Semana temática: Agua para la vida. Tribuna del agua.

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Título de la ponencia: *Interventions to reduce water and excreta related infections in low income settings*

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Resumen:
Limited access to water and excreta disposal facilities (sanitation) are associated with diarrhoea, intestinal worm infection, schistosomiasis, trachoma and many other conditions. Evaluating the health impact of water, sanitation and hygiene interventions is difficult. Even randomised trials have at times spectacularly failed to provide unbiased estimates. Estimates of non-health benefits and potential adverse effects in addition to the health impact data are therefore crucial for decision making. From this perspective, access to adequate water quantity and sanitation have the highest priority. Low cost technologies are needed, as the wasteful approaches in industrialised countries are unaffordable and probably unnecessary in many poor settings. The failure rate of sanitation interventions is high. Successful sanitation interventions are characterised by strong political support, local leadership and community mobilisation, while only relying on limited subsidies.

Such interventions can be complemented by the (mass media) promotion of personal hygiene (e.g. handwashing) which may provide additional health benefits. However, actual behaviour change has proved difficult in the absence of improvements in water access and sanitation. Point-of-use (household) water treatment has been advocated as a very effective means to reduce diarrhoea, but - as with hygiene interventions - the estimates from randomised controlled trials may to a large extent be exaggerated, while acceptability among poor populations remains low.

Palabras clave: public health interventions, sanitation, water, hygiene, diarrhoea

Introduction

Water supply and excreta disposal (sanitation) are key determinants, perhaps *the* key determinants of health, a fact that in industrialised countries is often only recognised once either of the two has broken down. In many developing countries, and in many low income settings within middle or high income countries, water supply and sanitation facilities do not meet the needs of the population, and are not only a sign of poverty, but also a cause of it, by contributing to child mortality and malnourishment as well as social and economic inequality. Water supply usually receives a lot more attention than excreta disposal. This does not mean that (at least in dense populations) excreta disposal is not equally important for health. Water supply and excreta disposal are in fact so closely linked with regard to disease transmission that from the epidemiological perspective it is impossible to treat them separately.

Water and sanitation related diseases and how they spread

A wide range of diseases are associated with inadequate water supply and sanitation. The vast majority of them are infectious diseases. An overview of major water and excreta related infections is shown in table 1.

Table 1: Major diseases and conditions related to inadequate access to water and sanitation.

Disease / pathogen	Assumed predominant route of transmission
Diarrhoea (viral, bacterial, protozoal)	*Person to person, soil-person, drinking water, food, flies*
Typhoid fever	*Person to person, drinking water, food, flies*
Cholera	*Person to person, drinking water, food*
Polio	*Person to person*
Intestinal worm infections (Ascaris, Hookworm, trichuris etc…)	*Soil to person (oral or through skin)*
Schistosomiasis	*Through skin in contaminated water*
Guinea worm	*Drinking water*
Trachoma	*Flies, person to person*

From: Chin J et al.: Control of Communicable Diseases Manual[1]

Most of these diseases can either kill or cause chronic illness, malnutrition and cognitive deficits, especially in children. Malnutrition leads to a reduced immune function and therefore increased susceptibility to many other diseases, most importantly pneumonia, perhaps the leading cause of death in children worldwide. Because of the inter-connectedness of these conditions and the multiple pathways by which water and excreta related infections spread it may be virtually impossible to estimate (1) the true burden of water and sanitation related diseases with sufficient accuracy and (2) the true effect an intervention can have to reduce these conditions.

The different pathogens differ in terms of the preferred route of transmission. They can be spread by person to person contact as is the case for most diarrhoea-causing pathogens, skin infections, and perhaps worm infections. An important route is via the contact with contaminated soil and

surfaces which is the main route for intestinal worm infections such as ascaris or hookworm, but also many diarrhoeal pathogens. Drinking contaminated water can lead to ingestion of pathogens particularly those causing typhoid fever and cholera but also many other intestinal pathogens. The importance of this water borne transmission route, historically perhaps the most infamous, has in recent decades been subject to intense debate.[2-4]

Food is regarded as an important pathway especially for bacteria causing diarrhoea. Interestingly, research has shown that most contamination of food takes place not in the fields (even if the fields are irrigated with waste water), but in the markets and within households, aided by the transmission of faecal matter by flies.[5] Flies are potentially important vectors of disease transmission for diarrhoeal pathogens and trachoma.[6] Schistosomiasis, a chronic worm infection leading to the destruction of vital organs like the liver and the urogenital tract, exerts a heavy burden of disease in hot climates, and is transmitted by skin contact with water contaminated with faeces and urine (via a complicated life cycle involving fresh water snails).

Interventions to reduce the burden of water and excreta related diseases.

There are many possible ways to reduce water and excreta related infections. In this paper I will focus on four major intervention types: 1) Interventions to increase the water quantity available to households, 2) interventions to improve sanitation, 3) interventions to promote hygienic behaviour, 4) interventions to improve water quality at the point of use.

As can be seen from Figure 1, these interventions are not independent of each other. Insufficient amounts of water make it very difficult for households to maintain hygiene and cleanliness, thus facilitating person to person spread of pathogens and the transmission of pathogens from the environment (for example the soil or other surfaces). Therefore, improving access to water should contribute to reducing diseases which are spread by person to person and soil to person contact by enabling people to be hygienic. Sanitation also facilitates hygienic behaviour and has the potential to reduce the contamination of water supplies, thereby improving water quality by breaking the cycle of pathogen transmission between people via drinking water. In contrast, hygiene promotion on its own does not improve sanitation nor does it increase water availability (although it may increase demand for it – a key aspect of sanitation interventions, see below). Likewise, point-of-use water treatment, a topic that has gained widespread attention in recent years, does not contribute to increasing water quantity or improving sanitation. Thus there is a clear hierarchy among the interventions described in this paper. Without access to sufficient water and sanitation, most other measures to reduce water and excreta related infections are – in theory – unlikely to make an impact.

Figure 1: Possible ways to interrupt transmission pathways
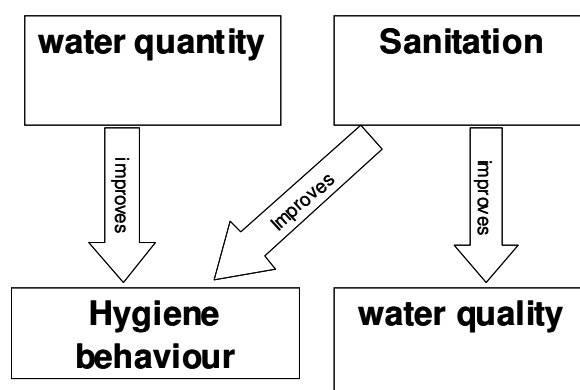
Before the four interventions are described in more detail, I will briefly describe briefly the methodological problems of evaluating these interventions with regard to their health impact. Health impact data are frequently cited to justify a particular intervention, often influencing policy decisions without taking into consideration the validity of such data.

Evaluating the health effect of water and sanitation interventions

Evaluating the health effect of water and sanitation interventions is problematic.[7] Many interventions cannot be allocated at random – for ethical or practical reasons. It is therefore often not possible to use a randomised controlled trial design, often regarded as the "gold standard" to evaluate the effect of environmental health interventions. But even if an intervention can be evaluated using a randomised trial, this does not mean that the result will be unbiased. Randomised controlled trials work well if the treatment and the outcome assessment can be blinded both from the study participant and the observed. If blinding is not possible as is the case with many environmental health interventions such as latrines or water supply, randomised controlled trials still can provide largely unbiased estimates if the outcome is an objective measure such as weight gain, presence of worm eggs, trachoma infection (assessed by a blinded observer) or – death. In contrast, randomised controlled trials using a more subjective outcome measure, such as self-reported symptoms of gastro-intestinal or respiratory infections usually do not provide an unbiased estimate. In fact, if the interventions are closely linked to social status and carry moral connotations, as is the case with many water, sanitation and hygiene interventions, they are particularly prone to responder and observer bias. Study participants in the intervention arm then have a strong incentive to under-report disease for fear of being seen as non-compliant. Those in the control arm have incentives to over-report disease because they may want to gain access to the intervention. Also, control group individuals tend to be lost to follow up more often, especially those of lower socio-economic status and education who may have a particularly high risk of disease. Another source of bias could come from over-enthusiastic field workers who for passion or the sake of job security want to demonstrate the effectiveness of an intervention.

In addition, most studies in the field of environmental health are conducted by researchers involved in political decisions around choice, scaling up and implementation of interventions. It would be naïve to assume that this does not affect the outcome of a study or the presentation of its results. There is overwhelming evidence that source of funding and conflicts of interests have a strong impact on results of randomised controlled trials.[8]

For these reasons, it can be argued that the term "gold standard" for randomised unblinded studies on environmental health interventions using subjective outcomes is misleading and should be avoided. Other study designs, such as observational cohort studies or case-control studies are unlikely to produce more reliable estimates. In general, the flexibility in study design, choice of outcome measures and assessment procedures in environmental health intervention is huge which on its own often leads to false positive results of a study or to vastly exaggerated estimates.[9] Any inference from studies in the sector can therefore only be made with a great deal of caution. Future studies should make every attempt to move away from subjective outcomes and focus on objective outcomes that really matter, most importantly nutritional status and mortality. In the meantime we have to make decisions regarding the benefits of interventions in the absence of reliable health impact data. Non-health benefits, such as savings in time and money, gain in social status, education and promotion of gender equality should therefore be given at least as much emphasis as potential health benefits.[10] Non-health benefits must be weighed against potential adverse effects. If a benign intervention is implemented on a false health premise, the principal harm lies in the waste of resources. In many circumstances choosing one intervention may distract funding and attention from others that are potentially more effective.

Water and sanitation interventions: health impact and non-health benefits

1) Increasing water quantity

Access to sufficient quantities of water has been a (perhaps *the*) driving factor in the development of human settlements over the millennia. Without sufficient water, it is very difficult to maintain personal hygiene, regarded as a key factor for health.[11] The effect of improving water access for use in the household on health is very difficult to measure.[10] However, what matters most for populations affected by water scarcity at the household level are not health considerations, but the enormous non-health benefits of having easy access to water. Water supply saves hours of drudgery carrying water, and is an important contribution to the emancipation of women. A World Bank study found that in most settings, investment in a high level of water supply service (house connections) could be amply justified by the value of the time savings alone, without considering the health impact at all.[12]

As a rule of thumb, water consumption will increase the closer the water source is to the home, but this association is far from linear. As shown in Figure 3, water consumption remains low if the water source is further away than say 5 or 10 minutes.

Figure 2: Time needed to collect water (minutes) and level of consumption (litre consumption per day)
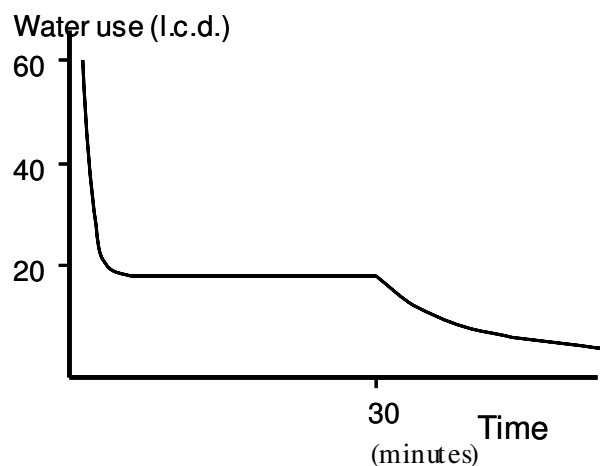
Source: Cairncross S, Feachem R 1993. Environmental Health Engineering in the Tropics; an Introductory Text. 2nd edition. Chichester: John Wiley & Sons, p. 63

There is also evidence that the increased water consumption due to easier access does lead to better hygiene behaviour. Table 2 show the results from directly observed hygiene behaviour in 10 Indian villages. Households with water in the home practised much more handwashing with soap than others, an association which was independent of socio-economic or educational factors. To conclude, adequacy of water supply is first of all a function of the distance to the water source. According to the scarce epidemiological evidence water quality considerations are secondary to this aim.[11] This is not to dispute that water can be an important carrier of pathogens and quality should therefore not be neglected, once sufficient water quantities are assured. However, as discussed above, water is just one among many transmission routes most of which are

independent of water quality. The impact of improving water quality on health may be more limited than often assumed.

Table 2: water access and hygiene behaviour in 10 Indian villages

Water source	Hand washing with soap after contamination
House	15%
Yard	9%
Elsewhere	5%

(Biran A, personal communication)

2) Sanitation

Excreta disposal (sanitation) has received less attention than water in recent decades.[13] On the grounds of biological plausibility however, sanitation should be as important or even more important than water access in reducing disease transmission. Sanitation removes faecal matter, a chief reservoir of pathogens, from the environment. It therefore facilitates maintaining a clean house and surroundings, and if implemented well, can also prevent contamination of water sources. A clean environment can also reduce the breeding sites of flies that have been shown to transmit diarrhoea pathogens and trachoma.[6;14] Sanitation should therefore contribute to the prevention of most diseases listed in table 1. There is some epidemiological evidence that this is in fact the case,[14-16] and little evidence to the contrary. For householders however, it is again the non-health benefits such as privacy, convenience, social status and re-use of waste in agriculture that matter most. Sanitation can also contribute to education as it has been shown that many girls temporarily stay away from school due to an absence of sanitation facilities.[13] In many settings where open defecation is still the norm, women are not supposed to defecate during daylight hours, with many adverse consequences in terms of convenience, health, and security when they do so during darkness.

There are many different techniques of sanitation ranging from simple pit latrines, pour-flush toilets, septic tanks and ecological sanitation to sewerage connected flush toilets (Figure 4). However, many sanitation campaigns have failed especially if delivered in a top-down fashion.[13] Successful campaigns have been characterised by strong and sustained political and community support, identifying what people want, building up of local businesses providing construction and services, and efforts made by energetic individuals with influence in the communities. Subsidies have only played a minor role in many successful programmes, but could be useful if specifically targeted at the very poor.[13]

There are no simple sanitation solutions. Importantly, programmes need to create a demand for sanitation, which especially in rural areas is not always present. In some rural settings with low population density, especially in hot and dry climates, open defecation may not only be the cultural norm but from the public health perspective may be as safe as improved sanitation (unless Trachoma is a public health problem). Here other public health or development measures may be of higher priority than sanitation.

Lack of demand and focus on one-size-fits-all technical solutions will almost inevitably lead to programme failure. In many ways, water supply and sanitation interventions require quite different approaches in many settings. Although not without problems, water supply is more

suitable for strong government leadership and control, top down implementation and sustainable maintenance and repair than sanitation. Thus, while water supply and sanitation are closely linked in terms of disease transmission, it may make sense in many low income settings to treat them as separate issues for implementation purposes.[13]

Figure 3: Examples of excreta disposal methods
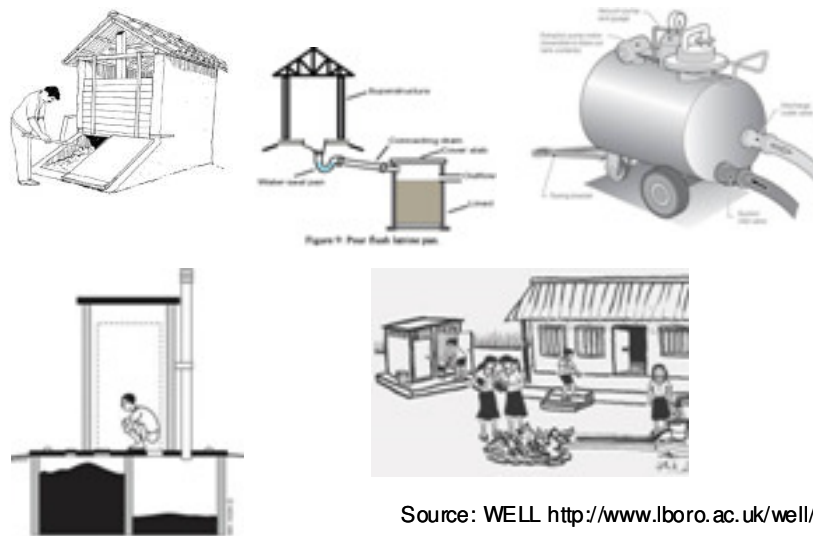
Source: WELL http://www.lboro.ac.uk/well/

Clockwise: ecological sanitation (solar desiccation), pour flush toilet, suction unit for pit emptying, school sanitation, ventilated pit latrine

3) Personal hygiene and hand-washing

A number of randomised controlled trials using reported disease signs and symptoms as primary outcomes have suggested that simple handwashing with soap can reduce the incidence or prevalence of diarrhoea and respiratory illnesses by up to 50%.[17] The figures have propelled hand washing to the top of the list of recent estimates of the cost-effectiveness of health interventions,[18] and have received widespread attention among donor organisations, governments and academia. Some public health experts hope that handwashing with soap may offer a "short cut" – a low cost solution that works even in the absence of political will to tackle the big and more costly problems like water access and sanitation.[19]

However, estimates that simple handwashing with soap can reduce diarrhoea and respiratory infections by large amounts need to be treated with caution. For reasons outlined above, there is perhaps no other intervention with such large potential for bias in self reported illness as hand washing promotion. Also, none of the published studies on handwashing have included hard, objective outcomes such as weight gain, growth or mortality.

Biological plausibility has been employed to explain the large disease reductions measured.[20] However, transmission of diarrhoea pathogens occurs through a complex interaction between individuals and between individuals and the environment, with countless of opportunities for infection every single day. The dominant risk factor for pneumonia is malnutrition – with this in mind how can simple hand washing a few times a day cut pneumonia risk by half as suggested by

one of the largest and most cited handwashing studies?[20] Overall, biological plausibility speaks against, rather than in favour of a large disease reduction through handwashing.

On the other hand, even if the reduction of diarrhoea and other diseases through hand washing with soap is much more modest than current estimates suggest, say around 10% to 15%, it would still be a very cost-effective intervention, since it can be promoted by mass media or integrated in other community health promotion activities along with other hygiene measures such as disposal of child faeces, food hygiene or domestic hygiene. Hand-washing promotion is therefore unlikely to divert large funds from other, possibly more effective interventions. However, there should be no illusions regarding the effect handwashing campaigns may have in the absence of water and sanitation interventions.

4) Point-of-use water treatment

Point-of-use (household) water treatment is an area that recently has received a lot of attention, especially among charity organisations, international health agencies and industry. Many different techniques for use in the household have been tried in field studies such as filtration, bio-sand filtration, chlorination, flocculation, and solar disinfection.[21] Systematic reviews have suggested that these methods can reduce diarrhoeal disease by 30% to 40%.[21;22] However, it can be argued that not enough attention has been paid to potential biases. First, in household water treatment a number of commercial interests are involved, which on its own makes it more likely that the results are exaggerated.[8] Since few of the studies included in recent reviews have been blinded,[21;22] the current estimates are likely to be strongly influenced by bias as discussed above. A study recently conducted by the Centre for Disease Control (USA) in Ghana using placebo controlled water treatment found no effect on diarrhoea morbidity. An unblinded study of reverse osmosis filtration conducted in Canada found a 30% reduction in self reported diarrhoea but no effect on health care seeking due to diarrhoea (a more objective measure), which again strongly suggests that the reported diarrhoea can be highly biased.[23]

The decision to promote widespread adoption of household water treatment and encourage households to spend money on it is a difficult one. It could have the unintended side effect of making provision of an adequate water supply appear like a private household problem, rather than a public good in which governments need to invest. Based on the rather optimistic conclusions currently drawn from the available evidence on household water treatments,[24] governments may gain the impression that their role in water supply is limited, even if health agencies like WHO emphasise the important role of adequate water supplies.[24]

Also, there is ample evidence of faecal contamination of drinking water during storage in the household.[25;26] Safe water handling and storage practices to prevent this can be promoted that require little investment from households. In other words, there can be little harm in promoting them. The question the research should attempt to answer is whether purchasable products to improve water quality (like chlorine, flocculants/disinfectants or filters) provide a health benefit *in addition to* safe water handling and storage, or perhaps solar disinfection. The vast majority of published studies do not address this question but rather: 'Can product X reduce diarrhoea compared to households that don't treat their water at all?' It is not objectionable that industry is interested in funding only studies of this kind. However, researchers and public health policy makers need to take into account that commercially viable interventions have a much greater chance of appearing beneficial than interventions not involving a commercial interest. Due to lack of funding non-commercial alternatives may not have even been tested at all. Finally, studies have shown that acceptability of many household water treatment products among poor people is low.[27]

For these reasons, it appears premature to promote household water treatment on a large scale, especially since it does not have any immediately apparent additional non-health benefits – in striking contrast to water access and sanitation, and perhaps even hygiene.

Conclusion

To reduce the burden of water and excreta related infections the top priorities in most settings remain access to sufficient quantities of water and to sanitation. Other priorities, such as hygiene promotion and water quality are likely to make a significant impact only if issues of water access and sanitation are adequately dealt with, taking into account local preferences and demand.

An important issue faced by many (although not all) low income countries, especially in Africa is that current water and sanitation efforts barely keep up with the ongoing population growth. For a variety of political, religious and other reasons, family planning has been a neglected field in recent years. Even among public health scientists there seem to be many misconceptions and reservations. However, research has shown convincingly that family planning – if promoted adequately – is not only feasible and acceptable among poor populations, but can also contribute to reducing child and maternal mortality as well as promoting economic development, gender equality and education.[28] Since population growth is perhaps the most important driver of environmental degradation and over-exploitation of resources, stabilisation of populations should in the long term also have a role in making water and sanitation efforts (which critically depend on space and the environment) less of an uphill struggle. This long term perspective does not diminish the fact that major investment in water and sanitation are needed now.

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