not affect study conclusions. The only area in which it might be important is in the comparison of insecticides, because the different bulk of different insecticides (particularly Ficam as opposed to malathion) leads to different distribution practices which may well result in less wastage and loss of Ficam as opposed to malathion. This advantage of Ficam was taken account of in the analysis in a qualitative rather than quantitative way;

- the analysis has made no allowance for the movement of malaria patients between districts, for instance in calculating district per capita costs. It is unlikely that this will have introduced any major distortions in the cost or cost-effectiveness analysis;

- joint costs presented a problem in the calculation of malaria control costs in ICHSDP districts and case detection and treatment costs by different approaches in NMEO districts. However, the great majority of costs are salary costs, which are the easiest to allocate out to different activities. It is therefore anticipated that the costs reported are of the correct order of magnitude, if not precisely accurate.

Effectiveness data

In the comparison of alternative approaches to vector control and alternative case detection and treatment methods, considerable use was made of indicators of intermediate output, particularly population covered, population and houses sprayed, slides taken, and cases detected and treated. It is therefore important to consider the reliability of this programme data.

Presumably for historical reasons, because in the early years of the control programme a detailed survey of houses and people was required, the NMEO has always kept its own population statistics. These are regularly updated through the means of the house-to-house visits of malaria field workers. These population statistics are generally believed in Nepal to be more accurate than estimates based on the dicennial population census and indeed are frequently used by socio-economic surveys to provide a sampling frame.

The quality of programme data is regularly checked by the internal and external evaluation teams. In general, for the period covered by the analysis here, the NMEO programme data was said to be reliable (though problems have more recently been experienced in those districts where cases have risen considerably). During the field work for this study, it was apparent that district officers had a regular programme of supervision of field workers. Similarly, slide collection seemed to be reasonably well done and cross-checking procedures were adhered to. The same was not true, however, for ICHSDP districts. Little supervision seemed to take place of community health worker activities and large backlogs of slides built up in district laboratories at the height of the transmission season. Statistics on such aspects of programme performance as the time-lag in providing radical treatment and the cross-checking of slides are incomplete for ICHSDP districts.

Programme data leaves unanswered the major question of the extent to which either the NMEO or ICHSDP are detecting all the cases of malaria that arise. Annual blood examination rates (ABER) in the study districts in 1984 were as follows:

NMEO districts	Morang	13.19%
	Rupandehi	17.96%
	Illam	23.92%
ICHSDP districts	Saptari	4.96%
	Parsa	7.74%

Assuming these are representative in time and space, which seems a reasonable assumption in NMEO districts given the regular routine of house-to-house visits, the high ABER of NMEO districts suggests that a high proportion of cases should be detected. The same is not true, however, of ICHSDP districts. There are thus good grounds for suspecting that the ICHSDP districts detect a smaller proportion of cases than NMEO districts.

Details of each malaria case, as revealed by the investigation and completion of the SF5 form, are likely to be less reliable than the simple count of cases or report of species type. This comment particularly applies to the classification of cases as indigenous, imported or relapse since this classification depends on obtaining a reliable account of the patient's movements. This he may be unwilling to give if it involved movement across the Indian border or illicit trading activities. Information on relapses and the presence or absence of a previous fever appears to be particularly unreliable.

Household resource costs

Information on household resource costs (private expenditure and losses resulting from the period of disability caused by malaria) were obtained from the patient and household surveys. The validity of the data from these surveys is therefore considered in turn.

Patient survey. When the survey was designed, it was appreciated that a number of features were likely to affect the accuracy of the data collected. Nonetheless, the survey was set up since it was the only feasible way of collecting the information from a range of districts. However its results need to be interpreted in the light of the following features.

Firstly, malaria workers were used to fill in the data collection form (termed the ESM1 form). This is likely to have had both advantages and disadvantages. Advantages include their generally good relationship with the community and their personal knowledge of its members. Disadvantages may be that respondents were hesitant about revealing their use of other sources of medical assistance, and/or magnified their reports of expenditure, possibly in the hope of reimbursement. Secondly, difficulties of communication and transport limited the guidance that could be given on the use of the ESM1 form. All efforts were made to simplify the form and print self-explanatory guidance on it, but the quality of the data is likely to have depended on the enthusiasm and motivation of district and unit malaria officers.

Thirdly it was recognised that the difficulties of wording the question on 'work lost', despite the care taken in translating and piloting the form, were likely to lead to differences in interpretation of the question. It did, however, appear from discussions in the districts and informal discussions with villagers that the definition of 'work' used by the form was one familiar to local communities.

Fourthly, it was anticipated that there were likely to be problems of recall since there could be a significant time lapse between the period of incapacity (primarily occurring prior to presumptive treatment) and the investigation of the case. This problem applied to information from both this form and the SF5 form, the report of the investigation of each malaria case which was also analysed. Table 8.1 shows the time-lapse between start of the fever and completion of the ESM1 form by district. The mean by district varied between 21 days (Rupandehi) and 71 days (Bara).

Finally, the NMEO's long experience of use of the SF5 form indicated a number of other factors affecting data quality. Dates (for instance of previous fevers, start of current fever) were known to be difficult to obtain and unreliable. Ages might be approximate rather than accurate. A reported 'previous fever' might not be malaria. And perhaps most important, depending on the purpose of their journey, people might be unwilling to disclose travel to India, making classification of the case as indigenous or imported difficult.

It is useful to comment here on the use of the ESM1 form in each district, using information gained from field visits to four of the six districts and discussions with the five district malaria officers and one district health officer.

Dang: No particular problems were reported. However communication problems are likely to have made supervision more difficult in Dang than in other districts in the survey.

Table 8.1: Number of days between start of current fever and completion of the ESM1 form.

	District						Total
	Dang	Rupandehi	Sarlahi	Morang	Bhojpur	Bara	
Time-lag start of curr.fev.to data coll.							
<1 week	3	233	2	5	12	0	255
column percent	1.4%	12.9%	1.5%	1.7%	9.0%	0.0%	9.8%
1-2 weeks	14	401	16	20	13	0	464
column percent	6.4%	22.3%	12.3%	6.9%	9.8%	0.0%	17.9%
2-3 weeks	40	473	28	33	19	1	594
column percent	18.3%	26.3%	21.5%	11.4%	14.3%	4.5%	22.9%
3-4 weeks	57	363	39	34	13	0	506
column percent	26.0%	20.2%	30.0%	11.7%	9.8%	0.0%	19.5%
>4 weeks	105	331	45	198	76	21	776
column percent	47.9%	18.4%	34.6%	68.3%	57.1%	95.5%	29.9%
Total	219	1801	130	290	133	22	2595
column percent	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Missing:458

Rupandehi: The district malaria officer reported that in checking some of the early forms some inconsistencies had been found. The forms were sent back for checking and the unit offices visited to provide guidance. Subsequently no problems had arisen.

Sarlahi: Unit officers had received little guidance and early ESM1 forms were not attached to their matching SF5 form. Some confusion had arisen over the question on 'work', for instance with number of days not worked being completed for patients who did not normally work. The district malaria officer and two of the unit officers were briefed on the proper completion of the forms. An attempt to locate SF5 forms to match the ESM1 forms failed and the forms analysed for Sarlahi date from the period after the visit, the early ESM1 forms being rejected.

Morang: The district malaria officer reported a tendency to exaggerate expenditure on treatment. His unit staff enquired how to fill in the form if they suspected exaggeration and were told to fill in the figure given.

Bhojpur: No particular problems with the form were reported. However, because the forms for Bhojpur disappeared in transit and re-supply took time, NMEO HQ instructed the district malaria officer to complete ESM1 forms for the cases that would have been interviewed if the forms had arrived on time. This accounts for the high proportion of cases in Bhojpur where ESM1 form completion occurred more than four weeks after the start of the current fever (see Table 8.1).

Bara: ESM1 forms were received late in Bara (October 1984). Shortage of laboratory technicians meant that a considerable back-log of slides had built up over the peak period of malaria transmission (approximately June to September). The time-lag from slide collection to radical treatment was thus generally longer than in the other districts, and also the time-lag between start of the fever and SF5 and ESM1 form completion (Table 8.1). The ESM1 forms received lacked matching SF5 forms: these were obtained but only approximately half the ESM1 forms could be matched. For the remainder, SF5 information was coded as 'missing'.

It had been intended to interview all cases occurring in the districts over a 12 month period. Because of a variety of problems to do with the supply and use of forms, this was not achieved. The proportion of district cases picked up by the survey can be roughly assessed by comparing the district cases reported by month with the cases in the survey. The proportion of district cases in the survey was very high in Rupandehi for 6 months, and around 80% in Morang for 5 months. Bhojpur achieved high coverage but with a considerable lag. Coverage in Dang, Sarlahi and Bara was poor.

In conclusion, it appears from scrutiny and analysis of the data that the information on the days of disability caused by malaria is reasonably reliable, though there probably is some confusion between current and past episodes of malaria, particularly in Morang. Expenditures on treatment, however, are likely to be exaggerated. This is primarily likely to stem from the information given by respondents, though may also reflect a bias in the cases picked up by the survey if the more remote cases, which would be those less likely to have access to private sources of treatment, were missed in the districts where coverage of the cases occurring in the months of the survey was poor. The existence of some level of private expenditure is, however, clear given the extent of the use of private sources of treatment. Around 50% of cases reported visiting a source of help other than the malaria service one or more times. Visits are more likely to be under-reported than over-reported, since patients may be unwilling to report visits to the malaria workers who collected the information, and the period asked about related to the time before presumptive treatment whereas expenditure refers to that period plus the period between presumptive and radical treatment.

The likely exaggeration of amounts spent does not completely invalidate the data collected. The level of expenditure is correlated with factors that might be expected to influence it, as discussed in detail in Chapter 7. The balance of the evidence suggests that substantial private resources are being used to obtain treatment for malaria, even if the exact magnitude of the expenditure is not known.

Household survey. Since the household survey was carried out by independent and trained interviewers, it was possible to include procedures and checks to help ensure the validity of the data collected in ways that were not possible in the patient survey. In particular:

- interviewers were used who were familiar with the survey area and able to speak the local languages;

- for each patient interviewed, a neighbourhood control was located and interviewed by the same interviewer;

- one of the criteria for selection of the survey areas was that a laboratory should be available in the unit office, so that the delay between a slide being taken and the case being diagnosed might be minimized, thus reducing also the delay between the onset of the illness and the interview and thus the recall period required of respondents;

- every effort was made to interview the malaria patient within one week of the case being diagnosed;

- a percentage of interviews were repeated by a different interviewer;

- completed questionnaires were checked in the field and in Kathmandu for completeness and internal consistency;

- the data were coded and put onto a computer in Kathmandu and limited checking done. They were then exhaustively checked and edited in London. Queries were sent to Nepal and answers received.

The errors identified during the checking process in London included variables coded as 'no' when 'not applicable' was appropriate; errors in summing variables to create a total; and data entry errors (for example characters misplaced). Some variables, particularly age but also dates (for example of illness and treatment), were recorded more than once, for instance in both the patient and the household questionnaire and by the independent interviewer in the patient questionnaire and by the malaria assistant in the SF5 form. The values of such variables were compared and not surprisingly, inconsistencies were found. For instance some respondents fell into one 5 year age-group according to one response and into an adjacent one according to another response.

In the design of the survey, it was recognized that it was difficult to predict the likely number of cases and that this might present problems for interviewers if many cases occurred at the same time and for survey numbers if few cases occurred. The latter possibility was allowed for by identifying an adjacent area that could be included if cases were few in the main study area. In Nawal Parasi, it was necessary to include this adjacent area. In contrast, in Dhanusa so many cases occurred that the survey team could not interview them all within a reasonable time of the diagnosis. All cases who could not be interviewed within 14 days of diagnosis were dropped from the survey, but when the interviewers had time, these cases were visited and a household interview completed in order to check whether any bias might have been introduced into the analysis by their omission.

Comparison of the missed households with the survey households showed that slightly more of the former had agriculture as their main occupation and slightly fewer wage labour; slightly fewer had no land and those with land had slightly more land and higher grain production. These differences were not sufficient to alter the conclusions drawn from the evidence on the survey households. It seems likely that the missed households were more remote, and thus more dependent on agriculture simply because access to employment was limited where they lived.

SF5 forms for the missed cases were also analysed. There were no differences between survey and missed cases in how they were detected or in the species of parasite. Slightly more of the missed cases were indigenous and on average they were detected and treated slightly more slowly than the mean for cases.

8.3 Findings of the cost-effectiveness analysis: choice of strategies

Ways of organizing an activity

The analysis in Chapter 6 compared the relative costs of NMEO and ICHSDP districts. It appeared that:

- the ICHSDP districts of Saptari and Parsa had a markedly lower cost per capita for surveillance than the three NMEO districts;

- costs per slide and per case were much closer to those of the NMEO;

- spraying costs were relatively similar.

Firmer conclusions on comparative costs are not possible without information from a wider range of districts. However the differing behaviour of costs as activities increase in the two types of district can be used to draw tentative conclusions. In ICHSDP districts, costs respond immediately to an increase in cases since time is diverted from other activities. In NMEO districts, the surveillance infrastructure is expensive in terms of cost per case when incidence is low and falls rapidly as cases rise. Thus NMEO districts with relatively few cases (eg Morang) are likely to be considerably more expensive than ICHSDP districts, whereas NMEO districts with higher APIs (eg Rupandehi) are likely to have similar or lower unit costs.

The cost behaviour of the two organisational patterns is thus likely to depend crucially on the level of cases. Their relative effectiveness is much more difficult to establish. There are grounds for suspecting that ICHSDP districts detect a relatively smaller proportion of total cases than NMEO districts. If this lower level of detection results in increased transmission, then ICHSDP districts may compare unfavourably with NMEO districts on the basis of a measure such as cost per case prevented. However it is difficult to draw any firm conclusions until better evidence is available on the true incidence of malaria in NMEO and ICHSDP districts.

Programme data indicate that in general, malaria control activities are carried out much less rigorously in ICHSDP districts than NMEO districts. ABERs are generally much lower, 6.3% in integrated districts in 1984 as opposed to 17.0% in NMEO districts. Only 27% of cases in integrated districts were given radical treatment within 7 days of diagnosis and 55% after 14 days in 1984 compared with 42% and 29% in all NMEO districts. 75% of cases detected in integrated districts were given radical treatment, leaving 25% receiving only presumptive treatment, compared to 92% and 8% in NMEO districts.

It is difficult to incorporate these aspects of performance in the cost-effectiveness analysis without knowing how they affected malaria transmission in integrated districts. It is clear, however, that the relatively low unit cost of malaria control activities in integrated districts results not only from possibly greater efficiency in the use of resources (eg less surplus capacity) but also from a less intensive application of malaria control activities.

Means of case detection and treatment

Table 8.2 summarizes the relative cost (to the NMEO) and contribution of the main case detection methods. It brings out clearly the important contribution now made by passive methods. ACD still collects the majority of slides and thus usually has the lowest cost per slide (though PCD (MC) in Rupandehi is lower). However PCD (V) and PCD (MC), as might be expected, have a much higher slide positivity rate and lower costs per case detected and treated. The pattern in all three districts is consistent: ACD incurs the highest cost per case, with PCD (V) cheaper, and PCD (MC) cheapest. In terms of the share they absorb of total case-detection costs and the return in terms of cases detected, the pattern is consistent across all three districts that ACD absorbs a considerably higher share of total case detection costs than its share of total cases. In contrast, the shares of PCD (V) in Morang and Ilam and of PCD (MC) are Morang are similar. In Rupandehi, the shares of cases detected by PCD (V) and PCD (MC) are more than double their share of case detection costs.

The addition of private costs (of treatment and loss of work time) does not alter these conclusions on the relative costs of the mechanisms. However, it is important to note that there were few differences in days of work lost by case detection mechanism. Given the association between days of work lost and time-lag between start of the fever and presumptive treatment, this lack of difference is likely to reflect the fact that this time-lag did not differ greatly between case detection mechanisms: indeed if anything, PCD mechanisms

Table 8.2: The relative contribution and cost [a] for the NMEO of different case detection methods.

Case detection method	Morang	Rupandehi	Ilam
ACD/APCD/Follow-up			
- % of total slides	87%	85%	84%
- % of total cases	56%	42%	65%
- % of total case-detection costs (b)	78%	77%	76%
- NMEO cost per slide (c)	Rs 10.32	Rs 8.44	Rs 16.76
- NMEO cost per case (d)	Rs 2059	Rs 791	Rs 6316
PCD (V)			
- % of total slides	5%	11%	15%
- % of total cases	19%	33%	24%
- % of total case-detection costs (b)	18%	16%	24%
- NMEO cost per slide (c)	Rs 43.15	Rs 13.49	Rs 29.80
- NMEO cost per case (d)	Rs 1518	Rs 336	Rs 5523
PCD (MC)			
- % of total slides	4%	2%	-
- % of total cases	2%	19%	-
- % of total case-detection costs (b)	2%	5%	-
- NMEO cost per slide (c)	Rs 4.67	Rs 21.45	-
- NMEO cost per case (d)	Rs 1048	Rs 98	-

(a) District-level programme costs only, excluding administration and regional and national programme costs.

(b) Total costs of ACD/APCD/Follow-up, PCD(V), PCD(MC), PCD(M), PCD (H), excluding radical treatment.

(c) Cost of case detection divided by number of slides.

(d) Cost of case detection and radical treatment divided by number of cases.

(especially the malaria clinic) provided presumptive treatment more rapidly than ACD.

Means of vector control

The cost of alternative insecticides was explored in Chapter 6. In terms of the 1984 cost per capita per cycle or cost per house sprayed per cycle, DDT was half the cost of malathion and this difference is much accentuated when the duration of the effect is taken into account. Ficam was considerably more expensive than malathion. However, from the NMEO's perspective (paying local costs only), Ficam had lower operational costs than malathion and was easy to use in the field because of its lightness. No comparison was possible of spraying with other means of vector control since these have not been used routinely.

Vector control versus case detection and treatment

This is the most difficult choice to evaluate, since it is essential to have information on the effectiveness of the two approaches, which is largely lacking for Nepal. Moreover, the issue is not either/or, but rather what mix of vector control and case detection and treatment is most efficient.

The annual cost per capita of case detection and treatment was estimated to be Rs 2.88 in Morang and Rs 3.76 in Rupandehi (Table 6.5). In contrast, the annual cost per capita of spraying was Rs 11.05 and Rs 10.03 (one cycle of DDT in Morang and Rupandehi) and Rs 31.40 (two cycles of malathion in Rupandehi) (Table 6.2).

This difference in the cost of the two approaches, especially when the number of cycles of spraying required is taken into account, suggests that considerable intensification of case detection and treatment would be possible before costs would exceed those of spraying. Thus altering the mix of activities in favour of increased case detection and treatment could be worthwhile if it could be achieved without significantly increasing malaria transmission.

It is realistic, however, to recognise that the main source of finance for the two approaches is different. From the NMEO's point of view, the local (non-insecticide) cost of spraying (around Rs 2.20 per capita per cycle at district level) is actually lower than the cost of case detection and treatment (Rs 2.40 - Rs 3.10 per capita per year in the Terai) if only one cycle of spraying is required, and not greatly more expensive if two cycles are required.

8.4 Findings of the cost-effectiveness analysis: malaria control versus other health programmes

Efficiency considerations

Table 7.6 estimated that the cost per case prevented was Rs 26 to Rs 170 in moderate receptive areas, and Rs 86 to Rs 2,628 in low receptive areas. In terms of cost per death prevented, it was Rs 1,281 to Rs 33,181 (moderate receptive areas) and Rs 4,125 to Rs 204,734 (low receptive areas). Net savings in total curative and preventive costs occurred at a level between the low and high case estimates in all areas except in the expensive, low receptive areas of Rupandehi and Ilam. Net savings in total costs occurred for both case estimates in moderate receptive areas.

Unfortunately, the cost-effectiveness estimates for malaria cannot be adequately compared with other health programmes in Nepal since only one study has produced a comparable ratio: that of $371 and $695 by Barnum and Yaukey (1979) shown in Table 2.3. Comparisons have therefore to be sought with programmes in other countries. In terms of deaths prevented, Table 2.3 presented an analysis of the cost per death prevented through different health interventions in a variety of countries. The estimates range from under $100 for immunization to several thousand dollars for hospital treatment and malaria eradication.

The Nepal results on cost per death prevented translate to a minimum of $78 (Rs 1,281 for high case estimate and 2% CFR) and a maximum of $12,438 (Rs 204,734 for low case estimate and 0.5% CFR). Taking the maximum for moderate receptive areas, thus excluding low receptive areas particularly for Rupandehi which is very expensive relative to the malaria risk, gives a maximum figure of $2,016 (Rs 33,181). This range of estimates for Nepal compares not unfavourably with the figures in Table 2.3 given that the major health consequence of malaria in Nepal is morbidity rather than mortality.

A recent paper (Prost and Prescott 1984) calculated cost-effectiveness ratios per year and discounted year of healthy life added for onchocerciasis control in West Africa and measles immunization in Ivory Coast and Zambia. A further study (Evans and Murray 1987) challenged many of their assumptions and reworked their figures. The results from these two studies can be compared with similar figures for Nepal by updating the Prost and Prescott figures from 1977 to 1984 dollars (on the basis of Barlow and Grobar 1986), converting the Nepal estimates from days to years and using the NMEO cost as the numerator. The Prost and Prescott and Evans and Murray papers also calculated 'cost per discounted productive year of healthy life added', including only productive years (considered to be the years between the ages of 15 and 60). A similar figure has been calculated for Nepal by applying the assumptions on proportion of cases engaged in economic activity and ages at death used to estimate lost work days. The resulting figures are shown below.

Study	Cost per year of healthy life added	Cost per discounted year of healthy life added	Cost per discounted productive year of healthy life added
Onchocerciasis control			
-Prost and Prescott	$32	$240	$240
-Evans and Murray	$273	$2119	$4852
Measles immunization			
- Zambia	$19	$89	$354
- Ivory Coast	$16	$78	$304
Malaria control, Nepal	$2-$336	$8-$1207	$14-$1247

The comparison of the Nepal results with the Prost and Prescott figures and with the immunisation results is highly sensitive to the expected level of deaths without control, for the Nepal estimates fall either side of these estimates for the other programmes. However, it is clear that malaria control is well worthwhile in areas where there is a considerable risk of resurgence and where the cessation of malaria control would result in considerable numbers of cases and deaths. If the Evans and Murray figures are a more accurate reflection of the cost-effectiveness of the onchocerciasis control programme, then the Nepal malaria programme is considerably more cost-effective.

Finally, the Nepal results can be compared with the cost-effectiveness ratios shown in Annex 5, Tables A5.2, A5.3 and A5.5. Since these costs are generally government programme costs, excluding consideration of direct and indirect benefits, similar cost-effectiveness ratios have been calculated for Nepal, namely:

NMEO cost per capita	$0.19 - $0.60
NMEO cost per case prevented	$1.52 - $154.66
NMEO cost per death prevented	$74 - $12,034

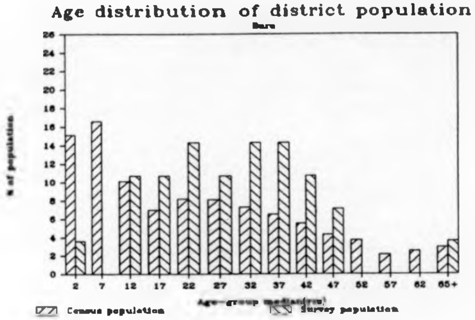
The Nepal costs per capita are very much at the lower end of the ranges shown in Table A5.2 for parasitic diseases. The minimum estimate of the Nepal cost per case prevented compares very favourably with many of the estimates for parasitic diseases in Table A5.3, though the maximum estimate exceeds most of them. It is of interest to note that the range of the Nepal cost per death averted is not dissimilar from the range shown in Table A5.5 for oral rehydration projects. These comparisons indicate that malaria control in Nepal is no less cost-effective than many other health interventions and when compared with many parasitic disease control programmes appears quite attractive.

Equity considerations

The relative attractiveness of malaria control can additionally be assessed by supplementing the evidence on cost-effectiveness with a discussion on which population groups benefit from malaria control. This discussion adds to the study the dimension of equity which has so far been ignored. Data from the patient survey of malaria provides evidence on the age of malaria patients, and from the household survey on their socio-economic status.

Although information on the age and sex of malaria patients is routinely collected, it is not analysed. Figure 8.1 shows the age-

Figure 8.1: Age-distribution of malaria cases and of the census population, by district: patient survey



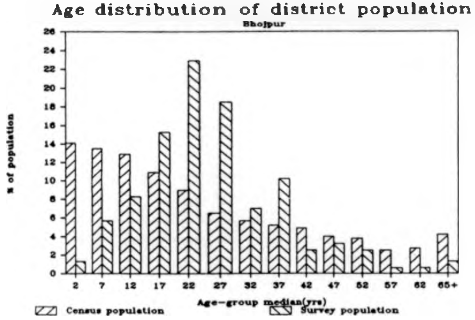
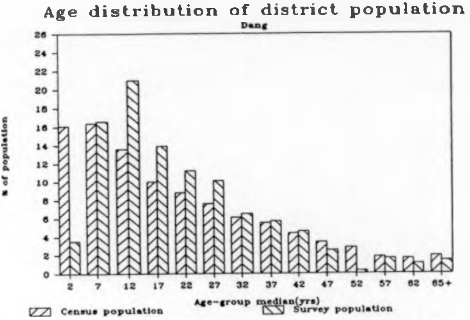


Figure 8.1: Age-distribution of malaria cases and of the census population, by district (continued).



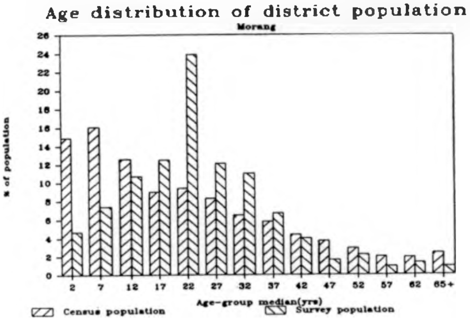
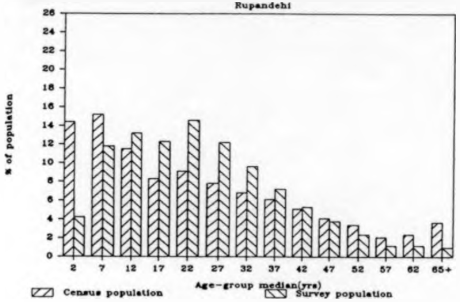
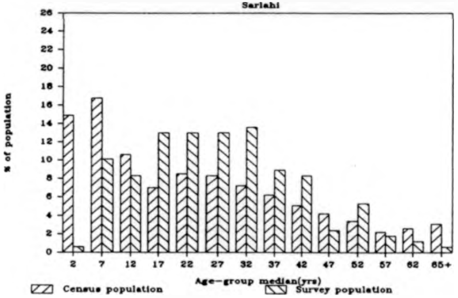


Figure 8.1: Age-distribution of malaria cases and of the census population, by district (continued).

Age distribution of district population



Age distribution of district population



distribution of cases in each district as analysed by the patient survey and compares this with the age-distribution of each district population taken from the 1981 census. In general, the proportion of cases amongst small children was considerably lower than their proportion in the total population. This position was reversed for teenagers and adults up to the age of 40.

The age-distribution of cases showed some variation between districts. In Bhojpur and Morang, the highest proportion of cases (nearly 25%) occurred in the 20-24 age-group whereas in Dang cases were concentrated in the 10-14 age group. Rupandehi and Sarlahi showed a less sharp peak, but cases were concentrated amongst young adults. The average age of cases by district was as follows:

<u>Average age of malaria cases</u>

District	Mode (yrs)	Median (yrs)	Mean (yrs)	Standard Deviation	n
Dang	11.0	16.0	21.2	14.5	367
Rupandehi	30.0	22.0	23.7	14.0	2060
Sarlahi	30.0	26.0	26.7	13.3	169
Morang	20.0	22.0	23.7	12.8	447
Bhojpur	22.0	23.0	25.2	12.0	157
Bara	30.0	29.0	29.1	14.6	28
All survey districts	30.0	22.0	23.7	13.8	3228

Since approximately 50% of malaria cases in Nepal in 1984 were classified as 'Imported A' (i.e. imported from India), it might be expected that the characteristics of migrants, in particular their age and sex, would affect the age and sex distribution of cases. In Figure 8.2, the proportion of indigenous and of imported cases by age-group has been expressed as a ratio of the proportion of each age-group in the district population. The resulting ratio fluctuates around 1 (where the proportion of cases in the age-group equals the age-group's share of the total population). The figure shows that the proportion of young adults amongst imported cases considerably exceeds their proportion amongst indigenous cases or the whole district population.

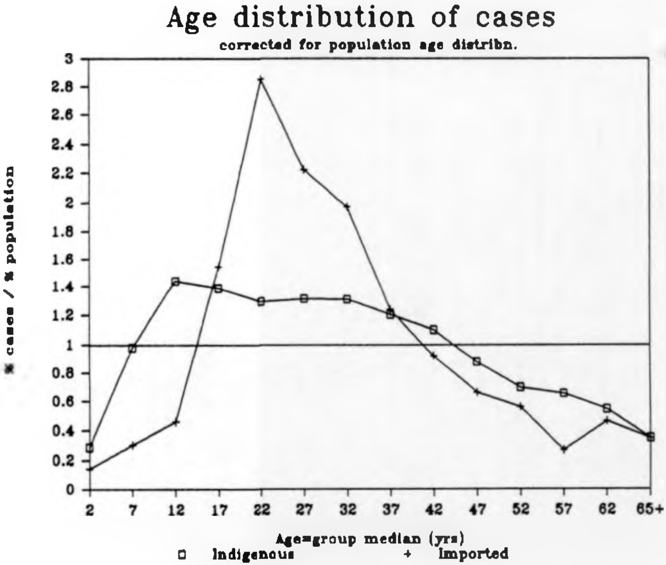


Figure 8.2: Age-distribution of indigenous and imported cases, corrected for population age-distribution: patient survey

Table 8.3 shows the sex distribution of total cases by age-group. The most marked feature is a preponderance of males in the 20-24 age-group. If cases are distinguished by their classification (Table 8.4), then imported cases are seen to be predominantly male.

An important influence on the age and sex distribution of cases therefore appears to be the relative significance of imported cases in each district. Imported cases are predominantly young adult men, and the variation in the age-distribution of cases between districts is thus associated with the pattern of migration and the risk of being infected by malaria in India. Indigenous cases are more evenly distributed across age-groups, though with some concentration also amongst young adult males which may possibly be related to their occupations and the likelihood of their spending time outside the village and being exposed to a greater risk of infection.

The age-distribution in Dang peaked earlier than in the other districts, with a concentration of cases in the 10-14 age group and a median age of 16 years in contrast to a median of 22-29 years in the other districts. The great majority of these cases were indigenous. In 1984, Dang experienced a considerable increase in malaria transmission, and it appears from the information here that teenagers were particularly at risk. This may therefore be an indicator of the consequences on different age-groups of a resurgence of malaria transmission.

This information on age and sex distribution of cases leads to the conclusion that unlike many priority health programmes in developing countries, malaria control in Nepal at present benefits not so much children as the male (and to a slightly lesser extent female) working population. To some extent this reflects the proportion of imported cases in the districts sampled, but even indigenous cases showed a preponderance of adult males. Malaria control thus has some importance in terms of assisting households to earn their living without the disruption caused by adult illness. Clearly, if malaria control were to cease and cases rose considerably as a result, the age distribution would change with a greater proportion of children being affected.

In the patient survey, it was not possible to enquire about the socio-

Table 8.3: Sex distribution of total cases by age-group: patient survey

	Age(of5)							
	0-4 yrs	5-9 yrs	10-14 yrs	15-19 yrs	20-24 yrs	25-29 yrs	30-34 yrs	35-39 yrs
Sex(of5)								
Male	64	203	246	264	382	283	217	152
row percent	3.1%	9.7%	11.8%	12.6%	18.3%	13.6%	10.4%	7.3%
column percent	51.6%	55.8%	57.6%	64.5%	74.8%	71.5%	70.2%	65.0%
Female	60	161	181	145	129	113	92	82
row percent	5.3%	14.1%	15.9%	12.7%	11.3%	9.9%	8.1%	7.2%
column percent	48.4%	44.2%	42.4%	35.5%	25.2%	28.5%	29.8%	35.0%
Total	124	364	427	409	511	396	309	234
row percent	3.8%	11.3%	13.2%	12.7%	15.8%	12.3%	9.6%	7.2%
column percent	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

	Age(of5)						Total
	40-44 yrs	45-49 yrs	50-54 yrs	55-59 yrs	60-64 yrs	65 yrs and over	
Sex(of5)							
Male	109	61	49	24	19	15	2088
row percent	5.2%	2.9%	2.3%	1.1%	.9%	.7%	100.0%
column percent	65.7%	57.5%	66.2%	63.2%	51.4%	45.5%	64.7%
Female	57	45	25	14	18	18	1140
row percent	5.0%	3.9%	2.2%	1.2%	1.6%	1.6%	100.0%
column percent	34.3%	42.5%	33.8%	36.8%	48.6%	54.5%	35.3%
Total	166	106	74	38	37	33	3228
row percent	5.1%	3.3%	2.3%	1.2%	1.1%	1.0%	100.0%
column percent	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Missing: 25

Table 8.4: Sex distribution of total cases by classification: patient survey

	Classification of case					Total
	Indigenous	Imported A	Imported other	Relapse	Untraced	
Sex(q5)						
Male	1286	640	44	113	0	2083
row percent	61.7%	30.7%	2.1%	5.4%	0.0%	100.0%
column percent	57.7%	81.6%	69.8%	79.0%	0.0%	64.7%
Female	943	144	19	30	1	1137
row percent	82.9%	12.7%	1.7%	2.6%	.1%	100.0%
column percent	42.3%	18.4%	30.2%	21.0%	100.0%	35.3%
Total	2229	784	63	143	1	3220
row percent	69.2%	24.3%	2.0%	4.4%	.0%	100.0%
column percent	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Missing:33

economic status of malaria patients. This information was collected in the household survey and can be compared with similar information for the controls. In Dhanusa, own agriculture was the main occupation for 66% of malaria patients and the secondary occupation for 6%, and for 69% and 8% of controls. Wage labour was the main occupation of 27% and secondary occupation of 38% of patients, the proportions for controls being 19% and 26%. In the rural subsistence economy of Nepal, those with land are generally better off than those without land, with those dependent on wage labour generally being the worst off. The above information thus suggests that those who get malaria tend to be the poorer members of communities.

This impression is supported by evidence on the value of household assets and crop production. In Dhanusa, controls tended to have a more valuable house than malaria patients. The mean land area cultivated per household owning land was 1.52 hectares (SD 1.30) for patients and 1.91 hectares (SD 1.95) for controls. Average paddy production per household producing paddy was 611 kg (SD 725) for patients and 879 (SD 1170) for controls. Average maize production was 682 kg (SD 689) for patients and 891 kg (SD 1133) for controls.

In Nawal Parasi, however, a slightly different picture is apparent. In terms of occupation, patients, as in Dhanusa, are slightly less likely to farm on their own account and more likely to be wage labourers than controls. However, the mean house value, mean cultivated land per household owning land, and mean paddy and wheat production are all slightly less for controls than for patients. In contrast the median for all these indicators is greater for controls than for patients. It may be that the patient means are inflated by a few more wealthy individuals who got malaria.

The data is therefore insufficient to draw firm conclusions on the socio-economic status of patients, but suggest that they may be the less well off.

8.5 The cost-effectiveness of the Nepal malaria control programme in comparison to malaria control programmes in other countries

As discussed in Chapter 2, section 2.4, there have unfortunately been few detailed studies of the cost-effectiveness of malaria control. Table 2.6 summarized the results of those studies that have produced cost-effectiveness ratios expressed in the form annual cost per person protected, cost per case prevented, or cost per death averted. To these results can now be added similar ratios for Nepal.

From Table 7.6, the following ratios can be calculated in US$ 1984. The costs in the first cost column are NMEO costs per capita of the relevant population: for case detection and treatment and combined methods, this means the population of each area in Table 7.6 and for spraying, the population sprayed (the population shown in Table 6.2 for DDT spraying but half the population for the malathion area because two cycles were sprayed). The cost per capita of combined methods is not the sum of the other two because the population denominator used is that for the whole area, only part of which was sprayed.

Nepal cost-effectiveness estimates ($ 1984)

Control method	Annual cost per person protected ($)	Cost per case prevented ($)	Cost per death averted ($)
Case detection and treatment only	0.19 to 0.60	2.40 to 68.50	119 to 11,938
Residual spraying only	0.61 to 1.91	Not available	Not available
Combined methods (where used)	0.37 to 0.60	1.52 to 154.46	74 to 12,034

The above figures and those in Table 2.6 should be compared cautiously since the source documents often provide inadequate information for judging the quality of the cost and effectiveness estimates. In particular, the cost estimates in Table 2.6 are liable to be incomplete, for instance omitting capital costs and administrative overheads, and are taken from very different types of programme, analysed at different stages in their evolution. Despite these cautionary words, some useful comparisons can be made from the broad orders of magnitude of the figures in Table 2.6 and those from Nepal. Comparing cost per capita, the Nepal programme is very economical. It is also surprisingly close to the recent estimates for Thailand of $0.16 and $0.61 for combined methods. In terms of cost per case prevented it also comes out reasonably well, especially considering that the upper estimate is very much a maximum figure for Nepal, but is still less costly than the Garki study, for example, though this was a research project implemented in an area of much higher endemicity. Thus as a malaria control programme, the Nepal programme appears to be relatively efficiently run.

8.6 Summary

This chapter has discussed in turn the research objectives and methods, the validity of the data and the findings of the cost-effectiveness analysis.

The research found that the recent developments in the methodology of cost-effectiveness analysis were applicable to malaria control. The greatest methodological problem was posed not by the cost analysis but by the absence of good evidence on the effectiveness of alternative malaria control strategies or of the programme as a whole. The value of the resource saving consequences included in the evaluative framework could be estimated with the help of survey data and their inclusion was justified. In the absence of an assessment of the utility of malaria control to individuals, the measure 'healthy days of life lost' was used as a proxy though the analysis highlighted the extent to which it favoured programmes which prevent deaths rather than episodes of illness.

The relevance of the evaluative framework to malaria control in Nepal was examined. Cost-effectiveness analysis, like cost-benefit analysis, is rooted in partial equilibrium theory. For example the methodology employed in assessing the desirability of malaria control assumed that the consequences of complete loss of control would be of the same nature as those from a much smaller number of cases, namely health consequences, resource costs and quality of life effects. However, it is generally agreed that a macro focus is appropriate to the evaluation of the costs and benefits of endemic disease control projects. In particular, two further consequences of control were ignored: abandonment of land by farmers and the interaction of this effect and that of loss of work time with a number of other economic variables to an extent that had ramifications throughout the economy. These issues were discussed and it was concluded that the loss of control of malaria would be unlikely to lead to major consequences that were not taken into account in the cost-effectiveness framework.

The validity of the data was considered at length. The limitations of the cost data included the small sample of districts, the difficulties of analysing the costs of integrated districts, and problems of joint costs. The effectiveness data displayed greater shortcomings, necessitating considerable reliance on indicators of intermediate output. Their accuracy was therefore assessed. The validity of the data from the patient and household surveys was discussed and their strengths and weaknesses pointed out.

Finally, the findings of the cost-effectiveness analysis were discussed. The cost behaviour of NMEO and ICHSDP districts was compared and it was concluded that their relative costliness would depend to a considerable extent on the level of cases. Little information was available on their relative effectiveness though programme data indicated that malaria control activities were carried out much less intensively in ICHSDP than in NMEO districts. The relatively low unit costs in ICHSDP districts thus resulted not only from possibly greater efficiency in the use of resources but also from a lower level of activity.

The relative cost to the NMEO and contribution in terms of proportion of cases detected was discussed for the main case detection methods. In general, ACD absorbed a considerably higher share of total case detection costs than its share of total cases. PCD methods detected cases at relatively low cost and if anything slightly more speedily than ACD.

Vector control costs differed considerably depending on the insecticide used, DDT being considerably cheaper than malathion. Vector control costs were considerably more expensive than case detection and treatment costs, suggesting that altering the mix of activities in favour of increased case detection and treatment could be worthwhile if it could be achieved without significantly increasing malaria transmission.

The cost-effectiveness ratios calculated to assess the desirability of malaria control were summarized. They could not be adequately compared with similar ratios from other health programmes in Nepal because only one could be located. Therefore they were compared with information on the cost of death prevented through different health interventions in a variety of countries. Given that the main health consequence of malaria is morbidity not mortality, the Nepal programme appeared reasonably cost-effective. The results from the Nepal analysis were also compared with cost-effectiveness ratios from programmes for onchocerciasis control and measles immunization. The comparison was highly sensitive to the expected level of malaria deaths without control, but the malaria control programme appeared to be well worthwhile in areas where there was a considerable risk of resurgence. Similarly a comparison with data on parasitic disease control projects suggested the Nepalese programme was relatively attractive.

The relative attractiveness of malaria control was additionally assessed by reviewing evidence on which population groups were currently benefiting. It was concluded that the majority of cases were young adult men and therefore that unlike many priority health programmes in developing countries, malaria control at present benefited not so much children as the male (and to a slightly lesser extent female) working population. Data on the socio-economic status of patients was insufficient to draw firm conclusions, but suggested that they may be the less well off members of communities. Therefore the malaria control programme might have important equity effects.

The chapter ended with a comparison of the Nepal costs per capita, case and death prevented with similar data from malaria control programmes in other countries. In general, the Nepal programme appeared relatively efficient in this comparison.

9. POLICY IMPLICATIONS FOR NEPAL

The information produced by the cost-effectiveness analysis provides the basis for considering possible changes to malaria control strategies in Nepal. It is important to stress, however, that it is not possible to include all factors relevant to the choice of strategy in a cost-effectiveness analysis, so the analysis contributes to, rather than determines decisions. Moreover, while the cost data is reasonably accurate, there are many uncertainties surrounding the effectiveness of both existing and alternative control measures. This, therefore, affects the confidence with which policy changes can be recommended. Policy changes are considered below firstly for vector control methods, secondly for case detection and treatment strategies and finally for the organisation of malaria control.

9.1. Vector control methods

A variety of vector control methods are possible, including

- spraying with residual insecticides;
- focal spraying;
- larviciding;
- biological control such as larvivorous fish;
- environmental management and modification;
- measures to prevent or reduce contact between the vector and an individual, such as impregnated bed nets, screening and the use of mosquito coils.

These are examined in turn below.

Residual spraying

The only insecticides used in routine spraying operations in the years immediately before and including 1984 were DDT and Malathion. In addition, the analysis was able to assess the costs of Ficam, sprayed for the first time in 1985, because of a further study in which the author had been involved. Various trials have taken place assessing insecticide consumption for a limited range of other insecticides, namely fenitrothion 40WP, lambdacyhalothrin 10WP (a pyrethroid) and pirimiphos-methyl 50EC in addition to bendiocarb 80WP (Ficam). Comparing the cost of these insecticides without data from their large-scale use is extremely difficult because price can vary depending on the purchaser, country of use, size of the potential market, and the age of the product. Moreover, little is known of the operational costs of some of these insecticides, and for some there is uncertainty about the optimal dosages for Nepal.

Table 9.1 therefore shows a rough comparison in terms of the insecticide cost alone of four insecticides, selected because they have been or may be used in Nepal, if only on a small scale. Prices for pirimiphos-methyl and bendiocarb are actual 1987 prices, while the others are quotations from the manufacturer. Fenitrothion appears to be the least expensive of the four, followed by lambdacyhalothrin and bendiocarb. The relative attractiveness of bendiocarb vis-a-vis pirimiphos-methyl depends on whether 1 or 2 gm/m^2 of the latter is required. Further investigation is needed of operational costs to see whether these would affect the attractiveness of the insecticides to donors and recipients. Fenitrothion and pirimiphos-methyl are bulky relative to bendiocarb, but the pyrethroids such as lambdacyhalothrin are similar to bendiocarb in terms of lightness and ease of use and thus are likely to have similar operational costs. If trials prove that their persistence is such that only one cycle is required, they are likely to have a significant cost advantage. Moreover their prices are likely to fall in the future.

Ultimately, however, choice of insecticide is determined firstly by who is the donor, and secondly by which of the insecticides are manufactured by firms of the donor's nationality. Where the donor has a choice of insecticide, cost-effectiveness considerations are likely to enter into its decision on which insecticide to donate, but the donor may also wish to spread its favours amongst competing firms. These donor considerations are reflected in the recent pattern of insecticide donations to Nepal. DDT is clearly the most cost-effective insecticide everywhere in Nepal except where A.annularis is the main vector. Yet since Nepal's main donors to the malaria control programme no longer manufacture DDT, Nepal has had great difficulty in obtaining additional supplies. In its place, Britain has donated British products, initially Ficam and subsequently Actellic (pirimiphos-methyl), which are

Table 9.1: Comparison of the 1987 cost per person per annum of four residual insecticides

Insecticide and Dosage	Cost of product CIF Nepal (Rs) (a)	Quantity per person per cycle (b)	Cost per cycle (Rs)	Cost per annum (Rs) (c)
Fenitrothion 40WP (1 gm/m^2)	81.05/kg	.239 kg	19.37	38.74
Lambdacyhalothrin 10WP (0.025 gm/m^2)	1350.89/kg	.020 kg	27.02	27.02/ 54.04
Pirimiphos-methyl 50EC				
-1 gm/m^2	170.89/L	.163 L	27.86	55.72
-2 gm/m^2	170.89/L	.326 L	55.71	111.42
Bendiocarb 80WP (0.4 gm/m^2)	984.46/kg	.041 kg	40.36	80.72

(a) Prices for fenitrothion and lambdacyhalothrin are based on quotations for the price of the active ingredient. Prices of the other insecticides are actual 1987 prices.

(b) Data from trials in Nepal.

(c) Assuming either one or two cycles for lambdacyhalothrin and two for the other insecticides.

considerably more expensive than DDT. Fenitrothion has not been an option so far for the malaria control programme since it is a Japanese product, and therefore donated only by Japan which has not until very recently been interested in assisting the control programme.

From Nepal's perspective, at present financing only local costs, the costs of applying the various insecticides are far more important than the insecticide cost. The newer, lighter insecticides such as bendiocarb and lambdacyhalothrin have both cost and operational advantages over bulkier insecticides such as malathion and fenitrothion. As yet, however, only the costs of bendiocarb have been investigated so no conclusions are possible on which of the newer insecticides is most cost-effective from Nepal's perspective.

The more expensive the insecticide, the greater is the share of insecticide in the total cost of spraying and thus the greater the effect on costs if reduction in consumption is possible, either by reduced dosages or more selective spraying. More selective coverage was suggested by the external assessment team in 1984 (HMG/WHO/USAID/ODA 1984). Making the plausible assumption that more selective spraying will reduce variable costs but not fixed costs, then approximately 75% of total spraying costs (in DDT areas) and over 80% (in malathion areas) would be influenced by selective spraying. Thus in contrast to case detection methods, where a high level of fixed costs means reduction in activity may have little effect on total expenditure, more selective spraying will have a fairly immediate effect on costs. This result was indeed shown by a trial using fenitrothion in Indonesia which compared the effects of 2 cycles of full coverage at $2gm/m^2$ plus one of selective coverage with 3 cycles of selective coverage. The latter reduced insecticide costs by 69% and operational costs by 52%, and reduced malaria rates and vector populations to very low levels though was less rapidly effective than full coverage (Gandahusada et al 1984). More investigation is required in Nepal of vector behaviour so that more informed decisions can be taken on whether spraying can be confined to certain areas of houses and outbuildings.

Focal spraying

Given the shortage of insecticide in Nepal, increasing emphasis is being placed on focal spraying, that is spraying particular villages when cases reach a certain level.

The cost of focal spraying will depend on how it is organized and how much is required. If spraymen are recruited when needed, unit costs are likely to be similar to residual spraying though total costs would be lower if focal spraying permits less extensive spraying. If a team is recruited and employed throughout the main transmission period, unit costs will depend on whether the team can be kept active or is unemployed for part of the time.

Other vector control methods

Unfortunately, only patchy information is available on the costs and effectiveness of the other methods of vector control in Nepal. Larviciding has been tried, but the cost and effort of achieving control of A.annularis with larvicides was considered to be uneconomical and the approach was discontinued (White 1982). No cost information was located.

In 1985 a small experiment in larviciding was started, using locally made up larvicide consisting of 74% Mobil waste, 25% kerosene oil and 1% detergent. The Mobil and detergent were waste products from local industry and were obtained free of charge. The kerosene oil cost Rps 6 per litre. At the time of this study, the experiment was still in its very early stages and issues such as the manpower required and frequency of application had not been decided, so cost estimates were not possible.

Studies have been conducted for some time on the potential for use of biological methods of vector control, especially larvivorous fish. At the time of the field research for this study, local larvivorous fish had been identified but no information was available from field trials. Since then, a trial has been conducted but was unsuccessful due to heavy flooding (HMG/WHO/USAID/ODA/JICA 1988). No cost data is available but it is unlikely that larvivorous fish would be an expensive option, though their effectiveness and potential coverage are uncertain. The 1988 External Review cited above commented that "these applications (including use of larvivorous fish) are only suitable for very special conditions".

Small experiments have been tried with vector control through environmental management, using means such as pond and ditch cleaning. The situation analysis report in 1977 noted that a small experiment with cleaning pools did not change the malaria pattern. The 1988 External Review reports the results of a study of simple environmental management measures (draining small seepages, making sluice gates for intermittent flushing, clearing vegetation from ponds and shore-line clearing) applied in moderate receptive areas of Dhanusa district. The work over the transmission season required 14,428 man-hours, of which 14% were provided free by communities. Free labour was difficult to obtain in the two months when farmers were busiest and for cleaning streams that lay between villages. The larval density of all anophelines fell but adult densities remained high in this area compared with sprayed areas and malaria cases continued to arise in significant numbers. The Review concludes that the area selected for environmental management was unsuitable and that in an area where active transmission is taking place, reduction of vector density by environmental management measures alone will often not be sufficient to reduce vectorial capacity.

Little cost data is available from any of the environmental management trials. The situation analysis report for 1984 reports a cost per capita for environmental management of Rs 1.23 for the 1982 transmission season. The per capita cost of the labour for the recent study reported above is Rs 0.90, assuming an 8 hour working day and a wage of Rs 10 (the 1984 rate for spraymen). The budget for a planned, externally funded research project suggests a per capita cost (1985 prices) of around Rs 1.40 (labour, equipment and community education materials only, excluding supervision) in the first year, and Rs 0.90 in years 2 and 3 when maintenance only would be required and community involvement would supplement hired labour. It therefore appears that simple environmental management measures would cost in the region of Rs 1 to 2 per capita (c. 1984). Such costs compare very favourably with the costs of spraying. If areas can be identified where this type of environmental management is effective in reducing vector densities and malaria transmission, it is likely to be a cost-effective means of vector control.

Control of transmission has been a particular problem in the foothills fringing the Terai. In 1985, experiments started with using small dams with sluices which could be opened every few days to flush larvae from streams. A trial began in 1987 but unusually heavy rainfall destroyed those dams made of local materials and provided lessons in dam design (Draper and Webber 1987). Further results have not yet been reported.

Personal protection methods have not been much explored in Nepal, though a study of impregnated bed nets is now being planned (Draper and Webber 1987). Published reports suggest that the cost of treating bed nets with insecticide (permethrin) is around $1.25 for an application rate of 0.5 g per sq.m (Schreck and Self 1985). The net itself is estimated to cost $15 in Nepal based on imported nylon. Under-fives (15% of the population) will not require a net since they share that of their mother, so the cost per capita is approximately Rs 225. Assuming the life of the net is 6 years, the approximate annual cost (12% discount rate) is Rs 55 per person protected, a relatively high per capita cost in relation to other control methods. Even if the net were to cost only $2 (the price in Thailand), the per capita cost (Rs 11) would still be relatively high.

No evidence is available of the cost or effectiveness of personal protection methods such as screening and coils.

An important consideration in evaluating the cost-effectiveness of personal protection methods will be 'who pays'. Where individuals are expected to purchase items, their cost needs to be evaluated in relation to personal disposable income, and the willingness of individuals to spend their income on these methods.

7.2. Case detection and treatment methods

A number of options face Nepal in moving to a more efficient and economical system of case detection and treatment. The following list of options is not meant to be exhaustive, but shows options being considered or introduced in other countries, or mentioned in various Situation Analysis or External Review reports. Some have already been tried out in Nepal.

The options are:

- remove ACD altogether
- remove ACD in certain areas
- fortnightly ACD visits
- eliminate follow-up of cases
- expand the numbers of PCD (MC)
- change radical treatment procedures
- decentralize malaria laboratories.

These options are evaluated in turn below.

Remove active case detection

Active case detection is still an important means of case detection in Nepal and absorbs a considerable share of total resources. However, the lower the case incidence and the greater the development of PCD mechanisms, the lower is the yield of ACD. Yet by the nature of its work, ACD has high fixed costs and cannot significantly reduce its level of activity to match the lower level of cases detected. Thus the lower the incidence of malaria, the more expensive ACD becomes in terms of slides collected and cases detected.

ACD has been described as 'having no place in long term malaria control' (WHO 1984). At the time the fieldwork for this study was being done, the NMEO was firmly committed to ACD. Since then, however, the 1986 External Situation Analysis Team has recommended its discontinuation (HMG/WHO/USAID/ODA 1986), the 1987 Internal Assessment has termed it 'uneconomical' (NMEO 1987) and the 1988 External Assessment Team has urged the implementation of the 1986 recommendation because of the low cost-effectiveness of ACD and the dangers of inadequately sterilized pricking needles (HMG/WHO/USAID/ODA/JICA 1988). However, the objective of ACD is not merely case detection, but also monitoring of the malaria situation. This is particularly crucial in Nepal given the rise in incidence in 1984 and 1985 and the threat of increased chloroquine resistance. If ACD were to be removed, some other method would need to be developed for detecting changes in the malaria situation and planning preventive action.

If the drastic action were to be envisaged of stopping ACD altogether and relying on PCD methods, it is important to establish whether overall savings could be achieved even with the necessary considerable expansion of the PCD network. Of the various PCD methods at present in use, PCD (H) is constrained by the availability of health units and there has always been some question over the commitment of general purpose health units to the intensive screening of fever cases for malaria. PCD(M) is tied to the location of malaria unit offices, determined by management considerations. Those PCD mechanisms with the greatest potential for rapid expansion are therefore PCD (V) and PCD (MC). PCD (MC) is unlikely to be economic at low levels of incidence outside urban centres and is analysed below for potential for expansion in its own right rather than as a replacement for ACD, so the discussion here concentrates on the cost of expanding PCD (V).

Removal of ACD would require firstly an increase in activity of existing volunteers and secondly the recruitment and support of new volunteers. The first will reduce the unit costs of volunteers since the costs of supporting volunteers depend largely on the number of volunteers rather than on their level of activity. Thus support cost would be spread over a larger number of slides taken and cases detected if the level of activity increases. The second is unlikely to increase unit costs unless it is anticipated that the costs of supporting a volunteer will increase significantly as the volunteer network expands. This may be the case in remote areas, but in these areas ACD is also expensive. Thus there is no reason to suppose that the expansion of PCD (V) will result in unit costs above those of ACD.

A more important consideration is likely to be whether the PCD network as a whole can achieve the same level of case detection as achieved at present with a mix of ACD and PCD. This can only be ascertained by experiments with removing ACD, on the lines already being tried by the NMEO. The opinion of the 1987 Internal Assessment was that "if there is no ACD mechanism, most of the cases detected by the ACD source would go to other sources" (NMEO 1987). However, particular attention would need to be paid to whether women and children would be adequately represented in the workload of passive mechanisms. A study in Thailand (Ettling, Thimasarn, Krachaiklin and Bualombai 1989) found that women and children were under-represented in malaria clinics when their workload was compared to the age and sex distribution of malaria prevalence in the community as established by a serological survey. The latter information is not available for Nepal, but the age and sex distribution of cases does differ between case detection mechanisms. For instance, data from the patient survey for Rupandehi showed that 23% of ACD cases were under 10 years but only 13% of all PCD cases and 10% of PCD (V) cases; and 47% of ACD cases were female compared to 35% for all PCD cases and 38% for PCD (V). If ACD were to be abandoned, ways would need to be found of ensuring adequate coverage of mothers and children, for instance by making the volunteer network sufficiently accessible and attractive.

Existing costs can be used to make a rough estimate of the resource implications of removing ACD and expanding PCD (V). In 1984, the cost of supporting a volunteer (district-level costs only and excluding parasitology and radical treatment) is estimated to be Rs 1476 in Morang, Rs 674 in Rupandehi and Rs 1215 in Ilam. Assuming a target of one volunteer per 2000 people and unchanged support costs per volunteer, the cost implications can be calculated as shown in Table 9.2 and compared with the present cost of ACD (case detection costs only). The figures suggest that the replacement of ACD by strengthened PCD (V) would indeed result in savings.

The difference in the support costs between Morang and Rupandehi suggests that the cost estimate may not be completely accurate. Moreover, the NMEO is conscious that it at present lacks the funds to provide adequate supervision and supplies to volunteers. However the difference between the cost of a complete PCD (V) network and ACD is so great that the cost of supporting volunteers could be considerably higher without exceeding the current cost of ACD. Allowance also needs to be made for the cost of replacing the monitoring role of ACD, but this is unlikely to be expensive if sampling methods are used.

Any policy that relies extensively on volunteers must consider the economic implications for volunteers. Evidence suggests that the current economic implications are not great (see Chapter 6). The implications of increasing the workload can be examined by assuming that the increased number of volunteers would handle all the cases currently detected by ACD (ie through ACD, APCD and Follow-up) and would maintain

Table 9.2: The cost implications of removing ACD and expanding PCD (V)[a]

	Morang	Rupandehi	Ilam
Cost of supporting a volunteer (Rs) [b]	1,476	674	1215
No of volunteers required [c]	252	195	33
Total support cost (Rs)	371,952	131,430	40,095
Current cost of ACD (Rs) [d]	658,710	474,478	262,060

(a) Costs are based on economic prices, and thus are not the same as budgeted expenditure.

(b) Costs are those of supervision, supplies and slide collection.

(c) Based on one per 2000 population.

(d) Case detection only.

their existing slide positivity rate. In Morang, for instance, this would mean a workload of 569 cases and 15,222 slides, or on average 60 slides per volunteer in contrast to the current figure of 35, and in Rupandehi, 1671 cases, 20,245 slides, and on average 104 per volunteer in contrast to 57 at present. If it is assumed that these are spread over the period April to October, this implies 9 a month per volunteer (Morang) and 15 a month (Rupandehi). This does not appear to be a significantly high time commitment for a volunteer.

Elimination of ACD would also lead to savings in parasitology costs. Annual blood examination rates are extremely high at present in many districts (for instance around 25% in Ilam) with a low return in terms of cases detected. While parasitology is relatively cheap (Rs 1.54 per slide in Ilam) a reduction in the number of slides, if it was sufficient to permit manpower to be redeployed, would produce savings that could be used more effectively elsewhere. For example, the reduced number of slides in Morang, assuming for purposes of illustration that PCD (V) detected all the ACD cases at the PCD (V) slide positivity rate and only district-level parasitology costs were saved (ie assuming parasitology overhead costs remain unchanged, a conservative assumption since, for example, regional cross-checking costs would presumably be reduced), would produce a saving of Rs 47,000 or 68% of the locally-funded recurrent costs of the parasitology programme. In Rupandehi, the saving would be Rs 100,000, or 67%. While the parasitology programme takes up only 6-10% of locally-funded district expenditure, such savings could none-the-less be valuable.

Selective reduction of ACD

Even if ACD be retained, it can be questioned whether it is appropriate for all areas of Nepal. The ACD network will always be more expensive in hill districts than in the Terai, since the terrain is difficult, populations scattered, salaries and allowances higher and incidence in general lower. In Ilam, 84% of the cost of ACD is accounted for by the salaries of MFWs and the other main cost item (DA/TA) takes up 12%. The NMEO has considered reducing the frequency of house-to-house visits from once-a-month to once every two months in order to reduce costs. This would considerably reduce salary costs and DA/TA per house visited though probably not halve them because MFWs would have to cover a much greater area. However, the yield in cases is likely to be considerably lower, because some potential patients would resort to self treatment or PCD mechanisms. A more worthwhile policy change would be to experiment with eliminating ACD in hill districts where the risk of increased local transmission is much less than in the Terai. In its place, more emphasis could be placed on the promotion of PCD (V), who would probably detect more cases and experience rapidly decreasing costs per slide and per case as their workload rises. It may well be at present that maintaining both ACD and PCD (V) networks, each involving high fixed costs, results in much higher total costs per slide and per case detected than if one of the networks were removed.

The above suggestion is put forward to reduce the cost of case-detection and treatment where malaria incidence is low. In 1987 the NMEO implemented an alternative approach to ACD in Kanchanpur district in the Far-West in order to cope with a large number of cases in difficult terrain. House-to-house visits by malaria field workers were stopped for three months and instead, the workers manned malaria "depots", stationary outreach stations to which fever cases could come for diagnosis and treatment. The morning was spent seeing patients, and the afternoon in outreach health education activities. No cost data are available on this experiment. It would presumably lead to some savings in DA/TA and in parasitology costs, and would mean that more cases would be detected by MFWs and with a shorter time-lag between infection and treatment. To some extent, though, it may simply have redistributed cases between case detection mechanisms.

The implementation of this approach is presumably not dependent on the existence of ACD since workers could be trained and depots established rapidly if an unexpected rise in cases occurs. It offers a less expensive alternative to the malaria clinic (since a microscopist is not stationed at the depot) and is thus likely to be cost-effective at a lower API than that required for the clinic (see below). It is not, however, likely to be a cost-effective solution where incidence is low since the high fixed cost characteristics of ACD are largely unchanged (workers are still employed full-time).

Elimination of Follow-up

The 1986 External Situation Analysis Team suggested that follow-up of *P.vivax* cases should cease because of the high workload, and that follow-up of *P.falciparum* cases should be intensified. This suggestion was made in conjunction with a recommendation that MFWs should be transfered from ACD to other duties (supervision of volunteers, motivation and mobilization of communities in treatment and control activities). Clearly, elimination of follow-up for *P.vivax* only makes economic sense if house-to-house visits for active case detection are stopped: otherwise the taking of an additional slide can be done at minimal marginal cost.

Fortnightly ACD

Fortnightly rather than monthly ACD has been suggested by various reports and tried as a means of reducing incidence when the API is increasing or has increased. The cost of ACD is influenced by the population density and the distance to be covered. MFWs usually live in their locality so doubling the number of visits is likely to result in some saving in travel time, though it is still likely that almost double the number of MFWs will be needed, thus doubling costs.

This is unlikely to be worthwhile unless incidence is high and PCD mechanisms do not detect significant numbers of cases. However, if fortnightly ACD can be seen as an alternative to spraying, then it may be economic. For instance, if it is assumed that it doubles the district-level cost of case detection and that cases are twice what they would have been with spraying, the additional cost of the increased case detection and treatment activities would be around Rs 2.40 per capita per annum (Morang) and Rs 3.10 (Rupandehi) compared to the cost per capita per cycle of introducing spraying of Rs 8.69 (for DDT) in Morang and Rs 13.35 (for malathion) in Rupandehi (figures from Tables 6.2 and 6.4). Thus fortnightly surveillance could potentially be quite a cost-effective measure if it reduces the need for spraying. This remains true even if allowance is made for the increased private expenditure and loss of work days resulting from the increased cases (for instance a doubling of the API from 3 to 6 would result in increased private costs in Morang of Rs 0.12 per capita and in Rupandehi of Rs 0.05 per capita).

Expansion of PCD (MC)

In the earlier analyses, malaria clinics have emerged as a particularly low cost method of case detection and treatment. It is therefore useful to explore in what circumstance they are likely to be appropriate. A malaria clinic will appear low cost only where it has a sufficiently large catchment population with a sufficient number of cases. For instance, if a cost per case for case detection and radical treatment of Rs 500 is regarded as an acceptable maximum, a malaria clinic such as that in Morang, costing Rs 14,615 per year, needs to detect 30 cases per year to achieve this unit cost. At an API of 2, this requires a catchment population of 15,000 in the vicinity of the clinic or with reasonable access to it.

At this level, there may well be some spare capacity in the clinic. In Morang 0.45% of malaria clinic slides were positive, and detecting 30 cases would thus require 6700 slides, or 24 per working day. An experienced laboratory technician is expected to examine 60 per day. The laboratory technician in the malaria clinic also has to take slides, give presumptive and radical treatment and do an epidemiological investigation. If even so, he has some spare time, a larger population or more cases could be served at decreasing average cost. If the slide positivity rate was as high as in the Rupandehi malaria clinics (22%), 30 cases would require only 136 slides, or less than one per day. At this level of slides, there would be considerable spare capacity, and a much larger population could be served at decreasing average cost.

The increased use of malaria clinics thus depends on identifying areas with a sufficiently large catchment population and sufficiently high incidence of malaria. Minimum levels are probably a catchment population of 15,000 and an API of 2. The higher the API, the lower can be the catchment population.

Changing radical treatment procedures

Two options to decrease the cost of radical treatment are already being tried out and are under review by the NMEO: reducing the treatment of P.vivax cases from five days to one or two days, and using MFWs to do radical treatment. A third option which is beginning to be discussed is using volunteers to do radical treatment, and a fourth option has been proposed by External Reviews, giving immediate radical treatment instead of presumptive treatment.

Since malaria workers are required to give a five day treatment personally, thus requiring them to visit five times or stay for five days, reduction in treatment length has considerable potential for reducing costs. However, it needs to be set against the cost of any increase in cases arising from a higher relapse rate. Costs will result firstly from detection and treatment of relapsed cases, secondly from detection and treatment of cases that result from increased transmission and thirdly from private expenditure on treatment and loss of work time of the relapsed and additional cases.

Although the NMEO has been studying the difference in relapse rates between one and five day treatment, no clear conclusions have yet emerged. Since reduction in the length of radical treatment appears to have such a clear potential for savings, it is important for the NMEO to establish whether relapses and increased transmission could offset the reduction in workload.

As long as the ACD system is retained, using MFWs to do radical treatment seems to be a sensible extension of the role of a single purpose worker since it is likely that the additional work can be taken on at a low additional cost. Similarly, using volunteers to give radical treatment will be a low cost option. An additional visit might be required to notify the volunteer of a case though this could be done through the usual courier system. The major problem would seem to be ensuring the volunteer gives appropriate treatment when cases are very infrequent. Simple treatment guides or pictures could overcome this problem. While a volunteer might be reluctant to undertake this work, it may also increase his satisfaction and feeling of involvement. Since the volunteer's catchment area is usually very local, five day treatment could be given with limited effort, and the volunteer could also be used to take follow-up slides if this is considered worthwhile.

While the costs of the volunteer's time may be low, the earlier analysis shows that the costs to the NMEO of supporting the volunteer (especially visits by a supervisor and courier) are significant. Since the supervisory visits are already being made, extra help connected with new duties of radical treatment could be done at the small extra cost of a longer stay, not a new visit.

Both the 1986 and 1988 External Evaluation Teams recommended that presumptive treatment should be discontinued and replaced by 5 day treatment of chloroquine and primaquine for any patient suspected of having malaria appearing at a PCD mechanism. The details of treatment practices are not specified: for example whether the 5 day treatment would be handed to the patient at one time and whether a blood slide would be taken. Reading between the lines, it seems most likely that one contact per patient is intended, and taking a blood slide only if the patient has failed to respond to an earlier treatment (or if the case is particularly severe or particularly likely to be P.falciparum).

Drugs are an extremely small percentage of total case detection and treatment costs. At Rs 0.59 per person given presumptive treatment and Rs 1.48 per case for radical treatment, they can be compared to a cost per case of detection and radical treatment of between Rs 200 and Rs 1518 (minimum and maximum costs for PCD (V), PCD (M) and PCD (MC) in Morang and Rupandehi). In 1984, 6% of all PCD (V) slides were positive and 14% of all PCD (M) slides. Therefore for every 100 people attending PCD (V), under the traditional system total drug costs would amount to Rs 71.42 (100 given presumptive treatment and 6 given radical treatment) and if immediate radical treatment were given, Rs 148. Expressed as a drug cost per true case of malaria, the cost would rise from Rs 11.90 to Rs 24.67. A similar calculation for PCD (M) gives drug costs per 100 people of Rs 88 and Rs 148, and an increase in drug costs per case from Rs 6.29 to Rs 10.57.

If the immediate radical treatment were given at one time, the increased drug cost would easily be offset by savings in the time required to contact those found to be positive. Moreover, if no slide was taken, savings per 100 suspected cases of at least Rs 97 (Morang) and Rs 195 (Rupandehi) would arise, which would more than offset the increased drug costs. From the cost point of view, therefore, immediate radical treatment appears worthwhile.

The 1986 External Situation Analysis Team gave the main reason for discontinuing presumptive treatment that it may be responsible for selecting chloroquine-resistant strains of P.falciparum, especially when the time-lag between presumptive and radical treatment is quite long (HMG/WHO/USAID/ODA 1986). The 1988 Team added that it suspected from the increased proportion of relapses amongst P.vivax cases that incomplete courses of radical treatment were common (HMG/WHO/USAID/ODA/JICA 1988). These arguments suggest that decreased cost may be accompanied by increased effectiveness in terms of more rapid cure and a reduction in the speed of the spread of chloroquine resistance. Moreover, the availability of immediate radical treatment may increase the attractiveness of PCD posts and increase the proportion of total cases that arise in the community that are treated. However, there are also dangers associated with the use of primaquine in population groups with a high frequency of Glucose-6-Phosphate Dehydrogenase deficiency.

Decentralise malaria laboratories

In 1984, most laboratory work was centralized in district laboratories. However, the NMEO was considering decentralization, providing one laboratory for every 2 unit offices. It is relatively straight-forward to establish the population and level of activity that would make a unit laboratory economic. For example, a population of 100,000 and an ABER of 15% would give rise to 15,000 slides per year or 53 slides per day if a laboratory technician works 280 days a year. Thus one laboratory between two unit offices would appear economic and could produce savings taking into account the reduced travel required for couriers and the more speedy notification and treatment of cases. However, if ACD were discontinued and/or if routine slide-taking were stopped, decentralized laboratories are unlikely to be economic unless the task of microscopist can be combined with other activities.

9.3 Organization of malaria control

One of the most important policy issues that Nepal has been facing for some years is the issue of the desirability of the integration of malaria control activities with general health service activities, and the speed with which integration should be pursued. Integration is unlikely to change markedly the costs of spraying since the two patterns of organization use similar approaches (unless it is argued that integrated districts are likely to have less effective case detection and treatment systems and thus may need to rely to a greater extent on spraying for the control of malaria). Indeed the analysis in Chapter 6 suggested that the cost of spraying was not dissimilar between NMEO and ICHSDP districts.

However, case detection and treatment costs appear to be considerably cheaper in integrated districts. Table 6.4 calculated the following district-level per capita costs:

NMEO districts	Morang	Rs 2.40
	Rupandehi	Rs 3.10
	Ilam	Rs 8.35
ICHSDP districts	Saptari	Rs 0.75
	Parsa	Rs 0.92

It would be misleading, however, to use these figures as the basis, without adjustment, for calculating the savings that might arise from integrating all districts. As discussed in Chapters 6 and 8, the total costs of case detection and treatment in an integrated malaria control service are likely to be very sensitive to the level of malaria, unlike NMEO costs. Both Saptari and Parsa detect and treat fewer malaria cases in relation to population than the NMEO districts, their respective APIs being 0.7 and 1.05 in contrast to 1.51 in Morang, 5.91 in Rupandehi and 1.08 in Ilam. Without a more extensive sample of NMEO and ICHSDP districts, it is difficult to anticipate how ICHSDP costs would respond in districts with higher APIs. If a linear relationship is assumed between per capita cost and API in ICHSDP districts, projecting the likely cost of an integrated service in Morang on the basis of the Saptari and Parsa APIs and per capita costs gives a per capita cost of approximately Rs 1.14. This suggests that costs of case detection and treatment in an integrated district are roughly half those of an NMEO district at an API of around 1.5.

It would be unwise, however, to assume that this relationship held over the whole range of APIs that might arise. Moreover, it would be realistic to expect there to be some limit to the extent to which resources could be switched to malaria control to cope with a rise in cases in integrated districts. It would be plausible to assume that up to a certain point, the integrated service could cope with a rise in cases but that eventually the number of untreated cases and delay in treatment would be such that an epidemic could occur, necessitating emergency and expensive measures.

A crucial issue, therefore, in any discussion of integration policy, is the extent to which the case detection and treatment activities of integrated districts are adequate to prevent a major rise in transmission. It is of note that despite regular warnings by internal and external evaluation teams that case detection and treatment activities in integrated districts were very poor, and that many cases of malaria were likely to have been missed or given radical treatment very late, there has not been, in those districts integrated up to 1984, any signs of a major increase in malaria. NMEO staff attribute this to the low receptivity of these districts. Since they are very similar to adjacent NMEO districts which report rather higher APIs, this suggests an element of overkill in NMEO malaria control strategies for these areas and the scope for a more economical programme.

However, the increase in cases that occurred in 1985 and 1986, particularly in NMEO districts in the Mid-West and Far-West, warns that not all districts may be equally suitable for integration. This hypothesis may soon be tested since in July 1987, a high level decision was taken to integrate all vertical programmes, including malaria. In 1987 all NMEO districts in the East Region were integrated and all Regional offices, and the district offices in the other regions were expected to be integrated in the near future. The precise pattern of integration is as yet, however, unclear, and there is some suggestion that some single purpose workers may be retained at district level.

9.4 Summary

This chapter has speculated on the likely costs and effectiveness of changes to current malaria control strategies in Nepal. Policy changes were considered firstly for vector control methods, secondly for case detection and treatment methods and thirdly for the organisation of malaria control.

Alternative vector control methods analysed were alternative insecticides, more selective spraying, focal spraying, larviciding, use of larvivorous fish, environmental management and impregnated bed-nets.

All other insecticides would be in total more expensive than those currently in use, but some of the new insecticides, for example lambdacyhalothrin, might be significantly cheaper to apply. The more expensive the insecticide, the greater was the share of insecticide in the total cost of spraying and thus the greater the effect on costs from more selective spraying. More research was required on the extent to which more selective spraying was possible in Nepal. The cost of focal spraying would depend on how it was organised.

Virtually no cost or effectiveness data were available on larviciding or the use of larvivorous fish. Scanty data on the cost of simple environmental management measures suggested a cost in 1984 of between Rs 1 and Rs 2 per capita, and trials suggested that areas for environmental management needed to be carefully chosen. It was concluded that if areas could be identified where simple environmental management measures were effective in reducing vector densities and malaria transmission, then they were likely to be a cost-effective means of vector control.

Estimates of the cost of personal protection methods such as impregnated bed-nets suggested that they were relatively expensive per person protected.

Case detection and treatment options analysed were removal of ACD, removal of ACD in certain areas, fortnightly ACD visits, elimination of follow-up, expansion of malaria clinics, changes in radical treatment procedures and decentralization of malaria laboratories.

The cost consequences of removal of ACD and expansion of PCD (V) were assessed. It was clear that replacement of ACD by strengthened PCD (V) would result in savings. Moreover, the implied workload for volunteers did not seem to be unreasonable. However, women and children currently made up a greater proportion of ACD than PCD cases suggesting that if ACD were to be abandoned, the volunteer network would need to be made sufficiently accessible and attractive to women. Even if ACD were to be retained as a strategy. It was suggested that it need not be used in the Hills where it was particularly costly and where the risk of increased local transmission was much less than in the Terai. Elimination of follow-up would only make economic sense if house-to-house visits were stopped: otherwise the taking of an additional slide could be done at minimal marginal cost.

Fortnightly ACD did not appear to be worthwhile in the presence of PCD mechanisms unless it could be seen as an alternative to spraying. If so, the additional cost of more frequent house-to-house visits would be only around Rs 3 per capita compared to a cost per capita per cycle of spraying of at least Rs 9.

The circumstances under which malaria clinics were likely to be cost-effective were explored. It was concluded that a catchment population of 15,000 and an API of 2 were minimum requirements. The higher the API, the lower could be the catchment population.

Changes in radical treatment procedures assessed included reducing the treatment of P.vivax from five days to one or two days, which would be attractive so long as the savings would not be offset by relapses and increased transmission; using MFWs and/or volunteers to do radical treatment, which would be attractive since it should be possible for MFWs and volunteers to take on the work at relatively low marginal cost; and discontinuing presumptive treatment in favour of immediate 5 day treatment of chloroquine and primaquine for any suspected case. The cost implications of this last option were assessed and it was concluded that the increased drug cost would easily be offset by savings in malaria worker time and parasitology costs. The decentralization of malaria laboratories appeared economic as long as ACD was retained.

Finally, the advantages and disadvantages of increased integration were assessed. In the districts evaluated, case detection and treatment costs were considerably lower in ICHSDP than in NMEO districts. However, the APIs in the ICHSDP districts were also considerable lower. On the assumption of a linear relationship between per capita cost and API in ICHSDP districts, it was estimated that costs of case detection and treatment in an integrated district were roughly half those of an NMEO district at an API of around 1.5. However, the extent to which integrated services could cope with a rapid increase in transmission was questioned. It was noted that despite concerns that control activities in integrated districts were poor, there had been no sign of a major increase in malaria despite many years of integration. This suggested an element of overkill in NMEO control measures in similar areas, but this conclusion could not be extrapolated to other areas with greater risk of increased transmission such as Mid-West and Far-West districts.

integrated services could cope with a rapid increase in transmission was questioned. It was noted that despite concerns that control activities in integrated districts were poor, there had been no sign of a major increase in malaria despite many years of integration. This suggested an element of overkill in NMEO control measures in similar areas, but this conclusion could not be extrapolated to other areas with greater risk of increased transmission such as Mid-West and Far-West districts.

10. CONCLUSIONS

10.1 Theoretical aspects of the methodology of cost-effectiveness analysis of disease control programmes in developing countries

This study has shown the relevance of cost-effectiveness analysis to decision making on disease control programmes in developing countries. In particular, it has shown that the current 'state of the art' in cost-effectiveness analysis of health programmes in developed countries is relevant and can be applied in developing countries.

Disease control programmes, and in particular malaria control, present choices to decision makers which encompass many of the choices reviewed in Chapter 2. For example, they involve choices of sector, strategy, place of intervention, time of intervention and target group. In some ways they present more of a challenge to the analyst than many of the topics chosen to be the subject of cost-effectiveness analyses in developed countries because they represent public health, community-wide interventions rather than curative interventions targeted at individuals which tend to be easier to evaluate.

The micro analytical framework of economic evaluation has been argued to be relevant in the Nepalese context. On largely practical grounds, cost-effectiveness rather than cost-utility analysis was employed to evaluate the malaria control programme. However, this decision can also be justified on theoretical grounds. In terms of the criteria listed by Torrance (1985) for determining when cost-utility rather than cost-effectiveness analysis is desirable (see Chapter 2, section 2.1), in malaria control:

- quality of life is not the only important outcome: malaria for most people is a relatively short, acute illness with no lasting effects;
- although malaria causes both morbidity and mortality, these effects can be combined in a common unit of outcome such as healthy days of life lost without using utility weights;
- no study of a developing country health programme has used cost-utility analysis: thus there are no studies to which the Nepal results could be compared;

- the quality of the effectiveness data is poor: the use of utility weights would only add further assumptions and uncertainties.

On theoretical grounds, in order to achieve consistency with economic evaluation methodology in other sectors, it is important to use shadow pricing in economic evaluations of health programmes in developing countries. In the Nepal study, the effect of shadow pricing was relatively slight but this does not destroy the arguments for shadow pricing.

In general, the cost-effectiveness literature underestimates the difficulties of formulating the measures of health effects required for economic evaluation and discovering the relationship between programme activities and health outcome. In the case of malaria, none of the conventional measures of health effect are very satisfactory except for the purpose of internal assessment of programme efficiency. In terms of comparisons with other health programmes which have been the subject of economic evaluations (eg immunization, diarrhoeal disease control) malaria is primarily a cause of morbidity rather than mortality, the episode of illness is relatively brief, if often acute, and in Nepal, adults are affected as much or more so than children. Thus if the measures 'cases and deaths prevented' are used to compare the cost-effectiveness of malaria control with other health programmes, they disguise the different nature of the health effects resulting from the various programmes. Moreover, while the measure 'healthy days of life lost' overcomes to some extent the problems caused by the differing impact of different health programmes on illness and death, it biases programme choice towards health programmes which prevent child deaths, and away from programmes such as malaria which also benefit adults and primarily prevent illness rather than death.

The difficulties of assessing the relationship between inputs and outputs are a consequence not only of the data collection problems in developing countries but also of the nature of disease control programmes. In the case of the Nepal malaria programme, these difficulties were accentuated because malaria incidence in most areas was low, making design of any field trial of control strategies difficult.

In general, these problems of assessing effectiveness are underestimated by economists engaged in cost-effectiveness analysis. Yet evaluation conclusions are often more sensitive to the values of the effectiveness data than the cost data.

One of the major features of the evaluation framework now used in cost-effectiveness studies in developed countries is the inclusion of resource - saving consequences. As discussed in Chapter 8, these can be an important consequence of health programmes and they need therefore to be considered in developing country studies. For example in the malaria control programme in Nepal, the means of case detection and treatment and its level of performance affected the period of illness of a malaria patient. The longer the delay between infection and slide collection, and slide collection and radical treatment, the more days of work were lost. Similarly, the longer the period of illness, the more private resources were spent on treatment.

These findings underline the importance of taking a social perspective, including not only government costs and consequences but also those falling on households, which have rarely been considered in the cost-effectiveness literature on health programmes in developing countries. However, if study results are to influence government decision makers, the study must also include an assessment of costs and consequences from the government's perspective and consider whether there is any conflict between government and social perspectives and between government and donor perspectives.

10.2 Methods of applying cost-effectiveness analysis to disease control programmes in developing countries

The research reported here illustrates both the scope for, and difficulties of applying cost-effectiveness analysis to disease control programmes in developing countries. The research was perhaps fortunate in encountering an information system that made analysis of programme costs relatively straightforward. However, in most countries and programmes, cost data tend to be the most readily available of all types of data, simply because they are required for accounting purposes. In contrast, until recently health programmes have often not been required to prove that they are effective in terms of indicators of change in health: hence the difficulties of obtaining the information required on effectiveness from the Nepalese malaria programme.

The research also illustrates the difficulties associated with evaluating a preventive, as opposed to a curative, programme. In a curative programme, the number of individuals affected with a particular condition is known, and also the proportion cured, though there may be some uncertainty over the extent to which individuals have benefited from treatment or the period for which the improvement will last. In a preventive programme the number of individuals affected is hypothetical: it is the number who would, in the absence of the programme, be infected. Assessing this number requires baseline information, either from the period before the programme was introduced or from areas where the programme has not been implemented. Both of these approaches have their difficulties, particularly in the case of malaria where the pre-programme situation may be long ago and non programme areas may not be comparable to programme areas.

Given the uncertainties over the effectiveness of a preventive programme such as malaria control, incremental analysis is particularly difficult to do. For example, in the case of the Nepal analysis this requires assessing the incremental effect of a change in strategy on malaria incidence. Many factors other than the strategy itself - for example the weather, temporary migration patterns, the Indian malaria situation - affect the annual incidence of malaria, making it difficult to isolate the effect of the change in strategy.

While the Nepal research demonstrates the importance of a social perspective in cost-effectiveness analysis it also demonstrates the difficulties of obtaining the required information on private costs and consequences. Some form of survey is required, and questions can be difficult to formulate. In the case of private expenditure on medical care, there is the problem of recall period and of assessing the reliability of responses when enquiries are being made about only one category of household expenditure (making it impossible to check the magnitude of all reported expenditure against income).

In the case of assessing time lost due to the disease, there is the problem firstly of assessing whether the time lost by the sick person is compensated for by an increased time input by other household members, and secondly of placing a value on any time loss. The Nepal analysis suggests that assuming that all the period of disablement of the ill person is lost to the household, and that this period should be valued at the local wage, will overestimate the actual cost of illness to the household.

Indeed, the Nepal research in general emphasizes the importance of including consideration of the role of the household in any cost-effectiveness analysis of disease control. The household uses its resources to cope with illness, it finances preventive activities, it influences the effectiveness of government preventive activities (for instance by whether or not houses are replastered after spraying) and it affects the cost-effectiveness of case detection and treatment activities by its decisions on the use of services.

Despite the difficulties the research encountered in the application of cost-effectiveness analysis, the research also underlines the importance of this type of evaluation. Malaria control is probably the largest single programme of the Ministry of Health in terms of resources used; it is in regular contact with about 9m of Nepal's 17m population, and it faces important choices to do with strategy and target population as the quantity of insecticide available to it is reduced, as it re-orientates itself from aiming at eradication to control, and as the nature of the malaria problem changes with population movements, environmental change, and development of parasite resistance to insecticides and drugs. Cost-effectiveness analysis can help malaria control programmes improve their efficiency by asking pertinent questions and bringing home the resource implications, for both the government and households, of alternative strategies and matching these with their likely effectiveness.

10.3 The potential for increasing the cost-effectiveness of the malaria control programme in Nepal

Chapter 4, section 4.2, discussed the various choices faced in making decisions on a malaria control programme. In particular, it classified these choices by the level of objective:

Level 1: choice of malaria control versus other health programmes
Level 2: choice of vector control versus case detection and treatment
Level 3: choice of means of case detection and treatment
: choice of means of vector control
Level 4: choice of ways of organizing an activity.

The conclusions here are thus discussed in terms of these levels, taking them in reverse order. Finally, conclusions are drawn on the relative costliness of malaria control in Nepal as compared to malaria control programmes in other countries.

Choice of ways of organizing an activity

Chapter 9 suggested a number of ways of increasing the efficiency of particular malaria control activities:

- increased use of MFWs for radical treatment;
- use of volunteers for radical treatment;
- one or two day radical treatment;
- immediate radical treatment;
- decentralization of laboratories;
- integration of malaria control activities.

The first should lead to a more economical use of staff so long as the ACD network remains in existence. The second depends on whether volunteers can be trained and would be willing to take on extra duties. If so, this is likely to be cost-saving. One day treatment could lead to a considerable time-saving for unit staff but better information is necessary on relapse rates. Immediate radical treatment would also save costs: drug costs would increase but they would be more than offset by savings in the time required to trace confirmed cases and give radical treatment and in parasitology costs. Decentralization of laboratories is clearly worthwhile as long as the number of slides collected is sufficient to keep a laboratory technician fully occupied.

No clear cut conclusions were possible on the cost-effectiveness of an integrated pattern of organization without better information on the true incidence of malaria in NMEO and ICHSDP districts. The analysis suggested that integration might be economical at low levels of malaria, but that its costs would approach those of the NMEO as cases increased.

It also seems that despite a lower level of performance than the NMEO, its activities in districts integrated up to 1984 were sufficient to contain malaria at a low level. However its ability to contain malaria in districts of higher receptivity has not been tested, nor its costs in circumstances of relatively high transmission.

Choice of means of case detection and treatment and means of vector control

Case detection and treatment. The analysis in Chapter 6 suggested that the proliferation of case detection methods is resulting in relatively high unit costs for each method. Chapter 9 therefore evaluated the costs of stopping ACD, either throughout Nepal or in Hill areas, and expanding the volunteer network. Financially this would bring advantages, but information is required on whether case detection would fall to unacceptable levels in the absence of ACD.

Other options considered included expanding malaria clinics since they are an economical means of case-detection and treatment in areas of concentration of population and cases. Malaria depots seem likely to be a cost-effective means of case detection and treatment at lower APIs than malaria clinics, though at low levels of incidence they will be expensive because a high proportion of their costs are fixed. Firmer conclusions on malaria depots are not possible because their costs have not been studied.

Vector control. Conclusions on the merits of different insecticides are relatively straightforward. DDT is the most economical insecticide in terms of total costs, followed by malathion. Of the newer generations of insecticide, those which are low in volume and weight such as Ficam have distinct operational advantages in Nepal. The more expensive the insecticide used, the more worthwhile become strategies to limit the quantities used. These include selective coverage and focal spraying. More information is required on their effects.

Very limited information is available on the costs and effectiveness of environmental management and modification, though trials are now underway which should produce better information. What evidence there is suggests that environmental management is likely to be a cost-effective means of vector control in the Outer Terai wherever small-scale, labour intensive methods can be used and are effective.

The value of personal protection has been little explored. However the risk of malaria is at present relatively low and personal protection measures are directed at the entire population (and may require expenditure by everyone). Thus the cost is likely to be high relative to the reduction in risk, though protective measures do protect also against diseases other than malaria.

Choice of vector control versus case detection and treatment

Clear-cut conclusions on the relative cost-effectiveness of vector control and case detection and treatment and the optimum mix of the two strategies is impossible in the absence of reasonable information on their effectiveness. Given the high cost of spraying (largely stemming from the insecticide cost), there is considerable potential for intensifying case detection and treatment activities before they exceed the cost of spraying, and this will be cost-effective if it reduces the amount of spraying required. However, as long as insecticide is available to Nepal at the cost of applying it alone, the cost advantage from the government's point of view of case detection and treatment strategies is considerably reduced, though not eliminated.

A considerable reduction in spraying has occurred in recent years and there are now attempts to assess its effect on transmission (Draper and Webber 1987). Hopefully this will enable a better evaluation of the cost-effectiveness of spraying and the circumstances under which spraying is worthwhile.

Further evaluation is also required of the optimal mix of strategies. For instance a combination of case detection and treatment and focal spraying is now being considered as a means of reducing insecticide requirements (Draper and Webber 1987). In the light of the spread of chloroquine resistance, it is clearly important that a capacity be retained for mounting spraying campaigns rapidly.

Choice of malaria control versus other health programmes

The evidence presented in Chapter 8 suggests that while the cost per case and death prevented by the Nepal malaria control programme is not as low as that of some other preventive programmes, notably those such as immunization targeted at young children, it nonetheless represents a worthwhile health service activity. However the analysis underlines the importance of stratifying geographical areas in terms of their malaria risk and determining the most cost-effective strategies for each area. The tendency has been to apply a particular strategy - for instance ACD - throughout the malarious area, at a cost which may not be justified by the results in terms of reduction in malaria risk in certain areas. The calculation of the cost-effectiveness ratios in Table 7.6 indicates that the cost-effectiveness of malaria control is highly sensitive to the numbers of cases and deaths prevented since a large proportion of the costs, especially of case detection and treatment, are fixed. Thus in high risk areas, malaria control appears to be highly cost-effective and in low risk areas, less so.

A further important consideration is the age-group protected from illness by malaria control. In contrast to those health programmes most commonly identified as cost-effective, namely those which improve the health of children, the malaria control programme in Nepal at present mainly treats older children and adults. It therefore represents an important means of improving adult health. In terms of the cases it prevents, it does protect children but also protects adults.

While quantitative comparisons of cost-effectiveness are not possible with other health programmes in Nepal, the discussion in Chapter 8 of the Nepal results relative to the results of analyses of malaria control programmes in other countries suggests that the Nepal programme is both economical and relatively efficient. It is therefore likely to represent a more efficient use of resources than many other existing health service activities in Nepal, notably curative services.

11. IMPLICATIONS FOR FURTHER RESEARCH

11.1 The methodology of cost-effectiveness analysis

There are two main priorities in developing the methodology of cost-effectiveness analysis in the developing country context. The first is to improve the measures of effectiveness used. In particular, a health index needs to be developed which is relevant to the diseases of developing countries. This could be built on the 'healthy days of life' measure, but should improve on the subjective assessment in that measure of the degree of disability imposed by different diseases. An assessment is required of what dimensions of health should be reflected in the index (eg physical, social, emotional functioning) in terms of the value placed on health by individuals. Then different levels of ill-health need to be ranked relative to each other. Finally, different diseases need to be scored in terms of the degree to which they impair health.

As a parallel effort, the relevance of the measure 'quality adjusted life years' to developing countries should be explored. In particular research should investigate whether the questionnaires used to elicit utility weights in developed countries are relevant to, and usable in, the developing country context, and whether they can be suitably adapted.

The second methodological research priority is to improve the methods available to investigate the consequences of illness for households. There are virtually no studies available to guide researchers wishing to include these consequences in their cost-effectiveness studies. The most problematic area is that of time loss due to illness and improved methods are required to study the extent of such time loss within households and the extent to which intra-household mechanisms operate to minimize the loss. These methods will need to be adapted to the nature of the disease (eg chronic versus acute) and its prevalence (common or rare). Research is also required on the best means for valuing time loss.

More studies have looked at private expenditure on treatment than at time losses, but there is still inadequate exploration of the methods appropriate for enquiring about private expenditure where this is done in isolation rather than as part of a household income and expenditure survey.

11.2 The application of cost-effectiveness analysis to disease control programmes

The top priority in research on the application of cost-effectiveness analysis to disease control programmes is simply to do more studies. Individual studies are rarely self-sufficient in the sense that policy conclusions can be drawn entirely on the results of that study alone. Comparisons usually have to be made with other studies from the same country or other countries in order to illuminate certain policy issues. Yet as shown by the study reported here, even for as prominent a disease as malaria, there are very few studies either of its overall cost-effectiveness or of the cost-effectiveness of particular malaria control strategies. The implications of the research results reported here are that different malaria control strategies can have very different cost and effectiveness implications. Thus national and international decision makers have much to gain from a larger stock of cost-effectiveness studies.

One important way of doing more cost-effectiveness studies is to ensure that a cost analysis is attached to any research on the effectiveness of alternative malaria control strategies. Similarly, project or programme evaluations should always have a cost component.

An important element of further application of cost-effectiveness analysis to disease control programmes should be to include consideration of the reasons for variations in the costs and effectiveness of control strategies between different geographical areas and control programmes. Little exploration of this topic was possible in this study because of the scarcity of other studies which report similar cost-effectiveness ratios. However, as the number of studies grows, more extensive discussions will be possible of the sources of cost and effectiveness variations.

11.3 Malaria control in Nepal

The research on the cost-effectiveness of malaria control in Nepal reported here leads to three main areas for research which would permit the conclusions of the study to be strengthened and increase knowledge of how the malaria control programme might be made more efficient.

The first area is to expand the research on the effectiveness of alternative vector control methods, particularly spraying of residual insecticides and environmental management. The questions to be answered are what effect does spraying have on malaria transmission in particular locations; are there ways of economizing on the spray coverage required, for instance by selective coverage or focal spraying; what forms of environmental management are cost-effective; in what parts of Nepal are they applicable and is there a mix of vector control strategies that would be more cost-effective than one strategy applied in isolation.

It is particularly important that environmental management be fully evaluated. Cost information should be collected as part of this evaluation, distinguishing costs borne by the NMEO and by communities. In addition, since the costs of this control approach will be compared with approaches that involve continuing expenditure alone (eg spraying), information should be collected on the length of life and maintenance requirements of environmental management measures such as dams.

The second area is to improve understanding of what determines the use of services by a person who develops a fever. What influences their choice of public or private services, and their use of active or passive methods of case detection? Greater understanding in this area would, for example, enable a better assessment of the scope for exploiting use of private sources of treatment for malaria, and of the scope for dropping one or more of the existing case detection methods and expanding others.

The third area is to investigate the effectiveness of alternative organizational patterns of case detection and treatment, particularly the advantages of a single purpose as opposed to a multi-purpose worker. Conclusions on the relative cost-effectiveness of the ICHSDP and NMEO are at present difficult to make because it is unclear what proportion of total cases each approach detects, and whether the likely lower level of detection and slower detection in integrated districts matters in terms of its effect on the level of malaria transmission.

ALMROTH S, GREINER T AND LATHAM M (1979)
Economic importance of breast-feeding. Food and nutrition 5(2), 4-10.

APPLIED COMMUNICATION TECHNOLOGY (1985)
Cost-effectiveness of the mass media and health practices projects. Unpublished.

BARLOW R (1976)
Application of a health planning model in Morocco. International Journal of Health Services 6, 103-21.

BARLOW R (1968)
The economic effects of malaria eradication. Bureau of Public Health Economics, University of Michigan, Ann Arbor.

BARLOW R (1967)
The effects of malaria eradication. American Economic Review May, 130-148.

BARLOW R AND GROBAR L M (1985)
Cost and benefits of controlling parasitic diseases. PHN Technical Note 85-17, Population, Health and Nutrition Department, The World Bank, Washington DC.

BARNETT A AND CREESE A (1980)
The economics of pharmaceutical policy in Ghana. International Journal of Health Services 10, 479-99.

BARNUM H (1987)
Evaluating healthy days of life gained from health projects. Social Science and Medicine 24(10), 833-841.

BARNUM HN (1986)
Cost savings from alternative treatment for tuberculosis. PHN Technical Note 86-11, Population, Health and Nutrition Department, World Bank, Washington DC.

BARNUM HN (1980)
Cost-effectiveness of programmes to combat communicable childhood disease in Kenya. Report AID/SOD/PDC-C-0201 Part 2, USAID, Washington DC.

BARNUM H (1978)
An economic analysis of a malaria control programme in the Outer Islands of Indonesia. Unpublished.

BARNUM H, BARLOW R, FAJARDO L AND PRADILLA A (1980)
A resource allocation model for child survival. Oelgeschlager, Gunn and Hain, Cambridge, Mass.

BARNUM HN, TARANTOLA D AND SETIADY IF (1980)
Cost effectiveness of an immunization programme in Indonesia. Bulletin of the World Health Organization 58(13), 499-503.

BARNUM HN AND TAUKEY D (1979)
Economic analysis of integrated rural health/family planning service project in Nepal. Report AID/SOD//PDC-C-0201, USAID, Washington DC.

BEKELE A (1980)
Schistosomiasis. Unpublished manuscript.

BERMAN PA (1982)
Selective primary health care: is efficient sufficient? Social Science and Medicine 16, 1054-59.

BERWICK DM, CRETIN AND SANDKEELER E (1981)
Cholesterol, children and heart disease: an analysis of alternatives. Pediatrics 68(5), 721-730.

BHOMBORE SR, BROOKE WORTH C AND NANJUNDIAH KS (1952)
A survey of the economic status of villagers in a malarial irrigated tract in Mysore State, India. Indian Journal of Malariology 6, 355-65.

BIRDSALL N (1987)
Willingness to pay for health and water in rural Mali: do WTP questions work? Technical Note Series no.87-2, The World Bank, Washington DC.

BOYLE MH, TORRANCE GW, SINCLAIR JC AND HORWOOD SP (1983)
Economic evaluation of neonatal intensive care of very low birth-weight infants. New England Journal of Medicine 308, 1330-7.

BRUCE-CHWATT LJ (1987)
Malaria and its control: present situation and future prospects. Annual Review of Public Health 8, 75-110.

BRUCE-CHWATT LJ AND ARCHIBALD HM (1959)
Malaria control project in Western Sokoto, Northern Nigeria. A report on four years results. Proceedings of the 6th International Congress of Tropical Medicine and Malaria 7, 347-61.

BUSH JW, CHEN MM, AND PATRICK DL (1973)
Health status index in cost-effectiveness analysis: analysis of PKU programme. In Berg RL (ed) Health status indexes: proceedings of a conference. Hospital Research and Educational Trust, Chicago.

BUXTON MJ, ACHESON R, CAINE N, GIBSON S AND O'BRIEN B (1985)
Study of the costs and benefits of the heart transplant programmes at Harefield and Papworth Hospitals. Her Majesty's Stationary Office, London.

CAMPBELL JG, SHRESTHA R AND STONE L (1979)
The use and misuse of social science research methods in Nepal. Centre for Nepalese and Asian Studies, Tribhuvan University, Kathmandu.

CARRIN G (1984)
Economic evaluation of health care in developing countries. Croom Helm, London.

CENTRAL BUREAU OF STATISTICS (1977)
The analysis of the population statistics of Nepal. HMG National Planning Commission Secretariat, Kathmandu.

CHAKRABARTI AK AND SINGH NN (1957)
Probable causes of disappearence of A minimus from the Terai area of the Nainital district of Uttar Pradesh. Bull. Nat. Soc. Ind. Mal. Mosq. Dis. 5(2), 82-85.

CHAPALAIN MT (1978)
Perinatality: French cost-benefit studies and decisions on handicap and prevention. In Major mental handicap: Methods and costs of prevention. Ciba Foundation Symposium no.59 (New Series), Elsevier, London.

CHARNY MC, LEWIS PA, FARROW SC (1989)
Choosing who shall not be treated in the NHS. Social Science and Medicine 28(12), 1331-1338.

CHRISTOPHERS SR (1911)
Malaria in the Punjab. Scientific memoirs by officers of the medical and sanitary departments of the Government of India. New Series no.46.

COCHRANE SH AND ZACHARIAH KC (1983)
Infant and child mortality as a determinant of fertility. Staff working paper no. 556, The World Bank, Washington DC.

COHN EJ (1973)
Assessing the costs and benefits of anti-malaria programmes: The Indian experience. American Journal of Public Health 63, 1086-96.

COHN EJ (1972)
Assessment of malaria eradication costs and benefits. American Journal of Tropical Medicine and Hygiene 21, 663-67.

CONLY GN (1975)
The impact of malaria on economic development: a case-study. Pan American Health Organization Scientific Publication no.297, Washington DC.

COONEY JC AND BROOKS RH (1986)
Economic considerations of the Tennessee Valley Authority's environmental management measures for vector control. Paper presented to the 6th meeting of the Panel of Experts on Environmental Management for Vector Control, Geneva 8-12 Sept, 1986.

CREESE AL (1984)
Cost-effectiveness of alternative strategies for poliomyelitis immunization in Brazil. Review of Infectious Diseases 6 (Supp.2) 405-407.

CREESE AL AND DOMINGUEZ-UGA MA (1987)
Cost effectiveness of immunization programmes in Columbia. Pan American Health Organization Bulletin 21(4), 377-392.

CREESE AL, SRIYABBAYA N, CASABAL G AND WISESO G (1982)
Cost-effectiveness appraisal of immunization programmes. Bulletin of the World Health Organization 60(4), 621-32.

CRETIN S (1977)
Cost/benefit analysis of treatment and prevention of myocardial infarction. Health Services Research 12, 174-189.

CULYER AJ AND MAYNARD AK (1981)
Cost-effectiveness of duodenal ulcer treatment. Social Science and Medicine 15C, 3-11.

CUMPER GC (1979)
Review of the adequacy of resources available for the anti-malaria project and of the economic value of the project. In Report of an independent assessment team on malaria and vector control programme - Thailand. Unpublished.

DEBORD DV, CARLSON GA AND AXTELL RC (1975)
Demand for and cost of coastal salt marsh mosquito abatement. North Carolina Agricultural Experiment Station Technical Bulletin no. 232.

DICHTER CR AND WEINSTEIN MC (1984)
Cost-effectiveness of lowering the aflatoxin tolerance level. Food and chemical toxicology 22(6), 439-445.

DRAPER CC AND WEBBER RH (1987)
Malaria control project Nepal: assessment of the value of insecticide spraying and a review of alternative strategies. Report on a visit Feb-March 1987. Unpublished. London School of Hygiene and Tropical Medicine.

DRUMMOND MF (1987)
Resource allocation decisions in health care: a role for quality of life assessments. Journal of Chronic Diseases 40(6), 605-616.

DRUMMOND MF (1985)
Survey of cost-effectiveness and cost-benefit analysis in industrialized countries. World Health Statistics Quarterly 38(4), 383-401.

DRUMMOND MF (1981)
Welfare economics and cost-benefit analysis in health care. Scottish Journal of Political Economy 28(2), 125-145.

DRUMMOND MF AND HUTTON J (1986)
Economic appraisal of health technology in the United Kingdom
Centre for Health Economics Discussion Paper 11, University of York, York.

DRUMMOND MF AND MILLS A (1987)
Survey of cost-effectiveness and cost-benefit analyses of key primary health care projects in Commonwealth countries. Commonwealth Secretariat, London.

DRUMMOND MF AND STODDART GL (1985)
Principles of economic evaluation of health programmes. World Health Statistics Quarterly 38(4), 355-367.

DRUMMOND MF, STODDART GL AND TORRANCE GW (1987)
Methods for the economic evaluation of health care programmes. Oxford Medical Publications, Oxford.

EDDY DM (1980)
Screening for cancer: theory, analysis and design. Englewood Cliffs, Prentice Hall.

ETTLING MB, THIMASARN K, KRACHAIKLIN S AND BUALOMBAI P (1989)
Evaluation of malaria clinics in Maesot, Thailand: use of serology to assess coverage. Transactions of the Royal Society of Tropical Medicine and Hygiene 85, 325-331.

EVANS TG AND MURRAY CJL (1987)
A critical re-examination of the economics of blindness prevention under the Onchocerciasis Control Programme. Social Science and Medicine 25(3), 241-249.

FARUQUEE R AND JOHNSON E (1982)
Health, nutrition and family planning in India. A survey of experiments and special projects. Staff Working Paper no. 507, World Bank, Washington DC.

FELDSTEIN MS, PIOT MA AND SUNDARESAN TK (1973)
Resource allocation model for public health planning: a case study of Tuberculosis control (Korea). Bulletin of the World Health Organization. 48 (supplement).

FIDLER PE (1977)
A comparison of treatment patterns and costs for a fluoride and non-fluoride community. Community Health 9, 103-113.

FONTAINE RE (1978)
House spraying with residual insecticides with special reference to malaria control. WHO /VBC/78.704. World Health Organization, Geneva.

FOWLER JG (1982)
Letter to the editor: Benefit cost analysis in the nutrition area: a project in the Philippines. Social Science and Medicine 16, 73-74.

GANDAHUSADA S, FLEMING GA, SUKAMTO, DAMAR T, SUWARTO, SUSTRIAYU N, BANG YH, ARWATI S AND ARIF H (1984)
Malaria control with residual fenitrothion in Central Java, Indonesia: an operational-scale trial using both full and selective coverage treatments. Bulletin of the World Health Organization 62(5), 783-794.

GHANA HEALTH ASSESSMENT PROJECT TEAM (1981)
A quantitative method of assessing the health impact of different diseases in less developed countries. International Journal of Epidemiology 10(1), 73-80.

GRAHAM JD AND VAUPEL JW (1981)
Value of a life: what difference does it make? Risk Analysis 1(1), 89-95.

GRIFFITH ME (1961)
Financial implications of surveillance in India and other countries. Bull. Nat. Soc. Ind. Mal. Mosq. Dis. 9(5-6), 385-411.

GROSSE RN (1980)
Inter-relation between health and population: observations derived from field experiences. Social Science and Medicine 14C(2), 99-120.

GROSSE RN (1967)
Preface, in TA Goldman (ed) Cost-Effectiveness Analysis: New Approaches in Decision Making. Washington Operations Research Council, New York.

GUYER B AND CANDY D (1979)
Injectable antimalaria therapy in tropical Africa. Iatrogenic disease and wasted medical resources. Transactions of the Royal Society of Tropical Medicine and Hygiene 73, 230-2.

HAGARD S, CARTER F AND MILNE RG (1976)
Screening for spina bifida cystica: a cost-benefit analysis. British Journal of Preventive and Social Medicine 303, 40-53.

HEDMAN P, BROHULT J, FORSLUND J, SIRLEAF V AND BENGTSSON E (1979)
A pocket of controlled malaria in a holoendemic region of West Africa. Annals of Tropical Medicine and Parasitology 73, 317-25.

HELLER PS (1975)
Issues in the costing of public sector outputs: the public medical services of Malaysia. World Bank Staff Working Paper no. 207, Washington DC.

HELLIWELL BE AND DRUMMOND MF (1987)
The costs and benefits of preventing influenza in Ontario's elderly. QSEP Report, Faculty of Social Sciences, McMaster University, Hamilton, Ontario.

HMG/AID/WHO (1975)
Report on the evaluation of integrated basic health services in Nepal. Kathmandu.

HMG/WHO/USAID/ODA/JICA (1988)
Report of an in-depth review of malaria control activities in Nepal. Kathmandu.

HMG/WHO/USAID/ODA (1986)
Report of an analysis of NMEO's activities for 1984 and 1985. Kathmandu.

HMG/WHO/USAID/ODA (1984)
Report on analysis of NMEO's activities in 1983. Kathmandu.

HORTON S AND CLAQUIN P (1983)
Cost-effectiveness and user characteristics of clinic based services for the treatment of diarrhoea: a case study in Bangladesh. Social Science and Medicine 17(11), 721-9.

IRVIN G (1978)
Modern cost-benefit methods. An introduction to financial, economic and social appraisal of development projects. Macmillan, London.

JEFFREY G (1984)
The role of chemotherapy in malaria control through primary health care: constraints and future prospects. Bulletin of the World Health Organization 62(Supp), 349-53.

JOBIN WR (1979)
Cost of snail control. American Journal of Tropical Medicine and Hygiene 28(1), 142-54.

JORDAN P (1977)
Schistosomiasis - research to control. American Journal of Tropical Medicine and Hygiene 26, 877-886.

KAEWSONTHI S AND HARDING AG (1984)
Cost and performance of malaria surveillance in Thailand. Social Science and Medicine 19(10), 1081-97.

KHAN MJ (1966)
Estimate of economic loss due to malaria in West Pakistan. Pakistan Journal of Health 16, 187-93.

KIELMANN AA AND ASSOCIATES (1983)
Child and maternal health services in rural India. The Narangwal experiment. Vol 1. Integrated nutrition and health care. Johns Hopkins University Press, Baltimore.

KLARMAN JE (1982)
The road to cost-effectiveness analysis. Millbank Memorial Fund Quarterly Health and Society 60(4), 585-603.

KNUDSEN OK (1981)
Economics of supplemental feeding of malnourished children: leakages, costs, benefits. Staff Working Paper no. 451, World Bank, Washington DC.

KORTE R, SCHMIDT-EHRY, KIELMANN AA AND BRINKMANN UK (1986)
Cost and effectiveness of difference approaches to schistosomiasis control in Africa. Tropical Medicine and Parasitology 37, 149-152.

KRIEDEL T (1980)
Cost-benefit analysis of epilepsy clinics. Social Science and Medicine 14C, 35-39.

KUHNER A (1971)
The impact of public health programmes on economic development. Report of a study of malaria in Thailand. International Journal of Health Services 1(3), 285-92.

LAVE L AND SESKIN E (1978)
Air pollution and human health. Resources for the Future, Washington.

LERMAN SJ, SHEPARD DS AND CASH RA (1985)
Treatment of diarrhoea in Indonesian children: what it costs and who pays for it. The Lancet Sept.21, 651-54.

LICHTENBERG ER AND GETZ W (1985)
Economics of rice-field mosquito control in California. BioScience. 35(5), 292-297

LIVADAS GA AND ATHANASSATOS D (1963)
The economic benefits of malaria eradication in Greece. Rivista di Malariologia 42, 177-187.

LOGAN AG, MILNE BJ, ACHBER C, CAMPBELL WP AND HAYNES RB (1981)
Cost-effectiveness of a worksite hypertension treatment programme. Hypertension 3(2), 211-218.

LOOMES G AND MCKENZIE L (1989)
The use of QALY's in health care decision making. Social Science and Medicine 28(4), 299-308.

LUDBROOK A (1981)
A cost-effectiveness analysis of the treatment of chronic renal failure. Applied Economics 13, 337-50.

LUDBROOK A AND MOONEY GH (1984)
Economic appraisal in the NHS. Northern Health Economics, Aberdeen.

MANGEN SP, PAYKEL ES, GRIFFITH JH, BURCHELL A AND MANCINI P (1983)
Cost-effectiveness of community psychiatric nurse or out-patient psychiatrist care of neurotic patients. Psychological Medicine 13, 407-16.

MASON J AND HOBBS J (1977)
Malaria field studies in a high-incidence coastal area of El Salvador, C.A. Bulletin of the Pan American Health Organization 11(1), 17-30.

MCNEIL BJ, DUDLEY RA, HOOP B, METZ C, THOMPSON N AND ADELSTEIN SJ (1981)
A cost-effectiveness analysis of screening for Hepatitis B surface antigen in India. Medical Decision Making 1(4), 345-359.

MILLER MJ (1958)
Observations on the natural history of malaria in the semi-resistant West Africa. Transactions of the Royal Society of Tropical Medicine and Hygiene 52(2), 152-68.

MILLS A (1988)
The impact of malaria control on the economic development of Nepal. London School of Hygiene and Tropical Medicine and London School of Economics and Political Science, Unpublished.

MILLS A (1987)
Economic study of Malaria in Nepal. The cost-effectiveness of malaria control strategies. Evaluation and Planning Centre, London School of Hygiene and Tropical Medicine, Unpublished.

MILLS A (1985)
Economic evaluation of health programmes: application of the principles in developing countries. World Health Statistics Quarterly 38(4), 368-382.

MILLS AJ AND COLBOURNE MJ (1985)
Economic study of malaria in Nepal: analysis of data collected by the NMEO and ICHSDP. Evaluation and Planning Centre, London School of Hygiene and Tropical Medicine, Unpublished.

MILLS A AND DRUMMOND M (1987)
Value for money in the health sector: the contribution of primary health care. Health Policy and Planning 2(2), 107-128.

MISHAN EJ (1982)
Cost-benefit analysis. Third edition, George Allen and Unwin, London.

MISHAN EJ (1971)
Evaluation of life and limb: a theoretical approach. Journal of Political Economy 79(4), 687-705.

MITCHELL A, DRUMMOND MF, HAYNES RB, JOHNSTON ME, AND GIBSON E (1983)
Cost-effectiveness of a strategy to increase patient compliance with anti-hypertensive therapy. Medical Decision Making 3, 355 (abstract).

MOLINEAUX L AND GRAMICCIA G (1980)
The Garki project: research on the epidemiology and control of malaria in the Sudan Savanna of West Africa. World Health Organisation, Geneva.

MOONEY GH (1982)
Breast cancer screening: a study in cost-effectiveness analysis. Social Science and Medicine 16, 1277-1283.

MOONEY GH (1977)
The valuation of human life. Macmillan, London.

MULLER A (1980)
Evaluation of the costs and benefits of motorcycle helmet law. American Journal of Public Health 70, 3586-592.

MULLEY AG, SILVERSTEEN MD AND DIENSTAG JL (1982)
Indications for use of Hepatitis B vaccine based on cost-effectiveness analysis. New England Journal of Medicine 307, 644-652.

MUSHKIN SJ (1962)
Health as an investment. Journal of Political Economy LXX 5(2), 129-57.

NEUHAUSER D AND LEWICKI AM (1975)
What do we gain from the sixth stool guaiac. New England Journal of Medicine 293(5), 226-8.

NEWMAN P (1965)
Malaria eradication and population growth with special reference to Ceylon and British Guiana. Bureau of Public Health Economics Research Series No 10, School of Public Health, University of Michigan.

NIAZI AD (1969)
Approximate estimates of the economic loss caused by malaria with some estimates of the benefits of MEP in Iraq. Bulletin of Endemic Diseases Vol II, 28-39.

NMEO (NEPAL MALARIA ERADICATION ORGANIZATION) (1987)
Annual Report of the Internal Assessment. HMG Ministry of Health Kathmandu.

NMEO (NEPAL MALARIA ERADICATION ORGANIZATION) (1984/5)
Plan of Action. HMG Ministry of Health, NMEO, Kathmandu.

NMEO (NEPAL MALARIA ERADICATION ORGANIZATION) (1970)
Global Strategy Review. NMEO, Kathmandu.

NMEO (NEPAL MALARIA ERADICATION ORGANIZATION) (1966)
Revised plan of operations for malaria eradication, Nepal. NMEO, Kathmandu.

OJO O (UNDATED)
A critical review of evidence of the effectiveness of malaria control strategies: Chemoprophylaxis, treatment and vector control. Unpublished paper, Department of Medicine and Clinical Epidemiology and Biostatistics, McMaster University, Hamilton, Ontario.

ORTIZ JR (1968)
Estimate of the cost of a malaria eradication programme. Bulletin of the Pan American Health Organization. 14-17.

OVERSEAS DEVELOPMENT ADMINISTRATION (1972)
A guide to project appraisal in developing countries. Her Majesty's Stationery Office, London.

PARKER BR (1983)
A programme selection/resource allocation model for control of malaria and related parasitic diseases. Computers and Operations Research 10(4), 375-389.

PEEM (PANEL OF EXPERTS ON ENVIRONMENTAL MANAGEMENT FOR VECTOR CONTROL) (1986)
Report of the Sixth meeting. VBF/86.2, PEEM Secretariat, World Health Organization, Geneva.

PHILLIPS JAS (1925)
Final report on a malarial survey carried out in the Hetour Valley in Nepal. Unpublished manuscript, Malaria Institute of India.

PHILLIPS M (1985)
The cost of diarrhoeal disease control in Nepal. London School of Hygiene and Tropical Medicine, Unpublished.

PHILLIPS MA, FEACHEM RG AND MILLS AJ (1987)
Options for diarrhoeal diseases control. The cost and cost-effectiveness of interventions for the prevention of diarrhoeal diseases. EPC Publication no.13, London School of Hygiene and Tropical Medicine.

PHILLIPS M AND MILLS A (1987)
The operational cost of insecticide spraying for malaria control. A case-study of Nepal. Evaluation and Planning Centre, London School of Hygiene and Tropical Medicine, Unpublished.

PONNIGHAUS JM (1980)
The cost/benefit of measles immunization: a study from southern Zambia. Journal of Tropical Medicine and Hygiene 83, 141-49.

POPKIN BM, SOLON FS, FERNANDEZ T AND LATHAM MC (1980)
Benefit-cost analysis in the nutrition area: a project in the Philippines. Social Science and Medicine 14, 207-16.

PORTER RS AND WALSH MR (1978)
Cost-effectiveness analysis in practice: a case-study of domestic water supplies in an African country. World Development 6(2), 195-208.

PRESCOTT N (FORTHCOMING)
The cost-effectiveness of chemotherapy alternatives in schistosomiasis control. In Lee K, Mills A (eds) Health Economics Research in Developing Countries. Oxford University Press, Oxford.

PRESCOTT NM (1980)
Economic appraisal of ADB assistance to the malaria control programme in Bangladesh. Bangladesh Public Health Programme.

PRESCOTT MN (1979)
The economics of malaria, filariasis and human trypanosomiasis. Paper prepared for the WHO/UNDP/World Bank Special Programme for Research and Training in Tropical Diseases. World Health Organization, Geneva.

PROST A AND PRESCOTT N (1984)
Cost-effectiveness of blindness prevention by the Onchocerciasis Control Programme in Upper Volta. Bulletin of the World Health Organization 62(5), 795-802.

PUBLIC HEALTH STUDY TEAM (1976)
Pest control: an assessment of present and alternative technologies. Vol.5. Pest control and public health. National Academy of Sciences, Washington DC.

QUO WK (1959)
In World Health Organization, Malaria information. Unpublished working document. World Health Organization: Mal/Inform/46.

RAMAIAH TJ (1980)
Cost benefit analysis of malaria control and eradication programmes in India. Public Systems Group, Indian Institute of Management, Ahmedabad.

RAO CSN AND BHOMBORE SR (1956)
A survey of the economic status of villages in a malarious tract in Mysore State (India) after residual insecticidal spraying. Bull.Nat.Soc.Ind.Mal.Mosq.Dis. 4(3), 71-77.

RAO CK, CHANDRASEKHARAN A, KAUL SM, NARASIMHAM MVVL AND SHARMA SP (1980)
Relative effectiveness of different methods of control of B Filariasis in India. Indian Journal of Medical Research 72, 194-202.

RAY A (1984)
Cost-benefit analysis. Issues and Methodologies. Published for the World Bank, Johns Hopkins University Press, Baltimore and London.

RICH G, GLASS NJ AND SELKON JB (1976)
Cost-effectiveness of two methods of screening for asymptomatic bacteriuria. British Journal of Preventive and Social Medicine 30, 54-9.

ROBERTSON RL, DAVIS JH AND JOBE K (1984)
Service volume and other factors affecting the costs of immunizations in The Gambia. Bulletin of the World Health Organization 62(5), 729-736.

ROBERTSON RL, FOSTER SO, HULL HF AND WILLIAM PJ (1985)
Cost-effectiveness of immunization in The Gambia. Journal of Tropical Medicine and Hygiene 88, 343-51.

ROMEDER JM AND MCWHINNIE JR (1977)
Potential years of life lost between ages 1 and 70: an indicaor of premature mortality for health planning. International Journal of Epidemiology 6(2), 143-151.

ROSENFIELD PL, GOLLADAY F AND DAVIDSON RK (1984)
The economics of parasitic diseases: research priorities. Social Science and Medicine 19(10), 1117-1126.

ROSENFIELD PL, SMITH RA AND WOLMAN MG (1977)
Development and verification of a Schistosomiasis transmission model. American Journal of Tropical Medicine and Hygiene 26(3), 505-516.

RUBERU PS (1977)
Economic justification of intensive malaria control programme in Sri Lanka 1977/81. Unpublished.

RUSSELL LB (1986)
Is prevention better than cure? Brookings Institute, Washington DC.

RUSSELL PF (1952)
Malaria: basic principles briefly stated. Blackwell Scientific Publications, Oxford.

RUSSELL PF AND MENON MK (1942)
A malario-economic survey in rural South India. Indian Medical Gazette 77, 167-80.

SALADIN B, SALADIN K, HOLZER B, DENNIS E, HANSON A, AND DEGREMONT A (1983)
A pilot control trial of schistosomiasis in Central Liberia by mass chemotherapy of target populations,combined with focal applications of molluscicide. Acta Tropica 40, 271-95.

SAN PEDRO C (1967-68)
Economic costs and benefits of malaria eradication. Philippines Journal of Public Health (12), 5-24.

SARHAN ME, HOWITT RE, MOORE CV AND MITCHELL CJ (1981)
Economic evaluation of mosquito control and narrow spectrum mosquitocide development in California. Giannini Foundation Research Report no. 330, Division of Agricultural Sciences, University of California.

SCHRECK CE AND SELF LS (1985)
Bed nets that kill mosquitos. World Health Forum 63, 342-44.

SHARMA VP (1986)
Cost-effectiveness of environmental management for malaria control in India. Working paper prepared for 6th meeting of the Panel of Experts on Environmental Management for Vector Control, Geneva 8-12 September.

SHEPARD D (1982)
Cost-effectiveness of the expanded programme on immunization in the Ivory Coast: a preliminary assessment. Centre for the Analysis of Health Practices, Harvard School of Public Health, Boston, Mass.

SHEPARD DS, BRENZEL LE AND NEMETH KT (1986)
Cost-effectiveness of oral rehydration therapy for diarrhoeal diseases. PHN Technical Note 86-26, Population, Health and Nutrition Dept, The World Bank, Washington DC.

SHEPARD DS, SANOH L AND COFFI E (1986)
Cost-effectiveness of the Expanded Programme on Immunization in the Ivory Coast: a preliminary assessment. Social Science and Medicine 22(3), 369-377.

SHEPARD RJ (1985)
The value of physical fitness in preventive medicine. In The Value of Preventive Medicine. Ciba Foundation Symposium 110, Ciba Foundation, London.

SHRESTHA BP (1974)
An introduction to the Nepalese economy. Ratna Pustak Bhandar, Kathmandu.

SHRESTHA SL (UNDATED)
Dynamics of malaria transmission in reference to development projects. NMEO, Kathmandu.

SIMPSON PR, CHAMBERLAIN J AND GRAVELLE HSE (1978)
Choice of screening tests. Journal of Epidemiology and Community Health 32, 166-170.

SINNIAH B AND SINNIAH D (1981)
The anthelmintic effects of Pyrantel Pamoate, Oxantel Pyrantel Pamoate, Levamisole and Mebendazole in the treatment of intestincal nemotodes. Annals of Tropical Medicine and Parasitology 75, 315-21.

SINTON JA (1935-6)
What malaria costs India nationally, socially and economically. Records of the Malaria Survey of India 5, 223-64 and 413-89, and 6, 96-169.

SQUIRE L AND VAN DER TAK HG (1975)
Economic analysis of projects. Johns Hopkins University Press, Baltimore and London.

STANGE PV AND SUMNER AT (1978)
Predicting treatment costs and life expectancy for end-stage renal disease. New England Journal of Medicine 298(7), 372-378.

STASON WB AND WEINSTEIN MC (1977)
Allocation of resources to manage hypertension. New England Journal of Medicine 256(13), 732-9.

STEPHEN KW AND CAMPBELL D (1978)
Caries reduction and cost benefit after 3 years of sucking fluoride tablets daily at school: a double-blind trial. British Dental Journal 144, 202-6.

STILLWELL JA (1976)
Benefits and costs of the schools' BCG vaccination programme. British Medical Journal 1, 1002-4.

STURCHLER D, STAHEL E, SALADIN K AND SALADIN B (1980)
Intestinal parasitoses in eight Liberian settlements: prevalences and community anthelminthic chemotherapy. Tropenmedizin und Parasitologie 31, 87-93.

THOMPSON MS, MCNEIL BJ, GANATRA DR, LARSON PR AND ADELSTEIN SJ (1981)
Cost-effectiveness of screening for hypo and hyperthroidism in India. Medical Decision Making 1(1), 44-58.

TORRANCE G (1985)
Measurement of health state utilities for economic appraisal - a review. Journal of Health Economics 5, 2-30.

TORRANCE GW (1976)
Health status index models: a unified mathematical review. Management Science 22, 990-1001.

TORRANCE GW AND ZIPURSKY A (1984)
Cost effectiveness of ante-partum prevention of Rh immunization. Clinics in Perinatology 11(2), 267-281.

TUGWELL P, BENNETT KJ, SACKETT DL AND HAYNES RB (1985)
The measurement iterative loop: a framework for the critical appraisal of need, benefits and costs of health interventions. Journal of Chronic Diseases 38(4), 339-351.

VAN DINE DL (1916)
The relation of malaria to crop production. Scientific Monthly November, 431-9.

WALSH JA AND WARREN KS (1979)
Selective primary health care: an interim strategy for disease control in developing countries. New England Journal Medicine 301(18), 967-974.

WARNER K (1979)
The economic implications of preventive health care. Social Science and Medicine 13C, 227-237.

WARNER KE AND HUTTON RC (1980)
Cost-benefit and cost-effectiveness analysis in health care: growth and composition of the literature. Medical Care 18(11), 1069-1084.

WEBBER RH (1987)
Malaria control project Nepal: visit by Dr RH Webber. Unpublished report.

WEINSTEIN MC (1983)
Cost-effective priorities for cancer prevention. Science 221, 17-23.

WEINSTEIN MC, PLISKIN JS AND STASON WB (1977)
Coronary artery bypass surgery: decision and policy analysis. In JP Bunker et al (eds) Costs, risks and benefits of surgery. Oxford University Press, New York.

WEISBROD BA (1977)
Collective action and the distribution of income. In Haveman RH and Margolis J (eds) Public expenditure and policy analysis. 2nd edition, Rand McNally, Chicago.

WEISBROD BA, ANDREANO RL, BALDWIN RE, EPSTEIN EH AND KELLEY AC (1973)
Disease and economic development. The impact of parasitic diseases in St. Lucia. University of Wisconsin Press, Madison.

WEISBROD BA, TEST MA AND STEIN LI (1980)
Alternative to mental hospital treatment. II Economic benefit-cost analysis. Arch. General Psychiatry 37, 400-5.

WEISS J (1978)
Problems in the use of world prices in social cost-benefit analysis: some experiences from a study in Pakistan. IDS Bulletin 10(1), 15-18.

WHITE GB (1982)
Malaria receptivity stratification and projections for malaria vector control in Nepal. Assignment Report, 1 Sept - 29 Oct 1980 and 24 August - 21 October 1981, SEA/MAL/144.

WHO (1984)
Malaria control as part of primary health care. Technical Report Series no 712, Geneva.

WHO (1982)
Country Resource Utilization Review. Health Resources Group for Primary Health Care, JRG/CRU.6/82, Geneva.

WILLEMS J, SANDERS CR, RIDDIOUGH MA AND BELL JC (1980)
Cost-effectiveness of vaccination against pneumococcal pneumonia. New England Journal of Medicine 303(10), 553-559.

WILLIAMS AH (1974)
The cost-benefit approach. British Medical Bulletin 30, 252-56.

WORLD BANK (1983)
Some current methodological issues in health sector and project analysis. PHN Technical Notes Gen 24. Population, Health and Nutrition Dept, The World Bank, Washington DC.

WRIGHT J (1977)
An economic analysis of malaria control in Java-Bali-Madura and Outer Islands. Unpublished.

THE RELATIONSHIP BETWEEN MALARIA, MALARIA CONTROL AND ECONOMIC DEVELOPMENT

Malaria control affects per capita income through influencing population size and the supply of land, labour and capital. The mechanisms through which these effects occur and the empirical evidence are reviewed below.

1. Population growth

> "Any economic study of the effects of a public health intervention is totally dependent on demographic projections, since economic growth must be understood in relation to population size." (Brown 1986).

Unfortunately, disentangling the effects of malaria control on population size and separating it from other influences on population growth is extremely difficult.

The most straightforward effect of malaria control on population size is the reduction of mortality directly due to malaria. However the magnitude of this effect and the age at which death is prevented depends crucially on the degree of endemicity of malaria. This is classified by WHO as:

Hypoendemic: spleen rate in children (2-9 years) not exceeding 10%;

Mesoendemic: spleen rate in children (2-9 years) between 11% and 50%;

Hyperendemic: spleen rate in children (2-9 years) constantly over 50%; spleen rates in adults also high (over 25%);

Holoendemic: spleen rates in children (2-9 years) constantly over 75%, but spleen rates in adults low (Bruce-Chwatt 1980).

In hypoendemic and mesoendemic malaria, only a small proportion of the population are infected and thus deaths are likely to be correspondingly low, except that occasional epidemics may cause substantial deaths at all age groups. After epidemics, population birth and death rates are said to return quickly to normal (Sinton 1935). In hyperendemic malaria, mortality is most likely to occur in children up to the age of 5 years (Bruce-Chwatt 1980). However, since transmission is intense but seasonal, acquired immunity is insufficient to prevent the effects of malaria on all age groups, and there is some mortality in adults. In holoendemic malaria, there is perennial intense transmission resulting in a considerable degree of immunity in all age-groups, but particularly in adults. Children are initially protected by passive immunity transmitted via the placenta, and then gradually develop acquired immunity. There is some considerable mortality due to malaria in children, but on the whole the indigenous adult population is little affected, though immigrants are at high risk.

Malaria is believed to contribute substantially to deaths from other causes. For example Giglioli (1972) studied the pattern of mortality before and after the eradication of hyperendemic malaria in Guyana, over a 30 year period. The fall in mortality specifically related to malaria was considerably less than the decline in general mortality. From an examination of causes of death and possible other explanations for the decline in general mortality, he concluded that malaria eradication was the prime factor. An earlier study of the Guyana data, using statistical methods of analysis, concluded that the spraying campaign reduced the crude death rate by 3.7 per 1000 (Newman 1965).

Other studies have come to similar conclusions on the indirect contribution of malaria to mortality. Payne et al (1976) observed a reduction in general mortality from 23.9 to 13.5 deaths per 1000 population and in infant mortality from 157 to 93 per 1000 live births following malaria control in a study in Kenya. A contrasting opinion, however, comes from the Garki project in Northern Nigeria (Molineaux and Gramiccia 1980). In treated villages, the fall in infant mortality and child (1-4 years) mortality was proportionately much smaller than the corresponding fall in malaria risk. They suggest that malaria is a common precipitating cause of death and that control removes the cause, but that in a large proportion of cases, death is delayed very little, possibly because these children have a high risk of dying from other precipitating causes or an underlying cause. They speculate that if chronic malaria affects adversely the general underlying condition, death rates may decrease further in the later stages of control.

A recent survey of studies of holoendemic malaria in Africa has concluded that the evidence suggests that holoendemic malaria caused an infant mortality rate of around 100 per 1000, this being the order of magnitude of the fall in infant mortality following control efforts (Bradley 1987). This conclusion draws on evidence from early studies; more recent studies imply a much lower infant mortality rate due to malaria possibly, Bradley speculates, because of extensive chemotherapy even in the absence of organized control programmes.

Malaria affects not only mortality but also fertility, by causing miscarriages. Malaria control thus has a direct influence on birth rates and also an indirect effect through reducing mortality and thus increasing the population size and the number of potential mothers. For example, Bruce-Chwatt (1980) comments that epidemic malaria is an important cause of abortions, miscarriages and neonatal deaths; and that the effects of endemic malaria on the 'reproductive wastage' in indigenous populations in highly malarious regions vary inversely with the degree of tolerance of the disease possessed by the community. Newman (1965) estimated that the campaign against hyperendemic malaria in Guyana raised the crude birth rate by 3.1 per 1000.

Much of the controversy to do with the economic effects of malaria control has concentrated on its impact on population growth. Many analyses have been done with data from Sri Lanka (for example, Gray 1974, Newman 1965, Frederiksen 1960) and population growth has also been emphasized by economists as an effect of malaria control in Mauritius (Meade 1961) and India (Cohn 1973). Reviews of malaria control in Nepal have also commented on this effect.

In Sri Lanka, the general mortality rate declined from the 1920s, though neither gradually or continuously, and population increased. Changes in mortality can be viewed in two ways: as a continuous regression line with deviations for higher death rates in the late 1930s and early 1940s, or as two distinct lines separated by a rapid fall in the crude death rate from 20.2 to 14.6 per 1000 which occurred in the first year of the anti-malaria campaign (Brown 1986). Since district-level data is available, analyses have tried to explain the observed decline in mortality and increase in population by correlating changes in crude mortality rates by district with indicators of malaria prevalence. Newman's conclusion was that malaria control contributed to 48% of the post-war fall in mortality (Newman 1965); Gray that it contributed about 23% (Gray 1974). This amounts to a fall in the crude death rate due to malaria control of 1.9 to 4.2 per 1000. Newman also argued that malaria control resulted in a rise in the crude birth rate, concluding that malaria accounted for 60% of the population growth that had occurred since the War.

While the exact contribution of malaria control to population growth in Sri Lanka remains controversial, it is clear that malaria control was more important than other explanations investigated such as improved health services, better nutrition and general economic development. The method of analysis adopted owed much to the availability of reasonable crude birth and death rates by district. Assessments in other Asian countries have had to do without such data and in consequence their analyses have been less sophisticated and conclusions more tentative.

For example, Cohn (1973) reviewed the data for India. Crude death rates had fallen from around 27.4 per 1000 in the 1940s to around 16-18 per 1000 in the late 1960s. Contributing factors were likely to be the control of communicable diseases (smallpox, cholera, tuberculosis, malaria), improved water supply and environmental sanitation, increased availability of antibiotics, expanded health services, fewer famines because of grain imports and an improved distribution system, and a government more responsive to distress. On the basis of an estimate of malaria deaths pre-eradication, Cohn concluded that the anti-malaria campaign was the major factor in the acceleration of population growth after 1951.

2. Supply of land

It is frequently argued that malaria control can promote economic development by increasing the availability of natural resources such as land, thus enabling an expansion of output by providing a greater return to labour and capital than that obtainable elsewhere. Numerous examples are quoted in the malaria literature of countries where malaria control has permitted new land to be cultivated. For example in Indonesia, in one area in Java where rice cultivation had been abandoned apparently due to malaria, it is said that DDT spraying at a cost of $12,000 permitted rice to be grown of the value of $740,000 (Ketterer 1953).

However, there are a number of problems with the valuation of benefits stemming from the increased supply of land. Firstly, as Barlow (1967) and Cohn (1973) emphasize, few studies (witness the one quoted above) take account of the opportunity costs of land development. Malaria control is a necessary but not sufficient condition for land reclamation, since investment is required in land clearance, road construction, irrigation, farm equipment, housing etc. These resources could have been used elsewhere and thus the new land is obtained at the price of a reduction in output elsewhere. The resources must therefore be valued according to their most productive alternative use. Secondly, crop production requires corresponding inputs of labour, seeds etc and thus the gross value of the crop overstates the gain. For example, unless the labour used in crop production was previously unemployed, its cost needs to be allowed for in terms of output forgone elsewhere by its use in the new area. Finally, it is not inevitably true that the new land gained provides a greater return to labour and capital than that available elsewhere (ie is more fertile): this needs to be demonstrated.

One of the few more rigorous studies to take into account the effect of malaria control on the supply of land is that by Barlow (1967, 1968) in Sri Lanka. Pre malaria control, 62% of the population was concentrated in the small and essentially non-malarious Wet Zone and malaria control permitted the spatial re-allocation of population. Barlow argues that if, as seemed likely, the marginal product of land in the malarious districts before control was higher than the marginal product of land elsewhere, control contributed to the expansion of output by leading to the relocation of labour and capital in districts where the marginal product of land was relatively high.

Barlow's investigation of the value of malaria control is based on a simulation model of the economy incorporating a Cobb-Douglas production function relating output to the quantity and quality of labour and capital. Since land is not a specific argument in the production function, the increased supply of land is viewed as permitting an improvement in allocative efficiency and is included in the form of one of the indexes of the quality of the capital stock. However the value of the index was guessed at, since Barlow had information only on the shift of the labour force between non-malarious and malarious areas and not on their relative fertility.

3. Supply of labour

Changes in the supply of labour as a result of malaria control can take the form of:

- reduction in deaths producing an increase in time available for productive activities;
- reduction in disability (time off work) also increasing the time available for productive activities;
- reduction in debility increasing the productive capacity of workers.

These changes are relevant whether the work in question is inside or outside the home, and whether workers are wage-earners or work on their own account. They are also relevant to children in the form of benefits from increased attendance at school and improved school performance.

Problems in assessing these changes in the supply of labour relate both to measurement and valuation. Measurement involves assessing the mortality, morbidity and debility caused by malaria. Mortality was discussed above. Morbidity assessment shares many of the same problems: the duration and frequency of malaria morbidity in an individual will depend on malaria endemicity, vector and parasite species, and the sex and age of the individual. For example in hypoendemic and mesoendemic areas, the number of individuals falling ill will be relatively few. If the parasite species is <u>*P. falciparum*</u>

illness may be relatively severe; if P. vivax relatively mild but if untreated, relapses may cause debility.

In hyperendemic and holoendemic areas, the degree of immunity will determine the morbidity of the working population. The extent of morbidity in a highly endemic area was the subject of considerable controversy in the early 1950s. For example Wilson et al (1950) argued that:

> "In the tropical zone, where transmission is both more constant and more intense, malaria carries an even greater hazard to immigrant groups and individuals; but at the same time it may show such slight manifestations among the indigenous adults that at first glance malaria might appear to be absent".

This view, however, was disputed by Macdonald and Viswanathan (Macdonald 1951, Viswanathan 1951). Viswanathan, for example, argued that the relative freedom from malaria of the indigenous population stood out only in contrast to the far worse experience of the immigrant: malaria was an appreciable public health problem even amongst indigenous adults in the worst malarious tracts in India.

Quantitative evidence is scarce. Sinton (1935) reviewed the evidence from India on days of work lost. Estimates ranged upwards from 2 days per person per annum but their significance is unclear because no information was given of the endemicity of malaria in the various areas and most patients received some form of treatment. A study in West Africans reported that adults living in an area of high endemicity and mainly P.falciparum infections still had clinical attacks though morbidity was relatively slight - attacks of 1 to 10 days duration, mean of 4.2 days of illness and 3 days off work, and an average of 1.5 attacks per person per year (Miller 1958). Another study, of a very small sample, also in West Africa, found that malaria caused on average only one day of sickness per adult per year (Colbourne 1955). No direct quantitative evidence appears to be available on the debility caused by continued attacks of malaria.

Two major difficulties arise in valuing changes in the supply of labour. Firstly, it is unclear what effect improved health will have on actual production. The latter will depend partly on the factors that govern the individual's allocation of time between leisure activities and activities that raise income. It will also partly depend on whether opportunities exist for additional work time to be productively employed, that is on the existence of unemployment and underemployment. Whether these exist, and if they do whether they should be taken into account, have been the subject of much controversy (Goode 1970, Mushkin 1962, Schultz 1962, Stevens 1977), mainly turning on whether unemployment and underemployment can be considered as temporary problems, susceptible to government monetary and fiscal policy, or rather as structural phenomena. In the context of underdeveloped economies, it is generally accepted that the likelihood of unemployment and underemployment should be allowed for in any assessment of the value of increased labour supply.

Secondly, a value has to be found for the marginal product of additional work time. This has tended to be approximated by measures of the average product of labour such as the average agricultural wage or even the minimum agricultural wage (Prescott 1979a). Neither of these may bear much relationship to marginal product, not least because additional workers may require the exploitation of relatively unfavourable production situations. However, the observed average product may understate the marginal product of healthy workers if the average product reflects the productivity of an 'ill' work force. Alternatively, additional labour units may be valued by an amount equal to the total product per worker, though this assumes that production is attributable to labour rather than to all factors of production.

A number of studies have looked in detail at the effects of ill health on the production and earnings of individuals and families. One methodological approach is a cross-sectional analysis correlating indicators of ill-health with indicators of productivity at the level of the individual (this method was adopted by Weisbrod et al (1973) to look at the effects of parasitic disease in St. Lucia). A major drawback to this approach is that unhealthy workers may reduce the returns to other inputs in the same enterprise - for instance to capital and other workers - so the earnings differential between the healthy and the sick may not be an adequate measure of the likely benefit of improved health (Stevens 1977). A more appropriate observation unit would be the production activity as a whole (i.e. the economic enterprise or household). A further problem with the cross-sectional approach, however, is that the effects of ill-health can only be discovered if the majority of workers are healthy, and not if more-or-less everyone is sick to some degree (Kamarck 1975).

A second methodological approach is longitudinal, comparing the output and earnings of individuals or families before and after disease control. Some studies combine this with a cross-sectional approach by incorporating a control group (for example a group of villages not included in malaria control activities). This approach found that annual expenditure on hired labour and land left uncultivated was significantly lower post-spray than pre-spray in a group of villages in India, presumably because of the increased availability of family labour time (Bhombore et al 1952). A similar combined longitudinal and cross-sectional approach was adopted by Conly in Paraguay (Conly 1975) though here the effect of control activities was not the prime focus of the study. Instead, a variation in the incidence of malaria from one year to the next provided the opportunity to study the extent to which malaria accounted for observed variations in economic indicators. Data were collected on illnesses (both malaria and other illnesses), population movements, farm-work (time spent, types of work, source of labour), harvest quantities and changes in the number of animals and poultry, other kinds of work and purchases and debts. Farms were classified by the severity of the malaria they experienced (the group most severely affected experiencing an average of two episodes per person per year), and economic indicators compared for each group between the malaria-free year and the malaria-epidemic year and between groups for both years. Malaria was found to have slowed down the land-clearing programme and to have reduced the amount of land brought under crops. Preferential attention was given to cash crops, increased use was made of extra family members and many tasks were delayed. The reduced availability of labour due to malaria thus appears to have affected not only the performance of daily production tasks but also the choice of crop and resources devoted to investment activities.

A number of macro level studies have estimated an annual national economic loss or output forgone by assuming that individuals who are ill suffer a certain percentage loss in working capacity (Prescott 1979b). This is multiplied by the total number of individuals who would be infected in the absence of control and valued by some measure of the productivity of labour. It is then assumed that disease control would result in a gain equal to the value of this loss. This method can be criticised on a number of counts:

- levels of malaria without control are usually calculated on the assumption that they would have remained as in the year before control started - though this is not necessarily true;
- since good malaria morbidity and mortality data are rarely available, various assumptions have also to be made on the effect of the control programme on malaria;
- the figure for the percentage loss in working capacity often has little basis in reality;
- assessing the value of this loss runs into the problems discussed above to do with unemployment and the value of a worker's marginal product.

Nonetheless, because of its simplicity, this approach has often been used to estimate both the retrospective and prospective gains from malaria control (Cumper 1979, Kuhner 1971). For example, Kuhner calculated the loss in agricultural gross domestic product by multiplying the assumed labour coefficient in the agricultural GDP (i.e. the contribution of labour to output) by the manpower lost due to malaria deaths and cases (assuming sixty cases per death and 15 days lost per year per case) and by the average output per worker. Unemployment was known to be negligible and underemployment assumed to be non-existent.

An alternative macro approach to estimating the effects of improved health on output was suggested by Malenbaum (1970). He applied step-wise regression analysis to an input-output model with output in agriculture as the dependent variable, and as independent variables, various indicators of agricultural inputs (e.g. labour, fertilizer), health status (e.g. infant mortality rate, malaria mortality), and labour quality (literacy rates etc). The model was run with both international and national data (for instance for provinces in Thailand). The formulation of the model has been severely criticised (Goode 1970, Beenstock 1980, Wells and Klees 1980) and its explanatory power was not very high. A particular problem concerns the direction of causality: from increased output to improved health or from improved health to increased output.

4. Supply of capital

The significance of the supply of capital stems from its effect on future income. Other things being equal, the higher the rate of capital formation, the higher will be the growth of per capita income in the future.

The effect of malaria control on the supply of capital rests on speculation rather than any empirical evidence. In his model, Barlow assumed that the larger population resulting from malaria control would have higher consumption requirements and thus would reduce the rate of private saving from a given aggregate level of disposable income (Barlow 1967). Moreover, savings would be more likely to be devoted to housing - assumed to be investment with relatively low returns - though reduction in the funds households required for treating malaria would increase the income available for savings.

In the public sector, Barlow distinguishes 'productive' physical capital, such as dams and roads, from public consumption such as police stations and schools. He assumed that an increased population requires a proportionate increase in public consumption expenditure, at the expense of public investment, though admits that many consumption expenditures such as education may create a more productive labour force. This effect is ignored by Barlow and others, on the grounds that there is a substantial lag before it is experienced and that in the absence of malaria control, funds could be invested with an immediate pay off. Cohn (1973) makes similar points in relation to malaria control in India, placing particular emphasis on the effect of malaria control on changing the age structure of the population (since children are most affected by malaria in highly endemic areas) and thus increasing dependency ratios. He argues that this increases marginal consumption, depresses marginal savings and investment rates, and alters the pattern of investment towards less directly productive forms such as housing, schools and medical care.

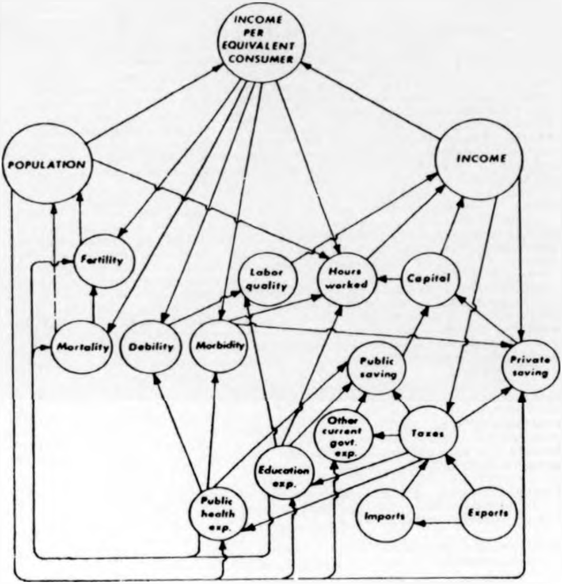
Barlow's assumptions on private and public saving mean that the greater the population size as the effects of malaria control accrue through time, the lower is the share of income saved and thus the lower is output per capita. These assumptions have been challenged. Borts (1967), for example, commenting on Barlow's model, thinks it unlikely that household savings behaviour will remain unchanged if the productivity of capital rises as a result of malaria control (for example, because new land is more productive). More generally, models such as Barlow's can be criticised for over-emphasizing the role of capital formation in economic growth (Cassen 1981).

5. Malaria control and economic development

Two rather different conclusions on the implications of malaria control for economic development emerge from this brief review. The conclusions from micro-level studies tend to be optimistic: malaria affects labour productivity and thus its control will produce economic benefits. However, such studies assume a partial equilibrium framework: that is they look only at marginal changes in labour supply, neglecting the possibilities of non-marginal changes and of their effects on other economic variables. In particular, the population growth consequence of malaria control is ignored. In contrast, the macro-level studies - primarily those by Barlow (1967) and Cohn (1973) - have focused particularly on the population growth consequence, making assumptions of its effect on consumption, savings, investment and output growth that lead to pessimistic conclusions.

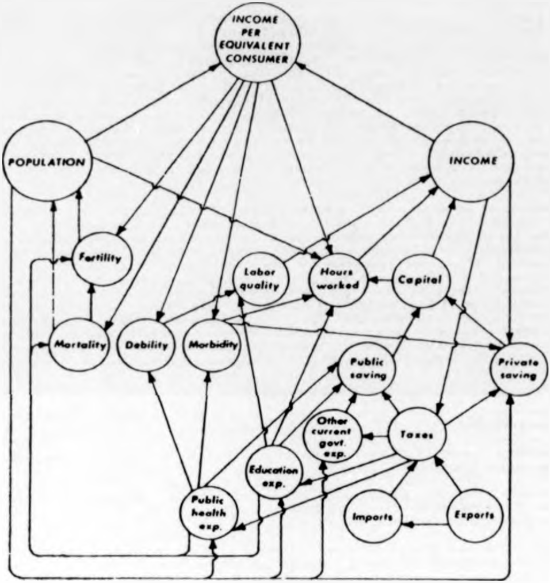
In the case of malaria control, a partial equilibrium framework will be inappropriate if non-marginal changes in a variety of economic variables are likely consequences and malaria control will have ramifications throughout the economy. Barlow's model, for example, included a large number of variables - a simplified version of the relationships between variables in the model is shown in Figure 1. A vital question is the extent to which a conflict exists, as Barlow's model implies, between reduction in malaria and increased per capita output. In a pessimistic scenario, malaria control results in

Figure 1: A simplified model for evaluating the impact of malaria eradication on per capita income



Source: Barlow and Davies (1974)

Figure 1: A simplified model for evaluating the impact of malaria eradication on per capita income



Source: Barlow and Davies (1974)

population growth which increases labour supply relative to other factors of production and produces declining returns. Per capita income thus falls.

In a more optimistic scenario, malaria control (alone or in conjunction with other health improvements), despite population growth, produces greater labour efficiency, greater returns to other factors of production and other favourable by-products. Stevens (1977), for example, criticizes existing studies for focussing on the short-run as opposed to the long-run where improved health may encourage organizational and technological change. In a society where ill health is the norm, organizational modes and technologies are likely to have been adapted to prevailing constraints - for example, a shortage of labour at harvest time. An increase in labour may have little short-term effect on output, but in the long-term improved health will encourage change in the whole productive environment. It may also in the long term lead to decreased fertility. Moreover, population growth is not inevitably inimical to economic development (Cassen 1981).

Which of these scenarios applies in a particular context is a matter for empirical investigation. It is appropriate to conclude, however, on a cautionary note. The review of the relationship between malaria, population mortality and fertility rates, and the supply of land, labour and capital warns against any simplistic generalizations of the economic effects of malaria control. Empirical findings have been too readily translated from one setting to another, or assumptions made which have little basis in reality. In the case of malaria, it is particularly important that any discussion of its economic consequences should pay attention to the characteristics of malaria in the areas being studied: in particular to the degree of endemicity, level of tolerance of malaria in the community and species of vector and parasite.

REFERENCES

Barlow R (1967) The effects of malaria eradication. American Economic Review, May, 130-148.

Barlow R (1968) The economic effects of malaria eradication. School of Public Health, Bureau of Health Economics Research Series No 15, University of Michigan, Ann Arbor.

Barlow R and Davies CW (1974) Policy analysis with a disaggregated economic-demographic model. Journal of Public Economics 3, 43-70.

Baenstock M (1980) Health, migration and development. Gower, Farnborough.

Bhombore SR et al (1952) A survey of the economic status of villagers in a malarious irrigated tract in Mysore State, India. Indian Journal of Malariology 6, 355-65.

Borts GH (1967) Discussion of 'The economic effects of malaria eradication' by R Barlow. American Economic Review May, 149-151.

Bradley DJ (1987) Malaria in sub-Saharan Africa. For expert consultation on: Disease and Mortality in sub-Saharan Africa. Levels, trends and data deficiences. Ross Institute and Department of Tropical Hygiene, London School of Hygiene and Tropical Medicine.

Brown PJ (1986) Socioeconomic and demographic effects of malaria eradication: a comparison of Sri Lanka and Sardinia. Social Science and Medicine. 22 (8), 847-859.

Bruce-Chwatt LJ (1980) Essential Malariology. Heinemann, London.

Cassen RH (1981) Population and development: a survey. In Recent issues in World Development. Ed P Streeten and R Jolly. Pergamon Press, Oxford.

Cohn EJ (1973) Assessment of malaria eradication costs and benefits. American Journal of Public Health. 63 (12), 1086-1096.

Colbourne MJ (1955) Malaria in Gold Coast students on their return from the United Kingdom. Trans R Soc Trop Med Hyg. 49 (5), 483-7.

Conly GN (1975) The impact of malaria on economic development: a case-study. PAHO Scientific Publication No 287. Washington DC.

Cumper GE (1979) Report of independent assessment team. Thailand. Mimeo.

Frederiksen HF (1960) Malaria control and population pressure in Ceylon. Public Health Reports 75, 865-9.

Giglioli G (1972) Changes in the pattern of mortality following the eradication of hyperendemic malaria from a highly susceptible community. Bulletin of the WHO 46, 181-202.

Goode R (1970) Comment on Malenbaum. In Klarman HE, Empirical Studies in Health economics. Johns Hopkins University Press, Baltimore.

Gray RH (1974) The decline of mortality in Ceylon and the demographic effects of malaria control. Population Studies. 28 (2), 205-229.

Kamarck AM (1975) Book review of Weisbrod et al (1973). Journal of Economic Literature 107-109.

Ketterer WA (1953) Economic benefits of malaria control in the Republic of Indonesia. Publ Hlth Rep. (Wash) 68, 1056-58.

Kuhner A (1971) The impact of public health programmes on economic development. Report of a study of malaria in Thailand. International Journal of Health Services 1 (3), 285-92.

Macdonald G (1951) Community aspects of immunity to malaria. British Medical Bulletin 8 33-6.

Malenbaum W (1970) Health and productivity in poor areas. In Empirical Studies in Health Economics. ed HE Klarman. Johns Hopkins University Press, Baltimore and London.

Meade JE (1961) Mauritius: a case study in Malthusian economics. Econ J LXXI 282, 521-534.

Miller MJ (1958) Observations on the natural history of malaria in the semi-resistant West African. Trans R Soc Trop Med Hyg 52(2), 152-68.

Molineaux L and Gramiccia G (1980). The Garki project: research on the epidemiology and control of malaria in the Sudan Savanna of West Africa. WHO, Geneva.

Mushkin SJ (1962) Health as an investment. J of Political Economy. 70, 129-57.

Newman P (1965) Malaria eradication and population growth with special reference to Ceylon and British Guiana. Bureau of Public Health Economics, Research Series No 10, School of Public Health, University of Michigan.

Prescott NM (1979a) Schistosomiasis and development. World Development 7(1), 1-14.

Prescott NM (1979b) The economics of malaria, filariasis and human trypanosomiasis. Paper prepared for the Special Programme for Research and Training in Tropical Diseases, WHO, Geneva.

Schultz TW (1962) Reflections on investment in man. J of Polit Econ 70, Supplement, 1-8.

Sinton JA (1935) What malaria costs India nationally, socially and economically. Records of the Malaria Survey of India. 1935, 5, 223-64, 413-89.

Stevens CM (1977) Health and economic development: longer-run view. Social Science and Medicine 11, 811-817.

Viswanathan DK (1951) A review of immunity and endemicity of malaria and a discussion of their relationship with malaria control. Indian Journal of Malaria 5(2): 251-69.

Wells S and Klees S (1980) Health economics and development. Praeger publishers, New York.

Weisbrod BA et al (1973) Disease and economic development. University of Wisconsin Press, Madison.

Wilson DB et al (1950) A review of hyperendemic malaria. Tropical Disease Bulletin 47(8) 677-698.

COSTING METHODOLOGY

1. Introduction

The cost analysis was divided into two parts. In the first part NMEO expenditure was analysed by region and district and related to the population covered and number of cases. Because of lack of suitable information in an appropriate form, this analysis could only look at total expenditure not expenditure by activity such as spraying and surveillance, only at recurrent not at capital costs, and could only be done for NMEO and not for ICHSDP districts. Therefore the second part of the analysis selected five districts, three NMEO and two ICHSDP, and analyzed the costs of malaria control in much greater detail. Total costs were calculated and allocated to operational activities in order to produce unit costs for malaria control activities.

The year 1984 rather than a financial year was chosen as the base for the analysis because the calendar year encompasses the main transmission season which is split into two by the financial year. For instance the first and second spraying rounds take place in different financial years.

2. Availability of financial information

The costing approach adopted was strongly influenced by the availability of financial information. This differed between the NMEO and ICHSDP, necessitating a different approach in each organization.

2.1 NMEO

In general, the availability of financial information in the NMEO is very good. Budgets are held by the NMEO headquarters (NHQ), by each Region and by each district. Districts are responsible for the great majority of the resources used in the districts, the exceptions being insecticide, drugs and laboratory equipment and chemicals which are recorded in NHQ accounts and supplied to districts without charge.

Over the last few years, the NMEO has been gradually implementing a programme budgeting system. Budgets have been allocated by programme for several years, but the reporting of expenditure by programme has been required only from 2041/2 (1984/85). However, two Regions and a number of districts have for several years been recording expenditure by programme and presenting this in their Annual Reports. The programme structure is shown in Table A2.1. This structure much facilitated the economic analysis.

Within each programme, budgets and expenditure are recorded by the budget code structure used within the government. The codes are shown in Table A2.2, together with an explanation of the expenditure included under each code.

The Nepali financial year runs from July 16 to July 15. Remarkably, financial accounts are available a month or two after the end of the financial year. In addition, since malaria statistics are recorded for

Table A2.1: Programme budget categories

PROGRAMME	ACTIVITIES INCLUDED
Surveillance	Operations of unit offices, border check posts, supervision by surveillance staff in district offices, regions, NHQ
Parasitology	All laboratories
Health education	Supplies for volunteers, supervision and support to volunteers and community motivation by districts, regions, NHQ
Spraying	Spraying operations, supervision and support by districts, regions, NHQ
Administration and miscellaneous	Administrative support at district, region, NHQ
Entomology	Entomological activities at regions and NHQ
Research and Training	Research activities NHQ, Research and Training centre, Hetauda.

Table A2.2: Budget codes

BUDGET CODE	DESCRIPTION	MAIN ITEMS PURCHASED
1	Salaries	Permanent & Temporary staff
2	Allowances	Staff allowances
3	DA, TA	Daily & travel allowances paid to staff travelling on duty
4.1	Services	Electricity, telephones etc
4.2	Other services	e.g. porters, printing
5	Rent	Rent of offices
6	Repair, maintenance	Of vehicles, equipment etc.
7.1	Office goods	Stationary
7.2	Newspapers	Newspapers, magazines
7.3.1	Fuel for vehicles	Fuel for passenger vehicles
7.3.2	Fuel for other purposes	Fuel for lorries, lamps etc.
7.4	Clothes, fodder	For spraymen, animals
7.5	Supplies	Forms etc
8.1	Encouragement prizes	
8.3	Drugs, lab supplies	Chloroquine, lab supplies, insecticides
9	Contingencies	Conferences, functions etc.
10.1	Furniture	Purchase of furniture
10.2	Vehicles	Purchase of vehicles
10.3	Machinery, equipment	Purchase of machinery, equipment
12.1	Building	Repair, maintenance of buildings

the years of the Gregorian calendar, most districts report 'expenditure to Paush', i.e. from the start of the financial year to December, making it possible to convert expenditure from financial years to calendar years. For these reasons, it was possible in the cost analysis to take 1984 as the year for the analysis.

External assistance is included in approved budget figures, with the exception of WHO assistance and unforeseen donations. Amounts actually disbursed are included in expenditure figures.

In the case of insecticides and drugs, actual expenditure may give a misleading picture of resource use in any given year since stocks may be run down or increased. In addition, it is difficult to apportion a national sum for these items to districts. For these reasons, expenditure on insecticides and drugs was excluded from NHQ expenditure. It was then added into district expenditure by applying unit prices to the drugs required for district malaria cases and to the quantity of insecticide used.

2.2 ICHSDP

Unlike the NMEO, the ICHSDP performs many functions and does not have a comprehensive programme budgeting system. Financial information could therefore not readily be obtained from accounts, but had to be estimated by field visits to districts.

At national level, the ICHSDP headquarters is funded partly by government funds and partly by various projects which are externally financed. It was not possible to obtain an estimate of the resources absorbed by malaria control.

At district level, malaria control is one of the functions of the district health office. The district health office and the health posts in the district are financed from two budgets, the regular budget which pays all staff salaries and some overhead expenses, and the development budget. Malaria has its own budget within the development budget, financing largely supplies (forms etc.) and some supervision costs. Two other budgets within the development budget, for supervision and for transport, may also be used for supervising malaria control activities, and the development budget for administration finances an accountant for the development budgets.

Expenditure on malaria control in integrated districts may thus be financed from five sources: the regular budget, and the development budgets for malaria, supervision, transport and administration. In addition, drugs, insecticides and laboratory supplies are provided free by the ICHSDP headquarters. Those supplies which originate from external assistance are recorded under NMEO expenditure. Accounts are maintained by financial and not by calendar year.

3. Prices: recurrent items

Prices were required for the main inputs into the programme. A particular problem was presented by pricing drugs and insecticides because some supplies currently used had been purchased several years before and for some of these their prices could not be traced. WHO estimates of prices for the main anti-malarial supplies were available for 1981/82 and 1984/85. Therefore these were used when actual prices were not known.

A major question concerns whether the original price paid or the price of replacement supplies should be taken. To evaluate the actual expenditure burden of the programme, historic prices are required. However, particularly in the comparison of alternative strategies, the supplies for the various strategies need to be costed consistently, in prices of a common year. Here, therefore, replacement prices are relevant.

In the sections below two prices are therefore calculated. The historic price is the actual price paid, or an estimate of it, for supplies used in 1984. The replacement price is an estimate of the value of the item in 1984. The replacement price is required particularly for the economic analysis. The appropriate value for traded commodities such as supplies is the 'border price', that is the 1984 c.i.f. (carriage, insurance, freight) price to the Nepal border (see section 6.4 for a discussion of pricing principles in the economic analysis). Taxes such as customs duties should be excluded from the border price and internal transport costs calculated separately. Taxes can here safely be ignored since donated supplies pay no duty and the prices calculated here have no tax included. Freight costs to Nepal could not be calculated precisely in this study, and charges are based on a recent study of the comparative costs of insecticides for malaria control (M Phillips, A Mills, The operational costs of insecticide spraying for malaria control. A case study of Nepal. EPC, LSHTM May 1987). Distribution from the main godowns to districts is paid for from Regional budgets and is thus accounted for separately.

3.1 Anti-malarial drugs

Chloroquine: Chloroquine (150mg base) is purchased annually in Nepal from the Royal Drugs Company at a price of Rs 195/1000. This is therefore the historic price, and also the replacement price for locally purchased chloroquine. If, however, supplies were purchased internationally, the estimated price from WHO is $6.40/1000, plus 25% allowance for freight gives a border price of $8/1000 or Rs 131.68.

Primaquine: The most recent supply of primaquine (15mg base) was from WHO in 1982, at a price of Norwegian Kroner 16/1000. This translates to Rs 33.09/1000 and adding 25% for freight gives Rs 41.36/1000. The 1984/85 WHO estimated price is $3.80/1000, plus 25% for freight gives a border price of $4.75/1000 or Rs 78.19.

Sulphadoxine and pyrimethamine: No information was found in Nepal on the price of sulphadoxine and pyrimethamine used in 1984, and it appears to have been supplied pre-1982. The 1981/82 WHO estimated price was $80/1000 and this, plus 25% freight, is used as the historic price, giving Rs 1234/1000 using a 1981 exchange rate. The dollar price of the drug has remained relatively constant, the WHO estimated price for 1984/85 being $79.50. The border price is thus $79.50 plus 25% freight or Rs 1635.71/1000. The higher border price in 1984 despite a constant dollar price reflects the devaluation of the Nepali rupee against the dollar.

Treatment costs can now be calculated. The NMEO estimates drug requirements on the basis of the following average drug usage patterns:

Presumptive treatment: 3 tabs chloroquine (150 mg base)
Radical treatment, imported P. falciparum: 2 tabs sulphadoxine and pyrimethamine plus 3 tabs primaquine (15mg base)
Radical treatment, all others: 6 tabs chloroquine (150 mg base) plus 4 tabs primaquine (15mg base).

This gives the following treatment costs:

Presumptive treatment:
historic prices Rs 0.59 per person
border prices (imported chloroquine) Rs 0.40 per person
border prices (local chloroquine) Rs 0.59 per person

Radical treatment, imported P. falciparum:
historic prices Rs 2.59 per case
border prices Rs 3.51 per case

Radical treatment, all others:
historic prices Rs 1.34 per case
border prices (imported chloroquine) Rs 1.10 per case
border prices (local chloroquine) Rs 1.48 per case

3.2 Insecticides

DDT: The DDT used in Nepal in 1983 and 1984 was a number of years old and its price and year of origin could not be traced. WHO estimated prices for DDT (75% w.d.p.) were $1500/metric ton in 1981/82 and $1400-$1700/metric ton in 1984/85. A 1985 consignment from WHO to Nepal cost $1950/metric ton. $1500/metric ton is thus taken as the historic price and $1755 as the border price ($1950 deflated by 10% to give a 1984 price).

The likely 1984 freight cost proved difficult to estimate. The freight cost of the 1985 consignment was therefore taken ($410/metric ton) and deflated by 10% to give a 1984 price of $369/metric ton. The 1984 border price was thus estimated at $2124/metric ton or Rs 34.96/kg.

The historic freight cost was calculated by discounting the 1985 freight charge by 10% per annum back to 1980, giving $0.24/kg. The total historic price is thus $1.74/kg or Rs 20.88 at 1980 exchange rates.

Malathion: In 1983, USAID supplied 2 shipments, each of 300 tons, at a cost of $1850/metric ton to Calcutta or Rs 26.92/kg. Freight to Nepal was estimated by USAID to be $233/metric ton or Rs 3.39/kg. Malathion sprayed in 1983 and 1984 is likely to have been mainly the 1983 stock. A historic price of Rs 30.31/kg is therefore taken.

The border price is calculated on the basis of the WHO estimated 1984/85 price of $1800/metric ton. Actual freight costs are available for a 1985 USAID consignment, of $379/metric ton. This is deflated by 10% to give a 1984 price of $341. The 1984 border price is thus $2141/metric ton, or Rs 35.24/kg.

Ficam: In 1985, 33.2 metric tons of Ficam was supplied at $30/kg f.o.b. Due to shortage of time, air freight was used at a cost of $2.26/kg, resulting in a total price of $32.26/kg or Rs 600.36. If surface freight had been used, the price would have been $1.09/kg, giving a total 1985 price of $31.09 or Rs 578.58/kg.

This insecticide is not included in analyses of 1984 expenditure patterns. However, its price is required in the comparison of alternative strategies, and for this has been translated to 1984 prices. It is assumed that the dollar price of the insecticide would have been the same, and the freight charge 10% less, giving $30.99/kg at surface freight rates or Rs 501.10 at 1984 exchange rates.

3.3 Salaries

Estimating the salaries of different grades of personnel proved a considerable problem in this analysis because government staff received a considerable increase in July 1984. District accounts for 2040/1 were thus based on the old salary scales, and for 2041/2 on the new salary scales. Moreover information on staff by grade and salary was readily available for the new salary scales but not for the old which had a complex pattern of allowances.

The new salaries represented an approximate 35% increase, though salaries appeared to increase more than this because the previously large allowances were largely eliminated and salaries increased to compensate. 1984 expenditure thus comprised 6 months of the new salary scales, and 6 months of the old scales approximately 35% lower. This is equivalent to an increase in 1984 of 17.5% (half of 35%). The new salary scales are thus multiplied by 117.5/135 to obtain an estimate of the actual salary payment to a particular officer in 1984. Employee contributions to the provident fund are included in this figure. An additional 10% of the monthly salary for 12 months has been added for the government's contribution to the provident fund, in order to obtain the total costs of employment.

4. Prices: capital items including equipment

An exhaustive listing of all capital assets was neither possible nor worthwhile. The major items were therefore taken, namely buildings, vehicles, microscopes and sprayers. These, with the exception of buildings (see below) were priced at their replacement value. They were then annuitized, taking into account their replacement price, length of life and a rate of interest to reflect the opportunity cost of the capital tied up in them. A rate of interest of 12% was used.

A listing of replacement and annual costs for the capital items is shown in Table A2.3.

Buildings: no estimate needed to be made of the cost of buildings because virtually all NMEO buildings are rented and an appropriate sum included in the accounts. In ICHSDP districts, buildings are generally government-owned and a rent was estimated based on locally prevailing prices.

Vehicles: Information was available in Nepal only for a newly purchased long-wheel-base Landrover. Estimates of similar costs for short-wheel-base and pick-up Landrovers were obtained from the Landrover company in the UK, and for Mitsubishi, Hino and Mazda vehicles from WHO. Length of life was taken as 10 years, based on advice in Nepal and the condition of the existing fleet.

Table A2.3: Cost of capital items

ITEM	REPLACEMENT COST ($1984)	LIFE (yrs)	ANNUAL COST ($1984)	ANNUAL COST (Rs 1984)
Vehicles:				
Landrover LWB	11,800	10	2,089	34,377
Landrover SWB	10,300	10	1,823	30,007
Landrover Pick-up	9,200	10	1,628	26,802
Mitsubishi 4WD	9,700	10	1,717	28,259
Hiro 2 ton	8,000	10	1,416	23,306
Mazda 3 ton	10,500	10	1,858	30,589
Motorbike	1,000		417	6,858
Bicycle (Rs)	750	3	-	313
Microscopes:				
Oil immersion	500	15	73	1,209
Entomological	800	15	117	1,934
Dissecting	600	15	88	1,450
Research	2,500	10	442	7,283
Spraying:				
Sprayers	100	5	28	457

Motorbikes were valued at the WHO supply price to Nepal, with a length of life of 3 years. Bicycles were costed at local prices, also with a life of 3 years.

Microscopes: Two microscopes had been supplied by WHO in 1983, at a price (excluding freight) of $210 and $344. Based on these and on WHO Geneva purchase prices, the prices in Table A2.3 were estimated. Length of life, based on current experience in Nepal, was estimated at 15 years.

Sprayers: Sprayers were supplied by USAID in 1982 at a price of $68 plus $13 freight each. Applying a price increase of 10% per year gives a 1984 replacement price of around $100 each. Life was estimated at 5 years. For convenience, the cost of replacement nozzles, an expendible item, is noted here. They were costed at $3 each and three per sprayer per round.

5. Analysis of NMEO district recurrent expenditure

The object of the analysis was to calculate total recurrent expenditure at district level, consisting of

- actual district expenditure
- an estimate of the cost of drugs used
- an estimate of the cost of insecticide used
- a share of regional expenditure
- a share of NHQ and RTC expenditure.

Information on NHQ, RTC, Region and district expenditure was available for FY 2039/40, FY 2040/1 and FY 2041/2 up to Paush. An analysis of a sample of districts indicated that on average, 46% of the expenditure of a financial year was spent in the first half, and 54% in the second half. 1983 and 1984 expenditure was thus calculated in the following way:

1983 = (2039/40 x 0.54) + (2040/1 x 0.46)

1984 = (2040/1 x 0.54) + (2041/2 to Paush)

To 1983 and 1984 district expenditure was added the cost of drugs and of insecticides costed at historic prices. Total slides were multiplied by the cost of presumptive treatment and total cases by the appropriate radical treatment cost. Outside boundary cases were included in total cases. Kilograms of insecticide used in each year were multiplied by the appropriate historic insecticide price.

While this method accurately identifies the minimum historic cost of drugs and insecticide, it is likely to be an underestimate to the extent that wastage or losses of supplies occurred.

In order to obtain a complete view of the cost of the various district activities, it is necessary to apportion to them an appropriate share of regional and national expenditure. The basic principle should be that expenditure is apportioned in relation to the call a particular district makes on regional and national resources. The demands a district makes will clearly depend on a number of factors, including the size of its population, the number of cases, population sprayed etc. Since programme budget figures are available, it is logical to consider each programme separately since, for example, the resources devoted by Regions to spraying will be drawn on only by districts where spraying takes place.

Table A2.4 shows how national and regional expenditure was apportioned to districts. The regional and national 'malaria index' was calculated in order to adopt a method of apportionment that reflected both the size of the district population and the number of cases. It is assumed that surveillance, parasitology and research and training resources, and also NHQ entomology are devoted to districts in relation to the malaria index, reflecting the magnitude of the malaria problem in each district. Health education activities are aimed at the general population and thus are distributed in proportion to population. Spraying resources are distributed in proportion to the population sprayed, as is regional entomology expenditure on the assumption that it is used primarily to monitor the effects of spraying. Finally, the larger a district's expenditure, the more claim it is likely to make on regional and national administrative resources. Thus the administration programme is distributed in proportion to total district recurrent expenditure.

NHQ expenditure was available only by code not by programme. Programme budgets were available for 2040/1 and 2041/2 and the average distribution by programme over these two years was used to break down total NHQ expenditure by programme. To this was added WHO assistance, allocated to administration (long-term and short term staff) and training (fellowships). Since the WHO contribution supports also ICHSDP malaria activities, only 68% (the NMEO's share of total protected population) of the WHO support to administration was included. The full amount for training and research was retained, and also USAID assistance to training since these support the role of the NMEO as a centre of expertise. Expenditure recorded in NHQ accounts on drugs and insecticides was excluded since these were separately estimated at district level. RTC expenditure was allocated to the research and training programme.

In both the East and West Regions, actual programme expenditure was known. In the Centre and Mid West Regions, the 2041/2 programme budget was used to apportion total expenditure between programmes.

6. Analysis of the costs of selected districts

In the second part of the cost analysis, five districts were selected for detailed study. The general approach to the analysis was first to account for all inputs used in each district, including externally donated items and regional and NHQ overheads; secondly, to allocate all inputs to operational activities, thirdly to convert the financial prices used to 'economic prices' (see below) and finally to divide the financial and economic costs of each activity by measures of output, to produce unit costs.

6.1 Choice of districts

The choice of districts for detailed analysis was partly determined by the earlier random selection of districts for the patient survey, and partly by convenience and feasibility. Selecting the districts of the patient survey provided the advantage that results from the analysis could be incorporated in the cost-effectiveness work. Morang and

Table A2.4: Apportionment of NHQ, RTC and regional expenditure to districts

	DISTRIBUTED TO DISTRICTS IN RELATION TO:			
	Share of malarious population in country/ region[1]	National or regional malaria index [2]	Share of total sprayed population in country/region [3]	Share of total expenditure in country/ region[4]
EXPENDITURE ON:				
Surveillance				
- NHQ		x		
- Region		x		
Parasitology				
- NHQ		x		
- Region		x		
Health Education				
- NHQ	x			
- Region	x			
Spraying				
- NHQ			x	
- Region			x	
Administration				
- NHQ				x
- Region				x
Entomology				
- NHQ		x		
- Region			x	
Research, training				
- NHQ		x		
- RTC		x		

[1] District malarious population divided by national NMEO /regional malarious population.

[2] 1/2 (district malarious population divided by national NMEO /regional malarious population) +1/2 (district cases divided by national NMEO /regional cases).

[3] District sprayed population divided by national NMEO /regional sprayed population.

[4] District expenditure divided by national NMEO /regional expenditure.

Rupandehi were thus chosen and in addition are reasonably representative Terai districts. They are also both the location of their respective Regional offices, enabling the necessary Regional cost data to be collected without additional travel costs. In addition, Morang provided the opportunity to study adjacent districts, thus economizing on transport costs. From Morang, the ICHSDP district Saptari could conveniently be visited, and also what was considered to be a fairly typical hill district, Bhojpur, which had also been included in the patient survey. Unfortunately no seats could be obtained on the flight to Bhojpur and instead a visit by road was planned to Ilam, a hill district on the edge of the Terai, and Panchtar, another hill district. Due to the state of the road to Panchtar, the vehicle failed to reach it and thus only data on Ilam could be obtained. In order to analyze a second ICHSDP district, Parsa was selected since access was easy from Katmandu.

The cost analysis is thus done on five districts:

Morang, a NMEO district in the Eastern Terai and the base of the East Regional Office;

Rupandehi, a NMEO district in the Western Terai and the base of the West Regional Office;

Ilam, a NMEO hill district in the Eastern Hills;

Saptari, a ICHSDP district in the Sagamatha zone, in the Eastern development region, integrated in 1975;

Parsa, a ICHSDP district in the Narayani zone, in the Central development region, also integrated in 1975.

This group of districts represents a compromise between the ideal and the practical. It does represent a reasonably typical range of districts, with two major omissions. Firstly, there is no mid-West district, due to difficulties of access and time constraints. Moreover no mid-West district, unlike those districts chosen here, reported expenditure by programme. Thus the cost analysis would have been more difficult and much more speculative.

Secondly, no recently integrated district was selected. This omission was made on the advice of national officials, who felt that the upheaval of integration would make cost analysis very difficult.

6.2 Collection of information

Before the visit to each district, as much information as possible on expenditure and control activities was gathered in Katmandu from the districts' Annual Reports. During the district visits, this information was checked. In particular, the programme expenditure was thoroughly clarified, in order to identify how strictly programme classification was adhered to, and whether expenditure belonging to one programme was in fact charged against another.

While NMEO programme categories provided a general framework for the analysis, some apportionment was necessary, for instance to separate case detection from treatment costs. Ideally, district and unit staff would have been asked to keep a diary of their activities, in order to assess the proportion of their time devoted to different activities. This was not possible, and due to the seasonal nature of control activities, would have needed to be done for a whole year to provide useful information. Instead, the views of malaria staff on their time allocation were relied on, supplemented where possible by records of field visits. Several unit offices were visited in each district, to interview unit staff on their activities.

Apportionment of time was a much more severe problem in ICHSDP districts, where most staff perform a number of functions. Here again, the views of staff had to be relied on, and information was obtained from district health office staff and also from visits to several health posts in each integrated district. An additional reason for not attempting any more detailed study of time allocation patterns in ICHSDP districts was that these districts were already being intensively investigated by various evaluation studies.

The accumulated cost data was entered into a Lotus 123 spread sheet for analysis.

6.3 Cost analysis methodology

The methodology adopted in the cost analysis is briefly described below, first for NMEO districts, then the two NMEO regions, the NMEO headquarters, and finally ICHSDP districts. Where local circumstances meant a different approach had to be adopted in a particular district, this is mentioned. Otherwise the approach described was applied to all the districts considered in the section.

6.3.1 NMEO districts (Morang, Ilam, Rupandehi)

The first step in the cost analysis was to take actual expenditure by programme and code for 2040/1, 2040/1 to Paush, and 2041/2 to Paush. From this, 1984 expenditure could be estimated by taking the second half of 2040/1 expenditure and adding it to the first half of 2041/2 expenditure. In Rupandehi, expenditure by programme was available for 2039/40 but not for 2040/1. Therefore 2040/1 programme expenditure was estimated by:

(a) allocating expenditure under a particular code to a programme where this was known to be the sole user of that code;
(b) allocating salary and TA/DA expenditure to spraying by using the 2039/40 expenditure as a base and adjusting it for a decrease in the population sprayed in 2040/1;
(c) allocating remaining expenditure to programmes in relation to the 2039/40 distribution.

The average of expenditure 2040/1 to Paush for all codes was then used in calculating 1984 expenditure.

In Ilam, expenditure 2040/1 to Paush was available only for all programmes. The average across all codes was therefore applied to 2040/1 programme expenditure to obtain 1984 expenditure, with the exception of spraying. No spraying took place in 1984, the spraying budget in 2040/1 being used for the Autumn 1983 round. Therefore no spraying expenditure was allocated to 1984.

The second step in the cost analysis was to adjust 1984 expenditure for misallocations between programmes and omitted items. Some of these adjustments varied between districts depending on how district staff actually spent their time. The main adjustments were:

(a) Total salary expenditure was increased to include the government contribution to the provident fund, not included in NMEO accounts.

(b) The salary of the district malaria officer is charged to the surveillance programme although he is involved in other programmes. Given the DMO's district-wide responsibilities, it would seem logical to charge his salary to administration. The DMO's salary and an appropriate sum for DA/TA was thus subtracted from the surveillance programme and added to the administration programme.

(c) The spraying programme contains salary expenditure only for temporary staff. An estimate was made of the time of district and unit staff spent on spraying, and the appropriate salary cost subtracted from the programme paying their salary and added to the spraying programme.

(d) In recent years, an additional malaria field worker (MFW) has been added to unit offices to support malaria volunteers and undertake health education activities. He is paid, however, from the surveillance programme. In Morang and Ilam, the salary of an appropriate number of MFW plus DA/TA was transferred to the health education programme. In Rupandehi it was considered that only half the time of this MFW was spent on health education, the rest being used for radical treatment. Thus only half the MFW's salary, plus DA/TA, was transferred.

(e) Surveillance aids are used to collect slides from malaria volunteers but are paid under the surveillance programme. An appropriate sum was transferred to the health education programme by dividing expenditure on aids by the number of 'points' visited (MFWs, health posts, volunteers) to obtain a cost per point. In this calculation, volunteers were given half the weight of the others since slides tended to be collected less frequently and the MFW for health education also collected volunteer slides. The cost per point was then multiplied by the number of volunteers to determine the sum to be transferred.

(f) In all districts, it was considered that funds for minor supplies were very short, particularly in the health education budget, and that the surveillance budget was on occasion used for volunteer supplies. However, the surveillance budget for supplies seemed too small to permit much re-allocation and so the recorded amounts were left unchanged. In Ilam, however, no expenditure was recorded for supplies for parasitology (codes 7.1 and 7.5) or for supplies and contingencies for health education (codes 7.1, 7.5 and 9). This appeared to be an accounting misallocation since these programmes and codes had sums entered for 2039/40 in Ilam and in other districts, and the sums in these codes in the administration budget for Ilam were unusually large. Therefore the administration budget for 1984 was left with the sums in codes 7.1, 7.5 and 9 spent in 2039/40, and the balance was distributed to the parasitology and health education programmes.

(g) Drug, insecticide and laboratory supplies costs were added in to the appropriate programmes by multiplying slides and cases by the presumptive and radical treatment costs; kilos of insecticide used by its cost; and transferring the district's share of laboratory supplies from NHQ expenditure to district expenditure.

(h) The annual equivalent cost was added for sprayers and microscopes. In the case of sprayers, districts had inherited more sprayers than they were currently using. Only the cost of sprayers actually used, plus one spare per three teams, was included. The cost of nozzles was estimated on the basis of three nozzles per round.

The third step in the cost analysis was to add to district expenditure an appropriate share of NHQ, RTC and regional expenditure. The method used is described in subsequent sections.

The fourth step was to distribute the administration programme to the other programmes, in order that all costs should be distributed out to operational activities. The criteria adopted for distribution was total (recurrent and capital) programme expenditure. Each operational programme thus received a share of the administration programme in proportion to its own total expenditure divided by total operational programme expenditure.

Finally, expenditure in the surveillance programme was distributed between the various types of case detection and radical treatment, and in the parasitology programme between the district laboratory and malaria clinic. This distribution is approximate since many costs are shared, but is necessary to gain an idea of the relative cost of ACD and PCD mechanisms. PCD (V) is already costed under the health education programme. Thus the activities to be costed here are ACD, PCD (M), PCD (MC), PCD (H) and radical treatment and investigation.

PCD (M), case detection by the unit office, can be regarded as an incidental and virtually costless addition to its normal activities. Therefore no attempt was made to attribute a proportion of unit office salaries to PCD (M).

PCD (H), case detection by a hospital or health post, can likewise be considered a minor additional workload, whose cost is borne by a non-NMEO budget. No attempt was made to calculate the cost incurred by the hospital or health post in NMEO districts. However the NMEO cost of supporting PCD (H) - time of surveillance aids, supplies, drugs, supervision - was estimated.

The method of cost distribution adopted was as follows. Firstly, salaries were distributed. From the total surveillance salary expenditure, the cost of MFWs at unit offices was allocated to ACD, the exception being Rupandehi, where district officers considered that on average 1.5 MFW per unit were used for radical treatment (half of the health education MFW and the reserve MFW). Therefore in Rupandehi, one less MFW per unit was allocated to ACD. Surveillance aid expenditure was distributed according to the method described earlier, based on the number of points visited. District office salaries in the surveillance budget (usually a malaria inspector and recorders) were allocated to 'supervision' and to malaria clinics, where appropriate. Remaining salary expenditure was allocated to radical treatment.

Secondly, TA/DA expenditure was distributed, allocating the estimated cost of TA/DA for MFWs to ACD, for supervisory work by the district office to supervision, and the remainder to radical treatment.

Codes 4.2, 7.1, 7.3.2 and 7.5.1 were distributed, arbitrarily, 50% to radical treatment and the remainder to slide detection in proportion to the slides collected by each mechanism. The cost of drugs for presumptive treatment was distributed according to the slides collected by each mechanism, and drugs for radical treatment were allocated to radical treatment.

Finally, supervision costs were distributed 50% to radical treatment and 50% to case detection, and then to each case detection method in proportion to the slides each collected.

To complete the costing of PCD (MC), the appropriate laboratory staff were subtracted from the parasitology programme, and other codes distributed in proportion to slides examined.

Since salaries make up the great majority of expenditure, they are the most important element to distribute correctly. In the above analysis, it has been assumed that the cost of all MFWs in unit offices (except in Rupandehi) belong to ACD, and the malaria assistant and inspector at the unit office to radical treatment and investigation. This is to some extent a simplification. When the pressure of cases is high, MFWs may be used for radical treatment. In Ilam and Morang it appeared that the great majority of cases were treated by the MA or MI. In Rupandehi, however, the district office stated that MFWs were used to treat all P.vivax cases, and all but the first day of treatment for indigenous P.falciparum. If possible this was done by the MFW on his normal rounds, but more usually by the reserve MFW or by MFWs on completion of their monthly schedule of visits. Some allowance has been made for this in the costings, though possibly an insufficient allowance.

A further simplification is to assume that the MA and MI cost belongs solely to radical treatment and investigation. This ignores their role in supervising case detection mechanisms. To some extent any misallocation here will offset any misallocation of MFW time.

6.3.2 NMEO Regions (East and West)

Analysis of Regional expenditure proceeded according to the same method and sequence of steps described above for the districts. The major re-allocations of expenditure required between programmes were as follows:

(a) An estimate was made of the proportion of regional staff time devoted to spraying and the cost transferred from the appropriate programme to the spraying programme.

(b) In the East, a large sum under code 7.3.2, used largely to pay for fuel for insecticide dumping, was recorded in the administration programme. This was transferred to the spraying programme.

In discussions with the Regions, it appeared that the Regional truck was used primarily for insecticide dumping, and in addition that the Landrover pick-ups were similarly occupied for three to four months of the year. Therefore the whole capital cost of the truck, and an appropriate portion of the capital cost of the pick-ups, was added to the spraying programme. The remaining pick-up cost and the cost of the regional SWB Landrover was shared between programmes in proportion to their expenditure on fuel for passenger vehicles (code 7.3.1.).

The share of regional expenditure belonging to the districts studied was calculated as follows. Surveillance and parasitology expenditure were distributed by multiplying them by the regional malaria index (see Table A2.4), which gave Morang 26%, Ilam 3% and Rupandehi 30% of regional expenditure on these programmes. Health education was distributed according to the district's share of total regional malarious population, and spraying and entomology according to the district's share of regional population sprayed. Finally, the administration programme was distributed in proportion to the district's share of total recurrent regional expenditure (including the cost of drugs and insecticides).

6.3.3 NMEO Headquarters and Regional Training Centre

Again, analysis of NHQ expenditure proceeded in a similar way to that of regions and districts. Programme expenditure was not available, and was estimated by applying the distribution of budget codes by programme in the 2040/1 budget to 1984 expenditure. Drug and insecticide expenditure was excluded. The capital cost of passenger vehicles was distributed in proportion to programme expenditure on code 7.3.1., and of lorries in proportion to the expenditure of the spraying and administration programmes on code 7.3.2.

WHO expenditure was divided between administration and research and training since no clear basis was apparent for distributing expenditure to other programmes. WHO activities to support malaria control assist not only the NMEO but also the ICHSDP. Therefore the NMEO's share of WHO expenditure allocated to the administration programme was calculated according to the NMEO's share of the total malarious population (68%).

NHQ expenditure was distributed to districts in the way described above for regions. The national malaria index (see Table A2.4) was used to distribute surveillance, parasitology, research and training, entomology and WHO administration expenditure, giving 6% to Morang, 1% to Ilam and 8% to Rupandehi. Each district's share of total population sprayed and total malarious population was used to distribute the spraying and health education programmes respectively. Finally the administration programme was distributed in proportion to total district expenditure.

This method will over-estimate the share of NHQ and RTC expenditure belonging to the districts to the extent that the NHQ and RTC support also malaria control activities in ICHSDP districts. Since the majority of NHQ and RTC activity is centred on NMEO districts, and only a small proportion of NHQ and RTC expenditure is attributed to any one district, any misallocation here would not have much effect on total district expenditure.

6.3.4 ICHSDP districts (Saptari and Parsa)

The objective of the cost analysis in ICHSDP districts was first to estimate the share of total expenditure absorbed by malaria control, and then to divide this share between different malaria programmes.

No information was available in Saptari and Parsa on expenditure for 2041/2. Therefore 2040/1 expenditure was used, and increased to an approximate 1984 level by increasing total salary and allowance expenditure by 17.5% (half of the 35% increase in 2041/2).

The share of the regular budget attributable to malaria control was estimated in the following way, based on the advice of the district health officer and health post staff. In the district health office an allowance for rent and the annuitized capital cost of vehicles and microscopes was added in. Then a proportion of the time of the district health officer was apportioned to malaria, based on the advice of the DHO (25% in Saptari and 21% in Parsa) and all of the time of the district malaria assistant and laboratory technicians. The proportion of salary expenditure attributable to malaria was then used to share out expenditure under the other codes of the district health office regular budget, except the microscope cost which was allocated totally to malaria.

Laboratory supplies and equipment were supplied free from ICHSDP headquarters. Since ICHSDP HQ expenditure could not be estimated, an allowance needed to be added in to make ICHSDP districts comparable to NMEO districts. The NMEO spends approximately Rs 100,000 per year on laboratory supplies, and takes 1,269,000 slides, giving a cost of Rs 79/1000 slides. This unit cost was applied to ICHSDP slide numbers to estimate the cost of laboratory supplies, and added to the malaria share of district health office expenditure.

Malaria expenditure at district health office level was then divided between parasitology (staff and supply costs of the laboratory), spraying (the time of staff spent supervising spraying), surveillance (all other staff time) and administration (malaria's share of general office overheads).

Allocation to malaria control was more difficult at health post level. In sharing out salaries, radically different results are obtained depending on whether the actual time involved in malaria is estimated, or a proportion of total time. In the first method, malaria is viewed as an addition to the normal work of staff, and only the incremental time attributable to malaria is included. In the second method, malaria is attributed a full share of staff time, including that not spent in direct patient care. To illustrate this point, village health worker (VHW) time on malaria could be estimated on the basis of 10 minutes per slide. Multiplying by the 17,354 slides from ACD and APCD in Saptari gives a total of 413 days for malaria. However, the time could also be estimated on the basis of the number of activities done by VHWS. These amount approximately to eight (malaria, TB, leprosy, EPI, under fives, maternal care, family planning, health education). Attributing one eighth of VHW time to malaria gives 2520 days for malaria (6 VHWS per health post for 12 health posts, working on average 280 days per year). Since one aim of this study is to compare NMEO and ICHSDP costs, it is appropriate that malaria should be regarded as a main and not an additional activity. Therefore one eight of the time of VHWS is attributed to malaria.

At health post level, however, the situation is rather more complex, and estimates must be regarded as very approximate. In Saptari, health post staff reported that 50% of the time of the health-post-in charge, and 50% of the time of one auxiliary health worker, were spent on malaria.

This was difficult to believe. Therefore their activities were taken and the time spent on each estimated. No spraying had been done in 1984 in Saptari, but in Parsa the time of health post staff spent supervising spraying was estimated. Time spent on radical treatment and investigation was estimated on the basis of assumptions, checked with health post staff, that the health post-in-charge treated three quarters of the cases and the AHW one quarter, and that of the cases requiring 5 day treatment, three quarters required 5 full days to visit and treat and one quarter 5 half days. Slide collection by health post staff was assumed to be additional to their normal clinic work, and 10 minutes per slide was allowed for slide collection. Finally, an allowance was made for the time spent by peons on collecting slides from VHWs and delivering them to the laboratory.

Expenditure in the non-salary codes of the regular budget for health posts was then distributed in proportion to the malaria share of salary expenditure.

Those parts of the development budgets drawn on by malaria control fall under the malaria, supervision, transport and administration development budgets. The malaria budget for Parsa for 2040/1 was increased to an approximate 1984 level by allowing for the increased level of spraying in 1984, and divided between spraying and surveillance according to the use made of the various codes of the malaria budget. The cost of drugs and insecticides used was added. A share of the supervision, transport and administration development budgets was attributed to malaria control by distributing code 3 (TA/DA) in proportion to health post time spent on malaria, and other codes in proportion to district health office time on malaria. Malaria control's share of the administration development budget was recorded under the administration programme, and the remainder under surveillance.

District staff in both districts were adamant that no malaria patients were admitted to hospital, and this was supported by an interview with the civil surgeon in Birganj (Parsa). No in-patient cost was therefore allocated to malaria in either ICHSDP or NMEO districts.

The end result of these calculations was expenditure on malaria separated into programmes for surveillance, parasitology, spraying and administration, and for each programme, the amount contributed by the district health office regular budget, the health post regular budget, the malaria development budget, and other development budgets. Finally, the administration programme was distributed to other programmes in proportion to their total expenditure.

6.3.5 ICHSDP Headquarters and Zonal offices.

In the time available, it was not possible to make an estimate of the proportion of ICHSDP headquarters and zonal expenditures devoted to malaria. Staff support at headquarters consisted of a deputy director with responsibilities for diarrhoeal diseases, EPI and other communicable diseases in addition to malaria, and two support staff. Other costs could not be estimated. Thus comparisons between ICHSDP and NMEO services can be made only at district level, ignoring the overhead costs of supporting the district level.

6.4 Economic analysis methodology

The appropriate concept for valuing resources in an economic analysis is that of social opportunity cost - the value to society of a particular resource in its next best alternative use, or what has to be given up by using the resource in its current activity. In a highly developed market economy, the relative prices of goods and services normally provide a reasonable approximation to the relative costs to the economy of producing them and to their value in the next best alternative use. This may not be the case in developing countries where, for example, additional workers may be taken from a pool of unemployed workers and thus their opportunity cost - i.e. output forgone - will be less than the wage paid to employ them.

Financial prices may thus be adjusted in an economic analysis to produce 'accounting prices' that reflect social opportunity cost. The approach adopted here is that recommended in the Ministry of Overseas Development's 'A Guide to the Economic Appraisal of Projects in Developing Countries' (HMSO 1977). Traded goods and services are valued at world (border) prices, that is the price prevailing on the world market, and the prices of non-traded goods and services adjusted so that all goods and services are valued in terms of a common yardstick. Prices can be further adjusted through use of a savings premium to favour those programmes which encourage saving rather than consumption in economies where the availability of savings is considered a constraint to the achievement of government objectives. Finally, prices can also be adjusted through use of a consumption weight to favour programmes which redistribute income in ways considered desirable. Accounting prices which reflect social opportunity cost are often called 'efficiency prices', and those which reflect savings or income distribution objectives, 'social prices'.

The main focus of the economic study of malaria is to evaluate the economic effects of malaria on individuals and the economy, and a detailed investigation was not possible of the precise accounting prices appropriate for Nepal. It is in any case desirable that different evaluations use a consistent set of accounting prices. Therefore recent World Bank and ODA reports for Nepal were studied, and the following principles adopted.

Accounting prices

Accounting prices were calculated as described below for traded and non-traded goods. No study was found which used a savings premium or consumption weight, and there did not seem to be strong grounds for choosing any particular weights. Therefore no adjustments were made to efficiency prices.

It can be debated whether the opportunity cost of donated items should be given a positive value, on the grounds that their use in the programme may not be at the expense of any other local investment. This argument is not accepted here, since many donors earmark investment sums for a country and then decide how to distribute them, so investment not made in malaria is likely to be made in some other local programme.

Traded goods

The major traded items used in malaria control are drugs, insecticides, and capital equipment. These were valued at world prices which were in general taken to be the estimated WHO price, plus carriage, insurance and freight to the Nepal border.

The only problem arises over chloroquine. Its world price is considerably below the price of locally produced chloroquine, but it would not be supplied from abroad since WHO supplies only items not available in Nepal, and the government would presumably not purchase from foreign sources. Following the ODA guidelines, chloroquine is therefore treated as non-traded.

Non-traded goods

It was not possible to value non-traded goods by the desirable method of separating the inputs used to make the goods into labour, traded goods and non-traded goods. The short-cut of a conversion factor was used, adjusted to take account of the estimated foreign exchange component of each non-traded good.

It seems to be generally agreed that the level of distortion of prices in the Nepalese economy is not very great, and a standard conversion factor (SCF) of 0.9 has been used recently by the World Bank (Babai Irrigation Project, Staff Appraisal Report, Jan. 1984) and in an ODA - funded feasibility study (Tumlingtar Irrigation Project, HMG, Nepal June 1984). This figure is therefore used here, adjusted as noted below. Since the cost analysis has been made by budget code, it is convenient to list conversion factors by code.

Labour: In Nepal, unskilled labour is usually valued at some proportion of the average daily wage, on the grounds that it is under-employed for a substantial proportion of the year. In malaria control, unskilled labour is used for spraying. However districts appear to have considerable difficulty in recruiting spraymen at the wage of Rs 10 per day, saying that the wage is not high enough to attract labour. This suggests that the marginal productivity of labour in its next best alternative use is not less than Rs 10, perhaps because spraymen are required at relatively busy times of the year (May-June and August-September). Thus no adjustment is made to the unskilled wage, and it is multiplied by the SCF of 0.9. Skilled labour is treated in a similar fashion.

DA/TA (code 3): The majority of DA/TA goes on per diem payments, a minority being transport costs. A conversion factor of 0.92 is therefore applied.

Services (code 4.1): Financial prices are multiplied by a conversion factor of 0.95.

Porterage, printing (code 4.2): Other studies report that porters are fully employed through the year. Printing costs will include a foreign exchange component so a conversion factor of 0.92 is applied.

Rent (code 5), **repairs and maintenance** (code 6), **office goods** (code 7.1), **newspapers** (code 7.2), **supplies** (code 7.5.1), **furniture** (code 10.1), **buildings** (code 12.1): Foreign exchange costs are likely to be small so 0.92 is used.

Fuel (codes 7.3.1, 7.3.2): The price of fuel will reflect its import price and local transport costs, which will have a very high foreign exchange component. Thus 0.98 is used.

Medical equipment (7.5.2), locally purchased drugs and supplies (8.3), machinery, equipment (10.3): These have a high foreign exchange component: 0.98 is used.

Contingencies (code 9): This code appears to fund the local costs of meetings so 0.90 is used.

Items in other codes and donor-funded items (donated drugs and insecticides, capital goods) are traded goods and are valued at border prices. The only exceptions are WHO local costs which will give rise to a higher foreign exchange component then local administration expenses and are thus given a conversion factor of 0.92.

ESM1 AND SF5 FORMS

(ENGLISH TRANSLATION) ESM 1

ECONOMIC STUDY OF MALARIA

District	Unit/Health post	Locality/Vek
Village	Patient's name	Age/Sex

Instructions:
Fill in this form when you fill in the SF5 form. Read the questions to the patient exactly as they are written. If the patient is a small child, ask a relative to reply for the child.

---

1. Do you normally work?

YES NO (go to Qu.2)

(a) During the present fever did you work ?

YES (go to Qu.2) NO

(b) How many days could you not work at all?

........................days

2. Do you normally go to school?

YES NO (go to Qu.3)

(a) During the present fever did you go to school?

YES (go to Qu.3) NO

(b) How many days of school did you miss?

........................days

3. Before blood was taken did you seek help for the present fever from any place or person?

YES NO (go to Qu.4)

(a) Where did you go?

- -hospital
- -health post
- -community health leader
- -community health worker
- -private practitioner
- -drug seller
- -ayurvedic dispensary
- -faith healer
- -other (specify) ....

4. Before radical treatment was given, did you spend any money to get help or treatment for the present fever?

YES NO (end of interview)

(a) How much did you spend?

Fees	rps______
Medicines, laboratory examinations, injections	rps______
Special foods	rps______
Sacrifice, worship	rps______
Travel expenses	rps______
Other (specify)	rps______
TOTAL	rps______

Copies

Health post/district malaria office
NMEO/ICHSDP HQ, KATHMANDU.

Signature of investigator______

Post______

Date______

Checked in district______

Post______

Date______

How to fill in form ESM 1.

1. Only information on the present fever should be recorded, not information on previous attacks of malaria.

2. In Question 1, "work" is defined to include all types of work such as household work (cooking, cleaning, child care etc), agricultural work, trading etc.

3. In Question 3, note that the question asks about action taken by the patient before the blood slide was made.

4. In Question 4, note that the question asks about any expenditure before radical treatment was given.

5. Two copies of the form should be made. Each copy should be attached to a copy of the completed SF5 form for the same patient. One set should be filed in the district malaria office/health post and the other sent to the NMEO/ICHSDP headquarters in Kathmandu.

ई. एम. एम.- १

औलो सम्वन्धी आर्थिक अध्ययन

जिल्ला ... ... शाखा । हेल्थ पोष्ट ... ... लो । मेक ... ...
गाउं ... ... रोगीको नाम ... ... उमेर । लिंग ... ...

निर्देशन:-

यो फाराम स. का. नं. ५ भर्ने बेलामा भर्न गर्नु पर्दछ । यसमा लेखिएका प्रश्नहरू जस्तो लेखिएको छ त्यसरी नै रोगीलाई सोधेर दिएको जवाफमा ठीक ठीक ठाउंमा लेख्ने गर्नु पर्दछ । यदि रोगी बालक भएमा नजदिकको नातेदारहरू (जस्तै–आमा, बाबु, दाजु, दिदी आदि) बाट जवाफ लिने गर्नु पर्दछ ।

१. हालैको ज्वरोको विवरण मात्र लेख्ने गर्नु पर्दछ । पुरानो मलेरिया ज्वरोको विवरण लेख्ने गर्नु पर्दैन ।

२. प्रश्न नं. १ मा 'काम' भन्नाले सबै प्रकारको काम – जस्तै घरको काम (पकाउने, सरसफाई गर्ने, बच्चाहरू स्याहार्ने) खेतिपातिको काम, व्यापार आदि बुझाउंछ ।

३. प्रश्न नं. ३ मा रगत लिएर जानु भन्दा पहिला गरिएको कुराहरू मात्र याद गर्नु पर्दछ ।

४. प्रश्न नं. ४ मा मलेरिया अफिस अथवा हेल्थ पोष्टबाट औषधि उपचार गरेको भन्दा पहिला भएको सम्पूर्ण खर्चको विवरण मात्र लेख्नु पर्दछ ।

५. यो फाराम दुई प्रति भर्नु पर्दछ र दुई प्रति साथ स. का. नं. ५ एक एक प्रति हुनु पर्दछ । एक प्रति जिल्ला औलो कार्यालय / हेल्थ पोष्ट र अर्को प्रति राष्ट्रिय प्रधान औलो कार्यालय / केन्द्रीय सामुदायिक स्वास्थ्य सेवा विकास परियोजना काठमाडौंमा पठाउनु पर्दछ ।

---

१. के तपाई काम गर्नु हुन्छ ?

गर्छु ☐ गर्दिन (प्रश्न नं. २ मा जानु होस) ☐

(क) हालको बिरामीमा तपाईले काम गर्न सक्नु भयो ?
(प्रश्न नं. २ मा जानुहोस)
☐ भयो ☐ भएन

(ख) यदि तपाईले काम गर्न सक्नु भएन भने कति दिन काम गर्न सक्नु भएन... ... ... दिन

२. के तपाई पढ्दै हुनु हुन्छ ?

हो ☐ होईन (प्रश्न नं. ३ मा जानुहोस) ☐

(क) हालको बिरामीमा के तपाई आफ्नो कक्षामा उपस्थित हुनु हुन्थ्यो ?
थिए ☐ (प्रश्न नं. ३ मा जानुहोस) थिएन ☐

(ख) यदि तपाई आफ्नो कक्षामा उपस्थित थिएन भने कति दिन सम्म उपस्थित थिएन ?............ दिन

३. रगत दिएर जानु भन्दा पहिला तपाईलाई ज्वरो आउंदा केहि औषधि उपचार गर्नु भएको थियो ?

थियो ☐ थिएन (प्रश्न न. ४ मा जानुहोस) ☐

(क) यदि औषधि उपचार गर्नु भएको थियो भने कुन मानिस अथवा कुन ठाउंबाट गर्नु भएको थियो ?

अस्पताल	☐	औषधि पसल	☐	हेल्थपोष्ट	☐
आयुर्वेदिक औषधालय	☐	सामुदायिक स्वास्थ्य अगुवा	☐	धामि / झाँक्री	☐
सामुदायिक स्वास्थ्य कार्यकर्ता	☐	प्राइभेट डाक्टर	☐	अन्य खुलाउने ... ...।	

४. मलेरिया अफिस / हेल्थ पोष्टले पाँच दिन औषधि खुवाउनु भन्दा पहिला तपाईले रोग उपचारको निम्ति केहि रकम खर्च गर्नु भयो कि ?

भयो ☐ भएन (समाप्त) ☐

(क) यदि खर्च गर्नु भयो भने के के मा खर्च भयो बताई दिनु हुन्छ कि ?

१. फिसको लागि रु... ... ...
२. औषधि, प्रयोगशाला जांच, सुई आदि रु... ... ...
३. लागतिलो खाना र औषधि रु... ... ...
४. पूजा अथवा भाकल रु... ... ...
५. सवारी खर्च (रेल, बस, रिक्सा) रु... ... ...
६. अन्य (खुलाउने)... ... ... जम्मा रु... ... ...

फाराम भर्नेको नाम ... ...
दर्जा / मिति ... ...
जिल्ला कार्यालयमा चेक गर्ने को नाम ... ...
दर्जा / मिति ... ...

प्रति
१. जिल्ला औलो कार्यालय / हेल्थ पोष्ट
२. रा. प्र. औलो कार्यालय / सामुदायिक स्वास्थ्य सेवा विभाग परियोजना काठमाडौं

Information on SFS.

Primary Investigation of Malaria Patient.

District
Unit
Locality No.
Village
No. of houses in village
Population in village
Patient name
Age
Sex
Name of house owner
House number
Date of investigation

Condition of slides

Slide No.
Source (ACD,PCD,etc)
Date of collection
Date of laboratory receipt
Date of examination
Result (density) and species
Date of dispatch of result to unit
Date of reception of result in unit

Description of fever

No. of days of fever before slide collection
Date started
Any people in the house or nearby have fever?
Was treatment given when slide taken
If so, how many tablets?
If not, why not?
Has patient had this type of fever before?
If so when, where.
Any drugs given?
Any collection of slides?
If so when, where, by whom?
Treatment given or not. If not why not?

Movement of patient

Have you been away from your home for last 2 months?
Description of journey, dates.

Ditto for last 2 years.

After this fever have you travelled?
Where?
When?
If patient has left, where has he gone?

Local description

Housing conditions - windows etc.

Any ponds, rivers etc near house?

DDT spray

Has the house/village been sprayed?
Has the house been re-plastered?
Present condition of the walls - is there a spray mark?

Classification of patient

Indigenous/imported A/relapse /untraced

Medical treatment

Date started drug treatment
Date of completion
How many mgs chloroquin?
" " " primaquin?

Remedial measures (optional)

Collection of slides - start date, completion date.

Number of people
No. of people with fever
Consumption of chloroquin
Total slides collected
No. of slides from fever cases
No. of slides from non-fever cases
Total positives
No. PV
No. PF
No. mixed

Focal spray (optional)

Date of completion
Houses and structures sprayed
Population protected

Entomological study (optional)

Date started
Date completed
Results

Mass Blood Survey (optional)

Date started
Date completed
No. of slides in sample
No. PF/PV/mixed

Suggestions from District

copies to: NHQ
Region
District
etc.

Investigator ....

Date...........................

Signature......................

Checked in District............

....

HOUSEHOLD SURVEY QUESTIONNAIRES

ECONOMIC STUDY OF MALARIA IN NEPAL
ODA/NEW ERA
1984

HOUSEHOLD INTERVIEW QUESTIONNAIRE

Household No. /_/_/_/_/_/

Household Type
Patient /_/
Control /_/

Checked by Interviewer /_/

Re-check (District) ________ Name ________ Date ________

Re-check (Kathmandu) ________ Name ________ Date ________

Coded by ________ Name ________ Date ________

Re-coded by ________ Name ________ Date ________

1. INTRODUCTION

1.1 Head of Household : ________

1.2 Name of Respondent : ________ Caste ________

1.4 Mother Tongue : ________ Religion ________

1.6 House Number (NMEO) : ________ Village ________

1.8 Locality Number : ________ Unit Number ________

1.10 Unit Office : ________ District ________

Record of Visits

Visit Number	Date of Visit			Interviewed	Moved away	Temp. absent	Refused	Other (specify)	Name of Interviewer
	Year	Month	Day						
1									
2									
3									
4									

2. INFORMATION ON HOUSEHOLD MEMBER

I would like to know how many people live and eat together in this house ______
Please tell me the following information of the family members.
(Instruction : Please start from the household head).

No. of family members	Q. Number 2.1	2.2	2.3		2.4	2.5	2.6	2.7	2.8	2.9
	Name of family members	Relation to the household head	Age		Sex	Marital status	Has this person been present con-tinuously for the past 6 months ? 1 = Yes 2 = No	Was this person here for the last 30 days 1 = Yes 2 = No	Is he/she able to read and write a simple letter ? 1 = yes 2 = No	Has he/she ever been to school ? 1 = Yes 2 = No
			Year	Month	1. Male 2. Female					
01										
02										
03										
04										
05										
06										
07										
08										
09										
10										
11										
12										
13										
14										
15										

Instruction: Q.No.2.3: Those children who are under 6 years please write the number of completed years and months and above 6 years write age only.

Q.No. 2.5
1. Married
2. Never married
3. Widow/Widower
4. Divorced
5. Separated

Q.No. 2.6 and 2.7
Ignore short over-night absences.

Q.No.	2.9.1	2.9.2	2.10	2.11	2.11.1
No. of family members	Up to what class (this person) passed ?	Is he/she persently studying ? 1 = Yes 2 = No	What is his/her main occupation ?	Is he/she involved in any secondary occupation ? 1 = Yes 2 = No	What is his/her secondary occupation ?
01					
02					
03					
04					
05					
06					
07					
08					
09					
10					
11					
12					
13					
14					
15					

Instruction : Q. No. 2.9.1

Code : 1. Up to class 5
2. Class 6-7
3. Class 8-10
4. Passed Intermediate level
5. Passed Bachlor level
6. Passed Master degree or above

Instruction : Q.No. 2.10 and 2.11.1

01. Own agriculture
02. Govt. or semi-Govt. employment
03. Employed by others in the Pvt. firm on salary basis
04. Self employed in Pvt. sector, e.g. business/contract
05. Teacher/Lawyer/Engineer/Doctor or other professional
06. Own cottage industry
07. Wage labour
08. Skilled labour (carpenter etc.)
09. Military/Police
10. Domestic work
11. Can't work/does not do any work (Chronically ill, disabled, elderly, child).
99. Other (specify) ______________

2.12 Please describe how he/she spent his/her time yesterday between when he/she got up and when he/she went to bed.
(Instruction : Don't ask to any child who does not go to school or do any work or to the person whose activities were recorded in the patient/control interview).

No. of family members	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15
Time	T				A					S					K
4 AM															
5 AM															
6 AM															
7 AM															
8 AM															
9 AM															
10 AM															
11 AM															
12 AM															
1 PM															
2 PM															
3 PM															
4 PM															
5 PM															
6 PM															
7 PM															
8 PM															
9 PM															
10 PM															

(Instruction: Interviwer should calculate hours by activities after filling the different tasks.

No. of hrs. / Activity															
01-Animal husbandry															
02-Agriculture (own)															
03-Hunting/gathering															
04-Fetching fuel															
05-Manufacturing															
06-Food processing															
07-Construction															
08-Domestic works															
09-Child care															
10-Trading															
11-Ag. wage labour															
12-Non-Ag. work for wages/salary															
13-Education															
Total hrs.															

Q. No. →	2.12.1	2.12.2
No. of family members	Were the activities you did yesterday and the time you spent typical for this time of year ? Code: 1-Yes ; 2. No.	(If no) Why not ?
01		
02		
03		
04		
05		
06		
07		
08		
09		
10		
11		
12		
13		
14		
15		

Q.No. 2.12.2

Code : 01 /__/ Festival
02 /__/ Religious duties
03 /__/ Child birth
04 /__/ Out-of-village visiting
05 /__/ Marriage ceremony
06 /__/ Illness
07 /__/ School holiday
08 /__/ Market day
09 /__/ Slack period for own work
10 /__/ Looking for paid work but not available etc.
99 /__/ Other (specify) ____________________

(Instruction : Do not ask the Malaria Patient and Control Person)

Q.No	2.13	2.13.1	2.13.2	2.13.3	2.13.4
Number of family members	Since the last visit, has any one not been completely well? 1.Yes(continue) 2.No	If yes, for how many days was he/she not completely well ?	During this period, was he/she totally disabled/unable to work/ unable to carry out his/her normal activities ? 1.Yes; 2.No (Go to Q. No. 2.14) (For child, ask whether he/she was not playing or not as active as usual)	If yes for how many days ?	What illness did he/she had ? Code: 1-fever 2-respiratory problems 3-eye infection 4-bad diarrhoea 5-skin disease 6-injuries and wounds 9-other (specify) ________
01					
02					
03					
04					
05					
06					
07					
08					
09					
10					
11					
12					
13					
14					
15					

Q. No	2.14	2.14.1	2.14.2	2.15	2.16
Number of family member	Since my last visit, were there any days when he/she could not carry out his/her normal activities or work for reasons other than illness ? 1.Yes ; 2.No	If yes, what were the reasons he/she could not work/carry out his/her normal activities ? Code :- 1.Festival 2.Religious duties 3.Child birth 4.Out-of-village visiting 5.Marriage ceremony 9.Other (specify)____	How many days he/she could not do work normal activities ?	Where did he/she normally sleep within last 30 days ? Code :- 1.Inside the room 2.Outside the room(Varanda) 3.Open space 9.Other(specify)_	Did he/she use mosquito nets at the sleeping time ? Code : 1 = Yes 2 = No.
01					
02					
03					
04					
05					
06					
07					
08					
09					
10					
11					
12					
13					
14					
15					

Instruction : Q . No. 2.14

Do not ask for the malaria patient or control person.

3. Which are the most busy months during the year for your household ? (Instruction: Nepali months to be recorded).

____
____
____

3.1 Which are the least busy months during the year for your household ?

____
____
____

(Instruction : The interviewer firstly observes and fill in the following information. If the interviewer is not able to record the information then only ask some of the questions to the respondent of household.)

4. What type of dwelling house is this ?

1 /__7 Room or flat in a larger structure shared by one or more other families.

2 /__7 Single family house.

9 /__7 Other (specify) ______________

4.1 What types of materials are mostly used in the walls ?

1 /__7 Baked bricks
2 /__7 Unbaked bricks
3 /__7 Mud walls
4 /__7 Bamboo fence with mud plaster
9 /__7 Other (specify) ______________

4.2 What type of roofing materials are mostly used in the structure ?

1 /__7 Tiles
2 /__7 Thatched
3 /__7 Corrugated sheets/Asbestos sheets
4 /__7 Local type tiles (Khapada)
9 /__7 Other (specify) ______________

4.3 What is the type of flooring of structure ?

1 /__7 Cement floor
2 /__7 Brick floor
3 /__7 Mud floor
9 /__7 Other (specify) ______________

4.4 Are the doors and windows screened against insects ?

1 /_/ Doors and windows
2 /_/ Neither
3 /_/ Doors only
4 /_/ Windows only

4.5 Would you give the present monetary value of your dwelling house ?

Rs. ... ...

5. Does your family own any other dwelling besides this one either here in this village or some where else ?

1 /_/ Yes 2 /_/ No

5.1 What would be the monetary value of those dwelling/s ?

Rs. ... ...

6. **LAND HOLDING**

"Could you please tell me how much land you and your family members own, how much you have rented out and how much you have rented in during the past 12 months ?"

(Instruction : Please ask this question in the way you think best. Remember to probe for land registered in the names of other members of the family besides household head. Also find out if any family member has land in another Panchayat or in the Terai or Hills and include this also. Get information on total land rented in by various members of the family on either tenancy (Mohiyani), share basis (Adhiyaa) or fixed amount basis (Koot).

(Bigha)

Type of Land Holding		Cultivated Land		Fallow Area	Total	Remarks
		Irrigated Area	Un-Irrigated Area			
A. Registered in family members' names (onward)						
B. Own Land Rented Out	Mohiyani					
	Adhiyaa/Koot/ Fixed Amt.					
	Total					
C. Own land cultivated by the family (A - B)						
D. Other's land rented in	Mohiyani					
	Adhiyaa/Koot/ Fixed Amt.					
	Total					
E. Total land cultivated by the family (C+D)						

7. (Interviewer: Please refer to question 6 and see how much land is cultivated by this family .)

Earlier I had asked about how much land you and your family owned and cultivated. I shall now ask you about the different crop cultivated and produced between Baisakh 2040 and Baisakh 2041.

Name of Crop		Production Received From				Production Sold (In unit)	Remarks
		Own land cultivated (Qty)	Own land rented out (Qty)	Others land rented in (Qty)	Total (Qty. in Unit) (2+3+4)		
1		2	3	4	5=2+3+4	6	7
Cereal Crop	1. Paddy						
	2. Maize						
	3. Wheat						
	4.						
Cash Crop	1.						
	2.						
	3.						
	4.						

8. Would you kindly tell me the number of livestock you are keeping ?

Types of Livestock	Number of Livestock	Estimated Price (all) (Rs.)
Buffalo		
Milch Buffalo		
Adult He-buffalo		
Cow		
Milch Cow		
OX		
Goat		
Horse/mule		
Pig		
Other (Specify)__________		
Total		

9. During the last year (Baisakh 2040 to Baisakh 2041, B.S.), has any one in this household earned income from different activities other than selling food grain and cash crop ?

1 /_7 Yes 2 /_7 No

9.1 From what types of activities did you earn ?

1 /_7 Selling livestock
2 /_7 Selling milk or clearified butter
3 /_7 Wage labour
4 /_7 Salary - Govt., Semi-Govt. or private institution
5 /_7 Business/Contract
6 /_7 Cottage industry (own)
7 /_7 Pension
9 /_7 Other (specify) ________

10. Have you employed any temporary wage laboures within the last 14 days ?

1 /_7 Yes 2 /_7 No

10.1 What was the total number of work days done by those wage labourers within the last 14 days ?

________ work days.

(To be filled in by interviewer after interview is completed).

1. Reliability of responses

- /_/ All reliable
- /_/ Mostly reliable
- /_/ Partially reliable
- /_/ Unreliable

2. Degree of co-operation

- /_/ Very good
- /_/ Good
- /_/ Not so good
- /_/ Not good at all

3. Did the person interviewed understand the questions ?

- /_/ No difficulty
- /_/ Little difficulty
- /_/ Much difficulty
- /_/ Great difficulty

4. Other comments, especially any particular responses you feel were unreliable .

____

____

____

ECONOMIC STUDY OF MALARIA IN NEPAL
ODA/NEW ERA
1984

QUESTIONNAIRE : INTERVIEW NO.1

Household Number / / / / /   Patient / / Control / /

Checked by Interviewer / /

Re-check (District) ________ Name ________ Date ________
Re-check (Kathmandu) ________ Name ________ Date ________
Coded by ________ Name ________ Date ________
Re-coded by ________ Name ________ Date ________

Name of Patient ________ Age ________ Sex ________
Caste ________ Religion ________ Mother Tounge ________
Name of Control ________ Age ________ Sex ________
Caste ________ Religion ________ Mother Tounge ________

Name of Respondent (if patient/control is a child) ________
Relationship to patient/control ________

House Number (NMEO) ________ Village ________
Locality Number ________ Unit Number ________
Unit Office ________ District ________
Date of Interview : ________ (Year) ________ (Month) ________ (day) ________

Fill this in only for the Patient, not for the Control
Record of Visits

Visit	Date of Visit			Interviewed	Moved away	Temp absent	Refused	Other (Specify)	Name of Interviewer
	Year	Month	Day						
1									
2									
3									
4									

Fill this form only for the control, not for the patient

Patient's Name ________ Age ________ age-band ________ Sex ________

Houses visited to obtain control	Control of suitable age/sex lives here	Had malaria during last 2 months ?	Interviewed	Absent from village	Refused	Failed after repeat visit to locate
1. 2. 3. 4.						

Control's Name ________ Age ________ Sex ________

1. How long have you lived continuously in this district ?

1 /__/ Less than a year
2 /__/ 1 - 2 years
3 /__/ 3 - 4 years
4 /__/ 5 - 9 years
5 /__/ 10 years and over
6 /__/ All your life

2. Please describe how you spent your time yesterday between when you got up and when you went to bed .

(Instruction: If the patient/control is a child of 9 years or under who does not work/go to school, ask his/her mother to tell you about her activities).

/__/ Patient/control /__/ Mother

Time	Task
4 AM	
5 AM	
6 AM	
7 AM	
8 AM	
9 AM	
10 AM	
11 AM	
12 AM	
1 PM	
2 PM	
3 PM	
4 PM	
5 PM	
6 PM	
7 PM	
8 PM	
9 PM	
10 PM	

Instruction: Interviewer should calculate 1-13 by activities after filling the different tasks which were done by patient/control/ Mother yesterday.

Activity	No. of hours
01 /__/ Animal husbandry	
02 /__/ Agriculture	
03 /__/ Hunting & gathering	
04 /__/ Fetching fuel	
05 /__/ Manufacturing	
06 /__/ Food processing	
07 /__/ Constrcution	
08 /__/ Domestic works	
09 /__/ Child care	
10 /__/ Trading	
11 /__/ Agricultural wage labour	
12 /__/ Non-agricultural work for wages/salary	
13 /__/ Education	
Total	

3. So you spent ________ hours yesterday working (and at school). On average did you spend about same hours working (and at school) on each of the last 7 days ?

1 /__/ Yes
2 /__/ No days worked (Go to Q.No.4).
3 /__/ No work/school all 7 days but on some days
4 /__/ Can't say (Go to Q. No.4).

3.1 What was the maximum and the minimum number of hours per day you worked (and spent at school) in the last 7 days, and for how many days did you work these hour ?

Maximum ____________ hours per day ____________ No. of days
Minimum ____________ hours per day ____________ No. of days

3.2 Were you paid for doing this work yesterday (selling goods and wage labour) ?

1 /__7 Yes 2 /__7 No (Go to Q. No. 4)

3.2.1 Mode of payment ?

Code : 1 = Cash (Piece rate)
2 = Cash (time rate)
3 = Exchange Labour
4 = In kind /__7
5 = Cash and kind (piece rate)
6 = Cash and kind (time rate)
7 = Sale of goods

3.3 How much did you earn ?

Rs. ____________ (both cash and kind)

4. Within the last 30 days, were there days when you were not completely well (ask to patient/control) ?

1 [ ] Yes 2 [ ] No (Go to Q. No.15)

4.1 What illness did you have ?

Name of illness ____________ starting date ____________

4.2 Did you have any other illness ?

1 [ ] Yes 2 [ ] No

4.3 What illness did you have ?

Name of illness ____________ starting date ________

(Instruction : If the patient/control has had more than one type of illness, ask questions 5-14 first for the more recent illness. Then repeat the questions for the earlier illness in the seperate forms).

5. Do you feel completely well now ?

1 /_7 Yes 2 /_7 No (Go to Q. No. 6)

5.1 On what day did you first feel completely well ?

____________________date

____________________total days of illness.

(Instruction : If the patient/control is 9 years and under who works or goes to school and over 9 years, continue the interview with Q.No.6. If the patient/control is 9 years and under and does not do any work or does not go to school go to Q.No. 8).

6. When you were ill with ________(illness), were there any days within the last 30 days when you were totally disabled/ unable to work/unable to carry out your normal activities because of illness ?

1 /_7 Yes 2 /_7 No (Go to Q.No. 7)

6.1 For how many days ?

__________ days.

6.2 How did you spent your time during these days ?

1 /_7 Resting

2 /_7 Sleeping

9 /_7 Other (Specify) _________

6.3 What activities were you prevented by your illness from doing on these days ?

Task	Av. hrs. per day	No. of days	Activity
______	______	______	01 /_7 Animal husbandry
______	______	______	02 /_7 Agriculture
______	______	______	03 /_7 Hunting & gathering
______	______	______	04 /_7 Fetching fuel
______	______	______	05 /_7 Manufacturing
______	______	______	06 /_7 Food processing
______	______	______	07 /_7 Construction
______	______	______	08 /_7 Domestic works
______	______	______	09 /_7 Child care
______	______	______	10 /_7 Trading
______	______	______	11 /_7 Agricultural wage labour
______	______	______	12 /_7 Non-agricultural work for wages/ salary
______	______	______	
______	______	______	13 /_7 Education

7. On some days of your illness within the last 30 days were you partly disabled/unable to work/unable to carry out your normal activities ?

1 /_7 Yes 2 /_7 No (Go to Q.No. 10)

7.1 For how many days were you partly disabled ?

________ days.

7.2 Could you work your usual number of hour ?

1 /_7 Yes (Go to Q.No. 7.4)

2 /_7 No

7.3 On average, how many hours a day could you work ?

____________ hours per day .

7.4 Could you work as hard as usual ?

1 [ ] yes 2 [ ] No

(if the answer to both 7.2 and 7.4 is "yes", check the answer to Q. No.7).

7.5 What activities did you do on these days when you were <u>partly</u> disabled ?

Task	Av. hrs. per day	No of days	Activity
....	______	______	01 [ ] Animal husbandry
....	______	______	02 [ ] Agriculture
....	______	______	03 [ ] Hunting & gathering
....	______	______	04 [ ] Fetching fuel
....	______	______	05 [ ] Manufacturing
....	______	______	06 [ ] Food processing
....	______	______	07 [ ] Construction
....	______	______	08 [ ] Domestic works
....	______	______	09 [ ] Child care
....	______	______	10 [ ] Trading
....	______	______	11 [ ] Agricultural wage labour
....	______	______	12 [ ] Non-agricultural work for wages/salary
....	______	______	13 [ ] Education

Total hrs. per day ______________ (Go to Q. No.10)

(Instruction: If the patient/control is 9 years and under who does not do any work or does not go to school ask the question to his/her mother about his/her illness).

8. When the child (Patient/control) was ill with ______ (illness) were there any days within the last 30 days when he/she was not playing or not as active as usual because of the illness ?

1 [ ] Yes 2 [ ] No (Go to Q. No. 9)

8.1 For how many days ?

__________ days

9. Did any one in the household have to spend extra time within the last 30 days looking after him/her during the illness ?

1 [ ] Yes 2 [ ] No (Go to Q. No. 13)

9.1 Who was the main person who looked after him/her ?

Name ____________________ Age ____________ Relationship __________

9.2 For how many days did the child (patient/control) need special care because of this illness ?

______________ days.

9.3 Did ______________ (Name of person providing care) spend much extra time each day looking after __________ (patient/control) ?

1 [ ] Less than 2 hours
2 [ ] 2 - 4 hours
3 [ ] 4 - 6 hours
4 [ ] 6 - 8 hours
5 [ ] All day

9.4 Was he/she able to carry out his/her normal activities as well during these days ?

1 [ ] Yes (Go to Q. No.13)
2 [ ] No

9.5 What was he/she prevented from doing ?

Task	Av. hrs. per day	No. of days	Activity
			01 [ ] Animal husbandry
			02 [ ] Agriculture
			03 [ ] Hunting & Gathering
			04 [ ] Fetching fuel
			05 [ ] Manufacturing
			06 [ ] Food processing
			07 [ ] Construction
			08 [ ] Domestic works
			09 [ ] Child care
			10 [ ] Trading
			11 [ ] Agricultural wage labour
			12 [ ] Non-agricultural work for wages/ salary
			13 [ ] Education

9.6 Did some one help to do this work ?

1 [ ] Yes   2 [ ] No (Go to Q.No. 9.10)
3 [ ] Don't know (Go to Q. No.13)

9.6.1 Who helped you ?

	First Helper	Second Helper	Third Helper
1 [ ] Household Member	[ ] Name ____ Age ____ Relationship ____	[ ] Name ____ Age ____ Relationship ____	[ ] Name ____ Age ____ Relationship ____
2 [ ] Hired Labour	[ ]	[ ]	[ ]
3 [ ] Labour Exchange	[ ]	[ ]	[ ]
9 [ ] Other (specify)__	[ ]	[ ]	[ ]
9.7 What work did they do ? (Code by activity, specify task)	[ ] ____ task	[ ] ____ task	[ ] ____ task
9.8 How many hours each day on average did they help ?	____ hrs.	____ hrs.	____ hrs.
9.9 For how many days did they help ?	____ days	____ days	____ days

(Instruction : If code 1 in Q. No.9.6.1 go to Q. No.11
If code 2 in Q. No.9.6.1 go to Q. No.12
If code 3 & 9 in Q. No.9.6.1 go to Q. No.13

9.10 (If no) why not ?

____

____

____

(Go to Q. No.13)

(Instruction : If the patient/control is 9 years and under who does work and goes to school and over 9 years ask the following questions).

10. Within the last 30 days, did any one have to spend to do extra work or spend time looking after you because of your illness ?

1 [ ] Yes 2 [ ] No (Go to Q.No.10.5 3 [ ] Don't know (Go to Q.No.13)

10.1 Who had to do extra work ?

		First Helper	Second Helper	Third Helper
	1 Household Member	[ ] Name ____ Age ____ Relationship ____	[ ] Name ____ Age ____ Relationship ____	[ ] Name ____ Age ____ Relationship ____
	2 Hired Labour	[ ]	[ ]	[ ]
	3 Labour exchange	[ ]	[ ]	[ ]
	9 Other (Specify)__	[ ]	[ ]	[ ]
10.2	What work did they do ? (Code by activity, specify task)	[ ][ ] ____ task	[ ][ ] ____ task	[ ][ ] ____ task
10.3	How many hours each day on average did they help ?	____ hrs.	____ hrs.	____ hrs.
10.4	For how many days did they help ?	____ days	____ days	____ days

Instruction : If code 1 in Q.No. 10.1 go to Q.No. 11
If code 2 in Q.No. 10.1 go to Q.No. 12
If code 3 & 9 Q.No.10.1 go to Q.No. 13

10.5 (If no extra work done) why not ?

____

____

____ (Go to Q. No.13)

(Instruction : If household members helped to do the work).

11. Did the extra work cause any problem for your family ? Did he/she/they have to stop doing other things in order to do the work ?

1 [ ] Yes 2 [ ] No (Go to Q. No.13)

11.1 What things did they stop doing ? who stoped ?

Name ________________ Age ____ Relationship ____ Task ____

Name ________________ Age ____ Relationship ____ Task ____

Name ________________ Age ____ Relationship ____ Task ____

(Instruction : Ask this question if labourers were hired to do the work).

12. How much money did you have to pay him/her/them ?

Per day (Rs.) ________ meals ________ Other (specify) ________

Total period ________ total amount paid (Rs.) ____________
(include in kind)

13. Within the last 30 days did the household lose any cash income because of this illness (exclude expenditure on medical treatment and hired labour) ?

1 [ ] Yes 2 [ ] No (Go to Q. No.14)

13.1 Why did the household lose income and what was its value ?

Reason	Value
-------	Rs. ________
------	Rs. ________
------	Rs. ________

14. Has the illness caused you or your household any other problems ? (record in words of patient/control).

____

____

____

14.1 Do you think your illness would effect any production ?

____

____

____

(Instruction : Ask Q. No.15 to the patient/control if he/she is over 9 years or 9 and under who does work and goes to school. Interviewer should ask the patient/control's mother if the patient/control is a child of 9 years and under who does not work or does not go to school).

[ ] Patient/control   [ ] Mothers

15. Within the last 30 days, were there days you could not carry out your normal activities or work for reasons other than illness ?

1 [ ] Yes   2. [ ] No --> For patient continue go to Q. No.16
For control if has been ill go to Q. No.25
For control if has not been ill go to Q. No.29

15.1 What were the reasons you could not work/carry out your normal activities ? What were you prevented from doing ?

Reasons	Prevented from doing	Activity Code
1 [ ] Festival ______	Task ______	[ ]
2 [ ] Religious duties ______	Task ______	[ ]
3 [ ] Child birth ______	Task ______	[ ]
4 [ ] Out-of-village visiting ______	Task ______	[ ]
5 [ ] Marriage ceremony ______	Task ______	[ ]
9 [ ] Other (specify) ______	Task ______	[ ]

15.2 How many days in all did you take up ?

________ days.

(For patient continue Q. No.16
If control has been ill go to Q. No.25
If control has not been ill go to Q. No.29)

THIS SECTION SHOULD BE COMPLETED FOR THE PATIENT ONLY

16. Can you describe how did you feel in the last 30 days when you had the fever ? What symptoms did you have ? (Record in Column - 1).

16.1 How many days did each symptom last ? (Record in Column - 2).

16.2 Did each symptom continue all day ? (Record in Column- 3).

Code : 1 = Yes (Go to Q. No.17)
2 = No

16.3 Which time during the day did these symptoms start ? (Record in Column - 4).

Code: 1 = Morning 3 = Evening
2 = Afternoon 4 = Night

16.4 On average, for how many hours each day did these symptoms last ? (Record in Column - 5).

Record Sheet for Question No. 16

Code:

	COLUMNS				
1	2	3	4	5	
Symptoms	No. of days lasted	All day	When it started	Hours per day	Remarks
1 [ ] Fever					
2 [ ] Shivering					
3 [ ] Headache					
4 [ ] Pains in lumbs back, joints of hands/legs					
5 [ ] Nausea					
6 [ ] Vomiting					
7 [ ] Joundice					
8 [ ] Diorrhoea					
9 [ ] Coma					
10 [ ] Weak					
11 [ ] Tired					
12 [ ] Giddy					
99 [ ] Other (Specify) ____					

17. How did you feel after the fever had gone ?

1 [ ] Feeling completely well [ ] -> (Go to Q. No.18)
2 [ ] Fever not gone
3 [ ] Feeling : 1 [ ] Weak
2 [ ] Tired
3 [ ] Giddy

17.1 How many days did it last ?

I ____________ days.
II ____________ days.
III ____________ days.

18. Have you treated yourself at home for this illness in the last 30 days ? (Do not include here purchased medicine. Q. No.19 ask about those).

1 [ ] Yes 2 [ ] No (Go to Q. No.19)

18.1 What was the treatment ?

____

18.2 Did it cost you any money ?

1 [ ] Yes 2 [ ] No (Go to Q. No.18.4)

18.3 How much did you spend ?

Rs. ______________

18.4 How many days after the start of the illness did you treat yourself ?

After ______ days.

19. Did you go to see someone for help to get better in the last 30 days such as a doctor, faith healer, malaria volunteer, etc. ?

1 [ ] Yes 2 [ ] No (Go to Q. No.21)

19.1 Where/to whom did you go ?

Code: 01 = Hospital
02 = Health Post
03 = Village health leader
04 = Village health worker
05 = Ayurvedic dispensary
06 = Malaria clinic
07 = Malaria office
08 = Malaria volunteers
09 = Faith healer
10 = Drug seller
11 = Private doctor/ practitioner
12 = Other (specify) ____

(Exclude visits to the patient by a malaria worker).

19.2 How long did it take you to go go there and come back ? (If it takes to go to ... place less than 10 minutes or the place is in the same village, code = 0

19.3 Did some-one go with you ? Code: 1=Yes; 2=No (Go to Q.No.19.5)

19.4 Who went with you ? Code: For household member write relationship and for other code '0'

Item	I Visit	II Visit	III Visit	Remarks
19.1	[ ]	[ ]	[ ]	
19.2	__hrs. __mts.	__hrs. __mts.	__hrs. __mts.	
19.3	[ ]	[ ]	[ ]	
19.4				

19.5 Did you have to pay any money for help/treatment ?

1 [ ] Yes 2 [ ] No (Go to Q. No.20)

19.6 How much did you pay ?

	I Visit	II Visit	III Visit	Remarks
1 [ ] Fee/present	Rs.			
2 [ ] Medicines, laboratory test injection, etc.				
3 [ ] Travel expenses (two way for patient and companion)				
4 [ ] Special food				
5 [ ] Sacrifice and worship				
9 [ ] Other (Specify) _____				
Total				

20. How many days after the start of the illness did you first seek help ?

_________ days (Go to Q. No.22)

(Instruction : If no visit made ask Q. No.21)

21. Why did you not seek help to get the illness treated ?

1 [ ] Too expensive
2. [ ] No need, not serious
3. [ ] Too far
4. [ ] Malaria worker came to house
5. [ ] Don't know
9 [ ] Other (Specify) _____

22. Have you been visited at home by a malaria workers within the last 30 days ? (all malaria workers)

1 [ ] Yes 2 [ ] No (Go to q. No.23)

22.1 On which day/s did he/they visit you ? (If the patient could not remember the actual date then the interviewer check the malaria stencil and write date on this form).

__________ date

__________ date

__________ date

(Instruction : Ask this question if the patient did not go to malaria clinic/office or volunteer).

23. Do you know where you can go and get free treatment when you have fever ?

1 [ ] Yes __________ 2 [ ] No (Go to q. No.24)
Name of place

23.1 Why did you not go there ?

1 [ ] Too expensive to travel
2 [ ] No need, not serious
3 [ ] Too far
4 [ ] Poor service
5 [ ] Waited for malaria workers to call at home
6 [ ] Don't know
9 [ ] Other (specify) __________

24. Within the last 12 months, have you had a fever like this before ?

1 [ ] Yes 2 [ ] No (Go to q. No.29)

24.1 When was the first time you had it ?

_______________ date.

24.2 For how many days were you not completely well then ?

_______________ days.

24.3 Did you receive any treatment ?

1 [ ] Yes   2 [ ] No (Go to Q. No.24.5)

24.4 Where did you get treatment and what was the treatment ?

_______________ place _______________ treatment .

24.5 Did you get the fever again between that first time and the present fever ?

1 [ ] Yes   2 [ ] No (Go to Q. No.29)

24.6 Altogether how many times did you get the fever within the last 12 months ?

_______________ times.

(Include first and last episode).

24.7 For approximately how many days were you not completely well on each occasion ?

_______________ days. (Go to Q. No.29)

(Instruction : Q. 25 - 28 to be asked of control respondents only)

25. When you were ill with _______________ (mention all illness if control has had more than one within the last 30 days) did you treat yourself at home ? (Exclude purchased medicines).

1 [ ] Yes   2 [ ] No (Go to Q. No.26)

25.1 What was the treatment ?

____

25.2 Did it cost you any money ?

1 [ ] Yes 2 [ ] No (Go to Q. No.25.4)

25.3 How much did it cost you ?

Rs. ___________________________

25.4 How many days after the start of the illness did you treat yourself ?

After _______________ days.

26. Did you go to see some-one for help to get better in the Last 30 days, such as a doctor, faith healer, malaria volunteer etc. ?

1 [ ] Yes 2 [ ] No (Go to Q. No.28)

26.1 Where/to whom did you go ?

Code:	I Visit	II Visit	III Visit	Remarks
01 = Hospital 02 = Health post 03 = Village health leader 04 = Village health worker 05 = Ayurvedic dispensary 06 = Malaria clinic 07 = Malaria office 08 = Malaria volunteer 09 = Faith healer 10 = Drug seller 11 = Private doctor/ practitioner 99 = Other (specify) ____	[ ]	[ ]	[ ]	
26.2 How long did it take you to go there and come back ? (If it takes to go to ... place less than 10 minutes or the place is in the same village, code = 0	__ hrs. __ minu.	__ hrs. __ minu.	__ hrs. __ minu.	

	I Visit	II Visit	III Visit	Remarks
26.3 Did some-one go with you ? Code: 1 = Yes; 2 = No (Go to Q. No.26.5)	[ ]	[ ]	[ ]	
26.4 Who went with you ? Code : For household member write relationship and for other code '0'				

26.5 Did you have to pay any money for help/treatment ?

1 [ ] Yes 2 [ ] No (Go to Q. No.27).

26.6 How much did you pay ?

	I Visit	II Visit	III Visit	Remarks
1 [ ] Fee/present	Rs.			
2 [ ] Medicines, laboratory test, injection, etc				
3 [ ] Travel expenses (two way, for patient and companion)				
4 [ ] Special food				
5 [ ] Sacrifice and worship				
9 [ ] Other (specify) ___				
Total				

27. How many days after the start of the illness did you first seek help ?

_____________ days (Go to Q. No.29)

(Instruction : If no visit made ask Q. No.28)

28. Why did you not seek help for the illness ?

1 [ ] Too costly
2. [ ] No need, not serious
3. [ ] Too far
4. [ ] Don't know
9 [ ] Other (specify) _______________

(To ask both the patient and control respondents)

29. Has anyone in the household (apart from patient/control) not been completely well within the last 30 days ?

1 [ ] Yes 2 [ ] No (End)

29.1 Who were they ?

1. Name of person ________________ Age _____ Relationship _____
2. Name of person ________________ Age _____ Relationship _____
3. Name of person ________________ Age _____ Relationship _____

29.1.1 For how many days was/were he/she/they not completely well ?

1. _____________ days.
2. _____________ days.
3. _____________ days.

29.2 Was/were/he/she/they totally disabled/unable to work/unable to carry out his/her/their normal activities during these days ?

(For a child, ask whether he/she was not playing or not as active as usual).

1 [ ] Yes 2 [ ] No (End)

29.3 For how many days ?

1. ______________ days.
2. ______________ days.
3. ______________ days.

29.4 What illness did he/she/they have ?

1. ______________
2. ______________
3. ______________

INTERVIEWER'S REPORT

(To be filled in by interviewer after interview is completed)

1. Reliability of responses

[ ] All reliable [ ] Partially reliable
[ ] Mostly reliable [ ] Unreliable

2. Degree of co-operation

[ ] Very good [ ] Not so good
[ ] Good [ ] Not good at all

3. Did the person interviewed understand the questions ?

[ ] No difficulty [ ] Much difficulty
[ ] Little difficulty [ ] Great difficulty

4. Other comments, especially any particular responses you feel were unreliable.

____
____
____

5. Describe what the patien/control was doing when you arrived at the house.

____
____
____

6. Where do you think the patient/control person comes from ?

1.[ ] Hills 2 [ ] Terai 3 [ ] India
4.[ ] Don't know 9 [ ] Other (Specify) ______________

ECONOMIC STUDY OF MALARIA IN NEPAL
ODA/NEW ERA
1984

QUESTIONNAIRE : INTERVIEW NO. 2

Checked by Interviewer ▱
Re-check (District) ________ Name ________ Date ________
Re-check (Kathmandu ________ Name ________ Date ________
Coded by ________ Name ________ Date ________
Re-corded by ________ Name ________ Date ________
Household Number ▱▱▱▱▱ Patient ▱
Date of Interview No.1 ________ Control ▱

Fill in only for control before second interview: Had the control been ill before the first interview ? 1 ▱ Yes 2 ▱ No	Fill in for patient only at end of interview: Cured of malaria – ▱ Not cured – ▱

Name of patient ________ Age ________ Sex ________
Caste ________ Religion ________ Mother tounge ________
Name of control ________ Age ________ Sex ________
Caste ________ Religion ________ Mother tongue ________

Name of Respondent (if pateint/control is a child) ________
Relationship to patient/control ________

House Number (NMEO) ________ Village ________
Locality Number ________ Unit Number ________
Unit Office ________ District ________
Date of Interview ________ (year) ________ (month) ________ (day)

Fill this in only for the Patient not for the Control
Record of Visits

Visit No.	Date of Visit Yr	Month	Day	Interviewed	Moved away	Temp. absent	Refused	Other (specify)	Name of Interviewer

1. Please describe how you spent your time yesterday between when you got up and when you went to bed ?

(Instruction: If the patient/control is a child of 9 years or under who does not go to school/work, ask his/her mother to tell you about her activities).

/__/ Patient/control /__/ Mother

Time	Task
4 AM	
5 AM	
6 AM	
7 AM	
8 AM	
9 AM	
10 AM	
11 AM	
12 AM	
1 PM	
2 PM	
3 PM	
4 PM	
5 PM	
6 PM	
7 PM	
8 PM	
9 PM	
10 PM	

Instruction: Interviewer should calculate hours 1-13 by activities after filling the different tasks which were done by patient/control yesterday.

Activity	No. of hours
01. Animal husbandry	____
02. Agriculture	____
03. Hunting and gathoring	____
04. Fetching fuel	____
05. Manufacturing	____
06. Food processing	____
07. Construction	____
08. Domestic works	____
09. Child care	____
10. Trading	____
11. Agriculture wage labour	____
12. Non-Agri. work for wages/salary	____
13. Education	____
Total	____

2. So you spent ____ hours yesterday working (and at, school). On average did you spend about ____ hours working (and at school) on each of the last 7 days ?

1 /__/ Yes
2 /__/ No days worked (Go to Q.No.3)
3 /__/ No work/school all 7 days but on some days
4 /__/ Can't say (Go to Q.No.3)

2.1 What was the maximum and the minimum number of hours per day you worked (and spent at school) in the last 7 days, and for how many days did you work there hours ?

Maximum ____________ hours per day ____________ No. of days
Minimum ____________ hours per day ____________ No. of days

2.2 Were you paid for doing this work yesterday (selling goods and wage labour) ?

1 /__/ Yes 2 /__/ No (Go to Q. No.3).

2.2.1 Mode of payment

Code : 1 = Cash (piece rate)
2 = Cash (time rate)
3 = Exchange labour
4 = In kind
5 = Cash and kind (piece rate)
6 = Cash and kind (time rate)
7 = Sale of goods

/__/

2.3 How much did you earn ?
Rs. ________ (both cash and kind).

If the patient/control has had more than one type of illness, ask question 3.5 to 12 first for the more recent illness. Then repeat the questions for the earlier illness in the seperate forms.

3. Since my last visit, were there days when you were not completely well ? (Ask to patient/control)

1 /__/ Yes 2 /__/ No →
- if control ill before first interview please go to Q.No.8
- if control not ill before first interview please go to Q.No.13
- for patient go to Q.No. 8.

3.1 Was your illness a continuation of an illness you had before or a new illness ?

1 /__/ Continuation of illness (Go to Q.No.3.4)
2 /__/ New illness

3.2 What illness was this ?

____

____

3.3 What date did the illness start ?
________________ date.

3.4 Did you have any other illness ?

1 /__/ Yes 2 /__/ No

3.5 What types of illness ?

Name of illness ________________ starting date ________________

3.6 Do you now feel completely well ?

1 /__7 Yes ✓ 2 /__7 No

3.7 On what day did you first feel completely well ?

__________ date.
__________ No. of days ill.

(Instruction: If the pateint/control is over 9 years or 9 and under who goes to school/work continue the interview with Q.No.4. If the patient/control is 9 years and under and does not go to school/work continue with Q.No.6)

4. When you were ill since my last visit, were there any days when you were totally disabled/unable to work/unable to carry out your normal activities because of your illness ?

1 /__7 Yes 2 /__7 No (Go to Q.No.5)

4.1 For how many days ?
_______ days.

4.2 How did you spend your time during these days ?

1 /__7 Resting
2 /__7 Sleeping
9 /__7 Other (specify) _______________

4.3 What activities were you prevented by your illness from doing on these days ?

Task	Av.hrs. per day	No.of days	Activity
______	______	______	01 /__7 Animal husbandry
______	______	______	02 /__7 Agriculture
______	______	______	03 /__7 Hunting and gathering
______	______	______	04 /__7 Fetching fuel
______	______	______	05 /__7 Manufacturing
______	______	______	06 /__7 Food processing
______	______	______	07 /__7 Construction
______	______	______	08 /__7 Domestic works
______	______	______	09 /__7 Child care
______	______	______	10 /__7 Trading
______	______	______	11 /__7 Agri.wage labour
______	______	______	12 /__7 Non-Ag. works for wages/salary
______	______	______	
______	______	______	13 /__7 Education

5. On some days of your illness since my last visit were you partly disabled/unable to work/unable to carry out your normal activities ?

1 /__7 Yes 2 /__7 No (Go to Q.No.8)

5.1 For how many days were you partly disabled ?
_____ days.

5.2 Could you work your usual number of hours ?
1 /__/ Yes (Go to Q.No. 5.4)
2 /__/ No

5.3 On average, how many hours a day could you work ?
_______ hours per day.

5.4 Could you work as hard as usual ?
1 /__/ Yes (Go to Q.No. 8) 2 /__/ No
(If the answer to both 5.2 and 5.4 is "Yes", check the answer to Q.No. 5).

5.5 What activities did you do on these days when you were partly disabled ?

Task	Av.hrs.per day	No.of days
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

Total hours per day _____
(Go to Q.No.8)

Activity
01 /__/ Animal husbandry
02 /__/ Agriculture
03 /__/ Hunting and gathering
04 /__/ Fetching fuel
05 /__/ Manufacturing
06 /__/ Food processing
07 /__/ Construction
08 /__/ Domestic works
09 /__/ Child care
10 /__/ Trading
11 /__/ Agriculture wage labour
12 /__/ Non-Ag.work for wages/salary
13 /__/ Education

(Ask Q.No.6 and 7 only if the patient/control is 9 years and under who does not go to school/work).

6. When _________ (patient/control) was ill since my last visit, were there any days when he/she was not playing or not as active as usual because of the illness ?
1 /__/ Yes 2 /__/ No (Go to Q.No. 7)

6.1 For how many days ?
_____ days.

7. Did anyone in the household have to spend extra time since my last visit looking after him/her during the illness ?
1 /__/ Yes 2 /__/ No (Go to Q.No. 11)

7.1 Who was the main person who looked after him/her ?
Name _______________ Age _______ Relationship _______________

7.2 For how many days did ________ (patient/control) need special care because of the illness ?
________ days.

7.3 Did ____________ (name of person providing care) spend much extra time each day looking after ____________ (patient/control) ?

/_7 Less than 2 hours
/_7 2-4 hours
/_7 4-6 hours
/_7 6-8 hours
/_7 All day

7.4 Was he/she able to carry out his/her normal activities as well during these days ?

1 /_7 Yes (Go to Q.No. 11)
2 /_7 No

7.5 What was he/she prevented from doing ?

Task	Av.hrs.per day	No.of days
____	____	____
____	____	____
____	____	____
____	____	____
____	____	____
____	____	____
____	____	____
____	____	____
____	____	____
____	____	____
____	____	____
____	____	____
____	____	____

Activity

01 /_7 Animal husbandry
02 /_7 Agriculture
03 /_7 Hunting and gathering
04 /_7 Fetching fuel
05 /_7 Manufacturing
06 /_7 Food processing
07 /_7 Construction
08 /_7 Domestic works
09 /_7 Child care
10 /_7 Trading
11 /_7 Agricultural wage labour
12 /_7 Non-Ag.work for wages/salary
13 /_7 Education

7.6 Did someone help to do this work ?

1 /_7 Yes 2 /_7 No (Go to Q.No. 7.10) 3 /_7 Don't know (Go to Q.No.11)

7.6.1 Who helped you ?

	First helper	Second helper	Third helper
1 /_/ Household member	/_/ Name ____ Age __ Relationship	/_/ Name ____ Age __ Relationship	/_/ Name ____ Age __ Relationship
2 /_/ Hired Labour	/_/	/_/	/_/
3 /_/ Labour exchange	/_/	/_/	/_/
9 /_/ Other (specify) ____	/_/	/_/	/_/

7.7 What work did they do ? (code by activity, specify task) /_/ ____ task /_/ ____ task /_/ ____ task

7.8 How many hours each day on average did they help ? ____ hrs. ____ hrs. ____ hrs.

7.9 For how many days did they help ? ____ days ____ days ____ days

(Instruction if code 1 in 7.6.1, go to Q. No. 9
" " 2 - in 7.6.1, go to Q. No. 10
" " 3 & 9 in 7.6.1, go to Q. No. 11

7.10 (If no) why not ?

____
____
____
____

(Go to Q.No. 11)

(If the patient/control is over 9 years, 9 years and under who does work and goes to school ask the following questions.)

8. Since my last visit, has any one had to do extra work or spend time looking after you because of your illness ?

1 /__/ Yes 2 /__/ No (Go to Q.No. 8.5) 3/__/ Don't know (Go to Q.No. 11)

8.1 Who had to do extra work ?

	First helper	Second helper	Third helper
1 /__/ Household member	/__/ Name ___ Age ___ Relation-ship	/__/ Name ___ Age ___ Relation-ship	/__/ Name ___ Age ___ Relation-ship
2 /__/ Hired Labour	/__/	/__/	/__/
3 /__/ Labour exchange	/__/	/__/	/__/
9 /__/ Other (specify)___	/__/	/__/	/__/

8.2 What work did they do ? (code by activity. specify task)	/__/ ___ task	/__/ ___ task	/__/ ___ task
8.3 How many hours each day on average did they help ?	___ hrs	___ hrs	___ hrs
8.4 For how many days did they help ?	___ days	___ days	___ days

Instruction: If code 1 in Q.No. 8.1 go to Q. No. 9
.. .. 2 .. .. 8.1 go to Q. No. 10
.. .. 3&9 .. 8.1 go to Q. No. 11

8.5 (If no extra work done) why not ? (Go to Q. No. 11)

____

____

(If household members helped to do the work)

9. Did the extra work cause any problem for your family ?
Did he/she-they have to stop doing other things in order to do the work ?

1 /__7 Yes 2 /__7 No (Go to 11)

9.1 What things did they stop doing ? Who stoped ?

Name ____________ Age _____ Relationship __________ Task ________
Name ____________ Age _____ Relationship __________ Task ________
Name ____________ Age _____ Relationship __________ Task ________

(Instruction : Ask this question if labourer were hired to the work)

10. How much money did you have to pay him/her/them ?

Per day (Rs.) __________ meals ________ other (specify) __________
Total period __________ total amount paid (Rs.) ____________
(include in kind)

11. Since my last visit, has the household lost any cash income because of this illness (exclude expenditure on medical treatment and hired labour) ?

1 /__7 Yes 2 /__7 No (Go to Q. No. 12)

11.1 Why did the household lose income and what was its value ?

Reason	Value
____	Rs. ____
____	Rs. ____
____	Rs. ____

12. Has the illness caused you or your household any other problems since my last visit ?
(record in words of patient/control) .

____

____

12.1 Do you think your illness would affect any production ?

____

____

(Instruction :1. Ask this question if the patient/control is over 9 years or 9 and under who does work and goes to school.

2. Interviewer should ask the patient/control's mother if the patient/control is 9 and under and does not work or does not go to school.

/_7 Patient/control /_7 Mother

13. Since my last visit, were there days you could not carry out Your normal activities or work for reasons other than illness ?

1 /_7 Yes For patient continue Q.No. 13.1

2 /_7 No End the interview, if patient control has been well since first interview.
If the patient has been ill go to Q.No. 14.
If the control has been ill go to Q.No. 20.

13.1 What were the reasons you could not work/carry out your normal activities ? What were you prevented from doing ?

Reasons	Prevented from doing	Activity code
1 /_7 Festival	Task ______	/_7
2 /_7 Religious duties	Task ______	/_7
3 /_7 Child birth	Task ______	/_7
4 /_7 Out of village visiting	Task ______	/_7
5 /_7 Marriage ceremony	Task ______	/_7
9 /_7 Other (specify) ____	Task ______	/_7

13.2 How many days in all did you take up ?

__________ days

Instruction : 2nd interview if patient/control has been well since first interview. If they have been ill, for patient go to Q. No. 14, for control go to Q. No. 20).

THIS SECTION SHOULD BE COMPLETED FOR THE PATIENT ONLY

14 Can you describe how did you feel when you were ill since my last visit ?

____

____

15. What symptoms did you have (Record in column - 1)

15.1 How many days did each symptom last ?
(Record in column - 2)

15.2 Did each sympton continue all day ?
(Record in column - 3)
Code : 1 = Yes (Go to Q. No. 16)
2 = No

15.3 Which time during the day did these symptoms start ?
(Record in column - 4)
Code : 1 - Morning 3 - Evening
2 = Afternoon 4 = Night

15.4 On average, for how many hours each day did these symptoms last ?
(Record in column - 5).

Record Sheet for Question No. 15

Code :	COLUMNS					
	1 Sympt-oms	2 No. of days lasted	3 All day	4 When it started	5 Hours per day	Remarks
1 /__7 Fever						
2 /__7 Shivering						
3 /__7 Headache						
4 /__7 Pains in lumbs/back joints of hands and legs						
5 /__7 Nausea						
6 /__7 Vomiting						
7 /__7 Joundice						
8 /__7 Diarrhoea						
9 /__7 Coma						
10 /__7 Weak						
11 /__7 Tired						
12 /__7 Giddy						
99 /__7 Other (specify)						

16. Have you treated yourself at home for this illness since my last visit ?

(Do not include here purchased medicine).

1 /__/ Yes 2 /__/ No (Go to Q.No. 17)

16.1 What was the treatment ?

____

____

16.2 Did it cost you any money ?

1 /__/ Yes 2 /__/ No (Go to Q. No. 17)

16.3 How much did you spend ?

(Rs.) ______________

17. Since my last visit, have you been to see someone for help to get better such as a doctor, faith healer, malaria volunteer, etc. ?

1 /__/ Yes 2 /__/ No (Go to Q. No. 18)

17.1. Where/to whom did you go ?

Code :	I Visit	II Visit	III Visit	Remarks
01 - Hospital 02 - Health post 03 - Village health leader 04 - Village health worker 05 - Ayurvedic dispensary 06 - Malaria clinic 07 - Malaria office 08 - Malaria volunteer 09 - Faith healer 10 - Drug seller 11 - Private doctor/ practitioner 99 - Other (specify) ____ (Exclude visits to the patient by a malaria worker)	▱	▱	▱	
17.2 How long did it take you to go there and come back ? (If, it takes to go to ... place less than 10 minutes/ the place is in the same village. Code = 0)	__ hrs __ min.	__ hrs __ min.	__ hrs __ min.	
17.3 Did someone go with you ? Code : 1 = Yes, 2 = No (Go to Q.No. 17.5)				
17.4 Who went with you ? Code : For household member write relationship and for other code "0".				

17.5 Did you have to pay any money for help/treatment ?

1 /__7 Yes   2 /__7 No (Go to Q.No. 19)

17.6 How much did you pay ?

	I Visit	II Visit	III Visit	Remarks
1 /__7 Fee/present	Rs.____			
2 /__7 Medicines, laboratory test, injection, etc.				
3 /__7 Travel expenses (two way, for patient and companion)				
4 /__7 Special food				
5 /__7 Sacrifice and worship				
9 /__7 Other (specify) ____				
Total	Rs.____			

(Instruction: If no visit made ask Q. No. 18).

18. Why did you not seek help to get the illness treated ?

1 /__7 Too expensive
2 /__7 No need, not serious
3 /__7 Too far
4 /__7 Malaria worker came to house
5 /__7 Don't know
9 /__7 Other (specify) ____________

19. Have you been visited at home by a malaria worker since my last visit ?

1 /__/ Yes 2 /__/ No (End of interview)

19.1 On which day/s did he/they visit you ? (If the patient could not remember the actual date then the interviewer check the malaria stencil and write date on this form).

____________ date
____________ date
____________ date

(End of the patient interview).

(Instruction : Ask Q. No. 20 – 22 only for the control and only if the control has been ill since the first interview).

20. When you were ill since my last visit, did you treat yourself at home ? (Exclude purchased medicines).

1 /__/ Yes 2 /__/ No (Go to Q . No. 21)

20.1 What was the treatment ?

____
____

20.2 Did it cost you any money ?

1 /__/ Yes 2 /__/ No (Go to Q. No. 21)

20.3 How much did you spend ?

(Rs.) ____________

21. Did you go to see someone for help to get better such as a doctor, faith healer, malaria volunteer etc., since my last visit ?

1 /__7 Yes 2 /__7 No (Go to Q. No. 22)

21.1 Where/ to whom did you go

	Code :	I Visit	II Visit	III Visit	Remarks
	01 - Hospital 02 - Health post 03 - Village health leader 04 - Village health worker 05 - Ayurvedic dispensary 06 - Malaria clinic 07 - Malaria office 08 - Malaria volunteer 09 - Faith healer 10 - Drug seller 11 - Private doctor/ practitioner 99 - Other (specify) ___	/__7	/__7	/__7	
21.2	How long did it take you to go there and come back ? (If it taken to go to — place less than 10 minutes/ the place is in the same village code "O"	___ hrs ___ min	___ hrs ___ min	___ hrs ___ min	
21.3	Did someone go with you ? Code : 1 -Yes, 2-No(Go to Q. No.21.5)				
21.4	Who went with you ? Code : For household member write relationship and for other code "O".				

21.5 Did you have to pay any money for help/treatment ?

1 /_7 Yes 2 /_7 No (End the interview)

21.6 How much did you pay ?

	I Visit	II Visit	III Visit	Remarks
1 /_7 Fee/Present	Rs.____	____	____	
2 /_7 Medicines, laboratory test, injection, etc.				
3 /_7 Travel expenses (two way for patient and companion)				
4 /_7 Special food				
5 /_7 Sacrifice and worship				
9 /_7 Other (specify) ____				

(Instruction : If no visit made ask Q. No. 22)

22. Why did you not seek help for the illness ?

1 /_7 Too coustly

2 /_7 No need, not serious

3 /_7 Too far

4 /_7 Don't know

9 /_7 Other (specify) ____________

Interviewer's Report

(To be filled in by interviewer after interview is completed)

1. Reliability of responses

/_7 All reliable /_7 Partially reliable

/_7 Mostly reliable /_7 Unreliable

2. Degree of Co-operation.

/_7 Very good /_7 Not so good

/_7 Good /_7 Not good at all

3. Did the person interviewed understand the questions ?

/_7 No difficulty /_7 Much difficulty

/_7 Little difficulty /_7 Great difficulty

4. Other comments, especially any particular responses you feel were unreliable.

____

____

5. Describe what the patient/control was doing when you arrived at the house.

____

____

6. Where do you think the patient/control person comes from ?

1 /_7 Hills 2 /_7 Terai 3 /_7 India

4 /_7 Don't know 9 /_7 Other (specify) __________

ADDITIONAL TABLES

Table A5.1: Outline of proposed form for collecting information on costs and effectiveness of parasitic disease control projects

DESCRIPTION OF PROJECT: e.g. insecticidal spraying in Zone 1

	Year 1		Year T	
	With project	Without project	With project	Without project
PROJECT EFFECTIVENESS				
1. Population of project zone (N)				
2. Prevalence rates (P)				
Disease A				
Disease B				
Disease C, etc.				
3. Case-fatality rates (F)				
Disease A				
Disease B				
Disease C, etc.				
4. Disability rates (D)				
Disease A				
Disease B				
Disease C, etc.				
5. Death rate from causes unaffected by project (F*)				
6. Disability rate from causes unaffected by project (D*)				

	In national currency	In foreign exchange	In national currency	In foreign exchange
PROJECT COSTS				
1. Incurred by project agency				
Labor				
Supplies				
Depreciation				
2. Incurred by other government agencies				
Labor				
Supplies				
Depreciation				
3. Incurred by domestic private sector				
Labor				
Supplies				
Depreciation				
4. Incurred by external donors				
Labor				
Supplies				
Depreciation				

Table A5.2: Cost-effectiveness ratios of parasitic disease control projects: annual costs per person protected (from Barlow and Grobar 1985)

Disease	Annual cost per person protected (1984 $)	Control method: Drugs	Control method: Vector control	Control method: Water supply	Country	Reference
African trypanosomiasis	0.76	x	x		Subsaharan Africa	Molyneux (1983)
Schistosomiasis	0.03*	x			Tanzania	Rugemalila et al. (1984)
	0.06*	x			Tanzania	Rugemalila et al. (1984)
	0.44	x	x		Sudan	Prescott (1983)
	0.65		x		Puerto Rico	Jobin (1979)
	0.96	x	x		Liberia	Saladin et al. (1983)
	1.05	x	x		Liberia	Saladin et al. (1983)
	1.22		x		Brazil	Jobin (1979)
	1.34		x		Zimbabwe	Evans (1983)
	1.42	x			St. Lucia	Jordan et al. (1982 b)
	1.45	x			St. Lucia	Cook et al. (1977)
	1.45	x			St. Lucia	Jordan et al. (1982b)
	1.50	x	x		Egypt	Iarotski & Davis (1981)
	1.60	x			St. Lucia	Jordan et al. (1982b)
	1.66		x		Puerto Rico	Jobin (1979)
	1.74		x		Puerto Rico	Negron-Aponte & Jobin (1979)
	1.79		x		Ghana	Chu et al. (1981)
	1.79		x		Zimbabwe	Evans (1983)
	2.09	x	x		Liberia	Saladin et al. (1983)
	2.14		x		Iran	Jobin (1979)
	2.20		x		Tanzania	Jobin (1979)
	2.27*	x			Zaire	Polderman (1984)
	2.37**	x	x		Zaire	Polderman (1984)
	2.48		x		Brazil	Jobin (1979)
	2.49		x		Puerto Rico	Jobin (1979)
	2.65	x			St. Lucia	Cook et al. (1977)
	2.91	x			St. Lucia	Jordan et al. (1982b)
	3.25**	x	x		Zaire	Polderman (1984)
	3.75		x		St. Lucia	Prentice et al. (1981)
	5.76		x		St. Lucia	Jordan et al. (1978)
	7.80		x		Egypt	Jobin (1979)
	8.05			x	St. Lucia	Jordan et al. (1982a)
	9.72			x	St. Lucia	Jordan et al. (1982a)
	11.14		x		St. Lucia	Jobin (1979)
	12.35			x	St. Lucia	Jordan et al. (1982a)
	12.61			x	St. Lucia	Jordan et al. (1982a)
	16.91		x		Brazil	Jobin (1979)
	18.32	Not specified			Cameroon	Duke & Moore (1976)

Table A5.2: Cost-effectiveness ratios of parasitic disease control projects: annual costs per person protected (from Barlow and Grobar 1985): continued

Disease	Annual cost per person protected (1984 $)	Control method			Country	Reference
		Drugs	Vector control	Water supply		
Filariasis	0.59		x		India	Rao et al. (1980)
	0.60	x			India	Rao et al. (1980)
	0.69	x			India	Rao et al. (1980)
	0.70	x			India	Basu (1971b)
	0.71		x		India	Rao et al. (1980)
	0.73	x	x		India	Rao et al. (1980)
	0.76	x	x		India	Rao et al. (1980)
	1.31	x			Kenya	Wijers & Kaleli (1984)
	1.39	x			India	Basu (1971b)
	1.91	x	x		India	Rao et al. (1980)
Ascariasis	0.10*	x			Kenya	Latham (1977)
	0.49	x			Malaysia	Sinniah & Sinniah (1981)
	0.50	x			Malaysia	Sinniah & Sinniah (1981)
	0.63	x			Malaysia	Sinniah & Sinniah (1981)
	0.64	x			Malaysia	Sinniah & Sinniah (1981)
	3.34	x			Liberia	Sturchler et al. (1980)
	11.77	x			Liberia	Sturchler et al. (1980)
Ankylostomiasis	0.49	x			Malaysia	Sinniah & Sinniah (1981)
	0.50	x			Malaysia	Sinniah & Sinniah (1981)
	0.63	x			Malaysia	Sinniah & Sinniah (1981)
	0.64	x			Malaysia	Sinniah & Sinniah (1981)
	1.28	x			Malaysia	Sinniah & Sinniah (1981)
	1.48	x			Malaysia	Sinniah & Sinniah (1981)
	1.50	x			Malaysia	Sinniah & Sinniah (1981)
	1.88	x			Malaysia	Sinniah & Sinniah (1981)
	3.34	x			Liberia	Struchler et al. (1980)
	11.77	x			Liberia	Struchler et al. (1980)
Trichuriasis	0.49	x			Malaysia	Sinniah & Sinniah (1981)
	0.50	x			Malaysia	Sinniah & Sinniah (1981)
	0.63	x			Malaysia	Sinniah & Sinniah (1981)
	0.64	x			Malaysia	Sinniah & Sinniah (1981)
	1.28	x			Malaysia	Sinniah & Sinniah (1981)
	1.48	x			Malaysia	Sinniah & Sinniah (1981)
	1.50	x			Malaysia	Sinniah & Sinniah (1981)
	1.88	x			Malaysia	Sinniah & Sinniah (1981)
Other diseases reviewed	No estimates of annual cost per person protected.					

NOTES: * Drug costs only.
** Materials costs only.

Table A5.3: Cost-effectiveness ratios of parasitic disease control projects: cost per case-year prevented (from Barlow and Grobar 1985)

Disease	Cost per case-year prevented* (1984 $)	Control method: Drugs	Vector control	Water supply	Country	Reference
Schistosomiasis	0.16**	x			Tanzania	Rugemalila et al. (1984)
	0.34**	x			Tanzania	Rugemalila et al. (1984)
	0.34	x			Upper Volta	Bruilhe et al. (1981)
	2.46	x			Iran	Rosenfield et al. (1977)
	2.32	x	x	x	Iran	Rosenfield et al. (1977)
	6.15	Not specified			Philippines	Farooq (1963)
	8.31			x	Iran	Rosenfield et al. (1977)
	8.83	x			China	Wiemer (1984)
	8.93	x			St. Lucia	Rosenfield (1979)
	9.13***	x	x		Zaire	Polderman (1984)
	9.29		x		Iran	Rosenfield et al. (1977)
	11.16	x	x		Liberia	Saladin et al. (1983)
	11.97***	x	x		Zaire	Polderman (1984)
	13.37		x		Tanzania	Foster (1967)
	13.99	x			St. Lucia	Bekele (1980)
	14.07	x			St. Lucia	Bekele (1980)
	14.99	x			St. Lucia	Jordan (1977)
	18.45	x	x		St. Lucia	Bekele (1980)
	20.01		x		St. Lucia	Prentice et al. (1981)
	24.23		x		St. Lucia	Bekele (1980)
	26.00	x	x		Iran	Massoud et al. (1982)
	26.10	x	x		St. Lucia	Bekele (1980)
	30.29	x		x	St. Lucia	Bekele (1980)
	30.66		x		St. Lucia	Bekele (1980)
	33.01	x		x	St. Lucia	Rosenfield (1979)
	34.62	x	x	x	St. Lucia	Bekele (1980)
	39.06	x		x	St. Lucia	Bekele (1980)
	40.54**	x			Zaire	Polderman (1984)
	41.90			x	St. Lucia	Rosenfield (1979)
	47.69		x	x	St. Lucia	Bekele (1980)
	50.62	x	x	x	St. Lucia	Bekele (1980)
	52.12	x	x		Liberia	Saladin et al. (1983)
	55.61			x	St. Lucia	Bekele (1980)
	57.40			x	St. Lucia	Bekele (1980)
	58.66		x	x	St. Lucia	Bekele (1980)
	63.02		x		St. Lucia	Jordan (1977)
	68.13			x	St. Lucia	Jordan (1977)
	84.23		x		St. Lucia	Rosenfield (1979)
	No effect		x		Sudan	Amin et al. (1982)
	No effect	x	x		Liberia	Saladin et al. (1983)

Table A5.3: Cost-effectiveness ratios of parasitic disease control projects: cost per case-year prevented (from Barlow and Grobar 1985): continued

Disease	Cost per case-year prevented* (1984 $)	Control method			Country	Reference
		Drugs	Vector control	Water supply		
Onchocerciasis	83.28		x		West Africa	Prescott (1980b)
	No effect		x		Nigeria	Davies (1968)
Filariasis	5.71	x			Kenya	Wijers & Kaleli (1984)
	11.79		x		India	Rao et al. (1980)
	137.64	x			India	Rao et al. (1980)
	251.96	x	x		India	Rao et al. (1980)
	No effect	x	x		India	Rao et al. (1980)
	No effect	x	x		India	Rao et al. (1980)
	No effect	x			India	Rao et al. (1980)
Ascariasis	0.39**	x			Kenya	Latham et al. (1977)
	0.52	x			Malaysia	Sinniah & Sinniah (1981)
	0.54	x			Malaysia	Sinniah & Sinniah (1981)
	0.64	x			Malaysia	Sinniah & Sinniah (1981)
	0.65	x			Malaysia	Sinniah & Sinniah (1981)
	1.07	x			Nigeria	Kale et al. (1982)
	2.64	x			Kenya	Stephenson et al. (1983)
	20.69	x			Liberia	Sturchler et al. (1980)
	78.58	x			Liberia	Sturchler et al. (1980)
Ankylostomiasis	0.95	x			Malaysia	Sinniah & Sinniah (1981)
	1.33	x			Malaysia	Sinniah & Sinniah (1981)
	1.59	x			Malaysia	Sinniah & Sinniah (1981)
	1.79	x			Malaysia	Sinniah & Sinniah (1981)
	1.83	x			Malaysia	Sinniah & Sinniah (1981)
	1.89	x			Malaysia	Sinniah & Sinniah (1981)
	2.29	x			Malaysia	Sinniah & Sinniah (1981)
	2.57	x			Malaysia	Sinniah & Sinniah (1981)
	6.77	x			Nigeria	Kale et al. (1982)
	27.96	x			Liberia	Sturchler et al. (1980)
	117.36	x			Liberia	Sturchler et al. (1980)
Trichuriasis	1.00	x			Malaysia	Sinniah & Sinniah (1981)
	1.32	x			Malaysia	Sinniah & Sinniah (1981)
	1.49	x			Malaysia	Sinniah & Sinniah (1981)
	1.53	x			Malaysia	Sinniah & Sinniah (1981)
	2.29	x			Malaysia	Sinniah & Sinniah (1981)
	2.37	x			Malaysia	Sinniah & Sinniah (1981)
	2.54	x			Malaysia	Sinniah & Sinniah (1981)
	2.88	x			Malaysia	Sinniah & Sinniah (1981)
Other diseases reviewed	No estimates of cost per case-year prevented.					

NOTES: *Annual cost divided by annual number of cases prevented, or total cost during project life divided by number of case-years prevented during project life.

**Drug costs only.

***Drug and molluscicide costs only.

Country	Puerto Rico			St Lucia	Brazil			Egypt	Iran	Tanzania
Locality	Vieques	Patillas	Guayama Arroyo	Cul-de-Sac	São Lourenço	Belo Horizonte	Taquarendi	Kom El Birka	Dez Scheme	Mwanza
Hydrology	Natural	Natural and irrigation	Natural and irrigation	Natural	Natural	Natural and irrigation	Irrigation	Irrigation	Irrigation	Natural
Annual rainfall (cm)	115	179	140	250	150	160	50	30	30	100
Controlled area (km^2)	130	122	207	18	80	200	2.5	52	220	100
Population	8,400	17,100	47,000	6,000	4,280	20,000	1,500	17,000	18,000	4,300
Annual volume of snail habitat treated (m^3)	65,000	89,000	106,400	182,000	80,000	39,000	15,000	1,154,000	500,000	200,000
Habitat volume per surface area (m^3/km^2)	500	739	514	10,000	1,000	195	6,000	16,000	2,300	2,000
Population density (persons/km^2)	64	140	227	333	54	100	600	330	82	43
Habitat volume per person (m^3)	7.8	5.2	2.3	30	18.5	2.0	10	80	28	46
Molluscicide	NaPCP	NaPCP	NaPCP	Bayer	Bayer	Bayer	Bayer	NaPCP & Bayer	Bayer	Bayer
Cost period (years)	10	7	1	11	10	4	5	1	1	1
Currency	U.S $	U.S $	U.S $	U.S.$	U.S $	U.S.$	U.S.$	Egyptian	U.S $	Shillings
Total cost of program	$43,600	$60,180	$8,290	$32,500	$316,800	$34,000	$6,800	£20,700	$13,000	TS 30,000
Base year for costs	1960	1960	1955	1972	1971	1968	1964	1963	1972	1972
Annual cost in 1972 U.S. dollars	$13,000	$17,000	$20,000	$25,000	$32,000	$10,000	$1,500	$58,600	$17,000	$4,170
Annual cost per 100 m^3 treated	$20	$19	$19	$17	$40	$26	$10	$1.40	$3.40	$2.10
Annual cost per km^2	$100	$139	$97	$1,700	$400	$50	$600	$1,130	$77	$41
Annual cost per person	$1.50	$1.00	$0.43	$4.00	$7.40	$0.50	$0.70	$3.45	$0.94	$0.75
Program cost breakdown labor	45%	61%		50%	80%	50%	36%	5%	6%	
Molluscicide	3%	6%	11%	22%	10%	11%	40%	85%	19%	25%
Transport and equipment	7%			16%	5%	15%	24%		21%	
Supervision	22%			16%		14%			54%	
Others	3%	33%	89%	6%	5%			10%		75%

Table A5.4: Comparison of molluscicide programme costs for ten schistosomiasis control projects (from Jobin 1979)

Table A5.5 Comparative cost-effectiveness of oral rehydration therapy based on diarrhoea-associated deaths (from Applied Communication Technology 1985)

Project or site	Country	Cost per child per year (1985 $)	Deaths averted per 1000 children	Cost per death averted
Matlab Hospital	Bangladesh	0.50	4.04	$124
Sukawati	Indonesia	1.14	6.97	$163
Darmaraja	Indonesia	1.50	8.46	$177
Mass Media	The Gambia	1.56	6.94	$224
Bandung	Indonesia	0.92	3.25	$283
Campurdarat	Indonesia	1.38	4.73	$291
Salt/Sugar Home	Egypt	4.76	8.20	$580
Oralyte Home	Egypt	4.99	7.80	$639
Mass Media	Honduras	4.14	5.16	$802
Salt/Sugar Pre.	Egypt	9.99	7.00	$1427
Oralyte Comm.	Egypt	5.56	2.00	$2780
Con 2-Awareness	Egypt	4.24	0.40	$10600

Source: Applied Communications Technology (1985)

Table A5.6 Comparative vaccination cost per fully vaccinated child (from Phillips, Feachem and Mills 1985)

Country (reference)	Vaccines delivered	Strategy	Cost per CFV (local currency & date)	Cost per CFV ($US 1982)
Brazil	Full EPI	(i) Routine (static)	4671 cruzeiros (1982)	26.0
(Creese 1982)	Full EPI	(ii) Intensification (outreach)	1579 cruzeiros (1982)	8.8
(Creese 1984)	Polio	(iii) Campaign (mobile)	378 cruzeiros (1982)	2.1
Cameroon (Ahmed 1982)	Full EPI	Mixed (static/mobile)	2758 francs (1981)	9.5
Gambia (Robertson et al. 1982)	Full EPI	Mixed (static/mobile)	38 dalasi[1] (1980/81)	19.2
			24 dalasi[2] (1980/81)	12.0
Ghana (Litvinov et al. 1979)	Full EPI	(i) Outreach	41 cedi (1979)	154.0
		(ii) Mobile	12 cedi (1979)	45.5
Indonesia (Creese 1981)	BCG, 2 DPT	Mixed (static/mobile)	1412 rupiah (1979)	2.6
Ivory Coast (Shepard 1982)	Full EPI	(i) Mobile unit - Abengourou	2628 francs (1980/81)	8.9
		(ii) Static centres - Abengourou	5432 francs (1980/81)	18.5
Kenya (Wang'ombe 1982)	Full EPI	Static	150 shillings (1981)	18.6
Philippines (Creese 1978)	BCG, 2 DPT	Outreach	30 pesos (1978)	6.2
Thailand (Creese 1980)	BCG, 2 DPT	Mixed (static/mobile)	217 baht (1979)	13.2

1. With expatriates
2. Without expatriates

Table A5.7: Analysis of NMEO district recurrent expenditure 1983

District	Population at risk 1983 (1)	Total cases 1983 (2)	Dist.-level expenditure (Rs) (3)	Value of insecticide used (Rs) (4)	Value of drugs used (Rs) (5)	HQ and RTC expenditure (Rs) (6)	Regional expenditure (Rs) (7)	Total dist. expenditure (Rs) (8)	Per capita expenditure (Rs) (9)
Morang	484,852	710	1,161,624	344,328	58,004	255,301	148,764	1,968,021	4.05
Sunsari	314,512	453	862,694	244,298	33,321	176,553	102,670	1,419,436	4.51
Jhapa	449,177	583	1,308,300	432,771	37,592	256,403	140,941	2,224,008	4.95
Ilam	63,277	75	528,126	68,129	13,833	69,834	38,234	716,556	11.32
Panchthar	78,233	353	618,185	0	14,142	97,383	55,905	778,134	9.95
Bhojpur	80,246	359	695,656	6,183	12,757	106,537	60,985	882,078	10.99
Udaipur	128,269	181	956,176	242,417	22,659	131,574	74,880	1,427,704	11.17
Khotang	69,203	153	656,242	0	8,458	86,896	48,822	799,618	11.55
Eastern region	1,658,969	2,867	6,778,921	1,338,126	232,466	1,178,800	678,322	10,207,635	6.15
Ramechhap	84,844	94	624,515	0	9,852	82,722	41,143	758,232	8.94
Sindhuli	127,358	269	1,041,688	123,234	18,671	145,813	72,806	1,406,311	11.04
Mahottari	358,493	1,096	1,139,995	190,862	51,280	255,699	131,095	2,368,851	6.61
Dhanusha	423,621	2,125	1,332,185	1,749,940	63,837	361,315	185,598	4,693,876	11.08
Sarlahi	322,532	745	961,194	560,659	57,509	287,429	107,374	1,894,164	5.87
Chitwan	283,775	464	1,087,699	250,085	48,819	186,067	86,518	1,581,188	5.57
Kavre	97,648	294	581,048	0	24,283	87,835	63,336	652,622	6.68
Central region	1,698,270	5,087	6,619,334	4,473,988	255,281	1,327,879	677,863	13,354,256	7.86
Rupandehi	373,989	1,182	1,249,056	711,123	38,922	273,582	183,318	2,435,928	6.57
Gorkha	219,894	653	1,065,430	15,393	22,406	187,987	187,134	1,398,410	6.36
Palpa	138,848	444	754,574	0	16,834	128,627	73,437	972,462	7.00
Kapilvastu	305,376	846	1,082,335	471,463	39,658	224,048	146,316	1,963,803	6.43
Nawalparasi	329,335	790	1,115,895	623,461	39,181	227,145	146,136	2,151,817	6.53
Western region	1,367,442	3,845	5,267,289	1,821,440	157,073	1,041,382	655,318	8,942,413	6.54
Surkhet	126,738	341	931,506	192,681	18,158	140,674	89,469	1,362,401	10.75
Dang	277,600	372	1,255,621	275,338	23,473	203,088	131,562	1,888,882	6.80
Bankey	197,683	165	783,537	317,543	19,840	122,245	79,327	1,242,492	6.29
Bardiya	201,859	189	663,187	173,625	17,480	112,268	71,464	1,037,016	5.16
Kailali	248,824	533	988,428	585,158	21,309	181,667	132,858	1,749,413	7.83
Kanchanpur	199,526	434	1,033,692	666,751	18,047	180,681	123,222	2,010,113	10.07
Mid west region	1,251,429	1,953	5,475,972	2,130,088	117,299	941,135	625,903	9,290,318	7.42
TOTAL (a)	5,976,110	13,845	24,141,515	9,763,474	762,526	4,490,216	2,637,397	41,795,029	6.99

(a) Includes expenditure on treatment of cases at HQ

Table A5.8 Analysis of NMEO district recurrent expenditure 1986

District	Population at risk 1984 (1)	Total cases 1984 (2)	Dist.-level expenditure (Rs) (3)	Value of insecticide used (Rs) (4)	Value of drugs used (Rs) (5)	HHQ and RTC expenditure (Rs) (6)	Regional expenditure (Rs) (7)	Total dist. expenditure (Rs) (8)	Per capita expenditure (Rs) (9)
Morang	504,610	760	1,260,902	254,746	48,014	273,147	158,684	1,895,487	3.76
Sunsari	320,623	463	916,850	122,041	31,328	185,065	99,336	1,355,420	4.23
Jhapa	463,201	686	1,427,486	256,315	73,394	280,529	148,879	2,186,083	4.72
Ilam	65,740	88	374,462	0	13,190	77,226	35,806	700,184	10.65
Panchthar	77,827	357	833,539	0	14,834	117,762	61,321	1,027,457	13.32
Bhojpur	81,393	433	772,373	0	14,304	115,373	63,094	965,143	11.86
Udaipur	123,832	441	1,100,103	43,409	26,771	162,194	83,702	1,433,959	11.58
Dhankuta	85,238	175	725,067	0	8,269	100,330	48,635	882,521	10.35
Eastern region	1,721,772	3,401	7,627,902	577,598	230,103	1,311,820	698,478	10,436,973	6.06
Ramechhap	69,679	91	703,627	0	9,380	91,596	40,049	844,652	13.12
Sindhuli	131,549	730	1,099,332	38,320	22,083	174,064	79,097	1,413,304	10.74
Mahottari	367,111	1,565	1,142,662	1,462,888	48,893	283,094	135,828	3,072,364	8.37
Dhanusha	435,776	2,349	1,477,312	2,863,153	60,688	371,325	177,377	4,949,644	11.36
Sarlahi	333,226	1,021	1,043,773	673,858	58,907	226,425	107,683	2,100,646	6.30
Chitwan	291,429	977	1,137,677	147,152	41,284	223,466	185,063	1,655,562	5.68
Kavre	99,660	342	625,828	0	15,504	99,997	45,849	786,290	7.89
Central region	1,728,436	7,083	7,328,564	5,184,579	249,669	1,469,168	689,967	14,822,626	8.58
Rupandehi	398,793	2,388	1,420,638	909,624	52,874	339,757	187,571	2,909,664	7.45
Gorkha	272,888	963	1,209,842	0	23,671	212,252	115,191	1,560,956	7.08
Palpa	140,889	695	831,416	0	19,950	144,702	78,196	1,074,263	7.63
Kapilvastu	304,835	1,683	1,127,727	446,309	46,207	259,236	144,065	2,023,543	6.63
Nawalparasi	340,823	1,318	1,208,147	608,606	43,295	259,927	143,851	2,263,806	6.64
Western region	1,410,128	6,957	5,797,869	1,964,639	185,190	1,215,874	668,673	9,832,234	6.97
Surkhet	135,756	876	928,682	0	17,079	161,351	71,779	1,178,891	8.68
Dang	285,949	1,421	1,462,318	0	28,650	278,636	126,137	1,887,641	6.68
Banke	205,889	1,207	741,189	83,459	25,636	172,952	89,223	1,111,460	5.40
Bardiya	209,883	855	723,316	48,590	20,862	255,944	79,931	1,027,895	4.90
Kailali	260,791	1,686	982,527	176,411	26,703	230,633	133,883	1,538,436	5.90
Kanchanpur	208,168	2,541	1,072,380	174,860	22,872	267,969	135,361	2,673,862	8.81
Mid west region	1,306,972	8,586	5,910,332	483,320	141,802	1,259,536	634,515	8,417,686	6.44
TOTAL (a)	6,167,294	26,038	26,564,647	8,209,108	805,460	5,257,098	2,673,653	43,509,927	7.05

(a) Includes expenditure on treatment of cases at HHQ

Table A5.9: NMEO expenditure by geographical area, 1983 and 1984

District	1983 Total expenditure	1983 Mainly Outer Terai	1983 Mainly Inner Terai	1983 Mainly Hill	1984 Total expenditure	1984 Mainly Outer Terai	1984 Mainly Inner Terai	1984 Mainly Hill
Morang	1,960,021	1,960,021			1,095,487	1,095,487		
Sunsari	1,419,436	1,419,436			1,355,420	1,355,420		
Jhapa	2,224,088	2,224,088			2,186,803	2,186,803		
Illam	716,556			716,556	700,184			700,184
Panchthar	778,134			778,134	1,027,457			1,027,457
Bhojpur	882,070			882,070	965,143			965,143
Udaipur	1,427,704		1,427,704		1,423,959		1,423,959	
Khotang	799,618			799,618	882,521			882,521
Eastern region	10,207,635	5,603,544	1,427,704	3,176,386	10,436,973	5,437,710	1,423,959	3,575,304
Ramechhap	758,232			758,232	844,652			844,652
Sindhuli	1,406,211		1,406,211		1,413,304		1,413,304	
Mahottari	2,368,051	2,368,051			3,072,566	3,072,566		
Dhanusha	4,693,876	4,693,876			4,949,646	4,949,646		
Sarlahi	1,894,164	1,894,164			2,100,646	2,100,646		
Chitwan	1,501,100		1,501,100		1,655,562		1,655,562	
Kavre	652,022			652,022	786,250			786,250
Central region	13,354,256	8,956,091	2,907,311	1,410,854	14,822,626	10,122,858	3,068,866	1,630,902
Rupandehi	2,455,921	2,455,922			2,909,664	2,909,664		
Gorkha	1,398,410			1,398,410	1,560,956			1,560,956
Palpa	972,462			972,462	1,074,265			1,074,265
Kapilvastu	1,963,803	1,963,803			2,023,543	2,023,543		
Nawalparasi	2,151,817	2,151,817			2,263,806	2,263,806		
Western region	8,942,413	6,571,541	0	2,370,872	9,832,234	7,197,013	0	2,635,220
Surkhet	1,362,481		1,362,481		1,178,891		1,178,891	
Dang	1,888,802		1,888,802		1,887,641		1,887,641	
Banke	1,242,492	1,242,492			1,131,460	1,131,460		
Bardiya	1,037,816	1,037,816			1,027,895	1,027,895		
Kailali	1,749,413	1,749,413			1,538,436	1,538,436		
Kanchanpur	2,010,223	2,010,113			1,673,562	1,673,562		
Mid west region	9,290,318	6,039,035	3,251,283	0	8,417,684	5,351,152	3,066,532	0
TOTAL (a)	41,795,029	27,170,211	7,664,299	6,950,519	43,509,927	28,108,733	7,559,357	7,841,837
Distribution	100.0%	65.0%	18.3%	16.6%	100.0%	64.6%	17.4%	18.0%

(a) Includes expenditure on treatment of cases at HQ

Table A5.10 Distribution of NMEO recurrent expenditure by management level and type, 1983 and 1984

District	1983 Dist.-level expenditure	1983 Drugs	1983 Insecticides	1983 Regional share	1983 HHQ/HTC share	1984 Dist.-level expenditure	1984 Drugs	1984 Insecticides	1984 Regional share	1984 HHQ/HTC share
Morang	59.3%	2.6%	17.6%	7.4%	13.0%	66.9%	2.5%	8.2%	7.9%	14.4%
Sunsari	60.0%	2.3%	17.2%	7.2%	13.4%	67.6%	2.3%	9.1%	7.3%	13.7%
Jhapa	58.8%	3.5%	19.5%	6.7%	11.5%	65.3%	3.4%	11.7%	6.0%	13.6%
Ilam	73.7%	1.8%	9.5%	5.3%	9.6%	82.1%	1.7%	0.0%	5.1%	11.0%
Panchtar	78.4%	1.9%	0.0%	7.2%	12.5%	81.1%	1.4%	0.0%	6.0%	11.5%
Bhojpur	78.9%	1.4%	0.7%	6.9%	12.1%	80.0%	1.5%	0.0%	6.5%	12.0%
Udaipur	67.0%	1.6%	17.0%	5.2%	9.2%	77.9%	1.9%	3.1%	5.0%	11.4%
Khotang	82.1%	1.1%	0.0%	6.0%	10.9%	82.2%	0.9%	0.0%	5.5%	11.4%
Eastern region	66.4%	2.3%	13.1%	6.6%	11.6%	73.1%	2.2%	5.5%	6.6%	12.6%
Ramechhap	82.4%	1.3%	0.0%	5.4%	10.9%	83.3%	1.1%	0.0%	4.7%	10.8%
Sindhuli	74.4%	1.3%	8.0%	5.2%	10.4%	77.8%	1.6%	2.7%	5.6%	12.3%
Mahottari	48.1%	2.2%	33.4%	5.5%	10.8%	37.2%	1.6%	47.6%	4.4%	9.2%
Dhanusha	28.4%	1.3%	58.6%	4.0%	7.7%	29.8%	1.2%	57.8%	3.6%	7.5%
Sarlahi	50.7%	3.0%	29.6%	5.7%	11.0%	48.6%	2.4%	33.0%	5.1%	10.8%
Chitwan	63.7%	2.6%	15.8%	6.1%	11.8%	68.7%	2.5%	8.9%	6.3%	13.5%
Kavre	77.8%	2.2%	0.0%	6.6%	13.3%	79.5%	2.0%	0.0%	5.8%	12.7%
Central region	49.6%	1.9%	33.5%	5.1%	9.9%	48.8%	1.7%	35.0%	4.7%	9.9%
Rupandehi	50.9%	1.6%	29.0%	7.5%	11.1%	48.0%	1.8%	31.3%	6.4%	12.7%
Gorkha	76.2%	1.6%	1.1%	7.7%	13.4%	77.5%	1.5%	0.0%	7.4%	13.6%
Palpa	77.6%	1.7%	0.0%	7.4%	13.2%	77.4%	1.9%	0.0%	7.3%	13.5%
Kapilvastu	55.1%	2.0%	24.0%	7.5%	11.4%	55.7%	2.3%	22.1%	7.1%	12.8%
Nawalparasi	51.9%	1.8%	29.0%	6.4%	10.6%	53.4%	1.9%	26.9%	6.3%	11.5%
Western region	50.9%	1.8%	28.4%	7.3%	11.6%	59.0%	1.9%	20.0%	6.8%	12.4%
Surkhet	67.6%	1.3%	14.1%	6.6%	10.3%	78.8%	1.4%	0.0%	6.1%	13.7%
Dang	66.5%	1.2%	14.6%	7.0%	10.8%	77.5%	1.5%	0.0%	6.7%	14.3%
Banke	56.6%	1.6%	25.6%	6.4%	9.8%	66.7%	2.2%	7.4%	8.0%	15.6%
Bardiya	64.0%	1.7%	16.6%	6.9%	10.8%	70.4%	2.0%	4.7%	7.0%	15.2%
Kailali	51.9%	1.2%	28.9%	7.6%	10.4%	63.9%	1.7%	11.5%	7.9%	15.0%
Kanchanpur	50.9%	0.9%	33.2%	6.0%	9.0%	64.1%	1.4%	10.4%	8.1%	16.0%
Mid west region	58.9%	1.3%	22.9%	6.7%	10.1%	70.2%	1.7%	5.7%	7.4%	15.0%
TOTAL	57.8%	1.8%	23.4%	6.3%	10.7%	61.1%	1.9%	18.9%	6.1%	12.1%

GLOSSARY

ABER
Annual blood examination rate (the annual number of slides taken expressed as a proportion of the population)

ACD
Active case detection (cases detected by house-to-house visits by malaria field workers and village health workers)

AHW
Assistant health worker

a.i.
Active ingredient (of an insecticide)

APCD
Activated passive case detection (cases detected by malaria field workers and village health workers outside their normal schedule of visits)

API
Annual parasite index (all cases detected expressed per 1000 population)

CBA
Cost-benefit-analysis

CEA
Cost-effectiveness analysis

CUA
Cost-utility analysis

DA/TA
Daily allowance and travel allowance (paid to workers on field trips)

EPI
Expanded Programme on Immunization

ESM1 Form
The form used by the patient survey of malaria to enquire about sources of treatment, expenditure on treatment and days of work and school lost

HFA
Health for All

Household Survey
A survey in two areas of 867 malaria cases and 867 controls and their households, enquiring about the consequences of an episode of malaria

ICHSDP
Integrated Community Health Services Development Project

Imported A
Malaria cases thought to have been infected in India

MBS
Mass blood survey

MFW
Malaria field worker

NHQ
National headquarters of the NMEO

NMEO
Nepal malaria eradication organisation

ORT
Oral rehydration therapy

Patient survey
A survey using the ESM1 form of 3253 malaria cases in 6 districts

PCD
Passive case detection (cases detected by passive methods)

PCD (H)
Cases detected by health units

PCD (M)
Cases detected by malaria offices

PCD (MC)
Cases detected by malaria clinics

PCD (V)
Cases detected by malaria volunteers

PHC
Primary Health Care

RTC
Regional training centre of the NMEO

SF5 Form
The form used by malaria workers to record the characteristics of each malaria case

SPR
Slide positivity rate (percentage of slides found to be positive)

VHW
Village health worker