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COSTING OF THE TALLOIRES CHILD SURVIVAL GOALS

A Report to the
Task Force For Child Survival

September 1990

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TABLE OF CONTENTS

EXECUTIVE SUMMARY 1

1. INTRODUCTION 2

2. COSTS BY EXTRAPOLATION TECHNIQUE 4

3. COMPARISON WITH THE REACH COST ESTIMATES 8

4. COSTS USING MODELING TECHNIQUE 10

5. OTHER CONSIDERATIONS 16

6. DETAILS OF EXTRAPOLATION CALCULATIONS 19
- 6.1 Polio and Measles 19
- 6.2 Neonatal Tetanus 22
- 6.3 Diarrheal Disease 24
- 6.4 Acute Respiratory Infections 26
- 6.5 Maternal Mortality 27
- 6.6 Infant and Child Mortality 29

APPENDIX A: Country Costs for Talloires Goals 37

APPENDIX B: Projected Current Spending on EPI to 2000 42

APPENDIX C: Affirmation of Bangkok Goals 44

APPENDIX D: Statement of the Linear Programming Problem 45

APPENDIX E: List of Contacts 46

APPENDIX F: Bibliography 47

EXECUTIVE SUMMARY

The Task Force for Child Survival, meeting in 1988 in Talloires, France, set forth an challenging set of seven goals in the Declaration of Talloires to be achieved by the year 2000. As part of the effort to gain a global commitment to the principle of Health For All by the Year 2000, the Task Force has investigated the cost of achieving these goals. This report finds that the probable cost of achieving these goals during the period from 1991 to 2000 is between $19 billion and $34 billion in excess of current health care spending. This broad range of possible costs is dependent upon how these goals are approached.

This report presents two independent calculations of the cost of achieving the Talloires goals. The first calculation is based on straightforward extrapolations of current health programs. The second method of calculation uses a simple model of multiple interventions affecting multiple goals. Both approaches are presented in this report because the extrapolation technique uses richer data and contains more detail, while the modeling technique overcomes some deficiencies of pure extrapolation.

Two estimates of costs are presented using the extrapolation technique. They are based on UNICEF data, which estimates current child mortality at 14.4 million, and World Bank data, which sets current child mortality at 12.4 million. The extrapolation technique of calculating cost indicates a total additional funding need of $33 billion using UNICEF mortality numbers and $28 billion with World Bank numbers for the following goals:

	Cost in $ Millions	
Goal	UNICEF	World Bank
Measles	$ 8,517	$ 5,707
Polio (in excess of EPI)	1,513	1,513
Neonatal Tetanus	3,978	3,978
Acute Respiratory Infections	2,623	2,158
Diarrheal Disease	4,980	4,279
Maternal Mortality	10,193	10,193
Infant and Child Deaths	1,591	1,095
Total Cost	$ 33,395	$ 28,923

The modeling technique of calculating the costs provides estimates of the total cost of achieving all the goals at once, rather than the individual costs of each goal. This approach estimates that the costs during the decade would be about $19.1 billion. To achieve these goals at this cost, however, would require careful application of an optimum set of interventions.

Implementing this set of activities would probably reduce child mortality in the developing world by five to six million deaths, or more than 40 percent. To have such a major impact, however, will likely require large scale reorganization of developing country health sectors, including close coordination of many of the current programs and careful allocation of scarce resources. These calculations also assume that current levels of funding of these activities would continue, and that these estimates are for additional funding.

1. INTRODUCTION

The Task Force for Child Survival, meeting in 1988 in Talloires, France, set forth an challenging set of seven goals in the Declaration of Talloires to be achieved by the year 2000. These goals were broadened and amended in the Task Force meeting of February, 1990, in Bangkok, Thailand and restated in the Affirmation of Bangkok (see Appendix C). The child survival goals, as amended, are:

- THE GLOBAL ERADICATION OF POLIOMYELITIS.
- ELIMINATION OF NEONATAL TETANUS DEATHS BY 1995.
- A 90 PERCENT REDUCTION IN MEASLES CASES AND A 95 PERCENT REDUCTION IN MEASLES DEATHS COMPARED WITH THE PRE-IMMUNIZATION LEVELS BY 1995.
- A 50 PERCENT REDUCTION FROM 1990 LEVELS OF DEATHS DUE TO DIARRHEA IN CHILDREN UNDER THE AGE OF 5 YEARS, AND A 25 PERCENT REDUCTION IN THE DIARRHEA INCIDENCE RATE.
- A ONE THIRD REDUCTION IN THE 1990 CASE/FATALITY RATES ASSOCIATED WITH ACUTE RESPIRATORY INFECTION IN CHILDREN UNDER 5 YEARS.
- A 50 PERCENT REDUCTION FROM 1990 LEVELS OF CURRENT MATERNAL MORTALITY RATES.
- REDUCTION OF INFANT AND UNDER-5 CHILD MORTALITY RATES BY ONE THIRD, OR TO 50 AND 70 PER 1,000 LIVE BIRTHS RESPECTIVELY, WHICHEVER ACHIEVES THE GREATER REDUCTION.

As part of the effort to gain a global commitment to the principle of Health For All by the Year 2000, the Task Force has investigated the cost of achieving these goals. This report finds that the probable total cost of achieving these goals over the period 1991 to 2000 is between $19 billion and $34 billion in excess of current health care spending. This cost is based on a gradual increase in spending and mortality improvements from 1990 until the goals are met in 2000. The broad range of possible costs is dependent upon how these goals are approached. Among the issues involved is whether the interventions necessary to achieve these goals are organized into separate vertical programs or as a more coordinated approach. There is also a question of whether the goals must be achieved in each country or globally. Finally, there is uncertainty about how costs will change with the magnitude of health

interventions implied by these goals. Indeed, the entire health sectors of many countries are likely to need significant reorganization to accomplished the Talloires goals.

This report presents two independent calculations of the cost of achieving the Talloires goals. A preliminary draft of this report estimated the cost at more than twice the amount projected here. Those preliminary projections were based on straight extrapolations of current health programs. Reviewers from the member agencies of the Task Force provided valuable comments that have led to the re-estimation included here. In addition, the first report noted the need for a model of how health interventions affected the achievement of the Talloires goals. Several reviewers suggested that methodological weaknesses in the extrapolation approach warranted development of such a model. Section 4 of this report, therefore, presents an alternative calculation of the costs using a simple model of intervention effects. Both approaches are presented in this report because the extrapolation technique is able to use richer data and thus contains more detail, while the modeling technique overcomes some deficiencies of pure extrapolation.

This revision of the report presents the results of two cost calculations using the extrapolation technique. During review of the draft report, a reviewer pointed out substantial differences in UNICEF and World Bank demographic projections. Since these projections form the basis for cost calculations, this report presents calculations based on both sources. A discussion of this issue is contained in the following section.

A first attempt at cost calculations was done quickly by the REACH Project[1] using some very general assumptions and data on 13 countries. Howard Barnum at the World Bank commented on these estimates, and they were subsequently revised[2]. The revised estimates considerably expanded the data used and incorporated a number of methodological improvements. Nevertheless, the Task Force decided to proceed with the present determination of the cost of achieving the Talloires goals, which includes additional methodological features and uses additional data not included in the REACH effort.

Section two of this report discusses the results obtained using the extrapolation technique of costing. Because this same technique was used by the REACH Project, section three provides a comparison of REACH and our estimates, and discusses reasons for differences in the estimates. Section four explains the methodology employed and results obtained using a simple model of intervention effects. Section five addresses several other questions raised by reviewers and discusses general issues involved in this estimation. Section six provides the details of how the extrapolation estimates were calculated. Finally, a number of appendices include country level estimates and other background material.

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[1]Notes on Estimation of Cost Implications of Attaining Targets Established in Talloires, France, REACH Project, no date.

[2]Further Estimates of the Costs for Meeting Talloires Targets, REACH Project, May 22, 1989.

2. COSTS BY EXTRAPOLATION TECHNIQUE

This approach to the cost calculations in this report is similar to the method employed by the REACH project, as well as much of the work by Mahesh Patel[3]. First, we determine the current status of the health indicators targeted by the Talloires Goals. Second, we develop forecasts of what those health indicators would be by the year 2000. Third, we determine what changes are needed to achieve the goals. Fourth, we determine at what level interventions, such as the Expanded Program of Immunization (EPI), would be needed to affect those additional changes. Fifth, we determine the cost of operating the interventions at that level.

This report presents the results of cost calculations using two different databases. The extent, and therefore the cost, of health service interventions depends on the baseline demographic projections of numbers of mothers and children at risk. Initial calculations were done with data from the UNICEF report, State of the World's Children[4]. UNICEF estimates that 1988 mortality for children under five is 14.9 million (14.4 in less developed countries). Subsequently, World Bank data[5] were provided which estimated 1990 child mortality at 12.9 million (12.4 million in less developed countries). Because of the significant variation in demographic estimates, cost calculations are presented using both baseline mortality estimates.

A further variation in the baseline estimates is the direction and rate of change in child mortality. The UNICEF data provided only current rates of population, crude birth rates and mortality rates and historical changes in those rates[6]. These rates of change projected into the future forecast a slight growth in child mortality during the decade, as shown in Table 2.1. World Bank data, however, provided both 1990 and 2000 estimates of population,

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[3] Eliminating the Social Distance Between North and South: Cost Effective Goals of the 1990s, Mahesh S. Patel, UNICEF Staff Working Paper, No. 5, October, 1989.

[4] The State of the World's Children, 1990, UNICEF, Oxford University Press, 1990.

[5] Population Projections, 1989-90 edition, R. Bulatao, E. Bos, P. Stephens, and M. Vu, Policy, Planning, and Research Working Papers, World Bank.

[6] UNICEF data used in this report are contained in the statistical tables of the 1990 UNICEF State of the World's Children Report. The information contained in the statistical tables of this publication is available on diskette. This dataset contains information about current health status, demographic and economic indicators for each country, as well as enough information on past rates to allow the calculation of several trends used in the analysis.

birth and mortality rates[7]. These data, also shown in Table 2.1, show a substantial decline in mortality over the decade. It is assumed that these changes in child mortality are independent of new interventions or of changes in intensity of existing interventions.

Table 2.1

Predicted Child Mortality in the 1990's

Year	Based on UNICEF data	Based on World Bank data
1989	14,384,183	
1990	14,420,349	12,403,887
1991	14,459,776	12,152,717
1992	14,502,467	11,901,546
1993	14,548,429	11,650,376
1994	14,597,670	11,399,206
1995	14,650,201	11,148,035
1996	14,706,032	10,896,865
1997	14,765,178	10,645,694
1998	14,827,653	10,394,524
1999	14,893,474	10,143,354
2000	14,962,660	9,892,183

Determining current health status and mortality conditions in 2000 is done in order to measure the amount of additional effort that will be needed to reach the Talloires Goals. The assumption used in this report is that current national government and international maternal and child health efforts are likely to continue at their current levels, even without a commitment to the Talloires Goals. The cost of achieving the goals, then, is the additional cost of boosting efforts above current status. Thus, the costs calculated here are for deviations from current mortality trends or from current estimates of mortality in the year 2000.

Forecasts using the UNICEF data were made on the basis of long-term declines in mortality rates and crude birth rates. While these declines may be related to changing economic conditions, the long-term effects of immunization programs or other causes, no attempt was made to attribute trends to specific causes. Mortality and birth rate trends by country were forecast through the next decade. These projections are developed in the following manner. The total number of child deaths is assumed to be:

Deaths = Population • Crude Birth Rate • Child Mortality Rate

[7] World Bank data used in this report was prepared from World Bank databases by My Vu, of the Population and Human Resources Department.

This calculation was done for each country. Population is assumed to be growing at its 1980s rate. The crude birth rate and the child mortality rate are assumed to follow the long term trend from 1960 to 1988. These projections of trends produced a slow upward climb to about four percent more child deaths per year by the end of the decade. The reason for this small increase is that population growth is moderated by declines in the birth and mortality rates.

The World Bank data, on the other hand, projected lower birth and mortality rates, which in many cases are expected to fall rapidly over the decade. Overall, birth and mortality rates fall enough that annual child mortality is less at the end of the decade in which world population is predicted to increase from 5.3 billion to 6.2 billion.

Calculations of the costs of the health interventions as they relate to each goal are explained in Section 5. The level of generalization required to estimate the cost of achieving the goals on a worldwide scale is daunting. Obviously there are a large number of possible interventions that may be undertaken. We have chosen for this calculation to consider the effects of five interventions:

EPI
Oral Rehydration Therapy (ORT)
Maternal health programs
Treatment of Acute Respiratory Infections (ARI)
Nutrition supplement programs

We have calculated the cost on the assumption that the increased levels of interventions would be phased in at a rate that allowed the Talloires Goals to be achieved at the time specified in the individual goal statements, either 1995 or 2000. For example, if the goal was to be achieved by 2000, we assumed that interventions would achieve 10 percent of the goal in 1990, 20 percent in 1991, etc. Depending on costing assumptions, this gradual approach to the goals reduces costs to about half of what it would cost to achieve the goals immediately.

The result of these calculations is a projection that meeting the goals of the Declaration of Talloires by the year 2000 would require additional expenditures of $28.9 billion to $33.4 billion above current spending. Section 6 of the report provides details of the calculations. The overall costs of achieving the Talloires goals are presented in Table 2.2.

The most expensive single goal to attain is the reduction by 50 percent in maternal mortality. This estimate also has a great deal of uncertainty, since it is based on a few proposed programs with little empirical evidence. The cost sufficient to reach the measles goal includes the cost of expanding the entire infant EPI, since it was considered impossible to identify the cost of measles immunization alone. The cost of reducing diarrheal disease deaths may seem low, but as explained in Section 6, the reduction of measles has a significant impact on this death rate. The additional expenditures shown here are the costs of further reductions after 95 percent of measles deaths have been eliminated. Costs of achievement of the infant and child mortality goals

has been estimated only in general terms, and are discussed in section 6. This is a category where cost diverged widely in calculations from the two data sources.

Table 2.2
Overall Costs of Talloires Goals

Goal	Cost in $ Millions based on: UNICEF	World Bank
Measles	$ 8,517	$ 5,707
Polio (in excess of EPI)	1,513	1,513
Neonatal Tetanus	3,978	3,978
Acute Respiratory Infections	2,623	2,158
Diarrheal Disease	4,980	4,279
Maternal Mortality	10,193	10,193
Infant and Child Deaths	1,591	1,095
Total Cost	$ 33,395	$ 28,923

Assumptions about costs present a major difficulty for this study. Earlier use of a single unit cost measure for each intervention across all countries was considered insufficiently detailed. Geographic, social and infrastructure differences affect costs. In addition, it is likely that unit costs are not linear, but that they rise as the goals are approached. Because countries are at different stages of development in the target areas, marginal cost will vary across country, so total costs must be revised to reflect this. The rising marginal cost question is a difficult issue, however, with surprisingly little evidence upon which to compute cost curves. Most information available consists of collections of historical observations of program costs. No one we consulted[8] was aware of studies specifically addressing the issue of how costs rise with the level of coverage of any intervention.

[8] Andrew Creese at WHO, Howard Barnum at the World Bank, and David Parker at UNICEF all expressed the desire to see studies which estimated true cost curves, but were unaware of such studies even for programs as heavily analyzed as EPI.

3. COMPARISON WITH THE REACH COST ESTIMATES

Cost estimates developed using the extrapolation technique differ considerably from those previously done by the REACH project. This section discusses the major reasons for these differences. Table 3.1 shows the comparison of REACH estimates and those developed in Section 2 of this report.

There are five principal reasons for the differences in cost estimates. The three major reasons are our use of the current status of the country goals, consideration of the interaction between interventions, and our use of a progression toward the goals.

The REACH estimates are based on the total rather than the marginal cost of each intervention for which they estimate a cost. They assume that the costing exercise must include past as well as future progress. Thus, to calculate the cost of the EPI program, they simply calculate the number of infants in the developing world and multiply that number by $15. The same approach is taken for use of ORT to prevent diarrheal disease deaths. In our work, we calculate the additional, or marginal, cost of achieving the goals, so that we do not include the cost of providing immunizations for that portion of the population that is already covered.

Table 3.1

Comparison of REACH and Current Estimates (In $ Millions)

Goal		REACH Total Cost Estimates First	Second	Current Marginal Cost Estimate
EPI Coverage, children		12,765	26,550	10,030
EPI Coverage, women		866	4,602	3,978
Acute Respiratory Disease		7,740	3,910	2,623
Diarrheal Deaths	Low	7,740	49,473	4,980
	High		161,973	
Maternal Mortality		15,055	85,670	10,193
Infant and Child Mortality		No est.	No est.	1,591

A second difference is that the interaction of interventions has an important effect on cost of achieving goals, but this was not included in the REACH work. This is incorporated in this work in several places. For example, the measles immunization program will have an effect on the incidence of diarrheal disease deaths.

The third major difference is in our assumption of progress toward a goal, reaching full effect only in the year targeted. REACH calculated the cost of achieving the goals immediately, so that their estimates include the cost of 100 percent EPI coverage from the year 1988. They followed the same pattern for all other goals. This difference raises their estimates over ours by about 40 percent.

There are also two other small differences in the calculations. They calculate from 1988 while we start in 1990. In addition, the target rates for diarrheal disease deaths were lowered by the Affirmation of Bangkok after the REACH work was performed from a 70 percent reduction to a 50 percent reduction. ARI death goals were raised from 25 percent to 33 percent, but this is a much smaller portion of costs than are diarrheal disease deaths.

4. COSTS USING MODELING TECHNIQUE

This section presents an alternative calculation of the costs of the Talloires goals. The approach described here partially overcomes several issues discussed below which were raised in the first report and by reviewers. This calculation indicates that over the decade of the 90's the cost of achieving these goals will amount to about $18.5 billion. While this amount is significantly lower than the cost calculated in section 2 of this report, it is important to note that it requires a number of assumptions discussed later in this section. Furthermore, the calculations presented in this section have been less completely worked out than the results discussed above, and should be considered tentative.

The calculation of the cost of achieving the Talloires goals using the extrapolation method has a number of methodological problems. These have been pointed out in comments on an earlier draft of this paper by Howard Barnum, Andrew Creese, and David Parker, among others. The principal issue was that the calculations were performed on an ad hoc or piecemeal basis, without any general model of how the health interventions interacted. As a result, it is extremely difficult to consider how the various interventions jointly affect the Talloires goals. Using the extrapolation method, each intervention's effect on the results of others, such as measles immunization on diarrheal disease incidence, must be worked out separately, without consideration of how ORT or nutrition programs might affect its effect.

The reviewers of an earlier draft commented that they would like to see some predictions of the optimum combination of interventions to achieve these goals. In addition, they expressed a desire for information on the marginal costs and benefits of each of the interventions. Several commented that the vertically structured programs such as EPI and CDD are not likely to maintain their current organization at the levels of operation contemplated by the Talloires goals. As a result, there was interest in a model of the joint production of all the goals through a coordinated set of interventions. This issue of a coordinated approach may be particularly important in the case of maternal mortality. Safe motherhood programs have been discussed as an increasing emphasis by international donors. Because such programs are likely to be high cost and to have a large number of elements, it will be important to coordinate any effort with other programs.

The calculations presented here illustrate how such a general model could be formulated. These results are based on a technique known as linear programming. A formal statement of this approach is contained in the Appendix. With this method, a certain objective is stated. In this case, it is to minimize the cost of several possible activities. That objective is constrained by several other factors (constraints) which must be met. In this case these constraints include the reduction in deaths from several causes. Once the objective is stated and the constraints are identified, various levels of interventions can be selected to determine which set of interventions satisfies the constraints at the minimum cost. In practice, this is done with the aid of a computer, which can try a large number of

combinations quickly. The results presented here were computed using the linear optimization feature of the Quattro Pro program.

Howard Barnum and Robin Barlow have conducted a similar exercise in developing A Resource Allocation Model for Child Survival. That exercise, however, was a major research activity using a sophisticated nonlinear optimization model. It is clear that the simple linear model presented here is only indicative of a useful approach to this issue, and that a more complex approach would be appropriate.

For these calculations, we used data from the World Bank database for the less developed countries. To achieve the Talloires goals required a reduction in annual mortality of 5.26 million deaths. These reductions are listed by goal in Table 4.1. The first five categories in the table are determined by specific mortality patterns. The final infant and child mortality goal of 400,000 is the residual reduction required to achieve the target goal of 70 per thousand. The calculation for this quantity is found in section 6.

Table 4.1
Required Increment in Annual Deaths Averted to Achieve the Talloires Goals

Diarrheal Disease	1,750,000
ARI	850,000
Measles	1,300,000
Neonatal Tetanus	790,000
Maternal Mortality	170,000
Infant and Child Mortality	400,000
Total Annual Mortality Reduction	5,260,000

To reach these goals, we expanded the range of possible interventions discussed above to include general medical treatments such as curative consultations, and programs such as nutrition supplements or water and sanitation services. These interventions, and the costs we assumed are:

INTERVENTION	COST
- EPI: providing full immunization to mother and child.	$18.00
- ORT: treatment of an episode of diarrheal disease.	1.20
- FP: providing family planning services to a couple for one year.	20.00
- NTR: nutrition supplements to an individual for one year.	15.00
- W&S: water and sanitation services per household annually.	10.00
- MH: a maternal health program for women at risk.	30.00
- MED: medical treatment, prescriptions, or preventive care.	5.00

With the needed reductions in deaths defined and the interventions chosen, it is then necessary to specify how those interventions will affect the probability of death from each cause. Table 4.2 shows the assumptions we used on the effectiveness of these interventions. In general, we have been conservative in estimating these entries, which would tend to overstate rather than understate the number of interventions needed. The entries in this table are quite subjective and suggestions for improved entries are encouraged.

Our approach to deriving these numbers was to determine the changes in probability of death from an intervention. To do this we determine the probability of death from a particular cause, and then determine the degree of change in that probability that results from any particular intervention. This is based on the fact that there are about 125 million children born in the developing world each year, of which about 14 million die, for a mortality rate of about 112 per 1,000. One example of this process is the EPI coefficient for measles. The UNICEF State of the World's Children Report indicates that about 2.87 million children, or about 2.3 percent, would have died of measles in the absence of immunizations. Therefore, we conclude that immunization reduces the probability of death from measles by 0.022 (since the vaccine is only 95% effective). Similarly, with four million diarrheal disease deaths each year, there is a 3.2 percent probability of death (or a proportion of 0.032). If the application of ORT can reduce this by one third, then the impact of ORT on the probability of diarrheal disease death is 0.01. Other entries in the table were derived in the same manner.

Table 4.2
How Interventions Affect the Probability of Death

	EPI	ORT	FP	NTR	W&S	MH	MED
Diarrheal Disease	0.001	0.01	0	0.025	0.01	0	0.001
ARI	0.001	0	0	0.005	0	0	0.005
Measles	0.022	0	0	0.01	0	0	0.0005
Neonatal Tetanus	0.018	0	0	0	0	0.0001	0.0001
Maternal Mortality	0	0	0.01	0.0001	0.001	0.020	0.0001
Inf. and Cld. Mort	0.006	0	0.05	0.001	0.001	0.001	0.0005

Although the entries in this table represent the change in probability of death that comes from each intervention, a convenient way to interpret it would be to move the decimal point over three places and think of it as the number of deaths prevented per 1,000 interventions. For example, this table assumes that every 1,000 fully immunized mothers and children prevents one diarrheal disease death, one ARI death, 22 measles deaths, 18 neonatal tetanus deaths, and six other deaths (primarily pertussis). Other columns can be interpreted similarly.

Given the relative effectiveness of these interventions and the numbers of deaths to be prevented, the computer then tries combinations of interventions that achieve the required reductions in mortality to reach the Talloires goals and selects the combination which has the minimum cost. These results are shown in Table 4.3.

Table 4.3
Annual Cost for Additional Interventions to Achieve the Talloires Goals

Intervention	Optimal Quantity	Cost
EPI	43,110,190	$ 775,983,424
ORT	86,116,616	103,339,939
FAMILY PLANNING	781,809	15,636,188
NUTRITION	28,514,404	427,716,055
WATER & SANITATION	0	0
MATERNAL HEALTH	7,302,205	219,066,165
GENERAL MEDICAL	132,863,558	664,317,792
	TOTAL	$ 2,206,059,562

This amount of $2.2 billion is the amount required to provide these services for a single year. Calculation of the total cost for the decade is done in the following manner. The Talloires goals would require that the measles and neonatal tetanus goals be achieved by 1995, and that the other goals be achieved by 2000. Although nutrition and general medical care contribute to these goals, they are for the most part achieved through the EPI program. If the EPI program is expanded by 20 percent per year until operating at the indicated level by 1995 and thereafter to 2000, the cost would be approximately eight times the single year cost. If the other interventions are expanded at 10 percent per year to full operation by 2000, their total cost would be about 5.5 times the single year cost. Summing eight times the EPI cost and 5.5 times the cost of the other interventions yields an estimated cost of about $17.6 billion for the entire decade. In addition, eradication of polio will require a special surveillance and eradication program not included in the model. The cost of this special program, discussed in section 6, is estimated to be about $1.5 billion. Adding in the polio eradication program provides a total estimated cost for the Talloires goals of about $19.1 billion.

Testing of the sensitivity of this model to changes in the assumptions revealed a relatively stable total cost estimate. Very large changes in the table of probabilities or in unit costs were required to force the model to predict costs outside the range of $2 to $2.4 billion. The composition of the optimum set of interventions, however, varies dramatically with changes in the table of probabilities, but less so with changes in the unit costs. It is more appropriate, therefore, to think of this calculation as providing a general estimate of the cost of achieving these goals than as a prescription

for which interventions to consider at what level. It is generally the case with linear programming solutions that the level of each intervention can changed greatly with small changes in the statement of the problem. Thus the fact that the solution presented here contemplates no water and sanitation activities does not imply that these activities are not cost effective under different assumptions, nor that they do not have significant consumption benefits.

This estimated cost is much lower than the cost calculations presented using the extrapolation method. There are a number of reasons why this might be expected. First, as has been pointed out, this model takes into account more interventions and greater interactions that other calculations. Because the extrapolation method does not incorporate the beneficial effects of, for example, nutrition or curative medical care on various goals, it probably overstates the required size of the interventions that are considered. Second, here we are considering a single approach to the entire developing world population, rather than making the calculation for each country. If the marginal cost of achieving the goals is higher in some countries than in others, then the total cost of achieving the goals in every country will by higher than simply achieving the goals globally. This is because if you only need to achieve the global goal, you can always do a little less in high cost countries and a little more in low cost countries. Thus, if you want to satisfy the goals in every country, this section probably underestimates the cost. Third, this approach represents an ideal mix of interventions to achieve the goals, whereas the extrapolation method assumes less coordination. However, this could also mean that the cost reported in this section is less realistic if proponents and workers in each intervention are unlikely to work together on a coordinated approach to health services delivery.

The linear programming approach to the Talloires goals also provides estimates of the marginal cost of deaths prevented from each cause specified in the goals. This is the measure of how much the total cost would rise if any of the deaths-prevented goals were increased by one. The marginal cost of each of the goals is shown in Table 4.4. Marginal cost calculations developed by such models are for the prevention of a death from one of the possible causes, rather than the marginal cost of any particular intervention. In general, a single change made anywhere in the model will affect all of the marginal cost calculations to some extent.[9]

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[9] This can be illustrated by an example involving the low marginal cost of neonatal tetanus death prevention. Raising the tetanus target from 790,000 to 790,001 deaths averted results in the model adjusting the least cost combination of interventions to achieve the entire set of goals to include increases in EPI, ORT, maternal health and general medical interventions. Family planning and nutrition interventions can then be decreased. The net total cost of all these changes to achieve the additional neonatal tetanus death averted is only $3.

Table 4.4
Marginal Cost of Each Goal

Diarrheal Disease	$120
ARI	862
Measles	744
Neonatal Tetanus	3
Maternal Mortality	1495
Inf. and Child Mort.	101

These marginal cost estimates are, of course, conditional on the choice of the proper model and the correct coefficients. They were found to vary significantly with changes in the model coefficients, and should be viewed with greater skepticism than the total cost estimates discussed above. Nevertheless, the magnitudes of most of these marginal costs tend to give greater credibility to this estimation method. Maternal mortality reduction, which is generally considered to be the most expensive goal per death averted, is shown here to have the highest marginal cost. ARI is also very expensive, corresponding to available evidence.

This simple linear model was all that was considered feasible within the scope of this study, but it is at best a first step toward a better representation of the real world than simply adding intervention programs. It is likely to provide inferior results to a more general, non-linear model such as the one developed by Barnum and Barlow. If more work is done on this model, other relationships should be examined. For example, the interrelationship between maternal mortality and infant mortality should be specified. In addition, the relation of neonatal tetanus programs and maternal mortality should be explored. Tetanus toxoid is a component of prenatal care, and maternal health programs include attention to clean delivery, thereby reducing neonatal tetanus.

There are significant non-linear interactions that cannot be captured in this model. The relationships among mortality causes is not merely additive, for example. If 50 percent of diarrheal disease deaths are eliminated, it is possible that the number of deaths from malaria and other causes will rise. Conversely, improving nutrition may make interventions to combat diarrheal disease and ARI more effective. The issue of how each intervention changes the environment within which other interventions work and how morbidity patterns interact will require a more sophisticated model than the one presented here. Such a model would probably involve a significant number of non-linear relationships and conditional probabilities.

5. OTHER CONSIDERATIONS

Several reviewers of the report draft expressed a desire to see projections of current levels of spending on activities that contribute to achieving the Talloires goals. Some estimates of EPI expenditures are included in Appendix B, but these numbers are simply inferred from coverage levels. WHO, PAHO and other agencies should be able to generate much more accurate spending figures. To maintain current levels of coverage, EPI expenditures for the decade, projected at the current level of spending, would be expected to be about $9.1 billion. Currently ORT is estimated to be used in about 20 percent of all diarrheal episodes. If there are about 350 million episodes annually, this would imply about 70 million annual treatments. At $1.10 per treatment, this would cost about $850 million for the decade. The level of general medical treatments for children also is unknown. If governments and donors are currently spending an average of $3.00 per child, decade long spending in the developing world could be about $4.2 billion. Total expenditures on nutrition, water and sanitation, and other interventions are unknown. It is likely that expenditures on child survival during the next decade, if projected at the current level of spending, would total between $15 and $20 billion.

An issue related to this level of expenditure is how to ensure that this level of effort will continue if donors commit themselves to the magnitude of spending required by the Talloires Declaration. There is no general solution to this problem, and it is likely that many governments will attempt to substitute new donor money for some of their current expenditures. Two factors that may help to mitigate this effect would be significant policy dialogue intended to encourage national governments to subscribe to the Talloires goals, and specific monitoring and requirements that would help maintain local spending. By the year 2000, we can expect to see a significant amount of funds being generated by the countries themselves. Requirements for the use of these funds on child survival goals can be incorporated into donor agreements.

As several reviewers pointed out, it is not likely that a set of specific interventions such as EPI, CDD, or safe motherhood will be the minimum cost method of achieving the Talloires goals. National planning for each is often done separately without consideration of interactions and coordination. In fact, it may be impossible to achieve the goals without a carefully coordinated attack on multiple causes of child morbidity and mortality. Such an approach will require major reorganization of child survival programs. Acknowledgement of this fact implies that the extrapolation method of calculating cost in the report is somewhat inaccurate. Perhaps what is needed at this point is agreement on more effective and efficient strategies for maximizing child survival.

Finally, it is important to acknowledge the context within which these estimates were produced. Factors exogenous to the health sector, available technology, and international variation in health status are all important determinants of child survival and its cost. Factors outside of the defined

activities of the health sector may have major effects on what the base levels of morbidity and mortality are. The general level of morbidity and mortality is closely tied to macroeconomic conditions, income distribution, the level of civil unrest, and nutrition.

The interventions discussed in this paper are targeted at specific diseases and causes of mortality in children and women, such as measles, diarrheal disease and maternal deaths during pregnancy and childbirth. It could be said, however, that many deaths in developing countries are the result of poverty and underdevelopment, rather than a clinical etiology such as measles or dehydration. The child who succumbs to measles in Guinea-Bissau likely would have only missed a few days of school had she been raised in the U.S. where the standard of living is higher and socioeconomic conditions are better.

Public health experts have long suggested that the dramatic declines in life expectancy in Europe and the in U.S. in the late 1800's and early 1900's were due primarily to improving socioeconomic conditions, higher GNPs per capita, education, clean housing and water supplies, etc. rather than the advancement of medical science[10]. There is, however, an increased knowledge of many health care technologies, including understanding about how to prevent illness, that have undoubtedly improved maternal and child survival. With respect to developing countries, some researchers debate the role of socioeconomic development versus public health and medical interventions in reducing life expectancies and mortality rates. Rogers and Wofford have shown through correlation and regression analysis, that percent of the population in the agricultural sector, and the literacy rate are more closely associated to life expectancy than access to safe water and population per physician.[11] Low socioeconomic status and overcrowding have been shown to be associated with high incidence of acute respiratory infection.[12] It is also true, of course, that an increasing level of health promotes increased productivity and income.

The above suggests that infant, child and maternal mortality can be reasonably expected to decrease with rising standards of living, even in the absence of accelerated efforts to improve the health of children and women through interventions targeted at specific diseases and conditions. In refining our costing algorithms we may want to reduce the overall global cost of reaching the Talloires goals by a factor which represents the improving socioeconomic conditions in many (but unfortunately not all) developing

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[10] Hennekens, C.H., and Buring, J.E. Epidemiology in Medicine. Boston/Toronto: Little, Brown and Company, 1987.

[11] Rogers, R.G., and Wofford, S. Life expectancy in less developed countries: socioeconomic development or public health? Journal of Biosocial Science. 21: 245-252, 1989.

[12] Stansfield, S.K., Shepard, D.S., Gwatkin, D., 1990. "Acute Respiratory Infection," in Health Sector Priorities Review, unpublished. The World Bank.

countries. This factor should be modest since mortality generally responds slowly to changes in the conditions which affect it. Rogers and Wofford allow for a ten year lag between change in conditions and change in life expectancy rates.[13] Given the economic performance of the 1980s, this could indicate increasing health problems during the 1990s.

[13] Rogers and Wofford, 1989.

6. DETAILS OF EXTRAPOLATION CALCULATIONS

This section of the report provides details on the calculation used to extrapolate the cost of each target based on current trends and costs. Actual calculations were made using the SAS statistical package on a micro computer. The program and the datasets are available from Abt Associates.

6.1 Polio and Measles

Polio and measles goals are both achieved through immunizations. They are both included in the EPI program, and so we have calculated the cost of both together. In order to achieve the targeted measles reduction, we calculated the cost of operating the EPI program at 95 percent coverage for fully immunized children. In addition to the EPI program, a special eradication program will be required for the increased level of surveillance required to eliminate polio. Each of these costs are discussed below.

MEASLES

Determining the cost of operating an EPI program at high levels of coverage is a difficult task for which there is no clear guidance. We searched literature and interviewed numerous health professionals in an attempt to find a description of a cost function that would relate the marginal cost of the program to the level of coverage. Unfortunately, most information consists of reporting of historical cost estimates for programs operating at lower levels of coverage. For programs in the range of 30 to 60 percent coverage, most experts suggested a cost of about $15 per fully immunized child. For higher levels of coverage, David Parker at UNICEF and Francois Gasse at WHO both suggests that marginal cost may eventually double.

Our measles calculations proceeded in the following fashion. We used current measles coverage as the baseline EPI activities in each country. We then set a target coverage of 95 percent in each country by 1995, and calculated the necessary increase in coverage rates for each country. Countries were assumed to increase their coverage by 20 percent of the difference between actual and 95 percent coverage in each of the five years leading up to 1995. After 1995, the Talloires EPI target cost was assumed to be the cost of covering the percentage of children between 95 percent and the 1989 coverage levels.

The cost of a fully immunized child (FIC) was assumed to be $15 up to a coverage level of 80 percent. Beyond that level, the cost of a FIC was assumed to rise by $1 for each percent increase in coverage, becoming $30 at the 95 percent coverage level. Calculating total cost with a rising marginal cost is done in the manner described below. Essentially, this is integration over the two linear segments of the cost function. With two parts to the cost function, there will be three different situations for calculating cost. These occur when:

	Current coverage (X) is	Target coverage (Y) is
1.	Below 80%	below 80%
2.	Below 80%	above 80%
3.	Above 80%	above 80%

For each situation, the formula should be (with X and Y expressed as numbers from 1 to 100):

1. Cost=infants/100 [(Y-X)•$15]
2. Cost=infants/100 [(80-X)•$15 + $.5 Y^2 - $65 Y + $2000]
3. Cost=infants/100 [$.5 Y^2 - $65 Y -($.5 X^2 - $65 X)]

POLIO

There have been few studies of the cost of immunizing solely against polio or of the cost of a polio eradication program. In estimating the cost of worldwide polio eradication, we have based our costs on data from the Americas. The Pan American Health Organization initiated a polio eradication program in the late 1980s as a means of reinforcing the ongoing EPI programs in the region.[14]

Using cost estimates from the PAHO program and from Phil Musgrove, an economist at PAHO, we suggested in the first draft of this report that the additional expenditure necessary for a Polio eradication program is approximately $2.9 billion. This was based upon the following logic.

Dr. Jean-Marc Olive of PAHO/EPI suggested that the combined cost of polio eradication and EPI strengthening would cost $470 million over the five year period 1987-91, with polio eradication perhaps half of that cost, or about $235 million. Musgrove also suggests that the cost of a 15 year polio eradication program in the Americas has been estimated at about $220 million.[15] This consists of $24 million per year during the active eradication campaign and an additional maintenance funds of about $10 million per year for 10 years afterward.

We assume that the cost per capita to eradicate polio in Africa and Asia is the same as in the Americas. We base this on per capita measures because most of the cost of an eradication program are related to the number of

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[14] Olive, J.M., 1989. The Polio Eradication Initiative: An Opportunity for Costing EPI. PAHO.

[15] Musgrove, P., 1988. Is Polio Eradication in the Americas Economically Justified?, PAHO Bulletin, 22(1).

persons covered. The 1988 World Health Assembly resolution declaring the goal of global eradication of polio by 2000 recommended a three part program of:

- Achievement and maintenance of high immunization levels
- Effective surveillance to detect all new cases
- Rapid and vigorous response to the occurrence of cases.

Since the population of Asia is 10.7 times that of the Americas, and Africa is 2.14 times as populous, we increased the $220 million figure by those amounts. Total cost under this scenario would be:

Asia	$ 2,354 million
Africa	471 million
Americas	100 million
Total Cost	$ 2,925 million

However, we received comments from reviewers contesting this estimation. Ciro A. de Quadros, of PAHO, commented that this method of extrapolation was likely to lead to an underestimate of the global program cost. He argued that in the Americas, "the overall health infrastructure and communication systems are better developed. So some kind of correction factors should be added to adjust for those factors."

A contrasting argument was provided by James Cheyne, Program Officer for EPI at WHO. He considered the $2.9 billion estimate extremely high, and offered an eradication program estimate of $560 million. He added that: "The only other idea we can add which would tend to bring the two figures closer together is that it is probably not realistic to assume that the rest of the world will carry out PAHO style polio campaigns. These are effective but they are recognized to be expensive and it is unlikely that they will be adopted in all other areas of the world."

Given this difference of opinion about eradication program costs, we elected to estimate a per capita cost in Asia and Africa of half that of the Americas. This estimate yielded:

Asia	$ 1,177 million
Africa	236 million
Americas	100 million
Total Cost	$ 1,513 million

Additional comment comes from a chapter on polio in the forthcoming

World Bank publication on evolving health sector priorities.[16] This work does not estimate the cost of an eradication campaign, though it says that eradication is possible. It does suggest that in a high mortality region with 1,000,000 persons a $300,000 budget would immunize two thirds of the population. If we assume that $450,000 would immunize the entire population, this would imply $0.45 per capita. Such a program covering about 3.5 billion persons in Africa and Asia would cost about $1.5 billion.

6.2 Neonatal Tetanus

WHO currently recommends a series of 5 tetanus doses to protect the infants of a woman throughout her childbearing years (14-45).[17] If given with the correct intervals, spread over a total of 31 months, the five tetanus doses are expected to provide approximately 30 years of protection. A young woman, receiving the tetanus toxoid beginning at age 14, would carry protection for her unborn babies through approximately age 45.

Another approach, which obviates a tetanus program for women 14-45, would have schoolgirls vaccinated at school with 5 or 6 injections before their 12th or 14th birthday. Such programs are reported to be in practice in Syria, Kuwait and Togo. Our costing is based on the administration of 5 vaccinations for women of childbearing age. The second model, which has a number of advantages (i.e. an easily accessible population of schoolgirls), will not be widely used for a number of years.

Our cost calculations depend on the following assumptions elaborated by Francois Gasse.

- Women of childbearing age (14-45) comprise approximately 22 percent of the population of developing countries.
- Five doses of tetanus toxoid (over a 31 month period) are required to protect a woman's infants from neonatal tetanus (protection lasts approximately 30 years).
- The comprehensive cost of this immunization program (including bilateral and multilateral technical assistance), as an identifiable part of the EPI program, is about $3.00.
- Current levels of tetanus coverage will continue, based on current

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[16] Poliomyelitis, by Lincoln Chen, Dean Jamison and Alberto Torres, Chapter 5 of Evolving Health Sector Priorities in Developing Countries, Edited by Dean Jamison and W. Henry Mosley, World Bank, forthcoming.

[17]. Personal communication with Dr. Francois Gasse, WHO/EPI, Geneva, 1990.

levels of funding. The additional cost required will be to provide immunizations for that portion of women of childbearing age who are uncovered, and a similar portion of women entering the childbearing years each year.

- Each year a cohort of female 14 year-olds enters the population and requires the 5 dose tetanus series. This group is approximately 2.5 percent of the population in any given year.

Costs are calculated in the following manner. The population of women aged 14-45 in 1990 is:

pw = population*0.22

The number of newly entering 14 year-old women each year is:

nw91 = 0.025*population in 1991
nw92 = 0.025*population in 1992
etc.

Then, if the proportion of women already covered is pc, total cost will be the cost of immunizing the remaining pool of women and those entering their childbearing years each year. The cost of the remaining pool of women is:

fc = pw*(1-pc)*$3.00

The extra cost of new entrants each year is:

mc91 = nw91 * (1-pc) * $3.00
mc92 = nw92 * (1-pc) * $3.00
etc.

The total cost of eliminating neonatal tetanus is then the cost of immunizing the remaining pool of women and increasing the immunization program to cover all women by 1995:

Cost = fc+.2*mc91+.4*mc92+.6*mc93+.8*mc94+mc95+mc96+mc97+mc98+mc99+mc20

Neonatal Tetanus is one area where there is great promise for an improved vaccine within the next five to ten years. However, since our target for the elimination of neonatal tetanus is 1995, we have not made any cost adjustments for this promising technology. Cost estimates beyond the year 2000 should attempt to factor in the cost of the new vaccine.

According to Francois Gasse of WHO/EPI an improved vaccine, currently being tested in animals, would be slow release, replacing the 5 recommended

doses with a single injection. The single injection would provide protection to babies during a woman's childbearing years.

Research and testing will translate into initial high costs. The advantages of such a single dose vaccine are great: complete coverage of a women will be much simpler and time efficient. The cost savings in the long run will be substantial.

6.3 Diarrheal Disease

There are several health interventions that have a significant impact on diarrheal disease deaths. Work in a forthcoming World Bank volume[18] points out the effects of several, including measles immunization, oral rehydration therapy, breastfeeding programs, safe water programs, and promotion of frequent handwashing. For this calculation, we are concerned with the effects of measles immunizations and ORT.

ORT is a simple technology to treat and prevent dehydration due to diarrhea, that was heralded as a revolution in the treatment of diarrheal disease when it was developed over a decade ago.[19] The use of premixed ORS packets and home treatments of sugar, salt and water have greatly increased in developing countries. Whereas in many countries the simple sugar, salt and water solution was promoted as a cheap and effective treatment, WHO CDD (Control of Diarrheal Disease) program is now recommending a simple message instead of the home sugar, salt, water solution.[20] The recommendation is that parents treat diarrhea in their children by providing liquids and continuing to feed the child. The home ORS mixture is difficult to control in terms of the proportions of the ingredients - sometimes inappropriate amounts of salt could be harmful to the sick child.

In our costing we have not made an effort to cost the new WHO approach to home care, for two reasons: there has been little costing in the field of what the costs are to reeducate, and the message is relatively new so much of the developing world has not yet adopted the new approach.

The changing emphasis away from the home prepared sugar, salt, and water solution toward simply providing any liquids and continued feeding have cost implications. The home solution is relatively inexpensive compared to premixed sachets of ORS, and the new home treatment will prove even less expensive. There may be initial costs associated with education of the

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[18]Martinez, J., Phillips, M., and Feachem, R., Chapter 4: Diarrheal Diseases, in Evolving Health Sector Priorities in Developing Countries, forthcoming.

[19] Unicef, 1989. State of the World's Children. New York: Oxford University Press.

[20] Robert Hogan, WHO/CDD, personal communication, 1990.

population and health workers about home care of diarrhea without the sugar, salt, and water solution.

Our approach for this target is to determine the number of diarrheal disease deaths that must be averted, and to then to reduce this target amount by the number of diarrheal disease deaths averted by measles immunization. The remaining reduction to reach the Talloires target is accomplished through increased use of ORT. The World Bank work states that measles immunization coverage of between 45 and 90 percent can prevent 44 to 64 percent of measles cases and eliminate 6 to 26 percent of diarrheal deaths among children. On this basis, we found that:

(100 - measles coverage in 1988)/2 = % decrease in DD deaths from measles immunization.

Because the measles target is reached in 1995, we reduced diarrheal disease deaths by this percentage from 1995 onward, and by 20, 40, 60, and 80 percent of this amount in years 1991-94 respectively. The remaining reduction required to reach the target number of deaths averted was assumed to be achieved through the use of ORT. To determine the needed amount of ORT use, we calculated the needed deaths averted. This is:

D = (remaining DD deaths after measles reduction)- half of 1990 DD deaths.

If D is negative, we have reached the goal for that country. If D is positive, then an increase in ORT use will be needed. ORT is assumed to be about 67 percent effective in eliminating diarrheal disease deaths. Based on this level of effectiveness, we calculated the required increase in ORT use:

ORT = (1/0.67) (D/(1990 DD deaths)) • 100

We have assumed a treatment cost of $1.10 per diarrheal episode, based on a note by Dr. M.H. Merson of WHO.[21] Episodes per child per year are shown in the World Bank Chapter[22] as the following:

LAC	4.9
Sub Saharan Africa	4.4
Middle East/N. Afr.	2.7
Asia and Pacific	2.6
India	2.7
China	1.2

Costs for ORT use to achieve the Talloires target can then be calculated as:

Cost = U5pop • ORT • $1.10 • ave episodes per child

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[21] Memo from Dr. M. H. Merson, Director, CDD, WHO, to Mrs. K. Cravero, UNICEF, 12 January, 1989.

[22] Martinez, Phillips, and Feachem, forthcoming.

6.4 Acute Respiratory Infections

Our approach to the cost of the ARI target is based on discussions with Sally Stansfield, and reference to a work in progress (Stansfield, Shepard and Gwatkin, 1990). There are various means of reducing deaths from ARI. They include, but are not limited to, case management, breastfeeding promotion, EPI vaccines, pneumococcal vaccine and reduction of malnutrition. The World Health Organization, through its ARI Control Program, promotes the case management approach to reducing ARI deaths. They have developed standard treatment protocols for care of pneumonia at primary health care facilities.

ARI may cause as much as 30 percent of under 5 mortality in developing countries.[23] The degree to which ARI specific mortality makes up more or less of total under 5 mortality is thought to be highest in high under 5 mortality countries.

Using the UNICEF State of the World's Children country groupings by U5 mortality, Stansfield, Shepard and Gwatkin predict ARI specific mortality represents the following percentage of total U5 mortality:

35-50% in very high (over 170/1000) U5 mortality countries
25-30% in high (95 to 170/1000) U5 mortality countries
15-20% in middle (30 to 95/1000) U5 mortality countries

For our calculations we took the midpoint, 43 percent, 28 percent and 18 percent respectively. Several countries which are generally considered developing countries, fall in the low U5 mortality range.[24] The low end of the range for middle U5 mortality countries was used, that is 15 percent.

Depending on the country's grouping (very high, high, middle or low U5 mortality) one of the four different percents (43%, 28%, 18%, 15%) was multiplied by the number of under 5 deaths in 1990 to give a figure for under five ARI deaths:

Expected ARI deaths yearly = Annual U5 mortality * % of deaths from ARI

The goal in each country is to get the level of ARI mortality down to two thirds of the 1990 level:

Goal = 0.67 * expected ARI deaths in 1990

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[23] Stansfield, personal communication, 1990.

[24] These include Mauritius, Chile, Trinidad and Tobago, Kuwait, Jamaica, and Costa Rica.

Since we want to reach this goal by the year 2000, we can set yearly goals for deaths averted that close the gap between expected deaths and the year 2000 goal at a rate of 10 percent per year:

1991 goal = 0.1 * (expected 1991 ARI deaths - Goal)
1992 goal = 0.2 * (expected 1992 ARI deaths - Goal)
1993 goal = 0.3 * (expected 1993 ARI deaths - Goal)
etc.

Stansfield et al. calculate the cost of case management for cost-effectiveness calculations. Their sensitivity analyses produce three costs per death averted, a most favorable, a least favorable and a most likely. These three amounts are $177, $421 and $252, respectively. Since it was not clear what exactly will result in higher or lower cost per death averted we used the middle figure ($252) as a worldwide average. Therefore, in order to achieve the 1/3 reduction over 1990 level, the number of deaths averted are multiplied by $252 to give a worldwide cost per year of the ARI program.

The pneumococcal vaccine licensed for use in the U.S. is not currently employed in the developing world. Clinical trials of the vaccine in Papua New Guinea have not shown a reduced incidence of pneumonia, though there does appear to be a reduced ARI-specific mortality.[25] A vaccine against pneumonia could produce dramatic results in the reduction of ARI mortality since this infection is one of the most frequent ARI. Until the efficacy is demonstrated in the developing world, and the vaccine becomes used widely, its inclusion in cost estimates of reducing ARI deaths is not recommended.

6.5 Maternal Mortality

Calls for interventions improving the maternal mortality rate are becoming more frequent and insistent. Perhaps the best known is the publication by Herz and Measham.[26] This work suggests a three part approach to reducing maternal mortality:

- Stronger community based health care to screen pregnant women, identify those at high risk and refer them for help; provide prenatal care, safe deliveries for women at less risk, education, family planning, and promote better family health and nutrition.

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[25] Stansfield, S.K., Shepard, D.S., Gwatkin, D., 1990. "Acute Respiratory Infection," in Health Sector Priorities Review, unpublished. The World Bank.

[26] The Safe Motherhood Initiative: Proposals for Action, Barbara Herz and Anthony R. Measham, World Bank Discussion Papers, No. 9, 1987.

- Stronger referral facilities to act as a backup network for complicated deliveries and obstetrical emergencies, and to provide clinical and surgical methods of family planning.

- An "alarm" and transport system to transfer women at high risk and emergencies from the community to the referral facilities.

Both the estimate made in the preliminary version of this paper of the cost of the maternal mortality target and that of the REACH project were extremely high. In both cases these estimates were based on projections made by Herz and Measham. Their work suggests that a program reducing maternal mortality by 67 percent would cost approximately $1.5 per capita, $50 per birth, or about $6,250 per maternal death averted. Based on these guidelines, a safe motherhood program for the entire developing world would have the following costs:

Population:	4.145 billion	• $1.50	= $6.217 billion per year.
Births:	125 million	• $50	= $6,228 billion per year.
Maternal deaths:	200,000	• $6,250	= $1.25 billion per year.

Using a gradual approach intended to achieve this target by the end of the decade, this indicates a total cost of from $7 to $34 billion.

In developing country estimates included in the appendix, we have chosen to use the cost per maternal death averted for two reasons. First, basing the country calculations on population or births completely disregards the level of health and development in the country. High and low mortality countries of the same size would be assumed to have the same cost for a safe motherhood program. An example of this is the calculations for Bangladesh and China. Bangladesh, with a maternal mortality rate of 600 per 100,000 births, would have a program costing $788 million where costs are calculated on the basis of mortality rates, whereas China, with a maternal mortality rate of 44, would have a program costing $181 million. Basing program cost on number of births, the Bangladesh program would cost $1.3 billion and the China program would cost $6.1 billion.

The second major reason for using the lower cost estimates is the argument that if the Talloires goals are achieved, these programs would be operated within health systems functioning at a much higher level of activity that currently. Safe motherhood programs would be able to take advantage of this strengthened health system. In particular, if all pregnant women are receiving tetanus inoculations, a maternal risk screening program could very easily be incorporated in these visits. This would, of course, require greater integration and coordination of vertical health programs, but as noted earlier, this is likely to be required anyway.

Maternal mortality results from the risk of becoming pregnant and the risk associated with the pregnancy. The term maternal mortality rate refers to the risk associated with pregnancy, but Herz and Measham discuss reduction in maternal deaths, which includes both risks. We also calculated the cost of

a 50 percent reduction in maternal deaths rather than the maternal mortality rate. Herz and Measham give the following equation:

$$D_m = CBR \cdot POP \cdot MMR$$

where:
- D_m = number of maternal deaths
- CBR = Crude Birth Rate per thousand population
- POP = Population in thousands
- MMR = Maternal Mortality Rate per thousand live births

Using this formula to calculate maternal deaths in 1990, we then determined the number of deaths to be averted to reach the maternal mortality goal. This number was multiplied by $6,250 to find the single year cost of the programs. Funding for such a safe motherhood program was increased 10 percent per year until the program was fully funded by the year 2000. Using this method of calculation, the cost of achieving this goal was $10.2 billion.

6.6 Infant and Child Mortality

Estimating the cost of achieving of this goal is challenging, since it is unclear what interventions to use or how many deaths must be averted. The REACH estimates appear to assume that achieving the goals for polio, measles, tetanus, diarrhea, and ARI would achieve the infant and child mortality goals, since they made no independent calculations for this target. In fact, this is true for low mortality countries but not for all countries.

Estimations of the cost of this target were performed on both the UNICEF data and the World Bank data. The specific interventions discussed above will reduce child mortality by 37 to 40 percent. This indicates that for countries that have an under-5 mortality rate of less than about 110 per 1000, the specified interventions will allow them to reach the overall mortality reduction goal. For higher mortality regions, however, the stated goal is to achieve a mortality rate of 70 per 1000. In these countries it will be necessary to employ other interventions as well.

An addicional EPI impact on mortality not captured in the measles and tetanus estimations is the elimination of many of the 510,000 pertussis deaths annually. This is likely to reduce mortality rates in all countries. Nevertheless, there will be a need for additional interventions in the very high mortality countries. There are a host of possible programs, including nutrition supplements, breastfeeding and weaning programs, general water and sanitation efforts, increased disease vector control, and AIDS prevention programs. The proper combination of these interventions is likely to vary by country, as a result of local infrastructure, resource costs, morbidity patterns, and other conditions.

Here we consider additional interventions for the countries with the highest mortality rates. As a result, we have to consider interventions

possible in nations with low income, poor infrastructure, and, as indicated by the UNICEF statistics used in this report, an inadequate daily calorie supply in most countries. Thus, we have chosen to estimate the cost of nutrition interventions. This is consistent with additional goals set by the Affirmation of Bangkok, in which nutrition related goals are by far the most common. These include:

- Less than 10 percent of all births with under 2.5kg birth weight.
- 50 percent reduction of under-5 severe and moderate malnutrition.
- Elimination of iodine deficiency disorders.
- Elimination of vitamin A deficiency.
- Reduction in iron deficiency anaemia in women by one third.

Patel[27] indicates that four percent of child mortality in the developing world is due to malnutrition, and expects this to be even higher in the low income countries considered here. Most of the available literature attributes nutrition related mortality to be greater than malnutrition deaths. Poor nutrition more often is a major secondary factor in many causes of child mortality. In addition, iodine deficiency and low birth weights are considered important causes of mortality.

Peterson, Burger, Habicht and Pinstrup-Anderson[28] provide cost estimates for nutrition programs which generally range from $10 to $25 for the total annual cost per recipient. Using this information, we have calculated a cost of providing a nutrition intervention of $20 annually for half of all births in those countries with an under-five mortality rate of more than 70 per thousand.

The effects of a nutrition supplement for every infant in high mortality countries, combined with the reduction in pertussis deaths, could bring the remaining high mortality countries to within the 50 and 70 per 1,000 goals set by the Talloires Declaration. A nutrition intervention on this scale would raise the total cost of achieving the Talloires goals by about 4 to 5 percent.

Table 6.1 shows the cost of this program when using the World Bank data. After all other interventions, 33 countries were found to still have mortality rates in excess of 70 per thousand. The cost of nutrition programs for this group is shown to be $1.1 billion. This goal is set for the year 2000, and is approached at a rate of 10 percent per year. Total cost, therefore, would be 5.5 times the annual cost.

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[27] Eliminating Social Distance Between North and South, UNICEF, 1989.

[28] Protein-Energy Malnutrition, Chapter 6 of Evolving Health Sector Priorities in Developing Countries, World Bank, forthcoming.

Table 6.1
Infant and Child Mortality Goal and Costs

Using World Bank Data

COUNTRY	Before Interventions Infant	Before Interventions Child	After Interventions Child Mort.	After Interventions Nutrit. Cost
AFGHANISTAN	156	234	131	62,742,983
SIERRA LEONE	122	204	114	12,100,847
MALAWI	128	203	114	29,461,579
GUINEA-BISSAU	116	194	108	2,676,420
GUINEA	113	189	106	16,463,992
GAMBIA, THE	111	185	103	2,583,264
MALI	151	202	113	27,087,057
ANGOLA	104	171	96	30,261,948
NIGER	103	169	95	25,592,507
SOMALIA	103	169	95	19,013,613
CHAD	100	164	91	15,466,367
YEMEN ARAB REP.	95	155	86	31,162,286
MAURITANIA	99	162	90	5,942,854
EQUATORIAL GUINEA	96	156	87	858,464
MOZAMBIQUE	112	164	92	45,726,654
BURKINA FASO	114	166	93	26,419,820
RWANDA	95	154	86	24,520,708
ETHIOPIA	107	155	87	163,661,108
DJIBOUTI	91	147	89	1,199,795
OTHER NORTH AFRICA	86	139	84	494,459
TANZANIA	94	154	86	80,069,981
LIBERIA	98	140	85	6,621,694
BHUTAN	103	148	83	3,447,691
NEPAL	99	143	80	43,401,150
CONGO, PEOPLE'S REP.	92	130	79	6,833,672
KAMPUCHEA, DEM.	82	115	64	
LAO PEOPLE'S DEM. RE	78	123	75	11,062,586
MADAGASCAR	96	138	77	28,425,662
SUDAN	80	128	72	64,767,658
YEMEN, PEOPLE'S DEM.	92	131	73	6,931,869
BANGLADESH	93	133	75	229,510,142
NIGERIA	75	119	67	
BENIN	90	128	71	12,812,735
CENTRAL AFRICAN REP.	76	120	67	
UGANDA	74	117	71	54,757,755
GABON	74	116	71	2,958,047
BOLIVIA	81	114	64	
ZAIRE	70	109	66	
HAITI	94	121	67	
COTE D'IVOIRE	71	111	67	
SWAZILAND	89	114	64	
TOGO	66	103	63	
GHANA	65	100	61	
PAKISTAN	81	102	62	

LESOTHO	72	99	60
COMOROS	69	95	58
NAMIBIA	76	94	53
CAMEROON	67	91	56
INDIA	71	88	53
SENEGAL	55	83	51
ZAMBIA	54	82	50
PERU	59	76	46
BURUNDI	48	71	40
EGYPT, ARAB REP. OF	54	69	42
KENYA	48	71	43
MALDIVES	50	65	41
TURKEY	52	67	43
LIBYA	52	62	38
MOROCCO	49	63	39
SOUTH AFRICA	46	59	36
VANUATU	47	60	36
ALGERIA	46	58	35
MYANMAR	45	58	35
KIRIBATI	41	58	35
IRAQ	51	64	41
INDONESIA	39	48	29
MONGOLIA	44	56	36
IRAN, ISLAMIC REP. O	44	57	36
SAUDI ARABIA	47	56	34
HONDURAS	48	57	35
PAPUA NEW GUINEA	41	51	33
ECUADOR	46	58	37
DOMINICAN REP.	42	53	34
NICARAGUA	37	46	28
EL SALVADOR	36	45	29
GUATEMALA	36	45	27
SOLOMON ISLANDS	32	43	27
GAZA STRIP	35	44	28
BRAZIL	41	48	31
GUYANA	36	45	29
ZIMBABWE	24	31	19
SYRIAN ARAB REP.	28	37	24
LEBANON	35	44	28
WESTERN SAMOA	32	39	25
TUNISIA	30	36	23
JORDAN-EAST BANK ONL	26	33	21
MEXICO	31	38	24
SAO TOME AND PRINCIP	27	32	21
BELIZE	30	36	23
VIET NAM	29	36	23
PHILIPPINES	29	34	22
CAPE VERDE	29	35	22
PARAGUAY	31	37	24
UNITED ARAB EMIRATES	15	33	21
SURINAME	28	34	22
OTHER LATIN AMERICA	25	31	20

BOTSWANA	26	31	20
COLOMBIA	27	33	21
ST. KITTS AND NEVIS	25	31	20
OMAN	20	24	15
VENEZUELA	25	30	20
NEW CALEDONIA	21	26	16
GRENADA	21	26	17
MONTSERRAT	21	25	16
ARGENTINA	20	25	16
CHINA (EXCLUDING TAI	20	24	15
OTHER MICRONESIA	19	23	15
QATAR	18	22	14
THAILAND	18	22	14
OTHER WEST AFRICA	18	21	14
BAHAMAS	17	21	13
BAHRAIN	15	19	12
WEST BANK	27	19	12
OTHER POLYNESIA	15	19	12
FEDERATED STATES OF	15	19	12
ST. VINCENT AND THE	15	18	12
TONGA	12	15	10
MALAYSIA	15	18	12
URUGUAY	13	16	10
PANAMA	15	18	11
MAURITIUS	14	18	11
FRENCH POLYNESIA	14	17	11
ANTIGUA AND BARBUDA	13	16	10
SRI LANKA	13	16	10
FIJI	13	16	10
ST. LUCIA	13	16	10
CHILE	13	16	11
VIRGIN ISLANDS (U.S.	13	16	10
SEYCHELLES	14	17	11
OTHER NORTHERN AMERI	12	15	10
COSTA RICA	12	15	10
DOMINICA	12	15	9
TAIWAN, CHINA	12	14	9
BARBADOS	12	15	10
TRINIDAD AND TOBAGO	10	13	8
KUWAIT	9	11	7
REUNION	9	12	7
GUADELOUPE	9	11	7
BRUNEI	8	10	6
MACAO	8	10	6
CYPRUS	7	9	6
JAMAICA	7	9	6
MARTINIQUE	7	9	6
NETHERLANDS ANTILLES	7	9	6
TOTAL COST			$ 1,095,037,364

Results using UNICEF data are in Table 6.2. The table shows the predicted year 2000 mortality rates before the Talloires interventions and what the rates would be after the specific activities to achieve the other Talloires goals. There are 34 countries that would not reach the overall mortality rates after the preceding interventions. These 34 countries had a total of 28,921,000 births in 1988. If a program were adopted that targeted half of all births within these countries for a nutrition program costing $20 per recipient, the annual cost would be $289 million. For the entire decade, the cost would be about $1.6 billion.

Patel arrives at a similar cost: "Worldwide, targeted nutrition programs for pregnant and lactating women, children, and pre-schoolers might cost about $3 billion. About half these costs, some $1.5 billion, would be incurred in low income countries where needs are highest."[29]

[29] Eliminating Social Distance page 194.

Table 6.2
Infant and Child Mortality in the Year 2000

1988 Child Mortality Rank		Mortality Rates Before Interventions		Mortality Rates After Interventions	
		Child	Infant	Child	Infant
1	Afghanistan	274	157	155	89
2	Mozambique	286	165	162	94
3	Mali	267	154	151	87
4	Angola	273	160	155	91
5	Sierra Leone	233	134	132	76
6	Malawi	232	132	132	75
7	Ethiopia	246	145	140	82
8	Guinea	220	128	124	73
9	Burkina Faso	200	119	113	67
10	Niger	201	118	114	67
11	Chad	195	114	110	64
12	Central African R	198	116	112	66
13	Somalia	199	118	113	67
14	Mauritania	192	109	109	62
15	Rwanda	192	112	109	64
16	Kampuchea	192	120	109	68
17	Yemen, Dem.	160	97	91	55
18	Nepal	170	111	97	63
19	Bhutan	170	111	97	63
20	Yemen	153	94	87	53
21	Burundi	167	99	95	56
22	Bangladesh	166	106	94	60
23	Benin	155	91	88	52
24	Madagascar	149	98	84	55
25	Sudan	153	91	87	52
26	Tanzania	155	93	88	53
28	Nigeria	143	86	81	48
29	Bolivia	145	94	82	53
30	Haiti	143	97	81	55
31	Uganda	152	92	86	52
32	Gabon	141	86	80	49
33	Pakistan	140	93	79	53
34	Laos	139	96	79	54
35	Togo	123	75	70	43
36	Cameroon	126	77	72	44
37	India	122	82	69	47
38	Liberia	122	71	69	40
39	Ghana	126	77	71	44
40	Cote d'Ivoire	116	79	66	45
41	Zaire	114	69	64	39
42	Senegal	106	63	60	36
43	Lesotho	117	86	66	49
44	Zambia	105	66	59	37
45	Egypt	97	66	55	37
46	Peru	100	74	57	42

47	Morocco	94	64	53	36
48	Libyan Arab Jamah	94	64	53	37
49	Indonesia	96	71	55	40
50	Congo	91	58	51	33
51	Zimbabwe	96	61	54	35
52	Kenya	93	59	53	33
53	Honduras	85	54	48	31
54	Algeria	82	57	47	32
55	Guatemala	77	46	44	26
56	Saudi Arabia	73	54	42	31
58	Nicaragua	75	48	42	27
59	Myanmar	74	54	42	31
60	Iraq	73	55	42	31
61	Turkey	70	57	40	32
62	Botswana	75	54	43	31
63	Iran, Islamic Rep	68	46	39	26
64	Viet Nam	67	49	38	28
65	Ecuador	69	50	39	28
66	Brazil	69	51	39	29
67	El Salvador	65	45	37	25
68	Tunisia	62	44	35	25
69	Papua New Guinea	61	43	34	24
70	Dominican Rep.	63	52	35	29
71	Philippines	60	36	34	21
72	Guyana	64	52	36	29
73	Mexico	54	37	31	21
74	Colombia	54	37	31	21
75	Syria	47	35	27	20
76	Oman	45	28	25	16
77	Paraguay	49	34	28	19
79	Jordan	41	32	23	18
80	Lebanon	42	32	24	18
81	Thailand	37	29	21	16
82	Venezuela	34	28	19	16
83	Sri Lanka	33	25	19	14
84	China	31	22	17	12
85	Argentina	30	26	17	15
86	Panama	25	17	14	10
90	United Arab Emira	22	17	12	10
91	Malaysia	24	18	13	10
93	Uruguay	26	22	14	13
94	Mauritius	21	16	12	9
97	Chile	18	13	10	7
98	Trinidad/Tobago	17	15	10	9
99	Kuwait	15	13	9	8
100	Jamaica	16	13	9	7
101	Costa Rica	15	13	9	7

APPENDIX A: Country Costs for Talloires Goals
Based on UNICEF Data

Under Five Mortality Rank	Country	Cost of Child Immunization	Cost of Maternal Tetanus Imm.	Cost of ARI Treatments	Cost of ORT Program	Cost of Safe Motherhood Program
1	Afghanistan	83,848,453	21,497,462	24,773,001	2,184,387	77,047,171
2	Mozambique	70,880,740	14,573,936	71,819,748	32,180,698	58,289,913
3	Mali	66,173,193	12,775,195	46,852,000	11,941,471	41,424,757
4	Angola	37,189,542	13,293,793	45,079,286	29,085,265	39,119,226
5	Sierra Leone	22,066,465	3,341,383	14,948,354	6,758,028	24,400,396
6	Malawi	18,898,029	5,176,714	40,361,625	43,423,294	13,768,714
7	Ethiopia	313,728,049	69,530,529	141,012,560	20,461,895	143,284,742
8	Guinea	42,427,838	10,469,666	22,884,053	8,093,356	26,217,662
9	Burkina Faso	38,146,786	12,430,852	25,219,629	20,922,008	89,917,358
10	Niger	51,586,887	10,781,257	29,101,294	9,446,002	47,921,008
11	Chad	37,348,669	8,293,966	14,874,026	3,878,162	56,714,063
12	Central African R	16,372,716	3,822,733	8,304,105	3,597,120	21,063,194
13	Somalia	52,509,225	9,422,930	33,060,870	8,666,080	140,274,125
14	Mauritania	9,133,322	2,199,220	5,828,756	3,831,174	7,653,501
15	Rwanda	15,285,740	6,922,299	30,200,800	42,585,266	24,973,051
16	Kampuchea	37,972,139	13,238,510	22,662,674	8,483,806	27,571,211
17	Yemen, Dem.	15,031,983	3,821,714	5,881,436	2,041,759	9,827,373
18	Nepal	63,418,362	21,695,055	37,569,866	2,752,036	160,838,892
19	Bhutan	6,667,493	1,460,969	2,595,511	908,009	24,147,354
20	Yemen	50,219,747	12,724,472	18,911,090	7,146,158	33,113,557
21	Burundi	26,940,886	2,753,874	15,551,808	8,377,588	22,320,207
22	Bangladesh	765,017,110	169,209,162	260,706,273	47,119,939	788,266,931
23	Benin	30,444,241	7,186,920	13,668,612	8,265,003	21,820,429
24	Madagascar	65,267,498	18,567,749	27,546,410	2,187,308	39,088,858
25	Sudan	86,411,561	33,440,605	58,257,394	50,751,213	212,323,484
26	Tanzania	31,631,319	21,133,102	89,087,597	187,003,972	151,533,673
28	Nigeria	424,048,709	150,733,245	297,290,311	476,891,178	1,400,164,201
29	Bolivia	31,600,032	8,977,050	14,486,468	17,053,612	41,661,737
30	Haiti	15,621,176	4,636,372	6,781,337	15,033,110	11,283,892
31	Uganda	86,717,786	26,417,608	37,265,425	60,001,956	87,482,493
32	Gabon	2,633,247	799,228	2,140,255	2,904,580	10,641,171
33	Pakistan	482,674,015	153,788,353	210,224,471	294,626,912	936,446,827
34	Laos	23,508,940	5,982,445	4,132,038	1,777,757	24,392,973
35	Togo	7,336,296	1,573,676	3,979,561	15,761,801	26,562,921
36	Cameroon	46,701,640	13,735,321	11,777,425	22,970,172	38,432,604
37	India	2,648,843,816	584,511,808	475,511,901	750,981,977	2,126,075,199
38	Liberia	9,474,370	3,400,373	3,308,233	7,711,488	21,046,650
39	Ghana	64,199,785	20,397,208	20,083,914	43,703,212	200,640,227
40	Cote d'Ivoire	84,829,482	11,574,799	20,879,486	31,045,560	132,799,658
41	Zaire	169,679,316	33,978,557	42,972,351	90,299,534	298,397,958
42	Senegal	28,664,021	9,190,770	6,819,641	20,693,004	56,394,216
43	Lesotho	2,959,873	1,983,974	1,896,359	8,198,073	12,571,209
44	Zambia	17,513,255	7,926,113	12,683,573	53,706,851	22,329,308
45	Egypt	60,819,867	10,720,420	30,866,665	143,390,692	159,913,209
46	Peru	56,749,366	33,853,822	11,979,303	62,399,311	16,094,342
47	Morocco	63,778,580	27,663,873	11,898,453	40,666,208	62,432,101
48	Libyan Arab Jamah	17,763,695	6,800,239	4,715,950	10,835,701	5,261,107
49	Indonesia	318,611,090	196,109,175	48,404,924	199,192,190	431,298,735
50	Congo	4,356,212	1,739,682	1,571,627	7,177,955	24,686,181
51	Zimbabwe	18,458,173	12,518,416	7,819,106	43,493,281	52,583,159
52	Kenya	101,807,119	16,150,569	35,976,831	130,882,277	80,624,524
53	Honduras	9,102,296	7,231,300	3,512,659	26,422,540	2,919,940
54	Algeria	75,197,424	28,123,226	14,657,123	82,376,691	38,013,893
55	Guatemala	30,735,328	12,426,398	5,113,333	28,641,744	10,998,399
56	Saudi Arabia	23,597,931	12,103,278	10,402,792	51,925,681	116,564,366
58	Nicaragua	12,994,368	4,801,831	2,401,778	15,373,407	2,142,969
59	Myanmar	186,653,760	51,461,892	11,169,889	11,032,419	33,613,446
60	Iraq	33,217,352	13,967,601	7,932,587	59,928,093	11,797,380
61	Turkey	92,899,029	84,910,757	7,674,942	80,913,791	70,488,298
62	Botswana	2,075,447	842,901	690,472	6,644,221	4,668,404
63	Iran, Islamic Rep	41,420,794	48,432,293	24,355,708	221,577,613	461,032,519

64	Viet Nam	170,903,731	73,109,867	12,266,072	79,840,416	70,279,981
65	Ecuador	31,729,267	16,878,581	2,799,888	29,126,707	18,146,256
66	Brazil	286,256,820	164,440,262	24,100,753	354,311,518	108,856,150
67	El Salvador	11,520,031	6,641,172	713,500	12,915,409	2,555,966
68	Tunisia	7,864,785	8,857,305	1,126,739	18,517,797	17,033,003
69	Papua New Guinea	15,025,569	5,448,814	992,842	4,667,226	37,282,194
70	Dominican Rep.	11,080,269	1,530,800	1,016,929	2,421,166	3,541,409
71	Philippines	85,644,620	64,758,651	12,705,145	13,577,661	46,408,114
72	Guyana	1,863,639	722,088	129,198	1,545,942	2,889,751
73	Mexico	131,861,605	97,075,240	11,155,219	271,040,577	45,489,572
74	Colombia	41,424,394	31,080,274	3,671,857	100,432,093	21,404,640
75	Syria	49,117,581	12,482,602	3,527,421	25,546,369	47,461,517
76	Oman	1,977,936	776,088	456,362	6,993,143	13,986,720
77	Paraguay	9,796,188	2,539,662	886,183	14,818,662	15,447,188
79	Jordan	4,932,443	3,244,846	1,199,350	17,439,535	36,519,153
80	Lebanon	2,790,566	3,005,389	165,179	4,521,528	8,278,819
81	Thailand	80,812,159	35,289,616	1,873,751	5,451,331	133,411,720
82	Venezuela	52,524,342	21,940,413	1,809,506	45,545,585	8,388,511
83	Sri Lanka	20,340,756	17,283,449	643,481	19,697,017	4,319,079
84	China	0	1,212,924,061	18,638,292	72,550,020	181,105,254
85	Argentina	37,656,508	34,744,214	1,645,859	59,567,454	10,279,580
86	Panama	2,807,714	2,842,254	106,736	7,477,494	783,656
90	United Arab Emira	2,680,614	1,914,580	88,168	6,416,315	6,258,163
91	Malaysia	39,445,467	13,314,717	819,960	20,504,547	6,523,701
93	Uruguay	2,862,595	4,320,647	100,469	2,819,135	437,718
94	Mauritius	895,962	636,313	7,690	1,896,637	324,179
97	Chile	0	14,175,320	199,395	43,733,039	2,922,057
98	Trinidad/Tobago	1,403,069	796,472	21,613	2,118,855	307,392
99	Kuwait	4,419,634	3,455,545	107,023	5,161,530	121,524
100	Jamaica	3,449,942	1,983,315	37,233	5,722,218	1,364,348
101	Costa Rica	52,060,245	505,138	73,070	15,439,510	703,841
		8,517,010,035	3,977,946,331	2,623,130,546	4,980,142,027	10,193,208,220

Country Costs for Talloires Goals
Based on World Bank Data

COUNTRY	Cost of Child Immunization	Cost of ORT Program	Cost of ARI Treatments
AFGHANISTAN	84,774,013	33,746,057	87,512,451
SIERRA LEONE	15,107,730	9,591,320	14,334,173
MALAWI	10,631,859	47,281,283	35,535,973
GUINEA-BISSAU	4,090,631	1,523,744	2,943,430
GUINEA	24,980,182	9,205,849	17,774,629
GAMBIA, THE	3,215,664	2,027,764	2,775,334
MALI	41,475,719	19,382,139	32,482,290
ANGOLA	24,941,593	34,264,479	30,872,888
NIGER	37,894,251	14,913,752	26,081,060
SOMALIA	27,561,636	7,272,244	18,847,570
CHAD	26,418,741	5,778,880	14,670,451
YEMEN ARAB REP.	45,187,526	10,663,595	28,202,078
MAURITANIA	6,424,021	5,575,734	5,631,664
EQUATORIAL GUINEA	1,342,845	407,210	745,830
MOZAMBIQUE	50,346,499	44,076,409	43,875,479
BURKINA FASO	26,157,319	28,792,182	25,531,641
RWANDA	8,419,601	38,900,622	22,250,324
ETHIOPIA	282,638,392	66,113,897	151,557,077
DJIBOUTI	1,040,577	776,034	657,245
OTHER NORTH AFRICA	442,752	293,946	248,792
TANZANIA	11,874,092	149,768,783	73,084,926
LIBERIA	6,035,580	6,722,990	3,394,578
BHUTAN	4,540,253	1,583,124	2,919,227
NEPAL	44,992,831	23,506,707	33,111,726
CONGO, PEOPLE'S REP.	3,191,568	9,835,012	3,435,833
KAMPUCHEA, DEM.	24,378,037	1,801,628	8,026,066
LAO PEOPLE'S DEM. RE	19,750,528	1,566,444	4,854,596
MADAGASCAR	39,542,289	20,086,613	21,707,584
SUDAN	55,810,940	69,377,763	46,787,213
YEMEN, PEOPLE'S DEM.	10,683,332	2,264,137	5,040,963
BANGLADESH	459,855,508	20,857,338	161,070,075
NIGERIA	264,459,835	361,948,887	224,171,307
BENIN	19,055,944	7,670,219	9,156,423
CENTRAL AFRICAN REP.	11,135,146	4,230,693	5,182,142
UGANDA	55,160,051	51,689,617	24,108,236
GABON	1,531,930	4,073,513	1,311,832
BOLIVIA	21,127,894	15,800,425	11,193,559
ZAIRE	107,942,467	76,509,661	38,204,734
HAITI	11,006,238	16,461,387	8,302,734
COTE D'IVOIRE	52,731,144	24,585,350	16,076,231
SWAZILAND	2,734,457	1,656,769	1,385,221
TOGO	4,983,391	13,945,101	3,882,260
GHANA	42,747,994	33,117,930	14,157,767
PAKISTAN	279,113,357	185,651,072	111,116,866
LESOTHO	1,531,440	5,834,666	1,426,122
COMOROS	1,204,009	1,404,899	479,293
NAMIBIA	4,371,870	2,240,194	1,748,908
CAMEROON	35,997,387	29,281,573	11,438,760
INDIA	1,794,384,710	509,099,586	394,681,137
SENEGAL	19,192,566	22,769,574	6,955,168
ZAMBIA	7,994,957	36,855,852	7,558,676
PERU	33,794,041	33,503,596	9,178,836
BURUNDI	18,519,977	10,473,688	6,304,166
EGYPT, ARAB REP. OF	25,699,893	80,679,078	22,932,003
KENYA	52,131,988	71,344,499	17,441,591
MALDIVES	330,942	397,068	85,858
TURKEY	66,679,907	55,394,023	12,376,326
LIBYA	11,556,516	7,487,321	3,018,344
MOROCCO	43,757,418	26,695,139	10,519,193
SOUTH AFRICA	64,375,248	52,588,783	13,373,938
VANUATU	317,676	203,836	79,208

ALGERIA	46,178,122	29,953,639	10,940,505
MYANMAR	136,358,699	(2,305,743)	13,036,434
KIRIBATI	125,159	59,835	24,881
IRAQ	18,173,995	48,371,619	7,446,714
INDONESIA	227,441,228	101,248,780	40,730,831
MONGOLIA	3,570,749	2,469,503	548,469
IRAN, ISLAMIC REP. O	33,802,636	117,721,213	16,440,832
SAUDI ARABIA	12,052,168	37,949,642	8,255,133
HONDURAS	5,099,306	18,823,584	2,364,957
PAPUA NEW GUINEA	9,096,714	2,997,712	884,335
ECUADOR	19,381,832	18,867,622	2,348,934
DOMINICAN REP.	6,879,916	13,777,190	1,245,922
NICARAGUA	8,243,002	7,848,331	1,443,556
EL SALVADOR	8,067,325	11,800,946	1,101,051
GUATEMALA	20,157,253	19,804,277	3,443,831
SOLOMON ISLANDS	477,411	592,691	90,089
GAZA STRIP	0	1,464,932	124,824
BRAZIL	191,813,501	205,170,001	21,075,063
GUYANA	1,076,603	634,270	83,255
ZIMBABWE	9,835,959	16,178,190	2,042,334
SYRIAN ARAB REP.	33,231,770	16,595,051	3,091,450
LEBANON	1,531,729	3,650,541	375,899
WESTERN SAMOA	185,146	165,763	22,300
TUNISIA	4,026,816	10,453,002	1,032,413
JORDAN-EAST BANK ONL	1,457,900	7,663,260	677,695
MEXICO	82,282,731	164,934,958	10,381,883
SAO TOME AND PRINCIP	152,291	252,259	18,070
BELIZE	242,812	560,927	33,891
VIET NAM	115,018,771	50,501,052	8,427,216
PHILIPPINES	44,747,938	69,976,962	7,069,261
CAPE VERDE	532,048	1,044,952	67,650
PARAGUAY	6,329,547	11,359,554	703,070
UNITED ARAB EMIRATES	1,782,276	1,301,800	163,300
SURINAME	479,433	866,247	49,934
OTHER LATIN AMERICA	275,245	232,279	18,193
BOTSWANA	737,497	3,271,793	159,735
COLOMBIA	23,060,139	61,122,185	2,880,253
ST. KITTS AND NEVIS	32,324	50,233	2,681
OMAN	823,689	3,614,492	242,219
VENEZUELA	35,763,698	28,688,888	2,002,908
NEW CALEDONIA	128,987	117,288	10,410
GRENADA	42,512	177,690	5,246
MONTSERRAT	4,157	20,068	550
ARGENTINA	24,015,334	44,289,510	1,845,473
CHINA (EXCLUDING TAI	0	576,843,231	64,204,536
OTHER MICRONESIA	110,089	115,418	8,678
QATAR	470,644	595,939	40,317
THAILAND	57,216,574	36,955,137	3,189,844
OTHER WEST AFRICA	6,386	11,124	448
BAHAMAS	80,849	518,566	11,673
BAHRAIN	243,308	710,937	27,209
WEST BANK	707,007	2,749,179	102,647
OTHER POLYNESIA	84,695	97,057	5,716
FEDERATED STATES OF	122,217	153,911	8,796
ST. VINCENT AND THE	95,365	166,771	5,252
TONGA	108,487	81,240	4,993
MALAYSIA	29,374,072	13,265,354	1,056,851
URUGUAY	1,642,947	3,602,939	100,733
PANAMA	1,623,694	4,344,173	113,337
MAURITIUS	567,666	1,272,169	31,357
FRENCH POLYNESIA	190,254	238,238	12,207
ANTIGUA AND BARBUDA	20,989	168,690	2,914
SRI LANKA	12,739,080	12,055,279	628,545
FIJI	655,889	562,356	29,319
ST. LUCIA	65,950	375,872	6,416
CHILE	0	29,060,931	419,392
VIRGIN ISLANDS (U.S.	0	227,598	3,123
SEYCHELLES	28,839	153,282	2,698
OTHER NORTHERN AMERI	33,876	184,772	2,810

COSTA RICA	0	7,536,862	97,348
DOMINICA	59,359	140,242	3,091
TAIWAN, CHINA	0	9,075,318	453,641
BARBADOS	68,885	406,563	5,665
TRINIDAD AND TOBAGO	1,007,740	2,091,478	34,736
KUWAIT	2,207,946	1,939,966	62,037
REUNION	203,844	1,220,547	14,121
GUADELOUPE	109,371	557,257	6,548
BRUNEI	99,357	336,464	6,688
MACAO	138,598	402,335	7,599
CYPRUS	197,060	560,413	9,604
JAMAICA	1,982,868	3,581,544	42,858
MARTINIQUE	94,116	502,891	4,620
NETHERLANDS ANTILLES	57,452	383,039	3,394
TOTALS	5,706,748,744	4,279,135,747	2,157,535,412

APPENDIX B: Projected Current Spending on EPI to 2000

Under Five Mortality Rank	Country	Cost of Current EPI Levels for: Children	Pregnant Women
1	Afghanistan	19,929,548	1,372,178
2	Mozambique	28,723,844	10,994,373
3	Mali	10,078,463	2,616,606
4	Angola	24,514,412	3,118,297
5	Sierra Leone	6,962,063	3,341,383
6	Malawi	32,866,027	8,814,405
7	Ethiopia	24,135,209	5,233,481
8	Guinea	8,051,376	668,277
9	Burkina Faso	18,990,922	2,193,680
10	Niger	8,281,501	937,501
11	Chad	3,917,641	921,552
12	Central African R	3,604,679	955,683
13	Somalia	10,364,503	3,310.759
14	Mauritania	3,855,572	1,083,198
15	Rwanda	27,835,193	5,222,085
16	Kampuchea	11,993,333	409,438
17	Yemen, Dem.	2,991,315	201,143
18	Nepal	35,675,733	9,747,054
19	Bhutan	1,944,644	1,057,943
20	Yemen	9,987,363	393,540
21	Burundi	9,601,456	6,129,590
22	Bangladesh	58,382,982	20,913,492
23	Benin	6,649,969	540,951
24	Madagascar	17,987,138	1,185,175
25	Sudan	59,166,969	8,360,151
26	Tanzania	114,154,624	24,808,424
28	Nigeria	313,834,196	37,683,311
29	Bolivia	12,803,802	2,992,350
30	Haiti	11,794,889	5,900,837
31	Uganda	42,703,816	4,300,541
32	Gabon	3,235,646	1,198,843
33	Pakistan	302,552,868	54,033,746
34	Laos	2,834,763	450,292
35	Togo	10,564,356	4,046,594
36	Cameroon	18,924,502	4,825,924
37	India	1,084,551,703	807,182,973
38	Liberia	5,961,079	850,093
39	Ghana	29,234,161	4,784,530
40	Cote d'Ivoire	18,402,695	9,860,014
41	Zaire	68,419,624	25,632,946
42	Senegal	16,730,024	2,902,348
43	Lesotho	5,432,224	977,181
44	Zambia	33,321,999	6,485,002
45	Egypt	150,131,526	78,616,411
46	Peru	39,269,773	2,943,811
47	Morocco	46,017,054	13,625,490
48	Libyan Arab Jamah	9,847,379	927,305
49	Indonesia	263,015,131	96,591,086
50	Congo	5,997,529	1,542,736
51	Zimbabwe	27,991,639	3,530,835
52	Kenya	77,903,614	26,350,928
53	Honduras	14,432,602	1,377,391
54	Algeria	53,862,637	13,851,738
55	Guatemala	18,720,879	2,727,746
56	Saudi Arabia	45,023,235	12,103,278
58	Nicaragua	8,209,763	1,600,610
59	Myanmar	15,689,961	16,251,124
60	Iraq	57,892,040	17,776,947
61	Turkey	90,497,697	6,391,132
62	Botswana	4,718,189	1,318,384
63	Iran, Islamic Rep	204,149,598	48,432,293
64	Viet Nam	104,847,490	36,009,338

65	Ecuador	17,868,254	888,346
66	Brazil	225,525,057	80,992,965
67	El Salvador	10,348,224	1,557,806
68	Tunisia	18,213,481	4,552,854
69	Papua New Guinea	6,621,834	1,115,022
70	Dominican Rep.	14,111,016	10,244,584
71	Philippines	144,011,829	38,032,858
72	Guyana	1,202,230	957,186
73	Mexico	160,350,919	47,813,178
74	Colombia	60,785,324	20,720,183
75	Syria	26,254,194	8,321,735
76	Oman	5,698,085	1,810,872
77	Paraguay	8,636,612	4,514,954
79	Jordan	15,818,670	3,809,167
80	Lebanon	5,822,674	1,480,266
81	Thailand	64,230,643	55,196,579
82	Venezuela	26,281,147	10,806,472
83	Sri Lanka	22,769,532	10,593,082
84	China	1,963,963,629	597,410,358
85	Argentina	41,847,486	17,112,822
86	Panama	4,318,973	1,051,245
90	United Arab Emira	1,909,156	943,002
91	Malaysia	24,274,836	15,014,468
93	Uruguay	3,844,815	645,614
94	Mauritius	1,271,938	1,181,725
97	Chile	26,449,734	6,981,874
98	Trinidad/Tobago	1,883,505	1,194,708
99	Kuwait	3,866,026	70,521
100	Jamaica	3,858,054	1,983,315
101	Costa Rica	7,422,474	4,546,243
		6,699,626,915	2,432,161,470

APPENDIX C: Affirmation of Bangkok Goals

The Affirmation of Bangkok greatly enlarges the goals originally set forth in 1988. Many of these goal are difficult to quantify, and Task Force staff expect that there will be further modification of these goals at a later meeting. Goals in the Affirmation that have definable target levels are:

- 50 percent reduction in maternal mortality rates.
- One third reduction in infant mortality, or to 50 per 1000.
- One third reduction in under-5 mortality, or to 70 per 1000.
- Primary education for 80 percent of primary school age children.
- 50 percent reduction in adult illiteracy rate.
- Less than 10 percent of all births with under 2.5kg birth weight.
- 50 percent reduction of under-5 severe and moderate malnutrition.
- Elimination of iodine deficiency disorders.
- Elimination of vitamin A deficiency.
- Reduction in iron deficiency anaemia in women by one third.
- Global eradication of poliomyelitis
- Elimination of neonatal tetanus by 1995
- 95 percent reduction in measles deaths and 90 percent reduction in cases.
- 50 percent reduction in diarrhoeal deaths and 25 percent reduction in cases.
- One third reduction in under-5 deaths from ARI.
- Universal access to safe water.
- Universal access to sanitary excreta disposal.
- Elimination of guinea worm disease.

The Affirmation of Bangkok has an extremely broad scope with a number of goals that would be affected by several different interventions. There are some interventions called for by the goals that are specific, identifiable programs, but there are also several general types of activities that would be difficult to cost. The interventions implied by the Affirmation include:

EPI program
ORT programs
Improved nutrition
Maternal health programs
Increased water and sanitation services
General improvements in child health care
Guinea worm disease program
Iodine, Vitamin A, and Iron nutritional programs
Primary education programs
Family planning services

APPENDIX D: Statement of the Linear Programming Problem

This appendix formally states the linear optimization problem presented in Section 3.

Let:

E = EPI: providing full immunization to mother and child.
O = ORT: treatment of an episode of diarrheal disease.
F = FP: providing family planning services to a couple for one year.
N = NTR: providing nutrition supplements to an individual for one year.
W = W&S: providing water and sanitation services annually.
S = SFM: a maternal program for a woman at risk.
M = MED: general medical treatment, prescription, or preventive care.

Then the solution to the cost minimization problem is:

Minimize Cost = 18*E + 1.2*O + 20*F + 15*N + 10*W + 30*S + 5*M

subject to:

```
0.001 E + 0.01 O +     0 F +0.025 N + 0.01 W +     0 S + 0.001 M >=1,750,000
0.001 E +     0 O +     0 F +0.005 N +     0 W +     0 S + 0.005 M >=  850,000
0.022 E +     0 O +     0 F + 0.01 N +     0 W +     0 S + 0.0005M >=1,300,000
0.018 E +     0 O +     0 F +     0 N +     0 W +0.0001S + 0.0001M >=  790,000
    0 E +     0 O + 0.01 F +0.0001N +0.001 W +0.02  S + 0.0001M >=  170,000
0.006 E +     0 O + 0.05 F +0.001 N +0.001 W +0.001 S + 0.0005M >=  400,000
```

APPENDIX E: List of Contacts

Michael Azefor	World Bank
Howard Barnum	World Bank
Mark Belsey	WHO
John Bennett	Task Force For Child Survival
Logan Brenzel	REACH Project
Rodolfo Bulatao	World Bank
Lincoln Chen	Harvard School of Public Health
James Cheyne	WHO/EPI
John Clemens	WHO/EPI
Andrew Creese	WHO
Stan Foster	CDC
Francois Gasse	WHO/EPI
Jonathan Gorstein	WHO
Guidotti	WHO
Kul Guataum	UNICEF
David Gwatkin	PEW Foundation
Philip Van Haecke	UNICEF
Rafe Henderson	WHO
Rolph Van Der Hoeven	UNICEF
Robert Hogan	WHO/CDD
Gwen Edwards Jenkins	UNICEF, Department of Statistics
Robert Kim-Farley	WHO/EPI
Parker Mauldin	Rockefeller Foundation
Anthony Measham	World Bank
Marc Olive	WHO/PAHO/EPI
David Parker	UNICEF
Allison Percy	REACH Project
Ciro A. de Quadros	PAHO
Erica Royston	WHO/Family Health
Vulmiri Ramalingaswami	World Bank
Michael Saggs	UNDP
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Sally Stansfield	World Bank (consultant)
James Tulloch	WHO/CDD
Nick Ward	WHO/EPI

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