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Strengthening health services to control epidemics: empirical evidence from Guinea on its cost-effectiveness

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Summary

objective To assess the cost-effectiveness of control measures implemented against epidemics in Guinea, West Africa.

methods We collected all routine data available on incidence, mortality, control measures implemented and their cost during epidemics of cholera, measles and meningococcal meningitis in 1993–95. Then we estimated for one prefecture the effectiveness and cost-effectiveness of epidemic control measures for three scenarios: (i) 'natural' situation, (ii) 'routine' health services and (iii) 'intervention'. Where uncertainty was considerable, we used sensitivity analysis and estimated ranges.

findings Routine health services reduced potential deaths by 51% (67%, 37% and 60% for cholera, measles and meningitis, respectively), and additional interventions further decreased potential deaths by 28% (28%, 27% and 30% for cholera, measles and meningitis, respectively). The marginal cost-effectiveness of epidemic control measures in routine health services was US$29 per death averted. The marginal cost-effectiveness of additional interventions was US$93 per death averted.

conclusion Even with the data weaknesses that characterize situations of epidemics it is possible to show that strengthening health services to control epidemics as was performed in Guinea was highly cost-effective. Moreover, sensitivity analysis over a range of assumptions confirms that (i) well-functioning health services averted the major part of avoidable deaths, (ii) combining existing health services with additional interventions minimizes the health impact of epidemics and (iii) case management should be a cornerstone of control of epidemics of cholera, measles and meningococcal meningitis.

keywords epidemics, cost-effectiveness, health services, cholera, measles, meningococcal meningitis

Introduction

Large-scale epidemics of infectious diseases, such as measles, cholera and meningococcal meningitis, are frequent throughout sub-Saharan Africa and cause substantial excess mortality. A rational choice of measures to reduce the impact of an epidemic would have to consider not only potential effectiveness, but also the cost, the feasibility and the acceptability of implementing the control measures envisaged.

Measures to be taken in response to a particular epidemic threat are often within the reach – and remit – of 'routine' health service activities (e.g. pre-emptive measles vaccination, or case management of patients with diarrhoea, meningitis or measles); other measures may have to be organized separately, as specific additional 'interventions' (e.g. a mass emergency vaccination campaign) (Brès 1986).

Case management, and particularly the involvement therein of the 'routine' health services, is an imperative during an epidemic, not a choice. Additional 'interventions' are more a question of choice and judgement. To a large extent, the choice of response package and the balance between working through routine services and additional interventions are questions of cost-effectiveness. But the fear, urgency and time pressure during epidemics may blur rational decision-making and complicate sound judgement (Van Damme & Van Lerberghe 2000).

The evidence base for many emergency health interventions remains weak (Sondorp *et al.* 2001). Except for work on meningococcal meningitis (Veeken *et al.* 1998), the cost-effectiveness of measures to control epidemics in sub-Saharan Africa has not been documented systematically. This is not surprising given the operational difficulties of collecting such documentation in the often-chaotic circumstances that characterize epidemics (Banatvala & Zwi 2000).

This paper examines the marginal cost-effectiveness of epidemic control measures by 'routine' health services and additional, specially set-up 'interventions' as they were organized for the control of cholera, measles and meningococcal meningitis in the Forest Region of Guinea, West-Africa, in the early nineties. With all their weaknesses, the Guinea data are sufficiently sound to allow for a robust assessment.

Methods

Study area and data sources

Guinea, West Africa, is one of the poorest countries in the world. Between 1990 and 1996 some 500 000 refugees from Liberia and Sierra Leone arrived in the Forest Region of Guinea (Van Damme 1995). Most settled among the host population, <20% in refugee camps (Van Damme 1999). The basic reaction of the Forest Region's health authorities after the influx of the refugees in their area was to strengthen and expand the development of the network of health centres and health posts, and to set up a disease surveillance system. With the help of the refugee-assistance programme, the health system was well established by 1991, assuring access to health care throughout the region for refugees and the local population alike (Van Damme *et al.* 1998). This study concerns the prefecture of Macenta, with a population of 355 000 inhabitants. Macenta was the prefecture worst hit by epidemics: between 1993 and 1995 – the period covered in this study – it experienced one epidemic each of cholera, measles and meningococcal meningitis. It was also the prefecture with the best health care network and the best routine data. These routine data are complemented with (i) vaccination coverage surveys; (ii) relevant documents from Ministry of Health and 'Médecins Sans Frontières', including their bookkeeping for costing purposes; (iii) in-depth interviews with health authorities, health workers, 'Médecins Sans Frontières' staff and key informants from Ministry of Health, UNHCR and other agencies and (iv) an extensive literature search in Medline and through the library collections of Institute of Tropical Medicine, Antwerp, and London School of Hygiene and Tropical Medicine, on cholera, measles and meningococcal meningitis.

Epidemic control measures

Measles vaccination and case management for cholera, measles and meningitis were part of the routine functioning of the health services. The only change in the routine during epidemics was a decision to provide care, free of charge for all patients with cholera and meningitis, even in facilities functioning on a cost-recovery basis. Additional 'interventions' aimed at further reducing the impact of epidemics were implemented. From 1990, with the arrival of Liberian refugees in Macenta, mobile measles vaccination teams were launched. When cholera and meningococcal meningitis epidemics broke out, additional mobile support teams started to implement the control activities that are listed in Table 1. For the purpose of this study, three scenarios are distinguished: (i) a 'natural' situation, in the absence of any health care, which served as the baseline; (ii) a 'routine' situation where routine health services are functioning, without any additional epidemic control measures and (iii) an 'intervention' situation, as was the case in Guinea, where routine health services were strengthened and additional epidemic control measures implemented (Table 1).

Effectiveness

We did the assessment of the effectiveness of the epidemic control measures in three steps, using the sources mentioned above. The first step was to estimate the number of cases and of deaths during the various epidemics as they occurred, in the 'intervention' scenario. These estimates are based on notification data, completed with data from the

Table 1 Overview of epidemic control scenarios (and total estimated marginal cost), Macenta, 1993–95

Scenario	Cholera control activities	Measles control activities	Meningococcal meningitis control activities
'Natural'	None	None	None
'Routine'	Case management of diarrhoea in health centres and hospitals (US$17 500)	Routine A: case management in health centres (US$7400) and routine B: pre-emptive vaccination in health centres (US$20 780 – 63 080)	Case management in hospitals (US$14 980)
'Intervention' (actual scenario)	Improved case management in cholera treatment centres linked to existing health facilities, with intensive support from specialised teams (US$53 350)	Pre-emptive vaccination by mobile teams (US$31 080)	Intervention A: improved case management in health centres with intensive training support (US$11 235) and intervention B: mass reactive vaccination campaign (US$52 000)

literature and expert opinion, to infer the number of deaths that actually occurred from those that were notified. The second step consisted of estimating what that burden would have been in the 'natural' situation. We used different methods, either extrapolation from the intervention scenario doing backward adjusting using intervention effectiveness and coverage information; or natural history data from primary and secondary sources, combined with case-fatality rates (CFRs) available in the literature. Numbers of deaths averted thus become sensitive not only to errors in counting how many actually occurred, but also in estimating 'what would have occurred if…'. One way to deal with such an amount of uncertainty is to use sensitivity analysis over a range of assumptions to test the robustness of any conclusions (Briggs *et al.* 1994; Campbell & Torgerson 1997). We calculated effectiveness of interventions with low-end and high-end estimations, where the range of uncertainty was large. We only report the extrapolations over the full range of uncertainty in those instances where they might invalidate conclusions or add useful qualifications. Else we report only the extrapolations on the most likely data points. The third step consisted of apportioning the difference between the estimates of step 1 and step 2 to either the impact of the routine health services or to the additional specific interventions, resulting in number of deaths averted because of 'routine' health services or 'intervention'. This allowed for assessing the potential of relying only on routine health services to react to (the threat of) epidemics, and the marginal effectiveness of organizing 'additional' interventions alongside the work through the 'routine' services. These various categories are summed up in Figure 1.

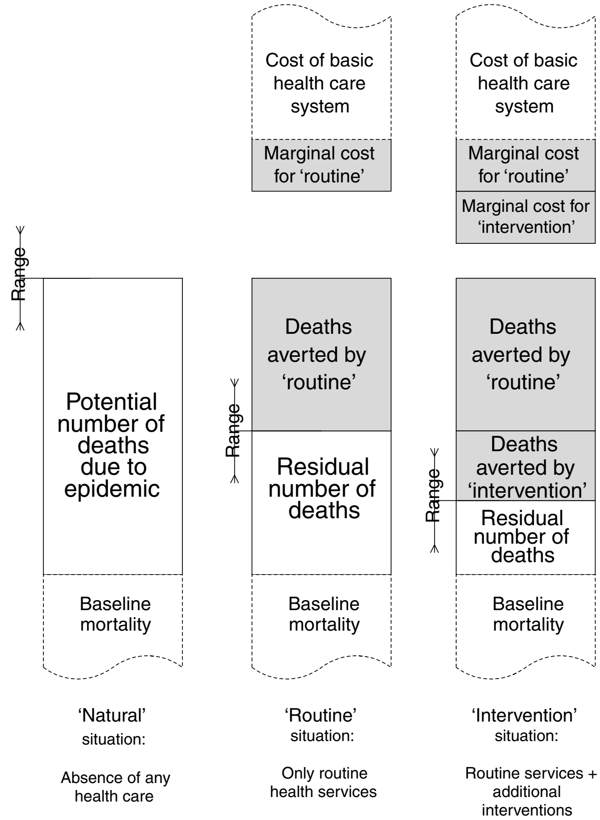

Figure 1 Excess mortality of an epidemic in 'natural', 'routine' and 'intervention' scenarios, with corresponding marginal effects and costs of control efforts.

Cost and cost-effectiveness

The economic analysis took the health service perspective, assessing only the direct costs for service provision during the epidemics. We did not attempt to estimate opportunity costs. All costs are estimated in US$, with 1995 as the reference year. The total cost of the basic health care system in Macenta has been estimated at US$3 per capita per year (Van Damme 1998). The marginal cost, or sunk cost, of dealing with the epidemics was defined as the additional direct cost of vaccines, drugs, material, vehicles, extra staff, etc. incurred because of the activities through the routine health services (marginal cost for 'routine') plus the marginal cost of additional control interventions (marginal cost for 'intervention'). This definition takes the existence of the basic health service for granted, and does not take into consideration opportunity costs for the health system nor the direct and opportunity costs for the population, but has the advantage of being feasible and straightforward (World Bank 1993b). The total marginal cost of the epidemic control measures in the 'routine' and 'intervention' scenarios is then divided by the effect of the strategy, in terms of number of deaths averted, to calculate the marginal cost per death averted in each of the scenarios.

Results

Cholera control

Cases, deaths and deaths averted. In 1995 in Macenta 6340 cases of cholera were recorded, of which 111 died, a reported CFR of 1.8%. We estimate that most cases were reported: the population perceived cholera as a major threat, and the health authorities took special measures to improve access to health services. It is unlikely that cases of cholera would occur without the patients and their

Table 2 Efficacy and effectiveness of epidemic control activities used

Epidemic control activities	Efficacy, as documented in the literature		Community effectiveness in the field situation in Guinea	
	Vaccine efficacy: reduction in attack rate	Efficacy of case management: reduction in CFR*	Reduction in attack rate	Reduction in CFR
Cholera case management: oral and intravenous rehydration (Brès 1986; Hanquet *et al.* 1997)		50% → 1–2%		50% → 10–20%(?)
Pre-emptive measles vaccination (Halsey *et al.* 1985; Bennett *et al.* 1990)	85%†		60%	
Measles case management: prevention and treatment of complications (Foster *et al.* 1993; Aaby 1995)		5% → 1.25%‡ 10% → 2.50%		5% → 2.5%(?) 10% → 5%(?)
Reactive meningococcal meningitis vaccination (Moore *et al.* 1990)	90%		50%(?)	
Meningococcal meningitis case management: antibiotherapy (Brès 1986)		50% → 5–10%		50 → 20%(?)

CFR, case fatality rate; (?), order of magnitude.
* Estimation of the reduction in CFR from the 'natural' CFR to the lowest possible CFR with timely and optimal treatment.
† Measles vaccine efficacy is 85% when administered at 9 months of age; it is only 60–70% when administered at 6 months of age, but increases to 95–98% at 15 months of age.
‡ CFR differs widely, probably depending on intensity of transmission (Aaby 1995). The efficacy of excellent case management was reported to be 78% (Foster *et al.* 1993).

environment at least attempting to reach a treatment centre. Rather, given the prevailing fear of cholera and the sensitive case-definition used, the figure of 6340 cases most probably contains a substantial number of false positives, possibly even up to 50%. A total of 6340 is therefore a high-end estimate of the range of the actual number of cases of cholera that occurred during the epidemic – intervention scenario – and 3170 a low-end estimate. The number of deaths, however, 111, is probably an underestimate, as a number of patients may actually have died before reaching a treatment centre. The actual number may have been up to 20% higher, which gives a range for number of deaths of (111–133), a CFR between 2% and 4% (Table 3).

The case-fatality rate of untreated cholera is of the order of magnitude of 50% (Table 2). In the 'natural' scenario, one could therefore have expected between 1585 and 3170 deaths from cholera in Macenta among the cases that actually occurred. Deaths averted by a possible reduction of incidence are not taken into account; they are probably negligible.

With routine services alone one could have expected between 317 and 1268 deaths among the 6340 cases, depending on whether (i) one considers all cases as true cholera cases, and whether (ii) one expects unassisted health facilities to get the 'natural' CFR of 50% down to 20% or to 10%. The number of deaths averted by 'routine' services is then estimated between 951 and 2536. The 'intervention' averted additionally between 184 and 1157 deaths.

Cost and cost-effectiveness. The total direct cost of the cholera control programme in Macenta was US$70 850. We can estimate that exclusive reliance on routine health services would only have cost US$17 500, i.e. the marginal cost for the medical supplies for the extra case-load. The 'intervention' required an extra US$53 350 for setting up, staffing and supervising the cholera treatment centres. The resulting marginal cost per death averted was US$11 (range between US$7 and US$18) for routine case management and US$80 (range between US$46 and US$290) for improved case management during the intervention (Table 3).

Measles control

Cases, deaths and deaths averted. Measles epidemics follow a triennial cycle in the Forest Region of Guinea. With a simple mathematical model it is possible to make an estimate of the measles attack rate (Black 1982; Anderson & May 1992; Foster *et al.* 1993). In a 'natural' situation,

Table 3 Effectiveness and cost-effectiveness of cholera control

Scenario	Activities	Cases (range)	Deaths midpoint [range]	Deaths averted midpoint [range]	Marginal cost	Marginal cost per death averted (range)
Natural	None	4755 (3170–6340)	2378 (100%)* [1585–3170]	0	0	0
Routine	Case management in health centres and hospitals	4755 (3170–6340)	793 (33%)* [317–1268]	1585 (67%)* [951–2536]	+US$17 500	US$11 (7–18)
Intervention	Improved case management in cholera treatment centres	4755 (3170–6340)	122 (5%)* [111–133]	+671 (28%)* [184–1157]	+US$53 350	US$80 (46–290)

* Proportion of potential deaths in 'natural' scenario.

Table 4 Effectiveness and cost-effectiveness of measles control

Scenario	Activities	Cases	Deaths midpoint [range]	Deaths averted midpoint [range]	Marginal cost (range)	Marginal cost per death averted (range)
Natural	None	37 000	2775 (100%)* [1850–3700]	0	0	0
Routine A	Case management in health centres	37 000	2497 (90%)* [1665–3330]	278 (10%)* [185–370]	US$7400	US$27 (20–40)
Routine B	+vaccination in health centres	25 900	1748 (63%)* [1165–2331]	+749 (27%)* [499–999]	+US$41 930 (20 780–63 080)	US$56 (21–126)
Intervention	+vaccination by mobile teams	14 800	999 (36%)* [666–1332]	+749 (27%)* [499–999]	+US$31 080	US$41 (31–62)

* Proportion of potential deaths in 'natural' scenario.

i.e. without vaccination, 10.4% of the total population, i.e. some 37 000 children in Macenta, would get measles during one 3-year cycle. In the absence of any case-management the CFR would be between 5% and 10% (Assaad 1983), resulting in between 1850 and 3700 deaths (Table 4).

In Guinea, only some 20% of children with measles are seen in health facilities (Van Damme 1998). Consequently, for the 'intervention' scenario, we could not assess the actual number of measles cases or deaths from the cases notified. As an alternative we used guesstimates on the basis of vaccine coverage, the effectiveness of vaccination and of case management. In Macenta, overall coverage with measles vaccine was around 70%, with health centres and mobile teams each accounting for about half of this. We estimate vaccine effectiveness at 85%, assuming that factors decreasing vaccine effectiveness in field conditions (Kenya 1990; Luthi *et al.* 1997) were balanced by a considerable proportion of children being vaccinated after 9 months of age. For the 20% of measles cases managed in health centres, we assume a reduction by 50% of the baseline CFR of (5–10%). Under these assumptions the 'intervention' (i.e. routine case management + vaccination in health centres + vaccination by mobile teams) would have averted 22 200 measles cases and 666 to 1332 deaths.

'Routine' case management alone would have averted 185–370 deaths among the 7400 children reached. The total contribution of health centres – case management + vaccination – would have averted 11 100 cases and between 185 + 499 and 370 + 999 deaths.

Cost and cost-effectiveness. The unit cost of ambulatory treatment of a case of measles in a health centre in Guinea has been estimated at US$1 (Soucat *et al.* 1997). In Guinea, routine vaccination by health centres cost US$8.80 per fully vaccinated child (which requires five encounters) (Soucat *et al.* 1997). This includes investment in cold chain and transport. If one attributes one-fifth of this cost to measles vaccination, the unit cost of measles vaccination is US$1.76. If one, however, considers the full investment cost, the cost is approximately US$5 per measles vaccination. The total cost for measles vaccinations carried out by the health centres over the

3-year period was US$23 000 or 65 300 (depending on the assumptions used). The total cost of vaccinations by the mobile teams amounted to US$33 300 (approximately 30% for the vaccines, and the rest for the mobile teams). Vaccination by mobile teams and by health centres saved some US$2220 each in treatment costs (Table 4 and Figure 2).

The marginal cost for measles case management amounted to US$7400; for measles vaccination in 'routine' health services to between US$20 780 and 63 080; and for measles vaccination by mobile teams to US$31 080. Using these cost estimates, the cost per measles death averted ranges between US$20 and 40 for case management in health centres, between US$21 and 126 for vaccination in health centres, and between US$31 and 62 for vaccination by mobile teams.

Meningococcal meningitis control

Cases, deaths and deaths averted. In 1993 in Macenta 539 cases of meningococcal meningitis were registered, with 35 deaths, a CFR of 6.5%. We consider that registration was near exhaustive, both for cases and for deaths, and thus use these data for the 'intervention' scenario. To establish the number of deaths in a 'natural' epidemic, one has to estimate the attack rate and the CFR that would have occurred without vaccination campaign or case management. In Macenta, vaccination was undoubtedly late and some might argue that it hardly prevented any cases (Veeken *et al.* 1998). However, assuming 90% protection among the 28% of the population that was vaccinated (the most optimistic hypothesis), the upper-end estimate of the 'natural' incidence would be 749, some 210 more cases than the registered 539. It is indeed unlikely that vaccination would have stopped transmission or influenced the dynamics of the epidemic (Greenwood 1984; Begg 1995): not only the coverage but also the timing of vaccination plays a major role. The number of cases averted is therefore more likely to be <210 (Table 5).

In the absence of any treatment one would expect about half of the expected 749 cases of meningitis to die. We estimate that in Guinea, case management in 'routine' health services would have brought the CFR down from 50% to 20%, averting 225 of the likely 375.

It is worthwhile to make an additional simulation to understand the relative contribution of improved case management and reactive vaccination for meningococcal meningitis. Accepting the high-end estimate of the impact of vaccination – 210 cases prevented – improved case management alone would have had to deal with a total of 749 cases, but could have reduced the CFR from 20% to

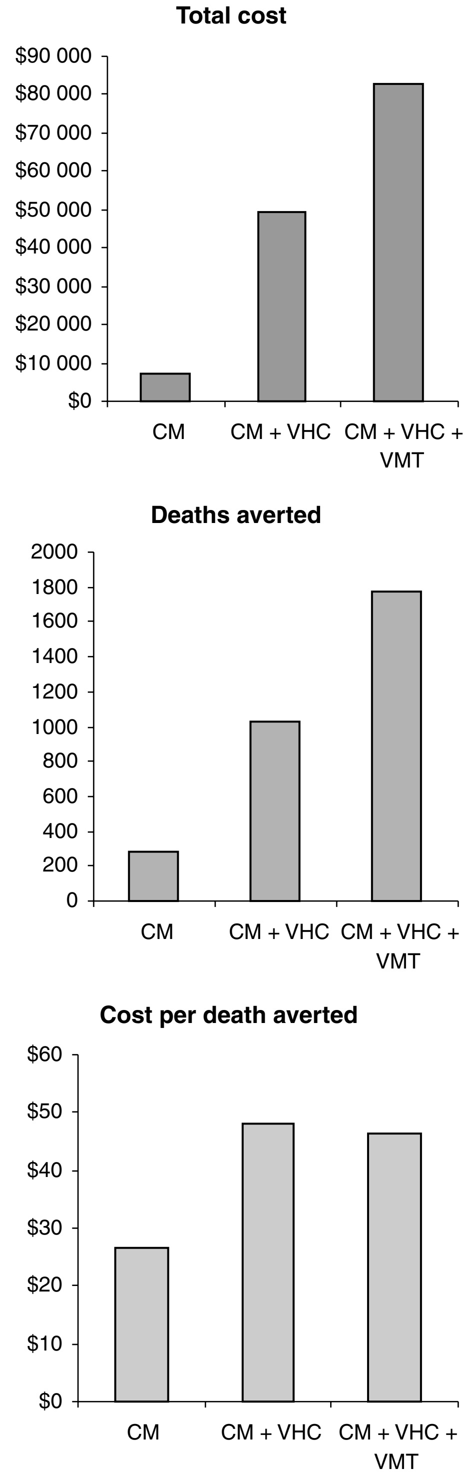

Figure 2 Effectiveness and cost-effectiveness of measles control strategies (midpoint estimates). CM, case management; VHC, vaccination in health centres; VMT, vaccination by mobile teams.

Table 5 Effectiveness and cost-effectiveness of control of meningococcal meningitis

Scenario	Activities	Cases	Deaths	Deaths averted	Marginal cost	Marginal cost per death averted
Natural	None	749	375 (100%)*	0	0	0
Routine	Case management in hospitals	749	150 (40%)*	225 (60%)*	+US$14 980	US$67
Intervention A	Improved case management in health centres	749	48 (13%)*	+102 (27%)*	+US$11 235	US$110
Intervention B	+ mass reactive vaccination campaign	539	35 (9%)*	+13 (3%)*	+US$47 800	US$3677

* Proportion of potential deaths in 'natural' scenario.

6.5% – the CFR observed – averting 102 deaths, leaving 48. Adding reactive vaccination to improved case management further reduces the number of deaths to 35, averting 13 additional deaths.

Cost and cost-effectiveness. The marginal cost of case management in 'routine' services, can be equated to the cost of medicines for meningococcal meningitis: approximately US$20 per patient, or a total cost of US$14 980. For improved case management, including extra supervision and support, the cost was estimated at US$35 per patient, similar to the cost documented in Nigeria (Veeken *et al.* 1998), US$15 per patient more than 'routine' or a total marginal cost of US$11 235 (Table 5). The total cost of the 104 000 vaccinations in Macenta prefecture was US$52 000 (Varaine *et al.* 1997). But vaccination may have saved up to US$4200 of drugs, leaving a total marginal cost of US$47 800 for 13 additional deaths averted, US$3677 per death averted.

Cost-effectiveness of control of epidemics

All routine activities together roughly halved potential deaths from epidemics: 51% for the three diseases combined (67% by cholera case management, 37% by measles case management and measles vaccination by health centres combined and 60% by meningitis case management; Figure 3 and Table 6). Additional interventions roughly halved again the residual deaths: a further 28% for the three diseases combined (28% by improved cholera case management, 27% by measles vaccination by mobile teams and 30% by improved meningitis case management and meningitis vaccination combined). Figure 4 summarizes the cost-effectiveness of the different epidemic control activities studied. Meningitis vaccination is clearly less cost-effective than any of the other measures.

The three epidemics – in the absence of adequate control measures – would have added a considerable number of deaths to the annual death toll in Macenta (Figure 3). As it was performed, the intervention to control a cholera

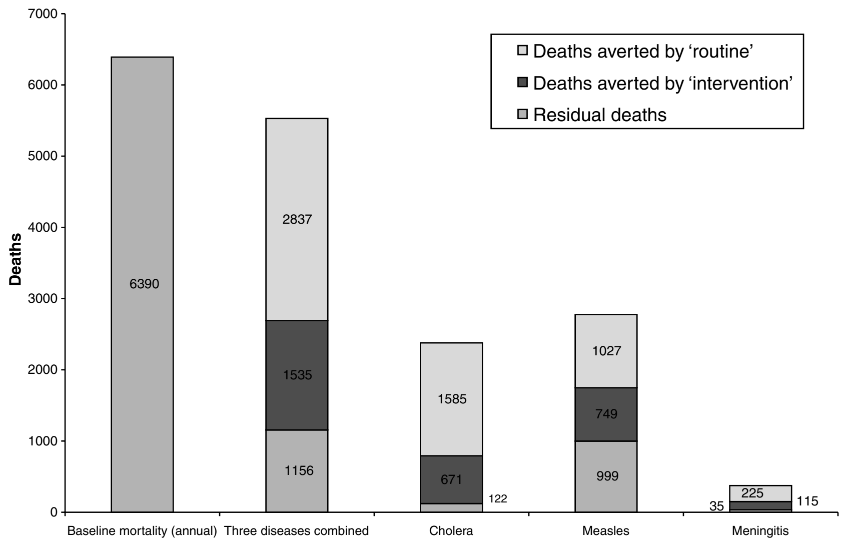

Figure 3 Deaths averted and residual deaths of the three epidemics, compared with the annual baseline mortality in Macenta (mid point estimates).

Table 6 Effectiveness and cost-effectiveness of control of cholera, measles and meningitis combined (midpoint estimates)

Scenario	Deaths	Deaths averted	Marginal cost	Marginal cost per death averted
Natural	5528 (100%)*	0	0	0
Routine	2691 (49%)*	2837 (51%)*	+US$81 810	US$29
Intervention	1156 (21%)*	+1535 (28%)*	+US$143 465	US$93

* Proportion of potential deaths in 'natural' scenario.

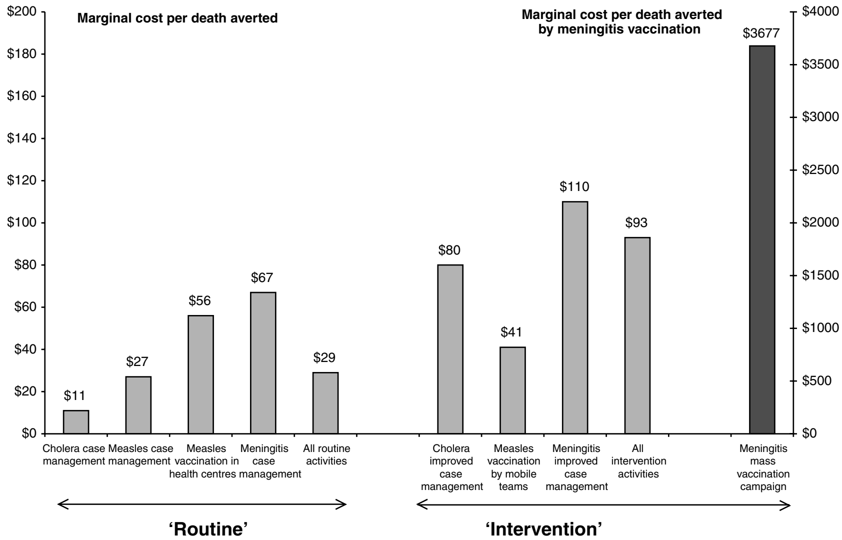

Figure 4 Cost-effectiveness of different epidemic control activities (mid point estimates).

epidemic adds US$0.15 per capita per year to the annual average expenditure of US$3 per capita per year; and controlling measles US$0.09 per capita. In the case of meningitis US$0.13 per capita per year was spent for vaccination – with a very small yield in deaths averted – while the cost for improved case management was only US$0.03 per capita per year. The routine health care system in the region, with its facilities, staff, vehicles and cold chain, was already functioning and funded: donor inputs and official user fees amounted to a total of about US$3 per capita per year (Van Damme 1998). The total cost of the interventions was US$145 685. This adds 4.6% to the total cost of the routine health system, estimated at US$3195 000 for the triennial period.

Discussion

In Guinea, reducing the burden of the epidemics was mainly the work of the routine health services: they avoided some 51% of the potential excess mortality, at an average marginal cost of US$29 per death averted. The additional intervention to help control the epidemics, such as mobile teams and cholera treatment centres, averted a further 28% at an average marginal cost of US$93 per death averted.

One should, however, treat these findings with caution, for several reasons. First, marginal costs per death averted as calculated are approximate at most. We had to use different primary and secondary sources for cost estimates, of varying reliability and degree of detail. A systematic ingredient approach was thus impossible. Moreover, costs were estimated as marginal to the routine health system. Activities developed within existing facilities have a lower marginal cost than activities for which an additional intervention was organized. However, this approach to cost estimation was the best one could do with the available data, and is widely used (Mills 1985; World Bank 1993b). Our data did not allow applying more recent guidelines on cost-effectiveness analysis (Johannesson & Meltzer 1998; Murray *et al.* 2000; Hutubessy *et al.* 2001a,b).

Second, effectiveness estimates also lack precision, because the assumptions used for attack rates and case fatality rates (CFRs) are imprecise. For instance, the 50% natural CFR often quoted for cholera and meningococcal meningitis (Table 2) may not be universally valid.

However, we accepted them for our analysis. Reported or estimated attack rates and CFRs are already imprecise ('intervention' situation), but attack rates and CFRs in the absence of any health care ('natural' situation), or in the absence of additional epidemic control measures ('routine' situation) are by necessity based on extrapolation. However, despite these limitations, sensitivity analysis showed that the conclusions are robust over a wide range of assumptions.

Third, cost per death averted is very sensitive to potential number of deaths estimated. In environments with lower measles CFR, such as southern Africa, or with higher meningitis attack rates, such as areas within the core of the Sahelian meningitis belt, cost-effectiveness estimates may differ significantly from Guinea.

On the basis of its cost-effectiveness ratio, relying on routine health services for controlling epidemics is an obvious first choice, with its 51% reduction of excess mortality (Figure 3) at US$29 per death averted (Figure 4). One would presume, however, that in most countries, as in Guinea, the residual death toll of solely relying on routine services would be humanely unacceptable and politically unfeasible. Complementing the control efforts of routine health services with specific additional interventions, be it at a lower cost-effectiveness ratio – a marginal cost of US$93 per death averted – eventually proved useful and affordable. This is particularly obvious in the case of measles (Figure 2). Although case management alone was highly cost-effective (US$27 per death averted), it would have reduced measles mortality only by 10%, clearly 'unacceptable'. The best strategy was undoubtedly the combination of all three activities.

An extra health budget of 4.6%, or US$0.14 per capita per year, to control such devastating epidemics seems a very reasonable amount. It represents only a very small share of the US$12 per capita per year estimated necessary by the World Bank for a minimum package of health services (World Bank 1993a; World Bank 1993b), the US$34 per capita per year judged necessary by the Commission on Macroeconomics and Health (Commission on Macroeconomics and Health 2001), or the cost of treating AIDS patients with antiretroviral drugs. For managers or policy makers it provides good value for money; all the more as action on their part is usually taken on the basis of an overestimation of the epidemic's threat. Public health interventions tend to anticipate worst-case scenarios, with decisions made under considerable time-constraints and on the basis of uncertain information (Van Damme & Van Lerberghe 2000).

Moreover, epidemics do not only cause death, disease and disability. They provoke fear and anxiety. Reductions in anxiety are difficult to measure and were not taken into account for the cost-effectiveness analysis in this paper. Nevertheless, the bio-demographic burden and the psychological impact are both integral parts of what is perceived as an epidemic, both by health professionals and by the population. In Guinea, the psychological impact seemed influenced by factors such as the degree of acquaintance with the diseases; the speed of transmission and the fear of further spread; the age groups involved; the perception of certain epidemics as being an 'invasion from outside'; and the history of the disease in the area (VanDamme 1998). These factors may explain why cholera and meningococcal meningitis were perceived as major threats, while measles was not, its higher mortality notwithstanding.

If epidemic control measures are as much a response to fear as an attempt to avert surplus mortality, it seems inadequate to measure the cost-effectiveness of epidemic control measures exclusively in terms of cost per death averted (Van Damme & Van Lerberghe 2000). To spend US$47 800 in Macenta for meningitis vaccination to prevent 13 deaths is not cost-effective, in terms of deaths prevented. If, however, one also considers this from the viewpoint of society, it may well have been worthwhile to spend that money to alleviate its fear through a highly visible operation. After all, to allocate resources in this (irrational) way is also the society's choice. Health authorities in Guinea acknowledged that the impact of meningitis vaccination on the course of the epidemic would be limited, but political pressure was so high that 'not vaccinating was not an option'.

Well-functioning health services can play a prominent role in handling complex emergencies, even of the scale of the refugee crisis in east Congo (Porignon *et al.* 1998). The experience from Guinea shows that they can also be the mainstay of the control of epidemics, even in severely resource-constrained situations. In Macenta, existing services were functioning reasonably well – all things considered – in part because the staff were paid decent wages and supply channels were adequate. In these circumstances, relatively little extra support – targeted supplies and training – was enough to further increase the performance of the health system.

However, these obvious minimum conditions are often not met in sub-Saharan Africa, where health services usually lack the means and experience to tackle epidemics adequately. They may run out of stock of the necessary drugs, and may have difficulties coping with the increased workload. But when they do function and get the means to respond to an emergency situation they have the comparative advantage of providing case management, which is an essential part of addressing fear and panic, and one of the most cost-effective interventions in various types of epidemics. There is thus a clear case for building up health centres' preparedness for disease surveillance and reaction to epidemics, and for beefing up these services when epidemics occur.

It is particularly significant that improved case management – as previously shown in Nigeria for meningococcal meningitis (Veeken *et al.* 1998) – has a far greater potential than commonly assumed. But even for additional interventions, such as improved case management for cholera and meningococcal meningitis, one cannot underestimate the role of pre-existing health facilities. It is without doubt easier, cheaper and more effective to set up a cholera treatment centre next to a health centre with adequate staff and supplies, where people come when they are already ill, than to set a cholera treatment centre up from scratch with new staff, in a place not previously known to treat patients.

It would be far-fetched to argue that one has to strengthen health services merely to prepare for epidemics. Still, their potential effectiveness and efficiency in such circumstances is one more argument against the current disinvestments in Africa's health care system (Lambo & Sambo 2003) and its providers.

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