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THE ECONOMIC IMPACTS OF TUBERCULOSIS

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The economic impacts of tuberculosis

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Executive summary

Tuberculosis (TB) is the largest single infectious cause of death among young people and adults in the world, accounting for nearly two million deaths per year.

The economic impact of tuberculosis come from the size of the problem and from the fact that in developing countries the majority of those affected are in the economically active segment of the population.

Women who suffer from TB are often less likely to be detected and treated than men.

Although tuberculosis is commonly thought to be a disease of the poor, this is not exclusively the case. Although the poor are more likely to suffer from the disease, a significant proportion of those infected are literate, have considerable education, and earn good incomes.

The substantial non-treatment costs of TB are borne by the patients and their families. These are often greater than the costs of treatment to the health sector. The largest indirect cost of TB for a patient is income lost by being too sick to work. Studies suggest that on average three to four months of work time are lost, resulting in average lost potential earnings of 20% to 30% of annual household income. For the families of those that die from the disease, there is the further loss of about 15 years of income because of the premature death of the TB sufferer.

When a woman suffers from TB, additional losses may result. The household loses the activities that the woman routinely performs in the household: cooking, cleaning, childcare, and managing the activities of the household.

In addition to the economic costs, TB causes psychological and social costs. TB patients may be rejected by family and friends or lose their jobs. In some societies, TB patients are seen as damaged for life or unmarriageable. Such discrimination can result in anxiety, depression, and reduction in the quality of life.

Households have developed a number of strategies for coping with the costs of illness and death that result in actual losses being less than the potential losses. However, some of these short-term coping strategies can have significant long-term costs. In particular, the sale of assets can reduce the economic prospects of the household. Reducing the food intake of children or removing them from school can seriously undermine their health, their education, and their future prospects.

A number of studies of the DOTS strategy showed that the introduction of DOTS considerably lowered the indirect costs of TB to patients and their families. Estimates suggest that the introduction of DOTS could halve the current potential national economic loss from TB. DOTS is very cost-effective and its introduction does not imply that more funds are needed: at least some of the funding could come from the reallocation of funds away from poorer, less cost-effective strategy.

Section 1

The morbidity and mortality burden of tuberculosis

Although much is known about the epidemiology of tuberculosis, relatively little is known of its economic and social impacts. The illness and death caused by the disease have far-reaching economic, psychological, and social consequences. By and large, households do not react passivelyto episodes of severe illness; instead, they develop coping mechanisms to lessen the impact of illness and death. This study will explore the economic, psychological, and social impacts of tuberculosis and the strategies that households use to cope with them.

In 1997, there were an estimated 7.96 million new cases of tuberculosis worldwide and 16.2 million prevalent cases (Dye *et al.* 1999). Tuberculosis is the largest single infectious cause of death among adults in the world, accounting for about two million deaths per year (Dye *et al.* 1999). Ninety-five percent of cases and deaths occur in developing countries and TB accounts for approximately seven percent of all deaths in developing countries (Murray *et al.* 1993, p. 239).

The economic impact of tuberculosis comes both from the size of the problem and from the fact that in developing countries the majority of disease and death occurs among the most economically active segment of the population: more than 75% among those 15 to 54 years of age (Murray, 1996, p. 212). Tuberculosis accounts for almost 20% of all deaths in this age group and 26% of preventable deaths (Murray *et al.* 1993, p. 241).

Of the estimated number of cases of tuberculosis worldwide, only half will be detected (Murray *et al.* 1993; Raviglione and Luelmo, 1996). Without effective chemotherapy treatment, 50% to 60% of people with tuberculosis will die of the disease (Murray, 1996, p.203). Those who remain untreated and are living with active tuberculosis will infect between 10 and 15 other people every year (WHO, 1998a). For those who are detected and receive treatment, the fatality rate is reduced to about 15% after five years, although the death rate can be lower depending upon the characteristics of patients and how drugs are used (Murray *et al.* 1993; Dolin, Ravigilone, and Kochi, 1994). Chemotherapy treatment increases the life expectancy of an otherwise healthy person with TB by 25–30 years (WHO, 1997, p. 166). However, treatment is often inconsistent or incomplete and can result in multidrug-resistant TB (MDR–TB). MDR–TB is more likely to be fatal and is as much as 100 times more costly to treat (WHO, 1998a). Indeed, the cost is so great—US$ 250 000 per patient in developed countries and an estimated US$ 1 000 to US$ 10 000 in developing countries (Sawert *et al.* 1997)—that treatment is all but impractical in most developing countries.

In many regions of the world, tuberculosis is a growing problem. Because of a combination of economic decline, insufficient application of control measures (case detection and chemotherapy), and the HIV/AIDS epidemic, tuberculosis is on the rise in developing and transitional economies. Between 1993 and 1996, there was a 13% increase in estimated tuberculosis cases worldwide, one-third of which can be attributed to HIV (WHO, 1998a). In 1997, there were 10.7 million people co-infected with TB and HIV (Dye *et al.* 1999). A person who is HIV-positive and infected with TB is 30 times more likely to develop clinical symptoms than is an infected person who is HIV-negative, because their weakened immune systems allow the bacteria to develop unchecked (WHO, 1998a). A person who is HIV-positive and develops tuberculosis can expect to survive only five to six weeks, although chemotherapy can increase such an individual's life expectancy by two to five years (WHO, 1997, pp. 156, 166). It has been estimated that an additional 105 000 to 210 000 cases of tuberculosis occur in sub-Saharan Africa each year because of the HIV/AIDS epidemic—8% to 16% of all cases—and about 250 000 in India—about 10% of all cases—(Murray *et al.* 1993, p. 237; WHO, 1997, p. 160). In sum, the HIV epidemic has produced more TB cases that are more difficult to diagnose and more expensive to treat (Raviglione *et al.* 1997).

In Eastern Europe and the former Soviet Union, economic dislocation has contributed to an increase in tuberculosis. For example, the Russian Federation has reported a 69% increase in new cases between 1991 and 1995. The Russian Federation now has the highest TB mortality rate in Europe (Migliori *et al.* n.d.).

The conditions leading to an increase in tuberculosis are unlikely to abate quickly. Consequently, WHO (1998a) estimates that by the end of the century HIV infection will cause an additional 1.5 million cases of tuberculosis annually. Under conservative assumptions, Murray *et al.* (1993) forecast a 10% increase in deaths from tuberculosis between 1990 and 2015. About two-thirds of the increase will result from demographic factors such as population growth and the changing age-structure of the population; the remainder will result from increasing incidence rates, except in sub-Saharan Africa where the proportions will be reversed due to the HIV epidemic (Dolin *et al.* 1994).

While tuberculosis is on the increase, economic difficulties in some countries are putting pressure on health budgets. In these circumstances, health departments need to use the most cost-effective treatments for tuberculosis, that is, those approaches that provide effective treatment or a cure for the lowest cost. In many cases, the most cost-effective treatments are not being used. Furthermore, decisions on what treatment regimes to follow are often based only on costs to the health ministry. The costs borne by patients have largely been ignored, even though such costs often exceed the costs to the health ministry. For example, Saunderson (1995) found that 70% of the cost of TB treatment in Uganda was borne by the patient and his or her family. When the costs and benefits of investments in health are being considered, the total social costs (public costs plus those borne by individuals), and not just the government costs, should be taken into account in order that efficient choices in health care may be made (Weinstein *et al.* 1996). If private costs are ignored, too little investment may be made and it may be allocated in a way that does not minimize the burden of disease.

Tuberculosis and women

The health of women has attracted increasing attention over the last decade, particularly in the wake of the International Conference on Population and Development held in Cairo in 1994. Much of this attention has focused on reproductive health and maternal mortality; relatively little attention has been given to tuberculosis despite the fact that tuberculosis is the single leading cause of death among women of reproductive age (WHO, 1998b). Indeed, it has been estimated that tuberculosis causes more than twice as many deaths among women of childbearing age as does maternal mortality

(World Bank, 1993; Murray and Lopez, 1996). Tuberculosis, along with several other diseases, imposes a heavy cost in morbidity and mortality. A study by the World Bank, WHO, and Harvard University showed that tuberculosis caused an annual loss of 8.7 million healthy years of life among women 15 to 44 years of age, while 3.6 million healthy years were lost from HIV and two million from malaria (WHO, 1998b).

Women may differ from men in infection and progression to disease, and in the probability of diagnosis, registration for treatment or treatment results.

Men have a higher prevalence of tuberculosis infection than women, but the prevalence of disease is the same or greater in women (Murray, 1991; Hudelson, 1996; Holmes, Hausler, and Nunn, 1998). This suggests that women are more likely to progress from infection to disease than are men, at least at some ages. Holmes *et al.* (1998) surveyed prospective studies of tuberculosis-infected individuals in developing countries and found that females in their reproductive years had a higher rate of progression to disease, a higher case-fatality rate (deaths due to tuberculosis divided by the population with tuberculosis), and higher mortality rates (deaths due to tuberculosis per 100 000 population). There is as yet no consensus about why these gender differences exist. Some possible explanations are discussed in the next section.

Differences in diagnosis and treatment

Why are women more likely to become ill and to die? In some countries, women who suffer from tuberculosis are less likely to be detected than are men. They are also less likely to receive treatment. In eastern Nepal, Cassels *et al.* (1982) found that the ratio of men to women suffering from tuberculosis disclosed with self-referral of patients to health services was twice that of active identification of cases by mobile teams. That is, men are more likely to seek treatment than are women. Another study carried out in Nepal found that the delay before receiving treatment for women was twice as long as that for men (Smith, 1994).

Explanations for these differences may include the high cost of seeking treatment for women because of their household duties and childcare responsibilities, and/or the fact that in certain societies women do not make the decision to seek health care no matter how ill they are. Their husband or other relative makes such decisions (Okojie, 1990).

The effect of costs on seeking care is illustrated in another study in Nepal, which found that women were more likely than men to attend mobile clinics, whereas men were more likely to attend more distant—and thus more costly—health posts and clinics (Harper *et al.* 1993). However, Rieder *et al.* (1997) point out that failure to examine women is not the only possible reason for their lower presentation among cases (any patient presenting for diagnostic examination with at least one positive result for acid-fast bacilli). A study of 42 laboratories in Benin, Malawi, Nicaragua, and Senegal revealed that women were being examined relatively frequently, but that cases were found less frequently among women, perhaps because of a higher prevalence of non-specific respiratory symptoms among them.

Besides contributing to the higher mortality from tuberculosis among young to early to middle-aged women, differential access to treatment has implications for the success of TB control programmes. Since successful control of the disease depends upon high levels of detection and successful treatment, lower access by women to treatment undermines successful tuberculosis control.

Impacts on the household

Relatively little attention has been given to the costs of TB to patients and their households. Studies that have addressed these costs have focussed on lost earnings from illness or death. This approach underestimates the cost of TB, particularly for women.

When a woman becomes sick or dies from tuberculosis, the household suffers from the loss of her earnings outside the household, but suffers additional losses due to the reduction of activities that the woman routinely performs in the household. The value of activities such as cooking, cleaning and childcare are rarely considered in studies that attempt to estimate the costs of tuberculosis, even though they may be considerable. In Tamil Nadu, India, for example, female TB patients reported a 50% reduction in household work and only one-third reported that they were able to attend adequately to the needs of their children (Ramachandran *et al.* 1997). Further insight into the impact of illness on the household activities of women can be obtained from a study of another debilitating disease, Guinea Worm. In an ethnographic study of Guinea Worm in Nigeria, Watts, Brieger, and Yacoob (1989) found significant impacts on the immediate household, which then radiated out to affect the extended family. They found that when women with infants are struck down by Guinea Worm, their self-care is likely to be neglected first, then their domestic duties and income generating activities are reduced. Women do their utmost to continue childcare. There were cases, however, where women were unable to care for their children, and some cases of acute malnutrition and underweight children were observed. Some women were unable to breastfeed; in these cases the health of the baby suffered severely.

When attempting to determine the impacts of disease on the household, care must be taken to estimate a value for any reduction in work done within the household, as well as for work that is done outside the household (whether paid or unpaid work). Ignoring the economic contribution of women to the household leads to an underestimation of the costs associated with disease.

Tuberculosis and the poor

Tuberculosis and poverty are closely linked. Given the often crowded conditions in which poor populations live, they are more likely to contract tuberculosis. Those who contract tuberculosis are also more likely to fall into poverty, given the economic consequences of the disease. Both the probability of becoming infected with the disease, and the probability of developing clinical disease are associated with malnutrition, crowding, poor air circulation and sanitation—factors also associated with poverty. A vicious cycle is established: poor people are malnourished and live in crowded, unhygienic conditions, then tuberculosis flourishes. The poor receive inadequate health care in which tuberculosis is not diagnosed rapidly. Treatment, if received at all, is often inconsistent or partial. Resultant ill-health and death worsens poverty.

The close link between poverty and tuberculosis has led many to think that TB is exclusively a disease of the poor, and of little economic consequence. Several recent studies of the socioeconomic characteristics of TB patients throw doubt on this view. Researchers in India found tuberculosis to be present among all strata of society, although prevalence was highest among the poor (Nayyar *et al.* 1989 cited in Pathania, Almeida, and Kochi, 1997; Ramachandran *et al.* 1997; Devi *et al.* n.d.; and Chakraborty, 1996). Table 1 shows that although the poor are more likely to suffer from the disease, a significant percentage of TB patients are educated and earn good incomes*. For example, the prevalence of TB among those whose income was less than US$ 7 per month was about twice that of those with a monthly income greater than US$ 20 (Nayyar *et al.* 1989 cited in Pathania *et al.* 1997). In the mid-1950s in Calcutta, the poorest areas had prevalence rates of over 50 per 1 000 compared to a rate of 2.48 per 1 000 in comparatively affluent areas (Chakraborty, 1997). In urban areas, prevalence among those with no schooling was four times that of tertiary graduates (Nayyar *et al.* 1989 cited in Pathania *et al.* 1997).

A study of 673 adult tuberculosis patients at 16 randomly selected government health facilities in Thailand (district hospitals, provincial hospitals, and referral centres) found that the majority of patients were not poor: 23% were poor, 29% had income below the national average but above poverty, and 48% had income above the average. While these figures are likely biased by the lower probability of the poor to seek treatment, they do indicate that tuberculosis is not necessarily confined to the lowest economic strata.

In addition to being more likely to contract tuberculosis, the poor are less likely to seek and receive care when ill-exacerbating the negative impacts of the disease. Among people in Tamil Nadu suffering from chest symptoms, only 64% of illiterates sought treatment, compared to 80% of high school graduates. The differences were similar for those with incomes under US$ 14 per month and greater than US$ 57 per month (Devi *et al.* n.d.). The poor are also two to three times more likely than other income groups to self-medicate (Pathania, Almeida, and Kochi, 1997, p. 14). Self-medication is likely to increase the chances of drug-resistant strains of TB emerging, further increasing the negative impacts on the poor and the risks to others in society.

As *The Economist* recently stated: “TB is a relentless leveller, an equal opportunity killer, hard-working and persistent … going about its deadly business with cool disregard for IQ, sex, class, race, occupation or even geographical boundaries” (1999, p. 11). Although overstated, the main point of *The Economist* discussion of TB is valid: those who callously disregard TB as a disease that afflicts only the “least valuable” in society, and so does not warrant the investment of scarce government funds, are seriously in error. Tuberculosis strikes the working age population and strikes the most productive as well as the less productive. One could further argue that not only measured economic costs and benefits should be considered when deciding government policy.

** These were studies of the prevalence of TB in different socioeconomic groups. The Nayyar et al. study was a population-based survey of 200 000 urban residents and 490 000 rural residents in Wardha District, Maharashtra. The Ramachandran et al. study was based on focus group interviews with 304 newly detected sputum positive pulmonary TB patients. They seem to have been drawn from Government clinics and hospitals and so may over-represent the poor. The Devi et al. study was a community-based survey of 4 624 rural and urban individuals in Tamil Nadu that yielded 689 “chest symtomatics” of whom 649 were interviewed.*

The economic and social burden of tuberculosis

The impact of tuberculosis is most often measured as the direct costs of treatment to the health service, that is, the costs of medicines, personnel, and facilities used. However, the economic impacts are considerably more far-reaching. Often patients seek costly treatment from traditional healers or the private sector before an accurate diagnosis is made. Only then, they may shift to the public sector. The costs to patients and their families that can be quantified are principally in the form of lost earnings from loss of work due to illness or death. Additional costs come from food required while in hospital and the costs of travel to hospital or clinic for care. In addition to these direct treatment and non-treatment costs, tuberculosis imposes intangible costs in the form of pain, suffering, grief and discrimination. Table 2 details some of the quantifiable costs of TB treatment for rural Uganda and South Africa. The total cost of treatment varies considerably, as does the distribution between the health service and the patient.

In order to fully appreciate the impacts of a disease such as tuberculosis on the well-being of a nation, the costs borne by individuals, households and communities, and not just the costs to the public health services must be examined. Similarly, to fully evaluate the costs and benefits of alternative strategies to combat and treat disease, one must look at the costs and benefits of each alternative approach to individuals, households, and communities, and not just the costs to the public health service. A goal of public policy is to maximize social well-being, subject to budget constraints. This is sometimes forgotten in favour of minimizing the expenditures of public agencies such as departments of health.

Treatment costs borne by patients and their family

The direct treatment costs of tuberculosis are often underestimated because only the costs to the health system are measured. However, these costs may be the smallest component of treatment costs, as is the case in rural Uganda reported in Table 2.

In many countries, individuals with tuberculosis seek assistance initially from traditional healers or private sector health care providers, either because of a preference for private sector treatment or a lack of awareness about available public TB services. In India, where private sector care is widespread, there is a perception that private providers are more effective, convenient, and sympathetic than public-providers (Pathania *et al.* 1997, p.3). However, lack of information may also play a role: only 15% of households in one rural study were aware that the government clinic offered free TB treatment (Uplekar, Juvekar, and Morankar, 1996). Another possibility is that "free" care at government hospitals is not free. Thailand has an official policy of "free care" for tuberculosis, yet Karnolratanakul *et al.* (1999) found that more than 20% of patients were charged for X-rays, more than 10% for sputum examinations, and almost 10% for drugs.

A study of tuberculosis patients in Malawi found that almost 40% had consulted and received four weeks' care from a traditional healer before seeking regular medical care (Brouwer *et al.* 1998). Cash payments for this care were relatively low. However, in other settings the cost of treatment before seeking help from conventional TB providers was substantial. In four northern districts of Bangladesh, Croft and Croft (1998) found that patients spent on average US$ 130 before reaching the TB clinic. This is almost 20% of the annual income of an average Bangladeshi household. In India, where use of private providers is widespread, the direct costs of diagnosis and successful treatment average US$ 100 to US$ 150, more than half of the annual income of a daily wage labourer (WHO, 1997).

Part of the reason for the high direct treatment costs for patients and their families is that it often takes more than a month before a diagnosis is made. Only about one-half of patients are diagnosed at the first source of help and are thus forced to "shop around" for a diagnosis. For example, in a study of adult tuberculosis patients in Thailand, Karnolratanakul *et al.* (1999) found that the delay between the onset of illness and diagnosis of tuberculosis was 61–76 days, even though one-third of patients had sought care during that time at government hospitals. Other reasons for the high costs of treatment include the extensive use of X-rays as a diagnostic tool, prescription of expensive nutritional supplements, and collusion among providers (Pathania *et al.* 1997).

The most significant cost of shopping around for a diagnosis is that the delay in treatment contributes to high early mortality and increased transmission of infection. This results in many patients presenting at government clinics with more severe disease that is much more costly to treat (Pathania *et al.* 1997, p.17).

Non-treatment costs borne by patients and their families

Earnings lost from illness and death from TB are commonly much greater than the direct costs of treatment. For example, 70% of the costs to patients in rural Uganda are from lost work time (Table 2). For individuals with TB, costs arise from a loss of work or a reduction in productivity due to illness. Further losses result from earlier mortality due to TB.

There are two sources of information on the non-treatment costs that are borne by patients and their families: surveys of patients that estimate their treatment costs and costs of illness; and simulation studies that estimate both the costs of illness and of premature death (Tables 3 and 4 respectively). The estimates of indirect costs from these sources are best interpreted as losses of potential income or potential income gains if the person had not been sick, and usually exceed actual lost income.

Estimates of costs from surveys of TB patients

Croft and Croft (1998) noted that a local Bangladeshi synonym for tuberculosis is "Rajer rog"—King's disease—since it is a disease that only Kings can afford to suffer. Their cost estimates bear this out. By the time the patients presented for treatment at the TB clinic, they had already incurred costs of US$ 130 for private sector treatment and lost 14 months of work time (range five days to five years) resulting in US$ 115 in lost income (range US$ 0–500). These losses are equal to one-third of annual household income.

Even when they enter the “free” government sector, patients often have to make informal payments when receiving treatment.

A study in Uganda found that 80% of wage earners had stopped work because of their disease and 95% of subsistence farmers reported that production had decreased due to their reduced capacity to work (Saunderson, 1995). The average time lost from normal activities was 9.5 months (range week to three years); the average income lost from inability to work was US$ 161 or 89% of GDP per capita. In South Africa, lost earnings were even higher: US$ 272 or 16% of GDP per capita (Floyd *et al.* 1997; Wilkinson, 1997). In Thailand, income reductions were much smaller: average income fell by 5% for poor households, 2.3% for households with income between poverty and the national average, and 3.3% for households with income above average (Karnolratanakul *et al.* (1999). A study of rural and urban patients in Tamil Nadu found substantial lost earnings—about 15% of annual household income (Ramachandran *et al.* 1997). The higher estimates of lost work time and lost income in the Uganda and Bangladesh studies probably reflect the influence of outliers on the means (lost work time of three and five years respectively). More reasonable estimates of lost work time and lost income from TB morbidity are three to four months— about 20% of household income. The loss of potential income is determined in large part by the initial resources of the household and the coping mechanisms employed to deal with the impacts of the illness. These will be discussed below.

Lost earnings exceeded direct medical costs by a factor of two in Tamil Nadu and almost three in Uganda and South Africa. These estimates, based on lost earnings, underestimate the costs to households since they ignore the value of lost household production, adverse impacts on the health and education of family members, costs of sub-optimal land use, the value of lost leisure, and the pain and suffering associated with TB.

Transport costs may appear to be a small part of the total cost of treatment, but this is not necessarily so. A survey of patients in Bombay showed that they could spend nearly 10% of income on travelling to the clinic twice a month to collect drugs (Chakraborty, Rangan, and Uplekar, 1995). Van der Werf *et al.* (1993) found transport costs to be larger than direct costs in rural Ghana. Clearly, such expenditures could lead to defaulting from treatment, particularly among the poor.

Costs from estimates of simulation studies

Simulation studies base their estimates of costs on data from survey studies (Table 3), on programme records and on the judgement of experts. Estimates from three such studies are shown in Table 4. The estimates for Indonesia and Thailand are based on data for particular programmes. The estimates for Bangladesh are based on a model that tries to mimic the impact of TB on the household of a riskshaw-puller.

In both Thailand and Indonesia, individuals who receive treatment are estimated to lose about two months’ work from illness; those who do not receive treatment lose about twelve months’ work, similar to the findings from the survey studies. The most dramatic losses of productive life come not from illness but from death due to TB. In Indonesia, individuals with TB but not infected with HIV lose 13 years of life; in Thailand individuals with TB but not infected with HIV lose 15 years of life. Those co-infected with HIV die two years earlier (Sawert, 1997; Sawert *et al.* 1997).

Data for average earnings are multiplied by the time lost due to morbidity and mortality to arrive at an estimate of the enormous potential monetary cost of TB. The losses due to treated illness are similar to those shown in Table 3. They are about 15% of GDP per capita. For the 50% of cases that go untreated, the potential costs are significantly higher because of the longer time missed from work.

The economic cost of premature death from tuberculosis overshadows the morbidity costs. For individuals not infected with HIV, death as a result of tuberculosis results in a loss of potential income to the individual's family of 13 times GDP per capita in Indonesia and 10 times GDP per capita in Thailand. In the case of the rickshaw-puller, tuberculosis also imposes significant costs: over a period of two years, the costs of illness and chance of premature death result in a loss of income of US$ 329, or more than three times the average per capita yearly income of the household. These estimates are larger than the actual income lost to families and households, principally because households use a number of coping mechanisms to reduce the economic impact of illness and death (discussed in Section 3). However, the estimates do provide an indication of the magnitude of the economic shock to households from illness or death due to TB.

The impacts of diseases such as tuberculosis are not confined to the infected person. The illness or death of an adult can increase the morbidity or mortality of their spouse; the illness or death of a mother or father can result in illness or death for their children. Martikainen and Valkonen (1998, p. 530) concluded: "The accumulated evidence [from research studies] suggests that excess mortality among bereaved persons persists after controls [for other influences on mortality] are introduced." They found that the burden of mortality after the death of a spouse was heaviest among the poor. Parental mortality is an important determinant of infant mortality. In Matlab, Bangladesh, a father's death was associated with an increase in male and female child mortality of six per 1000; a mother's death was associated with increases in male child mortality of 50 per 1000 and female child mortality of 144 per 1000 (Over *et al.* 1992). Nobel prize-winner Robert Fogel has recently shown that the impacts of childhood malnutrition are lifelong (1994). He established that stunting in childhood could lead to increased morbidity and mortality at middle and later ages. Such intergenerational effects are ignored when the costs of TB are evaluated and so the estimates of the cost of the disease are too low.

Psychological and social costs

Additional costs, both monetary and psychological, can occur due to discrimination against those infected with TB and members of their households. Family and friends may reject TB patients, they may receive less social support during treatment, or they may lose their jobs. A survey of patient's concerns in Bombay found men to be worried about the impact of TB on their capacity to work, while women were concerned about the impact on their marriage status and harassment by in-laws (Liefooghe *et al.* n.d.). Such concerns are well founded. In a survey carried out in Tamil Nadu, Ramachandran *et al.* (1997) found that while the vast majority of men reported that their family had accepted their disease, a sizeable minority of women—especially rural women—suffered some adverse reactions or outright rejection (see Table 5). In addition, 69% of rural women said that they could not discuss the disease with their neighbours. In a recent study carried out in India, Rajeswari *et al.* (1999) reported that 15% of rural and urban female patients faced rejection by their families. The association between AIDS and TB increases the likelihood of rejection and social isolation of TB patients (Saunderson, 1995).

The costs of discrimination are both psychological and economic. Discrimination, whether experienced or expected, has been found to be associated with increased anxiety and depression and lower life satisfaction, as well as with higher unemployment and lower income (Rosenfield, 1997; Markowitz, 1998). In some developing countries, discrimination against TB sufferers has taken particularly damaging forms, such as divorce or lowered prospects of marriage. A survey carried out in West Bengal found that almost 80% of respondents would not negotiate the marriage of their son or daughter to an ex-TB patient (Geetakrishnan, *et al.* 1988). Studies in India and Pakistan found that married women with TB were more likely to be divorced than other women and that unmarried girls with TB would find it difficult or impossible to get married (Khanna, *et al.* 1977; Liofooghe *et al.* n.d.). Such discrimination represents significant costs because the economic prospects for divorced or unmarriageable women in many societies are bleak.

Discrimination against those suffering from TB also has epidemiological consequences. Social support for the patient has been found to be critical to adherence to treatment (Pathania *et al.* 1997); without adherence to treatment, the likelihood of a cure is lower, relapse and death are more likely, and further transmission of the disease occurs.

Household coping strategies

Households face substantial immediate costs from tuberculosis: costs of diagnosis, costs of treatment, and lost earnings and household work. Families cope with the burden of these costs in a number of ways. They may:

- *divert resources from other forms of health care, increasing the vulnerability of family members to other diseases;*
- *reduce food consumption, which may increase the risk that others in the household will contract TB or some other disease;*
- *take in extra household members or move into a relative's house, increasing crowding and the risk of further transmission;*
- *withdraw children from school to save on school fees, thus jeopardizing the future prospects of the child;*
- *increase the hours of work of household members;*
- *borrow or sell productive assets;*
- *plant crops that reduce the amount of labour required;*
- *expel the individual suffering from TB from the household;*
- *pool work and resources with others.*

Many of these coping strategies reduce the future opportunities of household members, in particular children. Furthermore, the strategies are often not abandoned once the patient's health improves because, in certain cases, the patient never fully recovers his or her past productivity and the household often incurs long-term debt. In studies of the impacts of AIDS, such coping strategies have been observed as early as 18 months before a death and up to 30 months after a death.

The number of coping strategies open to a family depends to some extent on the social organization of the society in which it is situated. Where extended families share tasks and obligations and, perhaps, money, the impact of illness is likely to be more muted. The ability of the extended family to absorb the costs of illness of a member also depends upon the size of the group, the wealth of the group, and the number of members who are ill. Experience with the HIV/AIDS epidemic has shown that even with extended families, the ability of social systems to cope with illness, although impressive, is limited. In addition, modernization has made many traditional systems less effective. For example, in the Kyela district of Mbeya in Tanzania, the wider community no longer takes responsibility for providing care for the seriously ill. The responsibility now rests with the immediate family (WHO, 1997)

The poor have a more limited set of coping strategies because often the only asset they have to sell is their physical labour. This is why the illness of the head of the household is so devastating. The poor do not have a buffer to see them through a period of reduced income and they have little access to borrowing. The children of the poor are less likely to be in school but, because school fees are a significant portion of household income, are more likely to be withdrawn from school in the event of illness of a parent. A poor household is also likely to be a member of a poor extended family, limiting the wider resources it can draw upon.

Studies of tuberculosis have observed a number of coping strategies in households afflicted by tuberculosis. In Bangladesh, Pryer (1989) found that the initial response of households to a large medical expense is the sale of assets, followed by taking out consumption loans. These loans have very high interest and short repayment periods, which make the economic recovery of the household difficult. In a study in India, 20% of rural patients and 40% of urban patients went into debt as a result of expenses due to TB (Upelkar *et al.* 1996). In Tamil Nadu, the percentage of households who became indebted was much higher: 75% of urban households and 67% of rural households (Ramachandran *et al.* 1997). The average amount borrowed was US$ 59, or 12% of annual household income. These findings are consistent with a recent Indian study that found average household debts of 2079 rupees (US$ 59) due to tuberculosis. This is equal to 35% of the total household cost of tuberculosis (Rajeswari *et al.* 1999). In northern Bangladesh, Croft and Croft (1998) found that almost 40% of households sold assets, either livestock or land, and 14% took out a loan. In a study in Thailand, about 20% of patients received transfer payments from relatives, 20% used savings, about 10% took out loans, and a significant minority sold assets. Fully 16% of the poor sold assets, mostly land, and just over 7% of the non-poor sold assets (Karnolratanakul *et al.* 1999).

Another coping mechanism that reduces short-term costs but has potentially adverse long-term consequences is the withdrawal of children from school. In the Uganda study (Saunderson, 1995), five children from 32 families studied were withdrawn from school because their families could not afford the school fees. In Tamil Nadu, 11% of children whose parents became ill with TB were withdrawn from school and 8% entered employment (Ramachandran *et al.* 1997). In this study, children were withdrawn from school more often in urban areas and if the infected parent was the father (see Table 6). In a recent study in India, 11% of children were withdrawn from school and an additional 8% took up employment to help support their family (Rajeswari *et al.* 1999). This study also noted that the care-giving activities of female patients decreased significantly as a result of their illness. As mentioned above, this cost to households is rarely recognized in studies of the cost of tuberculosis. In the study of Guinea Worm discussed above, school-age daughters who were their mother's main helper were withdrawn from school to replace their mother's labour in the household (Watts *et al.* 1989). Withdrawing children from school lowers the child's economic prospects and, if widespread, can have social consequences such as higher fertility and lower production.

Many of these strategies are illustrated in a simulation study of a Chittagong, Bangladesh, rickshaw-puller's household (Carrin, Gray, and Almeida, 1998). Their model combines data and expert opinion to model a typical rickshaw puller's household and the impacts of TB upon it. Carrin *et al.* showed that the impact of TB when treated "conventionally" and with two relapses within a two-year period is a 55% reduction in assets, a 20% reduction in food consumption which lowers work capacity and income, and loans that are ten times the pre-TB level of household income*. However, family members increased their work hours and increased their earnings to partially offset the lost earnings of the household head. These coping mechanisms have long-term implications for the household. The sale of assets makes the household more vulnerable to future shocks, reduced food consumption increases the susceptibility to disease and, if severe, may stunt the growth and development of children, with long-term implications for morbidity and mortality; indebtedness can also impede the economic recovery of the household.

It must be remembered that even when coping strategies mitigate the impact of TB on an individual, the social and economic costs are borne by the family and community as a whole. Even if the income of the family does not fall because coping mechanisms have been used to compensate, a member becoming ill with tuberculosis does reduce the welfare of the family.

** Since one could argue about the precise values assigned to variables and parameters, Carrin et al. attach probability distributions to a number of variables and parameters.*

Section 4

Benefits and costs of new strategies of dealing with tuberculosis

Is there a rationale for government intervention in tuberculosis control? A rationale for public intervention is the presence of what economists call market failures. Examples include: a widespread lack of health insurance; externalities, such that others benefit if an individual remains free of tuberculosis or is effectively treated if infected, and others bear some of the costs if the individual does not (in such circumstances there is insufficient incentive for the individual to invest optimally in healthcare); and providers, who generally have more information about tuberculosis than do patients, and thus can exploit patients, leading to an inefficient use of resources. All of these conditions are met in the case of tuberculosis, and government intervention is justified.

Given that intervention is justified, what form should this intervention take? To answer this question, the public and private costs and benefits of alternative interventions should be considered. To date, emphasis has often been given to the costs and benefits to the public health system of different strategies to combat and treat tuberculosis. The costs and benefits to individuals have either been ignored or only partially considered. However, incorrect decisions can be made unless all costs and benefits are considered.

Intervention strategies for TB control

Chemotherapy can have a substantial impact on the incidence of tuberculosis. There is, however, debate on what form intervention should take (Sawert, 1996; Zwarenstein *et al.* 1998 and comments in *Lancet*, 1999). For instance, should short-course treatment replace conventional treatment? Should treatment be ambulatory or should it involve hospitalization? How critical is direct observation of treatment rather than self-supervision? Should fees be charged and, if so, how much?

In many countries, conventional treatment involves an initial, often lengthy, period of hospitalization followed by a period of outpatient follow-up. Drop-out rates are often high and cure rates are often low. In sharp contrast is Directly Observed Treatment, Short-course (DOTS), which the World Health Organization has determined to be the best approach for the delivery of TB chemotherapy. DOTS is a form of chemotherapy that lasts for six to eight months and combines five elements: political commitment, microscopy services, drug supplies, monitoring systems, and direct observation of treatment. This strategy produces cure rates of up to 95% even in the poorest developing countries, whereas non-DOTS treatments achieve a cure rate of only about 40% (WHO, 1998a). In addition, it is estimated that about 15% of those undergoing non-DOTS treatment die compared to as few as 5% of those on DOTS (Carrin, Gray, and Almeida, 1998, p. 10). DOTS has been shown to lead to an eventual decrease in cases (after an initial increase through improved case-finding) and a decrease in overall provider costs, especially if ambulatory strategies are used (Styblo, 1991; Barnum, 1986).

Short-course therapy is highly cost-effective: in a low-income country setting, it costs between US$ 1 and US$ 4 per discounted year of life saved (Jamison and Mosley, 1991). Indeed, short-course chemotherapy is the most cost-effective of all health interventions available (World Bank, 1993). Dye *et al.* (1998) have shown that the impact of DOTS is greatest where detection occurs quickly where DOTS replaces a poor programme under which cure rates are low and the incidence rate has been falling slowly or not at all, and where it is introduced in a young population.

Despite the cost-effectiveness of DOTS, only 16% of people with TB receive treatment consistent with DOTS (calculated from data in WHO, 1998c and Ravaglione *et al.* 1995). Why is this the case? Part of the reason may be that despite efforts by WHO to inform policy-makers of the benefits of DOTS, many are still unaware of the evidence on the effectiveness of alternative approaches to TB. Perhaps policy-makers are aware, but those that implement policies are unaware of DOTS. Resistance to change and distrust of new approaches may also inhibit the adoption of DOTS. Certainly, some decision-makers believe that their existing approach is “better” than DOTS. It is my contention that the failure to include the costs and benefits to individuals and households of alternative approaches to TB contributes to the belief that current strategies are “better” than DOTS.

We now turn to a consideration of the evidence on the questions posed above concerning alternative strategies to deal with tuberculosis.

Simulation studies of alternative TB treatment regimes

Short-course treatment and conventional treatments

Several recent simulation studies have evaluated the costs and benefits of short-course chemotherapy versus conventional treatment. Sawert *et al.* (1997) investigated replacing the current TB programme in Thailand (a detection rate of 50% and a treatment completion of 60%) with a new programme that would detect 70% of cases and 85% would successfully complete treatment. They found that the new programme would initially have higher costs than the current programme because of a greater number of cases detected, but that the benefits become greater the longer the evaluation period considered. The major impact of the new programme on costs is in lower indirect costs to patients and their families. Over a period of 20 years, a more effective programme would lower these costs by US$ 2.5 billion (range US$ 65 million to US$ 7.0 billion) or 32% of the projected indirect costs under the current programme. This is an underestimate of indirect cost-savings because it ignores all savings other than lost earnings. Sawert *et al.* argue that the situation in Thailand is similar to that in many other developing countries, so that their findings are likely to apply to those countries. This assumption is supported by evidence from rural Uganda (Table 7). Although DOTS may increase costs to the health service (depending upon the programme it is replacing), it dramatically reduces costs to the patients and is a cheaper treatment regime overall.

In 1994, Indonesia decided to replace its current TB programme with the DOTS strategy. An evaluation of a DOTS trial project in East Java, and comparison to other areas where conventional approaches were in use, was carried out. It was estimated that the adoption of DOTS would result in initial cost increases because of equipment and training costs and higher case detection. However, the DOTS strategy would save 12 million disability—adjusted years of life over 20 years at a cost of US$ 10 per year initially and US$ 5 per year later in the programme. A simulation showed that TB would cost Indonesia US$ 13 billion over 20 years under the current policy. The introduction of DOTS would halve these losses. It was estimated that every dollar invested in the DOTS programme would lead to a US$ 55 return to the country.

Similar results were found in South Africa, where TB incidence is one of the highest in the world. Wilkinson, Floyd, and Gilks (1997) carried out a study of direct and indirect costs in Hlabisa, northern KwaZulu-Natal, where the number of TB cases admitted to hospital increased three-fold between 1991 and 1996, partly as a result of HIV. They compared DOTS with the standard treatment of four months in hospital followed by four months of outpatient care. The cost of DOTS to both the patient and to the health system was one-third that of the standard treatment. The long hospitalization under the standard treatment not only increases costs substantially but it also reduces compliance and thus the cure rate. Under standard treatment, only 17% of cases were cured compared to 81% under DOTS (Wilkinson *et al.* 1997, p. 453). DOTS is almost 30 times as cost-effective as the treatment commonly used in sub-Saharan Africa and was also three times more cost-effective than treatment with a two-month hospital stay or with treatment in a sanatorium. It was estimated that even the most expensive drug treatment was equivalent in cost to just 1.3 days in hospital. In Malawi, Sawert (1996) estimated that a new ambulatory treatment for smear-negative patients would reduce direct costs by 45% and for smear-positive patients by 70%.

Further evidence of the cost-effectiveness of treatment regimes for TB comes from studies in Eastern Europe and the former Soviet Union. These countries have suffered an extraordinary demographic crisis, most notably dramatic falls in life expectancy. In the Russian Federation, life expectancy fell by six years from 1989 to 1995 (Becker and Bloom, 1998) and reported cases of tuberculosis rose dramatically. The probable causes are the sharp drop in real incomes, increases of psychological stress, and the decline in medical services accompanying the economic transition.

Economic problems are exacerbated by the expensive treatment regimes that are standard in eastern Europe and the Russian Federation, particularly the extensive use of long stays in hospital. Meerding (1997) compared a WHO strategy in Armenia that consisted of 2.2 months hospitalization during the intensive phase and four to five months outpatient follow-up with the standard treatment of four to six months hospitalization followed by 12 to 14 months of sanatorium and ambulatory treatment. The costs per cured patient under the WHO regime were US$ 176 and US$ 280 under the standard approach. The inclusion of indirect patient costs would have increased the cost differences even more. Migliori *et al.* (n.d.) carried out a similar comparison of alternative treatment regimes in the Russian Federation and reached similar conclusions: costs per cure under the new treatment were US$ 1 626 and under the old US$ 6 293. The WHO regime with short-course chemotherapy reduced costs by 62%; a reduction in the percentage of patients hospitalized from 100% to 10% reduced costs a further 13%.

Ambulatory treatment versus hospitalization

Several studies have focused on evaluating the gains to be made in adopting DOTS that accrue from replacing hospitalization with ambulatory care. Saunderson (1995) compared the current TB programme in Uganda, based on an initial period of hospitalization followed by a period of outpatient follow-up, with a DOTS programme which replaced the period of hospitalization with ambulatory care and expanded education and supervision.

Saunderson found that cost per cure under the conventional treatment, which is widely used in sub-Saharan Africa, was US$ 646, whereas the cost per cure for the DOTS regime was US$ 280. Almost all of the difference is explained by lower costs to the patient, primarily in the form of lower lost earnings because hospitalization is avoided.

DeJonghe *et al.* (1992) evaluated the direct cost-effectiveness of standard and short-course treatments for smear-positive patients in three sub-Saharan countries: Malawi, Mozambique, and Tanzania. They estimated that short-course treatment with hospitalization is about 23% cheaper for the health service than is standard treatment. Moving to an ambulatory short-course treatment would reduce the costs of short-course treatment by 35% for Malawi, 65% for Mozambique, and 50% for Tanzania (Table 8).

In a survey of cost-effectiveness studies published up to 1995, Fryatt (1997) found that ambulatory care is particularly cost-effective once the indirect costs to patients are considered. Work by Pryer (1989) further suggests that the relative gains may be greater for the poor since they lose more work time from TB than do those in better-off households. Obviously, a fully ambulatory treatment would reduce costs as long as the cure rate did not decline significantly. In the three sub-Saharan countries studied, Murray (1991) estimated that if hospitalization increases the cure rate by 15 percent, the cost per case cured is similar to any form of chemotherapy. Ambulatory programmes obviously require well-designed and well-implemented community-based care. Supervised chemotherapy must be available cheaply and conveniently to ensure compliance.

Supervised versus unsupervised treatment

The findings from a recent study in South Africa question whether direct observation rather than self-supervision is essential for effective treatment. Zwarenstein *et al.* (1998) carried out a randomized controlled trial in two communities to test the effectiveness of direct observation. They found no statistically significant difference in the success of direct observation versus self-supervision. A number of procedural and methodological criticisms have been raised concerning the study, such as the small sample sizes and low cure rates in both arms of the study (see *Lancet*, 1999 for criticisms and a response). Although the shortcomings of the study arguably undermine its conclusions, it does raise the very important question of whether the components of DOTS are additive or multiplicative; that is, is the success of DOTS greater than the impact of its component parts? If not, then countries may implement parts of DOTS. If so, there is a very strong argument for adopting the full DOTS approach.

Fees for treatment

The Carrin *et al.* (1998) study of the rickshaw puller's household discussed above illustrates the advantages of DOTS over conventional treatment in reducing the necessity for compensatory household coping strategies, but the result is affected by whether or not fees for treatment are charged. Carrin *et al.* show that if DOTS treatment is fully subsidized, then household assets are not sold, loans and reductions in food are greatly reduced, and the impacts on children's education are smaller. When fees are imposed, the indirect impacts under DOTS are smaller and the advantage of the DOTS strategy is a higher probability of treatment success and reduced probability of relapse in addition to lower treatment costs.

In pilot studies at mission hospitals in the north-west Province of Cameroon, Proctor and his colleagues found that 10% to 30% of patients were discharged without medication because of their inability to pay. This finding is significant because mission hospitals and clinics are important providers of health care in many African countries. Fully 50% to 60% of Cameroon's health care is provided by church missions, 58% of rural hospital beds in Zimbabwe are in church facilities, and it is estimated that about 40% of health care in Kenya is provided by churches. If this finding holds widely, then drives for cost recovery could undermine efforts to contain tuberculosis. Clearly, more information is required on how the behaviour of patients is affected by the imposition of fees for treatment.

The research discussed indicates the following:

1) In certain circumstances, initial costs to the health service of short-course treatment may be higher than those of existing treatments because of a rise in detection rates. However, within 20 years significant cost-savings can occur as detection and cure rates rise.
2) Short-course treatment results in significantly lower costs to individuals and households.
3) Ambulatory care has much lower costs to individuals and households than does hospitalization.
4) Charging fees may decrease the gains from DOTS because of reductions in seeking treatment and drop-outs from treatment.

Obstacles to the adoption of DOTS

According to WHO, DOTS is most effective where tuberculosis incidence is high, the population is large, existing treatment strategies are ineffective, and DOTS coverage is currently low—that is, in many countries in the developing world (WHO, 1997, p. 159). The cost-effectiveness analyses discussed clearly show that adoption of the DOTS strategy would improve health and lower costs. Why then are only slightly more than 10% of TB patients receiving DOTS?

There are several obstacles to the adoption of DOTS. Foremost among them is mobilizing commitment to DOTS among decision-makers and health professionals. Once such commitment exists, other obstacles, such as adequate funding to ensure a steady supply of drugs, diagnostic equipment, trained staff, and recording and reporting systems, can be faced. In many countries, a lack of commitment among health professionals may reflect a lack of knowledge about TB. For example, a study in Bombay found that private practitioners who treat TB use a variety of regimes that include 80 different drugs, even though only four of these drugs are effective against tuberculosis when used in the prescribed combination (Yesudikan, 1994). Although some of these regimes are efficient, many are not. Another study of specialist physicians in a large university teaching hospital in Karachi, Pakistan, found that few physicians follow the WHO guidelines for tuberculosis treatment. Particularly alarming, given the emergence of drug-resistant TB due to incomplete of inappropriate drug therapy, is the fact that only 30% of patients treated completed treatment as prescribed (Arif *et al.* 1997). Karnolratanakul *et al.* (1999) also noted insufficient awareness of tuberculosis and lack of diagnostic skills on the part of government health staff in Thailand. They concluded that intensive training activities should help to overcome some of the problems found among medical staff. In some cases, adoption of new approaches to treatment is due to resistance to change among medical personnel, heavy case-loads, and insufficient funding. These problems seem to be particularly severe in parts of the former Soviet Union (Gleissberg *et al.* 1999).

Expanding DOTS to the 84% of TB sufferers who do not currently receive it does not necessarily entail the provision of more assistance to developing countries. Funds (both public and private) are currently expended on ineffective TB programmes. For instance, in South Africa and Eastern Europe, 30% of the TB budget is spent on residential care. Much can be gained from a reallocation of these resources.

Further funds could come from reallocations within the health budget from uses with poorer cost-effectiveness than TB. Such reallocation could occur from other parts of the government budget. An ad hoc committee of WHO concluded that middle-income countries do not need further funding, but that low-income countries would need support in the introduction and expansion of DOTS; the least-developed countries would also need additional funds for the maintenance of the programme (WHO, 1998c).

Section 5

Conclusion

Tuberculosis accounts for nearly two million deaths per year worldwide. In many regions it is a growing problem, partly because of HIV, partly because of insufficient application of control measures, and partly because of the economic decline. Since more than 75% of infections and deaths are among the most economically active age group in the population (those 15 to 54 years of age), tuberculosis can have far-reaching economic and social consequences for those infected and for their households and communities. Although the poor are disproportionately affected by tuberculosis, the disease is not exclusively a disease of the poor.

Decisions on what treatment regimes to follow are often based only on costs to the health ministry. The costs borne by patients have largely been ignored, even though such costs are often larger than the direct costs to the health ministry. Ignoring these costs leads to an underestimation of the total costs of tuberculosis and, because these indirect costs vary across different treatment regimes, can lead decision-makers to make poor choices in health care. Although they are difficult, if not impossible, to quantify, psychological and social costs such as discrimination, and attendant anxiety, and depression add further to the costs of tuberculosis.

Households attempt to cope with the large immediate costs of tuberculosis by diverting resources from other forms of health care, reducing other forms of consumption, withdrawing children from school, borrowing or selling assets, and the like. Some of these short-term coping strategies can have significant long-term costs for household members. Such costs are rarely taken into account in studies of the impacts of tuberculosis.

Conventional treatments for tuberculosis are often expensive and have low cure rates. They tend to impose particularly large indirect costs on individuals and households. A considerable amount of evidence exists that short-course treatment, especially if ambulatory strategies rather than hospitalization is used, are much more cost-effective than conventional treatments. The cost-savings to individuals are particularly notable.

Why then are there more people with tuberculosis today than at any other time in history, despite the fact that a highly effective treatment has been available for over four decades and a highly cost-effective treatment strategy has been available for a decade? Reichman (1997) places the blame at the feet of the medical sector and politicians. Perhaps their reluctance to change current practice is understandable, although wrong. Changes in the design of treatment delivery do not always dramatically reduce costs to the health department; and it is these costs that health professionals and politicians care about most. But as has been shown in this study, the treatment of tuberculosis, particularly with the DOTS regime, substantially reduces the costs of the illness to patients and their families. Once these costs are taken into account, there is a compelling case for treatment for tuberculosis to be given a high priority by decision-makers and for DOTS to be adopted as the treatment regime.

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Table 1. Socioeconomic profile of TB patients—Tamil Nadu, India

	Percentages		
Years of education	**Male**	**Female**	**Total**
Illiterate	25	34	29
Less than 5	33	27	30
5–8	23	20	21
More than 8	19	19	19
Income (US$)	**Male**	**Female**	**Total**
Less than 14	8	13	10
14–29	24	18	21
29–57	29	41	34
More than 57	40	28	35

Source: Ramachandran *et al.* (1997)

Table 2. Costs of Tuberculosis Treatment—Uganda and South Africa

	Rural Uganda	**Rural South Africa**
Cost to health service (US$)	95	2,570
Cost to patient (US$)	229	371
Total (US$)	324	2,941

Source: Uganda: Saunderson (1995) — South Africa: Wilkinson *et al.* (1997)

Table 3. Estimated household costs of tuberculosis: Survey studies

Cost to patient	Bangladesh[1]	Uganda[2]	India[3]	South Africa[4]
Direct costs (US$)	130	68	41	99
Lost work	57%	91%	na	na
Time loss	14 months	10 months	3 months	4 months
Lost income (US$)	115	161	89	272
Indirect cost as % of annual household Income	15	na	14	na
Total cost as % of annual household Income	31	na	20	na

1. Croft and Croft (1998), Northwest Bangladesh, 21 patients registered at a clinic
2. Saunderson (1995), Southwest Uganda (rural), 34 patients at large hospital
3. Ramachandran *et al.* (1997), Tamil Nadu, India, 304 urban and rural TB patients under treatment for 2 to 6 months
4. Floyd, Wilkinson and Gilks (1997) Hlabisa, northeastern KwaZulu-Natal, South Africa

na = not available from the study

Table 4. Estimated household costs of tuberculosis: Simulation studies

	Indonesia[1]	Thailand[2]	Bangladesh[3]
Time loss			
• Morbidity			
Treated	2 months	2 months	na
Untreated	12 months	12 months	na
• Mortality			
HIV–	13 years	15 years	na
HIV +	2 years	2 years	na
Income loss (US$)			
• Morbidity			
Treated	149	317	329
Untreated	898	1 900	na
• Mortality			
HIV–	11 490	19 400	na
HIV +	1 718	3 490	na
Cost-effectiveness	10–5	‹ 32	na
Income per capita	898	1 900	105

1. WHO
2. Sawert *et al.* (1997)
3. Carin, Gray and Almeida (1998), Chittagong rickshaw puller's household. Income loss includes morbidity and mortality risk over two-year period. Annual household income for six persons estimated at US$ 629

na = not available from the study

Table 5. Acceptance of TB patients by family—Tamil Nadu, India

	Percentage			
	Rural		Urban	
	Male	Female	Male	Female
Accepted	93	82	85	68
Not well accepted	3	4	7	17
Rejected	4	14	8	15

Source: Ramachandran *et al.* (1997)

Table 6. Impact of parent's TB on child's schooling—Tamil Nadu, India

Region	Sex of patient	Percent stop school
• Rural	Male	8
	Female	4
• Urban	Male	16
	Female	16

Source: Calculated form data in Ramachandran *et al.* (1997)

Table 7. Comparison of costs of conventional and DOTS treatment—Rural Uganda

	Costs per Patient	
	Conventional	DOTS
Costs to health service	95	112
Costs to patient	229	84
• Before diagnosis	32	16
• During hospital stay	36	0
• Lost income from work	161	68

Source: Sanderson (1995)

Note:
Conventional treatment, which is widely practised throughout sub-Saharan Africa, consists of two months hospital treatment followed by 4–10 months outpatient treatment.
The alternative treatment, DOTS, assumes ambulatory treatment with supervised drugs weekly for 8 weeks, then 4–10 months outpatient treatment. Included is increased spending on health education and supervision.

Table 8. Cost-effectiveness of TB treatments—Developing countries

	Malawi	Mozambique	Tanzania	Hlabisa, South Africa
Short course/hospitalization	165	232	202	388
Standard/hospitalization	215	301	270	1 031
Ambulatory, Short-course	107	92	202	na
Ambulatory, standard	111	92	107	na

Source: Murray (1996) — Wlkinson *et al.* (1997)

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