Estimating the burden of disease in an English region

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Abstract
Background Health Authorities seeking to make appropriate investments in health care require information about the nature of the burden of disease in their populations. The World Bank instrument called DALY – Disability Adjusted Life Year – has been used in the South and West Region to measure this burden.
Method The burden of disease caused by a selection of diseases has been calculated using DALYs, which combine premature mortality and disability. An estimate of the total burden has been estimated by ICD chapter.
Results Premature mortality accounts for 52 per cent of the burden of disease and disability 48 per cent. Mental illness, for which its DALY value is largely derived from disability not premature mortality, contributes the third largest component of the total burden, after heart disease and cancer.
Discussion DALYs can be calculated using UK data, and, with an appreciation of the theoretical issues which surround the calculations, can be used to describe the burden of disease in a population. Although designed to assist investment decisions in developing countries, the DALY is likely to be valuable in established market economies.
Keywords: health economics, DALY, QALY, programme budgeting

Introduction
The range and size of services commissioned by Health Authorities are largely based on a historical pattern, developed in an incremental way. Basing spending on the past raises a number of obvious questions. Is the best combination of services being purchased? Is the balance of care between care groups, diseases and ages groups that which produces the most benefit to the people each Health Authority serves? The answer to these questions requires a knowledge of the total burden of disease in the population served and an understanding of which health care interventions will produce the greatest reduction in that burden. Which diseases cause the greatest burden? Is current investment directed towards them? The South and West Region DALY (Disability Adjusted Life Year) project has been established to help provide answers to these questions.

The objective of the research is to evaluate the potential use of DALYs in the region by estimating the burden of disease of each of the sponsoring district authorities and how much of the DALYs are 'avoidable', finding out how much each authority spends on each component and exploring whether strategic shifts in expenditure are likely to reduce the overall burden of disease. The results of the first year of research are presented for the population of the South and West Region of 6.3 million.

What are DALYs?
DALY stands for Disability Adjusted Life Year. It is a measure recently developed by the World Bank to estimate the burden of disease by combining premature mortality and disability. DALYs are founded on the following principles: (1) to the extent possible, any health outcome that represents a loss of welfare should be included; (2) the characteristics of the individual affected by a health outcome that should be considered in calculating the burden of disease should be restricted to age and sex, these being the only two characteristics which mean the same in all cultures; (3) the measure treats like health outcomes as like; (4) time is the unit of measure for the burden of disease.
DALYs are therefore similar to QALYs (Quality Adjusted Life Years). The principal differences are as follows:

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1. DALYs are used to measure the burden of disease, not the efficacy of individual treatments.
2. Using disability rather than quality to transform the time lived with disability avoids the sophistication in multidimensional measures of quality which is inappropriate when measuring the global burden of disease.
3. As DALYs have been introduced as an innovation by the World Bank they have been able to define rules involved in the measurement of the burden. They have included age weighting and discounting parameters and, unlike many approaches to QALYs, use a life table with no cut-off age, so that the burden suffered by the elderly is included in the calculations.

The reasons why the World Bank chose to develop this new measure were:
1. To improve estimates of mortality. A decade earlier, estimates of world mortality summed to equal several times the actual number of deaths at each age. Although the child mortality figures had since been improved, adult figures were still inconsistent.
2. To include disability. Previous studies had focused on premature mortality; in some cases, morbidity was only considered a problem in countries which had undergone the epidemiological transition from high mortality and fertility associated with low incomes to low mortality and fertility linked to high standards of living.
3. To obtain an objective measure. As most health planners are often faced with a multitude of health problems and priorities they need an objective measure to compare them fairly.

Accuracy of mortality statistics is not a problem in this country, and calculations of premature mortality are commonplace. However, disability has not been included in measures of disease burden except for a few selected diseases. The focus of QALYs has been on evaluation of specific interventions rather than measures of the burden of disease in populations.

**Calculating DALYs**

Premature mortality is measured by summing years of life lost calculated from age- and sex-specific mortality rates for each disease or group of diseases and life expectancy figures. It is added to estimates of disability derived from epidemiological studies of disability, and knowledge of its duration and severity. For each individual the years lost or lived with a disability are discounted and age weighted. These are then summed to form totals for the disease or group of diseases.

DALYs lost by an individual are calculated for each disease or disease group using the formula

$$\int_{x=a}^{x=a+L} D x e^{-\beta x} e^{-(x-a)} dx$$

where $D$ is the disability weight, $r$ is the discount rate ($r=0.03$ in the World Bank report), $\beta$ is the age-weighting function ($\beta=0.04$ in the World Bank report), $C$ is an age-weighting correction constant ($C=0.16243$ in the World Bank report), $a$ is
the age of onset and \( L \) is the duration of disability or time lost owing to premature mortality. In practice, DALYs are calculated for groups of individuals. When calculating the DALYs lost through premature mortality the disability weighting is unity.

**Study method**

Eight top diseases have been chosen by the project for special study. They include the most important causes of premature mortality, disability and cost to the National Health Service (NHS). The burden of disease from other diseases has also been calculated for each International Classification of Disease (ICD) chapter to complete the picture by providing an estimate of the total burden of disease suffered by people in the South and West Region.

The 1992 Office of Population Censuses and Surveys (OPCS) age-specific mortality data and population estimates for each district in the region were used to calculate the premature mortality ‘years of life lost’ (YLL) component. The morbidity component is derived from estimates of ‘years lived with a disability’ (YLD) in established market economies, which includes the United Kingdom, from the World Bank study. The estimates are scaled using 1994 population estimates.

**Results**

Previous exercises looking at population needs assessments have relied upon an analysis of ‘years of life lost (YLLs).’ Diseases with the highest YLLs are heart disease followed by cancer, with mental illness in eighth and musculoskeletal diseases in eleventh place (Fig. 1).

Adding disability to premature mortality DALYs changes the order of importance of some causes. Heart disease and cancer still remain the most important groups. Mental illness moves to third place and musculoskeletal diseases overtake nervous diseases in importance and are placed just behind digestive disorders (Fig. 2). Overall, premature mortality makes up 52 per cent of the total burden and the disability component 48 per cent.

The top eight diseases chosen for special study contribute one-third of the total burden of disease (Fig. 3). The size of the disability component allocated to Alzheimer’s, alcohol dependence, osteoarthritis and suicide related diseases is considerable. The disability component elevates these diseases to major contributions of the total burden of disease in South and West Region.

Of the remainder, cancers other than lung cancer, followed by heart disease other than coronary disease, and mental illnesses other than Alzheimer’s and dementia are the chief causes of premature mortality and disability (Fig. 4).

**Discussion**

**Economic technical considerations**

The initial phase of the research project explored the use of DALYs using UK data to see if the approach devised by the
World Bank is appropriate for a high-income established market economy such as exists in the South and West Region. The purpose is to explore whether the use of DALYs better enables purchasers to reduce the burden of disease in their populations from their limited resources. There are five major features of the formula which are contentious and require careful consideration both from an economic theory and from a public health viewpoint: (1) the level of discounting; (2) the use of age weighting; (3) the method of calculating life expectancy; (4) how to incorporate the concept of avoidability; (5) the weightings used for disabilities.

The use of discounting
Discounting health benefits is controversial. The Treasury discount rate, which applies to the NHS, is currently 6 per cent. The World Bank used a discount rate of 3 per cent. There are three main reasons why individuals are likely to value future health benefits less than benefits now: (1) impatience or...
myopia: we prefer benefits now to future benefits; (2) uncertainty: we may in future not be capable of receiving future benefits; (3) diminished marginal utility: we are likely to value additional units of benefit progressively less (for example, we value the first piece of chocolate we eat more than the fiftieth).

A reason for not discounting is that discounting life years means that future life years are worth less than current life years. Future generations become virtually valueless. A consequence of discounting is to devalue prevention, as such measures incur costs now but provide benefits many years hence. A reason for discounting is that if costs are discounted and benefits are not similarly discounted then it follows that it will always seem to be more cost effective to defer treatment. Choice of discount rate is hence a policy issue and not just a technical question. The project team has decided to discount at 3 per cent but to present results using different discount rates in its final report to health authorities.

**Age weighting**

The concept of weighting ages differently is also controversial. A reason for age weighting is that in human capital theory more weight is given to lives at ages which are materially productive and which have absorbed capital investment such as rearing and education. It is not age discriminatory because we all hope to live at all ages. A reason against age weighting is that society values children and old people as much as people of other ages. The World Bank used age weighting; the project has rejected it except to provide a comparison of our results with theirs.

**Methods of calculating life expectancy**

There are four possible life expectancy options which could be used to calculate the number of years of life lost:

1. Potential years of life lost – using a cut-off point to mark life expectancy, e.g. the Public Health Common Data Set uses a cut-off point of 74 years of age. This is a problem for those who live longer than the cut-off point with disability such as dementia.
2. Period expected years of life lost – based on life tables. This fails to treat premature death and disability equally, as some populations live longer.
3. Cohort expected years of life lost – uses predictive estimates for the whole population but measures current burden against best current outcome rather than best possible outcome.
4. Standard expected years of life lost – uses one life table with high life expectancy estimates for all populations.

UK life tables are available but their use would make comparisons with other populations impossible. The standard expected years of life lost approach was chosen by the World Bank as providing the most appropriate measure for their needs. For the same reasons it has also been chosen here.

**Avoidability**

Some components of the burden of disease in a community are impossible to do anything about. Others are potentially avoidable following the purchase of an appropriate health service intervention. Others have been avoided but could return if the intervention were to be withdrawn, e.g. immunizations. A key element of the research is to estimate the contribution of these three components (avoided, avoidable and unavoidable) to the burden of disease. Various approaches are under investigation. They include the application of concepts used in research work on measuring effects of health care, avoidable deaths and *Health of the nation* target setting.

**Weighting disabilities**

The World Bank drew up a set of six classes of disability weights, from very mild disability to those who need assistance with all activities of daily living, each with a defined weight, between zero and unity. A panel of experts assigned proportions of individuals suffering from the various causes, according to age, sex and the region in which they lived. In this project we will estimate the proportions of individuals in each class using local epidemiological data and compare our estimates with those used by the World Bank.

**Practical considerations for health authorities**

The objective is to help health authorities make good investment decisions. The aim is to seek to combine three different approaches: population needs assessment, cost per QALY analysis and programme budgeting. Health authorities cannot make sensible investment decisions without a knowledge of the health needs arising from the total burden of disease carried by its population; therefore, this is stage one of the process. However, this knowledge is of limited value unless it is also known which of the diseases are treatable and at what price. The use of cost per QALY analyses allows comparisons of cost effectiveness between different treatments for which QALYs have been estimated. The limitation of this approach is that few treatments have been analysed in this way. Our third approach, programme budgeting, has been chosen to deal with costs on a comprehensive basis. DALYs are used as the link between the burden of disease and the programme budgets.

Our approach steers a middle path between the grand scale 'rational comprehensive planning' approach fashionable in the 1960s and marginal analysis, which is more popular today. Both have limitations. The former was too complex and relied on too many assumptions to be meaningful. The latter perpetuates the incremental changes to historical patterns of provision. Our approach seeks to merge the results of macro-economic analysis with the marginal changes represented in purchasing programmes of health authorities.
Conclusions
This is the first time an analysis of the total burden of disease combining mortality and morbidity has been undertaken in a population of the United Kingdom. The addition of the disability component to the analysis changes the relative position of some of the top diseases. These preliminary results suggest that the DALY may be a useful investment tool for health authorities in established market economies.

References

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