



SAVING LIVES, BUYING TIME: ECONOMICS OF MALARIA DRUGS IN AN AGE OF RESISTANCE?

Professor Kenneth Arrow and Sir Richard Peto

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Office of Health Economics
12 Whitehall London SW1A 2DY
Telephone: +44 (0)20 7930 9203
www.ohe.org

About the Authors

Kenneth Arrow

Professor Kenneth Arrow studied at Columbia and Chicago before becoming a Professor of Economics at Stanford. He moved to Harvard (1968-79) and then back to Stanford where he is now Professor Emeritus. He won the Nobel Prize in Economics with John Hicks in 1972 for his work on general economic equilibrium theory and welfare theory. He has been a Fellow at Churchill College, University of Cambridge, and Visiting Fellow at All Souls College, University of Oxford. He is a Fellow of many associations including the British Academy, and the American Economic Association (of which he is Distinguished Fellow and past President).

He is the principal architect of modern welfare economics, and closer to home, of health economics. He is one of those amazing people whose PhD dissertation was so outstanding that it became a classic as soon as it was published in 1951 as *Social Choice and Individual Values* (Arrow 1951). That is where Arrow's famous "Impossibility theorem" was born, shortly to be followed by the first and second welfare theorems and, with Debreu, the proof of the existence of a competitive equilibrium. A host of brilliant inventions followed – constant elasticity of substitution production functions, learning-by-doing, the Arrow-Pratt measure of risk aversion, and so on. Most of these are today referred to in texts and other writings without attribution, so deeply have they penetrated the way we think.

Two 1962 papers, "The Economic Implications of Learning by Doing", *American Economic Review* and "Economic Welfare and the Allocation of Resources for Innovation" in Nelson, editor, *The Rate and Direction of Inventive Activity*, studied the efficiency with which the market encourages innovation and the implications of learning by doing for economic growth. In 1963 came the foundation article of health economics which both introduced the concept of moral hazard into economics in general and announced the dawn of information theory (Arrow 1963). In these and later papers, he pointed out that the special market characteristics of medical care and medical insurance could be explained by reference to differences in information among the parties involved. The 1963 paper provided the intellectual underpinnings for health economics as a discipline.

In this lecture, Professor Arrow discusses the recommendations of the Report "Saving Lives, Buying Time: Economics of Malaria Drugs in an Age of Resistance" of the US Institute of Medicine (IoM) Committee he chaired and which reported in 2004 (Arrow *et al.* 2004).

Richard Peto

Professor Sir Richard Peto is Professor of Medical Statistics and Epidemiology at the University of Oxford and co-director, with Professor Rory Collins, of the Clinical Trial Service Unit which is famous for its large-scale multi-centre randomized controlled trials and observational studies, and also for the development of systematic overviews and meta-analyses to assess treatment effects. He was made a Fellow of the Royal Society in 1989 for his contributions to the development of meta-analysis and was knighted for services to epidemiology and to cancer prevention in 1999. He served with Professor Arrow on the Institute of Medicine Committee.

Office of Health Economics

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Introduction:

Some epidemiology of malaria

Richard Peto

There are three fundamentally important things to understand about malaria. First, malaria is a massive cause of death. These deaths are concentrated in Africa. Within Africa they are particularly concentrated in young children. There are around 1 million deaths a year of young children in Africa alone from malaria.

Second, the overall number of episodes of malaria in the world is the subject of some argument but it is of the order of 500 million episodes a year. 500 million people get symptomatically ill with malaria that is moderate, severe, or very severe. Very severe malaria mostly affects children or people who are coming to malarial areas without having had much recent exposure to malaria. These can be people who have grown up in malarial areas, who go away for a few decades and then return, or people without any previous exposure who come into malarial areas. In general, however, the deaths are of young children born in areas where there is severe malaria, particularly falciparum malaria. This is the predominant form of malaria in Africa and it is the main form that kills everywhere.

Third, the odd thing about malaria is that these episodes are easily curable. If someone is seen to be developing severe malaria they can be treated and cured using simple drugs derived from the plant *Artemisia annua* (sweet wormwood). The treatment is easy to give, takes about three days to effect a cure, and does not cost very much. The product extracted from this plant is artemisinin and it is given to patients in the form of semi-synthetic derivatives called artesunate, preferably in combination with other drugs. This is called artemisinin-based combination therapy, or ACT for short.

So, if treatment is easy, cheap and it works, why do we still have a problem? The problem is that having artesunate alone widely available could produce a major public health disaster. There are very few drugs that are as good as artesunate but, if it is used on its own, then resistance could well develop and spread throughout Africa within a few years and our ability to save lives with artesunate will disappear.

This happened before with chloroquine, which had superseded quinine. Over the last half century chloroquine has been an extraordinarily effective drug for malaria, and it used to be as good as artesunate. It too was cheap to make, and was widely available in markets, shops, medical outlets – just about everywhere. People had it in their homes and it could treat themselves with it. It was also stable and easy to distribute. Unfortunately, it took only a few cases in which a single malaria parasite in a single patient developed a mutation that made it resistant to chloroquine for the medicine to lose its efficacy. The resistant parasite had a massive selective advantage over non-resistant parasites in that patient. When a particular mosquito that had picked up the resistant parasite from that patient bit other people the descendants of that parasite had the same massive selective advantage over the other malaria parasites that were still susceptible to chloroquine. Chloroquine eliminated the parasites that were sensitive to it but did not kill the ones that were resistant, and so chloroquine resistance spread. The mutation probably occurred only a few times in all of the billions of cases of malaria over the last few decades, but the result has been devastating. Chloroquine was, before artesunate, the most satisfactory way of treating malaria. Today in many parts of the world it just does not work any more.

An alternative treatment was a combination of drugs called SP (sulfadoxine-pyrimethamine) but here it proved much easier for the malaria parasites to become resistant. Almost as soon as SP started to be used to replace chloroquine, resistance to it started to develop.

If any effective is widely used on its own then resistance to it could well emerge.

Artesunate is a very good drug in terms of its ability to kill parasites. It is also a very good drug in terms of the probability of resistance arising. In spite of this, resistance may well eventually arise if artesunate is used on its own. There is no guarantee that it can be replaced in time. Big discoveries of wholly new antimalarials occur only once every few decades, not once every few years. To lose two or three important classes of drugs means that the number of deaths from malaria could increase to well over a million a year.

Malaria is nearly out of control. It is not yet, however, absolutely out of control. In most parts of the world the number of malaria deaths is probably stable rather than increasing but in some places mortality is already increasing. We therefore cannot afford to lose artesunate or

any other really effective class of drugs. The solution in principle is obvious but it is very difficult to put into practice: whenever a patient is treated they ought to be treated not with one effective drug but with two, each with a different mechanism of action – that is, by combination therapy. It may be several years before the first artesunate-resistant mutant parasite arises but if the patient in whom this happens is also being treated with an effective dose of some other drug (so killing that mutant parasite), then it could be many decades before one such mutant escapes and artesunate resistant parasites spread. The way to protect the continuing effectiveness of antimalarial drugs is therefore to give them in combination, so that one of the two drugs in the combination would kill any parasite that mutated to become immune to the other.

But, such combination therapy will, of course, cost more than either drug alone. Malaria mostly kills really poor people. If you were an economically rational patient sitting in a village with an income of about one dollar a day, and you had to buy your drugs out of your own pocket, and you could use either a combination of two drugs, A and B, or just one of those two drugs, which would still generally suffice, what would you do? The danger is that people will use drugs one at a time because it makes economic sense for an individual to do so. We therefore have to create economic incentives to use the combination and to use it correctly. This will not happen if we just leave drug manufacture and drug supply to market forces. Resistance to both drugs will then develop.

So, how is it possible to produce circumstances in which the economically rational thing to do is to use the combination and to use it correctly? Legislation to prevent the drugs being sold separately is unlikely to be effective. The solution which Professor Arrow proposes is designed to create circumstances where the combination of artesunate and something else that also works is procured centrally and then distributed through the usual commercial networks – not just through health services but through every network that there is, at no more than the cost of either A or B alone. It also has to be packaged and distributed in a way that encourages completion of the course of treatment.

When I was invited to join the Institute of Medicine's committee, I nearly refused because I am an epidemiologist and not an economist and I did not really think that the economic aspects of malaria control

would be very interesting. I was completely wrong, because it turned out to be one of the most interesting committees I have ever been involved with. If its main economic recommendations on the global structure of malaria drug procurement and distribution get taken seriously, then that committee will have saved more lives than any other committee I have been directly or indirectly involved with. This single recommendation could easily avoid several million deaths over the next few decades.

There is one last epidemiological point. There is a particular need to make sure that the drugs are affordably available to the people who are at most risk of death. These are children – especially children in rural Africa – who live in places where there may not even be a cash economy in the village. They will also almost certainly have to be treated on the basis of suspicion rather than diagnosis, at least in malaria endemic areas, for a reliable diagnosis could cost more than treatment, especially if the costs and delays of transport to a clinic are included. In areas where malaria is common, any child who is running a temperature and looks as though they have malaria probably has got it. Even if the temperature were due to something else and you could do a blood test you would probably find malaria parasites in the blood, even if those parasites were not causing the high temperature, because so many children in those areas have low grade asymptomatic parasitaemia (parasites in the blood) in any case. So, careful clinical diagnosis of what really underlies the fever need not precede treatment in, or near, the home. One final comment is that, because so many of those die are young children, there needs to be special consideration given to how in manufacturing ACT we make sure that packages that are suitable for rural children – really convenient and easily available – are devised, manufactured and distributed.

SAVING LIVES, BUYING TIME: THE ECONOMICS OF MALARIA DRUGS IN AN AGE OF RESISTANCE

Kenneth J Arrow

The committee that I had the honour of chairing, which produced the report that you have heard about (Arrow *et al.* 2004), and of which Richard Peto was a leading member, was one of the most exciting episodes of my life. While Richard Peto found getting into economics a challenge, I similarly was moving into biology and areas of medicine about which I am certainly not an expert, and I also found this to be a most interesting episode, as well as one of the socially most important issues that one can address. Sir Richard's Foreword has described the huge mortality attributable to malaria. It also has a huge impact on morbidity – the non-fatal consequences of having the disease.

Artesunates and related products are products of a plant called *artemisia annua*, also known as sweet wormwood. There has been considerable discussion by economists and others of the general process of innovation and how innovation gets into the economy. One can distinguish between technology and science, with technology being motivated more directly by the profit motive than science, and science being motivated by individual values like fame and recognition. In this case, the scientists were Chinese, and the motivation came from Vietnam and Chairman Mao, whose distrust of western medicine led them to look to traditional Chinese medicine for a cure for malaria. The original reports on the development of the *artemisia* products were published anonymously (China Cooperative 1982). The Vietnamese had found that chloroquine was no longer useful because of the development of resistance, and they appealed to the Chinese for help. Chinese scientists were assigned to work on it, but they had no idea what to do. They then looked at ancient books on herbal medicine and found in the third century AD a reference to a recurrent fever, which

looked like a pretty good clinical description of malaria. The book prescribed soaking a plant, *artemisia annua*, in water and then drinking the water. They tried it and it worked. Then they isolated the effective components of the plant; and these are the products manufactured today.

Let me deal with some of the economic issues involved with malaria. First is the question of the value of treatment. A big part is played by the value of life or, to be more accurate, the value of *statistical life*. This value can be derived from determining how much people are willing to pay for a small (say, 0.001) reduction in mortality, which is what economists call the marginal evaluation of a reduction in the risk of an adverse event occurring. There is also some evidence from the willingness of people to take jobs involving different degrees of risk on the job from contracting an occupational disease or of having an industrial accident. However, it turns out that the cost of using artesunate-related compounds is something like \$100 per disability-adjusted life-year (DALY) which is very low, in fact so low that there is hardly any point in comparing it with alternative methods of saving lives.

Another serious effect of malaria is lost productivity. Workers with malaria do not work efficiently: they take time off and the recovery process itself takes time. Some observers have argued that this lassitude is a major barrier to foreign investment in malarial countries. We know that foreign direct investment has been a major source of productivity growth for a large number of countries, including Korea, Taiwan and China. (By foreign direct investment I mean investment in real capital like a particular factory and not government bonds.) The argument is that resident managers coming from malaria free countries are at great risk and do not want to live there. It is hard to prove decisively, but macro-economic studies have compared countries having different incidences of *falciparum* malaria. Sachs and Malaney, for example, estimate that the average per capita gross domestic product (GDP) of malarial countries in 1995 (estimated at about \$1,500 adjusted for purchasing power parity) was roughly one fifth of the average across the non-malarial world (Sachs and Malaney 2002). Annual economic growth in malarial countries between 1965 and 1990 averaged 0.4% of per capita GDP, compared with 2.3% in the rest of the world, after controlling for the other standard growth determinants used in macroeconomic models. In the long run, the cumulative effect of malaria is to reduce GDP by nearly one half in the countries where it

is most endemic. This very substantial reduction may largely account for the relative economic backwardness of African countries.

Taken overall, the poorer countries of the world have rising standards of living. Such countries include China, India and to some extent Indonesia, as well as smaller countries like Taiwan and Korea. Of course, in population terms, China and India dominate the comparison. However, the African countries are increasingly falling further behind, and reputable scientists have argued that malaria has had a significant part to play in that issue.

Chloroquine has become largely useless, certainly in East Africa, and resistance is already developing in West Africa. The resistance first developed in South-East Asia, and chloroquine is not used there any more. What is, however, of particular interest about chloroquine is that the private sector dominated its manufacture and distribution. It was imported mostly from large Asian manufacturers, brought into the country, distributed by private wholesalers, brought to the neighbourhood stores and was pretty much available anywhere at something like 10 to 15 US cents per treatment. This included an average mark-up of about 8 cents per treatment over import prices. So long as it was effective, this was a very good deal because, even taking into account the low level of African incomes, 10 to 15 cents did not bar very many people. Chloroquine was widely available geographically and economically, and the public sector played very little role in its distribution. When one looks at public health expenditures this is not totally surprising. In Senegal, Zambia and Cambodia, for example, health expenditures per capita averaged about \$20 a year. It was not therefore surprising that most health care sectors were not capable of distributing it. Countries like Thailand and Vietnam are different, however, and their public sectors have played a major role in malaria treatment.

The per capita purchasing power of most malaria-endemic African countries lies approximately between \$270 per capita and \$490 per annum. ACTs cost about \$2 per treatment, and this is a much more significant bar to consumption. There are of course rich people in every country and so there are people who can afford it, but the numbers are, alas, not very big.

Sir Richard has observed that very few new anti-malarials have come along. It is not difficult to see why. The pharmaceutical industry is a

for-profit industry which has been very efficient in producing drugs, but the incentive to produce a drug depends on the size of the market. Drugs are products with very high fixed costs and low marginal costs, so research and development and the testing costs have to be spread over the buying population. One therefore needs a population that can afford to pay for them. The term for drugs that could be effective but that are judged by manufacturers to be unprofitable to develop, is “orphan drugs”. This orphan drug problem may occur even within a rich country in the case of drugs that treat very few people. Rich countries often create special incentive structures for them by, for example, offering tax credits and marketing incentives. Because malaria has been eliminated from highly developed countries the remaining world market for antimalarials is composed of extremely poor people and there is not much of an incentive to develop them.

Another term that has become very widespread in economics is, “externalities”. This is when something you do affects other people negatively (your train sends sparks in farmers’ fields as it passes) or positively (your honey bees pollinate neighbouring orchards as they collect nectar). Pollution is a common negative externality, such as dumping waste into water that flows into other people’s territory, or into the air, like the by-products of combustion. Sulphur dioxide is a major pollutant of this kind. The producer does not bear the costs that are being imposed on other people, even though these costs are the consequence of his production. In a well-functioning market you normally have to compensate a landowner for using his land for your own purposes and thus the cost to him is borne by you. You will naturally take that into account in your production decisions, including decisions about whether to produce anything on that land in the first place. But it is difficult or impossible to establish markets for everything and this is especially true when there is no private ownership, as there is not for the air we breathe. Climate change due to carbon dioxide emissions involves the same sort of problem – and it is on a global scale.

Resistance is another example of a global externality. If resistance develops anywhere it spreads and that is just what happened in the case of chloroquine. Resistance first developed in South-East Asia and was possibly exported to Africa by travellers. People carried the mutant parasites, they were bitten by mosquitoes, and it spread in that way. It was a global externality and no one country and certainly no one individual had any incentive to prevent it. Treating any commu-

nicable disease creates a positive externality by reducing the chances that other people will contract the disease. The person immunized benefits – but so do many others whose chances of falling ill are now lower. None of these other people has an incentive to pay for their ‘share’ of the cost of treating someone else – their benefit comes as an unintentional gift. They get a ‘free ride’. This is what economists call a “public good”.

There is another externality, but this time of a local kind. As the number of people who are free of malaria rises, when the mosquitoes strike the probability rises that they will drink parasite-free blood and so not acquire the parasite and thus not transmit it to other people. Reducing the number of people with malaria thus decreases the probability that other people will be infected.

These externality arguments suggest a case for public subsidy. In the case of malaria, the argument for public financing would justify making transfers only to governments. There is also, however, an international externality: if a country does not use ACTs – in particular, if it uses artemisinins as monotherapies – the possibility that resistance will develop is, as Sir Richard has explained, much greater. The subsequent spread of resistance to neighbouring countries and then on to more distant ones by travellers and migrant workers is inevitable. The universal adoption of combination therapy is therefore in the interests of the global community. The value of this international public good is extremely difficult to quantify, but it must include the value of averting all the cases of malaria that would result (including the treatment and productivity costs that are averted). So there is an argument for proceeding on a collective and international basis rather than locally, because no locality has a sufficient incentive to tackle the problem.

There is a further economic issue, and that is the question of inducing supply. We want to encourage the use of the combination drugs. We also want people to enter the market and invest in the necessary wholesaling and retailing activity. Farmers have to grow the artemisia annua plants. This is not difficult, but the land has to be cleared and prepared. It takes about 18 months or so for the first crop to appear, and so the costs of the investment are not immediately recouped and have to be financed. There is further investment activity on the part of the pharmaceutical manufacturers, and special processes have to be created. None of these is extremely difficult and there is no major knowl-

edge barrier. But, like every investment, it has to be paid for out of future sales. You need to have an expectation that there will be at least some reasonable period of time during which there is an assured market in order to recoup costs.

Given the low purchasing power and lack of wealth of the countries involved, the market needs some form of guarantee as to the predictability of a sufficient demand. I am not talking of a long-term contract for any one producer, for that would tend to destroy the benefits of competition, but the idea is that there should at least be a market in which they can compete. It is such a confidence-building guarantee that we are trying to achieve through a global subsidy arrangement.

Let me review the arguments. First of all, what is the argument for any subsidy? There is a kind of general presumption in favour of free markets for reasons which are well known to all of you. Our aim in the present case is to save lives. The market does not readily provide for that in any direct way, but saving lives (and reducing morbidity) has important economic consequences, so the country benefits if the incidence of malaria goes down. We want also to slow down the emergence of drug resistance and therefore need to create a market in which the combination therapies will thrive (there are highly specialised purposes for which monotherapy is better, such as in complicated malaria where there are special problems but this is not the chief issue that concerns us). We want also to provide incentives for innovation – we hope that the combination therapies we have now are not the end of the story, and there may be a number of ways in which they could be improved. The nature of the potential benefit is that it is an externality with characteristics of being ‘public’ – it is hard to exclude individuals from benefiting when the immunity of others increases. The combination therapy is cheap – though not as cheap as chloroquine – and the benefits are potentially enormous in comparison no matter how they are valued.

So what are we trying to achieve by a subsidy? The level of accessibility ought to be at least equivalent to the availability and ease of access of chloroquine. We want to reach the market and reach people, at least to the same extent that chloroquine was distributed and preferably even to improve upon that. We want the therapy to be correctly used – full courses once or twice a day for three days with minimal skimping and without making false savings by doing only one course

or using only one drug. The treatment has a more immediate effect than did chloroquine and so there is a temptation to stop before the course has been completed. The symptoms may have been alleviated on the first day but the parasites are still there.

Now one possibility would be to let each country proceed on its own. Each would see the advantage, and each could appeal for donor funds and subsidies which could be arranged nation by nation. However, protection against resistance is really a global problem, and a country might try to skimp a little and free ride, just as can be the case with vaccination. If everybody is vaccinated, any one person can skip vaccination without too much risk, but if everybody did so it would be a bad thing. Another problem is less global and arises in a bilateral situation. Transmission can take place, as we know, across borders. Suppose there is disease in one country, such as the Mozambique side of the Mozambique-South African border in the province of Natal. The controls in Mozambique are much poorer than those in South Africa, and so there is a lot of cross-border infection.

There is another more strictly economic problem. Suppose we let countries take care of themselves and subsidized each. If they actually used the subsidies to import the artesunates and allowed a domestic market to develop, then all would be well. But the chances that the funds will be diverted to other uses are high. In fact there is now pressure from some of the international organizations, particularly the International Monetary Fund, to withdraw from of support of this kind and transfer the resources elsewhere. This is exactly what you do not want to do.

The conclusion the Institute of Medicine Committee came to was that we should have a subsidy at a global rather than at a national level. There are potential problems, and this applies to any kind of subsidy. If the ACTs are cheap, then they may be used for the treatment of other febrile illnesses with similar symptoms, but there is not much one can do about that. That problem exists already with chloroquine and would not be made worse in the new situation. If your child wakes up with a fever, then in case it might be malaria you would like the treatment, as Sir Richard has explained, to be very rapid, even if there is no real diagnosis. You can give the treatment without calling upon any sophisticated medical system. So the tendency would be to use it in cases for which it would not have been prescribed had a diagnosis been

performed. I do not see any way out of that but, since the medicines do not have much in the way of side-effects it is no tragedy, and they are cheap so there is no great waste. It is a problem – but a minor one.

Another kind of problem has to be faced here. There is social and political resistance to the idea of subsidizing everyone in a recipient country. After all, in any of these countries there are people who can afford to pay the full price. Why should they be subsidised? However, in most of these countries a large majority will need subsidies and so the number of wealthy people who are going to get the drug at a subsidized rate is not very big. It is quite clear that administrative costs are far lower if one subsidizes in a universal way. Moreover, if you subsidise only one section of the population then they have an incentive to re-sell their drugs to the richer section. So for all these reasons we did not think that targeted subsidies offered any real possibility. Universality may pose some problems but, again, they are a minor price to pay for ensuring that the stream of benefits is generated.

There is a remaining question. Who ought to be subsidised: the farmer, manufacturer, importer, distributor, retailer, or end-user? Our view was that you want to place it as close to the producer and as far away from the end-user as possible. One reason for this is that the private distribution systems at least in Africa have been dominant. We see no reason for seeking to change this. Therefore, we wanted to preserve the private distribution systems, with all the incentives that are involved and that are actually in place.

If you have subsidies at the consumer level it is hard to see how they would be compatible with free enterprise. You could have vouchers but then you would also need a distribution mechanism, a system for checking and eliminating fraud, price controls and a regulatory apparatus, all of which would be costly and which in any country is apt to create problems and will certainly create problems in countries where the governmental institutions are as poorly developed as they are in most African countries. So we did not really want a subsidy to the consumer. Nor did we want one to the retailer, because there is too great a chance that the money would be diverted and not really serve its purpose.

A subsidy at a higher level up the chain means that you could have a global facility with a financing commitment on a multi year basis so that the producers know that the facility will continue to support the

market. You have to take a chance on what the needs of the individual countries are, but you will have feedback and if, for example, you find you are buying too much in one period you can reduce it in the next one. This would permit a global facility which would buy at the market price, say roughly \$2 for a course of treatment, and re-sell at some highly subsidised and very low price that would correspond to the present price of chloroquine.

We have national sovereignty of course, and we cannot tell a country that it has to have a private distribution system.. In fact they virtually all have some private distribution system. There are a few countries (Zambia is one) where non-governmental organisations play a dominant role in the market, but they are the exceptions.

The achievement of a high overall coverage with combination therapy and the elimination of monotherapies cannot really be achieved except through a subsidised global fund, with price competition being used to eliminate (a) the monotherapies (because they will not be subsidised) (b) chloroquine and (c) all alternatives which have proved to be unsatisfactory.

I believe the case is extremely clear. The problem now is to get it through international organisations. I am encouraged by the fact that the World Bank at a recent meeting has pretty much adopted it in principle. The World Bank is anxious to increase its participation in malaria programmes and have a booster programme, and it has decided in principle on the idea of a global facility which they will fund.

One might ask what costs are involved. Sir Richard has said that there are about 500 million courses of treatment taken throughout the world, which at \$2 would amount to \$1 billion a year. Everybody expects this price to go down as is typical of the evolution of many manufacturing patterns. First, there are economies of scale, and second, there is what is called a learning curve, because in the process of repeated production little tricks are discovered and the costs tend to come down. This was first observed in the manufacture of aeroplanes, where an aeronautical engineer in the 1930s observed that if you took any given design of aeroplane the cost of constructing the airframe came down pretty rapidly, giving a 20 per cent reduction in cost with a doubling of output. One would therefore expect that, as production increased, through economies of scale and learning the unit cost would come down. So the overall cost would be something like \$1 bil-

lion a year on a world scale, which is not a very big number. There have been promises by various countries, including mine, of a greater commitment to malaria and I trust they will be honoured – though I worry about it.

There are currently some reasons being put forward, which I do not find persuasive, for delaying progress. One is the indiscriminate application of principles that may apply in some cases but not all. For example, one slogan is “ownership”, in the sense that the country has to “own” the reforms. Procedures that are merely imposed as a condition of a loan by the World Bank or other international agencies do not last, so the idea is that countries have to make their own decisions and “own” these things. As a basic principle I think this is correct but I do not think it applies to this particular situation for all the reasons I have advanced and the fact that this is an international problem.

The other issue is “sector-wide planning”. You ought not to not pick out something specific like malaria but deal with the health sector, or something even broader. This is based on an idea which economists have pushed, that essentially each individual state knows the local conditions better than any international agency and therefore what you really want to do is just give them the resources (say, for the health sector as a whole) and then let them decide what is the best way of using them. Again, I do not think that is a correct principle when it comes to malaria. The subsidy is not being given for other health care programs, but for anti-malarial programs. A sector-wide subsidy would certainly entail some of the resources being used in ways not intended by donor countries.

I am very encouraged, however, by the fact that the World Bank, which is the organisation which has the largest financial possibilities, is strongly behind us and I look forward to hearing of its implementation in the near future. For an overall cost of around \$1 billion a year we can save about one million lives a year plus the impact on morbidity and on economic prosperity for malaria-endemic countries. The estimated benefits are less than \$100 per QALY. The alternative is a disease that’s out of control. We have to act.

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