The economics of drug development and use

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If our Victorian great grandfathers had been allowed a glimpse of the world in the 1980s, and had been given a chance to choose just one group of 20th century innovations to enjoy in the 19th century. I believe that they would have chosen modern medicines rather than air travel, TV, electricity, etc. Medicines have probably done more to alleviate tragedy and suffering, and to improve the quality of life, than any other single group of innovations over the past century.

The theme of my paper is that the case in favour of pharmaceutical innovation rests on an even broader base than its contribution to human wellbeing. For countries such as Britain which are major centres of medical research and the development of new medicines, the pharmaceutical industry has contributed enormous economic as well as social benefits. These benefits result from a massive industrial investment in pharmaceutical research and development, which has been made possible because, superficially, modern medicines appear 'expensive'. In other words, they are highly priced in order to fund industrial research and development and the other concomitant costs of innovation—as well as to contribute profits which for the most part are used to finance the further expansion of the pharmaceutical industry. In Britain the pharmaceutical companies plough back into capital investment each year a larger sum than their total profits from their sales to the National Health Service.

The scale of expenditure of pharmaceutical industry research is illustrated by the fact that in 1980 the pharmaceutical companies spent over two and a half billion pounds worldwide on their research programmes. However, this investment is concentrated in only a small number of countries (Figure 1). The United States, West Germany, Japan, Switzerland, the United Kingdom and France are the principal centres of pharmaceutical research.

Pharmaceutical industry research spending in Britain has escalated over the past 20 years from less than £25 m per year throughout the 1950s and 1960s to over £400 m per year in the early 1980s. This escalation is not surprising when you look at the estimated cost of developing a single

successful new pharmaceutical chemical entity (Figure 2). Already in the late 1970s it cost on average substantially more than £50 million to develop a single compound.

More strikingly, is the way in which the proportion of sales revenue allocated to research and development has increased in Britain since 1970 (Figure 3). By 1982 companies reported to the government in the Annual Financial Returns that they were devoting over 17% of their income from sales to the National Health Service to R & D. This is higher than the world average, and is further confirmation of the importance of the United Kingdom as a centre of international pharmaceutical research. In case anyone is tempted to argue that the NHS is paying too much for pharmaceutical research, it is important next to examine the economic benefits which flow from this research investment.

The first point is that there is no doubt that the new pharmaceutical products emanate from the same countries which invest heavily in research. It is the same six countries which spent most on pharmaceutical R & D which also produced the largest proportion of the important new pharmaceutical products in the world (Figure 5). It is these same six countries once again with one exception which had the largest positive balance of trade in pharmaceuticals. The one exception is Japan, which has been a late entrant in the field of pharmaceutical innovation. It is now spending heavily on research, and it is starting to produce important pharmaceutical innovations. However this success has not yet been translated into a positive economic contribution to Japan's balance of trade. There is little doubt that Japan will shortly rectify this situation, and will join France, Switzerland, the United Kingdom, the United States and West Germany as a substantial net exporter of pharmaceutical products.

Thus as far as national economics are concerned, it is clearly established that pharmaceutical research expenditure pays off in terms of contribution to balance of trade. In 1983, Britain had a pharmaceutical trade surplus of over £600 million, and pharmaceuticals were among the top six industries contributing to Britain's national wealth in this way.

Figure 1 Pharmaceutical R & D expenditure in 1982 (Office of Health Economics).

Figure 2 R & D cost per new drug, 1968-70 to 1977-79 (£ 1980) (Pharmaceutical Sector Working Party, unpublished)

Figure 3 R & D expenditure as a percentage of sales to the NHS in Britain in 1967-82 (Annual financial returns)

However, the pharmaceutical industry's economic contribution is not confined to its export performance. There are also substantial

Figure 4 Country of origin of leading international pharmaceutical products, 1982.

Figure 5 Pharmaceutical trade surplus by country, 1982 (United Nations commodity trade statistics, 1982).

savings within the National Health Service from the use of modern medicines. The classic example is in the treatment of tuberculosis. The numbers of beds occupied by TB patients fell from 29,000 in 1952 to 383 in 1981. Before the introduction of the antitubercular drugs there had been long waiting lists for admission to TB sanatoria. Another equally striking example is in the treatment of mental illness. Up to the date of the introduction of the first tranquilliser in 1954 the number of patients in psychiatric hospitals had been steadily rising. In 1954 this trend was reversed (Figure 6) and the number of patients in mental hospitals fell from 154,000 in 1954 to 74,000 in 1983. It should also be noted that the average length of stay for patients with disease of the chest fell from 41 days in 1962 to 14 days in 1981.

Taking these and other diseases together an elementary 'cost-benefit' equation may be constructed (Table 1). The savings from reduced hospital use for just eight diseases between 1957 and 1978 represented a saving of £783 million. Against this, the total cost of *all* medicines at manufacturers' prices was only £735 million. Thus there was a 'net saving' to the NHS of £48 million on this basis. The calculations can be worked in different ways, but the incontrovertible point is that on any basis pharmaceutical

Figure 6 Mental illness hospitals and units—inpatient population of England and Wales since 1950 (----, estimated) (DHSS statistical reports).

Table 1 Savings in expenditure on the treatment of eight diseases in England and Wales in hospitals in 1978 as compared with 1957 (Office of Health Economics).

Disease	£ million
Mental illness	354
Tuberculosis	300
Hypertension	40
Pneumonia	37
Ulcers	16
Bronchitis	16
Skin disease	10
Epilepsy	10
Total	783
All pharmaceutical manufacturers' sales to the health service	735
Net saving	48

products are a remarkably cost-effective method of treatment.

Another economic benefit comes from the avoidance of early mortality by the use of modern medicines. Although the savings are difficult to calculate, there is no doubt that a reduction in the working population through deaths of children and young adults can reduce the prosperity of the nation. For example the slowly declining death rate from tuberculosis in the 1930s has fallen much more sharply since the 1940s when the antitubercular drugs were first marketed (Figure 7). For patients in the age group 15–44 years, the number of deaths from respiratory tuberculosis fell from 12,000 in 1945 to 25 in 1982.

Figure 7 Mortality rate from tuberculosis in England and Wales from 1900–80 (DHSS).

Figure 8 Child mortality: death rates per 10 000 children aged between 1 and 14 years in England and Wales.

There was a steady decline in child mortality during the 1930s due to improved hygiene, social conditions and nutrition. However, in the 1940s and 1950s there is a steep dip below the previous trend which is shown as a straight line on Figure 8. This dip coincides with the introduction of the antibiotics and other lifesaving medicines of the 'first therapeutic revolution'. Since the 1950s, the rate of decline has returned to parallel the previous trend, so that there can be no doubt that there was a once-and-for-all saving of child lives in the 1940s and 1950s, primarily due to the control of the infectious diseases. This once-and-for-all drop can be calculated to have saved about 230,000 child lives, over and above the savings due to the long term trend. Thus it seems clear that medicines have been responsible for the avoidance of nearly a quarter of a million child deaths, each of which would have been an individual tragedy for the family involved, and a very real economic loss for the community as a

whole. A similar example would be the steep decline in maternal mortality in England and Wales (from 270 to 10 deaths per 100,000 births between the early 1940s and 1980).

Nevertheless, most of these examples of human and economic benefits are to some extent historical. The medicines which are responsible were in the main developed in the 1950s. Certainly newer medicines, such as the β -adrenoceptor blockers, are also lifesaving; but in the main in the 1980s medicines are making a greater contribution to the quality of life rather than to the avoidance of premature mortality.

For this reason, much recent thought has been given to ways in which these benefits in terms of quality of life can be measured. There are two principal approaches. The first is to construct a 'health index' which gives a single value to a patient's degree of wellbeing. The second is to construct a 'health profile' which gives a more descriptive and less quantitative measure of wellbeing. The health index is exemplified by the so-called 'quality-adjusted-life-year' which allows one to measure the increased well-being achieved by medical treatment over a life-span.

Such an approach is still at an experimental and theoretical stage. On the other hand, the use of a 'health profile' is now well-established to measure changes in wellbeing, for example, before and after heart surgery. One of the best known instruments (as they are called) is the Nottingham Health Profile. It seems likely that the use of both health indices and health profiles

will be extensively developed in the future to give measures of benefit to set against the costs and risks of medication.

There are undoubted national economic benefits for a country such as Britain which has become a centre of pharmaceutical innovation. The Government should encourage clinical pharmacology and basic medical science in the Universities in order to provide the seed-corn from which this innovation can be grown. It also needs to allow the pharmaceutical industry reasonable prosperity under the Pharmaceutical Price Regulation Scheme (which controls NHS prices) in order that the growth can flourish within the industry in Britain. The Government also needs to remember that not only does the pharmaceutical industry in Britain bring national prosperity but its products help to keep down costs in other much more expensive sectors of the NHS.

However, in the future, these economic benefits alone may not always justify the expenditure on medicines, particularly in cases where they make the life of the elderly and chronic sick more comfortable. In these cases, harder measures of improvements in wellbeing will be needed to justify both expenditures and inevitable risks. This is an area to which the Office of Health Economics is particularly addressing itself at present. It is likely to add significantly to the evidence of the human and economic benefits of drug development in the future.