Disease Control Priorities
for Child Health in the Tropics

Perla D. Santos-Ocampo[1, 2] and Jossie M. Rogacion[3]

[1]University Professor, Department of Pediatrics, College of Medicine- Philippine General Hospital, University of the Philippines Manila;
[2]Honorary President, International Society of Tropical Pediatrics; [3]Associate Professor, Department of Pediatrics,
College of Medicine- Philippine General Hospital, University of the Philippines Manila

ABSTRACT

Child health is an important indicator in measuring national development. This is particularly true in developing countries with meager resources where children constitute a large percentage of the population. One cannot overemphasize its significance in tropical, developing countries like those in Asia and Africa where childhood morbidity and mortality are highest especially in the under-five age bracket. It is also in these countries where infectious diseases consistently rank as major causes of deaths. Realizing the short-term and long-term devastating effects on the health of individual children of developing nations and the resulting implications on national development, the formulation of strategies to address these problems in the context of economic evaluation has increasingly become a priority for developing countries. Economic evaluation deals with costs and consequences. It is basically determining which of the available interventions will utilize the least amount of resources without sacrificing the effectiveness of such strategies and the benefits that are gained from their implementation.

This paper discusses economic evaluation of strategies to control specific diseases in children in the tropics as published in Disease Control Priorities Project (second edition): diarrhea, respiratory diseases, tuberculosis (TB), malaria, HIV/AIDS and malnutrition. It uses cost-effectiveness analysis (CEA) utilizing disability-adjusted life years (DALYs) as the consequence or effect. One DALY represents the loss of one year of equivalent full health. For diarrhea, the most cost-effective strategy is breastfeeding promotion. Improved case management, using the Integrated Management of Childhood Illness (IMCI) approach has resulted in significant reduction in mortality in children with Acute Respiratory Infections below five years old. Direct Observed Therapy Short-course(DOTS) is currently considered the most cost-effective intervention even in the most severe and infectious forms of TB. The use of combination drug treatment is the most cost-effective strategy in the treatment of malaria. Interventions directed towards both the host and the vector of malaria are also considered cost-effective. Data on cost-effective strategies in preventing AIDS are lacking and treatment strategies are expensive because of the prohibitive cost of drugs used for treatment. Community-based health programs have been found to be most cost-effective in the battle against malnutrition.

Economic evaluation of interventions and strategies to reduce childhood illness, disability and death has become imperative and is very important in developing countries with limited resources such as those in the tropics.

Key Words : economic evaluation; cost-effectiveness analysis; DALY; childhood diseases

Child health has become the priority of all nations, whether rich or poor, and has become an important indicator for which national development is measured. Control of diseases affecting children has been in the forefront of national and international endeavors. In the State of the World's Children 2005[1], the UNICEF estimates that more than one billion children are denied a healthy and protected upbringing, as promised by the Convention on the Rights of the Child (CRC). The United Nations' Millennium Development Goals (MDGs)[2] have been formulated to tackle the problem of child health either directly or indirectly and to ensure that the promises of the CRC are kept.

The United Nations' Millennium Development Goals: Implications on Child Health

Table 1 lists the United Nations' MDGs. Reduction in childhood mortality (goal 4) directly addresses the need to focus on saving the lives of children. Parallel to reducing childhood mortality is the improvement of maternal health (goal 5), which will ensure that children are born healthy. Improving the literacy rate among women by universal primary education (goal 2) and gender equality (goal 3) will translate to better delivery of quality child health care practices. Halting and reversing the spread of malaria, HIV and other diseases (goal 6) focuses on the impact of these

Table 1. United Nations Millennium
Development Goals

GOALS	
Goal 1	Eradicate extreme poverty and hunger
Goal 2	Achieve universal primary education
Goal 3	Promote gender equality and empower women
Goal 4	Reduce child mortality
Goal 5	Improve maternal health
Goal 6	Combat HIV/AIDS, malaria and other diseases
Goal 7	Ensure environmental sustainability
Goal 8	A global partnership for development

diseases on childhood mortality and morbidity through vertical and horizontal transmission. These diseases continue unabated especially in developing countries despite progress in technology. Ensuring the sustainability of the environment (goal 7) involves the provision of safe water supply, clean air and better waste management. The reduction of poverty and hunger (goal 1), which threatens the lives of innocent children, is considered to be the root of not only social problems but health issues as well.

It has now become imperative for nations to ensure that strategies be formulated and implemented in order to sustain whatever benefits or gains that accrue from programs or policies. To facilitate the attainment of these goals it is crucial that all stakeholders unite in a global partnership for development (goal 8).

The Challenge of Child Health in the Tropics

The care of children in the tropics has always been considered as a challenging task for pediatricians. Majority of these children live in developing countries and below the poverty level. The disparity between the rich and the poor is more palpable in tropical developing countries where the highest morbidity and mortality is in the under-five age group.

According to a World Health Organization (WHO) report in 2004,[3] about 15 million (>26%) of all deaths (57 million) worldwide are still due to infectious diseases. It is the world's greatest killer accounting for half of all deaths in developing countries. Six of these diseases such as pneumonia, tuberculosis, diarrheal diseases, malaria, measles and human immunodeficiency virus infection/AIDS, account for 90% of deaths due to infectious diseases.

Over half (51%) of deaths in children under five are due to four causes namely pneumonia, diarrhea, measles, and malaria, causes which are highly preventable and curable[4]. Globally, they account for approximately 10 million deaths annually in children under five years of age.

The Disease Control Priorities Project (DCPP)

Most of the discussion that will follow are derived from a book entitled Disease Control Priorities in Developing Countries, Second Edition[5] which provides estimates

of cost-effectiveness and impact of interventions. The objectives of the book are universal to mankind: to decrease illness, disability and death. Childhood diseases that will be tackled include some of the major causes of morbidity and mortality particularly important in tropical countries such as respiratory infections, diarrhea, malnutrition, tuberculosis, HIV, and malaria .

The DCPP is a joint project of the Fogarty International Center (FIC) of the U.S. National Institutes of Health (NIH), the World Health Organization (WHO), the World Bank and the Population Reference Bureau. The project is also funded by the Bill and Melissa Gates Foundation.

Aside from the tremendous wealth of science-based information provided for scientists, academicians, health-policy makers, public health administrators, investment program managers, development agencies, and the international health community, it is intended for all levels of decision makers and these include not only the aforementioned but community health workers and individual practitioners such as pediatricians. The data presented in the DCPP will be invaluable to pediatricians who need to make an informed decision when confronted with certain diseases, what interventions to utilize, keeping in mind their cost-effectiveness, and issues of equity and cultural factors as they care for child patients.

The Exigency of Economic Evaluation and Measures of Cost-Effectiveness

Treatment and prevention of childhood diseases has been beset by several problems and obstacles in the tropics especially in developing countries. With poverty and meager health resources, child health has often been relegated to the background, often competing for financial allocation with other basic social services. It becomes imperative for policy makers to turn to economic evaluations of program strategies and interventions to provide the most cost-effective strategy to deliver health services to combat the unabated problems of childhood diseases.

For the practicing pediatrician, orientation in the economic evaluation of health interventions will help him/her in decision-making regarding the best management options from the point of view of cost-effectiveness or cost-benefits. Oftentimes, a sophisticated diagnostic tool or a novel therapeutic option may not turn out to be the most cost-effective.

Economic evaluation deals with both inputs and outputs, sometimes called costs and consequences. The link between costs and consequences usually dictate how to reach a decision. It is concerned with choices. In the real world, resources are scarce and to produce the desired outputs necessitate that choices must, and should be made. These choices are made on the basis of several criteria, sometimes explicit but often implicit. Economic analysis seeks to identify and make explicit one set of criteria which may be useful in deciding among different uses for scarce resources. Thus an economic evaluation is the comparative analysis of alternative courses of action in terms of both their costs and consequences. The basic tasks are to identify, measure, value

and compare the costs and consequences of the alternatives being considered.[6]

It is not just important to know the epidemiology, management and prevention, of a particular disease entity, but more importantly, the burden of the disease in terms of costs to the individual, family, community and the entire health care delivery system, and the consequences of such in terms of morbidity and mortality. The ultimate goal is to control such diseases through interventions that can be implemented. If several interventions are available, there is a need to know which of these will consume the least resources but will be the most effective or beneficial. Such strategy obviously will require an economic evaluation.

There are four basic types of economic evaluation: cost minimization analysis (CMA), cost effectiveness analysis (CEA), cost benefit analysis (CBA) and cost utility analysis (CUA). CMA involves the comparison of program alternatives with the same consequences or outcomes. The economic evaluation is essentially a search for the alternative with the least cost.[6] CEA examines alternative programs in which costs are related to a single, common effect or consequence which may differ in magnitude and expressed as cost per unit effect.[6] The measurement or valuation of effects are in natural units, such as life years gained and disability days saved. CBA is resorted to if it is not possible to measure the outcomes of interest into a single effect common to all alternative programs or there may be multiple effects common to the alternatives. In cases like these, a common denominator is required to facilitate comparison of

outcomes. One measure of value is in dollars, such that the consequences of a program alternative is expressed in terms of their dollar benefit. Therefore CBA is a type of economic analysis which measures both the costs and consequences of alternatives in dollars.[6] CUA is an economic analysis that employs utility as a measure of the value of program effects. Utility refers to the value or worth of a specific level of health status measured by the preferences of individuals or society for any given health outcome.[6] The common denominator, usually expressed as healthy days or quality-adjusted life years is derived by assigning a utility value (on a scale of 0 to 1) on how much is the individual affected by the loss or gain of the outcome.

The DCPP embarked on a project that for the most part involved disease control from the perspective of economic evaluation. Majority of the discussion focused on one specific economic evaluation tool – the disability-adjusted life years or DALYs. In essence, this is a modification of CEA where the measurement of the outcome or effect is computed on the basis of DALYs.

DALYs for a disease are the sum of the years of life lost due to premature mortality (YLL) in the population and the life years lost due to disability (YLD) for incident cases of the disease or health condition.[7] One DALY represents the loss of one year of equivalent full health. Computation for YLL requires the number of deaths due to the disease and the standard life expectancy at age of death. YLD on the other hand requires the average duration of the disease and a weight factor called disability weight that reflects the severity
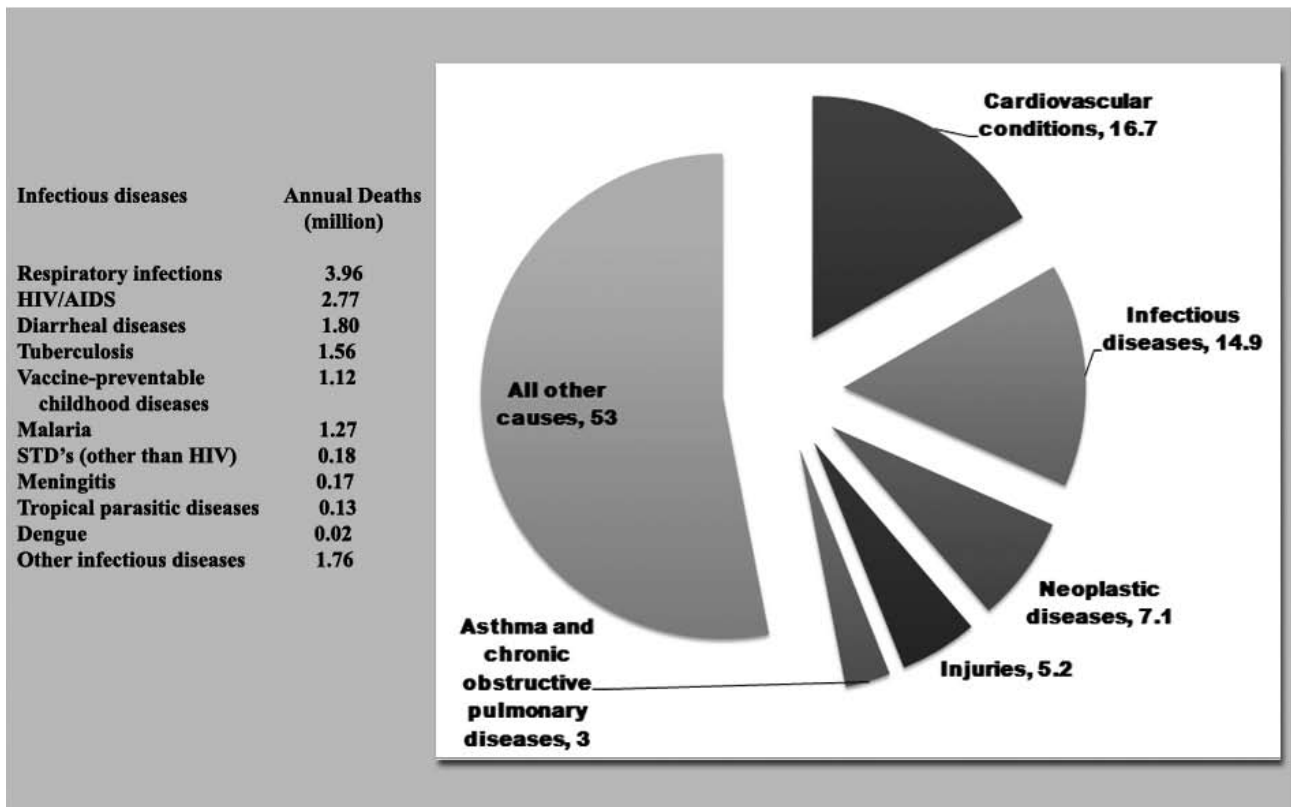

Infectious diseases	Annual Deaths (million)
Respiratory infections	3.96
HIV/AIDS	2.77
Diarrheal diseases	1.80
Tuberculosis	1.56
Vaccine-preventable childhood diseases	1.12
Malaria	1.27
STD's (other than HIV)	0.18
Meningitis	0.17
Tropical parasitic diseases	0.13
Dengue	0.02
Other infectious diseases	1.76

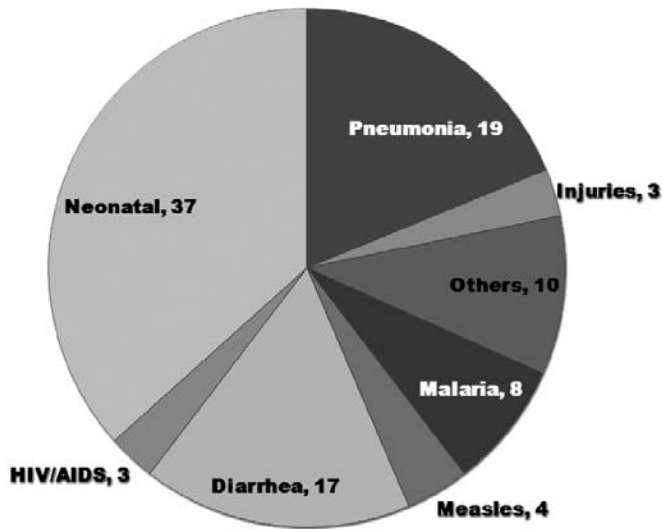**Figure 1. Leading causes of deaths worldwide**
(Source: **WHO Report 2004:** http://www.who.int/whr/en)

Figure 2. WHO Estimates of Causes of Death of Children Under 5 (2000-2003) Source: World Health Report 2005; http//wwwwho.int/whr/2005

of the disease on a scale from 0(perfect health) to 1(death). The disability weights have been estimated and used in the publication of Global Disease Burden 2000 for all regions of the world.[8] It assumes the same life expectancy standard for all populations and excluded all non-health characteristics such as race, socioeconomic status and occupations. It also considered non-uniform age weights (i.e. less weight to years lived at young and older ages) .

Priority Childhood Diseases and their Control

The following diseases in childhood are chosen to reflect their significance and impact in causing morbidity and mortality. These are the very same diseases that require urgent intervention and the options involved are examined on the basis of economic evaluation.

Diarrheal Diseases. Diarrheal disease is a universal disease, affecting both rich and poor, old and young. However, a strong relationship exists between poverty and the frequency and severity of diarrheal episodes especially in under-five children. Review of data shows that the median incidence in children five years old and below in developing countries has not changed significantly (Fig. 3).[5] Each child experienced 3.2 episodes per year in 2003 [9] vs. 3.5 episodes per year in 1993.[9] The peak incidence is between 6 and 11 months. The incidence in Sub Saharan Africa and Latin America is greater than in Asia and the Western Pacific region.

There is significant reduction in mortality but it still continues to be in the top five preventable killers of under-five children in developing countries (Fig. 4).[5] It accounted for 4.6 million deaths before1980, 3.3 million deaths in the period 1980-1990, and 2.6 million deaths in the period 1990-2000.[10-13] The steady decline in mortality proceeded despite the lack of significant changes in incidence. This could be

attributed to improved case management, particularly the use of oral rehydration therapy (ORT). Recent data showed that mortality was inversely related to the use of oral rehydration solution (ORS), with those countries with high usage rate experiencing significant reduction in overall mortality through the years.[14]

Long-term consequence is not very well-studied but in a prospective cohort study done by Niehaus et al in northeastern Brazil, there was a significant inverse correlation (average reduction of 5.6%) between episodes of early childhood diarrhea and overall intellectual capacity and concentration of children.[15]

The strategies for the control of diarrheal diseases include seven interventions that are considered effective and feasible: breastfeeding, improvement in weaning practices, rotavirus immunization, cholera immunization, measles immunization, improvement in water supply and sanitation facilities, promotion of personal and domestic hygiene.[5]

The most effective interventions for control of diarrheal diseases are grouped into two general categories: 1) early interventions within the first year of life which include breastfeeding promotion and immunization (especially measles); and (2) other interventions treating the entire cohort simultaneously using improved water and sanitation and the use of ORT.

Among the four interventions that are administered during the first year of life, breastfeeding promotion is the most effective accounting for $930/DALY, then measles immunization ($981/DALY), rotavirus immunization ($2478/DALY) and cholera immunization ($2945/DALY).[5]

For single year population level intervention in low and middle income countries, rural water and sanitation improvements were the most cost-effective ($7876/DALY) followed by ORT ($10020/DALY) and urban water and sanitation improvements ($25519/DALY). [5] The higher cost-effectiveness ratio (CER) of ORT is due to the high variance in treatment costs. Overall, a single year application of these three interventions is generally less cost effective than early interventions because of failure to prevent high reinfection rate in the following year. However, if the interventions are administered over the first five years, ORT and water sanitation are the more effective but also the most expensive due to higher infrastructure cost.

KEY MESSAGES
- Diarrheal diseases remain among the top five killers of children under five years of age in developing countries.
- Reduction in mortality through the years has been attributed to improved case management especially ORT.
- Using economic analysis, the most cost-effective intervention is where pediatricians can play a significant role in breastfeeding promotion.

Respiratory Diseases. Acute respiratory infection (ARI) is the most common and most important cause of illness and mortality in children below five years old. Each child
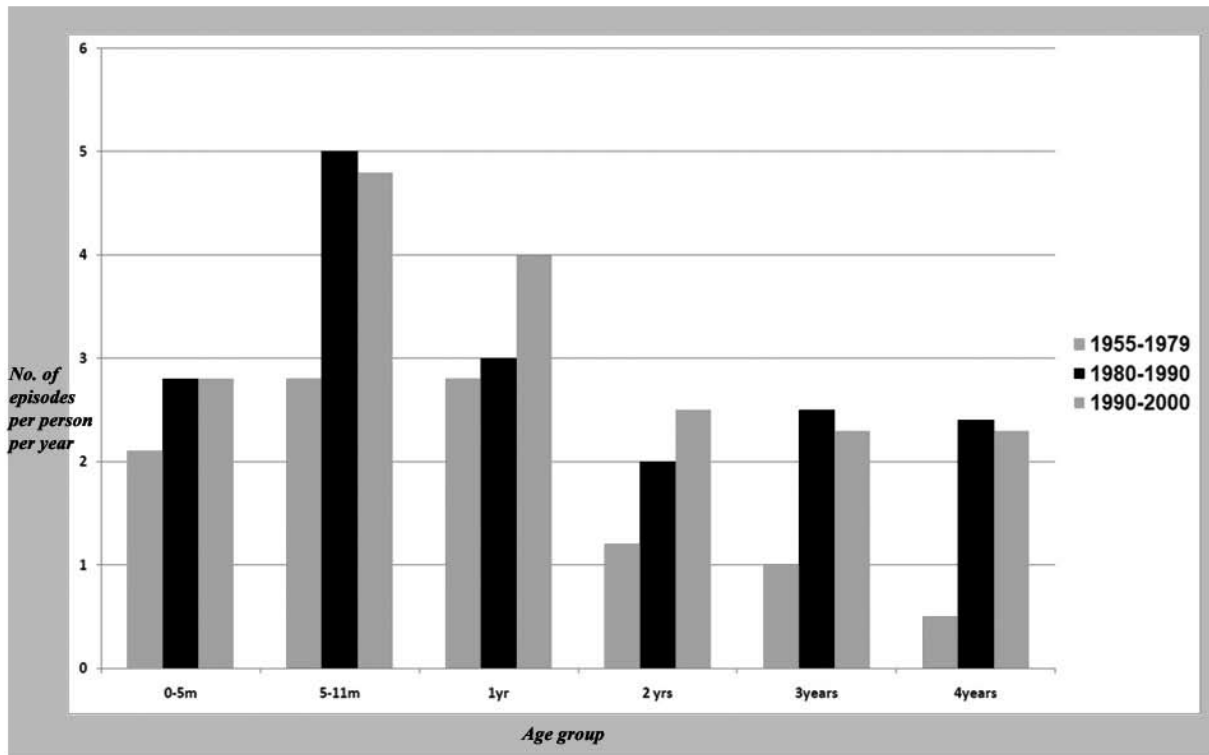
Figure 3. Median age-specific Incidences for diarrheal episodes per child per year from three reviews of prospective studies in developing areas, 1955-2000[5]
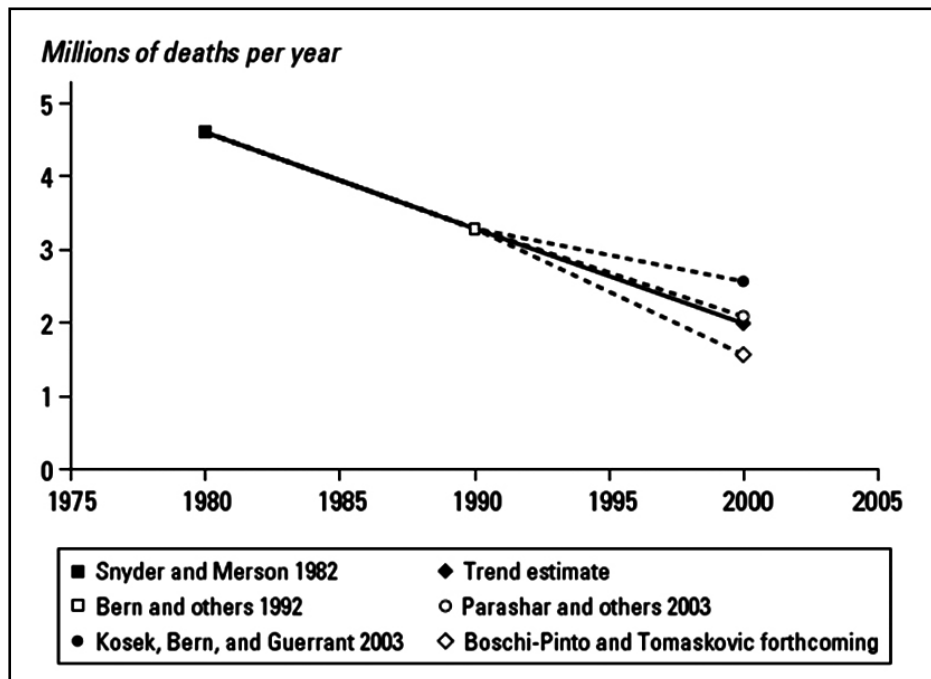

Figure 4. Trends in Diarrhea Mortality 1975 – 2000 [5]

experiences 3-6 episodes per year. Lower respiratory infections, mortality and severity due to this illness are more common in poor countries. Among 10.8 million children dying annually[16], 1.9 million (2000 estimate) were due to ARI[17], with 70% coming from Africa and Southeast Asia. The most important etiologic agents are _Haemophilus influenzae_ Type B (Hib) and _Streptococcus pneumoniae_ (SP).

In terms of strategies for control, these may either be

as primary prevention where infants and children are vaccinated against Hib and SP, or as secondary prevention which involves proper case management strategies. These case management strategies have been incorporated in the Integrated Management of Childhood Illnesses (IMCI) protocol which has now been implemented in over 80 countries.

In a meta analysis done of the effects ARI case management

intervention on mortality by Sazawal in 2003[18] using 10 community-based studies, there was a reduction of 27% in all-cause mortality among neonates, 20% among infants and 24% among children 0-4 years of age. Acute lower respiratory infection (ALRI) specific mortality was reduced by 42%, 36% and 36% respectively.

Among the vaccine strategies, Hib vaccine was introduced as routine immunization in developed countries in the early 1990's. However, the high cost of this vaccine prevents its routine use in developing countries. With the establishment of the Global Alliance for Vaccination and Immunization and the Vaccine Fund, Hib immunization is now gradually increasing. In 1997, 25/192 WHO nations introduced Hib and by 2002, 84 nations have been using it.

Regarding pneumococcal conjugate vaccines, this was introduced in the United States as part of routine immunization in 2000. Currently, the licensed 7-valent conjugate vaccine lacks certain serotypes important in developing countries and the cost is prohibitive.

KEY MESSAGES
- ARIs continue to be the top killer of children under five years of age in developing countries
- Improved case management usually through the IMCI approach has resulted in significant reduction in mortality in the under- fives.
- Vaccination against Hib and SP as a preventive strategy has not gained wider implementation due to cost constraints.

Tuberculosis (TB). TB is the second most important cause of death from an infectious agent after HIV/AIDS, despite availability of anti-TB drugs for more than 50 years.[3] Despite the enormous burden of disease, the availability and affordability of short course chemotherapy (SCC) makes TB control using SCC as one of the most cost-effective of all health interventions.[10,19] The international target for TB control by the UN MDGs is to detect 71% of sputum smear-positive cases and successfully treat 85% of such cases by the end of 2005. It is expected that TB death rates and prevalence will be halved by 2015.

It is estimated that 8.8 million new cases of TB were detected in 2003 and of these cases, 3.9 million were sputum smear-positive. Africa had the highest incidence (345/100,000/yr). The most populous countries in Asia (India, China, Indonesia, Pakistan, Bangladesh) accounted for 50% of new cases per year.[3] There is also an observed increase in incidence in Eastern Europe. Much of the recent increase in global TB was due to the spread of HIV in Africa. About 1.7 million HIV cases died of TB in 2003.[20]

Interventions for TB control involve prevention of infection through BCG vaccination especially in childhood, stopping progression from infection to active disease by treating latent TB infection (TLTI) and treatment of active disease through the Direct Observed Therapy Short-course (DOTS) strategy.

BCG vaccination is best given at birth or at the very first contact with a health worker. It has shown high efficacy against development of more serious complications such as meningitis and miliary TB although efficacy to prevent pulmonary lesion is low. BCG vaccination prevents about 36,000 cases of childhood meningitis and 14,000 cases of miliary TB per year or one case of meningitis for every 2800 vaccinations and one case of miliary TB for every 7000 vaccinations.[21]

TLTI is reserved for those individuals at high risk for development of TB, with positive tuberculin test, but without active disease. Single drug therapy with isoniazid or rifampicin will suffice.

The principal and most effective intervention is the DOTS which aims to diagnose and treat the most severe and most infectious forms of TB. High cure rates using the DOTS program in several countries (182 in 2003) were on the average at 82%[21] which was not far from the international target of 85%.

Studies in the poorest countries of Africa (Malawi, Mozambique and Tanzania) showed that a year of healthy life could be gained for < $ 5[22]. Cost-effectiveness of TB control depends not only on local costs but also on local characteristics of TB epidemiology and rate of application of any chosen intervention. Short course chemotherapy for infectious and non-infectious TB via DOTS strategy is highly cost-effective for control of epidemic and endemic TB ($5-50/DALY gained). BCG vaccination to prevent severe forms of childhood TB is much less effective ($40-170/DALY gained) compared with SCC but nearly as cost-effective. TLTI is the least cost-effective of the interventions ($5500–26000 per DALY gained) but is more cost effective during outbreaks ($150–500/DALY gained) and in those with HIV co-infection ($15–300/DALY gained).[5]

KEY MESSAGES
- Ironically, despite availability of anti-TB drugs, the disease remains to be an important cause of death.
- BCG vaccination especially in childhood has shown high efficacy against development of more serious complications such as meningitis and miliary TB.
- DOTS is currently considered the most cost effective intervention even in the most severe and most infectious forms.

Malaria. Malaria is the most important of the parasitic diseases of humans, with transmission in 88 countries, inhabited by close to 50% of the world's population.[23] It accounts for 1- 3 million deaths per year and close to 5 billion episodes occur in endemic areas per year. More than 90% of the disease burden is found in Africa.[24- 26] Most important problems being encountered presently are the resurgence of the infection in many tropical countries and the growing drug resistance of *P. falciparum* and the *Anopheles* mosquitoes. In 2001, malaria was the eighth contributor to the global disease burden but was second in Africa.[27]

The malaria DALY was based largely due to infection caused by *P. falciparum*. In relation to economic growth,

countries with substantial malaria burden grew by 1.3%/year less between 1965-1990. A 10% reduction in malaria was associated with 0.3% higher growth/year.[28]

Intervention strategies are three-pronged: (1) directed toward the host through rapid and accurate diagnosis, proper case management and intermittent preventive treatment of priority groups like pregnant women (who can transmit the disease to their children) and infants; (2) directed toward the vector through the use of insecticides against the mosquito vector, including the use of insecticide-treated mosquito nets; (3) directed toward the control of epidemics.

As to the economic impact of the different interventions for malaria control, in very low income countries, according to Goodman in 2000[29], insecticide treated nets (ITN's) resulted in $ 8-19/DALY averted; residual spraying (2 rounds per year) $32- 58/DALY averted; chemoprophylaxis for children $3-12 /DALY averted; intermittent treatment of pregnant women $4-29/DALY averted and improved case management $1- 8 /DALY averted.

The computation by Breman et al in DCPP2 did not differ significantly from that of Goodman.[5] One year treatment using ITN's resulted in a mean of $11/DALY averted; one round of residual spraying per year cost $5–18/DALY averted while intermittent preventive treatment of pregnant mothers had an average cost effectiveness of $24/DALY averted.

As to drug treatment, chloroquine (CQ), sulfadoxine-pyrimethamine (SP) and quinine are considered as the first, second and third-line drugs respectively. Due to high resistance, treatment options now utilize combination treatment in the form of artemisenin combination (ACT). Switching from SP to ACT will prove to be the most cost effective (<$150) compared to switching from CQ to ACT or CQ to SP (least cost effective).[5]

KEY MESSAGES:
- Malaria adversely affects not only human health but also the economic growth of nations.
- Interventions directed towards the host and the vector are available and cost effective.
- The use of combination treatment in the form of artemisenin combination proves to be cost effective in the presence of resistance to single drug therapy.

HIV/AIDS. HIV continues to spread in alarming proportion and speed. By the end of 2004 it was estimated that 39 million people worldwide are infected with the virus.[30] Close to 5 million new cases were estimated in 2004 with 3 million deaths[31] Sub- Saharan Africa is the most affected region but the disease is rapidly spreading in Asia and parts of Eastern Europe. Sub- Saharan Africa is home to only 10% of the world's population yet it houses 2/3 of all HIV cases worldwide and accounts for at least ¾ of AIDS-related deaths in 2003. The Asia –Pacific region registered 7.4 million infections or 19.5% of the current burden of disease. Women are the most affected accounting for 41% of those infected in 1997 to 50% in 2001. The DALY's attributed

to AIDS in 2001 was 57,908 worldwide, the highest being in Sub-Saharan Africa (44,294) followed by Southeast Asia (6,861).[5]

HIV/AIDS represents a disease for which several interventions can be done both as prevention and treatment. Several existing interventions can effectively prevent transmission. These include promotion of condom use, change of sexual behaviours, diagnosis and treatment of other sexually-transmitted infections, prevention of blood-borne transmission through harm reduction services and blood safety programs and prevention of maternal to child transmission by providing short-course anti-retroviral therapy, facilitating contraception to prevent unwanted pregnancies or by change in feeding patterns (reduction in breastfeeding among infected mothers).

As for treatment, this strategy proves to be the most expensive due to the cost of drugs but newer combination anti-retroviral therapy is more effective than the previous ones. The effectiveness of all these interventions is theoretically proven but in reality, the success varies according to the stage of epidemic, the context in which it occurs, the target population and the method of implementation. The data on cost-effectiveness evidence based on HIV/AIDS prevention are limited and there is an urgent need for research along this line.

KEY MESSAGES
- HIV/AIDS represents a disease for which both medical and social interventions are necessary for prevention and treatment.
- Despite the huge investment in research because of its dramatic impact, there is still a huge research gap including cost effectiveness studies of control strategies.

Malnutrition. In 2003, it was estimated that 1/3 of the global disease burden would be removed by eliminating malnutrition.[32] Malnutrition is linked to poverty. As of 2001, 19% of global deaths and 99% of all child deaths are among children in low and middle income countries. DALY's lost attributed to 0-4 year olds, maternal and perinatal conditions plus nutritional deficiencies and endocrine disorders amounted to 42% of the total all-cause, all-age, all-sex burden for developing regions. This high mortality and morbidity attributed to malnutrition is due to its direct and indirect effects. Direct effects are due to nutritional deficiencies and malnutrition-related mortality. Indirect effects refer to resultant infectious diseases that follow because of reduced immunity to such infections.

Several interventions have been proposed to combat the problem of malnutrition. One of the effective ways of dealing with the problem is through community-based health programs that offer a comprehensive strategy that includes women's health promotion, antenatal care, breastfeeding promotion, growth monitoring, promotion of complementary and supplementary feeding, micronutrient supplementation, immunization, deworming and oral rehydration. Using such programs, it is estimated that $200-

Table 2. Estimated reduction in disease burden (% DALYs lost) in developing countries from general malnutrition or micronutrient deficiency either as direct effect or as risk factor

	Direct Effect (%)	As a Risk Factor (%)	TOTAL
General malnutrition	1.0	14.0	15.0
Micronutrient deficiency	8.5	17.5	
TOTAL	10.0	22.5	32.5

$250/DALY is saved in sustained programs.[5] The cost is very minimal. Calculations from scarce financial resource data show that most government programs will only cost approximately $1/participant child/year or less.[5]

Translating underweight to measure of disease burden in terms of DALY's lost, a 32.5% reduction in DALY loss is associated with eliminating general plus micronutrient malnutrition as both direct effects and risk factors.

The estimates for the Asian Development Bank - UNICEF project in financial terms for developing countries (Bangladesh, Cambodia, Pakistan, Sri Lanka, Vietnam) showed that some $190-280 million per year would improve underweight by an additional 1.5 percentage points per year.[33]

KEY MESSAGES
- Malnutrition can cause high mortality and morbidity directly and indirectly.
- Community-based health programs have been shown to be effective and low-cost , entailing only approximately $1/participant child/year or less.

CONCLUSION

It is advocated that whenever an intervention is to be utilized to decrease illness, disability and death in a resource-constrained situation, consider not only its effectiveness but also the costs.

Although the process by which economic evaluation of interventions is very important and a lesson by itself, the synthesis and generation of the information is usually in the realm of methodologists, including interested clinicians, public health practitioners, administrators, and health economists. What is vital is to be able to assimilate, disseminate and effect behavioural change in the physician. For definitely, the adoption and utilization of cost-effective interventions will improve health and wellbeing and save lives. The last is usually very difficult to achieve. It is crucial that educational activities chosen can bring about change in physician behaviour.

In the same manner that evidence-based clinical practice guidelines are now followed by most practicing pediatricians, it is hoped that a decision making process which includes the assessment of costs in addition to effectiveness become part of every physician's approach to holistic patient management .

The overarching goal is '*cost effective best practice guidelines for better health of our patients and our people.*'

References

1. UNICEF. The State of the World's Children. UNICEF HOUSE, New York, 2005.
2. United Nations' Millennium Development Goals. Available from www.un.org.millenniumgoals
3. World Health Organization. The World Health Report 2004. Changing History. Geneva: World Health Organization. 2004. Available from www.who.int/whr/2004/en/report04_en.pdf
4. Bryce J, Boschi-Pinto C, Shibuya K, Black RE and the WHO Childhood Epidemiology Reference Group. WHO estimates of the causes of deaths in children. Lancet. 2005; 365: 1107 – 1152.
5. Disease Control Priorities Project 2nd edition. In press.
6. Drummond MF, Stoddart GL, Torrance GW. Methods for the Economic Evaluation of Health Care Programmes. Oxford University Press, New York, 1990.
7. Disability-adjusted Life Years. Available from www.who.int/health-info/boddaly/en
8. Global Burden of Disease 2000. Available from www.who.int/whr/2000/en/annex04_en./pdf
9. Parashar UD, Hummelman EG, Bresee JS, et al. Global illness and deaths caused by rotavirus disease in children. Emerging Infect Dis. 2003; 9:565-572.
10. Jamison DT, Mosley HW, Measham AR, et al. Disease Control Priorities in Developing Countries. Oxford University Press, Oxford, 1993.
11. Snyder JD, Merson MH. The magnitude of the global problem of acute diarrheal disease: a review of active surveillance data. Bull World Health Org. 1982; 60: 604-613.
12. Bern C, Martines J, de Zoysa I, et al. The magnitude of the problem of diarrhoeal disease: a ten year update. Bull World Health Org. 1992; 70: 705-714.
13. Kosek M, Bern C, Guerrant RL. The global burden of diarrhoeal disease as estimated from studies published between 1992 and 2000. Bull World Health Org. 2003; 81: 197-204.
14. Victora CG, Bryce J, Fontaine O, et al. Reducing deaths from diarrhoea through oral rehydration therapy. Bull World Health Org. 2000; 78: 1246-1255.
15. Niehaus MD, Moore SR, Patrick PD, et al. Early childhood diarrhea is associated with diminished cognitive function 4 to 7 years later in children in a northeast Brazilian shantytown. Am J Trop Med Hyg. 2002; 66:590-593.
16. Black RE, Morris SS, Bryce J. Where and why are 10 million children dying every year? Lancet. 2003; 361: 2226-2224.
17. Williams BG, Gouws E, Boschi-Pinto C, et al. Estimates of world-wide distribution of child deaths from acute respiratory infections. Lancet Infect Dis. 2002; 2: 25-32.
18. Sazawal S, Black RE. Pneumonia Case Management Trial Group: Effect of pneumonia case management on mortality in neonates, infants and preschool children: a meta-analysis of community-based trials. Lancet Infect Dis. 2003; 3: 547–556.
19. Barnum HN. Cost savings from alternative treatments for tuberculosis. Social Sciences and Medicine. 1986; 23: 847 – 850.
20. Corbett EL, Walt CJ, Walker N , et al. The growing burden of tuberculosis: global trends and interactions with HIV epidemic. Archives of Int. Med. 2003; 163: 1009 – 1021.
21. Bourdin Trunz B, Fine PEM, Dye C. Global Impact of BCG Vaccination on Childhood TB meningitis and Miliary TB. Geneva: World Health Organization, 2004.
22. Murray CJL, De Jonghe E, Chum HJ, et al. Cost effectiveness of chemotherapy for pulmonary TB in three Sub-Saharan African countries. Lancet. 1991; 338: 1305 – 1308.
23. Hay SI, Rogers DJ, Toomer JF, et al. Annual Plasmodium falciparum entomological inoculation rate (EIR) across Africa: literature survey, internet access and review. Trans Roc. Soc Trop Med Hyg. 2004; 94: 113 – 127.
24. Snow RV, Craig MH, Deichmann U, et al. Estimating mortality, morbidity and disability due to malaria among Africa's non-pregnant population. Bull World Health Org. 1999; 77: 624-640.
25. Snow RW, Trape JF, Marsh K. The past, present and future of childhood malaria mortality in Africa. Trends in Parasitology. 2002; 52: 235 – 264.
26. Breman JG, Alilio MS, Mills A. The intolerable burden of malaria: II. What's new, what's needed: Summary. Am J Trop Med Hyg. 2004; 71(Suppl 2): 1-15.
27. World Health Organization. World Health Report 2002. Geneva, World Health Organization, 2002.
28. Gallup JL, Sachs JD. The economic burden of malaria. Am J Trop Med Hyg. 2001; 64 (Suppl 1): 85–96.
29. Goodman C, Coleman P, Mills A. Economic Analysis of Malaria Control in Sub-Saharan Africa. Geneva: Global Forum for Health Research, 2000.
30. UNAIDS 2004. AIDS epidemic update, December 2004.
31. Worth D. Sexual decision-making and AIDS: Why condom promotion among vulnerable women is likely to fail. Std Fam Plann. 1989; 20: 297-307.
32. Mason JB, Musgrove P, Habicht JP. At Least One-third of Poor Countries' Disease Burden is due to Malnutrition. DCPP. March 2003.
33. Mason JB, Hunt J, Parker D, et al. Improving child nutrition in Asia. Supplement to Food and Nutrition Bulletin. 2001; 22: 5–8.