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# EVALUATING HEALTHY DAYS OF LIFE GAINED FROM HEALTH PROJECTS

by

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## ABSTRACT

This paper draws attention to the importance of incorporating weights for time preference and productivity in using the concept of healthy days of life lost to evaluate health projects. Two alternative health strategies are defined for Ghana and evaluated, over a range of discount rates from zero to twenty percent, with regard to the present value of productive life saved. It is found that the relative ranking of the projects is sensitive to the choice of discount rates. The sensitivity of disease rankings to the underlying morbidity and fatality rates is also examined and the results underline the importance of obtaining better epidemiological baseline data and information on project effectiveness if the potential usefulness of the healthy days of life approach to project evaluation is to be fully realized.

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# I. INTRODUCTION

The quantitative assessment of the effects of health projects in developing countries has encountered both empirical and conceptual difficulties that are typically more formidable than those found in other sectors. The principle empirical difficulties lie in the dearth of consistent epidemiological data and in the problem of measuring the change in health status that results from any given health intervention. A related conceptual problem lies in aggregating different health status effects across diseases and population subgroups and over time. No standard measure of health status has been developed and, indeed, a single measure of health status acceptable for all purposes may never exist, because the concept is inherently subjective, involves unobservable effects and aggregation can require interpersonal comparisons.

An important motivation for the development of techniques of quantitative assessment and solutions to the problem of aggregation stems from the need for a measure of cost-effectiveness that can be used to establish priorities among different programs in the allocation of limited resources. Primarily because of the difficulty of developing a measure that can be aggregated across diseases and population subgroups, the application of cost-effectiveness analysis has been largely limited to examination of alternative strategies for single diseases. A number of procedures or models, primarily theoretical or abstract, have been developed that attempt to combine morbidity and mortality measures into a single index[1] that could be used for cost-effectiveness analysis and program monitoring. Suggestions for health status indicators have ranged from the use of life expectancy to the development of indices based on functional capacity and health prognosis. Most of the measures suggested to date are either too limited in the scope of effects encompassed or are impractical to implement.

A recent promising approach to formulation of a measure of health impact that can allow multiple disease cost-effectiveness analysis is the concept of healthy days of life proposed by the Ghana Health Assessment Project Team (R. Morrow et al, 1981) [9]. Examples of applications of the healthy days of life approach to multiple disease analysis are provided by R. Grosse et al in a study of the cost-effectiveness of alternative health interventions in Indonesia [10], and more recently by G. Simmons, R. Grosse et al in a Rapid II micro computer simulation model [21]. The Ghana Team procedure is essentially an accounting approach that uses estimates of incidence, case fatality and duration and extent of disability to calculate the number of healthy days lost from disease. While this method does not account for qualitative differences among different morbidity states, does not directly consider interaction among diseases,[2] and also has substantial

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[1]See for instance Torrance [23]. This article reviews 16 models and unifies these in a common mathematical framework. The procedure applied below is consistent with the Torrance mathematical specification.

[2]An alternative approach, allowing interaction among diseases, examines the cost effectiveness of multiple interventions to maximize the probability of survival [4].

data requirements that are typically not met from the format of regularly collected information in developing countries, it is conceptually simple. At present, the weakness of the epidemiological database has limited applications of the healthy days methodology, but with effort, as shown by the Ghana case study, the data requirements can be met from reanalysis of available information from diverse sources[3] supplemented by epidemiological survey data. In addition the methodology can be extended to provide a basis for quantification of disease effects of alternative health strategies on health status across age groups and, thus, holds promise for applications to policy analysis.

The Ghana team methodology cannot, however, be applied to determine the most cost effective alternative in all situations. Cost-effectiveness analysis can only be applied to make choices among alternatives with comparable outcomes. In general the broader the scope of the policy choices the more difficult to measure the effect of project outcomes in comparable units. Although healthy days may provide a reasonable first approximation for the health output of projects it does not provide for other kinds of useful outcome measures. If a choice is to be made between projects in different sectors then project outcomes must be measured in terms of social welfare, a concept that subsumes health status but also includes other dimensions related to basic needs and social-economic well being. Even for many choices within the health sector having effects across population groups, outcomes may be better measured in broader terms than unweighted

[3]The National Census with age, sex and region specific death rates derived from a special sample, cause of death from detailed review of death certificates (available from about 12% of total deaths), inpatient and outpatient statistics, special surveys and published studies, and interviews with experienced clinicians.

healthy days of life lost. Only projects with the narrowly defined objectives can be compared using the unmodified concept of healthy days of life lost. Examples are alternative child immunization projects; or a little more broadly, comparison of oral rehydration and immunization alternatives; or perhaps still more broadly, comparison of outreach programs with multiple interventions all targeting children. Substantial progress has been made over the last few years in the application of cost-effectiveness analysis to aid project design where the objectives can be narrowly defined[4], although even for single diseases the weakness of the underlying epidemiological data has hampered the analysis [13,25]. But moving the technology of health project choice beyond narrowly defined objectives will require, in addition to substantially improved epidemiological data, adding the difficult step of evaluating healthy days of life lost. It is important to note that use of unweighted healthy days of life lost to evaluate a health program or policy having wide effects on morbidity and fatality throughout the population implies comparability across age groups and assumes indifference to adult productivity.

This paper draws attention to two important classes of value judgement that are inherent in the application of cost-effectiveness analysis to choices among projects within the health sector — social time preference and productivity weights. This is done by modifying the concept of healthy days of life lost from disease as proposed by Morrow et al. to include these

[4] Recent reviews of applications of cost effectiveness analysis to the health sector in developing countries are given in A. Mills [11,12], R. Barlow [2], and D. de Ferranti [8]. Guidelines for cost effectiveness analysis for specific diseases or interventions are given in A. Creese [6], D. Shepard and R. Cash [19], and more generally in R. Reynolds and C. Gaspari [17]. Some additional recent applications include schistosomiasis [14] and tuberculosis [3].

concepts.[5] An example of such a modification used to derive a measure of intervention effectiveness for the control of a single disease is given by A. Prost and N. Prescott in a recent study on onchocerciasis [16]. An example applying discounting and productivity weights in the case of multiple diseases and intervention packages is given below. The results demonstrate that policy implications can be strongly affected by the use (or omission) of weights for time preference and productivity. In Section II the procedure used in estimating healthy days of life lost is set forth with the modifications needed to include time preference and productivity effects. The modified procedure is applied to health sector analysis using the original Ghana data and the results are compared with the undiscounted and unweighted days lost reported in the original study. In Section III the procedure is applied to project analysis to contrast the cost-effectiveness of alternative project designs. Evaluation of multiple objectives is briefly discussed in Section IV. Conclusions are given in Section V.

## II. METHODOLOGY

The quantitative measure of disease proposed in the Ghana study has four components. These are days of healthy life lost from (a) premature death, (b) acute illness, (c) disability before premature death, and (d) chronic disability. Diseases vary greatly in the timing of these effects over the life span of an individual. This is clearly revealed in the basic Ghana data, defining the parameters of morbidity and mortality, reproduced

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[5]The Ghana team notes the existence of these concepts but does not develop their implications for policy formulation.

in Appendix 1. For example pertussis occurs early in life, causes premature death in approximately 1 percent of its victims, and about 30 days of temporary disability in the survivors, but is considered to have no long term effects over the life time of survivors. In contrast, the onset of hypertensive cardiovascular disease occurs much later in life, and the disease is accompanied by partial disability in 25 percent over the remaining normal life span and premature death in approximately 75 percent after a period of about 10 years of partial disability. There is, thus, a stream of effects that are characteristic of individual diseases.

## Discounting Healthy Days of Life Lost

Neither the individual nor the community are indifferent as to when the effects of disease occur. In general, temporally near events are given greater weight or value than distant events. This phenomenon has clear application in the case of financial benefits — one would obviously prefer an immediate financial payment compared to an equivalent payment to be received only after several years. Although perhaps not apparent at first thought, time preference is also applicable to disease events. A healthy day of life in the present has a greater intrinsic value to the individual than a day in the future. This is partly explained by the preference for immediate consumption compared to consumption in the future but is also explained by the inevitability and randomness of death which may intervene before future events are realized.

The time stream of healthy days of life lost to disease can be reduced to an equivalent present value through the use of a discount rate. The advantages of deriving the equivalent present value is that it allows a common comparison among diseases and thus among projects that target different diseases. The discount rate is chosen to reflect the trade-off between present and future events. The rate chosen should represent the consensus of society and be consistent across projects to be compared. As applied to social projects with important non monetary outcomes, the discount rate is not a positive concept, but is normative and the result of a value judgment comparing the relative importance of present versus future events. Considerable debate has taken place over the correct choice of discount rate, with suggestions ranging from zero or negative to over fifteen percent [26]. Most analysts, however, support a relatively low real rate (that is, a rate corrected for the effects of inflation) of between 3 and 6 percent. It is important to note that the difficulty of choosing a discount rate is not avoided by not discounting at all because this is equivalent to discounting using a rate of zero — a choice that is extreme and probably far from the social consensus.

Assuming that disease occurs at the age of onset with the incidence and case fatality rates in Annex One, the stream of days lost to premature death, disability, and acute illness can be calculated and discounted for each disease using the formulas in Annex two. The procedure is conceptually simple but sufficiently cumbersome that a computer program was used for the calculations. In addition to discounting, the original procedure was altered in the interest of accuracy by using a life table to calculate survival rates from one age group to another. A comparison of the ranking of diseases in order of magnitude of days lost using extreme discount rates of zero and twenty percent is given in Table 1. The differences in ranking are not dramatic and somewhat inconclusive yet the results do show an

## TABLE 1

## RANKING OF DISEASES BY DAYS LOST

| UNDISCOUNTED | | DISCOUNTED (R=.20) | |
|---|---|---|---|
| DISEASE | DAYS LOST | DISEASE | DAYS LOST |
| Malaria | 33206 | Malaria | 3558 |
| Measles | 23338 | Measles | 3235 |
| Pneum C. | 18540 | Cerevas | 2834 |
| Malnutr | 17449 | Gastroe | 2430 |
| Gastroe | 14457 | Pneum C. | 2046 |
| Accident | 14127 | Accident | 2039 |
| B. Injur | 14018 | Malnutr | 1986 |
| Prem Bir | 13890 | Pneum A. | 1655 |
| Tubercu | 9592 | B. Injur | 1251 |
| Cerevas | 8619 | Prem Bir | 1240 |
| Pneum A | 8427 | Influen | 1154 |
| Cirrhos | 6132 | Tubercu | 1086 |
| Neo Tet | 5674 | Hepatit | 1078 |
| Compl.Pgn | 5525 | Pertuss | 1060 |
| Pertuss | 4700 | Compl.Pgn | 875 |
| Hyperte | 4528 | Cirrhos | 861 |
| Typhoid | 4486 | Typhoid | 839 |
| Meningi | 4430 | Hyperte | 771 |
| Hepatit | 4401 | Oth Tet | 572 |
| Schisto | 4272 | Meningi | 564 |
| Oth Tet | 4234 | Neo Tet | 506 |
| Pepulcr. | 3332 | Pepulcr. | 455 |
| Leprosy | 3000 | Leprosy | 355 |
| Oncho | 1865 | Oncho | 209 |
| Influen | 1779 | Schisto | 172 |
| Polio | 1220 | Polio | 133 |
| Gyneaco | 764 | Gyneaco | 124 |
| Total | 236016 | Total | 33103 |

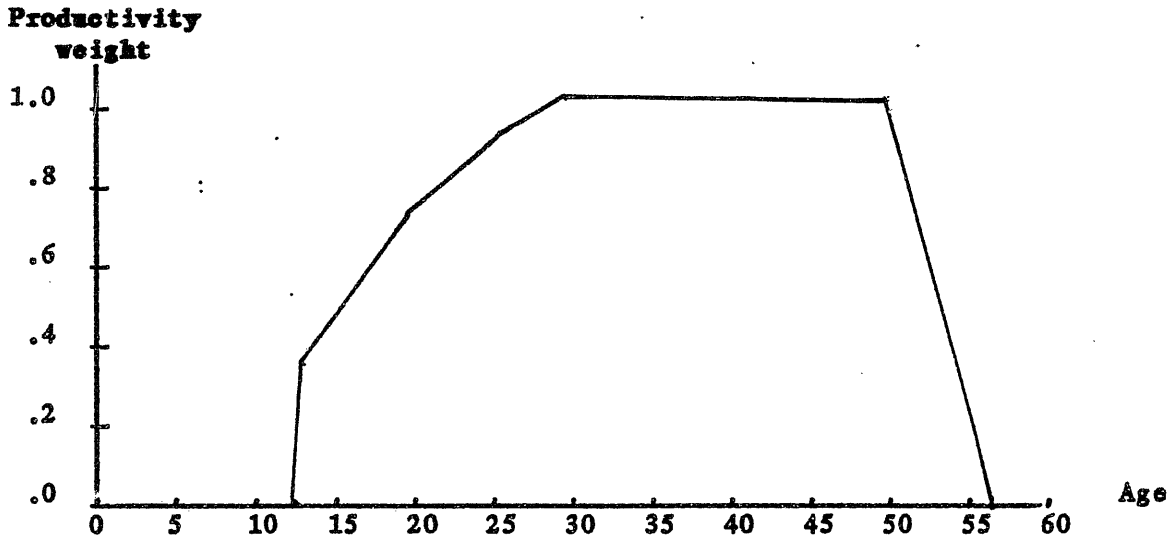
increase in importance of diseases having an immediate loss of days compared to diseases with effects distributed over a longer time period.

**Weighting Healthy Days of Life Lost by Productivity**

Addition of weights for productivity greatly changes the results obtained above, especially in interaction with the discount rate. The timing of health effects over the life span has implications for the economic contribution of the individual as productive days are lost from acute illness, disability and premature death. This is true even if the onset of the disease occurs in non productive child years because children can be assumed to grow into productive individuals. While it is not to be argued that economic productivity should be the sole criterion on which project choices are based, it is argued that it is a highly significant criterion that is amenable to quantitative analysis and which is often ignored in health policy analysis. Focusing on productivity does not ignore the welfare of children. Adult productivity is important to the quality and sustenance of life for all age groups.

Weights for productivity were added to the Ghana model by estimating the age earnings profile. The profile is derived by using labor force participation rates by age group to correct for unemployment. It is also assumed that entry into the labor force occurs at age 14 with an income of one half the mean for all age groups. Income then increases at regular increments up to the age of thirty. In addition per capita productivity is projected to grow by 2.5 percent per annum. Dividing the expected income of all wage groups by the income expected at age thirty gives the profile expressed in terms of productivity weights. The resulting productivity profile is depicted in Figure One. Productive days lost to disease are obtained by multiplying healthy days lost by the productivity weights for each age group and then discounting and summing over the expected remaining life span to get the present equivalent number of productive days lost.

**Figure 1**




**Age Productivity Profile**

## Sector Analysis

The dramatic effect of introducing both discounting and productivity weights is illustrated in Table 2. With a discount rate of zero thediseases with the greatest cost in lost product are primarily childhood diseases such as measles, childhood pneumonia, malnutrition, birth injuries, and gastroenteritis. Cerebrovascular problems, hypertensive cardiovascular disease and other diseases of adults are relatively low on the list. As the discount rate rises, adult problems increase in importance and childhood diseases fall in significance. The lines linking selected diseases in the table illustrate the shift in ranking. At the extreme discount rate of 20 percent the greatest income is lost from cerebrovascular diseases, adult pneumonia and accidents while childhood problems such as birth injuries and malnutrition have fallen to a relatively low ranking. This marked difference in rankings obviously has implications for the composition of projects where at least part of the objective is to reduce income losses from disease.

At first glance, given the large number of diseases, an interpretation of the results may not be readily apparent but groups of diseases with particular significance for sector analysis can be identified and examined for relative importance in contributing to healthy and productive days lost. For instance the analysis could aggregate diseases in groupings that have similar delivery strategies as an aid in choosing delivery infrastructure. Thus, a separate disease such as polio may be ranked near the bottom of the list, but when included with other diseases in a grouping of immunizable diseases the ranking of the combined group may be much higher and an immunization delivery package a priority[6]. Similarly, grouping of chronic versus non chronic diseases, or communicable versus non communicable diseases, could be informative in shaping sector strategy. In the Ghana case for example, days lost to adult chronic diseases measured as a percent of total days lost increases from 5 percent when the discount rate is zero, through 12 percent with a discount rate of .05, and 19 percent at a discount

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[6]A closely associated analysis , examining the cost-effectiveness of adding new immunizations to an existing program is given in [5].

TABLE 2

RANKING OF DISEASES BY PRESENT VALUE OF PRODUCTIVE DAYS OF LIVE LOST INCOME USING ALTERNATIVE DISCOUNT RATES (R)

| R = 0 | | R = .05 | | R = .10 | | R = .15 | | R = .20 | |
|---|---|---|---|---|---|---|---|---|---|
| Disease | Days Lost | Disease | Days Lost | Disease | Days Lost | Disease | Days Lost | Disease | Days Lost |
| Malaria | 35079 | Malaria | 6645 | Accdnts | 2678 | Pneum A | 1825 | Cardvas | 1509 |
| Measles | 23674 | Accdnts | 5254 | Pnuem A | 2459 | Accdnts | 1683 | Pneum A | 1462 |
| Pneum C | 19425 | Measles | 4709 | Tubercu | 2077 | Cardvas | 1642 | Accdnts | 1208 |
| Malnutr | 18211 | Tubercu | 3876 | Cardvas | 1803 | Tubercu | 1326 | Tubercu | 956 |
| B Injur | 15179 | Pneum C | 3863 | Malaria | 1744 | Cirrhos | 1064 | Hepatit | 835 |
| B. Prem | 15040 | Pneum A | 3696 | Cirrhos | 1550 | Hepatit | 988 | Influen | 823 |
| Gastroe | 14164 | Malnutr | 3622 | Comp Prg | 1358 | Comp Prg | 939 | Cirrhos | 791 |
| Accdnts | 13899 | Gastroe | 2817 | Measles | 1295 | Influen | 852 | Comp Prg | 725 |
| Tubercu | 9157 | B Injur | 2738 | Hepatit | 1287 | Typhoid | 843 | Tyhoid | 675 |
| Pneum A | 6414 | B. Prem | 2713 | Typhoid | 1172 | Hyperte | 795 | Hyperte | 634 |
| Neo Tet | 6143 | Cirrhos | 2510 | Pneum C | 1062 | Malaria | 579 | Pepulcr. | 415 |
| Schisto | 5460 | Comp Prg | 2340 | Hyperte | 1049 | Pepulcr | 551 | Oth tet | 351 |
| Comp Prg | 5179 | Cardvas | 2002 | Malnutr | 996 | Oth tet | 494 | Leprosy | 305 |
| Cirrhos | 4638 | Hepatit | 1989 | Influen | 908 | Measles | 449 | Malaria | 225 |
| Meningi | 4436 | Typhoid | 1942 | Pepulcr | 811 | Leprosy | 419 | Measles | 182 |
| Pertuss | 4306 | Oth Tet | 1576 | Oth tet | 796 | Pneum C | 369 | Pneum C | 150 |
| Oth tet | 4195 | Hyperte | 1465 | Gastroe | 774 | Malnutr | 346 | Meningi | 147 |
| Typhoid | 4169 | Pepulcr | 1382 | B Injur | 686 | Gastroe | 269 | Malnutr | 140 |
| Hepatit | 4018 | Meningi | 1303 | B Prem | 680 | Meningi | 257 | Gynaeco | 111 |
| Pepulcr | 2850 | Leprosy | 1206 | Leprosy | 650 | B Injur | 218 | Gastroe | 109 |
| Leprosy | 2848 | Neo Tet | 1108 | Meningi | 520 | B Prem | 216 | B Injur | 81 |
| Cardvas | 2248 | Influen | 1040 | Neo Tet | 277 | Gynaeco | 141 | B Prem | 80 |
| Hyperte | 2188 | Schisto | 1010 | Schisto | 245 | Neo Tet | 88 | Neo Tet | 32 |
| Oncho | 1926 | Pertuss | 815 | Pertuss | 214 | Schisto | 76 | Schisto | 29 |
| Influen | 1421 | Oncho | 443 | Gynaeco | 199 | Pertuss | 71 | Pertuss | 27 |
| Polio | 1274 | Gynaeco | 325 | Oncho | 140 | Oncho | 55 | Oncho | 25 |
| Gynaeco | 650 | Polio | 266 | Polio | 76 | Polio | 27 | Polio | 11 |
| TOTAL | 22805 | TOTAL | 62666 | TOTAL | 27518 | TOTAL | 16595 | TOTAL | 12050 |

rate of .1, to 28 percent at a discount rate of .2. Thus adult chronic diseases can be an important cause of ill health at the discount rates likely to be applicable, that is between .05 and .1.

**Data Requirements**

The techniques outlined above can help in the design of sector strategies and the identification of sector priorities, but in order to provide a sufficiently comprehensive sector analysis a substantial proportion of the causes of mortality in each age group, say 80-85 percent, must be included. For purposes of the illustration above the number of diseases was restricted to 27, out of a total of 55 originally included in the Ghana study. However, even the smaller number of diseases has data requirements that exceed the availability of reliable epidemiological information. Experiments demonstrate that the results are highly sensitive to changes in the parameters, especially morbidity and case fatality rates. For example, a decrease of 4.4 per thousand in the incidence of hepatitis (a halving of the estimated incidence) decreases the rank of the disease by 4 at a discount rate of zero and 5 at a rate of 20 percent.

Malaria is a further case in point that demonstrates the importance of the age pattern of disease. Given the parameter estimates in the Ghana study, malaria is ranked at the top of the list at low discount rates, but quickly falls as the discount rate increases. This is because the use of single average incidence and case fatality rates and age of onset to cover the entire population distorts the discounted results by centering on mortality and disability in childhood. In actuality, the incidence of malaria in the adult population is also high although the case fatality rate is much lower. Separating the population into age subgroups with regard to malaria increases the ranking of malaria at higher discount rates because of the increase in the immediate days lost to productivity with onset of the disease in older age groups. Thus, not only the average rates are important but also the age specific pattern of the disease.

## III. EVALUATION OF PROJECTS

To illustrate the application of the procedure to project analysis, two projects involving the same per capita expenditure were arbitrarily defined in terms of the expected effect the projects would have on disease incidence and case fatality rates. Because of the almost total lack of empirical analyses of the health outcomes of multiple interventions, hypothetical specifications of the two project alternatives were used to facilitate an illustration of project evaluation[7]. The first project includes outreach promoters and emphasizes selected preventive services, especially nutritional supplements for malnourished children, antenatal care, immunizations, and oral rehydration. The preventive services are backed up by minimal referral services relying on essential drugs and equipment. The second project does not have an outreach program and emphasizes treatment of disease at the health center level and above on the basis of self referral. A wider range of drugs and equipment is available. Although both projects have both preventive and curative aspects the first project is best

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[7]I am grateful to Dr. John Hamilton, Dean of the School of Medicine, University of Newcastle, Australia, and formerly health project officer with the World Bank for his assistance in specification of the morbidity and mortality effects of the hypothetical projects.

TABLE 3

PERCENTAGE REDUCTION IN INCIDENCE AND CASE FATALITY RATES FOR SELECTED DISEASES WITH ILLUSTRATIVE ALTERNATIVE HEALTH PROJECTS

| Disease | Preventive Oriented % Reduction in | | Curative Oriented % Reduction in | |
|---|---|---|---|---|
| | Incidence | Case Fatality | Incidence | Case Fatality |
| Typhoid | 40 | 0 | 10 | 60 |
| Gastroe | 0 | 60 | 0 | 40 |
| Tubercu | 60 | 0 | 10 | 50 |
| Pertuss | 70 | 10 | 15 | 40 |
| Meningi | 0 | 0 | 0 | 30 |
| Polio | 80 | 0 | 20 | 10 |
| Measles | 70 | 10 | 15 | 40 |
| Malaria | 80 | 20 | 15 | 40 |
| Leprosy | 30 | 0 | 0 | 0 |
| Schisto | 0 | 0 | 0 | 0 |
| Oncho | 0 | 0 | 0 | 0 |
| Hepatit | 0 | 0 | 0 | 20 |
| Neo tet | 70 | 0 | 15 | 30 |
| Oth tet | 70 | 0 | 15 | 30 |
| Malnutr | 80 | 20 | 15 | 40 |
| Hyperte | 0 | 0 | 0 | 20 |
| Cerevas | 0 | 0 | 0 | 20 |
| Influen | 0 | 10 | 0 | 20 |
| Pneum C | 0 | 20 | 0 | 60 |
| Pneum A | 0 | 20 | 0 | 70 |
| Pepulcr | 0 | 0 | 0 | 30 |
| Cirrhos | 0 | 0 | 0 | 10 |
| Cpregna | 50 | 0 | 20 | 50 |
| B Prem | 50 | 0 | 15 | 40 |
| B Injur | 40 | 0 | 10 | 40 |
| Gynaeco | 10 | 0 | 15 | 40 |
| Accident | 10 | 0 | 0 | 30 |

characterized as preventive and the second project as curative. The postulated effects each project would have on case morbidity and case fatality are summarized in Table 3. The estimates of effects take into account differences in use of services and range of available interventions.

To compare the two strategies with regard to their effect on production, the present value of productive days of life saved in a population of 1000 during one year of each strategy was calculated for discount rates ranging from zero to twenty percent. The results, summarized in Table 4, demonstrate that for discount rates below 8 percent the preventive strategy is cost effective relative to the curative strategy. At discount rates above 8 percent the curative strategy is cost effective. At a discount rate of 8 percent, the switching rate, the two strategies have approximately equivalent effects measured in terms of discounted days of productive life saved.

**TABLE 4**

**PRESENT VALUES OF PRODUCTIVE DAYS OF LIFE SAVED DURING ONE YEAR OF ALTERNATIVE HEALTH PROJECTS USING ALTERNATIVE DISCOUNT RATES***

| Discount Rate | Preventive Oriented Project | Curative Oriented Project |
|---|---|---|
| R = .00 | 112305 | 91407 |
| R = .05 | 25505 | 23575 |
| R = .10 | 8841 | 9463 |
| R = .15 | 4269 | 5183 |
| R = .20 | 2605 | 3451 |

*The present value of the two projects is approximately equal at R=.08

## IV. MULTIPLE OBJECTIVES

The analysis in the last section is important because it underlines the effect health strategies may have on productivity, an effect that is often not given sufficient regard in the formulation of health plans. (With the possible exception of disease specific strategies such as malaria or oncho programs related to the extension of new lands or improved agricultural output.) However, by itself the analysis is disconcerting, because social welfare is not influenced solely by economic production but is also related directly to health status. Similarly, an analysis such as that used in the first part of section II, relying only on the calculation of health effects unweighted for productivity, is not wholly satisfactory. More appropriate, would be a methodology that combines both health and production as social objectives.

Recent developments in the literature on project evaluation have pointed the way towards combining social objectives in the form of a social welfare function to facilitate project choice [1,7,24]. In application a non linear function allowing diminishing marginal social benefits could be used and the parameters (weights) determined through a delphi procedure. An illustration of such a function that would be amenable to specification through questions couched in the form of elasticities, was provided by R. Barlow at a meeting of a WHO/TDR working group [1]. The function used in that study contained seven components — three measures of health status, two measures of economic well being and an equity index. If it can be assumed that changes in health status do not significantly effect the "trade off" relationships between non health components, the function can be simplified to include only health outcomes, perhaps measured by weighted healthy days of life. Some procedures for specification of "utility" weights in a health status/welfare function are summarized by G. Torrance in a recent article [24]. These procedures have not yet been applied to health resource allocation problems in a developing country, but in concept at least, the techniques are available.

## V. CONCLUSIONS

This paper examines the question of evaluating healthy days of life in health policy analysis. There are other plausible approaches to health sector and health project evaluation, but because of its simplicity the discussion has used the healthy days concept to provide a vehicle to bring into focus several issues related to any effort to move cost-effectiveness analysis beyond the confines of its current applications to single diseases and interventions. The issues that have emerged from the discussion involve (1) the need to weight health outcomes, (2) the importance of discount rates, and (3) the need for improved epidemiological data and empirical tests of project effects.

### The Need for Discounting and Weighting

Healthy days of life lost and similar techniques hold great promise as major innovations incorporating epidemiological information in project and sector analyses. However, evaluation of healthy days lost through the use of weights, especially for productivity and time, is required if the techniques are to be applied to cost-effectiveness analysis. The results illustrate that weighting and discounting, and their interaction, potentially[a] effect the priorities and strategies that evolve from an epidemiological analysis of the health sector [section II]. Similarly, weighting for productivity and discounting effect project choice and composition [section III]. It is not argued that the healthy days methodology should be applied mechanically to either project or sector analysis. A full sector analysis (such as a World Bank Health Sector Review or WHO Country Health Sector Profile), preceding design of a strategy for sector development, is a complex undertaking and includes considerations such as management, organization, logistics, and complementary relationships between health and other sectors. Project design and appraisal is similarly complex. However, an epidemiological review is an essential part of the process and evaluation of healthy days of life lost, including weights and discounting, greatly facilitates the analysis. Significantly, failure to discount or weight does not avoid the issue of subjectivity as it implicitly assumes a discount rate of zero and no importance for adult productivity as an objective of social welfare — both assumptions are extreme and far from the implied choices of most societies.

Addition of discounting and weighting to the analysis necessarily introduces value judgments that are technically difficult to incorporate, nevertheless the extant literature has evolved procedures that can allow a logical and methodical introduction of weights into the planning process. Although this paper has avoided technical discussion, a number of references are included in the bibliography to allow entry into the technical

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[a]Epidemiological analysis is only part of the process of setting priorities. Analysis of costs and evaluation of available intervention technology is also necessary [25].

literature. A far more daunting impediment to application of the new epidemiological and economic tools to cost-effectiveness analysis is the lack of data.

## The Need for Improved Data

A major international effort is needed to collect consistent and accurate epidemiological information. The results in the illustration presented in sections II and III are highly sensitive to plausible changes in the underlying morbidity, case fatality and disability rates. The results are also dependent on the age profile of disease effects. Similar sensitivities have been observed for the cost-effectiveness analysis of single diseases or interventions. Yet, existing epidemiological data are highly variable in quality, and uniform procedures for data collection are lacking. Clearly, the technology of cost-effectiveness analysis and sector evaluation, whether for single or multiple diseases, has outrun the epidemiological basis for analysis.

Benefits from a systematic collection of morbidity and mortality information using uniform procedures across countries would exceed the benefits for cost-effectiveness analysis alone. Such a survey would facilitate a broad spectrum of medical, public health, economic, and sociological research, and aid in setting priorities for health sector efforts on a global scale. Yet the monetary benefits from more efficient allocation of resources via cost-effectiveness studies would, of themselves, be sufficient to justify the cost of data collection. The great strides that have been made in the design and extension of family planning programs are owed in part to the tremendous effort, over the last twenty years, to collect fertility data under the auspices of the World Fertility Survey and the series of Contraceptive Prevalence Surveys. Similar benefits could be expected from a parallel World Health Survey[9].

An effort is also needed to measure the health status effects — changes in morbidity, case fatality and disability — of key health interventions, not only for single interventions but also for packages of interventions using alternative delivery mechanisms. It is notable that very little actual data exists giving the health outcomes of project alternatives consisting of multiple interventions. In order to get on with the process of developing analytical techniques recent models applied to project evaluation have been specified subjectively [4,10,21]. This is defensible on the grounds that planners implicitly use subjective estimates of intervention effectiveness in project design even when analytical models are not employed. The use of formal analytical tools adds order and some rigor to the subjective policy choice. But ultimately a concerted effort must be mounted to produce objective measures of the health outcomes of interventions. Ideally, at least one site in each of the three developing regions could be identified for long term operational research, again with the support of an international consortium of donors. To be of maximum benefit the long term should be considered twenty years or more, and data collected should be immediately available to the world research community.

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[9]Perhaps the World Health Organization could take the lead in mounting the World Health Survey, coordinating the financing and technical assistance of a consortium of international and bilateral donors and foundations. The cost of a World Health Survey would be on the order of 50 to 100 million dollars spread over a 10 to 15 year period. At first thought a large financial undertaking, but actually a small sum in comparison with the global cost of health care in developing countries.

We have learned much from the errors in design of previous experiments, such as Narangwal and Danfa, and the next round of longitudinal studies should be substantially improved.

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## APPENDIX 1

### PARAMETERS NEEDED TO CALCULATE THE DAYS OF HEALTH LIFE LOST TO SELECTED DISEASE PROBLEMS (per 1,000 persons in balance per year)

| Disease | Ave. Age At Onset ($A_o$)+ | CFR (C) | Ave. Age At Death ($A_d$) | % Disablement to death ($D_{od}$) | % Perm. Disab. (Q) | % Disablement (D) | Days of temp. Disab. (t) | Incidence (1) |
|---|---|---|---|---|---|---|---|---|
| 1. Typhoid | 20 | 7.3 | 20 | – | 0 | – | 60 | 4.0 |
| 2. Gastroenteritis | 2 | 1.0 | 2 | – | 0 | – | 14 | 70.0 |
| 3. Tuberculosis | 20 | 35.0 | 25 | 25 | 0 | – | 200 | 2.0 |
| 4. Pertussis | 1 | 1.0 | 1 | – | 0 | – | 30 | 21.0 |
| 5. Meningitis | 10 | 20.0 | 10 | – | 0 | – | 30 | 1.25 |
| 6. Polio | 3 | 5.0 | 3 | – | 95 | 25 | – | 0.22 |
| 7. Measles | .2 | 3.0 | 2 | – | 0 | – | 21 | 39.0 |
| 8. Malaria | 1 | 2.3 | 1 | – | 97.7 | 2 | – | 40.0 |
| 9. Leprosy | 20 | 25.0 | 30 | 50 | 75 | 25 | – | 0.5 |
| 10. Schistosomiasis | 5 | 4.0 | 30 | 4 | 96 | 1 | – | 7.0 |
| 11. Onchocerciasis | 5 | 0.0 | – | – | 5 | 70 | – | 2.8 |
| 12. Hepatitis | 20 | 3.0 | 20 | – | 0 | – | 60 | 8.87 |
| 13. Tetanus (a) neonatal | 0 | 80.0 | 0 | – | 0 | – | 0 | 0.5 |
| (b) other | 15 | 35.0 | 15 | – | 0 | – | 30 | .75 |
| 14. Malnutrition (severe) | 2 | 60.0 | 2 | – | 0 | – | 180 | 1.5 |
| 15. Hypertension | 40 | 75.0 | 50 | 50 | 25 | 25 | – | 0.75 |
| 16. Cerebrovascular Disease | 50 | 35.0 | 50 | – | 35 | 75 | 120 | 2.3 |
| 17. Influenza | 20 | 0.1 | 20 | – | 0 | – | 21 | 50.0 |
| 18. Pneumonia (a) child | 2 | 40.0 | 2 | – | 0 | – | 30 | 2.4 |
| (b) adult | 30 | 10.0 | 30 | – | 0 | – | 30 | 7.0 |
| 19. Peptic ulcer | 25 | 2.0 | 35 | 20 | 98 | 5 | – | 3.88 |
| 20. Cirrhosis | 30 | 80.0 | 35 | 50 | 20 | 25 | – | 0.65 |
| 21. Complications of Pregnancy | 20 | 6.5 | 20 | – | 5 | 25 | 21 | 4.8 |
| 22. Birth Diseases | | | | | | | | |
| (a) Prematurity | 0 | 10.2 | 0 | – | 0 | – | – | 9.6 |
| (b) Birth injury | 0 | 50.0 | 0 | – | 50 | 20 | – | 1.6 |
| (c) Congenital malformations | 0 | 15.0 | 0 | – | 85 | 25 | – | 0.96 |
| 23. Gynaecological Disorders | 25 | 1.0 | 40 | 10 | 20 | 25 | 20 | 1.0 |
| 24. Accidents | 15 | 10.0 | 15 | – | 5 | 25 | 30 | 7.7 |

Source: Ghana Health assessment team, πA Quantative Method of Assessing the Health Impact of Different Diseases in Less Developed Countriesπ, International Document of Epid. Vol. 10, No. 1, pp. 73-80 (1981).

## APPENDIX 2

**Formula Used in Calculation of the Stream of Benefits from Disease Intervention [1] (disease subscripts are omitted)**

I. Value of Death Prevented:

$$VDP = IN \cdot CF \cdot \sum_{s=Ao}^{AD-1} SR_s \sum_{a=AD}^{AR} Y_a \cdot SR_a \cdot (1+R)^{-(a-AO)}$$

II. Cost of Disability before Early Death:

$$VDBED = IN \cdot CF \cdot DD \cdot \sum_{a=AO}^{AD} Y_a SR_a (1+R)^{-(a-AO)}$$

III. Cost of Chronic Disability:

$$VCD = IN \cdot PD \cdot DP \cdot \sum_{a=AO}^{AR} Y_a SR_a (1+R)^{-(a-AO)}$$

IV. Acute Illness:

$$VAI = IN \cdot Y_{AO} \cdot (1-CF-PD) \cdot (TD/365.25)$$

**DEFINITIONS**

AO = Average age at onset (yrs.)

AD = Average age at death (yrs.)

TD = Average period of temporary disablement (days) among those who are affected but neither die nor are permanently disabled, multiplied by the proportion disablement of those temporarily disabled.

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1/ Derived from Ghana study [xxx] with the addition of discounting and survival ratios.

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DD = Percent disablement in the period from onset until death among those who die of the disease.

PD = Percentage of those affected who do not die but who are permanently disabled.

DP = Percentage disablement of those permanently disabled.

CF = Case fatality rate (percent)

IN = Incidence (new cases/1000)

SR = Survival ratio

R = Discount rate

Y = Weights for productivity or days lost depending on application (to calculate days lost Y is set to 365.25)

## APPENDIX 3

## GHANA: TABLE A

### PRODUCTIVE DAYS LOST FROM SELECTED DISEASES

**(ONSET OF DISEASE OCCURS OVER A ONE-YEAR PERIOD, PER THOUSAND POPULATION, 1981 CEDIS x 10, DISCOUNT RATE = .10)**

| Diseases | Source Of Lost Income | | | | |
|---|---|---|---|---|---|
| | Premature Death | Disablement To Premature Death | Chronic Disablement | Acute Illness | Total |
| Accident | 2321 | 0 | 291 | 65 | 2678 |
| Pneum A | 2308 | 0 | 0 | 151 | 2459 |
| Tubercu | 1667 | 228 | 0 | 182 | 2077 |
| Cerevas | 991 | 0 | 753 | 58 | 1803 |
| Malaria | 938 | 0 | 806 | 0 | 1744 |
| Cirrhos | 1064 | 378 | 107 | 0 | 1550 |
| Compl.Pgn | 1086 | 0 | 210 | 62 | 1358 |
| Measles | 1295 | 0 | 0 | 0 | 1295 |
| Hepatit | 926 | 0 | 0 | 361 | 1287 |
| Typhoid | 1016 | 0 | 0 | 155 | 1172 |
| Pneum C | 1062 | 0 | 0 | 0 | 1062 |
| Hyperte | 306 | 619 | 123 | 0 | 1049 |
| Malnutr | 996 | 0 | 0 | 0 | 996 |
| Influen | 174 | 0 | 0 | 734 | 908 |
| Peptic Ul. | 108 | 34 | 668 | 0 | 811 |
| Oth Tet | 791 | 0 | 0 | 4 | 796 |
| Gastroe | 774 | 0 | 0 | 0 | 774 |
| B. Injur | 555 | 0 | 130 | 0 | 686 |
| Prem Bir | 680 | 0 | 0 | 0 | 680 |
| Leprosy | 191 | 131 | 328 | 0 | 650 |
| Meningi | 520 | 0 | 0 | 0 | 520 |
| Neo Tet | 277 | 0 | 0 | 0 | 277 |
| Schisto | 138 | 10 | 96 | 0 | 245 |
| Pertuss | 214 | 0 | 0 | 0 | 214 |
| Gyneaco | 8 | 2 | 175 | 12 | 199 |
| Oncho | 0 | 0 | 140 | 0 | 140 |
| Polio | 13 | 0 | 63 | 0 | 76 |
| | . | . | . | . | . |
| | . | . | . | . | . |
| | . | . | . | . | . |
| Total | 20429 | 1406 | 3896 | 1788 | 27518 |

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GHANA: TABLE B

PRODUCTIVE DAYS LOST FROM SELECTED DISEASES BY YEAR OF EFFECT

(ONSET OF DISEASE OCCURS OVER A ONE-YEAR PERIOD, PER THOUSAND POPULATION, 1981 CEDIS x 10, DISCOUNT RATE = .15)

| Year | Source Of Lost Income | | | | |
|---|---|---|---|---|---|
| | Premature Death | Disablement To Premature Death | Chronic Disablement | Acute Illness | Total |
| 0 | 766 | 224 | 299 | 1788 | 3077 |
| 1 | 773 | 222 | 297 | 0 | 1292 |
| 2 | 778 | 220 | 295 | 0 | 1293 |
| 3 | 783 | 219 | 292 | 0 | 1294 |
| 4 | 788 | 217 | 290 | 0 | 1295 |
| 5 | 1272 | 224 | 300 | 0 | 1795 |
| 6 | 1081 | 100 | 157 | 0 | 1338 |
| 7 | 1077 | 99 | 156 | 0 | 1331 |
| 8 | 1072 | 98 | 154 | 0 | 1324 |
| 9 | 1068 | 96 | 153 | 0 | 1317 |
| 10 | 1298 | 87 | 173 | 0 | 1559 |
| 11 | 1289 | 2 | 174 | 0 | 1464 |
| 12 | 1279 | 2 | 181 | 0 | 1461 |
| 13 | 1686 | 2 | 182 | 0 | 1869 |
| 14 | 1840 | 2 | 270 | 0 | 2112 |
| 15 | 2067 | 3 | 306 | 0 | 2376 |
| 16 | 2007 | 3 | 305 | 0 | 2315 |
| 17 | 2063 | 3 | 317 | 0 | 2383 |
| 18 | 2361 | 3 | 325 | 0 | 2688 |
| 19 | 2447 | 3 | 383 | 0 | 2833 |
| 20 | 2512 | 3 | 396 | 0 | 2910 |
| 21 | 2493 | 3 | 393 | 0 | 2889 |
| 22 | 2473 | 3 | 391 | 0 | 2867 |
| 23 | 2571 | 3 | 388 | 0 | 2962 |
| 24 | 2585 | 3 | 410 | 0 | 2998 |
| 25 | 2682 | 3 | 404 | 0 | 3089 |
| 26 | 2428 | 0 | 395 | 0 | 2822 |
| 27 | 2408 | 0 | 391 | 0 | 2799 |
| 28 | 2388 | 0 | 388 | 0 | 2775 |
| 29 | 2368 | 0 | 384 | 0 | 2753 |
| 30 | 2299 | 0 | 376 | 0 | 2676 |
| Discounted Total | 20429 | 1406 | 3896 | 1788 | 27518 |

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## TABLE C

### PRESENT VALUE OF PRODUCTIVE DAYS OF LIFE SAVED FOR SELECTED DISEASES FROM ONE YEAR OF ALTERNATIVE HEALTH PROJECTS

(DISCOUNT RATE = .08)

| Project #1 | | Project #2 | |
|---|---|---|---|
| DISEASE | VALUE | DISEASE | VALUE |
| Malaria | 2369 | Pneum A | 1881 |
| Tubercu | 1562 | Tubercu | 1306 |
| Measles | 1534 | Pneum C | 1034 |
| Malnutr | 1358 | Measles | 1030 |
| Cpregna | 824 | Malaria | 960 |
| Gastroe | 754 | Accdnt | 888 |
| Oth Tet | 711 | Cpregna | 859 |
| Prem Bir | 572 | Typhoid | 805 |
| Typhoid | 560 | Malnutr | 792 |
| Pneum A | 537 | Prem Bir | 561 |
| B Injur | 462 | Gastroe | 503 |
| Pneum C | 344 | B Injur | 452 |
| Accidnt | 340 | Oth Tet | 409 |
| Neo Tet | 327 | Hepatit | 224 |
| Pertuss | 258 | Meningi | 218 |
| Leprosy | 243 | Hyperte | 210 |
| Polio | 97 | Cerevas | 193 |
| Gynaeco | 23 | Neo Tet | 189 |
| Influen | 21 | Pertuss | 173 |
| Meningi | 0 | Cirrhos | 173 |
| Schisto | 0 | Pepulcr | 55 |
| Oncho | 0 | Influen | 42 |
| Hepatit | 0 | Gynaeco | 40 |
| Hyperte | 0 | Polio | 26 |
| Cerevas | 0 | Leprosy | 0 |
| Pepulcr | 0 | Schisto | 0 |
| Cirrhos | 0 | Oncho | 0 |
| TOTAL | 12906 | TOTAL | 13033 |