A ROLE FOR WATER SUPPLY AND SANITATION IN THE CHILD SURVIVAL REVOLUTION[1]

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BACKGROUND

Improvements in water supply and sanitation conditions played a fundamental role in improving health in industrialized countries during the nineteenth century *(1)*. In the mid-1970s it was generally agreed that water supply and sanitation had a similar role to play in the transition to low mortality rates in developing countries. As a consequence of this belief, water supply and sanitation were included as integral parts of the primary health care (PHC) package *(2)*, and the 1980s were declared to be the United Nations' International Drinking Water Supply and Sanitation Decade.

Upon closer examination of the PHC strategy, it was argued in an influential policy-oriented analysis *(3)* that insufficient resources were available to implement the complete package of PHC interventions, and that only those interventions which were most cost-effective in terms of reducing infant mortality should be implemented. In particular, it was argued that the cost per infant death averted through water supply and sanitation programs was much higher than the cost per infant death averted through a selective primary health care package that included oral rehydration therapy, DPT and measles immunizations, malaria treatment, and breast-feeding.

A second influential policy-oriented analysis *(4)* made a national-level comparison of life expectancy among countries with low and high water supply and sanitation coverage. As indicated in Figure 1, this study suggested that at both low and high levels of socio-economic development improvements in water supply and sanitation conditions would have relatively little effect on health, and that it was in the "middle-level" countries that the effect would be greatest.

As a result of these analyses, the *de facto* policy of several international agencies has been that water supply and sanitation interventions may occasionally be appropriate at relatively advanced stages of the development process, but that they are not cost-effective at the earlier stages where other interventions such as immunizations, oral rehydration, and family planning are believed more sensible. Thus, for instance, in the Asia Region USAID may give consideration to a water supply program in

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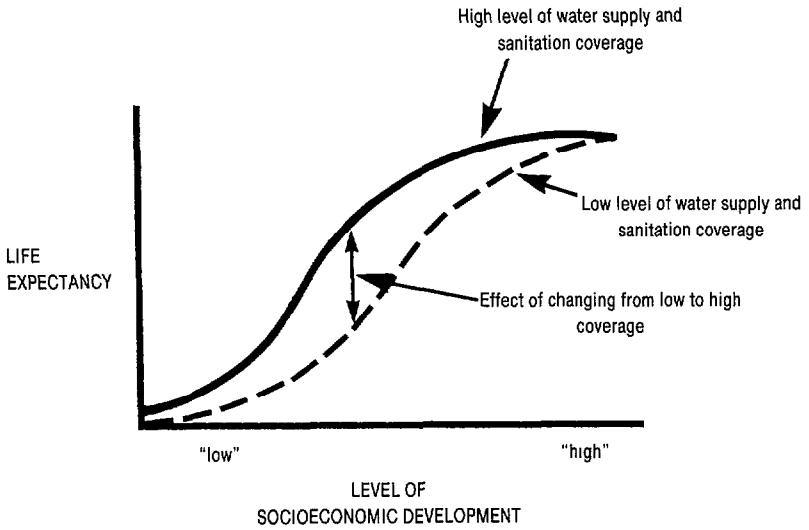
FIGURE 1. Relationship between level of socioeconomic development, level of water supply and sanitation service, and life expectancy (after Walsh and Warren—*3*).



Thailand (a middle-level country) but not in Bangladesh (a poor country).

Over the past couple of years, with leadership from UNICEF, strong support has developed for the "child survival revolution" *(5)*. Because of the belief that they do not constitute cost-effective health interventions, water supply and sanitation have been assigned a lower priority in this effort than have biochemical actions such as oral rehydration therapy and immunizations. For instance, in a US congressional bill authorizing the Child Survival Fund, water supply programs were not included among the child survival activities that could be funded *(6)*.

It is the thesis of this paper that this relegation of water supply and sanitation projects to a lower priority level is incorrect. It is argued that the methodology whereby priorities are established is systematically biased against systemic interventions such as water supply, that the direct effects of such interventions are generally underestimated, and that the indirect and long-term effects on health (which are presently ignored) appear to be substantial.

THE EFFECTS OF WATER SUPPLY AND SANITATION ON HEALTH

The Multiple Impacts of Water and Sanitation Programs

The use of a formal analytic procedure (such as cost-effectiveness) to set priorities for the use of health sector funds is essential if those funds are to be spent wisely. As presently applied, however, the cost-effectiveness approach used by several international agencies—such as USAID *(7)* and UNICEF *(5)*—does not deal adequately with interventions (such

as water supply and sanitation) that affect not only child survival but also a set of other health outcomes (including childhood morbidity as well as morbidity and mortality in other age groups) and a variety of nonhealth (social, economic, and political) outcomes.

To deal with water supply and sanitation programs in this framework, it is necessary to undertake two supplementary analyses so that such programs may be fairly compared with other health sector programs. First, it is necessary to partition the total costs of water supply and sanitation interventions into those costs that can be attributed to nonhealth benefits and those (the remaining) costs that can be attributed to health benefits. Second, it is necessary to express the set of health outcomes in terms of a common denominator such as "equivalent child deaths."

With regard to the partitioning of costs, it has been argued *(8)* that under normal circumstances the willingness of consumers to pay for a service is a measure of the nonhealth benefits, and therefore that the cost attributable to health is the difference between total costs and willingness to pay. Where tariffs are set correctly and where user charges are made, this difference will be the cost that is met through use of public funds. For example, as Table 1 indicates in the case of Lima, Peru *(9)*, if a piped water supply were installed in areas presently served by water vendors, the full costs of such a supply would be borne by the consumers.

In this particular instance, all the costs would be borne by private payments; and in many other cases only a small proportion of the total costs have to be borne by public funds. To make this "cost partitioning" concept useful for planners, the key requirement is information on the willingness of consumers to pay for water supply and sanitation services in different settings. From evaluations of water supply projects, it is apparent that willingness to pay for an improved supply is greater where water is supplied to the house rather than to a communal facility *(10, 11)*, and in arid rather than wet areas (traditional supplies often being considered satisfactory in the latter areas—*12, 13, 14*), and among high-income rather than low-income people *(10, 12, 15, 16)*. From these and other unpublished data, it would appear that the willingness to pay for water supply and sanitation services is as shown in Tables 2 and 3.

If the estimates on Tables 2 and 3 are even roughly correct, they imply that substantial private payments can be expected for water supplies in most

TABLE 1. Cost of water to consumers who are served and not served by piped water in Lima, Peru *(8)*.

	Quantity of water used (liters per capita per day)	Monthly expenditure (1972 soles per household per month)
Not served by piped system	23	105
Served by piped system	152	35

TABLE 2. Anticipated willingness to pay (as a proportion of household income) for water services in different social and natural settings. In this table "+++++" indicates a very high willingness to pay and "+" or "0" indicates a very low willingness to pay.

		Income group	Urban		Rural	
			Wet	Arid	Wet	Arid
Level of Service	High	Rich	+++++	+++++	+++	+++++
		Poor	+++	++++	++	++++
	Medium	Rich	++++	+++++	++	++++
		Poor	+++	++++	+	+++
	Low	Rich	+++	++++	+	++++
		Poor	++	+++	0	+++

TABLE 3. Anticipated willingness to pay (as a proportion of household income) for sanitation services in different social and natural settings. In this table "+++++" indicates a very high willingness to pay and "+" or "0" indicates a very low willingness to pay.

		Income group	Urban		Rural	
			Wet	Arid	Wet	Arid
Level of Service	High	Rich	+++++	+++++	+++	+++++
		Poor	+++	++++	++	++++
	Medium	Rich	++++	+++++	++	++++
		Poor	+++	++++	+	+++
	Low	Rich	+++	++++	+	++++
		Poor	++	+++	0	+++

unserved urban areas (generally low-income areas); for any adequate water supplies in arid rural areas; for water piped to yard taps in rural areas where abundant water is available; and for basic sanitation services in urban areas. Thus the implication is that in these settings the costs to be borne from public sources would be lowest; and, *ceteris paribus,* in these instances interventions are more likely to be cost-effective.

The second requirement in developing a correct estimate of "cost per infant death averted" for water supply and sanitation interventions is a method of expressing the full range of morbidity and mortality reductions produced by such programs in terms of "equivalent infant deaths." An analogous problem has been addressed by a United States Institute of Medicine study on setting priorities for vaccine development *(17).* Through an iterative procedure, a panel of public health experts agreed on the "infant mortality equivalents" for reductions of morbidity and reductions of mortality in all age groups.

A similar procedure could be followed for water supply and sanitation programs. However, because water supply and sanitation affect not only infant

mortality but also morbidity and mortality in other age groups, whatever the weighting emerging from such a procedure, the "equivalent child deaths" for water supply and sanitation will be greater than the "equivalent child deaths" for a targeted intervention with an identical effect on child mortality alone. Furthermore, it can be assumed that this difference would be substantial in developing countries, where economic welfare is dependent on productive adults, and where heavy emphasis should be given to reducing morbidity and mortality among adults *(18)*.

Typical Short-run Impacts on Child Survival

At the start of the International Drinking Water Supply and Sanitation Decade it was implicitly claimed that diseases among children in developing countries would be reduced by 80% if water supply and sanitation conditions improved. Probably because of the exaggerated nature of such claims, the pendulum has now swung to a point where it is often claimed that water supply and sanitation programs have little effect on health. In the original Selective Primary Health Care calculations, for instance, it was assumed that improved water supply and sanitation conditions would reduce diarrheal diseases by just 5%. A recent, authoritative study for the Diarrheal Diseases Control Program of the World Health Organization *(19)* has shown that water supply and sanitation programs typically have large impacts on diarrheal disease morbidity (Table 4), and even larger impacts on diarrheal disease mortality.

If water supply and sanitation programs are to have an impact on health, it is necessary not only that water supply and sanitation facilities be constructed and that they function adequately, but also that these facilities be used appropriately. As it has become evident that serious problems are frequently encountered with the use of improved facilities, more attention has been given to the hygiene education component of water supply and sanitation programs. In many cases hygiene education programs have been shown to have little impact on actual hygiene practices *(20)*. In three instances summarized on Table 5 *(21)*, only one of which involved a community setting, the impact of intensive hygiene education interventions on the incidence of diarrhea has been measured.

From Table 5 it appears that where personal hygiene practices can be improved through hygiene education programs, such interventions may have a substantial impact on diarrhea. (It

TABLE 4. Impact of water supply and sanitation interventions on diarrheal disease morbidity (after Esrey et al.—*19*).

Improvement in:	Number of studies	Median % reduction in diarrheal disease morbidity
Water quality	9	18%
Water quantity	17	25%
Water quality and quantity	8	37%
Excreta disposal	10	22%

TABLE 5. Effect of hygiene education programs on diarrheal disease (after Feachem—*21*).

Country	Setting	Intervention	Outcome Indicator	Result
Bangladesh	Households with index cases of shigellosis	Soap and water and education vs. nothing	Secondary shigella cases	Reduction of 84%
USA	Day care centers, children under three years old	Handwashing of staff and education of children vs. nothing	Incidence of diarrhea over 10 months	Reduction of 48%
Guatemala	Lowland villages, children under six years old	Hygiene education vs. nothing	Incidence of diarrhea	Reduction of 14%

should be noted that in many settings improvements in personal hygiene cannot take place without prior improvements in water availability.)

While global figures on costs and benefits are useful for getting a preliminary sense of which programs might be cost-effective, in fact both the benefits and the costs of water supply and sanitation and other health-related programs vary greatly with local social, economic, natural, and epidemiologic conditions. It is thus essential to develop locally applicable data bases on both the costs and the impacts of different interventions. In the specific case of water supply and sanitation, the critical information needed relates to the impact of the level of service (such as water distributed through standpipes, through a yard tap, or through house taps) and the interactions between water supply, excreta disposal, and hygiene education programs. Unfortunately the methodologic tools available for evaluating the health impacts of such interventions in specific settings are such that these evaluations are extremely expensive, take years to complete *(22)*, and are often methodologically flawed *(23)*. While recent work *(24)* offers some hope that valid and rapid epidemiologic assessment techniques may be applicable in this area, these methods are only now being field tested. Although initial experiences *(25)* are positive, at the present time health impact evaluations cannot be recommended for most water supply and sanitation projects, and planners have to draw on the global data base—suitably modified by an understanding of the specific local epidemiologic situation.

Necessary but Insufficient Interventions

In the best of situations (one in which a sound evaluation of the health impact of different levels of water supply and sanitation facilities has been conducted) there still remain two related

questions that need to be addressed before drawing conclusions about the overall health impact of a proposed project. First, as is done in this section, it is essential to consider the possibility that an improvement may be a necessary but not sufficient condition for improving health; and second, as is done in the next section, it is necessary to understand the relationship between the project's immediate effects (which are generally measured in impact evaluations) and the project's longer-term effects.

For a water supply improvement to have an impact on a fecal-oral disease (such as a diarrheal disease) it is necessary that the number of organisms ingested be reduced and also that this reduction translate into reduced disease. We will therefore briefly repeat an argument produced in more detail elsewhere *(26)*, which shows that under conditions of poor overall sanitation, major reductions in exposure may translate into only small reductions in disease.

Consider the simple model shown in Figure 2, where there are three parallel routes by which organisms can be transmitted from one person to another. For the most common (log-linear) type of dose-response relationship, it can be shown, as in Table 6, that elimination of just one transmission route (even the major transmission route) has little impact on disease. Table 6 also shows that elimination of the major transmission route is nevertheless of great importance in reducing disease, since it is only after this apparently ineffective intervention has been undertaken that subsequent interventions (reducing transmission via the other routes) can be effective. In the simple example given in Table 6, the elimination of Route A alone only reduces disease incidence by about one-quarter. However, the importance of eliminating Route A is not this modest direct effect, but rather the fact that its elimination creates conditions that allow subsequent interventions to be much more effective. In the example given, if only Route B were eliminated this would have little impact on disease transmission; whereas if Route B were eliminated after the elimination of Route A, this would have a major impact.

Simple as it is, this model captures some essential features of the real world in which water supply and sanitation interventions operate, and thus has important implications for assessing the impact of such interventions. In the many parts of the developing world where there are several parallel routes for

FIGURE 2. Multiple routes for the transmission of fecal-oral pathogens.

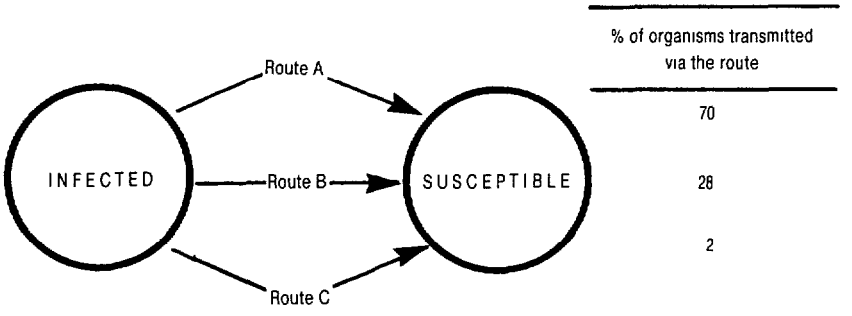


TABLE 6. An example of the effect of eliminating different routes on disease incidence (see Figure 2).

Exposure Group	Proportion of original number of organisms still transmitted	Proportion of original number of cases of disease still incurred
(1) Routes A + B + C	100	100
(2) Eliminate Route A only	30	74
(3) Eliminate Route B without having eliminated Route A	72	93
(4) Eliminate Route B after having eliminated Route A	2	15

effectively transmitting fecal-oral pathogens, it is quite possible that improvements in, say, water supply would have little direct impact on health and yet would still constitute important health interventions. In other words, in these circumstances such improvements are a necessary but not a sufficient condition for substantial disease reduction. As discussed in more detail elsewhere *(26)*, available empirical evidence (including that presented in Figure 1) suggests that this phenomenon is operative in many of the poorer parts of the developing world. Under such conditions, care needs to be exercised before concluding that a water supply or sanitation program was not a justified health intervention because there was little direct impact on disease.

The Relationship of Short-run and Long-run Impacts

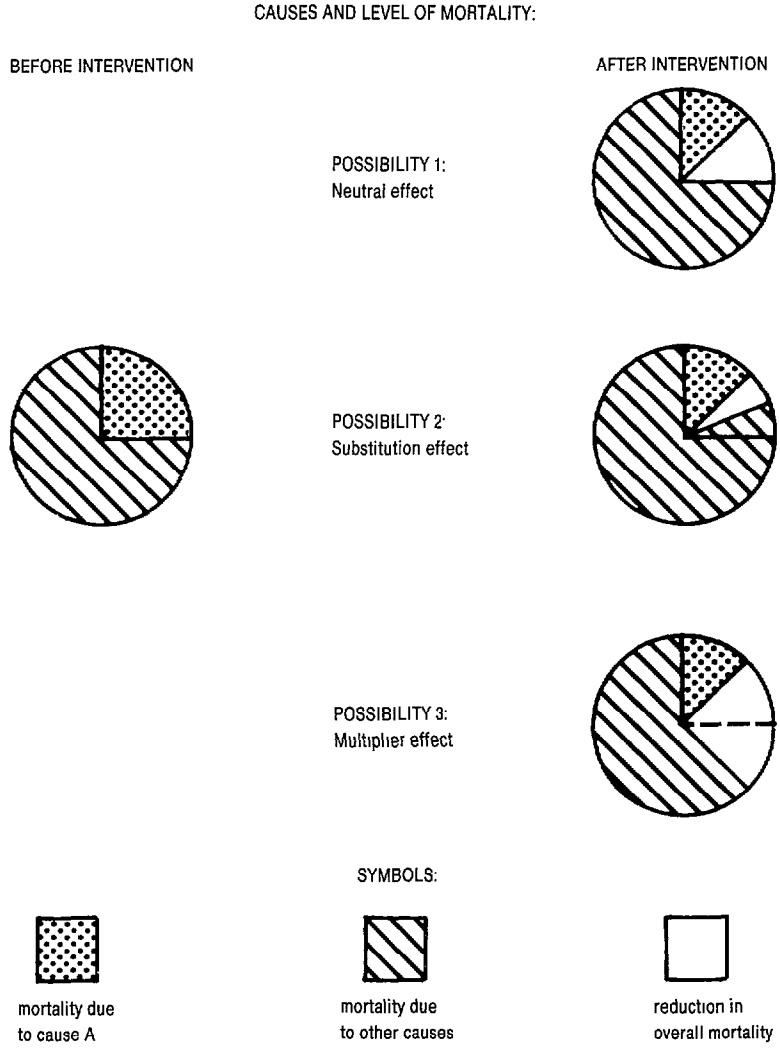
While the objective of child survival programs is (obviously) to reduce child mortality, these interventions are usually evaluated by assessing the impact on morbidity or mortality due to a particular disease. In most such analyses it is assumed that if disease A accounts for 30% of the deaths, and if the intervention reduces deaths due to disease A by 50%, then there will be an overall reduction in mortality of 15% (= 30% × 50%).

As illustrated on Figure 3, however, there are three distinct ways in which such specific interventions may relate to overall changes in child mortality.

A key question in assessing the overall impact of a particular health intervention is whether this type of intervention is one for which the "neutral," "substitution," or "multiplier" effect is operative. Because so few studies testing these hypotheses have been carried out, and because the effect of specific interventions will certainly be different in different settings, any general conclusions must be regarded as extremely tentative. The few relevant studies that are available suggest that measles immunizations may save lives that would be lost not only to measles but also to other causes (that is, the "multiplier" effect is operative), while for oral rehydration therapy in Bangladesh, at least, children whose lives are "saved" may not return to normal mortality risks (that is, the "substitution" effect is operative—*27*).

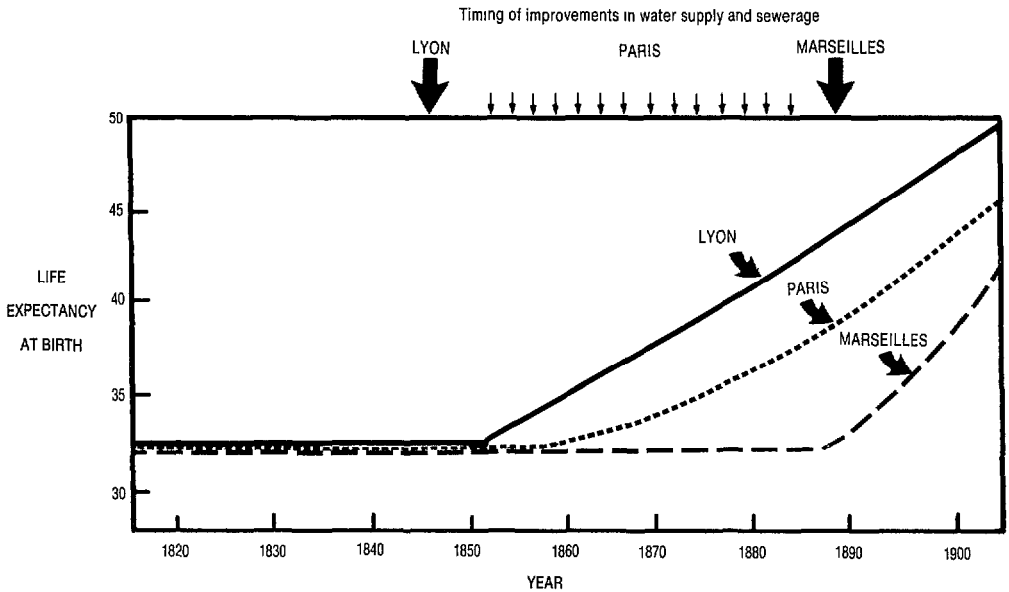
What might the effect for a water supply and sanitation intervention be? There is only one published study (on the causes of mortality declines in ur-

FIGURE 3. Possible impacts upon overall mortality of an intervention reducing mortality due to a specific disease ("cause A") by 50%.



ban France in the nineteenth century—*1*) that furnishes data adequate for testing this hypothesis. The authors of this study have attributed the different mortality patterns in the three cities (shown schematically in Figure 4) to the differences in the dates when water supply and wastewater disposal conditions were improved in each of the cities. An examination of the age-specific and cohort-specific mortality data shows that the patterns are consistent only with the "multiplier" hypothesis and quite different from those which would prevail if the "substitution" or "neutral" hypothesis applied *(28)*.

FIGURE 4. Mortality declines in urban France in the nineteenth century (after Preston and van de Walle—*1*).



Unfortunately, no other similarly rich data sets exist for contemporary developing countries. Although, as with other interventions, the effect of water supply and sanitation interventions would be different in different settings, from the single adequate set of data it appears that water supply and sanitation interventions have a multiplier effect on mortality. The effect of this multiplier effect is illustrated in Table 7, which shows the long-run mortality effects of the ac-

TABLE 7. The effect of different interventions on short-term and long-term mortality (after Briscoe—*29*).

	Intervention type (%):			Impact of B / Impact of A
	None	Type A	Type B	
Deaths averted in youngest age group:				
(a) In initial 15-year period	0	15.5	15.5	1.00
(b) In fourth 15-year period	0	15.5	62.4	4.03
Life expectancy of cohort:				
(a) born in the first period following intervention:				
(i) Assuming that age-specific mortality rates have stabilized 15 years after the intervention	100.0	102.7	103.7	1.37
(ii) Using true mortality rates experienced by the cohort	100.0	102.7	105.4	2.00
(b) born in the last (4th) 15-year period, assuming that mortality rates have stabilized	100.0	102.7	118.7	6.93

tual environmental improvement (Type B) as compared to the effects of another hypothetical intervention (Type A) that would have had the same impact on mortality in the youngest age group in the first period, but which had no increased impact over time and which did not affect the mortality experience of the older age groups.

As is evident from Table 7 (and a more detailed discussion elsewhere—*29*), by not considering whether the effect of a particular program is likely to have a "neutral," "substitution," or "multiplier" effect, the impact of those programs that have a "multiplier" effect (such as, tentatively, measles vaccination and water supply and sanitation programs) may be seriously underestimated; and the impact of those programs that have a "substitution" effect (such as, tentatively, oral rehydration therapy programs) may be seriously overestimated.

Conclusions

The current strategy for the "Child Survival Revolution" gives low priority to improvements in water supply and sanitation, because it has been concluded that these interventions are not cost-effective. The point of this article is that this conclusion is incorrect for the following reasons:

- Because water supply and sanitation projects have multiple impacts, care needs to be exercised in applying conventional cost-effectiveness techniques to such projects.
- Because adequate water supply and sanitation facilities are necessary but not sufficient conditions for improvements in health, the provision of improved facilities may be essential for improving health (by reducing exposure to fecal-oral pathogens) even though this does not have a large, immediate impact on health status.
- The long-run effect on child survival resulting from improved water supply and sanitation conditions is probably substantially greater than would be expected on the basis of an assessment of the immediate effects on diarrheal disease.
- In addition, a review of the immediate impact of water supply and sanitation projects on morbidity due to diarrheal diseases shows that these impacts are usually substantial.

From this perspective, it would appear that there are serious flaws in the analytic methods being used to decide on priorities for child survival activities, and that water supply and sanitation improvements (and other broad-based interventions) have a major role to play in the "Child Survival Revolution."

Acknowledgments

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Summary

It has been argued that investments in water supply and sanitation should not be a major element of primary health care because these are not cost-effective health investments. This article demonstrates that the methodology used to arrive at this conclusion is systematically biased against water supply and sanitation; that such investments may be important for health even if the direct effects are modest; that the long-run effects are substantially greater than the short-run effects; and that, these factors notwithstanding, the short-run impacts of water supply and sanitation improvements on health are usually substantial.

References

1 Preston, S. H., and E. Van de Walle. Urban French mortality in the nineteenth century. *Population Studies* 32(2):275–297, 1978.

2 World Health Organization. *Alma-Ata 1978: Primary Health Care; Report of the International Conference on Primary Health Care, Alma-Ata, USSR, 6–12 September 1978.* Geneva, 1978.

3 Walsh, J. A., and K. S. Warren. Selective primary health care: An interim strategy for developing countries. *N Engl J Med* 301(18):967–974, 1979.

4 Shuval, H. I., R. L. Tilden, B. H. Perry, and R. N. Grosse. Effect of investments in water supply and sanitation on health status: A threshold-saturation theory. *Bull WHO* 59(2):243–248, 1981.

5 United Nations Children's Fund. *State of the World's Children, 1985.* Oxford University Press, Oxford, 1985, 131 pp.

6 United States Congress, Committee on Foreign Relations and Committee on Foreign Affairs. *Legislation on Foreign Relations through 1984.* Section 4 on "Child Survival Fund." Washington, D.C., 1985, p. 23.

7 United States Agency for International Development. *AID Sector Strategy: Health.* Washington, D.C., 1984, 8 pp.

8 Briscoe, J. Water Supply and Sanitation in the Health Sector in the Asia Region: Information Needs and Program Priorities. Document prepared for the Near East and Asia Bureau of USAID. United States Agency for International Development, Washington, D.C., 1985, 46 pp.

9 Adrianza, B. T., and G. G. Graham. The high cost of being poor: Water. *Arch Environ Health* 28:312–315, 1974.

10 Dworkin, D. M., and B. L. K. Pillsbury. *The Potable Rural Water Project in Rural Thailand.* USAID Project Impact Evaluation Number 3. United States Agency for International Development, Washington, D.C., 1980.

11 Cooper and Lybrand Associates. *Egypt Provincial Water Supply Project: Report on a Survey of Consumers' Attitudes to Potable Water.* World Bank, Washington, D.C., 1979, 60 pp.

12 Chetwind, E., and D. M. Dworkin. *Korea Potable Water Systems Project: Lessons from Experience.* USAID Project Impact Evaluation Number 20. United States Agency for International Development, Washington, D.C., 1981.

13 Haratani, J., A. M. Viveros-Long, and A. M. B. M. Gonzales. *Peru: CARE OPG Water Health Services Project.* USAID Project Impact Evaluation Number 24. United States Agency for International Development, Washington, D.C., 1981.

14 Bigelow, R. E., and L. Chiles. *Tunisia: CARE Water Projects.* USAID Project Impact Evaluation Number 10. United States Agency for International Development, Washington, D.C., 1980.

15 Dworkin, D. M. *Kenya Rural Water Supply: Programs, Progress, and Prospects.* USAID Project Impact Evaluation Number 5. Washington, D.C., 1980.

16 Birdsall, N., and F. Orivel. Willingness to Pay for Health and Water in Rural Mali: Do WTP Questions Work? Population, Health and Nutrition Department. World Bank, Washington, D.C., 1983.

17 Institute of Medicine. *New Vaccine Development: Establishing Priorities; Volume I: Diseases of Importance in the United States.* Washington, D.C., 1985, pp. 17–27.

18 Chen, L. C. Control of diarrheal diseases morbidity and mortality: Some strategic issues. *Am J Clin Nutr* 31:2284–2286, 1978.

19 Esrey, S. A., R. G. Feachem, and J. M. Hughes. Interventions for the control of diarrhoeal diseases among young children: Improving water supplies and excreta disposal facilities. *Bull WHO* 63(4):757–772, 1985.

20 Aziz, K. M. A., K. Z. Hasan, K. M. S. Aziz, and M. M. Rahaman. Behavioural Changes in Water Use Following Health Education in a Rural Area of Bangladesh. In: International Center for Diarrheal Disease Research. *Proceedings of the Second Asian Conference on Diarrhoeal Disease.* Dhaka, Bangladesh, 1983.

21 Feachem, R. G. Interventions for the control of diarrhoeal disease among young children: Promotion of personal and domestic hygiene. *Bull WHO* 62(3):467–476, 1984.

22 World Bank. Measurement of the Health Benefits of Investments in Water Supply. Report of an Expert Panel, PUN Report No. 21. World Bank, Washington, D.C., 1976, 12 pp.

23 Blum, D., and R. G. Feachem. Measuring the impact of water supply and sanitation investments on diarrhoeal diseases: Problems of methodology. *Int J Epidemiol* 12(3):357–365, 1983.

24 Briscoe, J., R. G. Feachem, and M. M. Rahaman. Measuring the Impact of Water Supply and Sanitation Facilities on Diarrhoea Morbidity: Prospects for Case-Control Methods. Mimeographed documents WHO/CWS/85.3 and CDD/OPR/85.1. World Health Organization, Division of Environmental Health and Diarrhoeal Diseases Control Programme. Geneva, 1985, 71 pp.

25 Young, B. A., and J. Briscoe. Health Impact Evaluation of the Malawi Rural Water Supply: A Case-Control Study of Diarrhea. Report to USAID and the Government of Malawi. United States Agency for International Development. Lilongwe, 1986.

26 Briscoe, J. Intervention studies and the definition of dominant transmission routes. *Am J Epidemiol* 120(3):449–455, 1984.

27 Mosley, W. H. Child survival: Research and policy. In: W. H. Mosley and L. C. Chen (eds.). Child survival: Strategies for research. *Population and Development Review* 10(suppl):3–22, 1984.

28 United States Agency for International Development. Water Supply and Sanitation in Child Survival: A Report to and Discussion by an Expert Panel. Washington, D.C., 1985, 26 pp.

29 Briscoe, J. Evaluating water supply and other health programs: Short-run vs. long-run mortality effects. *Public Health (London)* 99:142–145, 1985.