Achieving the millennium development goals for health

Evaluation of current strategies and future priorities for improving health in developing countries

David B Evans, Stephen S Lim, Taghreed Adam, Tessa Tan-Torres Edejer, WHO Choosing Interventions that are Cost Effective (CHOICE) Millennium Development Goals Team

More resources are needed to enable developing countries to fund just the health interventions that are highly cost effective. Evidence that existing money is being well spent may help this cause

Five years after the Millennium Declaration was signed, few of the poorest countries in the world are on track to achieve the millennium development goals for health.[1 2] In September 2005, heads of state renewed their commitment to these goals and to finding the resources to achieve them. The needs are substantial. An additional $73bn (£42bn; €62bn) in external aid will be needed in 2006 alone for all the millennium development goals, with about $18.5bn for health.[3] In this series we have examined whether the strategies adopted for using the available resources, and those planned for future resources, are appropriate in view of the disappointing progress, changing circumstances, and new evidence.[4–8] Here, we summarise the key findings for each of the health conditions targeted by the goals and then take the perspective of a policy maker trying to achieve all of them.

Analysis of simultaneous interventions

Our method of analysis used two innovations to ensure the results had more relevance to practical policy decisions than traditional cost effectiveness analysis.[3 9–12] Firstly, the cost effectiveness of the existing use of resources could be evaluated at the same time as the cost effectiveness of possible future courses of action should new resources become available. Traditional cost effectiveness analysis has usually considered only future use of resources. Secondly, we incorporated interactions between costs and effects of interventions that are undertaken simultaneously, as they would be in practice. Previous studies have generally assumed, mostly implicitly, that every intervention is implemented in isolation from related activities.

Here we have analysed more synergies between concurrent interventions than were included in the analyses for separate health goals.[4–8] For example, different interventions that would be delivered as part of a basic obstetric package, often by the same person during the same visit, had been analysed separately in the maternal and neonatal health (tetanus toxoid),[5] HIV and AIDS (prevention of mother to child transmission),[6] and malaria (intermittent presumptive treatment with sulfadoxine-pyrimethamine in pregnancy)[7] analyses. Cost synergies between tetanus toxoid and other interventions aimed at maternal and neonatal health were included in that paper, but here we add synergies resulting from common delivery platforms across all the health goals.

The individual papers eliminated several interventions from further consideration because they proved to be more costly, with lower health benefits, than others (see table B on bmj.com). The remaining interventions were classified in a way that is useful for setting priorities across multiple health conditions. We earlier argued that the uncertainty around estimates of costs and health gains, especially when information must be taken from a limited number of data points, precludes basing policy advice on the point estimates of cost effectiveness.[3] For policy purposes, interventions should be compared in terms of order of magnitude cost effectiveness bands. Within any band, individual decision makers have a menu of interventions to choose from. We deemed interventions to be highly cost effective if they cost less than the gross domestic product per capita to avert each disability adjusted life years (DALY) and cost effective if each DALY could be averted at a cost of between one and three times the gross domestic product per capita. Other interventions are not cost effective.[13] This incorporates an element of affordability as regions and countries with lower national income will have lower cut-off points.

Recommended strategy changes for each goal

In some cases, we found current strategies and plans to be essentially appropriate, while more opportunities to

P+ *Members of the WHO-CHOICE millennium development goals team and further details are on bmj.com*

ELPS *This article was posted on bmj.com on 10 November 2005: http://bmj.com/cgi/doi/10.1136/bmj.38658.561123.7C*

This article is the last in a series examining the cost effectiveness of strategies to achieve the millennium development goals for health

See *Papers* p 1431

Health Systems Financing, Evidence and Information for Policy, World Health Organization, Geneva, Switzerland
David B Evans *director*
Taghreed Adam *health economist*
School of Population Health, University of Queensland, Australia
Stephen S Lim *research fellow*
Costs, Effectiveness, Expenditure and Priority Setting, World Health Organization
Tessa Tan-Torres Edejer *coordinator*
Correspondence to: David B Evans evansd@who.int

BMJ 2005;331:1457–61

Modifications to current strategies to meet millennium development goals

Maternal and neonatal health
Higher priority should be given to increasing access to clinical facility based services providing basic and emergency obstetric and neonatal care

Insufficient coverage of highly cost effective preventive interventions, including community support for breastfeeding mothers and low birthweight babies, treatment of neonatal pneumonia, provision of tetanus toxoid, and screening mothers for syphilis, bacteriuria, and pre-eclampsia

Lower priority should be given to high cost, low effect interventions such as antibiotics for preterm rupture of membranes and antenatal steroids for preterm births (in Sear-D)

Child health
Increased efforts to fortify processed food staples with multiple micronutrients, especially vitamin A and zinc

Current focus on personal interventions is appropriate: measles immunisation, case management of pneumonia, oral rehydration therapy

If more resources are available, vitamin A and zinc supplementation could replace fortification

When resources are very limited, these interventions should be given higher priority than higher cost, less effective alternatives

Research on more cost effective health interventions for malnutrition is urgently needed

HIV and AIDS
Prevention strategies based on treatment of sexually transmitted infections, educating sex workers, and some types of mass media messages are highly cost effective

School based education has uncertain effectiveness and is not highly cost effective in Sear-D

Treatment with first line antiretrovirals is at least as cost effective as some of the well known preventive interventions, such as voluntary counselling and testing

Malaria
In most countries of sub-Saharan Africa serious consideration should be given to improved case management with artemisinin based combination treatments

This should be integrated with use of insecticide treated bed nets or indoor residual spraying

Where these are being successfully implemented, intermittent presumptive treatment of pregnant women can bring an important additional health benefit

Greater effort should be given to increasing coverage of malaria interventions

Tuberculosis
Effective treatment of infectious (sputum smear positive) cases is the first priority, including for patients coinfected with HIV

Improving case finding should now also be given high priority

Once these elements are in place, treatment should be extended to patients who are less infectious (sputum smear negative) and with multidrug resistant strains

Antiretroviral therapy should be offered in conjunction with tuberculosis treatment for patients infected with HIV

reallocate resources existed in others (box). Significant reductions in maternal and neonatal mortality require, for example, increased access to clinic based services providing basic and emergency obstetric and neonatal care, but also increased community based prevention, including the encouragement of breast feeding, support of low birthweight babies, treatment of neonatal pneumonia, and wider provision of tetanus toxoid. If no new resources are forthcoming and substantial resources currently support relatively high cost, low effect interventions (such as antibiotics for premature rupture of membranes) policy makers could consider reallocating current spending to the more cost effective interventions.

Priority setting across health goals

Tables 1 and 2 classify interventions into the cost effectiveness bands described above for the two regions Afr-E (countries in sub-Saharan Africa with very high adult mortality and high child mortality) and Sear-D (countries in South East Asia with high adult and child mortality). Tables C and D on bmj.com gives details of costs, effects, and cost effectiveness ratios.

Application of results

In practice, resources are never allocated according to formulaic cost effectiveness rules described in textbooks—for example, by choosing the most cost effective intervention, then the next most cost effective, until all resources are used. This can sometimes suggest that only prevention should take place, or only treatment, but in reality mixes of interventions are generally found. Our analysis suggests this is appropriate. The highly cost effective group of interventions reported above includes a selection from each of the five goals in both regions, as well as mixes of curative and preventive actions and of population and individually focused activities. This is true even if the threshold for highly cost effective interventions is reduced to $Int100 per DALY averted.

Both regions have so much unmet need and so many underused interventions that the opportunities for reallocating resources are limited. Purely on cost effectiveness grounds, however, priority should clearly be given to highly cost effective interventions rather than activities such as second line antiretroviral therapy for AIDS and provision of supplementary food for children in Afr-E. More could be achieved if these resources were reallocated to any of the under-used, highly cost effective group. A similar picture unfolds in Sear-D. Attention should be focused on scaling up interventions that are highly cost effective rather than expanding second line antiretroviral therapy (which is just over the threshold for cost effective interventions), antenatal steroids for preterm births, and provision of supplementary food for children.

Both regions have a relatively large set of highly cost effective interventions, offering considerable flexibility to adapt packages to particular contexts. The relative size of the highly cost effective group reflects the unmet needs but also the fact that the millennium development goals were well chosen and need to be better funded. Many more interventions would fall outside the highly cost effective group had our analysis included conditions outside the goals, and it is here that greater potential to reallocate resources toward the goals may be found.

Validity of cost effectiveness

We accept that in practice, considerations other than cost effectiveness do, and should, influence decisions on resource allocation. Important debate continues about the appropriateness of using cost effectiveness analysis to drive decisions in health. For example, the technique focuses only on the health gains associated with different uses of resources and does not incorporate other effects of concern to society. This may be particularly relevant to antiretroviral treatment for

Table 1 Interventions to achieve health millennium development goals in region Afr-E by order of cost effectiveness

Goal	Intervention (coverage)
Highly cost effective*	
Maternal and neonatal health	Community based case management for neonatal pneumonia (95%)
HIV and AIDS	Mass media campaign to promote safer sex (100%)
HIV and AIDS	Peer education and treatment of sexually transmitted infections for sex workers (50%)
HIV and AIDS	Peer education and treatment of sexually transmitted infections for sex workers (expanded to 80%)
HIV and AIDS	Peer education and treatment of sexually transmitted infections for sex workers (expanded to 95%)
Tuberculosis	Treatment of new smear positive tuberculosis cases only under DOTS (50%)
Maternal and neonatal health	Community newborn package (95%): support for breastfeeding mothers and low birthweight babies
Tuberculosis	Treatment of new cases of smear positive tuberculosis only under DOTS (expanded to 80%)
Malaria	Case management of malaria with artemisinin based combination treatment (95%)
Tuberculosis	Treatment of new cases of smear positive tuberculosis only under DOTS (expanded to 95%)
Under 5s	Vitamin A fortification of food staple (95%) Zinc fortification of food staple (95%)
Maternal and neonatal health	Tetanus toxoid (95%)
HIV and AIDS	Prevention of mother to child transmission (antenatal care coverage)
Maternal and neonatal health	Screening for pre-eclampsia (95%) Screening and treatment of asymptomatic bacteriuria (95%) Screening and treatment of syphilis (95%)
Under 5s	Measles vaccination (80%)
Maternal and neonatal health	Normal delivery by skilled attendant (95%) Active management of the third stage of labour (95%) Initial management of post-partum haemorrhage (95%) Neonatal resuscitation (95%)
Maternal and neonatal health	Treatment of severe pre-eclampsia and eclampsia (95%)
Malaria	Insecticide treated bed nets (95%)
Under 5s	Measles vaccination (expanded to 95%)
Maternal and neonatal health	Facility based care of very low birthweight babies, severe neonatal infections, severe neonatal asphyxia, and neonatal jaundice
HIV and AIDS	Treatment of sexually transmitted infections (current coverage)
Under 5s	Case management for childhood pneumonia (80%)
Maternal and neonatal health	Management of obstructed labour, breech presentation, and fetal distress (95%)
HIV and AIDS	Treatment of sexually transmitted infections (expanded to antenatal care coverage)
Under 5s	Vitamin A supplementation (80%, replaces fortification) Zinc supplementation (80%, replaces fortification)
Tuberculosis	Treatment of smear negative tuberculosis under DOTS (95%)
Under 5s	Oral rehydration therapy for diarrhoea (80%)
Maternal and neonatal health	Antenatal steroids for preterm births (95%)
Malaria	Indoor residual spraying (95%)
Tuberculosis	Treatment of multi-drug resistant tuberculosis under DOTS-Plus (95%)
Maternal and neonatal health	Management of maternal sepsis (95%)
Malaria	Intermittent presumptive treatment with sulfadoxine-pyrimethamine during pregnancy (95%)
Maternal and neonatal health	Antibiotics for pre-term premature rupture of membranes (95%)
HIV and AIDS	Voluntary counselling and testing (95%)
Maternal and neonatal health	Referral care for severe post-partum haemorrhage
Under 5s	Vitamin A supplementation (expanded to 95%) Case management for childhood pneumonia (expanded to 95%) Zinc supplementation (expanded to 95%) Oral rehydration therapy for diarrhoea (expanded to 95%)
HIV and AIDS	Treatment of sexually transmitted infections (expanded to 95%)
HIV and AIDS	Antiretroviral therapy: no intensive monitoring, first line drugs only (95%)
HIV and AIDS	School based education on safer sex (95%)
HIV and AIDS	Antiretroviral therapy: intensive monitoring, first line drugs only (95%)
Not cost effective†	
HIV and AIDS	Antiretroviral therapy: intensive monitoring, first and second line drugs (95%)
Under 5s	Improved complementary feeding, monitoring and promotion of growth (95%)

*Incremental cost effectiveness ratio ≤$Int1576 (see table A on bmj.com for conversion factor).
†Incremental cost effectiveness ratio>$Int4728.
Note: No interventions fall into the cost effective band (incremental cost effectiveness ratio >$Int1576 and ≤$Int4728) for Afr-E.

HIV and AIDS, which keeps health workers and school teachers in their posts and could, at the limit, prevent a possible breakdown of society.[14 15] These benefits cannot be captured in terms of DALYs. Use of cost effectiveness analysis also raises several ethical issues, particularly the fact that equity is not explicitly incorporated.[15 16]

Policy makers, however, cannot escape from the unfortunate fact that the resources available are insufficient even to implement all the interventions designated in this paper as highly cost effective, and it is not yet clear that the additional resources required to reach the millennium development goals will be found. In such cases, informed decisions about how to allocate the available resources require knowledge of the likely effect on population health of different courses of action. Without this knowledge, decisions could be made to improve the health of a few people by a small amount at the expense of improving the health of more people by a larger amount, something that

Table 2 Interventions to achieve health millennium development goals in region Sear-D by order of cost effectiveness

Goal	Intervention (coverage)
Highly cost effective*	
HIV and AIDS	Peer education and treatment of sexually transmitted infections for sex workers (50%)
HIV and AIDS	Peer education and treatment of sexually transmitted infections for sex workers (expanded to 80%)
HIV and AIDS	Peer education and treatment of sexually transmitted infections for sex workers (expanded to 95%)
Maternal and neonatal health	Community based support for breastfeeding mothers (50%)
Maternal and neonatal health	Community based support for breastfeeding mothers (expanded to 80%)
Tuberculosis	Treatment of new cases of smear positive tuberculosis only under DOTS (80%)
Maternal and neonatal health	Community based support for breastfeeding mothers (expanded to 95%)
Maternal and neonatal health	Tetanus toxoid (80%)
Tuberculosis	Treatment of new smear positive tuberculosis only under DOTS (expanded to 95%)
Maternal and neonatal health	Tetanus toxoid (expanded to 95%)
Under 5s	Zinc fortification of food staple (95%)
Maternal and neonatal health	Community based support for low birthweight babies (95%)
HIV and AIDS	Mass media campaign to promote safer sex (100%)
Tuberculosis	Treatment of smear negative tuberculosis under DOTS (95%)
Under 5s	Vitamin A fortification of food staple (95%)
Under 5s	Case management for childhood pneumonia (80%)
Maternal and neonatal health	Normal delivery by skilled attendant (95%) Active management of third stage and initial treatment of post-partum haemorrhage (95%)
Under 5s	Case management for childhood pneumonia (expanded to 80%)
Under 5s	Measles vaccination (95%)
Maternal and neonatal health	Screening for pre-eclampsia (95%) Screening and treatment of asymptomatic bacteriuria (95%)
HIV and AIDS	Treatment of sexually transmitted infections (95%)
Maternal and neonatal health	Community based case management for neonatal pneumonia (95%)
Under 5s	Zinc supplementation (95%, replaces fortification) Oral rehydration therapy for diarrhoea (95%)
Maternal and neonatal health	Neonatal resuscitation (95%) Treatment of severe pre-eclampsia and eclampsia (95%)
Tuberculosis	Treatment of multi-drug resistant tuberculosis under DOTS-Plus (95%)
Maternal and neonatal health	Referral care for severe post-partum haemorrhage (95%)
Maternal and neonatal health	Management of maternal sepsis (95%)
HIV and AIDS	Voluntary counselling and testing (95%)
Under 5s	Vitamin A supplementation (95% replaces fortification)
HIV and AIDS	Prevention of mother to child transmission (antenatal care coverage)
Maternal and neonatal health	Facility based care of very low birthweight babies, severe neonatal infections, severe neonatal asphyxia, and neonatal jaundice (95%)
HIV and AIDS	Screening and treatment of syphilis (95%)
Maternal and neonatal health	Antiretroviral therapy: no intensive monitoring, first line drugs only (95%)
HIV and AIDS	Antiretroviral therapy: intensive monitoring, first line drugs only (95%)
Cost effective†	
HIV and AIDS	School based education (95%)
Maternal and neonatal health	Management of obstructed labour, breech presentation, and fetal distress (95%)
Maternal and neonatal health	Antibiotics for preterm premature rupture of membranes (95%)
Not cost effective‡	
HIV and AIDS	Antiretroviral therapy: intensive monitoring, first and second line drugs (95%)
Maternal and neonatal health	Antenatal steroids for preterm births (95%)
Under 5s	Improved complementary feeding, monitoring, and promotion of growth (95%)

*Incremental cost effectiveness ratio ≤$Int1449 (see table A on bmj.com for conversion factor).
†Incremental cost effectiveness ratio >$Int1449 and ≤$Int4347.
‡Incremental cost effectiveness ratio >$Int4347.

neither the proponents nor opponents of cost effectiveness analysis would want.

Many grounds may exist to justify implementing the interventions we have identified as less cost effective. For example interventions, such as feeding malnourished infants or management of obstructed labour, target a group in society with particularly poor health. Although this is perfectly legitimate, we argue that decision makers cannot make an informed decision without information on the opportunities to improve population health that are forgone elsewhere. Our results represent the best evidence currently available and show difficult trade-offs may need to be made. Another equally important message from our results is the need to redouble efforts to raise additional funds for health in poor countries. Our experience with economists in ministries other than health is that it is much easier to convince them of the need for funds if both additional and existing funds are well spent. We hope that this series contributes not only to improving population health with the available resources but to raising more funds for health as well.

We thank Megha Mukim, Jason Lee, and Marilyn Vogel for help with referencing.

Contributors and sources: All authors contributed to the development of the methods used in the paper and helped to decide on the implications of the individual results. DBE wrote the first draft. TA, TTTE, and SSL made substantial comments and modifications, and DBE prepared the final version and is the guarantor. Members of the WHO-CHOICE MDG group commented on the initial outline and results, as well as providing guidance on the implications of their papers for the final summary. SSL put the results together for tables and figures.

Summary points

Separate analysis for millennium health goals showed how resources could be used better

Combined analysis for all the goals highlights the priorities for policy makers with responsibility for all aspects

Many more interventions than countries can afford to fund are classified as highly cost effective

More resources urgently need to be made available

The opinions expressed in the paper are those of the authors and do not necessarily represent the views of the organisations they represent.

Competing interests: None declared.

1 Nanda G, Switlick K, Lule E. *Accelerating progress towards achieving the MDG to improve maternal health: a collection of promising approaches*. Washington, DC: International Bank for Reconstruction and Development, World Bank, 2005.
2 Evans DB, Adam T, Tan-Torres Edejer T, Lim SS, Cassels A, Evans TG, et al. Achieving the millennium development goals for health: time to reassess strategies for improving health in developing countries? *BMJ* 2005;331:1133-6.
3 Evans D, Tan-Torres Edejer T, Adam T, Lim S, the WHO-CHOICE MDG team. Achieving the millennium development goals for health: methods to assess the costs and health effects of interventions for improving health in developing countries. *BMJ* 2005;331:1137-40.
4 Tan-Torres Edejer T, Aikins M, Black R, Wolfson L, Hutubessy R, Evans DB. Achieving the millennium development goals for health: cost effectiveness analysis of strategies for child health in developing countries. *BMJ* Nov 10; epub ahead of print (doi:10.1136/bmj.38652.550278.7C).
5 Adam T, Lim SS, Mehta S, Bhutta ZA, Fogstad H, Mathai M, et al. Achieving the millennium development goals for health: cost effectiveness analysis of strategies for maternal and neonatal health in developing countries. *BMJ* 2005;331:1107-10.
6 Hogan D, Baltussen R, Hayashi C, Lauer J, Salomon J. Achieving the millennium development goals for health: cost effectiveness analysis of strategies to combat HIV/AIDS in developing countries. *BMJ* Nov 10; epub ahead of print (doi:10.1136/bmj.38643.368692.68).
7 Morel C, Lauer J, Evans DB. Achieving the millennium development goals for health: cost effectiveness analysis of strategies to combat malaria in developing countries. *BMJ* Nov 10; epub ahead of print (doi:10.1136/bmj.38639.702384.AE).
8 Baltussen R, Floyd K, Dye C. Achieving the millennium development goals for health: cost effectiveness analysis of strategies for tuberculosis control in developing countries. *BMJ* Nov 10; epub ahead of print (doi:10.1136/bmj.38645.660093.68).
9 Adam T, Evans DB, Murray CJL. Econometric estimation of country specific hospital costs. *Cost Eff Resour Alloc* 2003;1:3.
10 Johns B, Baltussen R, Hutubessy RCW. Programme costs in the economic evaluation of health interventions. *Cost Eff Resour Alloc* 2003;1:1.
11 Lauer JA, Rohrich K, Wirth H, Charette C, Gribble S, Murray CJL. PopMod: a longitudinal population model with two interacting disease states. *Cost Eff Resour Alloc* 2003;1:6.
12 Baltussen RM, Adam T, Tan Torres T, Hutubessy RC, Acharya A, Evans DB, Murray CJ. *Generalized cost-effectiveness analysis: a guide*. Geneva: WHO, 2003. http://www3.who.int/whosis/cea/background_documents/pdf/guidelines.pdf (accessed 27 Oct 2005).
13 Commission on Macroeconomics and Health. *Macroeconomics and health: investing in health for economic development*. Boston: Center for International Development at Harvard University, 2001. www.cid.harvard.edu/cidcmh/CMHReport.pdf (accessed 17 Oct 2005).
14 Evans DB. Communicable diseases: alternative perspectives. In Lomborg B, ed. *Global crises, global solutions*. Cambridge: Cambridge University Press, 2004:115-23.
15 Yong KJ, Shakow A, Mate K, Vanderwarker C, Gupta R, Farmer P. Limited good and limited vision: multidrug-resistant tuberculosis and global health policy. *Soc Sci Med* 2005;61:847-59.
16 Brock DW. Priority to the worst off in health care resource prioritization. In: Battin M, Rhodes R, Silvers A, eds. *Health care and social justice*. New York: Oxford University Press, 2003.

(Accepted 12 October 2005)

doi 10.1136/bmj.38658.675243.94

Invasive procedures

Another busy night shift as a medical house officer. At about 2 am my bleep shrills, and I call the number with a resigned sigh. I'm told about a sick patient in the high dependency unit, an elderly man who had coronary artery bypass grafting to treat his ischaemic heart disease 18 years ago. He has known heart failure, peripheral vascular disease, sepsis, and renal failure. No resuscitation decision made as yet. Just another call about just another sick patient with a dismal prognosis.

But, of course, it wasn't. The call was to my mother in a hospital in another city, and the sick patient was her brother. I wasn't asked to do anything, just to explain what was going on to my own family, who were too intimidated to ask the doctors on the ward. I listened in silence as my mother described the family bewildered and baffled: no one had told them how sick my uncle was until he was taken to the high dependency unit, and no one had discussed resuscitation with them until now, when the staff were struggling to put in a central line.

"They've asked us whether we want them to perform any more invasive procedures," my mother said. "I'm not sure what they mean by 'invasive procedures,' but, reading between the lines, we think 'invasive procedures' means things that hurt, and we don't want him to be in pain any more. Are we right?"

Invasive procedures means things that hurt. Yes, I supposed she was right. We talked for a while about how she could talk to the medical staff in the hospital, and to the rest of the family, about what was to be done. We both cried a little. And I returned to my shift feeling thoughtful.

My uncle died a few days later, having had no further invasive procedures and with his family around him. And I try not to use terms like "invasive procedures" to families any more. Not all of them have a junior doctor on hand to translate when they're too afraid of how busy we are and what the answer might be to ask us what we actually mean.

Victoria Thomas *foundation year 2 doctor, University Hospital of Hartlepool, Newcastle upon Tyne (v.e.thomas@ncl.ac.uk)*

We welcome articles up to 600 words on topics such as *A memorable patient, A paper that changed my practice, My most unfortunate mistake,* or any other piece conveying instruction, pathos, or humour. Please submit the article on http://submit.bmj.com Permission is needed from the patient or a relative if an identifiable patient is referred to. We also welcome contributions for "Endpieces," consisting of quotations of up to 80 words (but most are considerably shorter) from any source, ancient or modern, which have appealed to the reader.