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Efficient use of health care resources:

The interaction between improved health and reduced health related income loss

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Efficient use of health care resources: The interaction between improved health and reduced health related income loss

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Abstract
Cost effectiveness is a criterion that is often recommended for prioritizing between different types of health care. A modified use of this criterion can be justified as the outcome of a choice that is made “behind a veil of ignorance”. Reduced health will in many cases also gives an income loss that is shared between the patient and society at large. In the special case where the marginal utilities of health status (measured by QALYs) and income are independent of the health state, an efficient allocation of health resources is characterized by net marginal costs per QALY being equalized across different types of health care. Net marginal costs are equal to gross marginal costs minus the reduction in health related income losses due to treatment. In the general case where marginal utilities depend on the health state this rule must be modified.

1. Introduction

One criterion for prioritizing among different types of health expenditures that has received considerable attention in the literature, is some type of cost effectiveness. To define cost effectiveness one must introduce some aggregate measure of the health benefits from the health care system. The most frequently used measure is QALYs (quality adjusted life years), but several other measures have also been discussed in the literature.[1] Whatever measure one uses, cost effectiveness is defined as the minimum cost for a given health benefit, or equivalently, maximal health benefits for given expenditures on health care. The concept of cost-effectiveness and its relation to QALYs has been discussed by e.g. Weinstein and Stason (1977), Williams (1985, 1987), Birch and Gafni (1992), Johannesson and Weinstein (1993), and Gabler and Phelps (1997).

A number of authors have criticized the simple use of "minimum cost per QALY" as a criterion for allocating the health budget. A main criticism has been that the summation of QALYs across individuals lacks a good ethical or welfare theoretical basis, see e.g. Harris (1987), Wagstaff (1991), Nord (1994), Olsen (1997) and Dolan (1998). In health care, any specific choice of prioritizing treatment of one type of disease against another also implies prioritizing one group of individuals against another. The problems associated with comparing welfare or utility across individuals is well known.

In the present paper, we side step the comparison of particular individuals by assuming, in the spirit of Rawls (1971), that society's choices are made behind a veil of ignorance. More concretely, the following approach is used: A hypothetical decision-maker is assumed to allocate health expenditures behind a veil of ignorance. At this ex ante stage, there are several different health states, and the decision-maker is assumed to have a preference ordering over all of these health states. The decision-maker must choose all health expenditures behind a veil of ignorance, i.e. before

[1] For a discussion of QALYs and alternatives, see e.g. Mehrez and Gafni (1989), Carr-Hill (1989), Broome (1993), Culyer and Wagstaf (1993), Gafni et al. (1993), Johannesson (1995), and Nord (1999).

he/she knows his/her health state. The decision-maker is assumed to make this choice so that his/her expected utility is maximized. This gives a particular allocation of health expenditures, which thus is the optimal way to prioritize under the given approach.

In the analysis, it is assumed that the decision-maker has a von Neuman-Morgenstern utility function where the health state and material consumption (measured in money) are the arguments of the function. It is assumed that the health state may be summarized by a single index number measuring “health standard”. For much of the discussion, the exact nature of this health measure is unimportant. However, to relate the results to some of the existing literature, it is assumed that the health measure is QALYs. It is of course not unproblematic to assume that the underlying vector of health variables may be represented by a single index number. Moreover, since the length of life enters the QALY index, the utility function containing QALYs as well as material consumption assumes that the decision-maker implicitly makes a valuation of human life. In spite of their importance, all difficulties associated with measuring QALYs and weighing them against material consumption are ignored in the present paper.

The approach used in this paper is a useful starting point for a critical discussion of cost-effectiveness as a criterion for prioritizing among different types of health expenditures. Moreover, it allows us to study the interaction between direct health effects of health care and effects on health related income losses, some of which are borne by individuals and some by society at large.

The rest of the paper is organized as follows. Sections 2 and 3 discuss the different health states that are possible at the ex ante stage, and the relation between these and the income and consumption of the decision-maker. Section 4 introduces the budget constraint of the public sector. These preliminaries are used in Section 5 to derive the optimality conditions for the hypothetical decision-maker. These optimality conditions are discussed extensively in Sections 6-8. The main results are summarized in Section 9.

2. Health states.

Consider a hypothetical person making a decision about priorities behind a veil of ignorance. At this ex ante stage, there are m different health states. We assume that the decision maker has a preference ordering over all possible health states, and that this preference ordering may be summarized by a single index number measuring "health standard". As mentioned in the Introduction, it is assumed that the relevant index is QALYs. The probability of state i is denoted by p_i.

We use the notation h_i to denote the reduction in QALYs in health state i compared with the state describing perfect health. Denote the number of QALYs in the best health state by H. We thus have $H-h_i$ QALYs in health state i. Obviously h_i will depend on what treatment one is given. We denote the QALY reduction in the absence of any treatment by $h_i(0)$. Consider a given expenditure c_i used on health state i, and assume that this expenditure is used optimally in the sense that h_i is reduced as much as possible for this given expenditure. Then the reduction in QALY is given by $h_i(c_i)$. By assumption, the h_i functions are declining in their arguments. Moreover, we shall simplify our analysis by assuming that all h_i functions are differentiable and convex. More precisely, we assume that $h_i' \leq 0$ and that $h_i'' > 0$ for $h_i' < 0$. In reality, as health expenditure increases, there will typically be stages where one moves from one type of treatment to another. Therefore, the function may be discontinuous, and certainly non-differentiable, at some points. However, for the general ideas presented in this paper this is of minor importance. We therefore stick to our analytically simple h_i functions.

3. Work/income states

In addition to facing m different health states, the decision-maker also faces n different work/income states, henceforth simply called income states. It is assumed that the probability of income state j is independent of the health state, and is denoted by q_j. The joint probability of health state i and income state j is thus $p_i q_j$. Under income state j the gross income is Y_j provided one is perfectly healthy. The income tax is assumed to be $T(Y_j)$, so that net income is $Y_j - T(Y_j)$. The gross income Y_j must be interpreted as some measure of lifetime gross income. By introducing the tax function in the way we do we are ignoring the fact that lifetime taxes not only depend on lifetime income, but also on how this income is distributed across periods. This simplification is of little importance for the general ideas presented in this paper.

The net income of a person may be reduced if he or she has some health defect, due to reduced ability to work. Let y_{ij} be the reduction in gross income as a consequence of health state i when one is in income state j. Notice that this income reduction typically will differ between different types of work, even between two types of work that give the same gross income when healthy. The income reduction y_{ij} will normally depend on what health treatment one is given. In most cases the income loss will be lower the more health care one gets.

Let c_{ij} stand for the expenditure given to a person in health state i and income state j. Then the gross income loss under this combination of states is assumed to be $y_{ij}(c_{ij})$. However, given the tax and social security system, only part of this loss is borne by the person in this health/income state. Let $\theta(y_{ij})$ be the part of the income loss borne by the individual, with $0<\theta'<1$. The function θ captures the combination of social security rules (a considerable part of the gross income loss is covered by social security) and tax rules (the remaining gross income loss after social security contributions is partly offset through lower income taxes).[2]

Summarizing the discussion in this and the previous section: A person in health/income state ij will have a health standard given by $H-h_i(c_{ij})$ (measured in QALYs), and a material living standard given by $Y_j-T(Y_j)-\theta(y_{ij})$ (measured in money). Behind the veil of ignorance, the decision-maker does not know which of the mn states

2 We ignore the fact that the function θ generally depends not only on the sum of QALYs, but also on the unadjusted number of lifeyears a person has: Ignoring pensions to dependants, the income loss due to death causes a loss of tax revenue, but no additional social security expenditures.

he or she will be assigned to. But it is assumed that the probabilities are known, and as already mentioned we denote the probability of state ij by $p_i q_j$.

4. The health budget constraint

At the level of the society, the probabilities $p_i q_j$ are shares of persons in each of the mn states. Let government expenditures net of health expenditures and health related social security be G per capita. We shall assume that G is exogenous, i.e. we do not discuss the optimal size of such expenditures. Likewise, we assume that the tax function T and the function θ are both exogenous. In a full optimization problem, we would of course let both non-health government expenditure, the income tax rules and the social security rules be optimally chosen. Our goal is less ambitious: We take these important economic variables and rules as given, and ask how the government's income should be allocated to various health purposes, after having subtracted the exogenously given non-health expenditures. Obviously, the optimality conditions of our limited optimization problem will also be a subset of the optimality conditions for the more complete optimization problem referred to above.

From the notation of the previous sections we can write the government's budget constraint (per capita) as

$$\sum_{ij} p_i q_j c_{ij} + \sum_{ij} p_i q_j \left(y_{ij} - \theta\left(y_{ij} \right) \right) \leq \sum_{ij} p_i q_j T\left(Y_j \right) - G \tag{1}$$

The first term on the left-hand side gives the direct health expenditures, and the second term gives the government's social security expenditures (including tax loss from persons with reduced income due to their health state). On the right hand side, the first term is gross tax revenue, while the second term is non-health government consumption.

5. The optimal allocation of the health budget

The decision-maker is assumed to have a von Neuman-Morgenstern utility function where the health standard (measured by QALYs) and material consumption (measured in money) are the two arguments of this function. Denoting the utility level in state ij by U^{ij} we thus have

$$U^{ij} = U\left(H - h_i\left(c_{ij}\right), Y_j - T\left(Y_j\right) - \theta\left(y_{ij}\left(c_{ij}\right)\right)\right) \qquad (2)$$

where U is a von Neuman-Morgenstern utility function. It is assumed that U is increasing in both of its arguments. Moreover, U is assumed to be concave, implying that the decision-maker is risk averse (or risk neutral as a limiting case) both in health standard and in consumption.[3] The first order derivatives U_1^{ij} and U_2^{ij} denote marginal utilities with respect to health and consumption, respectively. The second order derivatives are denoted by U_{11}^{ij}, U_{22}^{ij} and U_{12}^{ij}. From our assumptions it follows that the first two of these are negative (or zero as limiting cases). We shall return to the sign of U_{12}^{ij} subsequently.

The decision-maker must choose all health expenditures c_{ij} behind a veil of ignorance, and does this so that his or her expected utility is maximized. Formally, the c_{ij}'s are chosen so that the following maximization problem is solved

$$\textit{Maximize} \sum_{ij} p_i q_j U^{ij} \ \ \textit{subject to (1)} \qquad (3)$$

where U^{ij} is given by (2). Straightforward optimization yields

$$U_1^{ij} \cdot (-h_i{}'(c_{ij})) = \lambda - \left[(1-\theta')\lambda + \theta' U_{21}^{ij}\right](-y_{ij}{}'(c_{ij})) \qquad i=1,\ldots,m;\ j=1,\ldots,n \qquad (3)$$

where λ is the shadow price of the government budget constraint (1).

[3] If the health variable H-h is QALYs, this means that the decision maker is risk averse in life years: A healthy life with equal probablity of dying in one of the years between 60 and 80 years old is preferred to a healthy life with equal probablity of dying in one of the years between 50 and 90 years old.

Since the terms U_1^{ij} and U_2^{ij} depend on income levels, it is clear form (3) that the optimal use of health resources c_{ij} will depend on income, and not only on health state. In other words, health treatment will differ across individuals who have the same health state, based on differences in income the individuals have. Although this is optimal according to our approach, one could argue that this type of discrimination is in conflict with other ethical norms. It therefore seems more plausible to carry out the optimization with the restriction that one should give equal treatment for equal health cases, independent on incomes. Formally, this means that we require that for any i, c_{ij} is independent of j. Denote this common value by c_i. The following notation is used in the characterization of the optimality conditions for this constrained optimization problem:

$$U^i = \Sigma_j q_j U^{ij} \tag{4}$$

$$y_i(c_i) = \Sigma_j q_j y_{ij}(c_i) \tag{5}$$

In other words, U^i is the expected utility level given that the health state is i, while y_i is the expected income loss given that the health state is i.

Solving the optimization problem (2) with the restriction that all c_i be independent of j gives us, instead of (3)

$$U_1^i \cdot (-h_i'(c_i)) = \lambda - (1-\theta')\lambda(-y_i'(c_i)) - \theta' \sum_j q_j U_2^{ij}(-y_{ij}'(c_{ij})) \qquad i=1,\ldots,m \tag{6}$$

where we have used the notation given by (4) and (5).

Using (4) and (5), we can rewrite the last term in (6) in the following way:

$$\sum_j q_j U_2^{ij}(-y_{ij}'(c_{ij})) = U_2^i \cdot ((-y_i'(c_i)) + \text{cov}^i(U_2^{ij}, -y_{ij}'(c_i)) \qquad (7)$$

where the notation cov^i indicates that it is the covariance for a given health state.

Using the expressions above, the equilibrium condition (6) may be rewritten as

$$\frac{U_1^i}{\lambda} \cdot \frac{-h_i'(c_i)}{1-(-y_i'(c_i))} = 1 + \theta' \frac{(\lambda - U_2^i)((-y_i'(c_i)) - \text{cov}^i(U_2^{ij}, -y_i'(c_i))}{\lambda(1-(-y_i'(c_i)))} \qquad i=1,\ldots,m \qquad (8)$$

This fundamental optimality condition for allocating health expenditures will be discussed in the next three sections.

6. The case of no health related income loss

We start with the simplest case in which there is no health related income loss. In this case the terms $y_i'(c_i)$ are all zero, so that (8) may be rewritten as

$$\frac{U_1^i}{\lambda}(-h_i'(c_i)) = 1 \qquad i=1,\ldots,m \qquad (9)$$

Consider for a moment the case where U_1 is independent of the health state. This is equivalent to assuming that the decision-maker is risk neutral in the health variable when making the allocation decision behind a veil of ignorance. If this is the case, it follows from (9) that the terms $-h_i'(c_i)$ should be equalized across health states. In other words, the optimal allocation implies that the marginal costs of additional health improvement (measured in QALYs) should be the same for all types of health expenditures. This is the same allocation as one would get from maximizing the sum of QALYs for a given budget for the sum of direct health expenditures. In the literature, this allocation is often referred to as the cost-effective allocation, see e.g. Weinstein and Stason (1977) for a further discussion.

If the $h_i(\bullet)$ functions are not differentiable, the condition for this type of cost effectiveness must be somewhat modified compared with (10). Notice also that if the starting point is not cost-effective, a ranking of different health expenditures according to their marginal effect on QALYs gives some information about the direction in which the budget should be reallocated in order to reach cost effectiveness of this type.

The assumption that the decision-maker is risk neutral is not very realistic. It seems more plausible to assume that the decision-maker is risk averse, i.e. that U_1^i is higher in states where the equilibrium number of QALYs is low than when this number is high. If this is the case, it follows from (9) (and the convexity of the functions h_i) that the health budget should be allocated so that the marginal costs of additional health improvement is lower in states where the equilibrium number of QALYs is low than when this number is high. In other words, risk aversion implies that health expenditures directed towards more serious health problems (measured by the QALY index) should be given a higher priority than they would in the simple case of cost effectiveness.

7. The case of no private health related income loss

We now consider the more general case in which health defects give some income loss. However, assume for now that the tax and social security system is designed such that this cost is not at all borne by those who become ill. In other words, the function θ has the property that θ'=0. For this case (8) may be rewritten as

$$\frac{U_1^i}{\lambda} \cdot \frac{-h_i'(c_i)}{1-(-y_i'(c_i))} = 1 \qquad (10)$$

The denominator of the second term on the l.h.s. of (10) is an adjustment factor to the cost of treatment. When we have income related income losses that can be reduced by health care, the denominator will be lower than one, reflecting that the *net* costs of treatment are lower than the *gross* costs, due to reduced social security expenditures. Typically the denominators, i.e. the ratios between net and gross costs, will differ between different types of health defects. Even if we had risk neutrality in health, the simple rule of cost-effectiveness, i.e. equalization of the terms $-h_i'(c_i)$ across health states, is not optimal. The rule would have to be modified so that it was the health benefit relative to the *net* cost of treatment that should be equalized across health expenditures.

8. The case of some private health related income loss

We finally turn to the most general case, where a health defect gives an income loss that in part is borne by the person affected by the health defect. In this case we thus have $\theta'>0$. This case is considerably more complex than the first two cases. As in the previous case, it is true that the more a particular type of health treatment reduces health related income losses, the more should be used on this type of health care. However, even if people are risk neutral in health, we cannot arrive at a rule of cost-effectiveness simply by using net instead of gross health expenditures. It is clear from the general expression (8) that the optimal allocation of health expenditures depends on how these expenditures affect both the public and private health related income loss. The relative weight given to the proportion of the income loss borne privately will depend on the size of U_2^i relative to λ. As long as the size of the health budget is exogenous, we cannot say anything about the size of the terms $\lambda-U_2^i$ in (8). Let us therefore now assume that the health budget is determined so that social welfare is maximized. To do this, assume that the tax function has a head tax (positive or negative) as one of its components, i.e. $T(Y)=t(Y)+t_0$. Let us keep G exogenous as before, and also let the term t(Y) of the tax function be exogenous. If t_0 is chosen optimally, i.e. by the optimization problem (2) with all $c_{ij}=c_i$, it is straightforward to see that this implies

$$\sum_i p_i U_2^i \equiv \sum_{ij} p_i q_j U_2\left(H - h_i(c_i), Y_j - t(Y_j) - t_0 - \theta(y_{ij}(c_i))\right) = \lambda \tag{11}$$

i.e. the expected utility of an increase in private income should be equal to the shadow price λ.

Given (11), the l.h.s. of (8) has a straightforward interpretation. The second term is the health gain per unit of income foregone achieved by the treatment, taking account of the reduced health related income loss. Alternatively expressed, the inverse of this term can be interpreted as the net marginal cost of treatment, taking account of the reduced health related income loss. The first term on the l.h.s. of (8) is the willingness to pay for improved health. The l.h.s. is thus the value of a particular treatment per unit of cost. If the right hand side were equal to 1 (as in the case discussed in Section 7), this means that in a social optimum the marginal value of a specific treatment should be equal to the marginal cost of the treatment. Notice in particular that it is the effect of treatment on the *total* income loss, and not only the portion that is privately borne, that is included in the adjustment factor from net gross to net marginal costs of treatment (i.e. the denominator of the second term on the l.h.s. of (8)).

In the general case, the right hand of (8) may differ from one for any particular treatment. If this is the case it is no longer optimal to have "marginal value equal to marginal cost", as long as marginal cost is simply measured as the inverse of the second term on the l.h.s. of (8). The reason for this is that to calculate the true net marginal cost of treatment, we must take into account how much of the reduced health related income loss is privately captured.

Let us first assume that all the covariance terms in (8) are equal to zero. From (11) it clear that the terms λ-U_2^i "on average" are equal to zero. However, for a particular health state this term may be positive or negative. In equilibrium, the after-treatment income losses may differ across health states, and may even differ across health states having the same level of health (i.e. same h_i). Consider a health defect giving a large income loss even after treatment for some or all income/work states, i.e. a lower net income in equilibrium than other health defects giving the same reduction in health. In such a health state the marginal utility of income will be relatively high, i.e. λ-U_2^i will be negative. From (8) it follows that when θ'>0, the r.h.s. of (8) will be less than one. To make the l.h.s. of (8) less than one, we must therefore use more resources for this health case than if the r.h.s. had been one. In other words, compared with the allocation rule defined by (10), more health resources should be used for health defects with large after treatment income loss than for health defects were these losses are small.

So far, nothing has been said about the cross derivative U_{12}. Although it is not obvious, it seems reasonable to assume that he marginal income of consumption is higher the better is ones health. If this is the case the cross derivatives U_{12}^{ij} will be positive. In this case the terms λ-U_2^i in (8) will be positive in states where the equilibrium health level is low and negative in states where the equilibrium health level is high. The isolated effect of this is that for the class of health problems that give a private income loss, expenditures directed towards more serious health problems (measured by the QALY index) should be given a *lower* priority than they would in the simple case of cost effectiveness (adjusted for reduced health related income losses). This is thus the opposite effect of the isolated effect of persons being risk averse in their health variable, cf. the discussion in Section 6. Without further assumptions on the utility function, it is not possible to say which of these effects dominates. However, for the special case in which there is risk neutrality in the health variable, one should give relatively *less* priority to more serious health problems than to less serious problems (measured by the equilibrium reduction in QALYs) compared to the how would prioritize with a simple rule of cost-effectiveness.

Finally, consider the covariance term in (8). It seems likely that in the absence of treatment, health related income losses typically are higher in high income states than in low income states. It is therefore also likely that the *reduction* in health related income loss due to treatment, measured by the terms $-y_{ij}(c_i)$, is typically higher in high-income states than in low-income states. Moreover since U_{22} is negative, the terms U_2^{ij} will be lower in high income states than in low-income states. Taken together, it therefore seems reasonable to expect the covariance terms in (8) to be negative.

Consider a "representative" health state, in the sense that $U_2^i=\lambda$. If the covariance in (8) is negative for this health state, the r.h.s. of (8) is therefore larger than one. This means that for such a health state, we should use health resources only up to the point where the marginal value of treatment is somewhat higher than the marginal cost of treatment, as measured by the inverse of the second term on the l.h.s. of (8). In other words, we should spend less on health treatment than the rule "marginal value equal to marginal cost" would suggest. The reason for this is that the inverse of the second term of the l.h.s. of (8) gives a downward bias of the true marginal cost: Since the reductions in health related income losses due to treatment are highest in high-income states, where the social value of income is low, the gross costs of treatment should be adjusted by subtracting somewhat less than the whole reduction in health related income loss.

9. A comparison with a simple rule of cost-effectiveness

The simplest rule for cost-effective allocation of a health budget is to maximize the health improvement (measured by e.g. QALYs) given this budget. In the paper we have argued that the relevant budget constraint should be net health expenditures, i.e. one should subtract the reductions in health related income losses from the gross health expenditures. The simple rule of cost-effectiveness for this case is to calculate net costs per unit of health improvement. Using this simple rule, and assuming for simplicity that all relevant functions are differentiable, we should allocate the health budget so that the marginal cost per unit of health improvement in the optimal outcome is equalized across health states.

In the paper it is shown that even this modified rule of cost-effectiveness does generally not give us the socially optimal allocation of health resources. The rule is optimal only if (a) the decision-maker is risk neutral when making a decision behind o veil of ignorance and (b) none of the health related income loss is borne privately. When we modify these assumptions, the optimal allocation of health expenditures changes. The analysis indicates how the optimal allocation deviates from the cost-effective allocation when assumptions (a) and (b) are relaxed. Three of the most important results are the following:

- If the marginal utility of income is independent of the health state, and there is risk aversion with respect to the level of health, *more* resources should be allocated to health cases for which the expected outcomes even after treatment are worse than average.
- If the marginal utility of income is increasing in the health state, and there is risk neutrality with respect to the level of health, *less* resources should be allocated to health cases for which the expected outcomes even after treatment are worse than average.
- More resources should be used for health states with large after treatment income losses than for health states where these losses are small.

References

Birch, S. and Gafni, A. (1992) "Cost-effectiveness / utility analyses: Do current rules lead us to where we want to be?", Journal of Health Economics 11, 279-296.

Broome, J. (1993), "Qalys", Journal of Public Economics 50, 149-167.

Carr- Hill R. A.(1989), "Background material for the workshop on QALYs: Assumptions of the QALY procedure", Social Science and Medicine, vol 29, no. 3, 469-477.

Culyer, A.J. and A. Wagstaff (1993), "QALYs versus HYEs", Journal of Health Economics 12, 311-323.

Dolan, P. (1998), "The measurement of individual utility and social welfare", Journal of Health Economics 17, 39-52.

Gabler, A.M. and Phelps, C.E. (1997), "Economic foundation of cost-effectiveness analysis", Journal of Health Economics 16, 1-31.

Gafni, A., Birch, S. and Mehrez, A. (1993), "Economics, health and health economics: HYEs versus QALYs", Journal of Health Economics 12, 325-339.

Harris, J. (1987), "QALYfying the value of life", Journal of Medical Ethics, 13, 117-123.

Johannesson, M. and Weinstein, M.C. (1993), "On the decision rules of cost-effectiveness analysis", Journal of Health Economics 12, 459-467.

Johannesson, M., Pliskin, J.S. and Weinstein, M.C. (1993), "Are healthy-years equivalents an improvement over quality-adjusted life years?", Medical Decision Making 13, 281-286.

Johannesson, M.(1995), ”Quality –adjusted life-years versus healthy-years equivalents – A comment”, Journal of Health Economics 14, 9-16.

Mehrez, A. and Gafni, A. (1989), ” Quality-adjusted life years, utility theory, and healthy-years equivalents”, Medical Decision Making, 9, 142-149.

Nord, E. (1994) ”The QALY – A measure of social value rather than individual utility?”, Health Economics, 3, 89-93.

Nord, E. (1999), Cost-value analysis in health care: making sense out of QALYs. Cambridge University Press.

Olsen, J.A. (1997), ”Theories of justice and their implications for priority setting in health care”, Journal of Health Economics 16, 625-639.

Rawls, J.(1997), “A Theory of Justice”, Cambridge, Ma, Harvard University Press.

Wagstaff, A. (1991), ”QALYs and the equity-efficiency trade-off”, Journal of Health Economics 10, 21-41.

Weinstein, M.C. and Stason, W.B. (1977) ”Foundations of cost-effectiveness analysis for health analysis and medical practices”, New England Journal of Medicine 296, 716-721.

Williams, A. (1985) ”The value of QALYs”, Health and Social Service Journal, 1985.

Williams, A. (1987), “Response: QALYfying the value of life”, Journal of Medical Ethics, 13, 123-.