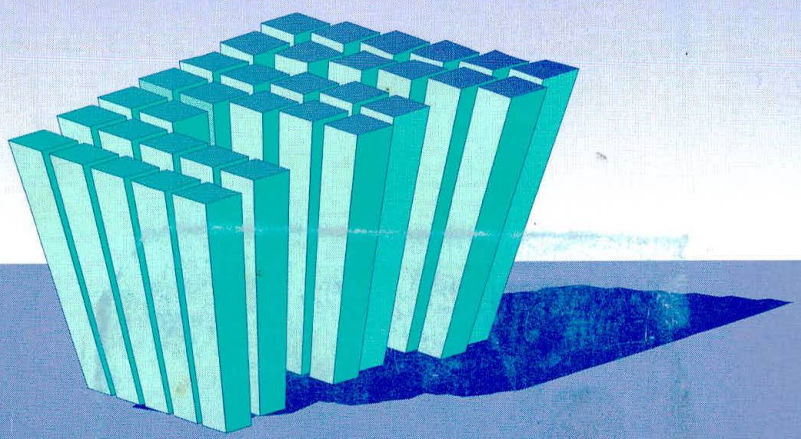
HEALTH ECONOMICS

COST ANALYSIS AND COST CONTAINMENT IN TUBERCULOSIS CONTROL PROGRAMMES

The case of Malawi



WHO TASK FORCE ON HEALTH ECONOMICS

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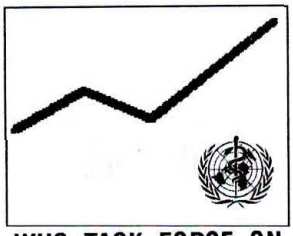

WHO TASK FORCE ON HEALTH ECONOMICS

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I. Introduction

The achievement of allocative and technical efficiency is a fundamental goal for the management of economic systems. The search for the most efficient combination of resources and the use of each resource in the most efficient way is mandatory to optimize the production of desired outputs. A driving force behind this process is the limited availability of resources. Both at the private and the societal level we are constantly forced to make choices between alternative options to spend available funds, and the obtainment of optimal utility levels depends on our ability to make those choices that fulfill both efficiency criteria. For many years, the field of health care appeared as an exception to this rule: "health" was taken as an absolute, of which "the highest possible level" had to be obtained without regard to available resources. In fact, the fulfillment of every health care need was regarded as a societal obligation in many countries.

Over the past decades, it has become apparent that this fundamental departure from basic economic rules has become unsustainable. Restrictions will have to be imposed and choices among possible health care interventions will have to be made, as in other aspects of our lives. While this is a new experience for patients and health care providers in industrialized countries (and thus violently opposed by many), the situation has been well known in low-income countries. Here, the choice is very often not only between various health interventions, but whether to spend money on health care at all, instead of building streets, constructing water-dams or training schoolteachers.

How then are these choices made? One possibility is that the decision making process is limited to the exercise of political power. This may lead to a situation where the distribution of health care funds addresses the specific needs of minorities, while societally important health issues remain underfunded.

In the form of cost-effectiveness analysis, health economists attempt to rationalize the decision-making process. The underlying idea is simple: realizing that not all health care interventions can be funded, an attempt is made to specify the costs for each intervention and relate them to the outcomes that it can achieve. If outcomes (or "effectiveness") of interventions are measured in comparable units, "cost-effectiveness ratios" can be calculated, i.e. the cost per unit of outcome for each intervention. As a result, those interventions that will provide the largest health gains for a given and restricted budget can be specified. Allocating the health care budget for these interventions will result in the most efficient use of funds and will produce the highest societal benefits.

Especially for the situation in low-income countries, this approach has become more influential in political argumentations during recent years[25]. The underlying concepts and techniques should therefore be known to managers of specific health care programs to be able to compete successfully for the limited funds that are available. Tuberculosis has been identified as the leading cause of death from infectious dis-

eases in adults worldwide[1]. However, the viewpoint of cost-effectiveness demands that this fact alone should not justify the allocation of scarce resources to fight the disease. Instead, it needs to be demonstrated that any proposed tuberculosis control intervention represents a choice promoting economic efficiency in the health care sector. If tuberculosis control managers want to make a convincing point for their intervention, they need to provide clear information on two aspects: outcomes of their activities and economic costs incurred. The demonstration of outcomes depends on the availability of an accurate recording system that shows numbers of patients treated and cured. Based on this information, the overall epidemiological impact of control interventions can be estimated through the use of epidemiological models. Finally, the combination of cost data and information on the epidemiological impact allows the determination of cost-effectiveness ratios[9,2]. Previous work in this field related to tuberculosis has led to the identification of short-course chemotherapy for tuberculosis as one of the most cost-effective of all available health interventions[25].

The cost analysis of tuberculosis control interventions can be performed with two purposes: to compare the efficiency of currently existing programs with those of other health care interventions (e.g., vaccinations or the provision of safe water); or, to determine if the current program can (and should) be modified to maximize health benefits with available resources. Based on these objectives, the topic of this document is therefore to determine the economic costs of

- existing tuberculosis control activities
- modifications to existing activities

II. Basic concepts

A. Economic or financial costs?

You are running a miniature TB control program, which consists of one nurse in a small TB clinic. Besides seeing patients at the clinic and handing out drugs, the nurse visits non-compliant patients on a motorcycle. Fortunately, she receives help from the local women's club, whose members spend afternoons as voluntary clinic aides. During the current year, the nurse receives an annual salary of $6,000.-, you have expenses for TB drugs of $4,000.-, and fuel and maintenance for the motorcycle add up to $2,000.-. You assume no inflation or changes in TB incidence rates, and calculate a total cost of $12,000.- to run your program in the following year. The minister of health approves your budget and acknowledges your excellent accounting capabilities.

In the same year, you are asked by the minister of economic planning to prove the cost-effectiveness of your program. Since you are treating 100 patients per year, you write a report saying that the cost per patient treated is $120,-. The minister of economic planning accuses you of gross misinformation. Your experience prompts you to consider the difference between financial and economic costs.

The figure that is reported in a budget for the minister of health represents the financial cost of a program. It is usually equivalent to the expenses captured on expenditure sheets, with the limitation that only expenditures for items actually consumed during the year should be counted: if there are drug expenses of $2,000.- but only drugs worth 1,000.- are used (e.g., because of stocking up for the next year), the financial drug costs are $1,000 per year.

The term "economic cost" is more comprehensive than financial cost. It includes all resources consumed for the program, even if there is no monetary expenditure for them. For the miniature program outlined above, resources that were used but not included in the expenditure sheet are: the health center, the motorcycle and the voluntary labor. Health center and motorcycle fall under the category of "capital" costs[3]. What is the economic cost of using these items? One way of clarifying this point is the notion that capital items have a limited lifespan. A building will normally last no longer than 20-30 years, so during one year a certain percentage of the lifetime worth of a building is "used up". The same is true for the motorcycles, which usually last for a shorter period of between 2-5 years. Another concept that can be used to explain the economic cost for these items is that of "opportunity costs": by using a resource for one activity, one is forgoing the opportunity of using it for another. Economic costs are the costs of forgoing the best possible alternative use for a resource. An alternative use of the health center or the motorcycle would be to rent it on the housing or vehicle market. The current market price for such rentals gives us an indication of the opportunity we are forgoing by using them for TB control. Similarly, the ladies from the women's club are forgoing the opportunity of earning an

income on the regular job market. We cannot assume that they will remain so benevolent in the future. Although they currently receive no salary, their economic costs should be valued (e.g., by using the regular wage rate for comparable labor, or by an assessment of the opportunity cost of leisure time).

There are other examples of the differences between financial and economic costs. They usually occur when government regulations have led to gross market distortions, so that market prices no longer reflect the opportunity cost of a resource. Of practical importance are artificially low exchange rates that governments may fix to decrease the price of imports. Since these rates do not reflect the actual scarcity of foreign exchange, their use may lead to problems in sustaining programs that heavily rely on foreign exchange to buy inputs on the world market. The economic value of foreign exchange is reflected in so-called "shadow" exchange rates. Other examples of "shadow" prices are those for subsidized imports or unskilled labor for which a minimum wage level may not reflect the true opportunity cost.

As a general rule, assessing the economic cost of an intervention is more comprehensive than calculating financial costs because it includes items like capital costs that do not occur on expenditure records. However, we will discuss below the important concept of "incremental" and "marginal" economic costs, which are often similar to financial costs. In certain circumstances, these cost categories are of more practical interest to decision-makers than the total economic costs, and the cost assessment can be facilitated. However, many situations will require the calculation of the total economic costs of an intervention. We will therefore describe the methodology for this purpose first[4,5,6].

B. Assessing economic cost

1. The viewpoint

In our discussion of economic costs, we have until now assumed the viewpoint of the Ministry of Health or other health care providers. The implicit question for the purpose of cost-effectiveness analysis was "How can the provider obtain the maximal amount of health gains under given budget constraints?" If the analysis is extended to the assessment of an intervention from a societal perspective, there are additional cost categories that should be taken into account. An example of costs that we have omitted are the costs to patients. These usually consist of the patients' "direct" expenditures for transportation or fees and the "indirect" costs of forgoing worktime for clinic visits etc. Inclusion of these costs can lead to widely differing results, e.g., when we consider the different costs for the Ministry of Health and patients of programs based on home visits or hospitalization. Despite its potential usefulness, assessments of the overall societal costs and savings from tuberculosis control interventions have not yet been performed extensively. This is partly due to the methodological difficulties in assessing indirect patient and household costs. Also, policy makers may be more influenced by data that have direct implications for their budgets, so that the political usefulness of a full societal cost analysis can be

limited. For the purpose of this manual, we limit ourselves to assessing costs from a provider viewpoint. However, if the economic gains and losses resulting from an intervention show a gross maldistribution between various economic agents in a society, an expansion of the analysis to account for a societal viewpoint should be considered.

2. Cost categories

For an assessment of the economic costs of an intervention, it is necessary to identify all resources consumed for its production. The variety of different inputs can be categorized in various ways to organize the costing procedure and facilitate the evaluation of study results. Some of these categorizations can be combined to address specific questions during the evaluation.

a) Capital costs / Recurrent costs

We already mentioned two examples of capital cost items: buildings (e.g., health center) and vehicles (e.g., motorcycles). In general, economists identify those items as capital resources whose useful life is longer than one year. Apart from buildings and vehicles, this category includes expenses for equipment such as microscopes and x-ray machines, as well as expenses for staff training or public education campaigns that occur rarely (i.e., less than once a year). The economic costs for these activities have to be calculated in a special way that takes into account their useful life and the discount or interest rate (see below).

Recurrent costs are costs for all those program inputs that have a useful life of less than one year. Often, the largest expenditures under this category are made for salaries. Other recurrent costs occur for drugs, supplies (such as syringes, sputum slides, x-ray files, stationary etc.), frequent training or public education activities and maintenance of buildings and vehicles. The exact assessment of the recurrent costs of an intervention is often crucial for its long-term sustainability. A beautiful new health center will lose its appeal quickly if no funds are available for its upkeep. Patient follow-up activities will become impossible if no funds are available for vehicle repair. The success of a program will critically depend on the availability of drugs and diagnostic material. It is therefore very important to be exhaustive in the listing of the recurrent resources needed.

Taken together, a basic classification of cost items that will reoccur throughout any costing procedure is:

Capital Costs

Vehicles

Equipment

Buildings

Training, non recurrent

Public education, non recurrent

Recurrent Costs

Salaries

Supplies (drugs, diagnostics etc.)

Vehicles, operation and maintenance

Buildings, operation and maintenance

Training, recurrent

Public education, recurrent

b) Costs at different programme levels

We have outlined above a "minimal" TB program that consisted of just one nurse in one health care center. Unfortunately, reality is much more complex. A national tuberculosis control program will consist of several levels that all contribute to ensure the delivery of adequate patient care at the peripheral level. Since the program could not function without any of these structural levels, the costs for each of them has to be included into the cost analysis. A typical TB program will consist of the peripheral, district, provincial and central level. At all of these levels, capital and recurrent costs occur, although the specific items in these cost categories may differ. We may therefore extend the structure of our cost table in the following way:

Program level:	Central	Provincial	District	Peripheral
Capital Costs				
Vehicles				
Equipment				
Buildings				
Training, non recurrent				
Public education, non recurrent				
Recurrent Costs				
Salaries				
Supplies (drugs, diagnostics etc.)				
Vehicles, operation and maintenance				
Buildings, operation and maintenance				
Training, recurrent				
Public education, recurrent				

c) Costs for specific activities

At each level of the TB program, various activities are performed that complement each other or represent separate program components. The required inputs should be determined separately for each activity for two reasons: to ensure that all ancillary services that are performed at higher levels are included in the cost of health care delivery at the peripheral centers; and to be able to identify those activities that consume the most resources as targets for special managerial attention. As an example, we give a possible list of functions that are performed at the district level of a TB control program. A similar list must be established for the peripheral, provincial and central levels. For some activities, inputs may be shared with other activities within the program or with other health care interventions. The topic of the necessary allocation of costs will be addressed below.

Program level: district

Activity:	Supervision	coordination of laboratory activities	treatment of referral cases	district TB register	preparation of reports
Capital Inputs					
Recurrent Inputs					

3. Sampling

To collect data on all costs that occur at the central level of a program should be a manageable task. However, collecting data on all activities that occur in every district or peripheral unit will usually be impossible. It is also unnecessary. The method to get around this problem is called "sampling". The term stems from statistical theory and the underlying concept is that by choosing a representative sample of the total population under study (e.g., the total population of district offices or peripheral health centers), one is able to draw conclusions (or, to "make inferences") about the average conditions in that population. How are the number and site of the sample units to study determined? Since the sampling method is rooted in statistical theory, there are elaborate methods to determine the number of samples one needs to study to draw "statistically significant" conclusions. Also, various methods exist to ensure the representativeness of the chosen units (e.g., random, systematic, cluster or stratified sampling). While these methods will increase the statistical merits of a study, they are unfortunately unpractical in many occasions. Time and financial constraints will usually prohibit the visit of a large enough sample to give statistical power. For the same reason, the choice of peripheral units is usually restricted to those that are accessible within the time limit of a study. The method that is most likely chosen may be called "judgment sampling", which means that, together with people who know the entire program, an informed judgment is made about which peripheral units will provide data that can be considered representative for the whole program. It may be difficult to convince a statistician of the merits of this approach, but in practical terms it is doubtful whether the increased effort for statistical sampling will make important differences to the results of a study.

4. The concept of unit costs

Once data on all cost items related to a program at a specific health center or program level are collected, one needs to decide about an appropriate method of pres-

entation. Reporting the total costs of the whole program or only those of one center will not be very helpful for comparing the performance of different centers or planning new activities: the size of the covered population may differ widely between centers, and the different number of services performed will result in large differences of total costs. The quantity of analysis should therefore be defined as an output unit. Outputs of a program are physical units like x-rays, sputum smears, distributed courses of chemotherapy etc. Costs should be reported as costs per one of these units, i.e. cost per x-ray, cost per sputum smear, cost per distributed course of chemotherapy. As a result, the costs of all the ingredients that are necessary to produce the outcomes of programs can be calculated. An outcome is the aggregate result of the production of outputs, e.g. a case of TB diagnosed and treated. For both outputs and outcomes one will usually find performance records at the examined site, e.g. number of sputum examinations performed, number of cases diagnosed, or number of patients who completed treatment during a year. The calculation of unit costs is then simply unit cost = total cost per activity / total number of units produced. Outcomes can be translated into program effects, which are general units that usually allow the comparison between various health interventions, e.g. deaths averted or years of life saved. Usually, some theoretical assumptions are necessary to calculate these effects, and one is not able to find actual reports of these at the health center. Ultimately, the cost per chosen unit of measurement for these effects can be used in a cost-effectiveness analysis. However, one should realize that unit costs for outputs or outcome measures may actually be more useful for the managerial task of assessing technical efficiency (see page 18).

5. The problem of joint costs

As stated above, each level of a program will perform not only one, but a variety of services. Also, inputs from activities performed at different levels will be necessary to perform certain services at others (for example, sputum smears performed at a district laboratory are necessary to guide treatment at a peripheral health center). Further, a health center usually does not only deliver tuberculosis control activities, but a variety of different primary health care services. Whenever the inputs needed to produce a specific service are shared with the production of another, the problem of joint cost allocation occurs. This means that one has to decide which share of a common input is used for a specific activity. The first step to tackle this problem is to determine an allocation basis. For a building, this may be the space used by a program activity; if personnel performs various tasks, salaries can be allocated based on the share of total worktime spent for an activity; time shares can also be determined for shared equipment; hospital administration costs can be allocated based on the number of personnel in a department etc. The costs of shared (or overhead-) inputs can be directly allocated to each final cost center of interest, based on the allocation criteria chosen. When the number of inputs required to produce a program output is large, the method of "step-down allocation" can be employed. For this method, inputs are ordered hierarchically, starting with those inputs that are shared by the greatest number of other activities, e.g., building space. At every step of the alloca-

tion procedure, inputs are allocated to a range of "intermediate cost centers" based on specific allocation criteria, thereby ensuring that an appropriate share of all "overhead" costs is allocated to the "final costs centers" i.e., the outputs of interest. A simple illustration of this procedure is given in Table 1.

Table 1: Step down allocation of overhead costs

Cost center	building space	main-tenance	administra-tion	laundry	x-ray	laboratory	wards
Allocation criteria	actual space occupied	building space	no. of personnel	no. of bed-days			
cost	**2000**	**4000**	**8000**	**4000**	**10000**	**10000**	**20000**
allocate building space	->	0	200	100	200	200	1300
		4000	**8200**	**4100**	**10200**	**10200**	**21300**
allocate maintenance		->	400	200	400	400	2600
			8600	**4300**	**10600**	**10600**	**23900**
allocate administration			->	430	860	860	6450
				4730	**11460**	**11460**	**30350**
allocate laundry				->	473	473	3784
Final cost centers					**11933**	**11933**	**34144**

It must be pointed out that there is a certain degree of subjectivity and arbitrariness involved in any allocation process. Should central office costs be allocated based on the space that a specific program occupies, or rather based on the share of the total budget that it consumes? How certain is it that a nurse devotes 30% of her time to TB control activities, and not 25 or rather 40%? Whenever it is likely that the uncertainty around assumptions has an important effect on the result of the cost assessment, one may consider to perform a sensitivity analysis to determine the actual effect of changes of assumptions on unit costs (e.g., by changing the share of the nurse's salary in the calculation stepwise between 25 and 40%). If the resulting cost ranges are unacceptably large or would lead to opposing decisions regarding alternative interventions, one should devote more time to assessing allocation shares to reduce the uncertainty around cost figures.

6. Average, incremental and marginal costs

You have costed the diagnostic services at one health center and determined a total cost for sputum examinations of $2,000.- From the laboratory reports you learn that 1,000 smears were performed during one year. Consequently, you calculate a unit cost of $2 per smear. Now imagine that your program is expanding and you expect 1,500 smears to be performed during the coming year. What will the cost of this level of activity be? $3,000? - Probably not, as we will show in this chapter.
Another example: You are setting up a new TB control program in an area with an existing primary health care structure. You know that there is some spare room in the district health office that you can use for the TB officer. Also you plan to use the existing staff at health centers for case-holding activities. What are the costs for office space and health center staff?

The problem we are touching on is the important distinction between the average, the marginal and the incremental costs of an activity. The two examples we have mentioned above describe two different aspects of this problem: one is the relation of the cost of a given activity to the level of output (analyzed as marginal costs), the other concerns the costs of a new activity for which parts of the already existing facilities and infrastructure will be used (analyzed as incremental costs). We will investigate both aspects in turn.

We have defined unit costs as the total cost of an activity divided by the number of output units produced. The specific economic term for this type of cost is the average cost of a unit of output. A very important observation is that this figure represents only one value on the cost function of the activity. Specifically, the average cost may be higher or lower than the value calculated, depending on what level of outputs a program currently achieves. The reason for this is that only a part of the input costs has a linear relationship with the number of output units produced (i.e., will increase the same amount for every additional unit produced). We call these costs the variable costs of an activity. The cost of other inputs, however, will remain stable, whatever level of output is achieved. These are the fixed costs of the activity. Costs that will remain stable over a certain range of output but will increase in a stepwise fashion if the range is exceeded are called semi-fixed. To illustrate these terms, we consider the cost of TB diagnosis with sputum smears. For each smear, one new slide and a certain amount of staining solution is needed. The cost of these inputs will be linearly related to the total number of slides produced, they are therefore variable costs. The costs for the microscope or laboratory technician, however, behave differently: only one microscope is needed, whether one or twenty slides are examined per day; its cost (and similarly, the cost for the microscopist) does not depend on the number of slides produced, they are fixed costs for this activity. However, we can imagine a situation where the workload for diagnosis becomes so large that it can no longer be handled by one microscopist. At this point, a second microscopist must be employed (and probably, a second microscope bought). The cost for these inputs has become semi-fixed. With these distinctions of the components of total costs in mind, we can analyze the different concepts of average and

marginal cost: the average cost reflects all elements of the total cost of inputs used at a specific level of output; the marginal cost consists of only those cost components that would change if the current level of output changes (precisely, the marginal cost of an activity is the cost of producing exactly one more unit of output). It is obvious that variable costs will always be a part of marginal cost, whereas true fixed costs will never be included. However, very few fixed costs will be totally independent of the level of production. Rather, they will behave in a semi-fixed way: once a certain level of production is exceeded, an additional unit of these inputs has to be bought. The problem in the calculation of marginal costs is therefore to decide how much capacity of fixed inputs is currently used. For our further discussion, we will assume that the economic cost of already existing and currently unused capacity is zero. This means that the marginal cost of a program expansion will be equal to the average variable costs in a situation of excess capacity for fixed inputs.

This postulate can be challenged. We remember that the opportunity cost of a resource is the cost of forgoing the best alternative use. Certainly, the best alternative to using, e.g., an x-ray machine for a TB programme is not not to use it at all. It could be employed for another disease control programme; one could also sell it or rent it to private providers. However, health care programs regularly do not exploit their full therapeutic or economic capacity. In reality, the alternative to using an existing facility with excess capacity will be its unproductivity. In these situations, the marginal economic cost is in fact zero. When the average unit costs for an existing intervention are determined, an attempt should therefore always be made to concurrently determine the level of capacity use for its fixed inputs.

Adding new program components to existing facilities represents another area where the analysis of the specific costs related to output changes is important. As mentioned above, the term "marginal" refers only to the production of an extra unit of an existing activity. It is therefore preferable to use the term "incremental" cost for this case, although the use of both terms is sometimes handled interchangeably. For the decision-maker who evaluates the economic merits of any such interventions, the additional costs they will impose, in relation to their presumed outputs and effects, are of primary importance. Therefore, if existing facilities can be used without diminishing any other ongoing activities (i.e., in the case of excess capacity with zero opportunity cost), these items should not be included in the assessment of economic costs. The guiding question should be, " what would the total cost of my program be with and without the new intervention?" Only the costs that occur in addition to the current cost level should be used for the economic analysis. It should be noted that the incremental economic costs of an added program component are often similar to its financial costs. In this case, budget figures can be directly used in an analysis of economic costs[7], and vice versa.

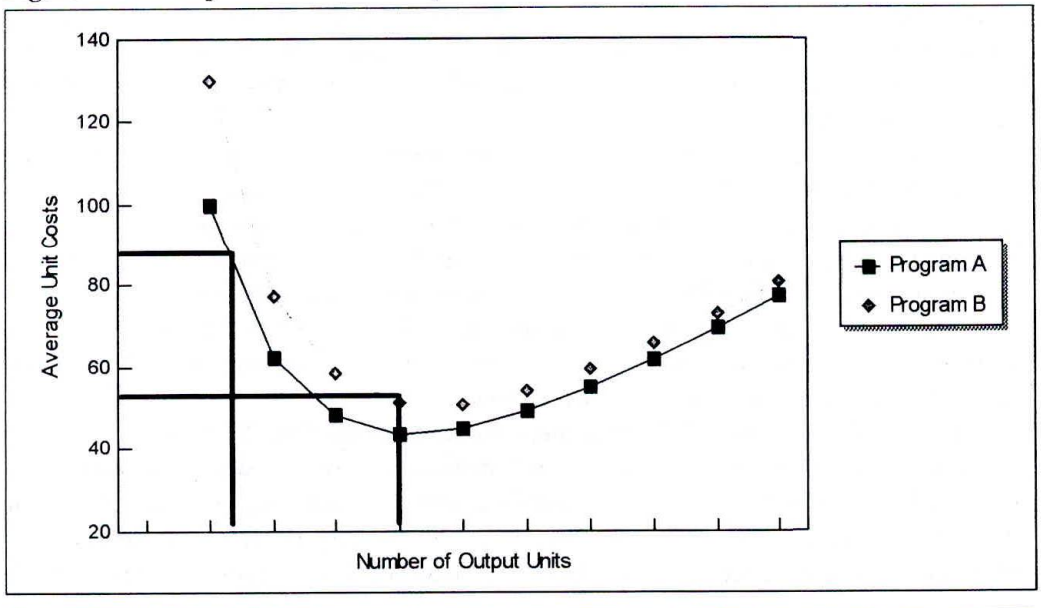
If the incremental costs of an activity are of prime importance for the decision-maker, what is the role of the somewhat laborious assessment of total economic costs? The primary aim of this activity is to draw generalizable conclusions from the cost study. Incremental costs of an activity are specific for the location in which they were

assessed. They may be fundamentally different in other settings with different pre-existing conditions. Since average costs include all resources consumed for an activity, they should be the same for all locations[8], and therefore allow an economic assessment without having to decide whether the necessary incremental resources are comparable.

7. Comparing costs at different capacity use levels

Various conditions in a tuberculosis control program can lead to the under-utilization of capacity: for equity reasons, the government may decide to cover geographically remote areas with health care facilities, even though the population density may be too low to operate at full capacity; excess capacity may have been built in anticipation of a future increase of use or random variations in usage levels; if excess capacity exists without a plausible explanation, it may be a sign of technical inefficiency of a program. Whatever the reason, it should be noted that the existence of excess capacity has important implications for the interpretation of cost-effectiveness ratios. If the average costs per unit of effect are measured in a situation of under-utilization of inputs and compared with an alternative program that operates at full capacity, a difference in cost-effectiveness ratios may be solely based on utilization levels, and not on the "inherent" cost-effectiveness of the interventions under investigation. This is illustrated in Figure 1: although program B has higher average costs than program A for each specific output level, a higher cost may be determined for program A if the two programs are compared at different output levels. One may want to repeat the costing study with sample programs operating at the same level of resource utilization. Alternatively, one can perform a sensitivity analysis under different assumptions about resource use.

Figure 1: The importance of the output level



8. The effect of inflation

When cost data are collected, they will probably be obtained for different years in the past. To ensure the validity of results, all prices should be converted to a "standard" year, and this year should be noted in the report. Neglecting this procedure may have important impacts on the results of a study: some expenditure records for capital items like buildings may date back a number of years; especially in countries with high inflation those costs may be completely incomparable to what one would have had to pay for these items in recent years. Price levels for various years can be determined from the official consumer price index or deflator series, which can be obtained from the planning or finance ministry[9]. The indices are usually based on one standard year, whose value is usually given as 100. The price level in each year is then given in relation to the standard year. The process of adjusting prices in various years to the price level for the standard year in your study is as follows:

1. Divide the purchase price of the respect input by the price level or deflator for the purchase year.
2. Multiply the result by the price level or deflator for the standard year in your study.

9. Using results for international comparisons and publications

If the results of an analysis are judged to be sufficiently important for publication in an international journal or as a help for decision-making in countries different from the study country, it is important that the results are modified to ensure their applicability in different circumstances. Probably the most important modification is to express results as average costs per output unit in addition to the marginal or incremental terms that were calculated for a specific country's situation. The reason for this is that one cannot make any assumption about existing infrastructure in other settings, so the results for one country may lead to misleading conclusions about the financial requirements in other settings. The provision of average cost data together with a detailed costing of the required inputs will make the results much more useful for a different setting.

A second important aspect for international comparisons is that one needs to express the results of a study in terms of hard currency. This task is straightforward: multiply the cost of each input in local currency (adjusted for the standard price level) by the exchange rate for the international currency you decide to use that was valid for the "standard year"[10]. This will result in the costs in international currency for the standard year. One can also express the currency costs for a different year by performing an additional price adjustment procedure as outlined above, this time using the deflator or price index series for the currency chosen.

Finally, traded and non-traded goods need to be distinguished. "Traded" in this connection means traded on the international market, and this category normally comprises all items that have to be paid for in convertible currency. The reason for this distinction is that one can assume these prices to be very similar in different countries, as price differences usually only arise from different transport costs. On the

other hand, there may be important differences between countries for those inputs that are not traded on the world market. Probably the most important category in this respect is salaries. Depending on the general economic situation in a country, there may be vast differences in the expenditure that will occur for various categories of personnel. One possible approach to this problem is to express expenditures for non-traded goods as a percentage of the GDP in a specific country, assuming that most of the costs vary proportionally to this general economic indicator. However, it may be more useful for the actual budgetary planning process to provide detailed lists of all necessary inputs, and then determine local prices for each specific country.

III. The Case of Malawi

To illustrate the practical performance of a cost analysis, we will now describe a cost assessment performed for the National Tuberculosis Programme in Malawi in March 1995.

A. Introduction to the Malawi setting

The National Tuberculosis Control Programme in Malawi was reorganised in 1984. It has adopted the WHO-recommended control strategy based on passive case finding, diagnosis mainly by sputum smears, short-course chemotherapy with patient observation and cohort analysis of treatment outcomes. The goals of the NTP are the detection of at least 70% of infectious cases and the cure of at least 85% of detected cases[11]. Since the introduction of the new strategy in 1984, the number of detected cases has more than tripled. Much of the increase in case numbers can be ascribed to the impact of the HIV epidemic. Malawi has been severely hit by this epidemic. Currently, HIV prevalence rates reach 30% in women of child bearing age in city populations, and HIV prevalence rates in tuberculosis patients are reported to be greater than 70% for some districts[12]. Diagnostic and therapeutic facilities for TB control have been overwhelmed by the increasing case load during recent years. With current occupancy rates of more than 200% in some hospital TB wards, and a further rise of case numbers expected for the coming years, the tuberculosis control programme's management is in need of a reassessment of its diagnostic and therapeutic strategies.

The consideration of the costs connected to each programme modification is of paramount importance in the Malawian setting. As indicated by its GDP per capita, Malawi ranks as one of the poorest countries in the world. Although a large share of drug costs and programme management expenditures is currently provided by donor agencies, the Ministry of Health is still responsible for many cost items, of which staff salaries and the costs incurred during hospital treatment are especially important. Partly due to the effects of recent structural adjustment policies, financial constraints for all government activities are expected to be even more pronounced during the coming years. Therefore, the Ministry of Health must seek to optimise its expenditure patterns in order to cope with the expected tuberculosis case numbers. The increase of case numbers has been especially large in city settings. The largely urban district of Blantyre alone accounts for more than 10% of the annual case load. Also, this district reports the highest incidence rates, the latest available figure being 440 per 100,000 in 199413 . It seemed appropriate to focus on the expenditure patterns in a city setting for the present study, since it can be expected that urban areas will continue to see the highest increases in HIV- and tuberculosis incidence rates. In this respect, the analysis presented here differs from previous reports on the cost of tuberculosis control in Malawi14 ,13, which focused on rural districts. Time requirements for the study were two weeks for the on-site collection of data, not including the time for the preparation of the report.

B. Calculation of economic costs for the existing programme

1. Demographic and TB-specific statistics

Demographic information was available from the Malawi government 1987 population and housing census. To estimate the population size in 1994, it was assumed that the average population growth rate of 3.7% per annum from 1977 to 1987 was sustained thereafter, which can be regarded as a conservative estimate. Appendix 1 shows the available information for 1977 and 1987, as well as estimated data for 1994.

Information on TB case notification was provided by the NTP Programme Manager. There has been a sharp increase in the number of reported cases since the restructuring of the programme in 1984. Between 1984 and 1994, the total case number rose from 5,334 to 19,496. Of the 19,496 cases reported in 1994, 5,988 (30.7%) were pulmonary smear-positive, 8,958 (46.0%) were pulmonary smear-negative, 504 (2.6%) were relapses, and 4,046 (20.8%) were extrapulmonary cases. In relation to the estimated population size for 1994, the total notification rate was 188 / 100,000, as compared to a rate of 95 / 100,000 in 1987. The respective figures for smear-positive cases are 58 / 100,000 in 1994 and 41 / 100,000 in 1987. The notification rates differ widely between districts, ranging from a peak of 440 / 100,000 in Blantyre district to a low of 61 / 100,000 in Dedza district (Appendix 2).

2. Determination of the programme structure

The general structure of the programme has been described in previous reports by the International Union against Tuberculosis and Lung Disease (IUATLD) as well as by the WHO advisor to the National TB Programme[15]. The accuracy of this information was verified in discussions with the Programme Manager. The Malawi National Tuberculosis Programme has three organizational levels: central, regional and district. The structure of the programme is similar to the country's administrative structure. The central office of the tuberculosis programme is part of the Ministry of Health and is located at the Community Health Sciences Unit. The regional tuberculosis officers are based at the three regional health centers, and a district tuberculosis officer is appointed to each district health center. Health services in the district are delivered at the district hospital and peripheral health centers. At the health centers, tuberculosis control activities are integrated into the general services, and no staff is employed full-time for this purpose. In Blantyre district, Queen Elizabeth Central Hospital also performs the functions of a district hospital. There are, in addition, 39 dispensaries and clinics.

3. Determination of activities performed at each level of the programme

The relevant information was obtained from discussions with the Programme Manager and, for each programme level, confirmed in discussions with the staff involved. The following activities are currently performed on a routine basis at each level of the programme:

Health clinics:

History and physical examination
"Chronic cough register"
Sputum collection and transport to district hospital
Drug distribution in continuation phase
Follow-up on defaulters
Health education

District hospital and medical office:

All activities as performed at the health center, in addition:
Sputum microscopy
X-ray
Patient register
Hospitalized intensive phase (not for smear-negative pts. In Blantyre district)
Drug storage and distribution
Supervision of health clinics
Staff training
Preparation of quarterly reports

Regional health office:

Planning of regional activities
Drug storage and distribution to districts
Training and supervision of district staff
Preparation of reports to the central level

Central level:

Evaluation of incoming reports
Preparation of reports to the ministry
General planning of control activities
Coordination of research activities
Training and supervision of regional and district staff
Budgeting of all training activities, stationery and drug supplies
Participation in clinical activitiesCentral reference laboratory: sputum cultures, drug sensitivity testing, training of laboratory staff, quality control

4. Currently utilized inputs

Information on the inputs used to perform the various activities at each programme level was obtained in discussions with the Programme Manager and verified through interviews with staff at each programme level. Since the purpose of the study was the assessment of economic costs, costs for capital inputs in the form of buildings and equipment were determined in addition to those for recurrent inputs occurring on financial expenditure records.

The analysis is structured in two ways: for each program level, we first give the inputs necessary for all activities (e.g., buildings), followed by a list of inputs specific for each of the activities listed above; in a second step, inputs are categorized (e.g., as capital or recurrent cost items), and a summary list of all inputs utilized at each programme level is provided. The detailed lists of activities and inputs are provided in Appendix 3.

5. Economic costs of inputs

a) Data sources

(1) Recurrent costs

Information on recurrent expenditures for the Malawi health sector is available from expenditure records compiled at the Ministry of Health. The data is disaggregated for the central ministry level, several central institutions like the Community Health Sciences Unit[16], the three Regional Health offices, as well as expenditures for each district. The district expenditure figures comprise the expenditures for the district hospitals as well as health centres in each district. The information on hospital expenditures was confirmed through discussions with a senior accountant at Queen Elizabeth Hospital, Blantyre. Detailed information on laboratory expenditures was obtained through interviews with staff at the Central Reference Laboratory, Lilongwe, and the laboratory at Queen Elizabeth Hospital. Expenditures for radiological investigations were determined in discussions with the chief radiologist at Kamuzu Central Hospital, Lilongwe, and Queen Elizabeth Hospital. The costs of drugs, training activities, travel expenses, stationery and sputum containers are funded by IUATLD, and separate expenditure records for these items are kept at the NTP Programme Manager's office in Lilongwe. The cost of training activities for HIV counsellors was determined in discussions with the Regional Health Officer, Blantyre district. Current prices for consumables are contained in the price catalogue of the Central Medical Store, latest edition 4/95.

(2) Capital costs

No construction costs could be obtained for the buildings at Queen Elizabeth Central Hospital. The economic cost of capital inputs therefore had to be estimated by the cost of comparable units in different settings. Construction costs for new health centers and TB wards were provided at the Ministry of Works, Lilongwe. Construction costs for a new laboratory annex were provided by Professor A.D. Harries, College of Medicine, Blantyre. Capital costs for laboratory and x-ray facilities were based on the cost estimate for the construction of a new District Hospital (Machinga District), and space for laboratories and x-ray facilities was allocated according to the situation at a District Hospital. Cost information for hospital equipment was derived from a tender for the equipment of Machinga district hospital, submitted to the Ministry of Health 11/94. The cost of vehicles and bicycles was provided by the Programme Manager of the NTP. Construction costs for a new Regional Health Office to be built in Blantyre district were obtained from the Regional Health Officer.

Capital costs were annuitized using a nominal discount rate of 12%[17]. We assumed a lifetime of 20 years for buildings and x-ray machines, 10 years for laboratory and x-ray equipment, 5 years for cars, 2 years for motorcycles and bicycles.

(3) Exchange rate

Average annual exchange rates since 1987 were provided by the Ministry of Finance, and weekly exchange rate were provided from 1994 onwards. At the time of the study (March 1995), the exchange rate had been stable since November 1994 at 14.36 Kwacha per US dollar. This exchange rate was used for the conversion of all local prices into 1995 US dollar prices.

(4) Price deflator series

GDP deflators were provided for the period of 1987 to 1995 by the Ministry of Finance. We used the deflator series for government consumption of goods and services, and all prices were deflated to 1995 levels.

(5) Cost allocation for overhead costs

For the allocation of overhead costs at Queen Elizabeth Hospital, hospital wards, x-ray department and laboratory were the final cost centres. Administration was regarded as an intermediate cost centre. In a first step, overhead costs for activities directly related to administration and all costs for transportation were allocated to the administration cost centre. Secondly, administration costs were allocated to the final cost centres, based on the number of staff employed in each cost centre. Overhead costs for maintenance were allocated to the intermediate and final cost centres based on building space occupied. The overhead costs allocated to the final cost centres were allocated to TB-specific activities based on the number of bed-days (for TB wards) and the share of TB-specific activities (for laboratory and x-ray). The costs of drugs and medical supplies were directly determined for each activity.
Overhead costs for health centres were determined based on the total expenditure for Blantyre district recorded at the Ministry of Health, divided by the number of health centres in the district. These costs were allocated to TB-specific activities based on the proportion of all visits at health centres related to the diagnosis and treatment of tuberculosis.

Overhead costs for the regional health office and the Community Health Sciences Unit (location of the NTP management offices) were allocated on the basis of building space occupied by the relevant offices.

(6) Total costs and unit costs

Total costs were derived for specific activities such as laboratory tests, x-rays and hospital bed-days. Also, total costs were determined for each organisational level of the National Tuberculosis Control Programme. Information on the total number of laboratory tests and x-rays produced was provided by the staff involved in each activity, and was used to calculate the respective unit costs. The number of patients treated in 1994, for the whole country as well as for regional and district levels, was provided by the NTP Programme Manager. These figures were used to determine the cost per patient treated.

b) Cost calculation: general cost categories

(1) Salaries

Salaries for government services in Malawi were increased by an average of 25% in April 1995. This latest salary increase was taken into account. Information on the grading of staff was obtained during interviews with the chief hospital accountant at Queen Elizabeth Hospital, as well as with the staff involved. In addition to salaries, a housing allowance of 15% is paid. There is also a bonus payment, which is dependent on the staff grade. Appendix 4 shows a listing of average salaries including benefits for each grade. All cost calculations provided in the appendix indicate the grade of each personnel category listed.

(2) Maintenance and overhead costs

Expenditure records for Queen Elizabeth Central Hospitals are available from the Ministry of Health. The latest available data were for the year 1993/94. The table in Appendix 5 shows the categorisation of expenditures used by the Ministry of Health. 10% of the staff of Queen Elizabeth Central Hospital are employed in administration, and total salary expenditures were allocated accordingly. For the final cost centres "x-ray", "laboratory", and "wards" staff salaries were determined based on the specific staff utilisation for each activity. The total allocated overhead costs were 4,588,255 Kwacha. The allocation to intermediate and final cost centres was performed as described in the methods section.

(3) Drug costs

Except for thiacetazone-INH tablets, drugs to the programme are currently supplied free of charge by IUATLD. Purchases are made through the International Dispensary Association (IDA) in Amsterdam, except for ethambutol/isoniazid tablets, which are purchased directly from the manufacturer. The calculation of drug costs was based on information on the free-on-board (FOB) prices (excluding insurance and shipping) from the IDA price catalogue 12/94 and invoices for ethambutol/isoniazid provided by IUATLD. A flat 15% was added to account for shipping/handling charges. Since no specific costing of the drug distribution system was performed, we also added a flat 10% to the drug costs to account for these costs[18]. The wholesale prices for thiacetazone-INH tablets supplied by the government were obtained from the price list of the central medical stores. In the district of Blantyre, the following drug regimens are currently used:

Table 2: Currently used drug regimens in Blantyre district

Category 1 : (short course) $1S_3\ R_3\ H_3\ Z_3$ /1S R H Z /6TH/HE
Category 2 : (re-treatment) 2SRHZE /1RHZE / $5R_3\ H_3\ E_3$
Category 3 : (standard modified) $2R_3\ H_3\ Z_3$ / 2HE/TH / 4H

In order to facilitate the analysis of costs by programme level, we divided the costs of each regimen into costs for the intensive phase, delivered at the hospital level, and

costs for the continuation phase, delivered at the health centre level. Average cost per regimen in 1994 were $20.42 (category 1, TH), $39.48 (category 1, EH), $9.19 (category 3, TH), $13.33 (category 3, EH), $60.87 (category 2). A detailed list of drug costs, also providing information on the cost of standard chemotherapy, is provided in Appendix 6.

c) Cost calculation: specific activities

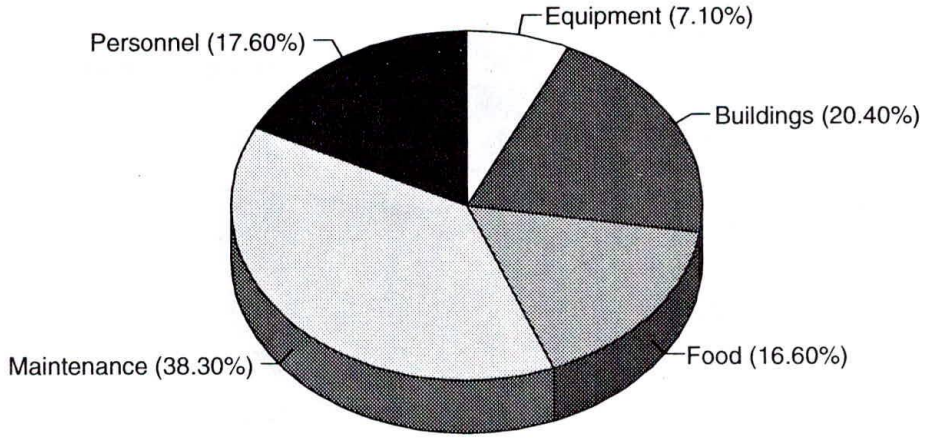
(1) Hospital bed-days

Queen Elizabeth Hospital has one female and one male ward specifically assigned to the care of tuberculosis patients. The female ward contains 18 beds, the male ward 50. However, bed occupancy rates averaged 200% in 1994. Except for food, no additional provisions are made for patients who exceed ward capacity: these patients bring their own bedding and usually accommodate themselves in the space under the regularly installed beds. In 1995, a new tuberculosis ward will be built at Machinga district hospital, containing 34 beds. To determine the capital costs of the TB wards at Queen Elizabeth Hospital, it was assumed that the present facilities are comparable to two wards of this size. Information on numbers of admissions and length of hospital stays was unavailable. The calculation of bed-days was therefore based on information on the number of beds and average occupancy rates provided by department clerks. Among all inpatient bed-days, the proportion for tuberculosis patients accounts for approximately 10%. This proportion was used for the allocation of running/maintenance costs and overhead salaries.

The specific care for tuberculosis patients is usually limited to the daily provision of drugs and emergency interventions. The daily cost of hospital food was determined as 3.31 Kwacha, based on averaged daily kitchen expenditure records for February 1995. In addition to the regular food, tuberculosis patients receive 200 ml of milk each day at a cost of 1.68 Kwacha.

Based on the cost calculation shown in Appendix 7, an average cost of $2.09 was calculated. The distribution of input cost categories is shown in Figure 2. Since the average fixed costs for bed-days are dependent on occupancy levels, costs would generally be higher under the assumption of "normal" occupancy rates.

Figure 2: Distribution of hospitalization costs



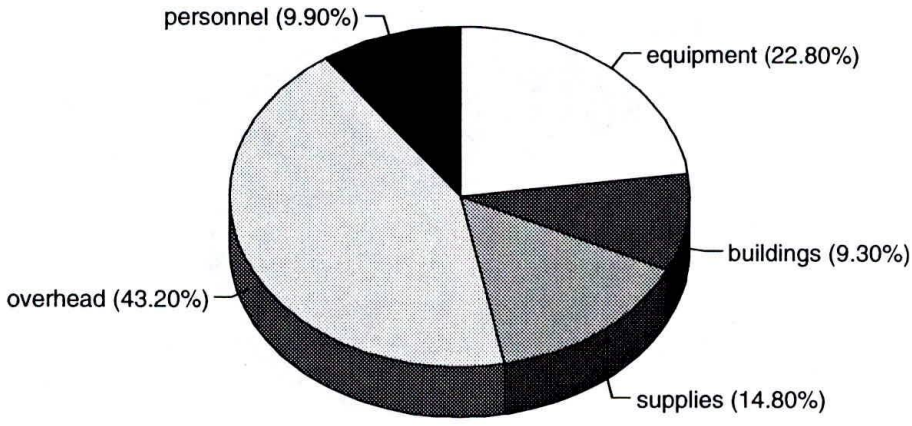
The incremental cost for tuberculosis-specific activities was determined as the cost for food and staff salaries only, at $ 0.72 per day. For the analysis of policy changes, only the effects of changing incremental costs were determined.

(2) Laboratory procedures

(a) Sputum smears

Smear examinations in Queen Elizabeth Hospital are currently performed using Auramin-Phenol staining and a fluorescent light microscope. It was assumed that this microscope was utilised exclusively for TB diagnostic procedures, whereas other necessary equipment is currently shared to perform other bacteriological investigations. To allocate building costs, it was assumed that laboratory facilities occupy 10% of the space of a district hospital, and TB specific diagnostic procedures account for 20% of the laboratory workload. Currently, there are three staff involved in preparing sputum examinations at Queen Elizabeth Hospital, however, no staff is allocated full-time for this purpose. Prices for supplies were derived from the catalogue of the central medical store. In the case where specific supplies were not listed, they were obtained from recent purchase orders by the College of Medicine in Blantyre. During 1995, a total of 24,555 slides were prepared at the laboratory at Queen Elizabeth Hospital, based on the laboratory register. Based on this information, a total cost of $ 12,059 and an average cost of $ 0.49 per slide were calculated (cost calculation in Appendix 8). Marginal costs were expressed as the average variable costs for supplies only, and were calculated at $0.07 per slide. The distribution of input costs is shown in Figure 3.

Figure 3: Distribution of costs for sputum microscopy



Based on discussions with the senior laboratory technician, it was determined that the number of slides produced in 1994 represents the capacity limit at the present input level. Limiting factors are building space and personnel. We therefore performed a scenario analysis under the assumption that a laboratory extension would be built exclusively for TB diagnostic purposes, and three staff would be employed full-time, using fluorescence microscopy. Under these assumptions, the chief laboratory technician estimated that the capacity for slide production could be doubled to an annual 50,000 slides. The cost calculation for this scenario is shown in Appendix 9. The total cost would rise to $ 13,633. The incremental cost per slide would thus be $ 0.13 (incremental cost: $ 3,358; additional slides: 25,000). The average cost per slide would fall to $ 0.31 under this scenario.

(b) Sputum cultures

In Malawi, sputum cultures are currently only prepared at the central tuberculosis reference laboratory located at the Community Health Sciences unit in Lilongwe on a routine basis. In 1994, a total of 1,169 sputum cultures were performed. The cost calculation based on the information provided at CHSU on staff requirement and consumed supplies is shown in Appendix 10. The total economic cost per culture was $ 6.20, marginal costs (expressed as average variable costs for supplies only) were $ 0.71 per culture. The large difference between the full and marginal costs reflects the high proportion of fixed costs in the calculation. This can be ascribed to the current low output at the central reference laboratory, which was due to the lack of adequately trained staff in 1994. It is expected that the output will be much greater in 1995, which will reduce the average cost per culture produced.

(c) HIV testing

Prices for all equipment currently used for HIV testing in Malawi were provided by the chief laboratory manager of the AIDS division of the Ministry of Health in

Lilongwe. at Queen Elizabeth Hospital, the current strategy for TB patients is to perform one ELISA test only. Confirmations of positive results are not performed in patients with clinical signs of AIDS. In patients without these signs, a second ELISA is performed as confirmation test. 20 volunteers were trained in Blantyre district to perform pre- and post test counselling services. The cost for one day of training was specified as 200 Kwacha by the regional Health Officer. The volunteers currently offer their services without monetary compensation. To assess the economic cost of their activities, it was assumed that their salary would be comparable to that of a health surveillance assistant (grade SC I), and each counselling would take one hour. The full cost calculation is shown in the appendix. In 1994, the laboratory at Queen Elizabeth Hospital performed a total of 14,000 HIV tests. Based on this figure, the full economic cost per test was $ 1.78, the marginal cost, as indicated by the average variable costs for the test kits and necessary laboratory supplies, was $ 0.88 per test. The detailed cost calculation is shown in the appendix.

(3) X-Ray

Building costs were allocated based on the assumption that x-ray facilities comprise 10% of the space of district hospitals, of which 50% are devoted for screening purposes for tuberculosis patients. Current prices for a standard x-ray machine and standard darkroom equipment were derived from the tender for a new district hospital in Machinga, supplied to the Ministry of Health in November 1994. Currently, one x-ray machine and three staff are exclusively used to perform chest x-rays for screening purposes. Prices for supplies were derived from the catalogue of the general medical stores. During 1994, 12,000 chest x-rays were performed for TB diagnostic purposes at Queen Elizabeth Hospital. Based on this information, the full economic cost per film was $ 2.82. Average variable costs for material only were $ 0.96 per film. See cost calculation in Appendix 12.

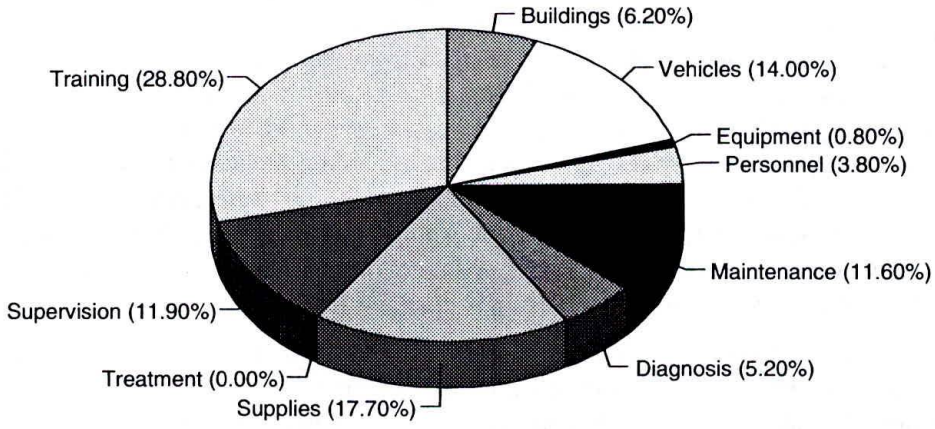
Miniature radiography has been suggested as a means to reduce the cost of radiographic diagnosis. A miniature radiography camera has been installed in 1991 at Queen Elizabeth Hospital, but has not been used yet because of uncertainty about the cost implications. We therefore assessed the cost per film under use of this technology in addition to the cost of conventional x-ray technology. It is important to notice that under the current caseload, the full capacity of each film roll for miniature radiography cannot be exploited. Instead, smaller pieces of film would be separated from the main roll every day and developed. Under these conditions, experiences in other countries have shown that about 350 exposures can be made per roll of 100*100 mm film (45 m)[19]. The cost calculation for the use of miniature radiography is given in Appendix 13. Although the marginal cost per film decreases substantially to $0.35[20], the average cost per film is slightly higher than the cost under the conventional technique ($ 3.13). This result is due to the higher capital cost of the miniature radiography equipment.

(d) Costs at various programme levels

(1) Costs at central level

The Programme Management office is located at the Community Health Sciences unit in Lilongwe. In addition to the running costs of this office, costs for the countrywide training and supervision activities as well as for the supply of stationery and sputum containers to the programme facilities were also allocated to the central level. Funding for these items is provided by IUATLD, and the Programme Manager keeps separate expenditure records for these activities. A detailed cost calculation for the costs at central level is provided in Appendix 14. Total costs at central level were $ 138,016 in 1994. The total number of tuberculosis cases reported to the NTP in 1994 was 19,600, therefore the average cost per patient treated was $ 7.04. Figure 4 shows the proportionate distribution of central level costs for each cost category.

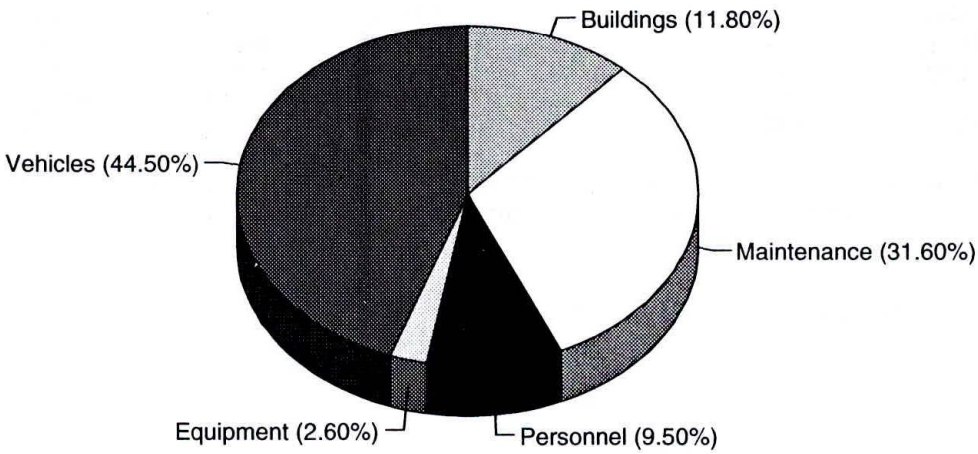
Figure 4: Cost distribution at central level



(2) Costs at regional level

The Regional Tuberculosis Officer is based at the Regional Health Office in Blantyre. He is responsible for supervisory and planning activities for the southern region. Total expenditures at this level in 1994 were $ 43,389 (detailed calculation shown in Appendix 17). The cost per patient treated was $ 3.84, based on a total number of patients in the southern region of 11,293 in 1994. The diagram below shows the share of the total costs incurred for each cost category. The largest cost item is transportation, due to the fact that the regional tuberculosis officer has a car at his sole disposition.

Figure 5: Cost distribution at regional level



(3) Costs at district level

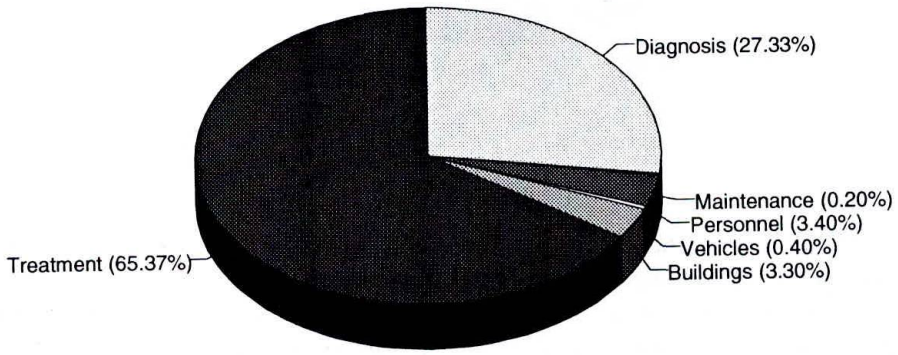
Queen Elizabeth Hospital is the site of diagnostic facilities for TB patients in Blantyre district, as well as for hospital treatment during the intensive phase of therapy. A "chronic cough room" is part of the outpatient department. This facility, which is staffed by two health assistants, is used for the screening of patients with chronic cough symptoms, who are referred for x-ray and sputum diagnosis if indicated. Construction costs for this separate building were available. Blantyre district has two district tuberculosis officers, one responsible for the urban area, located at Queen Elizabeth Hospital, the other responsible for the rural areas, located at the district health office. Since no construction costs for a district health office could be obtained, the cost for a regional health office was used, which probably represents an overestimation of building costs. The cost calculation in
Appendix 16 includes the previously calculated average costs for hospital bed-days. Overhead costs were therefore only determined for the district tuberculosis offices. A new drug regimen for smear-negative patients has been introduced in Blantyre district as described above. Treatment under this new regimen is fully ambulatory. New smear-positive patients under short course chemotherapy spend an average of 60 days for hospital treatment, patients under the re-treatment regimen spend an average of 90 days on the wards. For the cost calculation shown in the appendix, only the drug costs for the intensive phase of therapy were included, while drug costs for the continuation phase were attributed to the health centre level. A total cost of $ 157,742 was determined for all activities in Blantyre district. Table 3 shows the cost per patient for each category.

Table 3: Cost per patient at district level

	no.	Kwacha	Kwacha 95	Dollar
Cat.1 (TH)	203	1,861.63	2,163.88	150.69
Cat. 1 (EH)	474	1,861.63	2,163.88	150.69
Cat. 3 (TH)	543	341.06	341.06	23.75
Cat. 3 (EH)	1268	341.06	341.06	23.75
Cat. 2	59	2,640.97	3,094.34	215.48
AVERAGE:	2547	889.35	889.35	61.93

The distribution of cost categories at the district level is shown in the diagram below. The predominant cost categories are treatment and diagnosis, which will be analysed in more detail below.

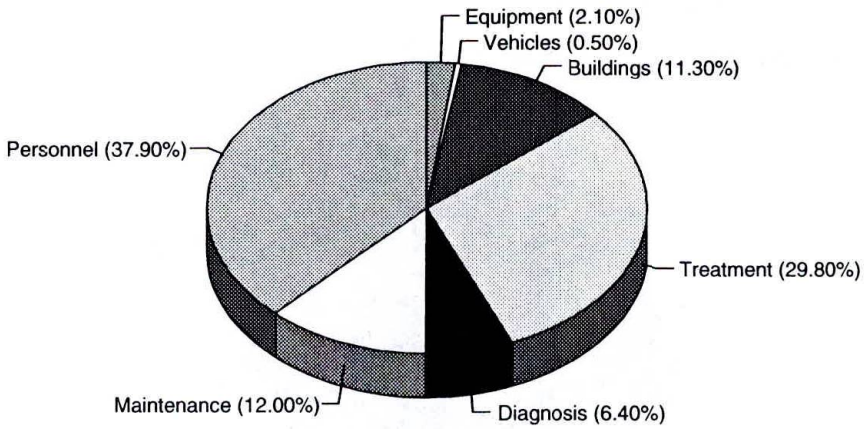
Figure 6: Cost distribution at district level



(4) Costs at health center level

Patients under the new smear-negative regimen are mainly referred to two specific health centres, whose staff level has been increased to ensure the adequate monitoring of therapy and follow up on defaulters. The cost calculation shown in Appendix 15 reflects the higher staffing level required for the intensified level of ambulatory care. In 1994, Blantyre district reported an HIV prevalence of 70% in new smear-positive cases, who received an ethambutol-containing regimen (EH) in the continuation phase. A similar distribution was assumed for smear-negative cases. These distributions are reflected in the case numbers for each treatment category. Based on these figures, the average costs per patient at the health centre level were $34.45 for smear-positive cases (TH), $53.51 for smear-positive cases (EH), $42.82 for smear-negative cases (TH), $46.96 for smear-negative patients (EH), $46.05 for re-treatment patients. The average costs for all patients treated at the district level was $53.71. The diagram below shows the cost distribution for a health centre staffed for the new smear-negative regimen, which reflects the high level of personnel costs required.

Figure 7: Cost distribution at health center level



e) Average costs per patient

Average costs per patient treated in each category were calculated by summing the costs incurred at each level of the programme structure. Results are displayed in the table below.

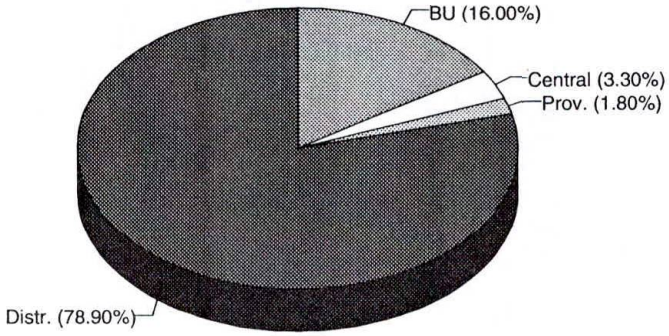
Table 4: Average total costs per patient

			Kwacha	Kwacha 1995	Dollar
Cost per patient:	Cat.1 (TH)	BU	494.74	494.74	$34.45
		Distr.	2,131.88	2,434.13	$169.51
		Prov.	50.19	55.17	$3.84
		Central	80.89	101.12	$7.04
		TOTAL	**2,757.70**	**3,085.16**	**$214.84**
	Cat.1 (EH)	BU	768.44	768.44	$53.51
		Distr.	2,131.88	2,434.13	$169.51
		Prov.	50.19	55.17	$3.84
		Central	80.89	101.12	$7.04
		TOTAL	**3,031.40**	**3,358.86**	**$233.90**
	Cat.3 (TH)	BU	614.84	614.84	$42.82
		Distr.	349.52	349.52	$24.34
		Prov.	50.19	55.17	$3.84
		Central	80.89	101.12	$7.04
		TOTAL	**1,095.44**	**1,120.65**	**$78.04**
	Cat.3 (EH)	BU	674.35	674.35	$46.96
		Distr.	349.52	349.52	$24.34
		Prov.	50.19	55.17	$3.84
		Central	80.89	101.12	$7.04
		TOTAL	**1,154.95**	**1,180.16**	**$82.18**
	Cat.2	BU	661.22	661.22	$46.05
		Distr.	3,296.67	3,750.04	$261.14
		Prov.	50.19	55.17	$3.84
		Central	80.89	101.12	$7.04
		TOTAL	**4,088.97**	**4,567.55**	**$318.07**
	AVERAGE:	BU	685.57	685.57	$47.74
		Distr.	982.39	982.39	$68.41
		Prov.	50.19	55.17	$3.84
		Central	80.89	101.12	$7.04
		TOTAL	**1,799.04**	**1,824.25**	**$127.04**

The large difference in the costs of treating smear-negative and smear-positive patients is noteworthy. To explain this difference, we analysed the cost distribution for

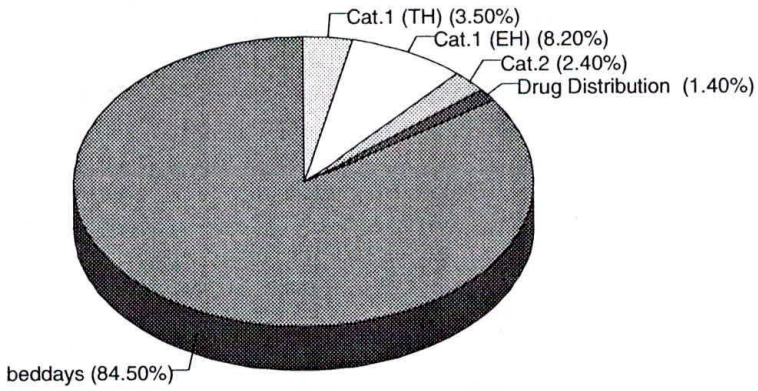
the treatment of a smear-positive case in detail. The diagram below shows the distribution of the total costs of treating a smear-positive patient with an ethambutol containing regimen by programme level.

Figure 8: Cost per patient by programme level



The largest share of costs occurs at the district level. We have shown above that the most important cost items at the district level are costs for treatment and diagnosis. These categories were therefore analysed in further details. The graph below shows the distribution of treatment costs at the district levels.

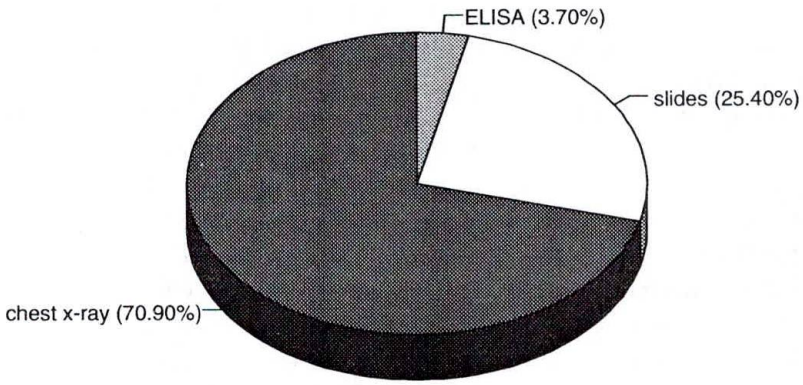
Figure 9: Distribution of treatment costs



It is evident that the costs for hospitalisation of patients outweigh the costs incurred for the various drug regimens. An analysis of the cost distribution for hospitalisation at the district level is shown in Figure 2.

For the situation at Queen Elizabeth Hospital, large proportions of the total costs are incurred for overhead and maintenance expenditures. Since Queen Elizabeth Hospital serves as a tertiary care hospital, it can be assumed that these costs would be lower for regular district hospitals. For an analysis of cost savings to be achieved through ambulatory therapy, we therefore accounted only for the costs incurred for personnel and food, which should be similar in different settings.
The share of total costs of diagnosis incurred for the various diagnostic methods are shown below. Evidently, the greatest cost savings could be achieved by limiting the number of x-rays performed.

Figure 11: Distribution of costs for diagnosis



C. Costs of programme modifications

1. Cost savings through ambulatory therapy

The primary purpose for the introduction of the new drug regimen for smear-negative cases in Blantyre district was to reduce the workload for hospital staff to be able to cope with the increasing number of patients. During the course of the study, we addressed the question whether this new policy had any implications for the total health care expenditures devoted to the care of tuberculosis patients. We compared the costs of treating patients under the new policy, i.e. fully ambulatory treatment using a revised drug regimen, with the costs of treating patients with a standard drug regimen and hospitalisation during the first month of treatment. In order not to overestimate the economic burden through hospital treatment, we evaluated only the impact of incremental costs directly related to the care of tuberculosis patients (i.e., personnel costs and food) for this analysis. As mentioned before, currently only two health centres in Blantyre districts have received additional staffing for monitoring and follow- up activities. We assumed that for a district-wide implementation of the new policy, an additional two staff members at the STA salary level would be necessary at the ten health centres currently implementing tuberculosis control activities (total 20 at 14,000 Kwacha). Training requirements are assumed to be 2 weeks per year (per diem 200 Kwacha). We also assumed that bicycles would be necessary as transport medium for follow-up visits (total 20 at 300 Kwacha annual cost). Table 5 shows that with the currently implemented strategy the costs of health care for tuberculosis patients could be reduced by a total of $ 37,775 in Blantyre district, even if one accounts for the additional personnel and transport requirements[21].

Table 5: cost savings through ambulatory therapy for smear-negative patients

"Standard" Strategy		
	T	E
No. of patients	543	1268
Drug costs	$3,500.41	$41,095.88
Hospital costs	$11,661.39	$27,231.38
Total	$15,161.80	$68,327.26
	Grand Total:	$83,489

New Strategy		
	T	E
No. of patients	543	1268
Drug costs	$4,990.20	$16,907.32
Hospital costs	$0.00	$0.00
Total	$4,990.20	$16,907.32
Additional Personnel		$19,498.61
Training		$3,899.72
Bicycles		$417.83
	Grand Total:	$45,714

Difference: $37,775.38

We also analysed the potential savings through a restructuring of care for smear-positive cases to be delivered on a fully ambulatory basis. Assuming an average length of stay of 60 days per smear-positive case, the hospitalisation of the 677 patients treated in 1994 resulted in incremental costs of $ 29,246. Even if one assumes that 30% of these patients required hospitalisation because of severe illness, a

policy change to ambulatory therapy would result in a saving of $ 20,470. This amount would be sufficient to employ an additional 20 staff (STA grade) at the health centre level for patient monitoring and follow-up purposes. These staff could be employed to increase the number of health centres offering ambulatory therapy for tuberculosis in the district.

2. Cost savings through HIV testing before thiacetazone replacement

With the advent of the HIV epidemic, serious and sometimes fatal side-effects have been observed during treatment with thiacetazone in HIV-positive patients. Two strategies have been proposed to avoid adverse drug reactions. First, thiacetazone could be completely replaced by ethambutol for all tuberculosis patients treated, regardless of their HIV status. Second, thiacetazone replacement could be based on the result of an HIV test. In Blantyre district, the second policy has been adopted. As shown in the section on laboratory procedures, the full economic cost of performing HIV testing in Blantyre district is $ 1,78 per test. In Table 6, the cost of testing the total number of patients treated in 1994 and replacing thiacetazone for ethambutol in the 70% of patients who were reported to be HIV- positive in 1994 is compared with a complete thiacetazone replacement strategy. It can be seen that the strategy of HIV-testing all patients has led to a cost saving of $ 1,694 in the year 1994. Above an HIV-prevalence of 78 %, the costs of full thiacetazone replacement would be less than the costs under the current strategy.

Table 6: Comparison of thiacetazone replacement policies

Full TH replacement

	Sm+	Sm-	
no. of patients		677	1811
additional drug costs		$ 12,903.74	$7,504.40
TOTAL:			$20,408.13

HIV Testing

HIV-Prevalence: 0.70

	Sm+	Sm-	
no. of patients		677	1811
HIV test		$ 1,205.06	$3,223.58
HIV-pos. patients		474	1268
add. drug costs		$9,032.62	$5,253.08
TOTAL:			$18,714.33
Difference:			$1,693.80

The analysis changes when only the marginal costs of HIV-testing (approximated by the average variable costs for supplies only) are considered. This may be appropriate for the situation in Blantyre district, where the equipment is already in place,

and counsellors deliver their services free of charge. Under this assumption, HIV-testing is preferable to a policy of complete thiacetazone replacement up to an HIV prevalence of 89 %.

D. Conclusions

In the current structure of the Malawian National Tuberculosis Control Programme, the highest costs occur at the district level. At this level, the costs incurred for diagnosis and treatment are the most important cost categories. Within the "treatment" category, the largest share of expenditures occurs for the hospitalisation of patients. Through the introduction of a new drug regimen for smear-negative patients which is delivered on a fully ambulatory basis, substantial savings in the delivery of health care to tuberculosis patients could be achieved in Blantyre district. This result remains stable, even when accounting for the increased staff level necessary for the supervision of ambulatory therapy at health centres. Additional savings would be possible by delivering care for smear-positive patients during the intensive phase of therapy on an ambulatory basis.

Within the diagnosis cost category, the largest share of expenditures occurs for the preparation of chest x-rays. A change from the current conventional x-ray technique to miniature radiography will lead to cost savings with regard to marginal costs for films and supplies. However, average economic costs are actually higher, due to the higher capital costs of miniature radiography equipment.

The current strategy of HIV testing tuberculosis patients to decide on a replacement of thiacetazone in the continuation phase has led to small cost savings, if compared to a policy of complete thiacetazone replacement. However, complete thiacetazone replacement becomes the more cost-saving option should the HIV prevalence among tuberculosis patients continue to rise.

E. Discussion

1. Comparison to previous studies

The results of the cost analysis performed in this study can be compared to the results of a previous analysis of the costs of the NTP in Malawi performed in 1990[22]. Average unit costs for short-course chemotherapy with hospital treatment are higher in the present study. De Jonghe et al. reported a figure of $160.53. This compares to a cost of $ 215 ($ 254 for costs deflated to 1989, using the 1989 exchange rate) for a patient under a thiacetazone containing regimen in the present study. Programme management costs were higher in the study by De Jonghe et al. than in the present study ($30.82 and $10.88 per case treated, respectively). The main reason for this can be seen in the steep rise of case numbers since 1990, which was not accompanied by substantial expenditure increases at the programme management level. The higher cost per case in the present study, despite a decrease in programme management cost, can be attributed to differences in the reported costs for hospitalisation

and ambulatory care. De Jonghe et al. reported an average cost per hospital day of $ 0.99 and $1.41 for two district hospitals, which compares to a cost of $ 2.09 in the present study. Deflating all prices to 1989 levels and using the dollar exchange rate for 1989 results in an even higher average cost of $ 2.61 per patient day. It is not clear whether capital costs were included in the study by De Jonghe at al., which accounted for 15% of all costs in the present study. Also, the costs comparable to "overhead and administration", which were less than 30% in the previous study, account for nearly 50% in the analysis presented here. This is most likely due to the different types of hospitals under investigation (district hospital and tertiary level institution).

Mills[23] reported a cost between $1.11 and $4.05 (costs in Kwacha converted to US Dollars at the 1988 exchange rate) per patient day in her study of seven district hospitals in Malawi. These figures were excluding capital costs, which they report as nearly 50% of total hospital costs (although no allocation to the tuberculosis wards was performed). However, the costs of drugs and "medical supplies" during hospital treatment were included and accounted for 25 to 37% of all recurrent costs. Excluding these costs, the recurrent costs amount to $ 0.80 to $ 2.60. The figure of $ 2.60 was reported for Chiradzulu district hospital, which at the time reported a bed occupancy rate of 64% in the TB ward. This compares to an average bed occupancy rate of 200% at Queen Elizabeth Hospital. It can therefore be assumed that the reason for the remaining cost difference lies in returns to scale due to the very high annual number of patients treated at Queen Elizabeth Hospital.

For the cost of ambulatory care, which we assume to be comparable to the cost at the health centre level (excluding drug costs) in the present study, the figure of $1.89 reported by De Jonghe et al. compares with a figure of $ 33.60 in the present studies. The reasons for this substantial difference remain unclear, since the study by De Jonghe et al. provides no detailed information on the cost categories included in their calculation of average unit costs for the delivery of ambulatory care.

The study by De Jonghe et al. reported an average cost per sputum slide of $0.43, similar to the cost in the present study. However, in the previous study, labour costs were reported as $0.25 per slide, compared to a cost of $0.05 per slide in the study presented here. The main reason for the difference in cost must be seen in different assumptions about laboratory productivity. De Jonghe et al. assumed an average productivity of 20 slides per day for laboratory assistants using the Ziehl-Neelsen staining method. With three staff employed only part-time for the purpose, the laboratory at Queen Elizabeth Hospital achieves a productivity of more than 90 slides per day, assuming 260 work days per year. This high productivity can be ascribed to the use of the fluorescent microscope technique, which leads to much faster slide evaluation. The results in this study thus confirms previous arguments for the use of fluorescence microscopy in laboratories with high workloads[24,25]. The average cost per slide could be decreased further by employing more staff to use the microscope at the capacity limit. For the conditions in an average district hospital using conventional Ziehl-Neelsen staining methods, this high workload cannot be assumed, and the use of conventional microscopy is still justified because of its lower capital costs.

In general, drug costs were higher in the study based on 1989 cost data. For in-

stance, the cost for short-course chemotherapy was reported as $31.93 which compares to a cost of $20.42 in the present study. However, it must be noted that the price reported refers to a thiacetazone containing regimen. For the ethambutol containing regimen, the current cost is actually higher than the 1989 cost at $ 39.48 per case.

In conclusion, the present study confirms the overall low cost of care for tuberculosis patients described in previous studies, although some differences for specific cost categories exist.

2. Should thiacetazone be replaced?

The role of thiacetazone as a component of multidrug-therapy of tuberculosis has been the subject of an extensive debate in the recent literature[26,27,28,29]. Although the potential toxicity of this drug was known even in the pre-HIV era, it has been widely used in tuberculosis control because of its very low cost. With the advent of the HIV epidemic, multiple reports have shown an increased incidence of severe and sometimes fatal side-effects in HIV positive patients. The mortality directly attributable to side-effects of thiacetazone has been estimated at 3%[30,31] in HIV-positive patients. WHO has therefore recommended to abandon the use of thiacetazone for the treatment of patients at a high risk of HIV infection[32]. However, it was also recognised that financial constraints might prohibit the complete discontinuation of therapy with thiacetazone in resource-poor countries. As one alternative Nunn et al. recommended the screening of TB patients with HIV tests before using a thiacetazone-free regimen. This was the strategy adopted in Blantyre district at the time of this study. Our analysis shows that some cost savings have actually been achieved by this strategy. However, a future increase of HIV-seropositivity would make the strategy of full thiacetazone replacement the more cost saving option. To evaluate this result, it should be noticed that the calculations were based on the cost of one ELISA test performed for diagnosis, which was the recommendation for patients with clinical signs of an HIV infection at Queen Elizabeth Hospital. Regardless of the presence of clinical signs, WHO recommends to perform a confirmatory test, if the tests are performed for individual diagnosis[33]. Under the simplifying assumption that the average cost per ELISA-test would be the same under increased output levels, the implementation of a policy of two tests per diagnosis would make a thiacetazone replacement strategy cost-saving at an HIV prevalence of 56%. The costs of replacing thiacetazone can be related to the effects of this policy to calculate a cost-effectiveness measure. Under the assumption that fatal side-effects occur in 3% of HIV-positive patients treated with thiacetazone, 52 deaths have been averted in Blantyre district during 1994 by avoiding this drug[34]. The incremental cost for the complete replacement of thiacetazone by ethambutol in all patients would have been $ 20,408. It should be noticed that the overall incremental costs to the programme are likely to be lower, since we do not account for the costs of hospital stays due to drug reactions, which would be minimised under this scenario[18]. Only accounting for additional drug costs, the cost per death averted by this strategy is $ 392, or, using an effectiveness measure used by the World Bank[35], a cost of $ 42 per DALY

saved[36]. This calculation ranks thiacetazone replacement among the most cost-effective health care interventions available[25]. Its implementation should therefore have a high priority in relation to other health interventions, i.e., reducing funding for more expensive interventions and using the freed funds for thiacetazone replacement will result in a higher gain of deaths averted or years of life saved. We concede that idiosyncrasies of programme organisation may make it practically difficult to adopt the viewpoint of cost-effectiveness analysis. In Malawi for instance, most drugs are donated by external donors. Recommending that thiacetazone replacement should take precedence over other health interventions is unlikely to affect their drug bill, which will always be higher under a replacement strategy. If the additional funds required exceed those available to the donors, negotiations with national authorities will be necessary regarding the redistribution of cost savings (e.g., through limiting hospitalisations and abandoning HIV screening) for drug purchases.

3. Should patients be screened with radiography?

Under the current level of inputs the sputum microscopy services at Queen Elizabeth Hospital have reached their productivity limit. With patient numbers still expected to rise, a decision has to be made on the most appropriate methods for screening and diagnosis. In general, WHO recommends the use of sputum microscopy as the standard diagnostic method[37]. We have shown that the laboratory output at Queen Elizabeth Hospital could be doubled at very low incremental costs and decreasing average costs. Under the policy for laboratory expansion, the average costs for the recommended strategy of three slides per patient ($ 0.93) are well below the average costs of performing conventional chest x-rays, although the difference to the marginal cost for x-ray supplies only ($ 0.96) is minimal. The question about the "correct" cost category (marginal or average) to use for policy analysis is not easy to answer. X-Ray machines usually have a very long useful life, probably more than the twenty years assumed in this analysis. Thus, in places like Queen Elizabeth Hospital, where the equipment is already in place, it appears acceptable to analyse the marginal cost only. Under this condition, cost savings through microscopy instead of x-ray screening do not appear very pronounced. Further, x-ray costs can be reduced substantially by the use of miniature radiography. The marginal costs of supplies for miniature radiography ($0.35) are comparable to the incremental costs of smears after increasing laboratory outputs ($0.31).

The decision about the use of sputum smears or x-rays for screening should be based on considerations that go beyond an analysis of costs only. First, it must be realised that the screening of large numbers of sputum smears negative for AFB is likely to reduce the quality of services, with implications for both the sensitivity and specificity of this test. Second, in the absence of radiography, the diagnosis of smear-negative patients is based on clinical signs only, which may lead to an over-diagnosis of this category of patients, with cost implications due to unnecessary treatment. In conclusion, it appears reasonable to recommend the use of x-ray for screening purposes in Queen Elizabeth Hospital. Cost savings could be achieved by the use of miniature radiography. For different locations, recommendations must be based on a

careful analysis of the current situation. If no x-ray facilities exist and equipment has to be purchased from the Ministry of Health budget, the use of x-rays should be discouraged, as the average costs of this technique are substantially higher than the cost of microscopy. If local authorities have to bear only the costs of supplies[38], e.g., because equipment is donated, the use of x-rays for patient screening appears justified in locations with very high caseloads. In these circumstances, the use of miniature radiography is preferable to conventional x-ray technique.

4. Reducing costs and ensuring quality of care

The results of this study show that substantial savings can be achieved in the delivery of health care to tuberculosis patients by delivering care on a completely ambulatory basis. This result is in accordance with previous observations,[39,18], although we are now able to substantiate this argument with a detailed analysis of the costs of ambulatory care at the health centre level. However, the main reason for avoiding hospital therapy is currently the severe state of overcrowding in tuberculosis wards. At Queen Elizabeth Hospital, bed occupancy rates presently average 200%, and case numbers are projected to increase during the coming years. Working conditions for staff as well as the state of physical surroundings for patients may be no longer acceptable. Should a decision to reorganise the care for smear-positive patients be made, prime importance must be given to ensure compliance rates similar to those under hospital care in the ambulatory setting. This will require the increase of staff level at health centres. It appears to be mandatory that any cost savings through decreased hospital costs should be used for this purpose. In fact, it does not appear to be necessary to attempt a further decrease in tuberculosis treatment costs. The present data confirms the overall low cost of care for tuberculosis patients in a developing country setting. The status of tuberculosis care as one of the most cost-effective health interventions therefore singularly depends on high cure rates achieved, and every effort must be made to sustain these in an ambulatory setting.

IV. Appendix: Data tables

Appendix 1: Population size: Malawi

POPULATION SIZE		1977	1987	1994 (estimated)
Northern Region	Chitipa	72,316	96,794	125,410
	Karonga	106,923	148,014	191,772
	Nkhata Bay	105,803	138,381	179,291
	Rumphi	62,450	94,902	122,958
	Mzimba	301,361	433,696	561,911
	TOTAL	**648,853**	**911,787**	**1,181,342**
Central Region	Kasungu	194,436	323,453	419,077
	Nkhotakota	94,370	158,044	204,767
	Ntchisi	87,437	120,860	156,590
	Dowa	247,603	322,432	417,754
	Salima	132,276	189,173	245,099
	Lilongwe	704,117	976,627	1,265,351
	Mchinji	158,833	249,843	323,705
	Dedza	298,190	411,787	533,525
	Ntcheu	226,454	358,767	464,831
	TOTAL	**2,143,716**	**3,110,986**	**4,030,699**
Southern Region	Mangochi	302,341	496,578	643,383
	Machinga	341,836	515,265	667,595
	Zomba	352,334	441,615	572,171
	Chiradzulu	176,184	210,912	273,265
	Blantyre	408,062	589,525	763,809
	Mwanza	71,405	121,513	157,436
	Thyolo	322,000	431,157	558,622
	Mulanje	477,546	638,062	826,695
	Chikwawa	194,425	316,733	410,370
	Nsanje	108,758	204,374	264,794
	TOTAL	**2,754,891**	**3,965,734**	**5,138,139**

Appendix 2: Tuberculosis incidence: Malawi

	population size 1994(estimated)	case numbers 1994	rate per 100,000
Northern Region			
Chitipa	125,410	113	90
Karonga	191,772	236	123
Nkhata Bay	179,291	613	342
Rumphi	122,958	308	250
Mzimba	561,911	951	169
TOTAL	**1,181,342**	**2221**	**188**
Central Region			
Kasungu	419,077	355	85
Nkhotakota	204,767	247	121
Ntchisi	156,590	138	88
Dowa	417,754	765	183
Salima	245,099	465	190
Lilongwe	1,265,351	2892	229
Mchinji	323,705	383	118
Dedza	533,525	323	61
Ntcheu	464,831	414	89
TOTAL	**4,030,699**	**5982**	**148**
Southern Region			
Mangochi	643,383	682	106
Machinga	667,595	659	99
Zomba	572,171	2142	374
Chiradzulu	273,265	893	327
Blantyre	763,809	3361	440
Mwanza	157,436	293	186
Thyolo	558,622	791	142
Mulanje	826,695	1070	129
Chikwawa	410,370	637	155
Nsanje	264,794	765	289
TOTAL	**5,138,139**	**11293**	**220**
Malawi TOTAL	**10,350,180**	**19496**	**188**

Appendix 3: List of currently utilized inputs

Health Centers:

I. common inputs:

1. building
2. standard equipment
3. maintenance

II. specific inputs:

A. history and physical examination:
1. personnel: medical assistant, nurse

B. chronic cough register:
1. personnel: health assistant
2. stationery: register book

C. sputum collection and transport to district hospital:
1. personnel: medical assistant
2. equipment: sputum container
3. stationery: container labels, laboratory request forms
4. transport to DH: public transport

D. drug distribution in continuation phase:
1. personnel: medical assistant
2. drugs: continuation phase for each regimen

E. follow-up on defaulters:
1. personnel: health assistant
2. equipment: bicycle
3. travel costs: per diem, allowance (only if overnight stay)

F. health education:
1. personnel: medical assistant
2. equipment: none (talk)

District level:

I. common inputs:

1. buildings: district health office, district hospital
2. standard equipment
3. maintenance

II. specific inputs:

A. history and physical examination:
1. personnel: medical officer, medical assistant, nurse

B. chronic cough register:
1. personnel: health assistant
2. stationery: register book

C. sputum collection:
   1. personnel: medical assistant
   2. equipment: sputum container
   3. stationery: container labels, laboratory request forms

D. drug distribution in continuation phase:
   1. personnel: medical assistant
   2. drugs: continuation phase for each regimen

E. health education:
   1. personnel: medical assistant
   2. equipment: none (talk)

F. sputum microscopy and laboratory register:
   1. personnel: laboratory chief, lab. technician, lab. assistant, lab attendant
   2. equipment: standard lab. equipment, microscope, safety cabinet, autoclave
   3. supplies: loops, slides, slide containers, slide racks, sterilizing bags, slide marker, staining solution (Ziehl-Neelsen, Auramin-Phenol for fluorescence)
   4. stationery: laboratory register

G. x-ray:
   1. building: darkroom
   2. personnel: x-ray technician, darkroom attendant
   3. equipment: x-ray machine, automatic processor, standard x-ray equipment
   4. supplies: films, developer, fixer, film envelopes

H. patient register:
   1. personnel: district tuberculosis officer (DTO)
   2. stationery: register book
   3. transport: motorcycle, fuel, maintenance

I. hospitalized intensive phase:
   1. building: TB ward
   2. equipment: standard ward equipment
   3. personnel: medical officer, nurse
   4. drugs: intensive phase drugs for standard regimens
   5. supplies: food
   6. patient transport: travel warrant (go/return)

J. supervision on health clinics:
   1. personnel: DTO
   2. transport: motorcycle, fuel, maintenance
   3. travel costs: per diem, allowance

K. staff training:
   1. personnel: DTO
   2. equipment: overhead-, slide projector
   3. supplies: education material
   4. stationery: notebooks

5. travel costs: travel warrants, per diem, allowance

L. preparation of quarterly reports:
1. personnel: DTO
2. stationery: quarterly report forms
3. transport: mail

Regional level:

I. common inputs:
1. buildings: district health office, district hospital
2. equipment: computer, printer
3. maintenance

II. specific inputs:

A. planning of regional activities:
1. personnel: regional tuberculosis officer (RTO), medical assistant

B. supervision of districts
1. personnel: RTO
2. transport: car, fuel, maintenance
3. travel costs: per diem, allowance

C. staff training:
1. personnel: RTO
2. equipment: overhead-, slide projector
3. supplies: education material
4. stationery: notebooks
5. travel costs: travel warrants, per diem, allowance

D. preparation of reports to central level:
1. personnel: RTO
2. stationery: quarterly report forms
3. transport: mail

Central level:

I. common inputs:
1. buildings: community health sciences unit
2. equipment: computer, printer
3. maintenance

II. specific inputs:

A. planning of country-wide activities:
1. personnel: programme manager (PM), assistant manager, TB registry clerk, secretary

B. supervision of regions and districts
1. personnel: PM
2. transport: car, fuel, maintenance
3. travel costs: per diem, allowance

C. staff training:
1. personnel: PM
2. equipment: overhead-, slide projector
3. supplies: education material
4. stationery: notebooks
5. travel costs: travel warrants, per diem, allowance

D. preparation of reports to ministry:
1. personnel: PM

E. central laboratory:
1. building: central laboratory
2. personnel: laboratory chief, lab. technician, lab. assistant, lab attendant
3. equipment: standard lab. equipment, microscope, safety cabinet, incubator, autoclave
4. supplies: loops, slides, slide containers, slide racks, sterilizing bags, slide marker, staining solution (Ziehl-Neelsen, Auramin-Phenol for fluorescence), glass dishes, glass bottles, culture medium
5. stationery: laboratory register

Appendix 4: annual staff salaries

Personnel

	Annual cost (Kwacha)
sister (STO)	**20,000.00**
nurse (STA)	**14,000.00**
nurse (TA)	**11,500.00**
attendant (SCI)	**10,000.00**
clerk (TA)	**11,500.00**
domestic (SC III)	**7,500.00**
non-grade	**4,500.00**
physician	**60,000.00**
lab.chief (PO)	**23,200.00**
lab techn. (STO)	**20,000.00**
radiogr. (TO)	17,400.00
tech. (TA)	11,500.00
assistant (SCI)	7,500.00
lab.chief	23,200.00
techn. (TA)	11,500.00
PM (P8)	31,500.00
assistant (STO)	20,000.00
registry clerk (TA)	11,500.00
secretary (TO)	17,500.00
driver (SCI)	10,000.00
RTO (STO)	20,000.00
assistant (TO)	17,500.00
clerk (TA)	11,500.00
driver (SCI)	10,000.00

Additional monthly bonus payment (included in above figures):

grade:

P5 - P8:	600.-
CTO/PO:	400.-
STO/TO:	300.-
STA/TA:	200.-
SCI - SC IV:	150.-
Unclassified:	100.-

Appendix 5: Allocation of overhead costs at Queen Elizabeth Hospital

		Administration		x-ray		lab		wards	
		allocation	costs	allocation	costs	allocation	costs	allocation	costs
PERSONAL EMOLUMENTS									
001 Salaries	7311000								
002 Non-Established Staff	500000								
007 Temporary Employment	0								
017 Students Allowance	0								
031 Housing Allowance	99392								
TOTAL PERSONAL EMOLUMENTS	7910392	0.1	791039.2	0	0	0	0	0	0
GOODS AND SERVICES									
105 Cleaning Materials	190000	0.1	19000	0.05	9500	0.05	9500	0.8	152000
106 Computer Costs	3645	1	3645	0	0	0	0	0	0
107 Consumable stores	160000	0.1	16000	0.05	8000	0.05	8000	0.8	128000
115 Food Provision	1231843	excluded	0	0	0	0	0	0	0
116 Fuel and Lubricants	1026496	1	1026496	0	0	0	0	0	0
117 Heating and Lighting	474135	0.1	47413.5	0.05	23706.75	0.05	23706.75	0.8	379308
118 Hiring Costs	29919	1	29919	0	0	0	0	0	0
119 Hospitality Expenses	7500	1	7500	0	0	0	0	0	0
121 Hotel Charges	18328	1	18328	0	0	0	0	0	0
123 Internal Training	4147	0.1	414.7	0.05	207.35	0.05	207.35	0.8	3317.6
124 L/Grant Transf. & Distur. A	99996	0.1	9999.6	0.05	4999.8	0.05	4999.8	0.8	79996.8
128 Maintenance of Buildings	226243	0.1	22624.3	0.05	11312.15	0.05	11312.15	0.8	180994.4
130 Maintenance of Office Equipment	372	1	372	0	0	0	0	0	0
131 Maintenance of Motor Vehicles	332508	1	332508	0	0	0	0	0	0
132 Maintenance of Equipment	70000	0.1	7000	0.05	3500	0.05	3500	0.8	56000
137 Postage & Postal Charges	397	1	397	0	0	0	0	0	0
138 Printing Costs	34629	1	34629	0	0	0	0	0	0
140 Publication & Advertising	980	1	980	0	0	0	0	0	0
141 Public Transport	120000	1	120000	0	0	0	0	0	0
142 Purchase of Drugs & vaccinations	3023054	excluded	0	0	0	0	0	0	0
143 Purchase of Medical Stores	4103585	excluded	0	0	0	0	0	0	0
145 Rents	0	0	0	0	0	0	0	0	0
146 Stationery	100600	1	100600	0	0	0	0	0	0
147 Subsistence Allowance	44769	0.1	4476.9	0.05	2238.45	0.05	2238.45	0.8	35815.2
148 Telephone Charges	99850	1	99850	0	0	0	0	0	0
149 Telex & Telegraph Charges	200	1	200	0	0	0	0	0	0
150 Transport Claims	17620	1	17620	0	0	0	0	0	0
152 Uniform & Protect. Clothing	99712	0	0	0.05	4985.6	0.05	4985.6	0.9	89740.8
153 Water and Sanitation	635000	0	0	0.1	63500	0.1	63500	0.8	508000
167 Board Meetings	0	1	0	0	0	0	0	0	0
184 Purchase of Fire fighting C	140	0.1	14	0.05	7	0.05	7	0.8	112
TOTAL GOODS AND SERVICES	12,155,668.00								
CAPITAL FORMATION									
302 Construction of Boreholes	0	0	0	0	0	0	0	0	0
303 Construction of Buildings	42457	0	0	0	0	0	0	0	0
307 Purchase of computer Equipment	0	0	0	0	0	0	0	0	0
308 Purchase of Equipment & Plants	0	0	0	0	0	0	0	0	0
309 Purchase of Furniture & Fittings	16391	0	0	0	0	0	0	0	0
313 Purchase of Office Equipment	0	0	0	0	0	0	0	0	0
316 Rehabilitation of Buildings	0	0	0	0	0	0	0	0	0
320 Rehabilitation of Water Supplies	0	0	0	0	0	0	0	0	0
321 Replacement of Equipment & Plants	0	0	0	0	0	0	0	0	0
322 Replacement of Furniture &	15000	0	0	0	0	0	0	0	0
323 Replacement of Motor Vehicles	0	0	0	0	0	0	0	0	0
TOTAL CAPITAL FORMATION	73848								
Totals:			2,711,026.20		131,957.10		131,957.10		1,613,284.80
							SUM		4,588,225.20

Appendix 6: Costs of drug regimens currently in use in Malawi

Cat.1	2HRZS/6HT							
	Dfl				Kwacha			
drug	cost per un	intensive	cont.	total	cost per un	intensive	cont.	total
R300	0.11	0.00	0.00	0.00	0.94	0.00	0.00	0.00
R150	0.07	0.00	0.00	0.00	0.55	0.00	0.00	0.00
RH 150/100	0.07	11.24	0.00	11.24	0.56	93.88	0.00	93.88
RH 300/150	0.12	0.00	0.00	0.00	0.98	0.00	0.00	0.00
RHZ	0.10	0.00	0.00	0.00	0.84	0.00	0.00	0.00
H100	0.01	0.00	0.00	0.00	0.06	0.00	0.00	0.00
Z 500	0.06	10.92	0.00	10.92	0.54	91.13	0.00	91.13
E 400	0.04	0.00	0.00	0.00	0.37	0.00	0.00	0.00
E400/H150	0.06	0.00	0.00	0.00	0.53	0.00	0.00	0.00
S 1	0.14	5.75	0.00	5.75	1.14	47.99	0.00	47.99
water/syringe/needle	0.14	5.80	0.00	5.80	1.15	48.39	0.00	48.39
HT 100/50	0.01	0.00	0.00	0.00	0.07	0.00	0.00	0.00
HT 300/150	0.01	0.00	1.42	1.42	0.07	0.00	11.87	11.87
		33.70	**1.42**	**35.12**		**281.39**	**11.87**	**293.25**

Cat.1	2HRZS/6HE							
	Dfl				Kwacha			
DRUG	cost per un	intensive	cont.	TOTAL	cost per un	intensive	cont.	TOTAL
2	0.11	0.00	0.00	0.00	0.94	0.00	0.00	0.00
2	0.07	0.00	0.00	0.00	0.55	0.00	0.00	0.00
2 (	0.07	11.24	0.00	11.24	0.56	93.88	0.00	93.88
2 (	0.12	0.00	0.00	0.00	0.98	0.00	0.00	0.00
2 (:	0.10	0.00	0.00	0.00	0.84	0.00	0.00	0.00
(	0.01	0.00	0.00	0.00	0.06	0.00	0.00	0.00
:	0.06	10.92	0.00	10.92	0.54	91.13	0.00	91.13
*	0.04	0.00	0.00	0.00	0.37	0.00	0.00	0.00
* (	0.06	0.00	34.20	34.20	0.53	0.00	285.57	285.57
3	0.14	5.75	0.00	5.75	1.14	47.99	0.00	47.99
WATER SYRINGE NEEDLE	0.14	5.80	0.00	5.80	1.15	48.39	0.00	48.39
1 4	0.01	0.00	0.00	0.00	0.07	0.00	0.00	0.00
1 4	0.01	0.00	0.00	0.00	0.07	0.00	0.00	0.00
		33.70	**34.20**	**67.91**		**281.39**	**285.57**	**566.96**

Cat.2	2S/3HRZE/5HRE							
	Dfl				Kwacha			
DRUG	cost per un	intensive	cont.	TOTAL	cost per un	intensive	cont.	TOTAL
2	0.11	0.00	0.00	0.00	0.94	0.00	0.00	0.00
2	0.07	0.00	0.00	0.00	0.55	0.00	0.00	0.00
2 (	0.07	24.09	16.06	40.16	0.56	201.46	134.31	335.27
2 (	0.12	0.00	0.00	0.00	0.98	0.00	0.00	0.00
2 (:	0.10	0.00	0.00	0.00	0.84	0.00	0.00	0.00
(	0.01	0.00	0.00	0.00	0.06	0.00	0.00	0.00
:	0.06	23.39	0.00	23.39	0.54	195.29	0.00	195.29
*	0.04	0.00	0.00	0.00	0.37	0.00	0.00	0.00
* (	0.06	17.10	19.00	36.10	0.53	142.78	158.65	301.43
3	0.14	8.21	0.00	8.21	1.14	68.55	0.00	68.55
WATER SY	0.14	8.28	0.00	8.28	1.15	69.13	0.00	69.13
1 4	0.01	0.00	0.00	0.00	0.07	0.00	0.00	0.00
1 4	0.01	0.00	0.00	0.00	0.07	0.00	0.00	0.00
		81.08	**35.07**	**116.14**		**676.92**	**292.76**	**969.68**

Cat. 3 2HRZ/2HE/4H

drug	Dfl cost per un.	Dfl intensive	Dfl cont.	Dfl total	Kwacha cost per un	Kwacha intensive	Kwacha cont.	Kwacha total
R300	0.11	0.00	0.00	0.00	0.94	0.00	0.00	0.00
R150	0.07	0.00	0.00	0.00	0.55	0.00	0.00	0.00
RH 150/15	0.07	6.43	0.00	6.43	0.56	53.64	0.00	53.64
RH 300/15	0.12	0.00	0.00	0.00	0.98	0.00	0.00	0.00
RHZ	0.10	0.00	0.00	0.00	0.84	0.00	0.00	0.00
H100	0.01	0.00	2.67	2.67	0.06	0.00	22.29	22.29
Z500	0.06	6.24	0.00	6.24	0.54	52.08	0.00	52.08
E 400	0.04	0.00	0.00	0.00	0.37	0.00	0.00	0.00
E400/H15	0.06	0.00	7.60	7.60	0.53	0.00	63.46	63.46
S 1	0.14	0.00	0.00	0.00	1.14	0.00	0.00	0.00
water/sy	0.14	0.00	0.00	0.00	1.15	0.00	0.00	0.00
HT 100/5	0.01	0.00	0.00	0.00	0.07	0.00	0.00	0.00
HT 300/1	0.01	0.00	0.00	0.00	0.07	0.00	0.00	0.00
		12.66	10.27	22.93		105.72	85.75	191.47

Cat. 3 1SHT/11HT

DRUG	Dfl cost per un.	Dfl intensive	Dfl cont.	Dfl total	Kwacha cost per un	Kwacha intensive	Kwacha cont.	Kwacha total
2	0.11	0.00	0.00	0.00	0.94	0.00	0.00	0.00
2	0.07	0.00	0.00	0.00	0.55	0.00	0.00	0.00
2 (	0.07	0.00	0.00	0.00	0.56	0.00	0.00	0.00
2 (	0.12	0.00	0.00	0.00	0.98	0.00	0.00	0.00
2 (:	0.10	0.00	0.00	0.00	0.84	0.00	0.00	0.00
(	0.01	0.00	0.00	0.00	0.06	0.00	0.00	0.00
:	0.06	0.00	0.00	0.00	0.54	0.00	0.00	0.00
%	0.04	0.00	0.00	0.00	0.37	0.00	0.00	0.00
% (	0.06	0.00	0.00	0.00	0.53	0.00	0.00	0.00
3	0.14	4.11	0.00	4.11	1.14	34.28	0.00	34.28
WATER SY	0.14	4.14	0.00	4.14	1.15	34.56	0.00	34.56
(4	0.01	0.00	0.00	0.00	0.07	0.00	0.00	0.00
(4	0.01	0.24	2.61	2.84	0.07	1.98	21.75	23.73
		8.48	2.61	11.09		70.82	21.75	92.57

) 1SHT/11EH

DRUG	Dfl cost per un.	Dfl intensive	Dfl cont.	Dfl total	Kwacha cost per un	Kwacha intensive	Kwacha cont.	Kwacha total
2	0.11	0.00	0.00	0.00	0.94	0.00	0.00	0.00
2	0.07	0.00	0.00	0.00	0.55	0.00	0.00	0.00
2 (	0.07	0.00	0.00	0.00	0.56	0.00	0.00	0.00
2 (	0.12	0.00	0.00	0.00	0.98	0.00	0.00	0.00
2 (:	0.10	0.00	0.00	0.00	0.84	0.00	0.00	0.00
(	0.01	0.00	0.00	0.00	0.06	0.00	0.00	0.00
:	0.06	0.00	0.00	0.00	0.54	0.00	0.00	0.00
%	0.04	0.00	0.00	0.00	0.37	0.00	0.00	0.00
% (	0.06	5.70	41.81	47.51	0.53	47.59	349.03	396.62
3	0.14	4.11	0.00	4.11	1.14	34.28	0.00	34.28
WATER SY	0.14	4.14	0.00	4.14	1.15	34.56	0.00	34.56
(4	0.01	0.00	0.00	0.00	0.07	0.00	0.00	0.00
(4	0.01	0.00	0.00	0.00	0.07	0.00	0.00	0.00
		13.95	41.81	55.75		116.44	349.03	465.46

Appendix 7: Calculation of the cost per hospital bed-day

Hospital bed-day

	number	unit cost	year of cost	lifetime	yearly equiv.	allocation	Total	deflated for year...	$TOTAL for exchange year: 1995	$TOTAL deflated for year: 1995
Buildings										
TB-ward	2	750,000.00	1994	20	100,409.09	1.00	200,818.17	281,061.47	$19,572.53	$19,572.53
			1990	20	0.00	0.00	0.00	0.00	$0.00	$0.00
			1990	20	0.00	0.00	0.00	0.00	$0.00	$0.00
Total:							**200,818.17**	**281,061.47**	**$19,572.53**	**$19,572.53**
Equipment										
bed	68	5,313.20	1995	10	940.35	1.00	63,943.95	63,943.95	$4,452.92	$4,452.92
locker	68	2,814.56	1995	10	498.13	1.00	33,873.01	33,873.01	$2,358.84	$2,358.84
			1990	10	0.00		0.00	0.00	$0.00	$0.00
			1990	10	0.00		0.00	0.00	$0.00	$0.00
			1990	10	0.00		0.00	0.00	$0.00	$0.00
			1990	10	0.00		0.00	0.00	$0.00	$0.00
			1990	10	0.00		0.00	0.00	$0.00	$0.00
Total:							**97,816.97**	**97,816.97**	**$6,811.77**	**$6,811.77**
Personnel										
sister (STO)	2	20,000.00	1995			1.00	40,000.00	40,000.00	$2,785.52	$2,785.52
nurse (STA)	4	14,000.00	1995			1.00	56,000.00	56,000.00	$3,899.72	$3,899.72
nurse (TA)	4	11,500.00	1995			1.00	46,000.00	46,000.00	$3,203.34	$3,203.34
attendant (SCI)	2	10,000.00	1995			1.00	20,000.00	20,000.00	$1,392.76	$1,392.76
clerk (TA)	1	11,500.00	1995			1.00	11,500.00	11,500.00	$800.84	$800.84
domestic (SC III)	6	7,500.00	1995			1.00	45,000.00	45,000.00	$3,133.70	$3,133.70
non-grade	4	4,500.00	1995			1.00	18,000.00	18,000.00	$1,253.48	$1,253.48
physician	1	60,000.00	1995			0.10	6,000.00	6,000.00	$417.83	$417.83
		0.00	1990				0.00	0.00	$0.00	$0.00
Total:							**242,500.00**	**242,500.00**	**$16,887.19**	**$16,887.19**
Overhead										
clinical wards overhead	1	1,613,284.80	1994			0.10	161,328.48	225,792.41	$15,723.71	$15,723.71
administration	1	2,711,026.20	1994			0.08	216,882.10	303,544.25	$21,138.18	$21,138.18
			1990				0.00	0.00	$0.00	$0.00
			1990				0.00	0.00	$0.00	$0.00
			1990				0.00	0.00	$0.00	$0.00
			1990				0.00	0.00	$0.00	$0.00
Total:							**378,210.58**	**529,336.66**	**$36,861.88**	**$36,861.88**
Food										
food	45930	5.00	1995			1.00	229,650.00	229,650.00	$15,992.34	$15,992.34
			1990				0.00	0.00	$0.00	$0.00
			1990				0.00	0.00	$0.00	$0.00
			1990				0.00	0.00	$0.00	$0.00
			1990				0.00	0.00	$0.00	$0.00
			1990				0.00	0.00	$0.00	$0.00
Total:							**229,650.00**	**229,650.00**	**$15,992.34**	**$15,992.34**
Total:										
full							**1,148,995.71**	**1,380,365.10**	**$96,125.70**	**$96,125.70**
marginal (personnel / food)							**472,150.00**	**472,150.00**	**$32,879.53**	**$32,879.53**
BEDDAYS:		**45930**								
COST PER DAY:										
full							**25.02**	**30.05**	**$2.09**	**$2.09**
marginal (personnel / food)							**10.28**	**10.28**	**$0.72**	**$0.72**

Appendix 8: Cost calculation for sputum microscopy

smear

	number	unit cost	year of cost	lifetime	yearly equiv.	allocation	Total	deflated for year: 1995	$ TOTAL for exchange year: 1995
Buildings									
DH/lab	1	6,000,000.00	1995	20	803,272.68	0.02	16,065.45	16,065.45	$1,118.76
			1990	20	0.00	0.00	0.00	0.00	$0.00
			1990	10	0.00	0.00	0.00	0.00	$0.00
Total:							16,065.45	16,065.45	$1,118.76
Equipment									
microscope (fluoros)	1	143,600.00	1995	10	25,414.93	1.00	25,414.93	25,414.93	$1,769.84
safety cab.	1	60,000.00	1994	10	10,619.05	0.50	5,309.52	7,431.11	$517.49
autoclave	1	16,000.00	1995	10	2,831.75	0.50	1,415.87	1,415.87	$98.60
centrifuge	1	30,000.00	1995	10	5,309.52	0.50	2,654.76	2,654.76	$184.87
general lab equipment	1	71,800.00	1995	10	12,707.46	0.20	2,541.49	2,541.49	$176.98
			1995	10	0.00		0.00	0.00	$0.00
			1990	10	0.00		0.00	0.00	$0.00
Total:							37,336.58	39,458.17	$2,747.78
Personnel									
lab.chief (PO)	1	23,200.00	1995			0.10	2,320.00	2,320.00	$161.56
lab techn. (STO)	1	20,000.00	1995			0.40	8,000.00	8,000.00	$557.10
TA	2	11,500.00	1995			0.30	6,900.00	6,900.00	$480.50
		0.00	1990				0.00	0.00	$0.00
Total:							17,220.00	17,220.00	$1,199.16
Overhead									
laboratory overhead	1	131,957.10	1994			0.20	26,391.42	36,936.95	$2,572.21
administration	1	2,711,026.20	1994			0.01	27,110.26	37,943.03	$2,642.27
			1990				0.00	0.00	$0.00
			1990				0.00	0.00	$0.00
			1995				0.00	0.00	$0.00
0	0		1990				0.00	0.00	$0.00
Total:							53,501.68	74,879.98	$5,214.48
Supplies									
Auramine	5	280.02	1995				1,400.10	1,400.10	$97.50
phenol	3	136.42	1995				409.26	409.26	$28.50
permanganate	1	114.88	1995				114.88	114.88	$8.00
alcohol	1	225.00	1995				225.00	225.00	$15.67
HCl	1	73.09	1995				73.09	73.09	$5.09
gloves	1	102.87	1995				102.87	102.87	$7.16
masks	1	125.00	1995				125.00	125.00	$8.70
containers	24555	0.67	1995				16,451.85	16,451.85	$1,145.67
slides	24555	0.13	1995				3,147.95	3,147.95	$219.22
microscope lamp	1	3,500.00	1995				3,500.00	3,500.00	$243.73
Total:							25,550.00	25,550.00	$1,779.25
Total:									
full							149,673.72	173,173.61	$12,059.44
marginal (supplies)							25,550.00	25,550.00	$1,779.25
slides:		24555							
COST PER SLIDE:									
full							6.10	7.05	$0.49
marginal (supplies)							1.04	1.04	$0.07

Appendix 9: Cost calculation for laboratory extension

smear

	number	unit cost	year of cost	lifetime	yearly equiv.	allocation	Total	deflated for year: 1995		
Buildings										
lab		1	50,000.00	1995	20	6,693.94	1	6,693.94	6,693.94	$466.15
				1990	10	0.00	0	0.00	0.00	$0.00
			0.00	1990	10	0.00	0	0.00	0.00	$0.00
	Total:							**6,693.94**	**6,693.94**	$466.15
Equipment										
microscope (fluoros)		1	143,600.00	1995	10	25,414.93	1	25,414.93	25,414.93	$1,769.84
safety cab.		1	60,000.00	1994	10	10,619.05	1	10,619.05	14,862.23	$1,034.97
autoclave		1	16,000.00	1995	10	2,831.75	1	2,831.75	2,831.75	$197.20
centrifuge		1	30,000.00	1995	10	5,309.52	1	5,309.52	5,309.52	$369.74
general lab		1	71,800.00	1995	10	12,707.46	0.1	1,270.75	1,270.75	$88.49
				1995	10	0.00		0.00	0.00	$0.00
				1990	10	0.00		0.00	0.00	$0.00
	Total:							**45,445.99**	**49,689.17**	$3,460.25
Personnel										
lab.chief (PO)		1	23,200.00	1995			0.1	2,320.00	2,320.00	$161.56
lab techn. (STO)		1	20,000.00	1995			1	20,000.00	20,000.00	$1,392.76
				1995				0.00	0.00	$0.00
TA		2	11,500.00	1995			1	23,000.00	23,000.00	$1,601.67
			0.00	1990				0.00	0.00	$0.00
	Total:							**45,320.00**	**45,320.00**	$3,155.99
Overhead										
laboratory overhead		1	**131,957.10**	1994	0.00	0.00	0.20	26,391.42	36,936.95	$2,572.21
administration		1	**2,711,026.20**	1994	0	0.00	0.01	27,110.26	37,943.03	$2,642.27
			0.00	1990	0	0.00	0.00	0.00	0.00	$0.00
			0.00	1990	0	0.00	0.00	0.00	0.00	$0.00
				1995				0.00	0.00	$0.00
	0	0		1990				0.00	0.00	$0.00
	Total:							**53,501.68**	**74,879.98**	$5,214.48
Supplies										
Auramine		10	280.02	1995				2,800.20	2,800.20	$195.00
phenol		6	136.42	1995				818.52	818.52	$57.00
permanganate		2	114.88	1995				229.76	229.76	$16.00
alcohol		2	225.00	1995				450.00	450.00	$31.34
HCl		2	73.09	1995				146.18	146.18	$10.18
gloves		2	102.87	1995				205.74	205.74	$14.33
masks		2	125.00	1995				250.00	250.00	$17.41
containers		50000	0.67	1995				33,500.00	33,500.00	$2,332.87
slides		50000	0.13	1995				6,410.00	6,410.00	$446.38
				1995				0.00	0.00	$0.00
	Total:							**44,810.40**	**44,810.40**	$3,120.50
Total:								**195,772.01**	**221,393.50**	$15,417.37
slides:			**50,000**							
COST PER SLIDE								**3.92**	**4.43**	**$0.31**

Appendix 10: Cost calculation for sputum cultures

culture

		number	unit cost	year of cost	lifetime	yearly equiv.	allocation	Total	deflated for year: 1995	$TOTAL for exchange year: 1995
Buildings										
CHSU/lab		1	6,000,000.00	1995	20	803,272.68	0.05	40,163.63	40,163.63	$2,796.91
				1990	20	0.00	0.00	0.00	0.00	$0.00
			0.00	1990	10	0.00	0.00	0.00	0.00	$0.00
	Total:							**40,163.63**	**40,163.63**	**$2,796.91**
Equipment										
incub.		1	30,000.00	1995	10	5,309.52	1.00	5,309.52	5,309.52	$369.74
safety cab.		1	60,000.00	1994	10	10,619.05	0.25	2,654.76	3,715.56	$258.74
autoclave		1	16,000.00	1995	10	2,831.75	0.25	707.94	707.94	$49.30
centrifuge		1	30,000.00	1995	10	5,309.52	0.25	1,327.38	1,327.38	$92.44
general lab		1	71,800.00	1995	10	12,707.46	0.10	1,270.75	1,270.75	$88.49
				1990	10	0.00		0.00	0.00	$0.00
				1990	10	0.00		0.00	0.00	$0.00
	Total:							**11,270.35**	**12,331.15**	**$858.71**
Personnel										
lab.chief (PO)		1	23,200.00	1995			0.10	2,320.00	2,320.00	$161.56
lab tech n. (STO)		1	20,000.00	1995			0.25	5,000.00	5,000.00	$348.19
STA		1	14,000.00	1995			0.25	3,500.00	3,500.00	$243.73
TA		1	11,500.00	1995			0.25	2,875.00	2,875.00	$200.21
			0.00	1990				0.00	0.00	$0.00
	Total:							**13,695.00**	**13,695.00**	**$953.69**
Overhead										
lab/CHSU		1	371,196.00	1994			0.05	18,559.80	25,975.96	$1,808.91
				1990				0.00	0.00	$0.00
				1990				0.00	0.00	$0.00
				1990				0.00	0.00	$0.00
				1995				0.00	0.00	$0.00
				1990				0.00	0.00	$0.00
	Total:							**18,559.80**	**25,975.96**	**$1,808.91**
Supplies										
bottles		1169	6.89	1995				8,057.68	8,057.68	$561.12
eggs		500	2.00	1995				1,000.00	1,000.00	$69.64
medium (total)		1	2,800.20	1995				2,800.20	2,800.20	$195.00
				1990				0.00	0.00	$0.00
				1990				0.00	0.00	$0.00
				1990				0.00	0.00	$0.00
				1995				0.00	0.00	$0.00
				1995				0.00	0.00	$0.00
				1995				0.00	0.00	$0.00
				1990				0.00	0.00	$0.00
	Total:							**11,857.88**	**11,857.88**	**$825.76**
Total:										
full								**95,546.67**	**104,023.62**	**$7,243.98**
marginal (supplies)								**11,857.88**	**11,857.88**	**$825.76**
cultures:			**1169**							
COST PER culture:										
full								**81.73**	**88.99**	**$6.20**
marginal (supplies)								**10.14**	**10.14**	**$0.71**

Appendix 11: Cost calculation for HIV tests

HIV-TEST

	number	unit cost	year of cost	lifetime	yearly equiv.	allocation	Total	deflated for year: 1995	$TOTAL for exchange year: 1995
Buildings									
DH/lab	1	6,000,000.00	1995	20	803,272.68	0.01	8,032.73	8,032.73	$559.38
			1990	20	0.00	0.00	0.00	0.00	$0.00
			1990	10	0.00	0.00	0.00	0.00	$0.00
Total:							**8,032.73**	**8,032.73**	**$559.38**
Equipment									
			1995	5	0.00		0.00	0.00	$0.00
pipette	3	1,550.88	1995	5	430.23	1.00	1,290.69	1,290.69	$89.88
Elisa Reader	1	74,887.40	1995	5	20,774.49	1.00	20,774.49	20,774.49	$1,446.69
pump	1	10,971.04	1995	5	3,043.47	1.00	3,043.47	3,043.47	$211.94
			1990	10	0.00		0.00	0.00	$0.00
			1990	10	0.00		0.00	0.00	$0.00
			1990	10	0.00		0.00	0.00	$0.00
Total:							**25,108.65**	**25,108.65**	**$1,748.51**
Personnel									
lab.chief (PO)	1	23,200.00	1995			0.10	2,320.00	2,320.00	$161.56
techn.(TA)	1	11,500.00	1995			1.00	11,500.00	11,500.00	$800.84
			1995				0.00	0.00	$0.00
			1990				0.00	0.00	$0.00
			1990				0.00	0.00	$0.00
Total:							**13,820.00**	**13,820.00**	**$962.40**
Overhead									
laboratory overhead	1	131,957.10	1994			0.10	13,195.71	18,468.48	$1,286.11
			1994				0.00	0.00	$0.00
administration	1	2,711,026.20	1994			0.01	27,110.26	37,943.03	$2,642.27
			1990				0.00	0.00	$0.00
			1995				0.00	0.00	$0.00
			1990				0.00	0.00	$0.00
Total:							**40,305.97**	**56,411.51**	**$3,928.38**
Supplies									
blood bottle	14	1,615.50	1995				22,617.00	22,617.00	$1,575.00
store box	1	3,653.90	1995				3,653.90	3,653.90	$254.45
Markers	1	215.40	1995				215.40	215.40	$15.00
Vials	14	1,096.39	1995				15,349.40	15,349.40	$1,068.90
tips	28	136.42	1995				3,819.76	3,819.76	$266.00
troughs	1	62.47	1995				62.47	62.47	$4.35
tips	1	118.47	1995				118.47	118.47	$8.25
Vac/needles	140	245.70	1995				34,397.94	34,397.94	$2,395.40
ELISA	70	1,378.56	1995				96,499.20	96,499.20	$6,720.00
			1995				0.00	0.00	$0.00
Total:							**176,733.55**	**176,733.55**	**$12,307.35**
Counselling									
Type:									
attendant/hr	14000	5.21	1995				**72,916.67**	**72,916.67**	**$5,077.76**
			1990				**0.00**	**0.00**	**$0.00**
			1995				**0.00**	**0.00**	**$0.00**
			1990				**0.00**	**0.00**	**$0.00**
Total:							**72,916.67**	**72,916.67**	**$5,077.76**
Training									
Type:									
course	20	200	1995				**4,000.00**	**4,000.00**	**$278.55**
			1990				**0.00**	**0.00**	**$0.00**
			1990				**0.00**	**0.00**	**$0.00**
			1990				**0.00**	**0.00**	**$0.00**
			1990				**0.00**	**0.00**	**$0.00**
			1990				**0.00**	**0.00**	**$0.00**
Total:							**4,000.00**	**4,000.00**	**$278.55**
Total:									
full							**340,917.57**	**357,023.10**	**$24,862.33**
marginal							**176,733.55**	**176,733.55**	**$12,307.35**
Tests:		**14000**							
COST PER TEST:									
full							**24.35**	**25.50**	**$1.78**
marginal							**12.62**	**12.62**	**$0.88**

Appendix 12: Cost calculation for conventional x-ray

x-ray

	number	unit cost	year of cost	lifetime	yearly equiv.	allocation	Total	deflated for year: 1995	$TOTAL for exchange year: 1995
Buildings									
darkr./lab.	1	250,000.00	1995	20	33,469.70	0.50	16,734.85	16,734.85	$1,165.38
DH/ x-ray	1	6,000,000.00	1995	20	803,272.68	0.025	20,081.82	20,081.82	$1,398.46
		0.00	1990	10	0.00	0.00	0.00	0.00	$0.00
Total:							**36,816.66**	**36,816.66**	**$2,563.83**
Equipment									
machine	1	714,912.60	1995	20	95,711.63	1.00	95,711.63	95,711.63	$6,665.16
equipment (incl. dev.)	1	230,635.96	1995	10	40,818.91	0.50	20,409.46	20,409.46	$1,421.27
			1995	10	0.00	0.10	0.00	0.00	$0.00
			1990	10	0.00		0.00	0.00	$0.00
			1990	10	0.00		0.00	0.00	$0.00
			1990	10	0.00		0.00	0.00	$0.00
			1990	10	0.00		0.00	0.00	$0.00
Total:							**116,121.08**	**116,121.08**	**$8,086.43**
Personnel									
radiogr. (TO)	1	17,400.00	1995			1.00	17,400.00	17,400.00	$1,211.70
tech. (TA)	1	11,500.00	1995			1.00	11,500.00	11,500.00	$800.84
assistant (SCI)	1	7,500.00	1995			1.00	7,500.00	7,500.00	$522.28
		0.00	1990				0.00	0.00	$0.00
		0.00	1990				0.00	0.00	$0.00
Total:							**36,400.00**	**36,400.00**	**$2,534.82**
Overhead									
x-ray overhead	1	131,957.10	1994			0.500	65,978.55	92,342.38	$6,430.53
administration	1	2,711,026.20	1994			0.010	27,110.26	37,943.03	$2,642.27
			1990				0.00	0.00	$0.00
			1990				0.00	0.00	$0.00
			1990				0.00	0.00	$0.00
0	0		1990				0.00	0.00	$0.00
Total:							**93,088.81**	**130,285.41**	**$9,072.80**
Supplies									
films	12000	12.11	1995				145,320.00	145,320.00	$10,119.78
developer (30l)	70	74.74	1995				5,231.80	5,231.80	$364.33
fixer (25l)	85	35.46	1995				3,014.10	3,014.10	$209.90
envelopes	12000	1.00	1995				12,000.00	12,000.00	$835.65
			1990				0.00	0.00	$0.00
			1990				0.00	0.00	$0.00
			1995				0.00	0.00	$0.00
			1995				0.00	0.00	$0.00
			1995				0.00	0.00	$0.00
			1990				0.00	0.00	$0.00
Total:							**165,565.90**	**165,565.90**	**$11,529.66**
Total:									
full							**447,992.46**	**485,189.06**	**$33,787.54**
marginal (supplies)							**165,565.90**	**165,565.90**	**$11,529.66**
films:		**12000**							
COST PER FILM:									
full							**37.33**	**40.43**	**$2.82**
marginal (supplies)							**13.80**	**13.80**	**$0.96**

Appendix 13: Cost calculation for miniature radiography

MR

	number	unit cost	year of cost	lifetime	yearly equiv.	allocation	Total	deflated for year: 1995	TOTAL$
Buildings									
darkr./lab.	1	250000	1995	20	33,469.70	1	16,734.85	16,734.85	$1,165.38
hosp.	1	6000000	1995	20	803,272.68	0	20,081.82	20,081.82	$1,398.46
	0	0	1990	10	0	0	0.00	0.00	$0.00
Total:							**36,816.66**	**36,816.66**	$2,563.83
Equipment									
machine	1	1,723,200.00	1995	20	230,699.91	1.00	230,699.91	230,699.91	$16,065.45
equipment (incl. dev.)	1	230,635.96	1995	10	40,818.91	0.25	10,204.73	10,204.73	$710.64
			1995	10	0.00	0.10	0.00	0.00	$0.00
			1990	10	0.00	0.00	0.00	0.00	$0.00
			1990	10	0.00	0.00	0.00	0.00	$0.00
			1990	10	0.00	0.00	0.00	0.00	$0.00
			1990	10	0.00	0.00	0.00	0.00	$0.00
Total:							**240,904.64**	**240,904.64**	$16,776.09
Personnel									
radiogr. (TO)	1	17,400.00	1995			0.10	1,740.00	1,740.00	$121.17
tech. (TA)	1	11,500.00	1995			0.25	2,875.00	2,875.00	$200.21
assistant (SCI)	1	7,500.00	1995			0.25	1,875.00	1,875.00	$130.57
	1	11,500.00	1995			0.25	2,875.00	2,875.00	$200.21
	0	0.00	1990			0.00	0.00	0.00	$0.00
Total:							**9,365.00**	**9,365.00**	$652.16
Overhead	0	0.00							
x-ray overhead	1	131,957.10	1994			0.50	65,978.55	92,342.38	$6,430.53
administration	1	2,711,026.20	1990			0.01	27,110.26	99,889.24	$6,956.08
		0.00	1990			0.00	0.00	0.00	$0.00
		0.00	1990			0.00	0.00	0.00	$0.00
		0.00	1995				0.00	0.00	$0.00
0	0	0.00	1990			0.00	0.00	0.00	$0.00
Total:							**93,088.81**	**192,231.62**	$13,386.60
Supplies									
films	35	1,436.00	1995				50,260.00	50,260.00	$3,500.00
developer	70	74.74	1995				5,231.80	5,231.80	$364.33
fixer	85	35.48	1995				3,014.10	3,014.10	$209.90
envelopes	12000	0.15	1995				1,800.00	1,800.00	$125.35
			1990				0.00	0.00	$0.00
			1990				0.00	0.00	$0.00
		0.10	1995				0.00	0.00	$0.00
		0.10	1995				0.00	0.00	$0.00
		0.20	1995				0.00	0.00	$0.00
			1990				0.00	0.00	$0.00
Total:							**60,305.90**	**60,305.90**	$4,199.58
Total:									
full							**440,481.02**	**539,623.83**	$37,578.26
marginal							**60,305.90**	**60,305.90**	$4,199.58
	Buildings		$0.21				36,816.66	36,816.66	2,563.83
	Equipment		$1.40				240,904.64	240,904.64	16,776.09
	Personnel		$0.05				9,365.00	9,365.00	652.16
	Overhead		$1.12				93,088.81	192,231.62	13,386.60
	Supplies		$0.35				60,305.90	60,305.90	4,199.58
	TOTAL:		$3.13				440,481.02	539,623.83	37,578.26
films:		**12,000.00**							
COST PER FILM:									
full							**36.71**	**44.97**	**$3.13**
marginal							**5.03**	**5.03**	**$0.35**

Appendix 14: Cost calculation for the central programme level

Central

	number	unit cost	year of cost	lifetime	yearly equiv.	allocation	Total	deflated for year: 1995	$ TOTAL for exchange year: 1995
Buildings									
office/CHSU	1	6,000,000.00	1995	20	803,272.68	0.10	80,327.27	80,327.27	$5,593.82
lab/CHSU	1	6,000,000.00	1995	20	803,272.68	0.05	40,163.63	40,163.63	$2,796.91
			1990	20	0.00		0.00	0.00	$0.00
Total:							120,490.90	120,490.90	$8,390.73
Vehicles									
Automobile	1	1,000,000.00	1995	5	277,409.73	1.00	277,409.73	277,409.73	$19,318.23
			1990	6	0.00		0.00	0.00	$0.00
			1990	6	0.00		0.00	0.00	$0.00
			1990	6	0.00		0.00	0.00	$0.00
Total:							277,409.73	277,409.73	$19,318.23
Equipment									
computer	1	57,440.00	1995	5	15,934.42	1.00	15,934.42	15,934.42	$1,109.64
			1990	10	0.00		0.00	0.00	$0.00
			1990	10	0.00		0.00	0.00	$0.00
			1990	10	0.00		0.00	0.00	$0.00
			1990	10	0.00		0.00	0.00	$0.00
			1990	10	0.00		0.00	0.00	$0.00
			1990	10	0.00		0.00	0.00	$0.00
Total:							15,934.42	15,934.42	$1,109.64
Personnel									
PM (P8)	1	31,500.00	1995			1	31,500.00	31,500.00	$2,193.59
assistant (STO)	1	20,000.00	1995			0.25	5,000.00	5,000.00	$348.19
registry clerk (TA)	1	11,500.00	1995			1	11,500.00	11,500.00	$800.84
secretary (TO)	1	17,500.00	1995			1	17,500.00	17,500.00	$1,218.66
driver (SC I)	1	10,000.00	1995			1	10,000.00	10,000.00	$696.38
Total:							75,500.00	75,500.00	$5,257.66
Overhead / Maintenance									
office/CHSU	1	371,196.00	1994			0.1	37,119.60	51,951.92	$3,617.82
lab/CHSU at culture costs!!!			1994				0.00	0.00	$0.00
cars	1	127,564.00	1994			1	127,564.00	178,536.26	$12,432.89
			1990			0	0.00	0.00	$0.00
			1990			1	0.00	0.00	$0.00
			1990			0	0.00	0.00	$0.00
Total:							164,683.60	230,488.18	$16,050.71
Diagnosis									
cultures	1169	88.99	1995				104,023.62	104,023.62	$7,243.98
			1990				0.00	0.00	$0.00
			1990				0.00	0.00	$0.00
			1990				0.00	0.00	$0.00
			1990				0.00	0.00	$0.00
			1990				0.00	0.00	$0.00
			1990				0.00	0.00	$0.00
			1990				0.00	0.00	$0.00
Total:							104,023.62	104,023.62	$7,243.98
Supplies									
total stationery	1	250,148.00	1994				250,148.00	350,102.60	$24,380.40
			1990				0.00	0.00	$0.00
			1990				0.00	0.00	$0.00
			1990				0.00	0.00	$0.00
			1990				0.00	0.00	$0.00
			1990				0.00	0.00	$0.00
			1990				0.00	0.00	$0.00
			1990				0.00	0.00	$0.00
			1990				0.00	0.00	$0.00
			1990				0.00	0.00	$0.00
Total:							250,148.00	350,102.60	$24,380.40
Treatment									
			1990				0.00	0.00	$0.00
			1990				0.00	0.00	$0.00
			1990				0.00	0.00	$0.00
			1990				0.00	0.00	$0.00
			1990				0.00	0.00	$0.00
			1990				0.00	0.00	$0.00
			1990				0.00	0.00	$0.00
			1990				0.00	0.00	$0.00
			1990				0.00	0.00	$0.00
Total:							$0.00	$0.00	$0.00
Supervision									
total travel	1	169,144.00	1994				169,144.00	236,730.87	$16,485.44
			1990				0.00	0.00	$0.00
			1990				0.00	0.00	$0.00
			1990				0.00	0.00	$0.00
Total:							169,144.00	236,730.87	$16,485.44
Training									
Type:									
total training	1	408,145.00	1994				408,145.00	571,232.34	$39,779.41
			1990				0.00	0.00	$0.00
			1990				0.00	0.00	$0.00
			1990				0.00	0.00	$0.00
			1990				0.00	0.00	$0.00
			1990				0.00	0.00	$0.00
Total:							408,145.00	571,232.34	$39,779.41
	SUMS:						**1,585,479.27**	**1,981,912.67**	**$138,016.20**

Appendix 15: Cost calculation for the health center level

Health Center

	number	unit cost	year of cost	lifetime		yearly equiv.	allocation	Total	deflated for year: 1995	$ TOTAL for exchange year: 1995
Buildings										
health center	1		624,000.00	1995	20	70,162.48	0.20	14,030.50	14,030.50	$977.05
				1990	20	0.00	0.00	0.00	0.00	$0.00
			0.00	1990	10	0.00	0.00	0.00	0.00	$0.00
Total:								14,030.50	14,030.50	$977.05
Vehicles										
bicycle	4		670.00	1995	2	337.27	0.50	674.54	674.54	$46.97
				1990	6	0.00		0.00	0.00	$0.00
				1990	6	0.00		0.00	0.00	$0.00
				1990	6	0.00		0.00	0.00	$0.00
Total:								674.54	674.54	$46.97
Equipment										
standard HC equipment	1		100,000.00	1995	20	13,387.88	0.20	2,677.58	2,677.58	$186.46
				1990	10	0.00		0.00	0.00	$0.00
				1990	10	0.00		0.00	0.00	$0.00
				1990	10	0.00		0.00	0.00	$0.00
				1990	10	0.00		0.00	0.00	$0.00
				1990	10	0.00		0.00	0.00	$0.00
				1990	10	0.00		0.00	0.00	$0.00
Total:								2,677.58	2,677.58	$186.46
Personnel										
medical assistant (STO)	1		20,000.00	1995			0.10	2,000.00	2,000.00	$139.28
nurse (STA)	2		14,000.00	1995			0.50	14,000.00	14,000.00	$974.93
assistant (TA)	2		11,500.00	1995			0.50	11,500.00	11,500.00	$800.84
surv. assistant (SCI)	2		10,000.00	1995			1.00	20,000.00	20,000.00	$1,392.76
			0.00	1990				0.00	0.00	$0.00
Total:								47,500.00	47,500.00	$3,307.80
Overhead / Maintenance										
health center	1		50,000.00	1995			0.30	15,000.00	15,000.00	$1,044.57
				1990				0.00	0.00	$0.00
				1990				0.00	0.00	$0.00
				1990				0.00	0.00	$0.00
				1990				0.00	0.00	$0.00
				1990				0.00	0.00	$0.00
Total:								15,000.00	15,000.00	$1,044.57
Diagnosis										
patient travel	2000		4.00	1995				8,000.00	8,000.00	$557.10
				1995				0.00	0.00	$0.00
				1995				0.00	0.00	$0.00
				1995				0.00	0.00	$0.00
				1990				0.00	0.00	$0.00
				1990				0.00	0.00	$0.00
				1990				0.00	0.00	$0.00
Total:								8,000.00	8,000.00	$557.10
Supplies										
costed at central level!										
				1995				0.00	0.00	$0.00
				1990				0.00	0.00	$0.00
				1990				0.00	0.00	$0.00
				1990				0.00	0.00	$0.00
				1990				0.00	0.00	$0.00
				1990				0.00	0.00	$0.00
				1995				0.00	0.00	$0.00
				1995				0.00	0.00	$0.00
				1990				0.00	0.00	$0.00
Total:								0.00	0.00	$0.00
Treatment										
Cat. 1 (TH)	14		11.87	1995				166.11	166.11	$11.57
Cat. 1 (EH)	34		285.57	1995				9,709.38	9,709.38	$676.14
Cat. 3 (TH)	39		131.97	1995				5,146.80	5,146.80	$358.41
Cat. 3 (EH)	91		191.47	1995				17,424.14	17,424.14	$1,213.38
Cat. 2	4		292.76	1995				1,171.03	1,171.03	$81.55
Drug Distribution	1		3,361.74	1995				3,361.74	3,361.74	$234.10
				1990				0.00	0.00	$0.00
follow-up trips	104		4.00	1995				416.00	416.00	$28.97
Total:								$37,395.19	$37,395.19	$2,604.12
Supervision										
costed at central level!										
				1990				0.00	0.00	$0.00
				1990				0.00	0.00	$0.00
				1990				0.00	0.00	$0.00
				1990				0.00	0.00	$0.00
Total:								0.00	0.00	$0.00
Training										
costed at central level!										
				1990				0.00	0.00	$0.00
				1990				0.00	0.00	$0.00
				1990				0.00	0.00	$0.00
				1990				0.00	0.00	$0.00
				1990				0.00	0.00	$0.00
				1990				0.00	0.00	$0.00
Total:								0.00	0.00	$0.00
SUMS:								125,277.80	125,277.80	8,724.08

Appendix 16: Cost calculation for the district level

DISTRICT

	number	unit cost	year of cost	lifetime	yearly equiv	allocation	TOTAL	deflated for year:	$ TOTAL for exchange year.
BUILDINGS									
DHO	1	5,500,000.00	1995	20	736,333.28	0.10	73,633.33	73,633.33	$5,127.67
OPD	1	6,000,000.00	1995	20	803,272.68	0.01	8,032.73	8,032.73	$559.38
			1990	20	0.00		0.00	0.00	$0.00
Total:							81,666.06	81,666.06	$5,687.05
VEHICLES									
			1990	2	0.00		0.00	0.00	$0.00
Motorcycle	1	18,868.00	1995	2	11,045.82	1.00	11,045.82	11,045.82	$769.21
			1990	6	0.00		0.00	0.00	$0.00
			1990	6	0.00		0.00	0.00	$0.00
Total:							11,045.82	11,045.82	$769.21
EQUIPMENT									
			1995	10	0.00		0.00	0.00	$0.00
			1990	10	0.00		0.00	0.00	$0.00
			1990	10	0.00		0.00	0.00	$0.00
			1990	10	0.00		0.00	0.00	$0.00
			1990	10	0.00		0.00	0.00	$0.00
			1990	10	0.00		0.00	0.00	$0.00
			1990	10	0.00		0.00	0.00	$0.00
Total:							0.00	0.00	$0.00
PERSONNEL									
DTO(STA)	2	14,000.00	1995			1.00	28,000.00	28,000.00	$1,949.86
health assistant (SCI)	3	10,000.00	1995			1.00	30,000.00	30,000.00	$2,089.14
clerk (TA)	1	11,500.00	1995			1.00	11,500.00	11,500.00	$800.84
		0.00	1990				0.00	0.00	$0.00
OPD:SCI	2	10,000.00	1995			0.80	16,000.00	16,000.00	$1,114.21
Total:							85,500.00	85,500.00	$5,954.04
VEHICLE - MAINTENANCE									
DHO	1	50,000.00	1995			0.1	5,000.00	5,000.00	$348.19
			1990			0.01	0.00	0.00	$0.00
			1990			0	0.00	0.00	$0.00
			1990			1	0.00	0.00	$0.00
			1990			0	0.00	0.00	$0.00
			1990			0	0.00	0.00	$0.00
Total:							5,000.00	5,000.00	$348.19
DIAGNOSIS									
slides	24555	7.05	1995				173,173.61	173,173.61	$12,059.44
			1990				0.00	0.00	$0.00
			1990				0.00	0.00	$0.00
			1990				0.00	0.00	$0.00
			1990				0.00	0.00	$0.00
			1990				0.00	0.00	$0.00
ELISA	1000	25.50	1995				25,501.65	25,501.65	$1,775.88
chest x-ray	12000	40.43	1995				485,189.06	485,189.06	$33,787.54
Total:							683,864.32	683,864.32	$47,622.86
SUPPLIES									
costed at central level!									
			1995				0.00	0.00	$0.00
			1995				0.00	0.00	$0.00
			1990				0.00	0.00	$0.00
			1990				0.00	0.00	$0.00
			1990				0.00	0.00	$0.00
			1995				0.00	0.00	$0.00
			1990				0.00	0.00	$0.00
			1990				0.00	0.00	$0.00
			1990				0.00	0.00	$0.00
			1995				0.00	0.00	$0.00
Total:							0.00	0.00	$0.00
TREATMENT									
Cat.1 (TH)	203	281.39	1995				57,121.57	57,121.57	$3,977.83
Cat. 1(EH)	474	281.39	1995				133,377.46	133,377.46	$9,288.12
Cat. 3 (TH)	543	0.00	1995				0.00	0.00	$0.00
Cat. 3 (EH)	1268	0.00	1995				0.00	0.00	$0.00
Cat. 2	59	676.92	1995				39,938.08	39,938.08	$2,781.20
Drug Distribution	1	23,043.71	1995				23,043.71	23,043.71	$1,604.72
beddays	45930	30.05	1995				1,380,365.10	1,380,365.10	$96,125.70
	0		1990				0.00	0.00	$0.00
Total:							$1,633,845.91	$1,633,845.91	$113,777.57
SUPERVISION									
costed at central level!									
			1990				0.00	0.00	$0.00
			1990				0.00	0.00	$0.00
			1990				0.00	0.00	$0.00
			1990				0.00	0.00	$0.00
Total:							0.00	0.00	$0.00
TRAINING									
costed at central level!									
			1990				0.00	0.00	$0.00
			1990				0.00	0.00	$0.00
			1990				0.00	0.00	$0.00
			1990				0.00	0.00	$0.00
			1990				0.00	0.00	$0.00
			1990				0.00	0.00	$0.00
Total:							0.00	0.00	$0.00

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Appendix 17: Cost calculation for regional level

Region

	number	unit cost	year of cost	lifetime	yearly equiv.	allocation	Total	deflated for year: 1995	$ TOTAL for exchange year 1995
Buildings									
DHO	1	5,500,000.00	1995	20	736,333.29	0.10	73,633.33	73,633.33	$5,127.67
			1990	20	0.00		0.00	0.00	$0.00
			1990	20	0.00		0.00	0.00	$0.00
Total:							**73,633.33**	**73,633.33**	**$5,127.67**
Vehicles									
Automobile	1	1,000,000.00	1995	5	277,409.73	1.00	277,409.73	277,409.73	$19,318.23
Motorcycle			1990	6	0.00		0.00	0.00	$0.00
			1990	6	0.00		0.00	0.00	$0.00
			1990	6	0.00		0.00	0.00	$0.00
Total:							**277,409.73**	**277,409.73**	**$19,318.23**
Equipment									
computer	1	57,440.00	1995	5	15,934.42	1.00	15,934.42	15,934.42	$1,109.64
			1990	10	0.00		0.00	0.00	$0.00
			1990	10	0.00		0.00	0.00	$0.00
			1990	10	0.00		0.00	0.00	$0.00
			1990	10	0.00		0.00	0.00	$0.00
			1990	10	0.00		0.00	0.00	$0.00
x-ray machine			1990	10	0.00		0.00	0.00	$0.00
Total:							**15,934.42**	**15,934.42**	**$1,109.64**
Personnel									
RTO (STO)	1	20,000.00	1995			1.00	20,000.00	20,000.00	$1,392.76
assistant (TO)	1	17,500.00	1995			1.00	17,500.00	17,500.00	$1,218.66
clerk (TA)	1	11,500.00	1995			1.00	11,500.00	11,500.00	$800.84
driver (SCI)	1	10,000.00	1995			1.00	10,000.00	10,000.00	$696.36
		0.00	1990				0.00	0.00	$0.00
Total:							**59,000.00**	**59,000.00**	**$4,108.64**
Overhead / Maintenance									
RHO	1	1,408,161.00	1994			0.1	140,816.10	197,083.66	$13,724.49
			1990			0	0.00	0.00	$0.00
			1994			1	0.00	0.00	$0.00
			1990			0	0.00	0.00	$0.00
			1990			1	0.00	0.00	$0.00
			1990			0	0.00	0.00	$0.00
Total:							**140,816.10**	**197,083.66**	**$13,724.49**
Diagnosis									
			1990				0.00	0.00	$0.00
			1990				0.00	0.00	$0.00
			1990				0.00	0.00	$0.00
			1990				0.00	0.00	$0.00
			1990				0.00	0.00	$0.00
			1990				0.00	0.00	$0.00
			1990				0.00	0.00	$0.00
			1990				0.00	0.00	$0.00
Total:							**0.00**	**0.00**	**$0.00**
Supplies									
			1990				0.00	0.00	$0.00
			1990				0.00	0.00	$0.00
			1990				0.00	0.00	$0.00
			1990				0.00	0.00	$0.00
			1990				0.00	0.00	$0.00
			1990				0.00	0.00	$0.00
			1990				0.00	0.00	$0.00
			1990				0.00	0.00	$0.00
			1990				0.00	0.00	$0.00
			1990				0.00	0.00	$0.00
Total:							**0.00**	**0.00**	**$0.00**
Treatment									
			1990				0.00	0.00	$0.00
			1990				0.00	0.00	$0.00
			1990				0.00	0.00	$0.00
			1990				0.00	0.00	$0.00
			1990				0.00	0.00	$0.00
			1990				0.00	0.00	$0.00
			1990				0.00	0.00	$0.00
			1990				0.00	0.00	$0.00
Total:							**$0.00**	**$0.00**	**$0.00**
Supervision costed at central level!									
			1990				0.00	0.00	$0.00
			1990				0.00	0.00	$0.00
			1990				0.00	0.00	$0.00
			1990				0.00	0.00	$0.00
Total:							**0.00**	**0.00**	**$0.00**
Training costed at central level!									
			1990				0.00	0.00	$0.00
			1990				0.00	0.00	$0.00
			1990				0.00	0.00	$0.00
			1990				0.00	0.00	$0.00
			1990				0.00	0.00	$0.00
			1990				0.00	0.00	$0.00
Total:							**0.00**	**0.00**	**$0.00**
SUMS:							**566,793.58**	**623,061.14**	**43,388.66**

V. Annotations and references

[1] Raviglione, M. C., Snider, D. E. and Kochi, A. Global epidemiology of tuberculosis. Morbidity and mortality of a worldwide epidemic. J.A. M.A. 273, 220, 1995.

[2] Sawert H, Kongsin S, Payanandana V et al. 1996: An assessment of the costs and benefits of improving tuberculosis control. The case of Thailand. Soc Sci Med. submitted for publication

[3] Detailed explanations of cost categories will be given below

[4] Creese A, Parker, D 1994: Cost analysis in primary health care. Geneva, World Health Organization

[5] Drummond MF, Stoddart GL, Torrance GW 1987: Methods for the economic evaluation of health care programmes. Oxford, Oxford University Press

[6] Phillips M, Mills A, Dye C 1993: Guidelines for cost-effectiveness analysis of vector control. PEEM guidelines series 3, WHO, Geneva

[7] However, all expenditures for capital items should be annuitized

[8] Exceptions for international comparisons are discussed below

[9] This information is also contained in the International Financial Statistics published by the IMF, Washington DC

[10] Assuming that the exchange rate is expressed as "units local currency per unit international currency"; if the rate is expressed as "units international currency per unit local currency", local costs must be divided by the exchange rate, not multiplied

[11] Tuberculosis Programme, World Health Organization 1994: Guidelines for effective TB control. WHO, Geneva

[12] personal communication; Prof. A.D. Harries, Blantyre

[13] Statistics available at the Central Office of the National Tuberculosis Programme, Lilongwe

[14] Murray CJ, DeJonghe E, Chum HJ et al 1991: Cost effectiveness of chemotherapy for pulmonary tuberculosis in three sub-Saharan African countries. Lancet 338:1305-8

[15] reports available from the Tuberculosis Division, World Health Organization, Geneva

[16] Location of the central offices of the National Tuberculosis Control Programme

[17] Official discount rate used for project appraisals in Malawi in 1995, information provided by the Ministry of Finance

[18] Chaulet P 1992: The supply of antituberculosis drugs and national drug policies. Tubercle Lung Dis 73:295-304

[19] personal communication; Prof. P. Chaulet, Geneva

[20] This result was obtained using a cost of $ 100.- per roll of film, similar to the cost reported from countries that regularly use the MR technique; during the time of the study, the TB programme in Blantyre had ordered film rolls for test purposes at a cost of $ 200.- per film; it can be assumed that the price would drop to international levels once large quantities for routine use would be ordered

[21] This calculation assumes the same proportion of thiacetazone replacement (70%) in both scenarios; under the assumption that all patients under the "standard" regimen would be treated with thiacetazone throughout, cost savings are smaller at $ 4,883

22 De Jonghe E, Murray CJL, Chum HJ et al 1994: Cost-effectiveness of chemotherapy for sputum smear-positive pulmonary tuberculosis in Malawi, Mozambique and Tanzania. Int J Health Planning Management 9: 151-81

23 Mills AJ 1991: The cost of the district hospital; a case study from Malawi. Washington DC: The World Bank. World Bank Policy, Research and External Affairs Working Paper 742

24 Mitchison DA 1974: Bacteriology of tuberculosis. Trop Doctor 4: 147

25 Githui W, Kitui F, Juma ES et al 1993: A comparative study on the reliability of the fluorescence microscopy and Ziehl-Neelsen method in the diagnosis of pulmonary tuberculosis. East Afr Med J 70: 263- 6

26 Nunn P, Porter J, Winstanley P 1993: Thiacetazone - avoid like poison or use with care? Trans Royal Soc Trop Med Hyg 87: 578-82

27 Kelly P, Buve A, Foster SD et al 1994: Cutaneous reactions to thiacetazone in Zambia - implications for tuberculosis treatment strategies. Trans Royal Soc Trop Med Hyg 88: 113-5

28 Okwera A, Whalen C, Byekwaso F et al 1994: Randomised trial of thiacetazone and rifampicin-containing regimens for pulmonary tuberculosis in HIV-infected Ugandans. Lancet 344: 1323-8

29 Use of thiacetazone (letters). Lancet 345: 62-3

30 Nunn P, Kibuga D, Gathua S et al 1991: Cutaneous hypersensitivity reactions due to thiacetazone in HIV-1 seropositive patients treated for tuberculosis. Lancet 337: 627-30

31 Munthali MM, Warndorff DK, Koka CW, Glynn JR, Salaniponi FLM: Fatal thiacetazone reactions in Northern Malawi (in press)

32 Anonymous 1992: Severe hypersensitivity reactions among HIV-seropositive patients with tuberculosis treated with thiacetazone. Wkly Epidem Rec 67: 1-3

33 Global Programme on AIDS 1992: Recommendations for the selection and use of HIV antibody tests. Wkly Epidem Rec 67: 145-52

34 Total case number of 2,488 times HIV prevalence of 70% times fatality rate of 3%

35 The World Bank 1993: Investing in Health. World Development Report 1993. Oxford University Press

36 Assuming an average age of death of 23 years and an average life expectancy of 7 years for HIV positive individuals; the respective number of DALYs lost is 9.38 due to a higher age-weighting of years in the young adult age group

37 Tuberculosis Programme, WHO: Guidelines for tuberculosis control

38 We did not perform a specific analysis of the maintenance costs of x-ray facilities for this study; however, under the assumption that our allocation of general hospital overhead costs provides a reasonable estimate, the cost per x-ray are slightly less than the cost of microscopy if three smears are performed per patient

39 Murray C, Styblo K, Rouillon A 1993: Tuberculosis. in: Jamison DT, Mosley WH, Measham AR, Bobadilla JL (eds.): Disease Control Priorities in Developing Countries. Oxford University Press