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Water, sanitation and hygiene for the health of developing nations☆

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Summary The water and sanitation needs of the poor in developing countries are huge. To meet the target of water and sanitation for all by the end of 2025, some 2.9 billion people will have to receive improved water supplies, and 4.2 billion improved sanitation. The technologies used must be appropriate and, in particular, simple, affordable and sustainable.

Introduction

Terms like 'water crisis' and a 'water-short' world are now in common usage, but we actually live in a 'water-desperate' world. Many of us who live in industrialized countries are 'water rich', but there are many millions of us in developing countries who are 'water poor' and, in fact, 'water desperate'. The global statistics are simply horrific: at the end of 2000, there were around 1.1 billion people (18% of the world's population) without adequate water and 2.4 billion people (40%) without adequate sanitation.[1]

One of the millennium goals is to reduce by half the number of people without adequate water supplies by the end of 2015,[2] and the same goal for sanitation was recently added at the Johannesburg Earth Summit.[3] However, the World Health Organization and UNICEF are advocating a target of water and sanitation for all by the end of 2025; to meet this target, some 2.9 billion people will need improved water supplies, and an almost unbelievable 4.2 billion people will need improved sanitation.[1] These figures translate into 310,000 people needing improved water supplies and 460,000 people needing improved sanitation per day during the 25 years to 2025. We should be able to meet the water target—we did better in the 1980s—but there is almost no chance that we will meet the sanitation target.[4]

So the world is not doing well in water supply and sanitation, and consequently not well in personal and domestic hygiene. However, our knowledge is great. Even so, there is a major problem: too few professionals in both tropical public health engineering and tropical public health medicine have (and even fewer apply) this knowledge. My eclectic historical review of relevant knowledge covers four major 'milestones' in our understanding of the relationship between water, sanitation and hygiene on the one hand, and health on the other. The first milestone is the following quotation from Hippocrates, who lived in the fifth and fourth centuries BC: "My other topic is water, and I now

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wish to give an account both about waters that cause disease and about those that are healthy, and what bad things arise from water and what good things. *For water contributes very much to health*"[5] (emphasis added).

The next three milestones are more recent: two from the 19th century and one from the 20th century:

(a) Chadwick's 1842 'Report on the Sanitary Condition of the Labouring Population of Great Britain';[6]
(b) Snow's 1855 book 'On the Mode of Communication of Cholera';[7] and
(c) White, Bradley and White's 1972 book 'Drawers of Water',[8] in which David Bradley developed his environmental classification of water-related disease.

Chadwick's report recognized that an absence of adequate water and sanitation in urban areas leads to disease on a massive scale, and this was the rationale for the UK Parliament passing The Public Health Act of 1848, which in turn led to the watering and sewering of British towns and cities in the 19th century. Snow's book was a landmark: in it he demonstrated, through careful epidemiology, the waterborne transmission of cholera. Bradley's environmental classification of water-related disease shows that waterborne transmission is just one of four water-related transmission routes; one of the other three is the water-washed route—a hugely important concept which tells us that water quantity and personal and domestic hygiene are more important than water quality in reducing the incidence of faeco-oral disease.

Faeco-oral diseases are still a major killer today: roughly two children under the age of five years die from diarrhoeal disease every minute of the year in developing countries. In more general terms, diseases due to deficient water supplies, deficient sanitation and deficient hygiene together are responsible for 7% of all deaths and 8% of all disability-adjusted life years (DALYs) lost in developing countries—second only to malnutrition, which is responsible for 15% of all deaths and 18% of all DALYs lost.[9] They are still major killers because so many people in the world today are without adequate water and sanitation.

Diarrhoeal disease has an additional insidious effect of horrific global dimensions, which we are only just beginning to understand: diarrhoea in infancy is associated with poor cognitive function in later childhood.[10] The macro-economic implications of this for developing countries are huge: they will continue to have many millions of poorly educated workers unable to contribute their full potential to development. This will only cease when faeco-oral disease in infancy is effectively controlled to the point where its incidence is minimal.

The macro-economic toll of water- and excreta-related disease is almost incredibly high. Data for 1979[11] (and there seem to be no more recent data) show that, in that year, some 360–400 billion working days were lost in developing countries due to water- and excreta-related diseases that kept people from work. Valuing these days lost at only US$ 0.50, developing countries lost some US$ 180–200 billion. Their GNP was around US$ 370 billion in 1979, so output was below potential production by as much as 33–35%. The cholera epidemic in Peru in 1991 provides another good economic example: 350,000 people became infected, and the total cost of the epidemic (due to lost tourism, lost agricultural exports and absences from work) has been estimated at US$ 500 million[12]—more than had been invested in the country in water supply and sanitation improvements during the previous 10 years, which were ironically the years of the International Drinking Water Supply and Sanitation Decade.

Improved water supplies and sanitation

The types of water supply and sanitation technologies that we have developed in the UK and other industrialized countries are inappropriate for the 2.9 billion people needing adequate water supplies and the 4.2 billion people needing adequate sanitation by the end of 2025. They are inappropriate because they are too expensive to use in poor communities in developing countries, and because the water they need is not available to poor communities, and even if it were, they could not afford it.

The technologies to be used in peri-urban and rural areas have to be suitable for poor people—2.8 billion people (nearly half the world's population) live on less than US$ 1/day.[13] So above all, these technologies must be both low cost and affordable. They must also be socioculturally acceptable to their users. In rural areas, community participation in planning, design, implementation and operation is essential for a water supply and sanitation project to succeed. Both women and men need to participate in this process. In fact, operation and maintenance (O & M) are best completely devolved to the local level; generally

village-level O & M for water supply and household-level O & M for sanitation, with good support (e.g. training, supply of spare parts) from a local governmental or non-governmental agency. The lead British agency in rural water supply and sanitation in developing countries is WaterAid, which is active in nine countries in Africa and four countries in South Asia. WaterAid's philosophy is to help people to help themselves, and its work is most commonly done in association with local non-governmental organizations, supporting these to support the local people.[14]

Rural water supply and sanitation is essentially simple engineering but much less simple sociology, and there needs to be a good and sustained programme of hygiene education so that people with an improved water supply and improved sanitation know how to use them to maximize the benefits to their health. The technologies are very simple (at least in comparison with those in industrialized countries and even in urban areas of developing countries)—for example, handpump supplies (about which we now know much more as a result of the handpump testing programme undertaken by the Consumers' Association for the World Bank[15]) and gravity piped supplies (the best model for which is that developed, with UK government support, in Malawi[16]). Improvements in water quantity, availability, reliability and (consciously in last place) quality are required to minimize the water-washed transmission of faeco-oral diseases, but it is not necessary, from a purely public health perspective, to have a 'Western' water supply, i.e. excessive quantities of very high quality water that is always and reliably available to users. What is needed is a greater quantity of better (certainly not lower) quality water which is reliably more available.[17] We should remember Voltaire's dictum: "the best is the enemy of the good"[18] (alternatively: "half a loaf is better than no bread"). We need to reduce the long water collection journeys that women and girls undertake each day in all parts of the developing world; water collection should take no more than ~30 min as the volume of water falls sharply if more than 30 min are needed.[19] So the water should be brought to within this collection journey time, although, of course, if women are spending several hours a day collecting water, they will welcome any reduction. The availability of tricycle carts generally encourages boys to collect the water, thus freeing time for their mothers to devote to more productive uses.

Rural sanitation technologies are simple, affordable and easy to design so that they are socioculturally acceptable. Examples are ventilated improved pit latrines and pour-flush toilets, the latter being especially suitable where water is used for anal cleansing; both can be designed for either sitting or squatting, whichever is the locally preferred position for defecation. Full details are given on the Sanitation Connection website.[20]

In contrast, peri-urban water supply and sanitation is less simple engineering but generally simpler sociology; these also require good and sustained hygiene education. In addition, a sensible tariff structure is needed to encourage full cost recovery. Peri-urban areas generally cover two types of settlement: legal and illegal settlements. The former are low-income areas where people have legal title to the land they occupy; the latter are slums or shantytowns where the people do not have legal title. The solutions for these two types of peri-urban settlement are different, as urban water supply and sanitation authorities generally will not install services for individual households which they view as temporary phenomena (despite many being de facto permanent settlements, in the sense that the slum or shantytown may have existed for many years, even decades). Thus the solution is commonly communal water points—often kiosks where people buy water by the bucketful at a very high unit price—and (maybe) communal sanitation blocks. Even where such interventions have taken place, the service remains unsatisfactory (better than nothing certainly, but still unsatisfactory). Clearly, better solutions need to be found and tested, and organizations like WaterAid have recently begun to work towards the provision of better services in these 'illegal' peri-urban areas, including their legalization and granting of land tenure.[21]

In legal low-income peri-urban areas, water and sanitation engineering is less complicated than in slums and shantytowns. Low-cost extensions to the urban water reticulation system can serve these areas, either by individual on-plot connections (i.e. one tap per household) or by 'standpipe co-operatives' (i.e. one tap per 5–10 households). Such supplies are best not metered; each household pays a 'minimum tariff' based on an assumed water consumption of 10–15 m^3/household/month (or more if the supply is to an extended family compound). Generally, the payment for this level of improved supply is, in fact, much lower than the amount paid to water vendors for smaller quantitie of water. However, with sanitation in legal peri-urban areas, there is an apparent institutional difficulty; urban water and sewerage authorities are reluctant (generally to the point of refusal) to

become involved with on-site sanitation, as this is 'not their job', and it is normally left to the city or town council's environmental health department to set up an on-site sanitation programme. The problem is that almost no local environmental health department has the experience to do this on the scale needed in its area of jurisdiction, and the result is often piecemeal solutions by local non-governmental organizations that are not co-ordinated across the town or city as a whole, and many peri-urban communities remain unserved. Simplified sewerage is a better solution and one which is acceptable to local water and sewerage authorities simply because it is a sewerage system, albeit a low-cost one.[22,23] Simplified sewerage is basically conventional sewerage stripped down to its hydraulic basics, i.e. with none of the now very conservative rules-of-thumb of the latter—for example, 100-mm-diameter PVC sewers laid at a gradient of only 1 in 200 can serve up to 234 households of five persons, each with a water consumption of 100 l/day; in contrast, in the UK, 100-mm-diameter sewers can only serve up to 10 houses.[24] Simplified sewerage was developed in the early 1980s in North-east Brazil to serve low-income peri-urban areas, for which conventional sewerage would have been far too expensive.[25] However, CAESB, the water and sewerage company for Brasília and the Federal District, now uses simplified sewerage in all areas—both rich and poor alike—for the very low capital cost of only US$ 22–34/person. (Rich areas in Brasília are very rich indeed, even by the standards of the industrialized world.) Actually Chadwick, as long ago as 1852, recommended that what he termed 'backyard tubular drainage' be used in preference to the conventional sewer design and layout of that time,[26,27] and his system is identical to simplified sewerage as we know it today. As Britain ignored Chadwick's recommendation (probably because he was a lawyer and not an engineer), the rest of the developing world had to wait 130 years for it to be 're-invented'.

Concluding remarks

We have the technologies to supply water and sanitation to everyone. The technologies are simple, appropriate, effective and affordable. We have the money to do this, but we choose to spend it on other things. Currently, the world spends around US$ 30 billion/year on water and sanitation in developing countries, but the same amount again is needed to meet the target of water and sanitation for all by 31 December 2025, with most of this additional money going to sanitation.

If the nations of the world do meet this target, it will be one of the most important contributions ever made to the health of nations. The water target can be met—more people were supplied with water per day during the International Drinking Water Supply and Sanitation Decade (1981–1990) than the number required each day of the current quarter century. But the sanitation target (4.2 billion people to have adequate sanitation) is almost certainly too great, and the faecal peril is likely to remain in developing countries to continue to threaten the health of the poor and the very poor in this grossly unequal world well into the next quarter century.

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