Economic evaluation of measles catch-up and follow-up campaigns in Afghanistan in 2002 and 2003

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This paper assesses the cost-effectiveness of, and the return on the investment in, the 2002 catch-up and the 2003 follow-up measles campaigns in Afghanistan from the perspective of the donor.[2] The catch-up campaign targeted nearly 12 million children aged between six months and 12 years, while the follow-up campaign targeted over five million children aged between 9 and 59 months. Both campaigns successfully vaccinated approximately 96 per cent of the respective target populations, and are expected to avert an estimated 301,000 measles deaths over the next 10 years. The average cost per dose of measles vaccine delivered was USD 0.40. The cost per death prevented is USD 23.6, assuming a case fatality rate of 10 per cent and a discount rate of three per cent. With more than 42,000 measles deaths avoided for every one million US dollars spent, the campaigns are an excellent public health investment for precluding childhood mortality in a country affected by a complex emergency.

Keywords: Afghanistan, complex emergency, economic evaluation, measles campaigns, mortality reduction, return on investment

Introduction

In 1999, Afghanistan, a country with a population of 28 million, was experiencing a complex emergency.[3] As a consequence of more than 25 years of conflict, childhood mortality rates in Afghanistan are among the highest in the world, with one in four children dying before reaching the age of five.[4]

Measles is a major cause of morbidity and mortality in countries affected by complex emergencies, including Afghanistan. In these settings, the collapse of public health infrastructure leads to low vaccination coverage in a population suffering from displacement and undernourishment (Toole and Waldman, 1997). Measles outbreaks have resulted in high morbidity and mortality among such vulnerable populations, making measles control a priority in these situations (Toole et al., 1989). Hence, the Sphere Project, established in 2000 to provide minimum standards for disaster response, recommended measles vaccination for all children aged between six months and 12 years at the earliest opportunity (Sphere Project, 2000). A recent revision of its recommendations has expanded the age range to cover all children aged between six months and 15 years (Sphere Project, 2004).

From 1998–2001, only 40–47 per cent of infants aged less than one year in Afghanistan reportedly received one dose of measles vaccine (CDC, 2003); coverage was low

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because of the collapse of the public health infrastructure, insufficient material and human resources and logistical difficulties connected to the terrain. During this time, measles accounted for an estimated 35,000 deaths per annum in Afghanistan, nearly all preventable by immunisation (WHO, 2001). A 2001 survey in Kohistan District revealed that 15.7 per cent of all deaths in children aged less than five years in the preceding six months were due to measles (Assefa et al., 2001).

After the fall of the Taliban government in December 2001, there were concerns about a widespread measles outbreak against a backdrop of low routine measles coverage, poor access to health care and crowding among displaced persons. This prompted the Ministry of Health (MoH) of the Transitional Islamic State of Afghanistan, with assistance from international organisations, to conduct a nationwide measles vaccination campaign, from 1 December 2001–31 December 2002, targeting all children aged between six months and 12 years regardless of prior immunisation status. That 95 per cent of all reported cases were in this age range determined the selection of the target group; this age group also complied with Sphere Project recommendations (Dadgar et al., 2003). An estimated 11.5 million children, comprising 96 per cent of the target population, were reportedly vaccinated nationwide.

To maintain low levels of susceptibility to measles among the population, a follow-up campaign was conducted in 2003, targeting children aged between 9 and 59 months. This campaign aimed to reach children less than five years of age missed during the 2002 campaign as well as the large number of refugees returning from other countries. More than five million children were vaccinated, approximately 96 per cent of the estimated target population.

Nationwide immunisation campaigns are a key component of the World Health Organization (WHO) and United Nations Children's Fund (UNICEF)'s 'Measles Mortality Reduction and Regional Elimination. Strategic Plan 2001–2005' (WHO and UNICEF, 2001). Measles 'catch-up' campaigns are one-time vaccination events targeting all children in a particular age group. The goal is to 'catch-up' all children who may not have been previously vaccinated against measles or who did not develop immunity to measles after the first dose of vaccine. During a 'catch-up' campaign, all children in the targeted age group receive a dose of measles vaccine, regardless of prior disease or vaccination history (de Quadros, 1997). Measles 'follow-up' campaigns are conducted periodically to maintain low levels of susceptibility. A follow-up campaign offers children a second opportunity to get the measles vaccine and aims to reach all children aged nine or more months who were born after the earlier catch-up or follow-up campaign (de Quadros, 1997). These campaigns provide an opportunity to immunise children missed by routine services as well as a second opportunity to immunise children who have been immunised by routine services. In addition, they buy time while routine immunisation services are being strengthened.

Wide age range campaigns to control measles have frequently been conducted both within small populations affected by complex emergencies and nationwide in stable countries. However, this was the first measles campaign for a broad age range to be implemented nationally in a country affected by a complex emergency (CDC, 2003). Although measles mortality is concentrated among children aged less than five years, it does occur among older age groups (Barkin, 1975a; 1975b) and can be prevented by vaccinating a wide age range. The main benefit of vaccinating older children, though, is to decrease the transmission of measles, thereby protecting the age group most vulnerable to the virus: children aged less than one year.

Because vaccinating against measles may require forgoing other health initiatives when resources are scarce, it is important to assess the cost-effectiveness of, and the return on the investment in, this kind of intervention.

Methods

This paper presents a cost-effectiveness and return on investment analysis of the 2002 catch-up and 2003 follow-up measles campaigns in Afghanistan. In cost-effectiveness analysis, the added costs and health outcomes associated with an intervention are used to calculate the incremental cost-effectiveness ratio relative to some comparator. The comparator here is 'no measles campaigns'. The return on investment is a measure derived from the cost-effectiveness ratio, expressed as units of health outcome for a given amount of money invested in an intervention. We compare the impact on mortality during low routine measles immunisation coverage prior to the campaigns with that of improved coverage afterwards.

The perspective taken determines which costs and outcomes are included in a cost-effectiveness analysis. Although the analysis can be performed for several perspectives (those of the donor, health care sector or society), the assessment of the measles campaigns in Afghanistan is conducted from the perspective of the donor, since only donor costs were available for the campaigns in Afghanistan. In addition to the United Nations Foundation, Australia, Canada, Germany, Italy, Japan, Poland, the United Kingdom and the United States donated to the measles campaigns in Afghanistan. A case fatality rate (CFR) of 10 per cent and a discount rate of three per cent are used in the base case analysis of cost-effectiveness and return on investment. While no data are available for Afghanistan, measles CFRs ranging from 2.3–32 per cent have been reported in other populations affected by complex emergencies (Allegra, Nieburg and Grabe, 1983; Shears et al., 1987). We perform sensitivity analysis using CFRs of five and 15 per cent. Sensitivity analysis involves changing the parameters employed in an evaluation and studying how this affects the outcome. A base case discount rate of three per cent and sensitivity analyses over the zero to seven per cent range are the recommended standard for cost-effectiveness analyses (Gold et al., 1996). The lower bound provides the decision-maker with insights into the effects of discounting by showing what happens in its absence; the upper bound represents a reasonable ceiling on the real consumption rate of interest in current markets. Discounting is a technique widely used in economic evaluation to find the equivalent value today of monetary sums or health outcomes expected in the future. Mathematically, it is the reverse of compounding. The discount rate reflects the time preference for present over future outcomes. Although successful measles immunisation results in lifetime immunity, we adopt an analytical horizon of 10 years.

Effectiveness

To estimate the number of measles deaths averted, a spreadsheet-based modified version of the model proposed by Stein et al. (2003) was built in Microsoft Excel—this is the method currently used by WHO to calculate annual cases and deaths attributable to measles. The model estimated the total number of measles cases, allocated them to age groups and applied CFRs to the cases to determine the number of deaths. The model incorporates the higher risk of measles mortality among infants aged less than one year, and the lower risk among children aged more than five years. Estimates of cases prevented in the vaccinated cohorts over the next 10 years by both campaigns were used to compute the total number of deaths averted. The Afghan MoH estimated campaign coverage from administrative data and provided the authors with the coverage figures. Since age-specific coverage rates were not available, the model assumed equal vaccine coverage for the entire target population. The model, other assumptions and sources of data are described below.

Model of measles transmission

The fundamental goal of the model is to derive the average annual number of cases of measles transmission, given current vaccination rates. Because of the highly infectious nature of the virus, in lower coverage environments sero surveys have revealed that, by age 25, most members of the population show serological evidence of either immunisation or infection-derived immunity; hence one can conclude that all those not effectively immunised eventually get measles. Thus, if only routine services provided immunisation, the average number of cases per year would be equal to the number of those in the birth cohort who did not become immune through vaccination. Other immunisation activities, such as the introduction of a second routine dose, or supplementary immunisation activities, reduce the population of susceptibles, thereby further decreasing the number of cases per year.

The model employed is a static one. The results from this model have been carefully compared with those that could be obtained from a dynamic model of measles transmission. Dynamic models are more accurate in some ways, since they can be used to determine both the seasonal and periodic nature of measles transmission. These models, though, are not without their problems. In the absence of serological data from the country being modelled, the timing of outbreaks is likely to be inaccurate. Mathematically speaking, the static model employed here is equivalent to taking a five-year average from a dynamic model (assuming that coverage remained the same over the five-year period). Hence, for estimating the cost-effectiveness of an intervention, the static model is more appropriate, since it is difficult to predict accurately measles epidemic cycles, and using inaccurate estimates could lead to drastic overestimation or underestimation of cost-effectiveness ratios.

Parameters underlying burden of disease projections (base case)

Structure of model in the absence of the campaigns (base case):

$$\text{Protected}_{\text{Year i}} = 1 - (1 - VE_{<1} \times MCV_1)$$

$$Cases_{\substack{\text{All Ages}\\ \text{Year i}}} = Births \text{ x } (1 - \text{Protected}_{\text{Year i}})$$

$$Cases_{\substack{\text{Age Group j}\\ \text{Year i}}} = \left\{ \begin{array}{c|c|c} \text{Protected} <80\% & \text{Protected} >80\% & \text{Age Group} \\ \hline 12\% & 12\% & <1 \\ \hline 65\% & 47\% & 1\text{–}4 \\ \hline 18\% & 25\% & 5\text{–}9 \\ \hline 4\% & 11\% & 10\text{–}14 \\ \hline 1\% & 5\% & 15\text{–}19 \end{array} \right\} \text{ x } Cases_{\substack{\text{All Ages}\\ \text{Year i}}}$$

$$Deaths_{\substack{\text{Age Group j}\\ \text{Year i}}} = Cases_{\substack{\text{Age Group j}\\ \text{Year i}}} \text{ x } CFR_{\text{Age Group j}}$$

In the above set of equations:

- VE is the vaccine efficacy;
- MCV_1 is coverage with the first routine dose of measles-containing vaccine; and
- the CFRs are allocated on a country-specific basis, and it is always the case that the CFR among children less than one year of age is larger than the CFR among children aged between one and four years, which in turn is larger than the CFR among children aged between five and nine years. The CFR for children aged 10 or more is effectively assumed to be zero—this simplifying assumption has the effect of essentially including any deaths among those aged more than 10 years in the five to nine age group. In Afghanistan, it is assumed that the CFR among children aged between one and four years is 10 per cent for the base case analysis.

Data sources

The WHO/UNICEF and MoH estimates of national vaccination coverage were used for the historical routine coverage figures. WHO also maintains a database of coverage achieved through supplementary immunisation activities (SIAs), and extensive efforts were made to validate all of the historical data on SIAs that were used in our calculations. The estimated number of births by single years was obtained from the United Nations Population Division.

Parameters underlying burden of disease projections (with intervention)

The base case calculations yield the number of cases per age group (<1, 1–4, 5–9, 10–14 and 15–19). We assume that a campaign has the impact of decreasing the number of cases according to the proportion of the cohort that was effectively vaccinated. Consequently, we applied the average effective coverage among the cohort in an age group to reduce the number of cases in the age group, and then applied the age-specific CFRs as above.

$$Cases^{SIA}_{\substack{\text{Age Group j}\\ \text{Year i}}} = Cases^{BaseCase}_{\substack{\text{Age Group j}\\ \text{Year i}}} \text{ x } \left(1 - SIACov^{2002}_{\substack{\text{Age Group j}\\ \text{Year i}}}\right) \text{ x } \left(1 - SIACov^{2003}_{\substack{\text{Age Group j}\\ \text{Year i}}}\right)$$

The average coverage in a cohort is obtained by examining what percentage of the cohort was effectively immunised during the SIA (vaccine efficacy of 85 per cent is used for children immunised when they were infants (less than one year old), and 95 per cent is used for children immunised when they were more than one year old). For example, in 2005 (three years after the 2002 campaign, which achieved 96 per cent coverage), SIA coverage in the one to four year age group was:

$$SIACov^{2002}_{\substack{\text{Age Group 1–4}\\ \text{Year 2005}}} = \underbrace{.5 \text{ x } 0\%}_{\substack{\text{The children aged 1}\\ \text{and 2 years were not}\\ \text{immunised in the}\\ \text{2002 SIA}}} = \underbrace{.25 \text{ x } (96\% \text{ x } 85\%)}_{\substack{\text{The 3 year olds were infants}\\ \text{when immunised in the 2002}\\ \text{SIA, so VE of 85\% is used}}} + \underbrace{.25 \text{ x } (96\% \text{ x } 95\%)}_{\substack{\text{The 4 year olds were >1 when}\\ \text{immunised in the 2002 SIA, so}\\ \text{VE of 95\% is used}}} = 43\%$$

For simplification, we assumed that each single year of age is an equal proportion of the age group (so the one to four age group is split into four equal portions for ascertaining SIA coverage).

A drawback to the way in which these estimates are calculated is that they fail really to incorporate the 'herd immunity' effect—if the population of susceptibles is adequately reduced for a period of time, overall transmission may be interrupted, and thus SIAs can have an effect beyond direct immunisation. However, for the purposes of cost-effectiveness analysis, the model we are using is conservative, and hence underestimates the impact of the SIA.

Costs

Only the financial costs of the campaign borne by the donors are included in the analysis. Financial costs are those directly related to the campaign and included in the budget, such as the price of vaccines and supplies, and operational charges. Supplies include auto-disable syringes, reconstitution syringes and safety boxes, while operational expenses include the cost of training, incentives, transportation, monitoring, social mobilisation and logistics. Salaries, financial or in-kind contributions from the national MoH, and in-country contributions are not part of the estimate of costs. Since cold chain equipment[5] purchased for previous polio campaigns was available for use during the measles catch-up and follow-up campaigns, these costs were not included in the analysis. Cost data was collected in 2003. All costs were compiled and analysed using Microsoft Excel.

Results

Base case

Over the next 10 years, an estimated 301,000 deaths are expected to be averted by the campaigns in the vaccinated cohorts. Figure 1 illustrates the time path of cumulative deaths prevented by the catch-up campaign alone, and by both campaigns, assuming a CFR of 10 per cent. From the donor perspective, the total cost of the 2002 catch-up campaign was USD 4.53 million and the total cost of the 2003 follow-up campaign

Figure 1
Cumulative deaths averted by the measles campaigns in Afghanistan (CFR = 10%)

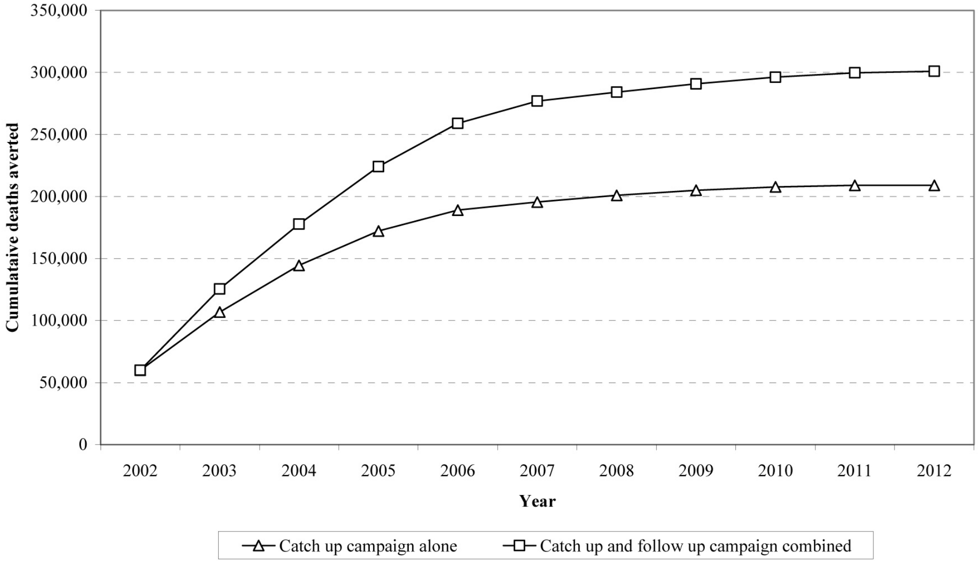

Table 1
Cost of delivering one dose of measles vaccine

	2002 [a]	2003 [b]
Vaccines and supplies (USD)	0.27	0.24
Percentage of total cost	69	59
Operational costs (USD)	0.13	0.17
Percentage of total cost	32	42
Total cost per dose delivered (USD)[c]	**0.39**	**0.40**

Notes:
[a] Catch-up campaign
[b] Follow-up campaign
[c] Total cost of campaign/total number of doses delivered

was USD 2.18 million. Table 1 lists the cost per dose of measles vaccine delivered during the campaigns. The combined (for both campaigns) cost per dose of measles vaccine delivered was USD 0.40. At a discount rate of three per cent, the combined cost of both campaigns is USD 6.65 million. The ratio of costs to the more than 281,100 deaths averted at the same discount rate yields the base case cost-effectiveness ratio of USD 23.6 per death averted. For every one million US dollars invested by donors, an estimated 42,300 deaths were prevented by the campaigns. For the same investment, the catch-up campaign averted 43,700 deaths, while the follow-up campaign averted 38,300 deaths.

Figure 2
Sensitivity analysis: cost per death averted for combinations of CFRs and discount rates

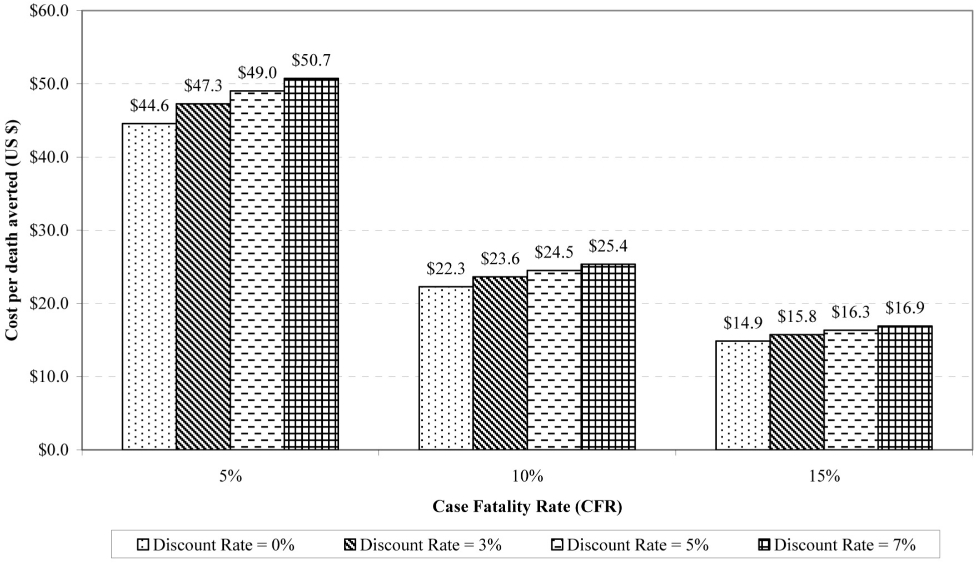

Table 2
Sensitivity analysis

Deaths averted for one million US dollars invested				
	CFR=5%			
Discount rate	0%	3%	5%	7%
Catch-up campaign	23,100	21,800	21,100	20,400
Follow-up campaign	21,100	19,100	18,000	16,900
Both campaigns	22,400	21,200	20,400	19,700
	CFR=10%			
Discount rate	0%	3%	5%	7%
Catch-up campaign	46,100	43,700	42,200	40,900
Follow-up campaign	42,300	38,300	35,900	33,800
Both campaigns	44,900	42,300	40,800	39,400
	CFR=15%			
Discount rate	0%	3%	5%	7%
Catch-up campaign	69,200	65,500	63,300	61,300
Follow-up campaign	63,400	57,400	53,900	50,700
Both campaigns	67,300	63,500	61,200	59,100

Sensitivity analysis

To test the robustness of the cost-effectiveness model and the return on investment results, the CFR (five, 10 and 15 per cent) and discount rate (zero, three, five and seven per cent) were varied. Figure 2 illustrates the results for various combinations of CFRs and discount rates. The cost per death averted ranged from USD 14.9 (CFR of 15 per cent and discount rate of zero per cent) to USD 50.7 (CFR of five per cent and discount rate of seven per cent). Table 2 illustrates the return on investment for various combinations of discount rates and CFRs. For every one million US dollars invested by donors, the number of deaths averted by both campaigns ranged from 19,700 (CFR of five per cent and discount rate of seven per cent) to 67,300 (CFR of 15 per cent and discount rate of zero per cent). The estimated number of deaths prevented by the catch-up campaign ranged from 20,400 to 69,200, while those averted by the follow-up campaign ranged from 16,900 to 63,400.

Discussion

The economic evaluation of the measles campaigns in Afghanistan demonstrates that it is possible to conduct successfully cost-effective mass immunisation campaigns in countries experiencing a complex emergency. Although complex emergencies present a multitude of constraints, including difficult logistics, lack of trained health workers and ongoing insecurity, it is in these settings that measles campaigns have the greatest impact in terms of deaths averted from an easily preventable disease. The campaigns in Afghanistan were extremely cost-effective and provided excellent returns on investment under all scenarios considered in the analysis.

In addition to the large number of deaths prevented by the catch-up campaign, the follow-up campaign had a significant incremental impact, with one-third of the cumulative deaths averted attributable to it. The follow-up campaign was able to reach a large proportion of the estimated 1.14 million children born since the catch-up campaign and aged nine or more months, the estimated 478,500 children missed during the catch-up campaign, and repatriated refugees. Given the target population of 5.4 million, the significant incremental impact of the follow-up campaign is not surprising. The majority of the deaths averted are in the age range of one to five years, indicated by the steeper slope of the curves for the first five years following the campaigns (Figure 1). The bulk of measles-related mortality occurs in this age range.

The cost per dose to donors of USD 0.40 for the campaigns in Afghanistan is substantially lower than that of USD 0.55–0.86 estimated for similar campaigns in stable countries in Africa (Otten et al., 2003). This estimate of costs in Afghanistan challenges the argument that campaigns in nations experiencing complex emergencies are expensive to conduct due to the multitude of constraints encountered. However, in countries where no cold chain equipment from previous campaigns is available, donors should anticipate higher costs per dose. The higher cost of vaccines and supplies delivered by the 2002 catch-up campaign in Afghanistan is a result of the higher wastage rate (15 per cent), compared to 12 per cent for the 2003 follow-up campaign.

The gains in efficiency due to the lessons learned from the 2002 campaign are significant, evidenced by the lower cost of vaccines and supplies during the 2003 campaign. However, economies of scale resulted in a lower operational cost per dose of measles vaccine delivered during the 2002 campaign, leading to a marginally lower total cost of USD 0.39 per dose. Since the total operational costs of the catch-up campaign are spread out over a larger target population, the outcome is a lower cost per dose compared to the follow-up campaign.[6]

The ratio (Figure 2) of USD 23.6 (range: USD 14.9–50.7) per death averted indicates that these campaigns constitute an extremely cost-effective intervention for preventing childhood deaths. It compares very favourably with the donor cost of USD 122 per death prevented in the six West and Central African countries that conducted campaigns targeting children less than 15 years of age in December 2001 (Otten et al., 2003). Stated differently, 42,300 deaths (range: 19,700–67,300) are averted for every one million US dollars invested in the campaigns in Afghanistan. The deaths avoided by the follow-up campaign for the same one million dollar investment (base case: 38,300; range: 16,900–63,400) compare very favourably with the return on investment from the catch-up campaign (base case: 43,700; range: 20,400–69,200). The results for the catch-up campaign are largely driven by the high CFR typical in emergency settings, and the poor coverage of measles vaccine delivered by routine health services.

The 2001 report of the WHO Commission on Macroeconomics and Health suggested that interventions costing less than three times the gross national income (GNI) per capita for each disability adjusted life year (DALY) averted represent good value for money and that, if a country cannot afford to support them all with its own resources, the international community should find ways of assisting (WHO Commission on Macroeconomics and Health, 2001). DALYs are an indicator developed to assess the global burden of disease. They are computed by adjusting age-specific life expectancy for loss of healthy life due to disability. The value of a year of life is weighted, as are decrements to health from disability due to specified diseases and injuries (Gold et al., 1996). Mathematically, they are the sum of 'years of life lost because of premature mortality' and 'years of life lived with disability'. It is estimated that more than 95 per cent of DALYs lost because of measles are due to premature mortality and not to disability (Duflo et al., 1986). The standard life expectancy table of Murray (1994) yields 34.5 DALYs per death averted for ages zero to 10. This translates to USD 0.68 per DALY averted (USD 23.6/34.5) for the base case results of the measles campaigns in Afghanistan. Although no recent data are available for the country, the World Bank classifies Afghanistan as a low income economy, defined as a country with a GNI per capita rate for 2002 of USD 735 or less (World Bank, 2003). Assuming that Afghanistan's 2002 GNI per capita rate is close to USD 90, the lowest GNI recorded for a country (Democratic Republic of the Congo) in that year, USD 0.68 per DALY averted meets the WHO Commission on Macroeconomics and Health's definition of a very cost-effective intervention.

Specific aspects of measles epidemiology in Afghanistan that were not factored into the model are likely to affect the results of the analysis. For example, given the remote rural location of much of the population, measles is transmitted among older children and adolescents because of the relative lack of exposure to wild virus. Surveillance data show a high proportion of measles cases (38 per cent) among those aged more than five years (Dadgar et al., 2003). Due to the lower risk of death in the higher age groups, the campaigns will avert fewer deaths, resulting in higher cost-effectiveness ratios.

Although true adverse events following immunisation (AEFI) with measles vaccine are rare (Duclos and Ward, 1998), in campaigns where large numbers of children are vaccinated in a short period of time, sporadic cases can be expected (WHO, 1999). The burden of disease model did not include AEFI, since no reporting mechanisms were in place in Afghanistan.

Incorporating potential herd-immunity effects into the burden of disease model would have a positive impact, resulting in more favourable cost-effectiveness and return on investment results. If data were available, using age-specific vaccine coverage rates would alter the outcomes of the analysis, with the direction of change dependent on the age ranges with the highest coverage. The campaigns would likely be cost-saving if the economic evaluation was based on the perspective of society or the health care sector in Afghanistan. Compared to the combination of high direct medical costs of treating complications of measles cases, and the attendant indirect costs of work and productivity loss for caregivers (Carabin et al., 2002), the relatively low cost of the campaigns would make them an excellent public health investment from both perspectives.

Globally, differences in child mortality across socioeconomic strata are unacceptably wide, and in some areas, they are becoming even wider. These inequities are compounded by reduced access to preventive and curative interventions (Victora et al., 2003). Evidence from a study by Bishai, Koenig and Khan (2003) has demonstrated that measles vaccination improves the equity of health outcomes. In this study, conducted in Bangladesh in a setting of high childhood mortality, universal distribution of measles vaccination largely nullified mortality differentials associated with differing socioeconomic status. However, since the equity impact of increased measles vaccine coverage attributable to the campaigns was not evaluated in Afghanistan, it was not included in the analysis.

Although measles is responsible for a relatively small proportion of childhood morbidity and mortality, the intervention to prevent it, measles vaccination, is inexpensive, effective, and easy to implement. There is also evidence of beneficial non-specific effects of measles immunisation on overall child mortality (Aaby et. al., 1995; Kabir et al., 2003). Other major causes of major childhood mortality, like diarrhoea and respiratory infection, are not organism specific and necessitate complex interventions over a longer period. These usually require (for delivery) a functioning public health infrastructure, which can take decades to implement.

The successful implementation of measles campaigns in Afghanistan may have also contributed to building and improving the technical and managerial capacity of public health staff in charge of immunisation programmes at all levels of the health care system. Such campaigns should continue to be considered in similar contexts where there is a risk of high morbidity and mortality due to measles. However, sustained political, financial and social commitment is necessary to ensure high levels of protection from measles in the population by strengthening routine immunisation services and conducting regular follow-up campaigns. To build on the success of the 2002 and 2003 campaigns, the allocation of adequate financial and technical resources, and coordinated international support to aid national efforts, are crucial to the long-term success of measles mortality reduction activities in Afghanistan.

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Endnotes

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2 The findings and conclusions in this report are those of the authors and do not necessarily represent the views of the agencies where they are employed.

3 Complex emergencies have been defined as 'relatively acute situations affecting large civilian populations, usually involving a combination of war or civil strife, food shortages and population displacement, resulting in significant excess mortality' (Toole, 1995).

4 See http://www.who.int/countries/afg/en/ (accessed 31 August 2004).

5 The system used for keeping and distributing vaccines in good condition is called the 'cold chain'. This consists of a series of storage and transport links, all of which are designed to keep the vaccine at the correct temperature until it reaches the user. See http://www.who.int/vaccines-access/vacman/cold chain/the_cold_chain_.htm (accessed 21 February 2006).

6 See http://www.unc.edu/depts/econ/byrns_web/Economicae/EconomicaeA.htm.

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