

THE SPATIAL DISTRIBUTION OF
PHYSICIANS IN THE UNITED STATES:
A REVIEW OF THE LITERATURE

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Introduction

One manifestation of a contemporary concern with equality in the provision of health care services is the growing interest that appears to be developing in the spatial location of medical manpower. There is no evidence that any country has ever achieved, much less sustained, a statistical balance between the spatial distribution of its population and its stock of medical manpower, yet increasingly the judgement appears to be made that imbalances are excessive and should be corrected. Indeed, although some imbalance is inevitable in any country, whatever its methods of organising health care delivery or remunerating physicians, countries with quite small variations in physician-population ratios (PPRs) seem as ready to perceive a distributional problem as those with gross imbalances. Variations of up to ten-fold are not uncommon between the PPRs of urban and rural areas in many countries (WHO, 1976), yet the difference between the average list sizes of primary care physicians in the best and worst areas in England in 1970, when financial incentives to encourage the movement of physicians to under-serviced areas were increased, was only one and a half-fold (Butler, et al, 1973). There are special historical reasons why the notion of inequality may be defined more rigorously in Britain than in many other countries, but attempts by governmental and other agencies to influence the locational decisions of physicians appear to be widespread (Glaser, 1976). Together with this burgeoning policy interest in the spatial distribution of medical manpower has been a similar growth in the academic study of the nature, causes and possible solutions to the 'problem' of maldistribution, much of it of American origin. This paper is an attempt by an outside observer to summarise the American literature on the theme and to offer some comments on the problems and potentialities of current research.

Concepts in the spatial distribution of medical manpower

The notion of spatial distribution implies the existence of criteria for sub-dividing the territory within which the distribution is observed. When the concern is with the distribution rather than the total supply of medical manpower, the territorial interest must shift from the whole unit to identifiable sub-units of it. In most countries, various ways exist of making this division. Official statistics of manpower distribution frequently group the data on the location of physicians according to central or local government units; in other cases ad hoc territorial units may be created; in yet other cases the units may be groupings of non-contiguous areas with common characteristics, such as the Standard Metropolitan Statistical Areas (SMSAs). However it may be done, the whole unit must in some way be divided if the concept of spatial distribution is to have meaning, but the specific method of division is always likely to affect the magnitude of the variations observed between the sub-units. The apparent imbalance in the distribution

of manpower within a country can be enlarged or diminished according to the delineation of sub-unit boundaries, and larger units are likely to display less variability in physician-patient ratios than smaller units. For example, the nine census divisions of the United States showed less than a two-fold variation in the availability of physicians between the best and worst endowed divisions in 1973, yet the range in the supply of active non-federal physicians per 100,000 population between the states (excluding DC) was from 71 in South Dakota to 195 in New York (Roback, 1974). Below the level of the state, the variations are even greater. In Los Angeles county, for example, the ratio of physicians to population in 1968 was 1:680, but the range between districts within the county was from 1:200 in Beverley Hills to 1:2,400 in Watts (Association of American Medical Colleges, 1969).

The problem of choosing the appropriate units is particularly evident in ecological-type analyses (see page 9) which deal with sums and means of variables on an area basis, and which seek to relate the variables to some measure of manpower supply. As Shannon et al (1969) point out, the use of correlations between variables arranged in this way is a weak indicator of the real nature of the problem, for the larger the areas of comparison the more likely it is that most of the variance will occur within the areas, not among them. There may also be a weakness in using administrative or governmental units for the purpose of describing the geographical location of medical manpower if those units fail to reflect the real ways in which suppliers and consumers of services are related. Area boundaries that are drawn for administrative purposes may correspond very imperfectly with the invisible boundaries of the medical catchment area (Dickinson, 1954), and the statistical manipulations involved in making necessary adjustments for cross-boundary patient flows may be complex (Rickard, 1976).

The selection of an appropriate measure of manpower dispersion between the chosen geographical areas also presents a number of choices. The simplest measure of dispersion is the total number of medical graduates within each area expressed as a rate per unit of total population, but this is a weak indicator of the equity of distribution. The inclusion of all medical graduates, whether engaged in active patient care or not, fails to reflect the more basic concern with the distribution of medical care services, and a more sophisticated physician-population ratio would be one in which the physician component of the ratio is limited to those engaged in the care of patients. Further adjustments may be made to distinguish between individual practitioners and whole-time equivalents, between physicians in general practice and in each of the major specialties, and between those in training and those in career grades. Empirical studies have rarely adjusted the PPP more

finely than this, although the implicit interest in manpower not as an end in itself but as one of a set of factors in the production of services to patients, opens the theoretical possibility of adjusting the physician component still further to allow for variations between practitioners in the quantity and quality of care they deliver to their patients. It may ultimately be argued that the most equitable distribution of manpower is that which secures an equality of outcome, measured in terms of the health status of the population, even though such a distribution may in fact require substantial inequalities in the distribution of medical manpower in favour of the most deprived localities. In fact, however, our restricted understanding of the relationship between physician manpower and health, and our apparently limited ability to control the locational patterns of physicians, preclude this definition of equity as a feasible policy objective.

The use of total population in the PPR may likewise be criticised as a weak indicator of equity. 'Needs' for the services that physicians produce are not distributed evenly throughout the population: they tend to cluster in certain demographic and socio-economic sectors of the population. An equity objective that related resources to needs would therefore require a method of adjusting total population numbers to allow for the variations in population structure between different territorial units. In fact this has rarely been done in measuring the spatial distribution of physicians, even in the United Kingdom where important progress has been made in the last few years in sensitising resource allocation mechanisms to regional and area variations in need (Department of Health and Social Security, 1976), and the conventionally used ratios of physician manpower to total unadjusted population are for this reason imperfect indicators of the equity of any distributional pattern.

The spatial distribution of physicians in the United States

The most complete data on distribution trends in the United States come from the American Medical Association's Physician Masterfile. In each year since 1963 the Association has extracted and published data from the Masterfile on a variety of topics, including the location of medical manpower. The most recent report (Roback, 1974) contains the following ratios of active non-federal physicians per 100,000 population in the nine census divisions in 1973: New England, 202; Middle Atlantic, 201; Pacific, 197; South Atlantic, 153; Mountain, 149; E.N. Central, 136; W.N. Central, 132; W.S. Central, 121; E.S. Central, 109. The states in 1973 containing fewer than 90 active non-federal physicians per 100,000 population were: Alabama (82), Alaska (78), Arkansas (81), Mississippi (77), Ohio (85), Illinois (87) and South Dakota (71); whilst the States with ratios in excess of 150 were: British Columbia (339),

California (168), Connecticut (169), Maryland (159), Massachusetts (177) and New York (195).

The AMA data also show an increasing trend over the decade of the series towards the concentration of physicians in large metropolitan areas in the United States. Between 1963 and 1973 the proportion of non-federal physicians located in the Standard Metropolitan Statistical Areas rose from 83.7 per cent to 86.4 per cent, and at the mid-point of the decade (1968) the Association reported that almost all of the 2,546 physicians seeking vacancies through its placement service wanted a practice in a community of 100-500 thousand population (American Medical Association, 1968). The trend, however, is not new: in 1934 the correlation was noted between the population density of the states and their physician-population ratios (Leland, 1934), and data published in 1941 showed a marked increase since 1900 in the number of physicians (relative to population) practising in urban centres and a corresponding decline in the number engaged in rural practice (Edsall and Putnam, 1941). However, the most complete data on trends in the location and movement of physicians in the US. during the first half of the century are contained in the important war-time series of papers from the US Public Health Service (Mountin et al, 1942a, 1942b, 1943, 1945).

Using information on some 227,000 physicians culled from the American Medical Directory, Mountin and his colleagues traced the changes occurring in the composition and distribution of physicians in America between 1923 and 1938. Although the total number of physicians per 100,000 population remained static over the period (131 in both 1923 and 1938), significant changes occurred in their locations. The states with the highest proportions of their populations residing in urban areas in 1923 not only experienced the most favourable PPRs in that year, they also improved their ratios over the subsequent 15 years at the expense of less urbanised states. By 1938, states with 70 per cent or more of their populations living in urban areas had relatively twice as many physicians as states with less than 50 per cent urbanised population, resulting in an increasing maldistribution between states over the fifteen-year period. The shift in the distribution of physicians resulted not from the net mobility of established practitioners from rural to urban areas (of which there was very little), but from a combination of the failure to replace rural-based physicians who died and retired, and the preference of newly-qualified practitioners for urban and city practice. The result of this combination of events was seen also in the changing age-structures of the profession in the urban and rural areas. Physicians in rural areas not only had a higher median age than their urban counterparts at the beginning of the period (1923), but the failure to

replace losses through deaths and retirements in the rural places resulted in an even wider disparity in median ages by the end of the period. This in turn has made rural practice less attractive to newly qualifying physicians, and the cycle of rural deprivation has continued. Thus, Steele and Rimlinger (1965) in the post-war period found that the two most important factors affecting the change in the location of physicians in the US between 1950 and 1959 were the regional degree of urbanisation and the rate of population increase. Isolated rural areas lost 0.7 per cent of their population but 4.4 per cent of their physicians during these nine years; greater metropolitan areas, by contrast, experienced a gain of 18.7 per cent in their stock of manpower. Like Mountin, Steele and Rimlinger emphasise that these changes resulted more from entries and exits to the profession than the mobility of the physicians.

The problem of the spatial distribution of physicians in America is now seen largely as that of the rural-urban imbalance, and countless papers have appeared in the State medical journals documenting local deficiencies. One study in the eleven counties represented on the Rochester Regional Hospital Council (New York State) reported a loss of 61 per cent between 1905 and 1960 of physicians practising in isolated and semi-rural counties, and the number of towns devoid of physicians rose from 27 to 70 per cent during the period (Parker and Tuxhill, 1967). Another study of some 1,600 towns and cities in Minnesota, Montana and North and South Dakota identified over 1,000 that were entirely without physicians, and a further 200 with only one. Most of these communities were small, economically declining, and located in remote rural areas (Fahs and Peterson, 1968). In the Buffalo-Rochester-Syracuse region of Upstate New York, the rural counties suffered a 23 per cent decrease in the physician-patient ratios between 1930 and 1950 whilst the ratios in the urban counties increased by 18 per cent, but the authors in this study noted the tendency for rural areas to retain manpower in periods of economic depression and to lose physicians at times of relative prosperity (Terris and Monk, 1956). Summarising many of these local studies, Cooper et al (1972) used the 1970 AMA definitions on 'degree of urbanisation of counties' to illustrate the linear relationship between that variable and the PPR in the United States. The number of physicians per 100,000 population ranged from 195 in the most urban counties to 40 in the most rural counties, with regular gradations through the eight intermediate classifications.

Although the urban-rural imbalance is probably still seen as the most critical problem of medical manpower distribution, the deprivation of manpower and other medical services in inner city zones has also been a matter of growing concern in recent years. The data on intra-city variations in the

PPR are less profuse than those for larger areas as they depend more upon ad hoc studies and less upon routinely available statistics, but two such studies illustrate the essence of the problem. Cherkasky (1969) described a block of census tracts in the South-east Bronx in which some 45,000 inhabitants, mainly Negro and Puerto Rican, were sharing the services of only five physicians in 1966. In 1938 the block had been occupied by 25,000 middle-class white residents, served by 50 physicians. Cherkasky generalises his data about the population living in this block as typical of millions to be found in urban areas throughout the United States. Navarro (1971, 1974), tracing the movement of population and physicians within the Baltimore SMSA over the decade 1958-68, found an increasing movement of people from the city centre to the suburbs, with a proportionately larger increase of physicians accumulating in the peripheral areas. Although the PPRs in the inner-city areas remained quite high over the period, this was an artefact of the presence of two large teaching hospitals in the downtown areas. In fact a growing number of large areas in the inner city were totally devoid of primary care, and Navarro predicted a further change in PPRs in favour of the outer suburbs over the next decade.

The theoretical interest in the growth of inner-city deprivations concurrently with a continuing urban-rural imbalance in the spatial distribution of medical manpower lies in the light which these trends might shed upon the causes of manpower location patterns, and it is to this that the review now turns.

The causes of location patterns

Three preliminary observations must be made before reviewing the substantive evidence of the reasons why physicians are spatially distributed as they are. First, the available evidence is the fragmentary, largely unco-ordinated work of researchers in several disciplines, including economics, sociology and social medicine. Consequently there is a lack both of a reasonably integrated body of research data and of tested theoretical frameworks for organising and interpreting the empirical material. Attempts to explain distributional patterns have been made by sociologists in terms of status-consistency theory, by economists in terms of the income-maximisation behaviour of physicians, and by epidemiologists in terms of a critical relationship between the size of the medical enterprise (including manpower) and the epidemiological characteristics of the population within defined spatial areas. It is evident both from the continuing concern in the literature about organisational frameworks and from the apparent failure at a pragmatic level to induce substantial changes in locational patterns, that any one theory is unlikely to suffice in a general context. For example, it would seem on a priori

grounds that the status-consistency theory (that physicians will tend to locate in communities most closely resembling their own sociocultural backgrounds) will offer a better explanation of distributional patterns in countries which remunerate physicians on a salaried basis than in those with an unsubsidised fee-for-service system of remuneration. In the latter situation the economic inducements to seek practices in urban areas with a high per-capita income may weaken or even over-ride whatever other dispositions the physician might have towards a status-consistent area of practice.

Second, most explanations have utilised cross-sectional data, although the explanations themselves often involve statements or inferences about secular trends. The distinction is important because cross-sectional data, whilst revealing structural relationships among variables, do not readily clarify the manner in which change has occurred. Indeed, it is frequently hazardous on the basis of cross-sectional survey data to draw any conclusions about the likely direction of a relationship, or whether it is a causal relationship. For example, Rimlinger and Steele (1963), in the first of their two classic papers on medical manpower distribution in the US, present data for 1959 showing a positive curvilinear association between the per capita income of county groups and their ratios of physicians to population. The assumption is invited that the two variables are related causally, and that the direction of the relationship moves from per capita income to physicians per population. However, in the second of their two papers (Steele and Rimlinger, 1965), the authors plot the changes in the location of physicians over the decade leading up to 1959, relating them to concurrent changes in the degree of urbanisation, the movement of population and the increase in per capita incomes. The results of this more elaborate analysis showed that an increase in per capita income within counties was indeed associated with a gain in the number of physicians over the decade, but the relationship held good only in the large metropolitan areas. Across the country as a whole, the most important factors affecting the change in the location of physicians were the regional degree of urbanisation and the rate of population increase. The relative inequality of distribution based on per capita income had actually decreased over the nine years, while the urban-rural inequality had increased. Moreover, not only was income shown to be a less significant factor than the authors had originally suspected, there was also some evidence to suppose that the relationship observed between income levels and the availability of physicians in 1959 may have been mutually reinforcing. Physicians, together with other professional and technical workers, tend to follow the movements of the population to high-income areas (through entries to and exits from the profession rather than through physical mobility), but once there, they contribute to an infrastructure of service provision that is conducive to further productivity and gains in per capita income.

Third, the independent variables that have been invoked to explain the pattern of manpower distribution are so diverse that considerable care must be taken in understanding their inter-relationships. In particular, as Anderson and Marshall (1974) point out, the error must be avoided of assuming that variables which, in isolation, are shown to be associated with the PPR of areas, are necessarily cumulative in their effect. This may be the case under certain circumstances, but two obvious reservations must be noted. One is that a high correlation might exist between one or more of the independent variables, which would have the effect of one variable being used to some extent as a proxy for a second variable; the second is that the impact of one variable is likely to be modified by the operation of another. The analysis by Rushing and Wade (1973) offers an example of this. Responding to the commonly accepted finding that the provision of hospital facilities increases the attractiveness of communities to physicians, Rushing and Wade sought to establish the community contexts in which this relationship was strengthened or diminished. Using AMA data for 1966 on the distribution of physicians for all 2,971 counties in the US, they derived a correlation of +0.52 between physician-population ratios and hospital bed provision across all counties; but the correlation was eight times stronger in the greater metropolitan than in the isolated rural counties. The same point is made by the findings of Steele and Rimlinger (1965) and Marshall *et al* (1971) that the relationship between income level and PPR is much more marked in large urban than in rural areas.

Against this background of general comment about the difficulties of summarising the literature on the causes of location patterns, the reported studies can be broadly classified as of two kinds: those dealing with motivational explanations and those concerned with ecological explanations. The distinction is not intended to reflect any profound theoretical differences of approach, but rather to summarise the two dominant strands that appear to characterise both the assumptions and the methods of reported studies. The motivational approach concentrates on the individual physician and the 'reasons' for his choice of practice location. The problem of maldistribution is seen as the outcome of an aggregation of individual choices, and the solution therefore requires first, an understanding of the elements that enter into the individual's choice, and second, a policy that will either change those aspects of the environment which are endowed with negative qualities, or that will restructure the physician's perception and evaluation of them. The method most commonly used in studies of this kind is a social survey of physicians designed to answer such questions as: what are the reasons they give for their choice of practice area?; what do they find most

attractive about their present locations?; what environmental features would they wish to avoid? Such surveys may be valuable in uncovering the subjective perceptual and attitudinal dimensions of the matter in a way that the ecological analysts entirely miss, and they may yield contributions towards a policy programme that would not be available from other sources. The results of such surveys, however, will be of diminished value unless analysed in the context of an understanding of the structural constraints in the movement and location of physicians, and they are always open to the charge of positivist bias.

The ecological approach is more difficult to summarise. Rather than seeking an explanation for the distribution of physicians in terms of motives (whether economic, professional or cultural), this approach focuses on communities and community properties, and analyses the relationships between the structural characteristics of communities, of which medical care is one element. The spatial location of physicians is thus viewed as part of a more general pattern of the social and economic differences between communities in which physicians themselves have little part to play. They, together with other service groups and institutions, are constrained in their locational patterns by the pre-existing spatial relationships between those community characteristics to which they typically respond. Ecological-type studies have generally adopted a multivariate form of statistical analysis to relate the dependent variable (some form of physician-patient ratio) to a range of independent area-based variables that are assumed to act as positive or negative inducements to doctors, the data being aggregated at whatever territorial level is available or deemed appropriate. A regression model is often used that enables the concomitant variations between the elements of the model to be quantified. For example, Elesh and Schollaert (1972), using data on Chicago census tracts from the 1960 census, regressed two categories of PPR (primary and other physicians) on population size, commercial activity, hospital bed provision, and the age, educational and racial structure of the population. The model enabled them to conclude that, holding the remaining variables constant, a one per cent increase within census tracts in the number of families with an income in excess of \$10,000 would increase the number of physicians by 0.029.

An important contribution of the ecological approach is the insight that the maldistribution of medical manpower is not an isolated problem of health care delivery, but is one element of a wider socio-economic process governing the distribution of all services. Physicians do not behave in totally idiosyncratic ways in their decisions of where to practise; rather, they are open to and constrained by a similar set of social and economic considerations

as other professionals. Some evidence for this is supplied by Rushing, who, using the 1966 AMA data on the nationwide distribution of physicians by county, regressed the ratios of physicians and of other professional workers on median family income and degree of urbanisation (Rushing and Wade, 1973; Rushing, 1975). The result showed almost identical regression coefficients for both groups, and similar (though less marked) results were found for nurses and other para-medical workers. Obviously, the detailed mechanisms securing the spatial distribution of a particular profession will vary from one profession to the next. The opportunities and constraints that play upon the individual, independent contractor who requires little capital equipment to practise his skills will differ from those affecting the professional worker employed in a bureaucratic organisation, and these in turn will differ from the structural constraints that face, for example, the surgeon who requires a complex array of capital plant and equipment, supporting skills (of anaesthetists and nurses), and various other services in order to practise his profession. Nevertheless, the very fact that the differing locational constraints and needs of different professional groups produce a common pattern of spatial clustering is further evidence of the strength of ecological or area-based variables over those of personal choice.

What then, is the nature of the relationship between the results of motivational and ecological studies? With the exception of Anderson and Marshall (1974), the question seems to have been ignored in the literature, but the way it is answered may carry significant consequences for the initiation or development of policies based upon the results of empirical work. The view offered by Anderson and Marshall is that the ecological constraints and opportunities are sufficient in themselves to explain the distribution of physicians, and that the self-reported reasons which physicians give for their locational decisions are merely confirmations or rationalisations of behaviour patterns that are motivated by more fundamental considerations. Thus, they describe the preferences expressed by some specialists for city life or for a practice that is located near to family and friends as idiosyncratic to the general tendency for specialists to cluster near to medical schools and large hospitals: the plain fact is, they argue, that such facilities provide important support for their activities that cannot be reproduced elsewhere. This example appears to take a special case to support an attenuated view of the importance of the ecological over the motivational approach. It is obviously true that where physicians depend heavily upon supporting services and facilities, their distribution will match the distribution of the facilities; but this type of explanation does not account for the decision of any particular physician to locate in town A rather than town B (assuming they both have the necessary

facilities), nor does it explain how the necessary facilities come to be distributed in the first place. In the case of many services and facilities, it is possible that the movement of physicians to a particular area will precede and generate the supply of those services rather than simply follow a pre-existing pattern of service distribution.

The purpose of stressing the relationship between the results of these two research techniques is partly to emphasise the extremely complex task of those responsible for relating the products of applied research to the development of policy, and partly to caution against the tendency to compartmentalise the results of reported studies into motivational and ecological boxes. Although it will be convenient to discuss the studies as though such a division exists, the total picture can only be assimilated through an awareness of the dynamic relationship of personal motivations and structural constraints in producing a particular pattern of manpower distribution.

It is scarcely surprising that most American studies of the causes of locational patterns have incorporated some measure of per capita income as an independent variable. Indeed, until very recently the American literature accepted as axiomatic that a positive correlation exists between the income level and the PPR of an area. As Aring (1972) observes, the pressures of an industrial world heighten the physician's awareness of his own pecuniary interests and turn him into something of a man of business. The evidence is almost consistent: positive correlations have been reported between community income levels and PPRs at the level of the state (Weiskotten, et al, 1960; Benham et al, 1968; Rimlinger and Steele, 1963), the county (Rushing and Wade, 1973) and the city sector (Terris and Monk, 1956); but the nature of the link is far from clear. Classically, it is the free play of market forces in the health sector that directs resources towards those areas best able to command them; but this is scarcely a total explanation. Quite apart from the functions of perceived need and taste in determining the demand for care (which may well vary in idiosyncratic ways with variations in spending power), the operation of the market might be expected to produce a rather more even distribution of medical manpower throughout the United States than actually exists. If physicians are motivated in their choice of a practice location solely by a desire to maximise their income, many newly-qualified physicians are likely to find better opportunities among the numerous communities devoid of manpower than among those already experiencing a relative surfeit. There must be values and mechanisms in addition to those of the market that attract physicians to high income areas and enable them to compete in circumstances that sometimes approach market saturation.

Two pieces of evidence appear in the literature which indicate the possible means by which a high ratio of physicians to population can be maintained in large urban areas. Rimlinger and Steele (1963) conclude in the first of their two papers that it is the fee schedules of doctors rather than the population income levels per se which best distinguish areas with high and low PPRs. If the income level of an area is sufficient to support rising fee schedules, the total volume of work can be shared among a larger number of physicians with no diminution in the average income of each physician. In areas with much lower fee schedules, by contrast, a similar total volume of work would have to be undertaken by fewer physicians if each was to receive a comparable income to his colleague charging higher fees. Provided physicians are willing to make the necessary substitution of leisure for income, the point at which the market becomes saturated may be capable of prolonged delay. A second means of supporting large numbers of physicians in high-income areas in the US is suggested by the data collated by de Vise (1973), showing a direct relationship in 1970 between the per capita payment of Medicaid and Medicare subsidies in each state and the number of physicians per 100,000 population. Federal dollars (which now account for more than a quarter of all physicians' bills) flow more plentifully to the doctor-rich than the doctor-poor states, thus acting as a kind of hidden incentive to exacerbate the uneven location of manpower. Since many of these payments are made to inner-city residents, physicians in these cities can afford to live in the more attractive neighbourhoods through a combination of wholly-private and federal-subsidised practice.

The argument that in a fee-for-service system the distribution of physicians will be determined by wholly unrestrained market behaviour is thus untenable: physicians seem willing to some extent to sacrifice an element of income in order to enjoy an increased amount of leisure or other non-financial benefits which would not be available to them in locations where income might be maximised. This conclusion carries important implications not only in fee-for-service systems but also in salaried and capitation systems which embody an element of weighting or incentive in favour of underserved areas. It is also consistent with the general conclusion of Glaser's (1970) world survey that higher pay alone has never succeeded in attracting physicians into country towns and rural areas in sufficient numbers. Indeed, the overwhelming attraction of large centres of population is the second dominant theme (together with income levels) in the American literature on physician location. At the national level, Reskin and Campbell (1974) found that population size alone accounted for almost 97 per cent of the variance in the distribution of all physicians across the 22 greater metropolitan areas in the US in 1966, and a linear relationship was

found between population size and each of six specialty groups. Marden (1966) likewise found very high correlations indeed between population size and PPRs for all metropolitan areas: +0.98 for all physicians, +0.99 for general practitioners and +0.97 for specialists. Rushing and Wade (1973) report a linear relationship between the proportion of urbanised population and the PPR for all counties in the US in 1966, and similar results at the intra-state level have been reported from Kansas (Marshall, et al., 1971) Upstate New York (Parker, et al., 1969) and North Carolina (Fein, 1954).

The interpretation of these results is problematic beyond a broad statement that physicians generally have a preference for working in large, expanding urban areas. This statement, however, is essentially descriptive, not explanatory and it must be hedged with qualifications. There is some evidence, for example, that population size is a better predictor of the distribution of specialists than of general practitioners (Dickinson, 1954; Joroff and Navarro, 1971); and the conceptual and empirical distinctions between 'urban areas' and 'population size' are weak in many of the studies. Moreover, an emphasis on the sheer size of communities as a factor in their attractiveness to physicians conceals the qualitative aspects of the population that may be equally important attractions.

The hypothesis that physicians tend to seek practices and locations with characteristics consistent with their own status preferences has been tested explicitly by Elesh and Schollaert (1972) in Chicago. Using race as the indicator of status, they posed the question of whether, having controlled for three major components of demand (ability to pay, disposition to seek care and medical need), physicians were less likely to be found in predominantly black areas of the city. The results of the analysis indicated a positive answer, although the explanatory power of the model was low, suggesting that important variables in the intra-city location of physicians had been omitted from the study. A similar study by Kaplan and Leinhardt (1973) in Pittsburgh drew comparable conclusions. Using a multiple regression analysis of six variables, they found that the proportion of coloured people in the population accounted for some of the variation in the distribution of physicians between census tracts in the city, but less than the proximity of short-term hospitals or the presence of large amounts of commercial zoning. Other investigators reporting a negative correlation between the concentrations of coloured people and of physicians include Reskin and Campbell (1974) and Marden (1966), the latter of whom found the variable to have a stronger negative correlation with the location of general practitioners than of specialists. A stronger status-related variable in the distribution of specialists was found to be the median years of education completed by the

population, which is also interpreted by Marden as an attempt by physicians to assemble a practice population with characteristics most closely resembling their own. Parker et al (1969) likewise found in their study of eleven counties in Upstate New York that counties achieving an absolute net gain of physicians over the years 1940-1960 had populations with a median number of school years 10 per cent higher than those in counties suffering an absolute net loss of physicians over the period. Similar results are reported from North Carolina by Fein (1954).

A third measure of population structure that has appeared in several studies is that of age. Joroff and Navarro (1971), in a complex analysis of the relationship between 10 community characteristics (independent variables) and 27 physician-population ratios (dependent variables) across the 299 SMSAs in 1966, found the proportion of the population over the age of 65 to be the best predictor of the distribution of general practitioners, though not of specialists (for whom, as noted above, community size was a better predictor). Such a result might be interpreted as a tendency on the part of general practitioners, at least, to locate in areas where the need (and, since the passage of the Medicare legislation in 1965, the effective demand) is greatest. A more explicit test of the propensity of doctors to respond to geographical variations in health levels is offered by Reskin and Campbell's (1974) study of the 22 greater metropolitan areas of the US. Using data from the National Health Survey on days of bed-disability, sickness absence and self-reported acute conditions as indicators of health levels, a positive correlation was found between the volume of morbidity in the metropolitan areas and the supply of each of six categories of specialists. The interpretation of this finding is problematic: Reskin and Campbell regard it as evidence of the responsiveness of supply to demand, but alternative hypotheses about the incidence of iatrogenic disease and about the responsiveness of demand to supply are also suggested.

A further set of explanations for the pattern of physician distribution concerns the location of hospital facilities and centres of medical education. It is argued that most physicians regard the access to hospital facilities and to colleagues as necessary to their professional development, and will tend to settle in areas offering these kinds of professional contacts. The construction and improvement of hospital facilities was suggested thirty years ago as a possible remedy of the shortage of manpower in rural areas and small communities of the United States (Mountin, et al, 1945), and the enabling legislation was passed the following year (the Hill-Burton Act). The data discussed above on the post-war continuation of the trend towards urban practice suggest that the most optimistic hopes have not been fulfilled, although there is some evidence of local success in the programme. Williams

and Uzzell (1960) studies the effect on manpower recruitment of the construction of 42 hospitals in small communities in Georgia between 1949 and 1956 under the Hill-Burton Programme; they found that all the communities gained some physicians during the period (the rural communities gaining relatively more than the larger towns and cities), and they continued to do so even after the initial impact of the hospital had passed. Against this must be set experiences such as that reported by Durbin (1973) of a group of counties in Illinois, some of which constructed new hospitals between 1950 and 1960 under the Hill-Burton Programme and others of which remained without hospitals during the period. No differences occurred between the two groups of counties in the recruitment of manpower; indeed, all the counties suffered a net loss.

The existence of hospital facilities appears to exert a stronger influence on intra-urban locations than on the urban-rural distribution. Ratios of hospital beds to population have been found to be associated more closely with the PPR in small than in large American urban areas (Marden, 1966; Reskin and Campbell, 1964), and also to be related more closely to the distribution of specialists than of general practitioners. Joroff and Navarro's (1971) analysis of the 299 SMSAs in 1966 showed the availability of hospital beds to be the best predictor of the distribution of all surgical specialists; and Scheffler (1971), using the Pearson product-moment coefficient on data for all states in 1963-7, derived correlations of +0.75 and +0.70 between the number of hospital beds per capita and the number of medical and surgical specialists per capita respectively, but a correlation of only +0.43 for general practitioners. Results consistent with these emerge also from studies of physicians' personal views and preferences. Bible (1970) found that physicians working in isolated rural areas away from the large centres of education and research tended to stress the self-sufficiency of their work and their role as community and professional leaders as positive attractions of their locations, and this style of work is likely to be more accessible to the general practitioner than to the specialist. Parker and Tuxhill (1967) found that an important motivation distinguishing physicians in small (< 25,000 population) and large communities in the Rochester (NY State) region in 1964 was the desire to build a busy practice early in one's career; again, this is more likely to be achieved by those in general rather than specialty practice, working in relatively under-serviced areas.

The nature of the link between the location of medical schools and the distribution of medical manpower is somewhat different from that of the hospitals. Three stages appear to be involved. First, regions produce medical school students in rough proportion to the number of medical places

available within them; second, students wishing to study medicine tend to seek places at medical schools within their home regions; third, medical graduates tend to practise in areas near to their medical schools (Yett and Sloane, 1974). Places with no centres of medical education are thus at risk of a cumulative deprivation: they fail to send their share of students to medical school, and fewer of those they do send are likely to return home to practise than would be the case if they were educated within their home locality.

The results of studies that have incorporated the availability of medical school places as an independent variable in ecological-type analyses are, however, conflicting. Reskin and Campbell (1974) actually found a negative association between this variable and the PPR across the 22 greater metropolitan areas in 1966, whilst Joroff and Navarro (1971) found it to be the best predictor of the location of all physicians and all medical specialists among the 299 SMSAs. Scheffler (1971) derived a product-moment coefficient correlation of +0.69 between the total number of physicians per population and the per capita provision of first-year medical school places across the 50 states in 1963-7; but, consistent with Joroff and Navarro's findings, the correlation was much higher for specialists than for general practitioners. Scheffler found an even higher correlation (+0.90 for all physicians) with the number of internship places per capita, but again the correlation was very much higher for specialists (+0.93 for surgeons) than for general practitioners (+0.28). The potential importance of internship places in attracting manpower was also noted by Mountin *et al* (1942a), who found that states achieving the greater gains over the period 1923-1938 were generally those with the greatest number of internship places. On the other hand, the use of preceptorships (schemes in which medical students spend part of their clinical training outside the medical school under the auspices of practising physicians) does not appear to be effective in inducing newly-qualified practitioners to settle in rural areas (Steinwald and Steinwald, 1975), although such schemes may well have other educational merits. A conceptually ambitious task was undertaken by Breisch (1970) in attempting to relate the quality of medical school education to the distributional pattern of physicians between SMSAs and other areas in the US in 1966. Using the per-student operating expenditures of the medical schools as an index of their quality, Breisch found a 2 per cent increase in the proportion of medical graduates practising in SMSAs for each \$10,000 increase in per-student operating expenditures. The highest quality schools in 1966 were supplying 8 per cent more of their graduates to the metropolises than the lowest quality schools.

The most complete attempt in the United States to relate the main

geographical points of reference in physicians' lives to their locational choices has been made by Weiskotten et al (1960) using data from an ongoing study of every fifth class graduating from all American medical colleges between 1930 and 1950. Among the 1930 graduates, 21 per cent went into practice in the same city as their medical school and 36 per cent in the city of their residence prior to entering medical school. The corresponding percentages for the 1950 graduates were 15 and 25. At the level of the state, 56 per cent of the 1930 graduates practised in the same state as their medical school and 66 per cent in the state of their prior residence; among the 1950 graduates the percentages were 46 and 58 respectively. The authors concluded from these figures that, although the commitment to a familiar location had apparently weakened over the twenty years, the attraction of the medical school and, even more markedly, of the family home residence, remained strong. In a subsequent analysis of the 1950 graduates only, Weiskotten plotted the combined effect of the location of the medical school, the place of family residence prior to admission to medical school, and the location of internship and residency training. Among the 1,040 graduates in the sample who were practising in the same city as any one or any combination of these four events, the greatest pull was exerted by the place of family residence alone (217 graduates), followed by all four locations (187 graduates) and the location of residency training alone (142 graduates). The least attractive combination was the location of the medical school and internship. Of the 1,566 graduates in the sample who were practising in the same state as any combination of the four events, by far the greatest attraction occurred when all four events were located in the same state as their area of practice. Comparable results have also been noted in studies of dental manpower (Wechsler, et al, 1973; Williams, et al, 1969).

The importance of the home background of physicians in influencing their choice of a practice location is further emphasised by studies of the size of the 'community of orientation' of physicians. For example, those practising in small communities are more likely to have been reared themselves in small communities than those practising in large communities. Bible (1970) found that although no more than a third of a sample of all physicians in non-metropolitan counties in 1967 had been reared in communities of less than 2,500, the proportion rose to 49 per cent among those in the sample who were practising in communities of a similar size, and dropped to 21 per cent among those practising in communities with 25,000+ population. Diehl (1951), in a survey of all medical graduates from the University of Minnesota over a fifteen-year period, found that 58 per cent of graduates from small communities (less than 5,000 population) were practising in communities of a similar size, compared with 22 per cent of graduates from large cities. Among the 1950

graduates in Weiskotten et al's (1960) study, 36 per cent of those located in communities of less than 5,000 population originated from communities of a similar size, and only 15 per cent originated from cities of 500,000+ population. Conversely, among those practising in the large cities, two-thirds had family origins in cities of a similar size and fewer than one-tenth had originated from very small towns. Similar results are reported also by Champion and Olsen (1971), Cooper et al (1972), and Parker and Tuxhill (1967), the latter of whom conclude that 'the majority of small-community physicians surveyed grew up in a small community and chose to practise there because they liked small-community living and had the opportunity to quickly build busy practices. The majority of large-community physicians grew up in urban areas and chose to remain there because of a preference for urban living and the availability of large medical centres.'

Policies for change

Various strategies have been used, or suggested for use, by governmental and private agencies to ameliorate what is perceived to be an undesirable spatial distribution of medical manpower. Three general observations may be made about these strategies before describing their substance. First, corrective policies have not usually been aimed at explicitly identified factors that are held to be causal factors in maldistribution. Many policies appear to be based more upon the general assumption that all physicians have their price than upon specific measures to modify or change demonstrable causes of undesired locational patterns. Moreover, the contents of policies often appear insensitive to the different factors underlying maldistribution within cities and maldistribution between urban and rural areas. The most explicit attempt to relate causes and policies is that of Eisenberg and Cantwell (1976). They first abstracted from the literature a total of 17 hypotheses concerning intra-urban and urban-rural differences in the location of physicians. Next, they used available empirical evidence to judge the degree of confidence that might be attached to each hypothesis. They then listed the incentive mechanisms involved in 10 public and 12 private sector programmes in the United States aimed at influencing the distribution of physicians, and they compared each incentive mechanism against the validity of the hypothesis upon which the mechanism was (explicitly or implicitly) based. The results indicated that two of the most commonly used incentive mechanisms in rural America (economic incentives and training programmes) have little basis of support in the empirical evidence, whilst the provision of group practice opportunities has been little exploited as an incentive mechanism even though such opportunities are an important attraction in rural areas. The greatest success in aligning policies and hypotheses has occurred in the attempts to bias the intake of

medical students in favour of those from rural backgrounds, thereby exploiting the well-established tendency for physicians from rural and small-town backgrounds to practise in similar locations.

Second, as Rushing's (1975) thesis emphasises, the profound effects of socio-economic processes on the spatial location of professional services and institutions imply an ultimate solution beyond the medical care system, perhaps even beyond direct administrative action and government regulation. The general thrust of the ecological approach to manpower distribution identifies the sources of fundamental change in distributional patterns in a profound reorganisation of the structure of communities; but such change, if it occurs, is more likely to result from spontaneous social action than from measured governmental activity. Two consequences stem from this analysis for the development of micro-policies: that policy-makers must be careful to distinguish between causal factors that are and are not amenable to change in predictable ways; and that in order to be successful, policies must be broadly consistent with the basic movements in society. Rushing argues that the failure of many policies in the United States has resulted in large measure from a disregard of these constraining factors. His own preferred solution explicitly acknowledges the continuing uncompetitive nature of many American communities, and seeks to alleviate their shortage of medical manpower by linking them through referral systems with medical centres in areas offering greater occupational opportunities.

Third, the pursuit of redistributive strategies must take account not only of the broader macrosocioeconomic features of society, but also, more narrowly, of the total health care context within which the strategies are located. It is simple but naive for researchers to identify one or more variable with a high capacity to explain the observed distribution of physicians between area units, and to recommend appropriate changes in that variable as a remedy for the maldistribution. Many of the studies reported in the previous section concluded in this way. Scheffler (1971), having demonstrated a high correlation across states between the supply of physicians and the number of internships, recommended the provision of more internship programmes in under-served areas. Wechsler's (1973) finding of the importance of the family home area in the locational patterns of dentists sustained the conclusion that dental schools should bias the recruitment of students in favour of those from rural and low-income areas. Parker *et al* (1969), concluded on the basis of their results that the provision of more rural health centres and day-release programmes to enable rural physicians to work in larger medical centres would help to resolve the manpower shortage in isolated counties. Each of these strategies, and the many others that

have been proposed, may in isolation achieve some change in a desired direction, but is clearly impracticable to advocate the adoption of every strategy with a demonstrable chance of success, not only because their interactive effects upon manpower distribution are largely unknown, but also because of the broader consequences which such a wide-ranging programme of change would have upon the total structure of health services. The maldistribution of medical manpower is rarely seen as an overriding problem in any health service, and policies for its correction are likely to be adopted only if they are felt to have a minimal, or incidentally beneficial, effect upon other current policies. It is perhaps for this reason that most government attempts to redirect the location of physicians have ignored the structural factors in maldistribution in favour of cosmetic attempts to improve the financial or professional attractiveness of chronically under-serviced areas.

An administratively simple way of enhancing the gravitational pull of a region of locality is through a loading of the incomes available to physicians practising within it. The strategy rests upon the assumption that spatial differentials in income levels can be introduced that are sufficiently low to be politically acceptable to the medical profession yet sufficiently high to persuade a certain number of physicians to forego some valued environmental or professional advantage in favour of a larger income. Glaser (1970) documents the experiences of several countries in pursuing such a strategy. He describes post-war schemes in Greece, France, Sweden, the Soviet Union, Egypt, Turkey and Israel, where attempts to encourage a more even spread of physicians between urban and rural locations through differentials in remuneration have largely failed, and more direct ways of controlling the location of manpower have been introduced. Similar experiences have been reported from Yugoslavia (Steinman, 1974), Norway (Evang, 1963) and England (Butler, et al, 1973). These results do not necessarily invalidate the principle of financial incentives: as Eisenberg and Cantwell (1976) comment, they merely indicate that the economic benefits of most programmes have failed to reach the threshold level of income necessary to attract a physician to a shortage area.

An alternative to the direct loading of salaries and incomes of physicians in under-serviced areas is the offer of grants, loans and scholarships to students who undertake, when qualified, to practise for a specified period of time in the region offering the money. In pre-war years grants were made available by the Commonwealth Fund for students during their medical education on the condition that they practised for at least three years in rural areas in Maine, Mississippi or Tennessee (Aring, 1972). In fact, most students failed to fulfil their contracts in full, and repaid the outstanding

portions of their grants on moving to urban practices. In 1946 the Mississippi State Medical Education Scholarship Programme was founded, giving scholarships and loans to medical students who contracted, following their internship, to practise in a Mississippi community of no more than 5,000 population. By 1960 some 350 students had benefited from the programme, and it was judged to have succeeded in its primary objective (Pankratz and Davies, 1960). At much the same time the AMA Council on Rural Health organised a consortium of 17 states offering a variety of scholarship and loan programmes administered through state and county medical societies. Many recipients of the loans have apparently settled permanently in small communities (Turner, *et al.*, 1955), although more recent reports indicate a growing number of students repaying the loans in preference to working in rural areas (Petersdorf, 1975). Mason (1973) has estimated that, since the inception of state administered loan programmes, nearly 45 per cent of participants have chosen either to buy or to default on their practice commitments. Four state programmes and one private programme (sponsored by the Sears Roebuck Foundation) have been discontinued entirely for these reasons.

In fee-for-service systems, where an income loading in favour of underdoctored areas is not possible to the same extent as in salaried systems, more fundamental solutions have been proposed. To the extent that supply is sensitive to demand, and to the extent also that effective demand is conditional upon the ability to pay, it has been argued that a redistribution of manpower is only likely to occur if effective demand can be equalised on a geographical basis. This mode of analysis leads either to the passive conclusion that the worst disparities in manpower distribution will automatically be corrected with the long-run tendency towards a regional equalization of per capita income (Rimlinger and Steele, 1963), or to the active conclusion that ways must be found, either directly or through third-party insurance, of accelerating the tendency by boosting the personal resources available for health-care expenditure in the low-income, under-manned localities (Feldstein, 1973). The modification of market operations as a solution to the distribution problem has, however, been severely criticised. Rushing (1975) points out that the effect of equalising demand potential does nothing about the causes of maldistribution that are essentially unrelated to the economic motivations of physicians. 'These include institutional differences in communities that lead to differential productivity rates, physician preference to practise in a setting resembling the community in which one was reared, and the concern for social and cultural opportunities for oneself and one's family.' Navarro (1974) questions the assumption of consumer sovereignty in the health market that is implied in the solution of equalising demand. He argues that, in the provider-consumer relationship in the American health

sector, the provider has far more influence than the consumer in the allocation of resources: the system is oriented primarily towards the provider's interests and only secondarily towards the consumer's interests. Thus, as Rinlinger and Steele (1963) allow, there may be considerable scope for physicians to neutralise the tendency towards an equalisation of per capita income, and to continue indulging their taste for urban living, first by stretching the fee schedules to the maximum range the market will bear, and second by making further substitutions of leisure for income. Moreover, as both Elesh and Schollaert (1972) and Rushing (1975) point out, the effect of measures in the United States to increase the resources available to people with low incomes (whether through National Health Insurance or an extension of Medicaid) will benefit large numbers of inner city residents as well as those in rural communities, increasing still further the resource-base supporting a disproportionate clustering of physicians in the vicinity of metropolitan areas.

An alternative set of proposals for modifying some of the structural factors perpetuating a maldistribution of medical manpower centres in the institution of medical education. It has been argued, for example, that by increasing the total supply of manpower available at the national level, an overflow of physicians will occur from well-endowed to poorly-endowed areas (Association of American Medical Colleges, 1969). Beyond a certain level of supply, the argument is probably valid. Even in non-market-oriented health care systems, a point will eventually be reached when supply exceeds effective demand in the attractive areas and additional physicians are forced to locate in other areas if they wish to practise medicine in their own country. However, the number of additional physicians required to achieve a state of natural saturation (and hence the cost of training them) is unknown, and governments have naturally avoided commitment to such a policy. A more modest increase in the supply of physicians would certainly enlarge the pool of manpower that is potentially available for under-manned localities, but there is no reason to assume that, in the absence of negative controls over where physicians can locate, the additional manpower will distribute itself on a different basis than the existing stock. Communities that are unable to attract any of the existing pool of available manpower are unlikely to be much more successful just because the pool is increased by 10 or 20 per cent. Indeed, the evidence presented by Rushing and Wade (1973) actually suggests a negative link. Between 1950 and 1971, when the output of physicians in the United States rose by 54 per cent, the number of counties without an active physician more than doubled, from 64 to 133. On the assumption, however, that increases in the stock of manpower will be distributed in a similar way to the distribution of the existing stock, it may be possible at times of

manpower expansion for the relative variations in the PPR to remain constant between area units, whilst increasing the actual PPR to a minimally acceptable level in some units.

A second contribution that the medical school might make towards an alleviation of the problem is through the selection procedures of new students. The consistent tendency of physicians to practise in or near the areas in which they were reared has led some writers to advocate a bias in the selection procedures of medical and dental schools in favour of applicants from under-serviced localities (Mountin, et al, 1945; Wechsler, et al, 1973). Associated with this proposition is the further argument that the selective siting of new medical schools and the expansion of existing schools in regions with unfavourable PPRs would encourage a larger proportion of qualified school-leavers to choose medicine as a career. Legislative action along these lines has been taken in the United States: in 1971 an Act was passed by Congress authorising schools of medicine to 'establish and operate projects designed to identify and increase admissions to and enrolment in schools of medicine of individuals whose backgrounds and interests make it reasonable to assume that they will engage in the practice of their profession in rural or other areas having a severe shortage of personnel' (US Congress, 1971). Other programmes have included the National Health Service Corps and the initial funding approved by the Nixon administration for eight new medical schools to be strategically located throughout the United States in localities with persistent recruitment problems.

Whatever, the theoretical attractions of such policies, it seems unlikely in practice that medical schools and universities will subjugate their broader interests to accommodate an instrumental role of this nature. Medical schools are unlikely willingly to abandon the traditional criteria of selection of students in favour of a geographical bias towards applicants from under-manned localities; and a university desirous of acquiring a new medical school may not readily concede the claim to a competing university that happens to be located in a region or area of manpower shortage. Other substantive counter-arguments are made by Rushing (1975). He argues that the relationship between the presence of a medical school and the concentration of physicians (on which the case for the selective siting of new schools rests) is probably not a causal relationship. Part of the association, Rushing suggests, is spurious, because the staff attached to a medical school are usually counted as part of the medical population of the area; but it may also be the case that medical schools and clinically active physicians are both attracted by the social and economic character of the surrounding area. 'Medical schools are not located in isolated rural areas for much the same reasons that most

practising physicians are not located there. They tend to be located in communities with populations large and dense enough to provide sufficient clinical material on which both medical education and medical practice can thrive.' Rushing further argues that a recruitment bias in favour of medical school applicants from low-income rural areas is also unlikely to achieve much success unless linked with a type of training that encourages such students to become generalists capable of thriving away from large centres of medical technology. His analysis of data from the American Association of Medical Colleges' longitudinal study of medical graduates in 1960 showed that the tendency for physicians to practise in communities similar to those in which they were reared was much stronger among generalists than specialists. Since generalists constitute a relatively small and probably declining proportion of all physicians in America, the selection of more medical students from poorer communities would not in itself greatly influence the way physicians are distributed.

The failure of the American medical care system, with its mixture of fee-for-service payments backed by private insurance and federal aid and a growing emphasis on pre-paid schemes and health maintenance organisations, to secure a more desirable geographical spread of manpower has led some recent writers to conclude that only a direct control over the supply and location of resources will suffice. It is argued that the structural influences in the socio-economic system producing the observed forms of spatial clustering are so pervasive that their effects can only be counter-acted through direct regulatory control. In a weak form, the argument leads to proposals such as those of Aring (1972), that young physicians should be offered a choice between the military draft and two years' practice in an under-serviced area; and of Fein (1972), who puts the case for a compulsory two-year period to be spent wherever the need is deemed to be greatest. In its stronger form, the argument leads into more radical proposals about the institutional democracy of the health sector. Navarro (1974) argues for 'a strengthening of the planning and regulatory responsibilities of the public sector by investing government with regulatory power over physical and human resources'. Ideally, Navarro wishes to see a 'certification of need legislation', through which the human health resources in states and areas would be catalogued to identify overserved and underserved areas, and a restriction placed on the location of new physicians in the overserved areas. That is, 'physicians would not be told where to practise, but where not to practise' (Navarro's italics). It is in this contentious area that the most promising future developments may be located.

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