IMPROVING PERSONAL AND DOMESTIC HYGIENE:

Does it reduce diarrhoeal disease?

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To all my classmates.

It was a great honour

to learn with them.

And from them.

It is better to be healthy than ill or dead.

That is the beginning and the end

of the only real argument for preventive medicine.

It is sufficient.

(Geoffrey Rose, 1992)

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1. INTRODUCTION

1.1 DIARRHOEA DISEASE: MAGNITUDE OF THE PROBLEM

There are 631 million of under five children in the world (The World Bank, 1993); of these, 522 million (83%) live in Demographically Developing Countries (DDC).
Each of these children experiences an average of 2.6 episodes of diarrhoea per year (Bern et al, 1992), which means a global total of 1.35 billion of diarrhoeal episodes every year in DDC.
The incidence is different in the various segments of the childhood, ranging from 1.0/child/year in the 4-5 aged to 4.6 in the 6-11 months aged. (Fonck, 1993).

Many would argue these figure are too low.
Kirkwood (1991) calculated a median of 4.9 episodes per child, which would bring the annual total to 2.5 billion.
In another review (Huttly, 1990) incidence estimates based on more than 350 cross-sectional surveys in 70 countries have yielded a global median incidence rate of 3.4 episodes/child/year.

The diarrhoeal mortality rates have been estimated 18.5/1000 live births in infants and 8.9/1000 in child aged 1-4 years (Fonck, 1993), which brings to 3.2 million the total of under five who die of diarrhoea every year in Developing Countries.
This is lower than the 1982 estimation of 5 million (Snyder & Merson, 1982), but still account for one quarter (24.8%) of all the deaths in Developing Countries. (Tulloch & Richards, 1993)

In the review previously mentioned, Huttly (1990) calculated a mortality rate for diarrhoea of 12/1000 under five/year, which, based on demographic data 1989, accounts for 4.82 million diarrhoea associated deaths, i.e. 35.8% of all the deaths in under five children in the period 1981-86.

However different, all the figures emphasise that diarrhoeal disease is an incredibly huge problem in Developing Countries. When morbidity and mortality are combined (The World Bank, 1993), diarrhoea account for 16.2% in females and 15.7% in males of the total Disability Adjusted Life Years (DALYs) lost in < 5 aged, ranking in third place after respiratory infections and perinatal diseases.

It is universally accepted that diarrhoeal mortality has been declining in the last 20 years, whereas morbidity is by and large at the same levels. (el Rafie et al, 1990) Although not supported by wide scientific evidence, Oral Rehydration Therapy (ORT) strategy for controlling diarrhoea has been pointed as main responsible for this improvement. But ORT is a measure of secondary prevention, aiming, when successful, at lowering the case-fatality rate of diarrhoeal disease; it would never claim any impact in diarrhoea morbidity, which must be dealt with by measures of primary prevention.

1.2 ORAL REHYDRATION THERAPY

It is not the aim of this work to review the evidence for ORT effectiveness; but no innovative approach to Diarrhoeal Disease Control Programme, however scientifically sound, will gain proper consideration without a critical review of the impact of ORT.

ORT has been the cornerstone of every DDCP in the last 25 years (Richard et al 1993) and its name has been so strongly linked to that of such a respected international organization (UNICEF), that the celebration of the ORT success (Unicef, 1994; Greenough & Maung, 1991) seems more a necessity of political convenience than a matter of scientific reasoning.

ORT is claimed to save 1 million of children per year (Taylor & Greenough, 1989), on the assumption that its proven efficacy in a well supervised setting (Kumar et al, 1987) might easily be transformed in effectiveness and impact.

Actually the only study which tried to evaluate the ORT impact on a national basis (el Rafie et al, 1990) showed that mortality in Egypt started to decline six years before the ORT programme and concluded saying that the reduction in mortality is probably due to a combination of factors, rather than ORT.

Habicht (1988) made it clear that what is usually done in diarrhoea control programme is just an "adequacy evaluation" of outputs and outcomes. This is very limited in establishing that an intervention actually had an impact, since it does not control for all the other confounding influences to the same outcome.

Problems of compliance in preparation and administration, cultural acceptability and logistic distribution have hampered its expected results.
ORT is also time-consuming, and women in developing countries are already overloaded. 1 litre of ORT (the WHO recommended daily amount) takes 3 hours and 20 minutes (a teaspoon/min); over 4-5 days illness, this becomes an impossible task. (Riyad et al 1991)

In Bangladesh, a pioneer country in the implementation of ORT, diarrhoeal mortality is reported to have increased, despite a widespread diffusion of ORT utilization. (Faveau et al, 1992)
Doubts about its impact in the long term come also from Papua New Guinea. (Rogers et al, 1991)
Even the definition of the usage rates which measure the success of a programme is far from be agreed upon. (Larson & Mitra, 1992)
Knowledge of what we have been calling "diarrhoea" for 25 years seems difficult to be explored. (Mull & Mull, 1988)
In most cultural settings people distinguish among different types of diarrhoeas, based on elaborate set of criteria: physical appearance of the stools, beliefs concerning the causes of illnesses, child development stage, or combination of the three factors. (Pelto, 1991)

In other words, the successful application of ORT in hospital settings (WHO, 1985) may not have been transferred into effective primary health intervention. (Barros et al, 1991)
However simple the ORT is still a "selected medical technology" which is "unlikely to lead to sustained improvement in health for

the population" (Rifkin & Walt, 1986), and therefore, has been already criticized. (Hirschhorn et al, 1989)

In Mozambique, Cutty et al (1988) found that ORT is widely regarded as a medicine, like a syrup which is taken a teaspoonful three time a day.

In USA, less of 30% of pediatricians and doctors interviewed (Snyder, 1991) reported to use glucose-electrolyte solutions meetings the recommended concentration of sodium and carbohydrate.

A lack of association between perception of severity and use of ORT has also been shown. In Zimbabwe cases of severe diarrhoea were 5 times more likely to be given herbal medicine than cases of ordinary diarrhoea, and the latter were 7 times more likely to be given ORT. (Yoder & Hornik, 1994)

Home-made oral rehydration solutions have been promoted to overcome some of the practical constraints of packet based ORT. They appear to be as efficacious as packet solutions and also reduce stool output. (Sabchareon et al, 1992)

Therefore are more acceptable to users (Molla et al, 1989), but scientific evidence about their effectiveness is still uncertain. (Teferedegn, 1993)

* More than half of salt-sugar solutions which were prepared using not standard formulae in Brazil (Barros et al, 1991) had unacceptably high concentration of sodium.
* The ability of well trained mothers to prepare safe home made salt-solutions appears to deteriorate after six months in Bangladesh. (Chowdhury et al, 1988)

Moreover, ORT is only efficacious in reducing case-fatality rate in watery acute diarrhoea, especially severe cases (Palungsih et al, 1992), which accounts, according to WHO estimates, for only half of the diarrhoea associated deaths. (Tulloch and Richards, 1993)
New knowledge is recently emerging about the increasing relative importance of dysentery and **persistent diarrhoea**, (diarrhoea lasting for more than 14 days). (Black et al, 1993; Molbak et al, 1992)
In both these pathologies ORT has shown no significant effect, (Behrens, 1993) and, together they are responsible for 50% of diarrhoea associated deaths in under 5 children. (WHO, 1988)

The relative importance of persistent diarrhoea compared to watery acute diarrhoea seems to increase with age. In Bangladesh, persistent diarrhoea accounted for 63% of all diarrhoea-associated deaths in children aged 1-4, (Fauveau et al, 1991) and for 22% in infants (Victora et al, 1991). Nevertheless, in the same multicentre study (Victora et al, 1991) the percentage of diarrhoea deaths in infants due to persistent diarrhoea was as high as 62% in Brazil and 47% in India.

So, **in conclusion**, the message of this brief review, are:

* "ORT as a magic bullet" for diarrhoeal control is ready for critical evaluation.
* Alternative approaches for case-management at home are promising, but still need field confirmation.
* The need of reducing the diarrhoeal morbidity has become more urgent and pressing, because it is the only way to get a durable impact on mortality.

1.3 PRIMARY PREVENTION

Against this background, primary prevention strategies must be identified and implemented (Martines et al, 1993) if a reduction in diarrhoea incidence is to be achieved.

The eighteen non-clinical interventions which have been selected and reviewed by WHO (Feachem, Hogan et al, 1983) are presented in Table 1 according to their judged effectiveness and/or feasibility. (Feachem, 1986)

Since than, although other technologies have been developed no re-evaluation of the strategies has been made.

Table 1: Primary Prevention Strategies for controlling diarrhoea

INEFFECTIVE OR TOO COSTLY	Improving lactation chemoprophylaxis supplementary feeding controlling flies
UNCERTAIN EFFECTIVENESS	prevention of low birth weight use of growth monitoring vitamin A supplementation improvement of food hygiene epidemic control
UNDER REVIEW	increasing child spacing control of zoonotic infections
ADEQUATE EFFECTIVENESS AND FEASIBILITY	**promotion of breast feeding** **measles vaccination** **cholera vaccination** **rotavirus vaccination** **improving of weaning practices** **improvement of water and sanitation** **promotion of personal and domestic hygiene**

Two of the seven most effective strategies, **measles vaccination** (Koster et al, 1981) and **breastfeeding** have many other strong reasons to be promoted and there is therefore little question of these strategies being pursued.

New **cholera** and **rotavirus vaccines** are promising but not available yet.

The importance of "weaning diarrhoea" has been widely recognized (Hendricks & Badruddin, 1994). Strategies focused on wet food, early consumption after preparation and reheating of left-over food have been supported. (Henry et al, 1990)

But, while strategies to **improve weaning foods** for the purpose of better child nutrition are clearly a priority, the effectiveness of this intervention on diarrhoea remains unclear. (Ashworth & Feachem, 1985)

The last two strategies, potentially have the most direct role in preventing diarrhoea.

Esrey et al (1991), in their review of 84 studies estimated that **improved water and sanitation** can bring a median reduction in diarrhoea morbidity of 22% (range of 0-100%).

But the general feeling is that what has been achieved during the "International Water Supply and Sanitation Decade" (IWSSD) (1981-90), is less than expected.

Huge investments have been made in the "hardware" of these project, neglecting the "software" components (Pinfold et al, 1991) and the results are "disappointing and conflicting". (Huttly, 1990)

To provide people with water and latrine, in the assumption they already knew how to make the best use of them, has been a poor and wrong strategy.

Actually, to integrate improved water supply, sanitation and health education was a requirement of the IWSSD, but in practice nothing has been done to explore the relationship between

provision of facilities and hygiene. (Kolsky, 1993)

The "**personal and domestic hygiene**" packet of actions (in particular: -handwashing, -sanitary disposal of faeces and -protection of drinking water from contamination) is receiving greater attention.

They are necessary to complement any water and sanitation project (Feachem, 1986; Esrey et al, 1985), and also regarded as an intervention effective in itself. (Esrey et al, 1991)

The first review of the studies on the health impact of personal and domestic hygiene was completed in 1984 (Feachem, 1984); two hospital based studies from Bangladesh and USA and one community based study from Guatemala were reviewed in detail and reductions in diarrhoea incidence between 14% and 48% were documented.

Since than many other studies have been done either to quantify the relative risk of unhygienic behaviours for diarrhoea disease, or to test the effectiveness of improving hygiene behaviours in the field.

This dissertation aims at updating that review, taking in account all the available studies, and trying to estimate the impact of this intervention on diarrhoeal disease.

Firstly a definition of each of the hygienic behaviours which might potentially be effective, and their role in interrupting the transmission of diarrhoea disease is outlined. (Chapter 2)

Secondly an insight in the methodological problems related with measurement of hygienic behaviour is given. (Chapter 3)

Thirdly a measurement of the expected impact of hygiene behaviours interventions on diarrhoeal disease will be attempted, based on the studies reviewed. (Chapter 4)

Finally, conclusions and practical implications of the findings are discussed. (Chapter 5)

2. PERSONAL AND DOMESTIC HYGIENE

2.1 DIARRHOEA TRANSMISSION

Diarrhoea is a complex of diseases, mainly infectious, transmitted by faecal-oral route; i.e. germs are excreted into the environment in the faeces and enter the new host through the mouth.

Man is the principal reservoir for many of the enteric pathogens (Faechem 1984), but for *Campylobacter jejuni, Salmonella and Yersinia species* reservoirs are found also in animals. In the last case, contamination can occur both from human and animal faeces.

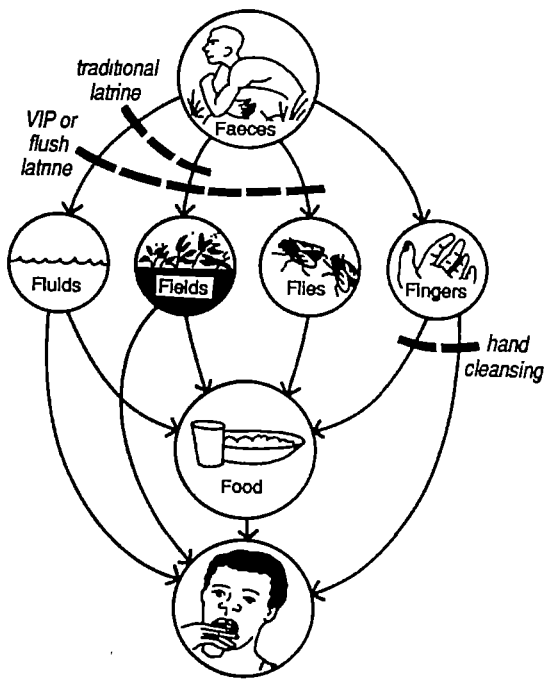
Faecal-oral transmission may be:

a. water-borne, when water contaminated by faeces is drunk;
b. food-borne, when food contaminated by faeces is eaten;
c. direct, via fingers, objects (cooking utensils), bed linen, or simply dirt ingested by young children.

In practice, it is difficult to keep the three routes separate; hands, for ex., are commonly contaminated during defecation and may lead to transmission not only through direct contact with the mouth, but also through contamination of drinking and cooking water, contamination of food and contamination of vessels for drinking water or water storage. (Bateman, 1991)

The transmission routes have been summarized in what is called the "F diagram" (Figure 1), firstly proposed by Kawata, 1978 and then elaborated in (Bateman, 1991).

Figure 1: Transmission of diarrhoea germs



Diarrhoea is spread by faecal germs contaminating fields, fluids, fingers, flies or food, which then eventually are swallowed.

(from Dialogue on Diarrhoea, issue no. 57, June-August 1994)

2.2 BARRIER TO TRANSMISSION

The primary barrier to disease transmission is obviously preventing infectious agents from getting into the environment; and this means essentially adequate sanitation.

Scientific evidence of the importance of sanitation in preventing diarrhoea dates back to 1958, when Mc Cabe & Haines found in Boston (USA) a reduction of 52% in *Shigella* infection rate due to the construction of bore-hole privy.

When the primary barrier works imperfectly, secondary barriers must be relied on to prevent transmission; these secondary barriers are essentially based on **hygienic behaviours**, defined as "*a wide range of actions that promote health*". (Boot and Cairncross, 1993)

Table 2 summarizes these barriers to transmission (adapted from Bateman, 1991).

Table 2: opportunity for Behavioral Intervention to prevent Faecal-Oral Transmission of disease

Primary Barriers Sanitary disposal of faeces Corral or remove animals
Secondary Barriers 1. **Avoidance of Infectious Organisms** Avoid unsafe water source Avoid contamination of: *Water*-during handling and storage *Hands*-by contaminated water, objects, soil *Cooking utensils, food containers and preparation surfaces*-by contaminated hands, water, objects, soil Avoid putting unclean objects and hands in the mouth Avoid contaminated food Fly control 2. **Removal of Infectious Organisms** -Disinfect water prior to drinking and food preparation (e.g., boiling, filtering) -Handwashing -Clean utensils and surfaces prior to food preparation -Cook food

Among these various hygienic behaviours which can reduce

transmission of faecal-oral transmission, it is important to select those that are simple to promote and do not require sophisticated technology.

Scientific evidence, biological reasoning on the spread of diarrhoea and common sense suggest that the most promising are: (WHO, 1993)

A. handwashing;

B . sanitary disposal of faeces;

C. prevention of water contamination.

Also, where domestic animals are common,

D. corralling them

may be an appropriate preventive strategy.

A brief review of these behaviours in Developing Countries follows.

2.3 HANDWASHING

Handwashing after defecating or handling babies faeces and before preparing food, feeding children or eating, is crucial to reduce the transmission of diarrhoea germs.

Hand contamination as route of transmission for hospital infections was well documented many years ago. (Salzman et al 1967)

In England, hands have been found responsible also for transmission of respiratory syncytial virus. (Isaacs et al, 1991)

Rotavirus has been found in the handwashings of attendants of children with diarrhoea in Bangladesh, supporting the hypothesis that outbreaks of Rotavirus could be due to contamination of

hands. (Samadi et al, 1983)

The efficacy of handwashing in removing pathogens from the hands has been confirmed; Sprunt et al (1973), comparing five different wash agents, found that they were equally effective (including plain water) when followed by drying on a paper towel, supporting the idea that organisms are removed from hands by the mechanical abrasive action of rubbing, rinsing and drying on a towel, rather than killed by a chemical preparation.
However, in another study (Hoque & Briend, 1991), plain water reduced faecal coliform contamination but the result was not statistically significant. Interesting, in the same study, the finding that mud, ash and soap are more or less equally effective in reducing hand contamination, pointing again at the importance of mechanical rubbing. (WHO, 1992)

Handwashing after defecation is not a widespread practice in developing countries. In a study in Lima, Peru, (Huttly et al, 1994), handwashing after defecation was registered in only 11% of the observations, and usually without soap. In the same study, quality of handwashing (in term of thoroughness) was checked, and the "best" handwashing was observed when the person was preparing to go out. This supports the idea that the value of personal appearance, and not concept of germ theory, motivates handwashing. The same was found in Bangladesh (Zeitlyn & Islam, 1991), where the authors conclude that cleanliness is viewed in a larger, socio-religious context of purity vs impurity and is not based on germ theory. In all the Moslem world, concepts of

clean and dirty and purity and pollution refer more to a ritual state (Simpson-Hebert, 1984); cleanliness may or may not coincide with purity, and neither term is closely associated with disease causation.

In Bangladesh, soap is regarded as a cosmetic rather an agent for removal of microorganisms moreover, because of their cooling properties, both soap and water are perceived as having potentially deleterious effects, especially for children. (Zeitlyn & Islam, 1991)

A study from Thailand (Rauyajin et al, 1994), using qualitative methods (observation and focus group-discussion), reveals that none of the mothers washed hands before preparing milk or food for the children, even though there were no significant physical barriers to obtaining water, and soap was available in every observed household.

In conclusion, at least three messages can be drawn from these considerations (Borghorff, 1987a):

- emphasizing cleanliness through handwashing with soap can easily be misunderstood, because this message does not necessarily fit into traditional belief systems;
- personal hygiene may be a strongly developed notion in some cultures, that can be built upon;
- people may want to be clean for other than health reasons.

2.4 SANITARY DISPOSAL OF FAECES

Safe disposal of faeces is vital, as a primary barrier for avoiding environmental contamination. It has been shown (Esrey et al, 1991) that improved sanitation has a greater impact on child health than water provision.

But stools of infants and small children are generally thought to be innocuous (Isely, 1984), although they contain a greater number of pathogenic organisms per unit of weight (Feachem, Bradley et al 1983). The extent to which faeces are believed to be harmful may vary between different cultures; Zeitlyn and Islam (1991) report from Bangladesh that stools of infants who were on breast-milk only, were thought to be harmless. In Peru (Huttly et al, in preparation) faeces, both human and animal, are considered "dirty" because they attract flies, but are not regarded as sources of disease; faeces of children and small animals like chickens are considered less dirty because they have less smell.

In developing countries, young children rarely use latrines, yet many hygiene studies just ask mothers whether the child uses a latrine. (Henry, 1994) In Sri Lanka, although 46% of people had a own latrine, only 10% of children < 5 observed used them. (Mertens et al, 1992) In Lima, Peru (Huttly et al, 1994) about half of the house had a pit latrine, but only 4% of children aged 2-3 years and 27% of over 3 were observed to use them. Parents may not encourage children to use them for fear they may fall in. (Adeniyi, 1974) Children do not like to use them because of smell, darkness, or distance from the house. (Borghorff, 1987b)

Instead, young children frequently defecate indiscriminately in or near the home. Foe example, in Lima, Peru, (Huttly et al, 1994) faeces are left accessible to children and animals in 42% of observations; stools deposited inside on the floor were usually just swept aside, covered with earth or eaten by dogs. Those deposited outside the home were frequently left untouched.

However people do not need to wait for latrines to be built to safely dispose of faeces (Anonymous, 1993). Simple low-cost measures, such as encouraging people to bury faeces, sweep up faecal matter around the house and avoid defecating near water sources, or near people's homes can also reduce the spread of disease. (WHO, 1993) Appropriate technology has been described but no confirmation of effectiveness is convincing: Isely (1984) suggests a child-sized pour-flush latrine, that was developed in Sri-Lanka, but it is not clear to what extent the design has been successful in the field.

In conclusion, the practice related to the disposal of faeces of young children is a complex area that can be broken down into various components (Table 3 adapted from Borghorff, 1987b):

Table 3: practices for sanitary disposal of faeces

a.	Use of nappies: -methods of keeping soiled nappies -methods of cleaning soiled nappies
b.	Use of potties: -place where potty is emptied -method of keeping and cleaning potty
c.	Defecation not using potties or diapers: -in the house; methods and speed of disposal -around the house; methods and speed of disposal -special places: -rubbish tips or holes -latrines
d.	Methods of keeping and cleaning soiled clothes
e.	Methods of anal cleaning
f.	Hand-washing after stool disposal.

2.5 KEEPING WATER FREE FROM CONTAMINATION

Many reviews suggest that increasing the quantity of water available for domestic use has a greater impact on diarrhoeal disease than just improving its quality. (Kolsky, 1993)
But in the broadest of these (Esrey, 1991), the evidence is not striking; when only 11 more rigorous studies (out of 30) were considered, the reduction in diarrhoea incidence estimated was:

* 15%, improving water quality,
* 20%, improving water quantity and
* 17% improving both water quality and quantity.

Moreover it has also been shown that, although water consumption tends to increase as the journey time to a source decreases, a

plateau is reached when the return journey takes less than half an hour. (Cairncross, 1987)
Then, only when the water is supplied in the house or yard, does consumption increases further.

So to recognize the importance of increasing water availability for hygienic practices does not mean to neglect that contaminated water is still one of the easiest ways to get diarrhoea.
Water becomes easily contaminated between collection and use through various behaviours, such as collection and storage in open vessels, or in vessels which are not cleaned regularly, use of communal cups to draw water, and hands touching the water during collection, storage and use. (Huttly et al, 1990)

The majority of faecal bacteria found in stored water are most likely transferred from the environment through activities of water handling; in rural Thailand (Pinfold and Horan, 1991) information gathered through observation, support that the main method of obtaining water from a container was by use of a dipper, which often came into contact with surfaces, dirty fingers and other objects.

This was confirmed in Guinea Bissau by Molback et al (1989) who found that water in storage container was more contaminated than at the source. In Nigeria Blum et al (1990) reported that borehole water becomes heavily contaminated during collection and storage. In Lima, Peru, (Yeager et al, 1991), children in household with water stored in container without a faucet, were twice as likely to

have a high incidence of diarrhoea.

2.6 CORRALLING DOMESTIC ANIMALS

Animals, especially small domestic animals are important reservoirs for *Campilobacter jejuni* and some Salmonella and Yersinia species. Yet the evidence about the importance of contacts with domestic animals in the transmission of diarrhoea is poor and unclear. (Boot & Cairncross, 1993)

In Huascar, Peru, 42% of the rectal samples taken from the animals living in the houses were positive for *Campylobacter jejuni* (78% of the chickens) and infants in these households were significantly more likely to acquire *C. jejuni* infection. (Black et al 1989) In Varanasi, India, *Campilobacter jejuni* was the second most common bacterial enteropathogen isolated after *Escherichia coli*. (Nath et al, 1993)

In Lima, Peru, in a study utilising direct observation for collection of data, a mean of 3.9 faeces-to-mouth episodes/12 hours occurred and *C. jejuni* was found viable for up to 48 hours after deposition. (Marquis et al, 1990)

In another study in Lima, (Grados et al, 1988), subjects in households with live chickens had an much higher risk of contracting diarrhoea (OR=11, adjusted for confounding), suggesting that direct contact with the faeces of infected

chickens was responsible for the transmission of *C. jejuni*.
In Bangui (Central African Republic), a significant higher rate of *C. jejunii* isolation was found in stool from sick children living in houses with live poultry. (Georges-Courbot et al, 1990)
In the only intervention which tried to reduce contact between domestic animals and people, providing cages to restrain chickens (Lanata, 1991) the preliminary results do not suggest a significant impact.
On the opposite, in Nigeria, (Huttly et al, 1987) in the houses where animals were allowed to go inside, the risk of acquiring diarrhoea was surprisingly reduced; the collection of data made through single spot observation probably accounted for this odd "protective" factor. Also in urban Bangladesh (Clemens et al, 1987) no important differences were noted for the proportion of case and control families in which animals were observed in the kitchen.

Due to the lack of evidence of the efficacy of this hygiene behaviour, it was not included among the three priorities by World Health Organization; neither it will be treated in the analysis of this work, since no intervention study other than noted above was located.

3. REVIEW ON HOW TO MEASURE BEHAVIOUR CHANGE

3.1 INTRODUCTION

Any intervention which aims at reducing diarrhoea through implementation of hygienic behaviours will need:
-to measure health impact, or
-to measure the behaviour change, or, more realistically
-to measure both.
The measurement of health impact has been hampered in water & sanitation intervention by some methodological problems which have been remarked by Blum & Feachem (1983):

-lack of adequate control, -confounding variables,
-health indicator recall, -one to one comparison,
-failure to analyze by age, -health indicator definition,
-failure to record facilities usage.
There is no reason to foresee less difficulties in measuring health impact from hygiene intervention.

Cairncross (1990) suggested that.... "*measurement of behavioral change...is likely to be easier, more reliable and more useful to water and sanitation programme manager as an operational evaluation tool than any attempt to measure the health benefit directly*".

This view seems to be too optimistic; indeed when we focus on

human behaviours, we move into a domain in which efforts to increase precision often involve intrusive technique. (Jenkins, 1991) And, when the behaviour is sensitive, as, for example, defecation practice, the intrusiveness is unlikely to produce accuracy. Another difficulty arises from the tendency, measuring human behaviour, to mix description and interpretation based on our cultural experience. (Zeitlyn, 1991)

Hence the need of clear, careful definitions of every behaviour studied not only to assess the reliability of data, but also because the final aim is to improve behaviours and it is possible to change something only if it has clearly been agreed upon.

3.2 OBSERVATION vs INTERVIEW

The first step in measuring hygiene behaviour is to collect information.

There are essentially two main ways to gather these information, i.e. interview and observation. The two methods will be briefly reviewed before analysing the studies which have tried to compare the two methods in the field.

Interview

This is the meeting of two or more persons face to face, with the purpose to find out what is in the mind of the person(s) being interviewed. (Boot & Cairncross, 1993)

All interviewing is based on the fact that human beings can describe their own behaviour or those of others.

There are two main forms of interviewing: informal and formal, the latter usually is based on a questionnaire.

Formal methods try to maximize "reliability", by standardizing the questions, whereas informal methods try to maximize "validity", i.e. to catch what people really mean.

The informal interview can be:

-individual, useful for private information and very detailed exploration, more expensive;

-group interviewing, or **focus-group discussion**, in which 6 to 8 people, homogeneous but preferably unknown to each other, openly discuss on a specific subject. Advantage of gathering a large amount of information in a relatively short time, uses the "group interaction" to generate more in-depth information.

The limitation of focus-group discussion in behavioral research in developing countries have been reviewed recently by Khan et al (1991); according to the authors, anonymity is almost impossible in small villages, as well as to find time and space for women to concentrate for two hours on a subject, and tape recording might be unacceptable. Methodological questions are still unsolved, as ideal number of subjects, ideal number of sessions, and degree of homogeneity of the group, so that "..unless attention is paid to strengthening the methodology, it is feared that the indiscriminate use of focus groups can cause more harm than benefit". (Khan et al, 1991)

But whatever the method, interview will only gather information about what people say the do, not what they really do.

People tend to say what is socially more acceptable, according to the dominant concepts of ideal behaviour ("social bias"), and may find it embarrassing to answer freely, because of constraints of gender, age, social class etc.
Moreover they are likely to forget most of the things that happened to them, not to notice or misinterpret key aspects of their own behaviour.
The great advantage of a questionnaire based survey is that is easier to carry out, and produces quantitative data that are amenable for analysis.

Observation

Observation means watching or noticing by using all our five sense: seeing, touching, tasting, hearing and smelling. (Boot and Cairncross, 1993) The behaviour is observed in its proper context and therefore better analyzed.
Observation is essential not only for directly observing people' behaviour, but also for capturing the so-called "physical clues" of behaviour, such as use of soap and water near latrine, covered food, scattering garbage, traces of faeces, etc. Often these clues can act as surrogate of actual behaviours which are too sensitive or happen too rarely to be observed.
But also observation is not free from bias; people tend to react to the presence of an observer by behaving in a different way from usual. This "**reactivity**" can go in different directions: the mothers can behave in the beginning in a way they think would please the observer or might avoid some behaviours which are too sensitive to be shown. It has been noticed that the reactivity

decreases in repeated observation, suggesting that the mothers get accustomed to the presence of the observer. (Curtis et al, 1993) On the other hand (Cousens et al, 1994), it might happen that the mother, only in subsequent observations becomes aware of which events are of interest to the observer and modify only those behaviours; i. e. the reactivity can increase with time.
To minimize reactivity it is necessary to start observation only when the community has fully accepted the observer's presence and these have developed good relations with the villagers. (Widstrand, 1991) At the same time they should pay attention in not becoming too much involved; Lindskog et al (1987) reported of an observer in Malawi who was "bewitched".

There are three main types of structured observation: (Boot and Cairncross)

a. continuous monitoring; involves observing and recording the behaviour of interest for an extended period of time.
b. Spot check, when the observer records the presence or absence of a behaviour at the first moment of observation, usually at the observer's arrival. Better for observation of physical clues. An alternative is to ask people to demonstrate the behaviour of interest, and then to observe whether it is done correctly.
c. Rating checks, require the observer to make a judgment on individuals and environment; it is difficult to be objective and need a lot of training.

3.3 COMPARATIVE STUDIES

Three studies have been located which tried a field comparison of hygiene data collected through questionnaire interviews and data obtained by observation.

1) **Stanton et al (1987)** compared data on practices related to water storage, handwashing and defecation among 247 families in urban Dhaka (Bangladesh).

Methods:

5 households, randomly selected in each of the 38 communities were administered:

a) KAP questionnaire about water usage and sanitation;

b) 24-hours sanitation recall questionnaire (after 6-14 weeks);

c) prolonged observation (3-5 hours) of actual morning sanitation practices within one month of the previous questionnaire.

Results:

neither recall of sanitation practice, nor the description of technology, attitudes and referred practice were as accurate as observation. Agreement between KAP questionnaire and observation was low (K score < 0.20) and lower (K = 0.10) was the agreement between handwashing and defecation practice and those reported in the 24-hours questionnaire.

Over-reporting of "correct" behaviour was frequently responsible for the discordance.

Limitations:

the three instruments were not administered to household concurrently, and only the first episode of a particular observed

activity was presented. Nothing can be said on the repeatability of the observations; it might be that agreement of repeated observations could have been as low as that between questionnaire and spot observation.

2) Curtis et al (1993) in Burkina Faso, compared data on hygiene behaviours obtained from questionnaire with data obtained using a structural observation, and examined the repeatability of the latter and spot observation of environmental conditions.

Methods:

case-control study, cases being children with diarrhoea discharged from the hospital and control chosen in the neighbourhood.

-2775 interviews to the mothers;

-548 household were visited for observation of environmental conditions in and around the house courtyard;

-57 (10%) were revisited for a repeated observation;

-10 household were observed on six repeated occasions.

Results:

agreement between questionnaire response and observation on child defecation and stool disposal were relatively poor (K=0.25, 0.28). A tendency to over-report those practices that were perceived to be good was confirmed.

A higher degree of concordance was found between repeated observations of child defecation and stool disposal behaviour than between the questionnaire and the first observation.

Analysis from the households observed on six occasions revealed a pattern of repeatability consistent with that suggested by two

observations.

Limitations:

because not all behaviours were observed at all the visits, the effective sample size for some behaviours is too small to draw any firm conclusion.

Moreover data from observation were compared with questionnaire data obtained using only one particular form of open-ended question, referring to habitual behaviour.

Conclusions:

single observation may be useful to determine incidence or prevalence of different behaviours in the community but not to identify behaviours as risk factors; hygiene behaviours change, they are often not habitual.

3) **Cousens et al (1994)**, in Burkina-Faso, measured again the repeatability of structured observations of hygiene behaviour. Furthermore they tried also to investigate whether the degree of agreement between data obtained by structured observation and data obtained by interview varies according to the form of the question.

Methods:

-213 mothers were observed on three separate occasions at weekly intervals, and a sub-sample of women was also observed on a further five consecutive mornings.

-than they were administered two questionnaires, similar in structure and approaches; the difference was that one of them asked about "yesterday", the other asked about "usually"; the first was administered at the end of the observations, the second

one week later, in a random order.

Results:

- the agreement between questionnaire and observation was low to moderate, but also agreement between observations (repeatability) was also low.

-an important difference was reported from the type of questions: asking direct closed questions about events surrounding a behaviour (e.g. child defecation) tends to lead to systematic over-reporting of desirable behaviour.

But, asking "open questions" about the use of soap and handwashing will generally lead to underestimates of the frequency of these behaviours in the population.

The conclusions are similar:

* hygiene practice may be too variable to assign individuals to exposed and unexposed groups (on the basis of a single observations) for identifying links with health outcomes.

* At population level, many behaviours appear to be repeatable, so a single measurement will suffice when the aim of the study is only to establish the relative frequency of certain behaviours, for example evaluating the impact of behaviour change interventions.

Biological indicators

According to Pinfold (1991), on the background that the questionnaire produce unreliable information and the observations take a lot of time and are extremely difficult to standardise, "simple indicator of behaviour change are needed in order to assist the monitoring and evaluation of hygiene programmes"

That is why he proposed the development of a **microbiological indicator** of handwashing practice, involving the exam of fingertips for faecal bacteria. *Faecal Streptococcus* was preferred to *Escherichia coli* for its ability to persist for a far longer time on skin.
The method has been tested in northern Thailand.
Preliminary investigations had suggested that in people who have to carry water to their homes, faecal streptococcus is usually present on fingertips. A study promoting handwashing (Pinfold, 1993) also showed a significant reduction in fingertips bacteria attributable to the intervention.

Is this the solution?.
Probably not. It refers only to a particular behaviour (handwashing) and it requires microbiological facilities which are not widespread in developing countries neither are cheap. Anyway, as the author suggests,...*the indicator could be useful as a relative measure to compare different groups of populations and should not be considered as an absolute measure of handwashing behaviour*.

3.4 CONCLUSION ON MEASURING BEHAVIOURS

To measure hygiene behaviour is not easy, and more researches need to be done before a "golden standards" be found against which to compare the various methods available.
Some points emerge from this brief review:

1) To rely only on reported behaviours collected through questionnaire-based interviews to test the magnitude of a risk factor-disease association is a non valid method.

2) Observations are not entirely valid but they probably provide a more valid picture of the distribution of behaviours over a population, that the questionnaire.

3) One point in time observation is as unreliable as questionnaire in determining exposure status of individuals.

4) Cross-validation between questionnaire and single observation may leave unsolved the question of which one is the most reliable method, but surely increase validity of the data collected.

5) Repeated observations may be time-consuming, expensive and intrusive, but seem to be the only way to get accurate data. Methodological question, like training of observers, number, length and deepness of observation, recording patterns, need further research.

6) Checking health behaviour is a sensitive matter. Whatever the method used, it is doomed to fail without a deep involvement of the whole community and its leaders.

7) The acceptability of a method may vary in different community, according to cultural patterns, socio-economic conditions and prevalence of behaviours.

8) Microbiological measure of hygiene behaviour need further testing in the field. They might be useful for evaluation of intervention, to compare the same population over time.

9) Focus-group discussions is a useful method but it needs to

be adapted to field conditions in Developing Countries.

10) Qualitative data collection are essential before starting any study, in order to give guidelines for structured observation and questionnaire.

In conclusion, measuring behaviour change is not easy and, although its role in evaluating impact of interventions at population level has already been anticipated, the measurement of health impact is still desired by many for judging the results of behaviour change interventions.

Where behaviour change is implemented to produce an health impact, evidence for both needs to be searched, but to measure the former as surrogate for the latter is still a weak assumption.

However, since it is the behaviour change that is expected to produce the health impact, methods for measuring behaviours require further development.

3.5 FURTHER WORK NEEDED

Although the association between hygiene behaviour and diarrhoea reduction is clear, to measure health impact after an intervention and to assume that it is due to the behaviour change implemented without measuring this change, is scientifically unacceptable.

Moreover, if a behaviour is identified, measured and targeted,

the final aim is to change it, not only to reduce its potential consequences.

Some points seem to need priority attention in order to enhance the accuracy of hygiene behaviour measurement.

a) **Clear definition** of any behaviour we try to measure is essential; although the meaning and the reason of a hygienic behaviour may change in different cultural setting, there is the need of agreeing on definitions which can be used consistently over different situations. That is often more difficult than it appears to be. For example, even the simplest one, handwashing, may encompass various practices different in effect and meaning: (Zeytlin, 1991) type of water, quantity of water, type of cleansing agent, abrasive action of a towel, drying system.

b) The **reactivity during observation** needs further investigation and attempts to be reduced. The observation of practices different from those previously agreed on with the family, has been suggested (Zeytlin, 1991), but this may arise ethical problems.

c) The **questionnaire-based interviews** are not to be abandoned, but further evidence is needed on the relationship between type of question wording and validity of reported behaviours. (Clemens, 1994) Should they refer to habitual practices or to specific events such as the "yesterday behaviour" ?

d) There is no need of polarization between quantitative and qualitative methods (Jenkins, 1991). Probably data collection methods should be shaped on the different behaviours; e.g.

sensitive practices like defecation of adults are likely to be less amenable to observation than handwashing or water storage.

e) Further research is needed on the **methodology of observation:** how long?, how many?, who from? Probably this will be different in specific settings, but "minima criteria" of reliability are needed.

f) **When to measure:** qualitative methods have already shown their importance in understanding the reasons why people adopt particular behaviour and so in selecting specific behaviours amenable to be promoted; same kind of research are needed after an intervention to investigate the "cultural impact" of a behavioural change for understanding reason of different levels of compliance.

g) **Microbiological indexes of behavioural changes** need to be tested in experimental field against traditional methods of behaviour measuring to verify both their reliability and cost-effectiveness.

4. HEALTH IMPACT OF IMPROVING HYGIENE BEHAVIOURS

4.1 METHODS

The studies included in this analysis were identified by a computer search using the Medline and the Health Plan data bases from 1984 to July 1994, to look for all the published literature containing information on hygiene behaviour and diarrhoea worldwide.

During the search, the english words "hygiene, behaviour, handwashing, soap, and defecation" were one by one coupled with the word "diarrhoea or diarrhea" to look up in the CD database.

Studied published in scientific journals, in books or in official reports were used; there was no limitation of language, but no non-english study has been located.

References cited in the articles identified, which were not located in the computer, were also sought. These were more numerous than the data base papers.

Other unpublished papers, presented to an informal consultation in Geneva (18-20 May 1992) on " Improving Water and Sanitation Hygiene Behaviours for the Reduction of Diarrhoeal Disease" were obtained from the Department of Global and Integrated

Environmental Health in the World Health Organization.

All of the workpapers presented at the "Workshop on Measurement of Hygiene Behaviour" in Oxford, UK (April, 8-12 1991) were obtained from one of the participants and from the International Water and Sanitation Centre (IRC) in The Hague, Holland.

Finally a visit was paid to the resource centre of AHRTAG (London), publisher of the journal "Dialogue on Diarrhoea", which permitted the location of further unpublished references.

4.2 STUDIES ON HYGIENE BEHAVIOUR AND DIARRHOEA

Thirty-three studies were located in the review:
-seventeen of them are observational studies, 10 case-control studies and 7 cohort studies;
-sixteen are intervention studies, the intervention implemented being the most various from simple handwashing to complex health education messages.
Summary of the main characteristics of the 33 studies are given in Table 4 (next 2 pages).

Table 4: Summary of the main characteristics of the studies

Study						Study population			Exposure/Intervention		Outcome			Main Result
N.	Ref.	Time	Country	Setting	Type	Who	How many	How long	What	How	Main	Definition	Collection	
1	Aulia et al 1994	>88	Indonesia	rural	case-control	under 3	332	20 weeks	hygiene behaviour	quest. + spot observat.	diarrhoea	WHO def.	home surveil. 2/week	unsan. disp. faeces OR>10.4
2	Baltazar & Solon 1989	85	Philippines	urban /rur.	case-control	under 2	281 ca 384 co	5 months	disposal of faeces	questionnaire	diarrhoea	no	hospital	unsan. disp. faeces OR=1.34
3	Clemens & Stanton 1987	84-85	Bangladesh	urban	case-control	under 6	45 ca 53 co	3 months	water/sanitation practices	quest. + single observ.	diarrhoea	WHO def.	home surveil fortnightly	handwashing OR=0.65
4	Daniels et al 1990	88	Lesotho	rural	case-control	under 5	806 ca 814 co	6 months	improved sanitation	quest. + sample single observ.	diarrhoea	WHO def.	clinic	latrine + handwashing OR=0.70
5	Dikassa et al 1993	88	Zaire	urban	case-control	under 3	107 ca 107 co	8 months	maternal behaviours	quest. + observ	severe diarrhoea	diarrhoea + dehydrat.	hospital	synergism between behav. risks
6	Ekanem et al 1991	89	Nigeria	urban	case-control	6-36 months	67 ca 206 co	3.5 months	food-hygiene related behaviours	focus group dis. + observations	acute watery diarrhoea	WHO def.	home surveil 2/week	faeces around toilette RR=1.79
7	Ekanem et al 1994	89	Nigeria	urban	case-control	6-36 months	20 ca 206 co	3.5 months	food-hygiene related behaviours	focus group dis. + observations	persistent diarrhoea	> 14 days	home surveil 2/week	no association
8	Knight et al 1992	89	Malaysia	rural	case-control	4-59 months	98 ca 98 co	2 months	modifiable risk factors	quest. + observ.	diarrhoea	WHO def.	health centres	absence of water container in latrine OR=2.8
9	Menon et al 1990	85	USA	rural	case-control	under 2	50 ca 45 co	8.5 months	risk factors for rotavirus	quest. + 5' observat.	rotavirus diarrhoea	lab. conf.	hospital	poor sanitation OR=3.0
10	Mertens et al 1992	87-88	Sri Lanka	rural	case-control	under 5	2458 ca 5799 co	15 months	environmental and behavioural risk factors	quest. + sample spot observ.	diarrhoea	WHO def.	hospital	unsan. disp. of faeces OR=1.68
11	Bukenya & Nwokolo 1991	87-88	Papua New Guinea	peri-urban	cohort	under 5	479	1 year	etiologic factor for diarrhoea	single observ.	diarrhoea	WHO def.	home surveil alternate days	faeces in compound OR=1.48
12	Han et al 1986	85	Burma	urban	cohort	under 5	386	1 months	hand contamination after defecation	questionnaire	diarrhoea + dysentery	Newell def	home surveil daily	water users to paper users RR=3.8 (n.s.)
13	Han & Moe 1990	86-87	Burma	urban	cohort	0-17 months	240	2 years	house faecal contamination	single observ.	diarrhoea	Newell def.	home surveil 2/week	association not quantified
14	Henry & Rahim 1989	85	Bangladesh	peri-urban	cohort	1-6 years	137	1 year	hand and water contamination	microbiological assessment	diarrhoea	WHO def.	home surveil fortnightly	hand contamination RR=3.38

15	Thongkraja i et al 1990	84-85	Thai land	rural	cohort	under 5	1364	4 months	health behaviours	questionnaire	diarrhoea	no	home surveil fortnightly	hasdwashing before giving milk RR=.075
16	Wright et al 1991	82-83	Egypt	rural	cohort	0-11 months	317	1 year	household factors	questionnaire	diarrhoea	no	home surveil 2/week	hygiene pract. explain 3.1% of diarrhoea
17	Yager et al 1991	85-87	Peru	urban	cohort	under 3	677	27 months	defecation practices	questionnaire	diarrhoea	WHO	home surveil 2/week	child. defect. in latrine OR=0.35
18	Ahmed et al 1993	86	Bangla desh	rural	interve ntion	0-18 months	185	9 months	health education	weekly lectures	diarrhoea + severe diarrhoea	up to 5 stools/ day	home surveil weekly	diarrhoea reduction approx. 40%
19	Alam et al 1989	80-83	Bangla desh	rural	interve ntion	6-23 months	314 in 309 co	3 years	Health education + environmental improvement	Handpumps + home visits, group disc., demonstrations	diarrhoea	WHO def.	home surveil weekly	health educ. + hundpumps up to 43% diarrhoea reduction
20	Aziz et al 1990	84-87	Bangla desh	rural	interve ntion	under 5	5000 in 4600 co	34 months	health education + environmental improvement	handpumps + hyg. messages to mothers (3 years)	diarrhoea+ dysentery	WHO def.	home surveil weekly	25% diarrhoea reduction
21	Black et al 1981	76-77	Usa	urban	interve ntion	6-29 months	116	10 months	handwashing	promotion in children and staff	diarrhoea	staff judgment	day of attendance in centre	48% diarrhoea reduction
22	Blum et al 1990	83-86	Nigeria	rural	interve ntion	0-6 years	1400	3 years	health education + environmental improvement	boreholes, latrines, handpumps + person. visits	diarrhoea	WHO def.	8 d. period prevalence 2/year	no significant reduction
23	Haggerty 1991	88	Zaire	rural	interve ntion	3-35 months	2082	12 weeks	health education	4 messages on handwash. and faeces dispos.	dysentery	WHO def.	home surveil. weekly	11% dysentery reduction
24	Han & Hlaing 1989	85	Burma	urban	interve ntion	0-4 years	236 in 238 co	5 months	handwashing	soap + advices	diarrhoea + dysentery	Newell def.	home surveil. daily	30% diarrhoea reduction
25	Khan 1982	?	Bangla desh	urban	interve ntion	all ages	279 in 218 co	10 days	handwashing	promotion, soap, pitchers	shigellosis	lab. conf.	rectal swab daily	35% diarrhoea reduction
26	Lanata 1991	?	Peru	urban	interve ntion	6-18 months	100 family/ group	4 weeks	handwashing + water quality	soap + containers	diarrhoea, shigell., campilob.	WHO def.	home surveil. daily	43% diarrhoea reduc. in post-interv.
27	Pinfold 1990	?	Thai land	rural	interve ntion	under 5	469 in 199 co	3 months	health education	mass-media campaign, soap + containers	diarrhoea	WHO def.	home surveil. monthly	34% diarrhoea reduction
28	Stanton & Clemens 1987	85	Bangla desh	urban	interve ntion	0-6	937 in 986 co	6 months	health education	intensive training for 8 weeks	diarrhoea	WHO def.	home surveil. fortnightly	26% diarrhoea reduction
29	Sircar et al 1987	82-83	India	urban	interve ntion	all ages	1810 in 1858 co	13 months	handwashing	soap + advices	diarrhoea, dysentery	watery motions	home surveil. weekly	41% diarrhoea reduction
30	Torun 1982	79-80	Guate mala	rural	interve ntion	under 6	274 in 32 co	14 months	health education	9 1 hour participatory lectures	diarrhoea	no	home surveil. 2/week	14% diarrhoea reduction
31	Wilson et al 1991	?	Indo nesia	rural	interve ntion	under 11	136 in 179 co	20 weeks	handwashing	soap + promotion repeated every 2 weeks	diarrhoea	WHO def.	home surveil. fortnightly	89% diarrhoea reduction
32	Mahoney et al 1990	89	Usa	urban	interve ntion	all ages	43 h.h. 33 co	3 weeks	health education	face-to-face or phone explanations	dysentery	lab. conf	home surveil. daily	no reduction
33	Odomusu 1982	?	Nigeria	urban	interve ntion	babies	100	?	health education	teaching session at clinic	diarrhoea	no	??	not reliable

Most of the studies have been done in Asia (19/33=58%), some in Africa (8/33=24%), few in the Americas (6/33=18%).

Only one work (18) in the Philippines, studied at the same time urban and rural areas, the others are in one single setting, equally distributed between urban and rural. (see Table 5)

Table 5: Distribution of studies per continent and setting

	Asia	Africa	Americas	Total
Rural	9.5	4	2	**15.5**
Urban	9.5	4	4	**17.5**
Total	**19**	**8**	**6**	**33**

Most of the studies are community based (24/33=73%), 8 are hospital (or clinic or health centre) based and one is mixed. The cross-distribution of the type of study is given in Table 6.

Table 6: Type of studies

	case-control	cohort	intervention	Total
community-based	4	7	13	24
hospital-based	5	0	3	8
mixed	1	0	0	1
Total	**10**	**7**	**16**	**33**

The studies will be analyzed in two separate sections, 4.3 for the observational studies and 4.4 for intervention ones.

Observational studies are useful to identify unhygienic behaviours in children or mothers which are risk factors for diarrhoea (or protective hygiene behaviours), and try to quantify the magnitude of their association with the disease. No specific casual relationship between level of risk and level of outcome can be expected.

Intervention studies, which allocated the exposure promoting the hygiene behaviour of interest only in the intervention group give the possibility of comparison of diarrhoea incidence in intervened and control group. They also allow to measure the change in health behaviour which is being promoted and therefore give the opportunity of a establishing a causal relationship between exposure level and outcome, i.e. a measurement of impact. (Habicht, 1988)

4.3 OBSERVATIONAL STUDIES

Seventeen observational studies have been located which try to measure the magnitude association between hygiene behaviours and diarrhoeal disease.

Ten of them are case-control studies, 7 are prospective cohorts.

Recently the case-control design has been extended to the study of common diseases, such as diarrhoea. (Rodriguez & Kirkwood, 1990)

According to this methodology, the studies, called also "**prospective case-control**" select incident cases of diarrhoea over a fixed period of time; controls are selected "concurrently" from those still at risk when a new case is diagnosed.

Cases return to the population at risk after recovery so this remains practically constant over time, in the assumption that the disease lasts short time. A person originally selected as a case can become a control later, and viceversa.

Therefore it is possible to obtain direct estimates of Relative Rate in the study population.

The list of case-control and cohort studies located, with references, location, and main hygiene behaviours assessed is given in Table 7. The number in the table will be the reference number for each study, from here onwards. Further study details are in Table 4.

Table 7: List of observational studies on hygiene behaviour and diarrhoea

No.	REFERENCE	MAIN HYGIENE BEHAVIOURS ASSESSED
1	Aulia et al (1994)	Disposal of children faeces; mothers handwashing; bathing children in the river; children eating with their hands; household members defecating in open spaces; domestic animal keeping; eating left-overs.
2	Baltazar & Solon (1989)	Where children defecated and final disposal of their faeces.
3	Clemens & Stanton (1987)	Food and water storage; defecation practices; animal in the kitchens; mother handwashing before preparing food, after defecation and after cleaning child's anus; garbage disposal.
4	Daniels et al (1990)	Latrine ownership and their usage; handwashing after defecation.
5	Dikassa et al (1993)	Disposal of child's faeces; garbage disposal; caretaker hygiene.
6	Ekanem et al (1991)	Defecation practices and final disposal of faeces; waste disposal; mothers handwashing before cooking; reheating left-over food before eating; washing dishes and cooking utensils immediately after use; storing water in uncovered container; food storage.
7	Ekanem et al (1994)	The same as in 6.
8	Knight et al (1992)	Boiling drinking water; eating left-over food; washing water in latrine; animal seen in the house;
9	Menon et al (1990)	Poor environmental sanitation (animal stools, unprotected garbage, standing water, etc..)
10	Mertens et al (1992)	Unsanitary stool disposal; (handwashing and boiling water studied as confounders).
11	Bukenya & Nwokolo (1991)	Presence of faeces (human or animal) and pigs in compound; anal cleansing method; removal of children faeces; utensils washing habits.
12	Han et al (1986)	Methods of anal cleansing after defecation (water, paper, water + paper).
13	Han & Moe (1990)	Household faecal contamination (presence of faeces, going about without footwear, facilities for handwashing, drainage maintenance).
14	Henry & Rahim (1989)	Hand contamination and drinking water contamination
15	Thongkrajai et al (1990)	Handwashing (before meals, cooking, giving milk, after defecation); dish washing with soap or detergent; boiled water to infants.
16	Wright et al (1991)	House maintenance, food preparation, ownership of animals, leftovers kept for consumption; handwashing practices; waste management; water storage.
17	Yager et al (1991)	Water storage container and practices; left-over food; children defecation practices; use of soap when washing bottles and changing nappies.

Case-control and cohort studies will be analyzed separately in the two following sub-sections.

4.3.1 Case-control studies

Only one of the c.c. studies (10) is both community and hospital based. The others are almost equally divided, being four in the community and five in health facilities (hospital, clinic, health centre).

A description of methods, hygiene behaviour identified as risk factors, limitations and main message of each of the studies is given in **Appendix A.**

Summary of case-control studies

Seven of the studies used the concurrent design, selecting incident cases in hospital (4, 5, 8, 10) or in the community (1, 6, 7, 10) through active surveillance.

Ascertainment of hygiene behaviour was done through questionnaire based interview, but eight of the studies used also extensive observation in collecting data (1, 3, 4, 5, 6, 7, 8, 10).

Only one of the case control studies (7) investigated risk factors for persistent diarrhoea; no hygiene behaviour was found associated with that, but the sample size (only 20 cases) was too small for meaningful conclusion. The remaining nine investigated risk factors for acute watery diarrhoea (6), for rotavirus diarrhoea (9) or for any diarrhoea (1, 2, 3, 4, 5, 8, 10).

The outcome was ascertained in children, but in different age-groups. Two studies (2, 9) in under 2, two in under 3 (1, 5), two in under 5 (4, 10), two in 6-36 months aged (6,7), one in under 6 (3) and the last one (8) in 4-59 months aged.

Case-definition of diarrhoea was given in all the studies but one (2) and is consistent with the WHO definition (three or more loose stools in 24 h.) in six of them (1, 3, 4, 6, 8, 10). In one of these (10) it was defined in the same way and/or "stool with blood or mucous". One study (9) looked at rotavirus diarrhoea which was confirmed by virus isolation. The last two studies looked respectively at "severe diarrhoea" (diarrhoea + dehydration, 5), and persistent diarrhoea (lasting > 14 days, 7). In four studies (1, 3, 6, 7) diarrhoea incidence was ascertained through active surveillance at home, fortnightly in one (3) and twice/week in the others.

Risk factors:

Five studies looked at handwashing (1, 3, 4, 6, 7) as risk factor, one (10) as confounder. It was found protective in 2 studies (3, 4), in the second case in association with ownership of latrines.

In another study, absence of water container in latrine had the same OR (2.8), as the absence of latrine, compared to presence of latrine + washing water, (8) suggesting further evidence to the importance of handwashing.

Unsanitary final disposal of faeces was a significant risk factor in five (1, 2, 5, 6, 10) out of the six studies which looked specifically at it, with Odds Ratio varying from 1.34 (2) to 10.4 (1). The only one that did not find a significant association was

investigating risk factors for persistent diarrhoea (7). Another study (3) found a significant association between diarrhoea and children defecating in the house compound, but did not look at final disposal of faeces.

Two studies (5, 10) have suggested a mutual reinforcing between handwashing and sanitary disposal of faeces.

Methods of water storage at home were investigated in three studies (3, 6, 7), but no significant association to diarrhoea incidence was found.

Indiscriminate disposal of garbage was a significant risk factor in two studies (3, 6) out of the four which looked at it (3, 4, 6, 7).

Risk factors significant in only one study were:

-children eating with their hands (1), children seen to place garbage in their mouth (3), feeding children with street food (7), consumption of left-over food (8).

4.3.2 Cohort studies

Only seven cohort studies were located, all are prospective and community based.

For each of them a brief description of methods, hygiene behaviour identified as risk factors, limitations and main message is given in **Appendix B.**

Summary of cohort studies

All the seven studies ascertained diarrhoea through active

surveillance at home. The period of surveillance varies between 1 month (12) and 27 months (17), with both median and mode of one year. The surveillance frequency varied from daily (12) to fortnightly (14, 15); in one case was in alternate days (11) in three cases twice weekly (13, 14, 17).

Diarrhoea was defined in three cases (11, 14, 17) as "three or more episodes of loose stools per day", as WHO recommends, in two case according to a Newell definition (12, 13) which unfortunately was not localized, and in two cases no definition at all was given (15, 16).

The data collection on exposure (risk factors) was done through questionnaire in four cases (12, 15, 16, 17), one point in time observation in two studies (11, 13) and by microbiological test in the last one (14).

Hygiene behaviours as risk factors do not reach clear evidence. Handwashing before giving milk was protective (25% of reduction in under five) in (15), and hand contamination was found associated with a RR of 3.38 (14). Presence of faeces in the compound was associated with a 48% increase in diarrhoea morbidity (11), and children seen eating faeces (17) had an OR=2.71 of diarrhoeal incidence; in the same study (17) open defecation of children outside is associated with a 65% higher risk of diarrhoea. In another study hygiene-related variables (including availability of hand soap and use of diapers) explained only 3.1% of the variance in total incidence of diarrhoea in infants, and 8% of the variance due to environmental factors (16); but nearly 75% of the variance remained

unexplained.

Another studies (13) uses a global index of household contamination (linked also to unsanitary disposal of faeces), and found a significant association of that with diarrhoea.

In Papua New Guinea (11), presence of faeces was associated with a 48% increase in diarrhoea incidence.

In one study (14) diarrhoea incidence was associated with hand contamination (RR=3.8) but not with water contamination.

Finally, among the method of cleansing anus after defecation, plain water seems associated (RR=3.8, non significant) with the highest degree of hand contamination (12), compared to papers users.

4.3.3 Summary of observational studies

The studies reviewed confirm that hand contamination and unsanitary disposal of children faeces are probably the most dangerous among the common practices of personal and domestic hygiene in Developing Countries. Evidence for keeping water free from contamination and for corralling domestic animals is still patchy. Other risk factors related with garbage disposal or eating left-over food need further definition.

Some studies utilize **global index of environmental contamination** as proxy for hygiene behaviours, and explore their relationship with diarrhoea disease. This does not permit any discrimination of the relative importance of various risk factor so that they are almost useless.

The given quantification of Relative Risk for diarrhoea associated with this practices should be taken cautiously. The low agreement of repeated observations and between observation and questionnaire, underline that health behaviours, at individual level are not habitual; they change so easily that the assignment of level of exposure based on single observation or on questionnaire-based interview is subject to error. Nevertheless, being this a non-differential misclassification, the RR calculated probably underestimate the real magnitude of the effect. To estimate an expected health impact from the implementation of changes in these selected behaviours, based on the evidence so far collected is therefore not easy. But the same evidence is sufficient to justify the need of intervention studies; the review of intervention carried on and whose results are known is the aim of the following section.

4.4 INTERVENTION STUDIES

Since many observational studies point consistently at the same behaviours as risk factors for diarrhoea disease, the experimental design is needed, to allocate an intervention to one group of people and measuring the incidence of diarrhoea and the change in behaviour in comparison to a control group.
The comparison pre-\post-intervention is not sufficient: any community based intervention is likely to produce an effect anyway, for the simple reason that people behave differently when they are studied. Moreover they are easily confounded by external factors; "a new bus-line coming through the village is enough to change the situation of the study population almost completely" (Widstrand, 1991)
Nevertheless an attempt to quantify the impact on diarrhoeal disease of an hygiene intervention has to be done. Otherwise, theoretical discussions of educational approaches or qualitative description of field experiences (Feachem, 1984) will never succeed in convincing policy makers to include hygiene intervention in diarrhoeal disease control programmes.

The list of intervention studies located, with reference and brief description of the implemented intervention is given in Table 8. Further details are in Table 4. The number in the table will be the reference number for each study, from here onwards.

Table 8: List of intervention studies on hygiene behaviour and diarrhoea

No.	REFERENCE	TYPE OF HYGIENE INTERVENTION PROMOTED
18	Ahmed et al (1993)	Three themes for a total of 20 messages: 1) ground sanitation (keeping babies from touching disease-causing matters.; 2) personal hygiene (after defecation and general cleanliness); 3) food hygiene, especially bottle.
19	Alam et al (1989) Alam & Wai (1991)	Promotion of consistent and exclusive use of handpump water, improvement of water handling and storage practices, disposal of stool faeces, handwashing before handling food and rubbing hands in ash after defecation.
20	Aziz et al (1990)	Use of handpump water for all personal and domestic purpose, and the need of all the members of household, including children to use latrines
21	Black et al (1981)	Promotion of handwashing in employees before handling food and after arriving at the centre; children helped to wash their hands when entered the centre, used the toilet, were diapered or prepared to eat.
22	Blum et al (1990) Huttly et al (1990)	Broad health education on various health and hygiene behaviours (including handwashing and sanitary disposal of faeces) was provided by VHWs visiting individual households over one year; than approx. monthly "mass rallies" held in the villages and specific topis discussed in each occasion.
23	Haggerty (1991)	4 key messages implemented: 1)sweeping the yard twice/day; 2)handwashing before cooking and eating and after defecation; 3) washing hands and buttocks of children after def.; 4) disposal of child faeces
24	Han & Hlaing (1989)	Mothers provided with 2 bars of soap and asked to wash their hands after defecation and before preparing or eating meals; message reenforced every day and compliance checked by weighting the soap.
25	Khan (1982)	Families provided with soap and pitchers, and urged to wash their hands after defecation, after children anal cleansing and before eating. Each family observed 1-2 hours/day to assess compliance.
26	Lanata (1991)	Five intervention cells: water quality, cages to restrain chickens, handwashing intervention, all three int. together and none. Handwashing families provided with soap, container for bathing and soap, towels and jars for clean water. Instruction to wash hands after defecating or changing diapers, before cooking and eating.
27	Pinfold (1990)	Promotional campaign through media and schools to improve only 2 messages: 1) handwashing before eating, cooking or feeding baby, and after defecation or cleaning a baby's bottom; 2) dishwashing immediately after meals.
28	Stanton & Clemens (1987)	Three messages on: -mothers handwashing preparing food, -avoiding defecation of children in the living area, -proper disposal of faeces and garbage, implemented through group discussions, larger demonstrations and community meetings.

29	Sircar et al (1987)	Families provided with 2 cakes of soap and advised to use one after defecation and the other before eating or handling food. The dimension of soap checked every week for compliance. Every three months message reenforced by medical staff visits.
30	Torun (1982)	Nine 1-hour sessions between educators and groups of mothers (9-27/group) using stories and discussions assisted by radio plays and evocative pictures. The content covered recognition and treatment of diarrhoea, excreta disposal, hand-washing, breastfeeding, food-hygiene, care of drinking water and diet.
31	Wilson et al (1991)	Promotion of handwashing with soap after defecation and before contact with food; mothers given soap and explanation about faecal-oral route of diarrhoea transmission.
32	Mahoney et al (1990)	Messages about the mechanism of spread of *shigella* and methods of prevention (handwashing, isolation and food preparation) given to the primary caretaker of children with culture-confirmed shigellosis. Messages delivered either by telephone or home visits.
33	Odumosu (1982)	Health talks given to the mothers in health centre about nutrition, food hygiene, personal hygiene, infant feeding and environmental sanitation.

The 16 studies are not homogeneous: both the interventions themselves and the methods used to evaluate them, vary. Here they will be analyzed by the type of intervention they tried to implement.

a) -handwashing;

b) -mixed hygiene education;

c) -integrated intervention (mixed health education + water and/or sanitation facilities).

4.4.1 Handwashing intervention

Five studies have been located which focused their intervention only on promotion of handwashing, although it appears in almost every study promoting health education. To them another one is added (26), which compared handwashing with improving water quality.

Their description is presented in Table 9.

Table 9: Handwashing intervention studies

FINDINGS	PROBLEMS	CONCLUSIONS
21) Black et al (1981); Atlanta, urban USA 116 children aged 6-29 months were studied in 4 day-care centres. Two centres received promotion campaign (regularly reenforced) for children and staff handwashing after toilette and before eating. Incidence of diarrhoea monitored for 10 months.		
Incidence of diarrhoea in children 6-29 months old was reduced by 75% in comparison to pre-intervention period and was approximately half that of the control centres.	No attempt to identify diarrhoea at home. Frequent visits by the investigators make difficult generalizations. No measure of compliance of handwashing.	48% of reduction in diarrhoea incidence in day-care centres in children 6-29 months aged with handwashing programme, under strict supervision. Reduction more significant in 6-18 m. age group.
24) Han & Hlaing (1989); Rangoon, urban Burma Randomized handwashing intervention in poor community. Two bars of plain soap provided + advice on handwashing after defecation and before preparing or eating meals. Diarrhoea and dysentery of 474 children aged 0-4 years (236 intervened, 238 controls) monitored during 4 months.		
Diarrhoeal incidence significantly lower among the children in the intervention group. For dysentery the reduction was only in < 2 group and not significant.	No measurement of compliance is given; only said that "poor compliance was assessed as minimal". Dramatic reduction in incidence also in the control group.	Handwashing reduced diarrhoea incidence by 30% compared to control. Incidence in dysentery not reduced in older children because of more contacts person-to-person

25) Khan (1982); Dhaka, Bangladesh Families of patients with culture-confirmed shigellosis were given soap and/or pitchers and urged to wash their hands after defecation and before eating.		
Secondary case rate was 2.2% for the soap and pitcher group, 14.2% in the control group. No significant reduction in groups provided only with water.	Surveillance for only 10 days. No measure of compliance is given. No explanation on the educational message.	Handwashing had lowered the shigellosis secondary case rate by 84%, which corresponds to a reduction of 35% in attack rate. Attack rates for other diarrhoea was 37% lower
29) Sircar et al (1987); Calcutta, urban India Handwashing was introduced in one slum, while another nearby slum served as control. 370 families (1810 persons) received 2 cakes of soap every two weeks. Subject advised to use one after defecation, the other before handling food. Every three months meeting staff-dwellers to improve awareness about importance of handwashing. Active surveillance once a week for 13 months by physician to record watery diarrhoea and dysentery. 370 families (1858 persons) acted as controls		
No difference in the overall incidence of watery cases between the study and control groups. Significant difference in incidence of shigellosis only in older children.	The baseline incidence of diarrhoea and dysentery in children in the two groups is not Known; so no comparison pre to post-intervention. Not clear how the intervention was introduced.	41% of reduction in shigellosis in children aged over five in test group in relation to controls. The same reduction not observed in under five because handwashing could not be effectively enforced in this group.
31) Wilson et al (1991); Lombok, rural Indonesia Sixty-five mothers from one village were given soap and an explanation of the faecal-oral route of diarrhoea transmission. Message reinforced fortnightly during active surveillance for registration of diarrhoea cases repeated over 20 weeks). In the control village mothers were not given health education about ORT.		
130 mothers and 315 children covered by the survey. After the campaign 92% of mothers claimed to wash their hands with soap after defecation. Dramatic reduction in diarrhoea episodes in under 11 children.	No measure of intervention compliance is given. 2 week recall period too long for diarrhoea. Not clear how the mothers were selected. Follow up claimed for 20 weeks, but in the tables it appears max. 11 weeks. % of literate mothers was higher in study group (10% to 3%). No attempt to control for confounding, cursory analysis.	89% reduction in diarrhoea episodes compared to pre-intervention period (30% reduction also in control village). Two years after the intervention, 79% of mothers were still using soap, despite the fact they now had to buy it.(Wilson & Chandler, 1993)

26) **Lanata (1991); Lima, Urban Peru** Randomized controlled trial to evaluate the protective efficacy of improving water quality and hygiene practices in reducing diarrhoea rates and infections with Shigella and Campylobacter in children 6-18 months old. People in handwashing group provided with free soap, plastic container for bathing, soap container, towels and a plastic jar. People in water quality group provided with container with faucet, containers for transport and storage. Control group provided with nothing. Each group of 100 randomized families.		
All groups, including control, had a significant less diarrhoea incidence after study. When measure of compliance used, only handwashing associated with significant reduction in diarrhoea, in the intervened group compared to control	Team of field workers never rotated, possibility of measurement bias. Only preliminary results available.	In a very contaminated environment only handwashing with soap seems to have a role in preventing diarrhoea. Number of handwashing done per day seems more important than the reason for doing it.

Summary of handwashing interventions

Evidence of the efficacy or effectiveness of handwashing is given in all the five studies, and it is quite consistent. Reduction in diarrhoea incidence has been observed in every setting:

-30% in a rural poor community in Burma (24);

-89% in a poor rural community in Indonesia (31);

-48% in a urban richer setting in USA (21).

It is effective also in reducing incidence of shigellosis:

-84% of secondary attack rate reduction in Bangladesh (25);

-41% in India (29), in children over 5.

Providing only water seems to have no impact (25), whereas water + soap produced a significant reduction estimated in 35% on shigellosis and 37% on other diarrhoeas.

It is impossible to work out how much the strict supervision from the investigator influenced the impact. But the report from rural

Indonesia is comforting; 2 years after the end of the study, 79% of the intervened mothers were still using soap, despite they had now to buy it.

Age pattern is contradictory; in Burma (24) diarrhoea was reduced in 0-4 aged and not in older children, whereas in India (29) it is the opposite: shigellosis decreased (41%) in over five and not in under five. In the first case (24) the authors blame the greater No. of person-to-person contacts in older children, and in the second case (29) they inform that the message could not be effectively reinforced in younger children. The relationship between age and handwashing effectiveness needs further investigations.

In the last study, diarrhoea incidence is reported to have a striking relationship only with handwashing with soap whereas no reduction was reported to improved water quality. Further results of this study are waited, but preliminary findings suggest that number of handwashing done per day is more important than reason for doing it; probably in heavily polluted environments, opportunities for hand contamination are much more numerous than the ones we suspect, so that no handwashing, however oddly timed, is wasted.

4.4.2 Mixed hygiene education intervention

Seven studies have been located and of each of them a brief description is in Table 10.

But only six studies will be analyzed because the last one (33) gives no clarification on how the outcome is measured; in it diarrhoea is estimated by mothers recall in over a undefined "pre and after intervention period". Neither clear is the kind of intervention implemented and, finally, there is no control group.

Table 10: Mixed health education intervention studies

FINDINGS	PROBLEMS	CONCLUSIONS
18) Ahmed et al (1993); Manikgonj, rural Bangladesh Hygiene education during 7 months in 5 villages, provided by health community workers, through participatory approach. Main messages about ground sanitation, personal hygiene and food hygiene. Diarrhoea morbidity, cleanliness and growth monitored for 6 months in 185 children aged 0-18 months and in 5 control villages.		
Intervention site: dramatic improvement in cleanliness, prevalence rates of diarrhoea consistently lower, decrease in the rate of bottle feeding (from 40 to 5%) and reduction in of severe malnutrition.	Diarrhoea morbidity measured as daily prevalence, not as incidence. Improvement in cleanliness also in control site. Difficult quantification because only graphs presented. Difference disappeared in the last month of the study.	Community-based education can improve hygiene knowledge, even in an impoverished setting. Reduction in diarrhoea prevalence approximately 40%.

23) Haggerty (1991); Kikwit, rural Zaire Randomized, controlled trial of an educational intervention to reduce diarrhoea through improved personal and domestic hygiene, in 18 separate village clusters. Diarrhoea morbidity of 2082 children aged 3-35 months collected at weekly home visits during 12 weeks, in pre- and post-intervention period.		
Incidence rates from pre- to post-intervention periods declined in 6/9 villages, both in intervened and control areas.	Several of the volunteers were inadequately selected, poorly motivated and lacked supervision. Time frame for the study too short: only three months between intervention and evaluation of impact.	11% reduction in reporting risk of diarrhoea in post-intervention period, in intervened areas to control areas.
27) Pinfold (1990) and Pinfold (1993); Ban Daengnoi, rural Thailand Intervention study to improve handwashing and washing dishes immediately after use, in 422 households for a population of 2110. Health education to two groups, one also received a plastic container with tap. Main outcome indicator was *Escherichia Coli* contamination of stored water and fingertips, but also diarrhoea incidence measured, in a random sample of 60 households.		
The post-intervention levels of fingertips contamination for "education & tap" was consistently less than its pre-intervention levels, whereas the "education only" remained at the same levels.	Pre-intervention levels of contamination were not similar for the groups. Surveillance in the control group only for 6 months (12 in the intervention). Doubts about efficacy of bacteriological indicator for hygiene behaviour.	34% of diarrhoea reduction in the intervention group that received also container in comparison to the control.($p<0.01$) Both the behaviours implemented improved in the intervened area but not in the control.
28) Stanton & Clemens (1987); Dhaka, urban Bangladesh Randomized trial, personal and domestic hygiene educational intervention. Intensive training programme over 8 weeks, including small group discussions, demonstrations and action meeting. 3 main messages: handwashing, disposal of faeces and removal of garbage. Diarrhoea monitored in 937 intervened and 986 control children aged 0-6 years. Hygiene practices of 247 families observed.		
Diarrhoeal reduction in intervened communities, largest reductions in children 12-35 months. Improvement in handwashing (49% in intervened to 33% in control) but not in defecation and waste disposal practices	High rate of migration in the study area, but baseline data are similar. No improvement in two target behaviours. Difficult to discern whether handwashing is the only responsible for the impact or is just easier to measure.	Hygiene education led to 26% reduction in childhood diarrhoea. Impact on behaviour greater when educational message is simple and acceptable.

30) **Torun (1982); Florida Aceituno, rural Guatemala** Promotion of health awareness and hygienic behaviour among mothers in 153 target families. Diarrhoeal morbidity of children 1-6 years old and domiciliary behaviours monitored in target and 32 controls families.		
Behavioral improvement in both groups, but significantly greater in targets. Reduction of proportion of days with diarrhoea greater than reduction in incidence. The largest reductions in peak season, and in children 0-23 months.	Control group represented by people who refused to participate in the intervention (selection bias). No definition of diarrhoea was given.	Hygiene education can lead to 14% of reduction in childhood diarrhoea. Seasonality of impact of hygiene behaviours: 32% to 36% in peak season.
32) **Mahoney (1990); Shreveport, urban USA** During an outbreak of shigellosis, households with culture-confirmed *S. sonnei* were contacted and provided education on prevention of dysentery. A survey was done in 43 intervened and 33 control households to measure secondary attack rate of shigellosis and knowledge on prevention practices.		
Members of intervened households had more knowledge about handwashing (rate ratio [RR] 4.7); but they experienced higher attack rates of *Shigella*-associated diarrhoea ([RR] 1.4.	Cases identified through telephone interview months later the outbreak. Only reported behaviours were assessed	The intervention programme improved knowledge about prevention but came too late to prevent transmission. Only 25% of the households were contacted by the eighth day after onset of dysentery in index case, when 90% of transmission has already occurred.
33) **Odumosu, (1982) Ile-Ife; urban Nigeria** one hundred nursing mothers attending welfare clinics were taught methods on personal and domestic hygiene. The incidence (?!) of gastroenteritis among babies was investigated.		
Significant difference in the incidence of among babies at the 1% level after exposure of their mothers to health education is reported.	Diarrhoea episodes are recalled by the mothers and are referred to a not-specified period (before and after the intervention!). No control group, neither attempt to control for confounding.	The magnitude of flaws in the study does not permit any conclusion. It will be excluded from the analysis

Summary of health education interventions

Out of the six studies analyzed, only one (32) provides negative evidence on the effectiveness of hygiene education but

also gives reasons for that. Health education given to household contacts in an outbreak of shigellosis, improved health knowledge but failed to decrease the spread of disease because it came to late. 75% of the households were contacted after one week, when more than 90% of transmission has already happened.

The other five studies provide clear evidence of the effectiveness of hygiene education in reducing diarrhoeal disease.

In one of them, in rural Bangladesh (18) the reduction is clear but difficult to quantify since the outcome is measured as daily prevalence of sick children over total children observed.

In the remaining four studies the impact of hygiene education is clear and consistent. In is expressed in a reduction in diarrhoea incidence which is:

-11% in rural Zaire, in children 3-35 month old (23);

-26% in rural Bangladesh in children aged 1-6 (28);

-34% in rural Thailand in "younger children" (27);

-14% in Guatemala in under 6 children (30)

All the interventions focused on personal and domestic hygiene, but the type of health education given varies from the broadest rang of 54 messages in Guatemala (30) to the minimum of 2 messages in Thailand (27). All of them included sanitary disposal of faeces among the main messages.

In all the four studies, the intervention was implemented only after another companion study had identified those hygiene behaviours believed to be greater risk factors and amenable to change.

In one of the studies (27), the education intervention was

supported by the provision of a plastic container with a tap to a limited group of intervened people. Only this sub-group showed a significant improvement in hand contamination, while it is not clear whether the diarrhoea reduction referees to all the intervened persons or only to these.

Problems of "spill-over" of the educational messages were reported, not surprisedly, in four studies (18, 23, 27, 28), which showed a reduction of diarrhoea disease also in the control area (but less important that in the intervened area). When the intervention is an educational message it is problematic to keep the two groups completely separated if they are located in neighbour areas. When the intervened and control area are very distant, it is easier to separate messages but they may lack comparability; moreover logistic difficulties may pose a major obstacle to field operators monitoring and support. (Haggerty, 1991)

4.4.3 Integrated environmental interventions

Only three studies have been located which provided health education in connection with a broader environmental intervention. Description of them is given in Table 11.

Table 11: Integrated environmental interventions

FINDINGS	PROBLEMS	CONCLUSIONS
19) Alam et al (1989), Alam & Wai (1988); Teknaf, rural Bangladesh Integrated environmental project providing handpumps and health education to a village (2173 habitants). Health education focused on hygiene behaviours and use of handpump water. Adjacent village (2067 people) as control. Diarrhoea of 314 intervened and 309 control children aged 6-23 months, + water, sanitation and hygiene practices monitored, through weekly visits		
Large diarrhoeal reductions in both intervened and control areas. Lower diarrhoeal rates associated with improved personal and domestic hygiene. Handwashing reported 27% more common in intervention area.	Lack of baseline data prevents evaluation of impact of hygiene education. Hygiene observed for only one day, not in peak diarrhoea season	Without hygiene education, integrated environmental projects may not reduce diarrhoeal incidence. Adoption of 4 hygiene practices + handpump associated with 43% diarrhoea reduction
20) Aziz et al (1990); Mirzapur, rural Bangladesh Integrated environmental project providing handpumps, latrines and health education to 5000 people in two test villages. Diarrhoea morbidity of children aged < 5 years, domestic and sanitation behaviours monitored in test and 3 control villages (4600 persons).		
Diarrhoeal reduction in intervened and control areas, but 25% greater reduction in intervened, primarily among children 6-59 months old. Dysentery incidence about 30% less than the control area.	Difficult to distinguish between effects of different interventions	Combined package of WSS and health education resulted in significant decrease in diarrhoea (25%) and dysentery (30%). Persistent diarrhoea remained constant in intervened areas but about doubled in control area.

22) **Blum et al (1990), Huttly et al (1990); Ohoazara, rural Nigeria** Integrated environmental programme providing boreholes, handpumps, latrines and hygiene education to three test villages. Diarrhoea morbidity of 1400 children aged 0-6 years, and water/sanitation/domestic hygiene behaviours monitored in test and 2 control villages.		
No consistent differences in diarrhoea rates between study areas. No clear behaviour change. Water became heavily contaminated during collection and storage.	Emergence of a new spring in the control area confounded water source comparison.	Diarrhoea incidence related to time spent collecting water. When > 2 h/day, risk significantly increased in 0-4 children (OR=2.91).

Summary of integrated interventions

Two of the three studies (20, 22) provided health education annexed to an intervention aimed at improving both water (handpumps) and sanitation (latrines). The third one's intervention (19) provided only water.

In two of them (19, 20) there was clear evidence of a positive impact of integrated intervention on diarrhoea morbidity:

-43% reduction in rural Bangladesh in children 6-23 months aged (19), when all the four hygiene messages were adopted;

-25% reduction in under 5 in another part of Bangladesh (20);

-30% of reduction in dysentery in the same study.

The third study (20) showed no difference in diarrhoea reduction in control area as in intervention area; measures of behaviour change were not well done making it difficult to assess the impact of the hygiene education.

The intervention was confounded by the emergence of a new spring in the control area during the study. In fact, daily water collection time of more than 2 hours was associated with a three-

fold increased rate of diarrhoea among children aged 0-4.

In Teknaf, Bangladesh (19) the use of handpumps without any hygienic measure adopted, produced no reduction in diarrhoea incidence. Only when handwashing and sanitary disposal of faeces was added to improved water, diarrhoea disease decreased.
In Mirzapur, Bangladesh (20) the intervention was effective also against persistent diarrhoea, whose incidence doubled in control area and remained constant in the intervention area.

These studies broadly confirmed the need of adding educational messages to environmental interventions, but they make difficult to work out the relative contribution of each component.
In none of these projects health education appears to have been promoted in a very "aggressive" way; it is always the "3rd" component of the intervention, so that the evidence of a multiplicative effect is not proved yet.
The effect of two of the three studies (20, 22) appears similar to that reported by Esrey, 1991 from hygiene interventions (33%) and sanitation intervention alone (30%)
In order to fully address this multiplicative effect issue it would have been necessary studies able to compare integrated intervened group (receiving health education messages + water & sanitation improvements) both to a intervention-free control and to a group receiving only hardware improvements.

The study from Teknaf, Bangladesh, (19) however weak in his single day hygiene behaviour observation, reported an interesting

finding: no significant difference in diarrhoea incidence between groups observing the same number of practices, whatever the combination of these. However diarrhoea rates were found significantly lower when the number of practices increased from 1-2 to 3-4.

This finding confirms the complexity of diarrhoea transmission which Briscoe (1984) tried to explain with the "residual fallacy" theory.

Because the dose-response relationship is not-linear and the transmission is due to several routes, any single intervention will not show the expected effect unless other simultaneous or subsequent multiple changes in environmental conditions and personal health practice happen.

4.4.4. Summary of intervention studies

In **summary** (see Table 12) the intervention studies reviewed yielded a median expected reduction in diarrhoea incidence of 35% when handwashing alone was implemented and 26% when handwashing and sanitary disposal of faeces were included in "packets" of health education.

Table 12: Summary of diarrhoea reduction in intervention studies

HANDWASHING			Packets of HEALTH EDUCATION		
Ref. No.	**Location**	**% diarrhoea reduction**	**Ref. No.**	**Location**	**% diarrhoea reduction**
21	USA	48%	18	Bangladesh	app. 40%
24	Burma	30%	23	Zaire	11%
25	Bangladesh	35%	27	Thailand	34%
29	India	41%	28	Bangladesh	26%
31	Indonesia	89%	30	Guatemala	14%
median reduction		**35%**	**median reduction**		**26%**

The difference between the two medians calculated seems to suggest that simple, single messages are likely to produce a greater impact; although the evidence for this is not conclusive, common sense should advice to keep as limited as possible the number of messages implemented.

The casual association between hygiene behaviours and diarrhoea reduction is enhanced in those studies (17, 19, 20, 27, 28, 30) which were able to provide evidence of a parallel change in health behaviour promoted.

Where it is impossible to assess behaviour change, at least

measures of compliance should be given. Indeed two studies (26, 29) provide indirect confirmation of improved behaviour through a "physical clue", the weight of soap consumed; this seems to be the minimum requirement for any further reasoning on the association investigated.

5. CONCLUSION AND RECOMMENDATIONS

5.1 IS THAT EFFECTIVE?

The main objective of this review was to update the evidence on the impact of changing hygiene behaviour on diarrhoea disease.

The few messages which seem conclusive are summarized as follows.

1. The hygiene intervention that has been most studied is **handwashing**, and it appears to be effective (median reduction in diarrhoea incidence 35%) under a variety of conditions, although it does not seem to be uniformly efficacious in all ages and in all types of diarrhoea. The provided evidence is sufficient to promote this specific behavioral objective either by itself or in conjunction with other interventions.

2. Most of the other studies looked at packages of educational interventions, all of them including **sanitary disposal of faeces** (median reduction in diarrhoea incidence 26%). The evidence provided seems sufficient to target this behaviour change, in any setting, even where improvement in sanitation & water are still to come.

3. Therefore any Diarrhoeal Disease Programme which wishes to include hygiene behaviours promotion among its activities,

might start with the implementation of the two mentioned above.

4. In the absence of substantial improvements of water supply and sanitation, promoting handwashing and sanitary disposal of faeces is less attractive but still possible. And it may be necessary in places where hardware improvements are not forthcoming or feasible. The opposite does not make sense. No **environmental intervention** will work properly without a component in hygiene education.

5. Other priorities in behavioral interventions will be based on **local factors**, which are essentially of three types:
   a) physical factors, i.e. availability of latrines, environmental contamination, water supply, presence of animals.
   b) **cultural factors**, i.e. current behaviours, prescribed and proscribed behaviours, broader significance of hygiene.
   c) **socio-economic factors**, mainly literacy of mothers and housing condition. It seems that literacy is synergistic with water quality, whereas it has an antagonistic effect with latrine, in the sense that the impact of improved sanitation is greater in illiterate than in literate. (Esrey et al, 1985) The association of mother's literacy with hygiene behaviour is even more complex and need further investigation

6. There is enough evidence to suggest that **water contamination** during the house storage is an important risk factor in diarrhoea disease; but it is not clear yet the impact on diarrhoea disease of practical and simple solutions to reduce it.

7. **Observational studies** suggest the existence of many others hygiene risk factors, but their evidence is inconclusive to distinguish those which really interrupt the disease. These studies have played their role in identified broad categories of important behaviours; but the inter-relationship between behaviours is so complex that trying to disentangle them on observational basis may seem endless. The direction now should be to aim for well-designed effective interventions; observational studies may help, in the preparation phase, to shape the intervention on the specific needs and practices of the chosen community.

In conclusion, improving personal and domestic hygiene is effective in reducing diarrhoeal disease; whether it is also cost-effective is an essential topic for further investigation. Earlier estimations (Phillips et al, 1987) do suggest so, but they need to be updated, with the richer evidence now avaliable.

Anyway, while pursuing for water & sanitation improvements, and waiting for new rotavirus and cholera vaccines, the combination of hygiene promotion with measles immunization and breastfeeding,

appears to be the best strategy to reduce significantly the diarrhoeal burden in Developing Countries, in an effective but yet cheap and affordable way.

Incidentally this review has enabled another question to be considered -whether narrowly focused interventions can be successful in changing complex behaviours or more global goals of increasing hygiene awareness are also necessary. (Bateman, 1991) There is no straight answer to that, but this review suggests that the implementation of small hygiene projects at peripheral level, with limited targets, carefully chosen within a actively involved community, may work in reducing diarrhoea disease even in the absence of a national institutionalization.

Advances in women education, literacy and empowerment, environmental improvements in water & sanitation are not, in some Developing Countries next to come. While waiting and looking for broader goals of development, diarrhoeal problem urges for innovative small-scale solutions at village or district level. NGOs, especially those involved in long-term P.H.C. programmes, may play a decisive role in arising the community awareness of the validity of hygiene interventions and supporting the onset of them.

5.2 PRACTICAL IMPLICATIONS

Once an hygiene behaviour has been recognized and targeted, a strategy needs to be developed and than implemented to change it. It is theoretically possible that the health impact of hygiene behaviour interventions will be even greater as their design and implementation strategy improve.

It is not the aim of this work to define a strategy for implementation of hygienic behaviours, but the revision of studies and papers provided suggestions on **some issues** which will be summarized as follows.

1) Human behaviours stem from a combination of socio-economic and cultural factors which is often hard to understand. But **any behaviour can be changed.**

2) A change in behaviour may be followed by a change in attitude; it is not always the other way around; so a change in knowledge and attitude is neither sufficient nor a necessary cause for behaviour change. In Thailand Pinfold (1993) reported that increased knowledge about the importance of handwashing was not followed by a significant behaviour change in the group provided with only "education".

3) An hygienic behaviour, although is health related, **can be carried out for other than health reasons.** (Borghorff, 1987c). For example, hand-washing may be promoted on the basis of symbolism (Kunstander, 1991), it is not necessary for children's parents to learn about etiologic models.

4) Mothers in developing countries are already over-loaded,

and any strategy which forgets it, however justified, is doomed to fail. The focus must be on **simple, clear, cheap improvements** that can be carried out without subtracting energy and time to other activities regarded as priorities for surviving (food preparation, agriculture, house duties, trade, child caring).

5) Most hygiene education activities emphasize working with women. (Hubley, 1992) While it is true that they bring up children and undertake most of hygiene activities, they are often not the persons who have the **power in the community.** Fathers, older children and community leaders need to be addressed as deeply as the mothers in order to achieve permanent improvements.

An **example to illustrate the two precedent points** comes from the attempt to improve handwashing in Zimbabwe (Morgan, 1990) and Guatemala (Hurtado, 1993).
The provision of simple containers, like *Tippy tap* or *Mukombe* (see **Appendix C**) which allow handwashing with very small amount of water have been tested and are extremely promising.
More interesting is the attempt to involve other members of the family in the handwashing implementation.
The father in making "Tippy tap" and an older child in the responsibility of taking care in the house of a *handwashing corner*, which means: filling in with water, letting parents know when the soap ran out or the cloth needed changing, stopping children from playing with him, and helping to wash young children's hands.

Innovative, simple techniques like this, which are culturally acceptable and economical affordable need to be worked out also for sanitary disposal of faeces and for water storage.

6) It is true that an educational programme will only influence people's actions if they have the **resources** to do what is asked of them. (Hubley, 1987) But sometimes people may have resources but not the willingness to use them unless

it is proven to be effective. The provision of simple support in the beginning of the intervention can switch it on. The example of Indonesia is illustrative of this message. (Wilson et al, 1993)

7) Two are the **main approaches** that attempt to change health-related behaviours (broadly "health education"): (Borghorff, 1987c)

a) Educational approach:
is based on people's immediate interests and needs and poses problems which participants themselves solve through discussion and action taking. It demands extremely flexible planning in management, is expensive and it is hard to do in large scale programme. Moreover the community's priorities may not concern health at all, or may concern the need for curative services.

b) Promotional approach:
It means to pay attention to the "consumer" by understanding their behaviour, investigating the determinants of current behaviours and designing an intervention that is culturally appropriate and uses communication messages that make sense to the population. Social marketing is the best example of this approach which has been successfully used in Thailand in promoting handwashing (Pinfold, 1993). In Thailand, for example, diarrhoea was not stressed in promoting handwashing, because there is no immediate benefit to the consumer from disease prevention. Social marketing is attractive but obviously more difficult than commercial advertising:
-social products are more complex than commercial ones;
-social products give less immediate satisfaction to the consumer;
-the target audience for social products is generally poorer and less educated.

The choice between the two approaches is essentially a choice between short- or long-term achievements, i.e. essentially a political choice.

8) To provide hygiene behaviour messages **within a general health package** including other important activities (weaning, growth monitoring, immunization, breast feeding, etc.) carries the risk of diluting the hygiene message and loosing its efficacy.

9) The **selection and prioritarization** of target behaviour is one the most difficult task of health planners. (Booth, 1992)

Two main criteria must direct the selection: potential impact and amenability to change; the latter includes aspects like: perceived consequences, cost, complexity, frequency, persistence and observability of the behaviour.

10) Interventions are more likely to achieve behaviour change if they **build on what people are already doing** correctly. It means that often existing behaviour which and are approximations of ideal behaviour should be preferred.

11) **Teaching hygiene behaviours to schoolchildren** is essential, not only because of the risk of contracting diarrhoea at school, but also because of the role of the schools in modelling behaviours that will have long-term influence on the child and his/her future family.

12) So far the need of a **control group** in experimental intervention has limited the choice of adequate strategies and channels. In an unpublished project in Guatemala, strategies and channels were selected according to potential contamination of the control group rather than target audience needs. (Booth & Hurtado, 1992)

In the future strategies of implementation of behavioural changes need to be tested on a broader scale out of the experimental setting: their efficacy has already been proved, what they now need is just **political commitment** and **technical persistence** to build up their effectiveness.

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A P P E N D I C E S

Appendix A: description of case-control studies appendix.1

Appendix B: description of cohort studies appendix.6

Appendix C: examples of simple home-made containers for handwashing appendix.10

APPENDIX A

Description of case-control studies

1) Aulia et al (1994); Rambutan, rural Indonesia	
Methods	20 week case-control study of 48 household with high incidence of diarrhoeal disease and 111 household with low incidence. Surveillance twice a week in children under 3. Data collection through questionnaire interview and short observational check list
Main risk factors	Disposing of children's faeces in open places rather than in latrine (0R>10.4); -children eating with hands (OR=3.22); - household members defecating in open places rather than latrines (OR=2.6). Also house without sewage system (OR=6.98)
Limitations	Based only on reported behaviours (96.5% of people reported to boil drinking water!). Claimed short observational checklist do not appear in the results. Arbitrary cut-off point of 2.8 episodes/year/child to divide cases from controls appears too high.
Main message	Factors most affecting the frequency of diarrhoea are those related to the contamination of environment within and adjacent to household.

2) Baltazar & Solon (1989); Cebu, urban and rural Philippines	
Methods	281 < 2 children with diarrhoea (cases) and 384 < 2 children with ARI (controls) were selected in 16 clinics. Data collection through questionnaire, partially administered at the clinic, partially in a follow-up visit at home.
Main risk factors	Unsanitary disposal of faeces was associated with a 34% increase (OR=1.34 95% C.I.=0.93-1.92) in clinical diagnosed diarrhoeas and a 63% increase (OR=1.63) in pathogen-positive diarrhoeas. Sanitary disposal considered to throw away the faeces in the toilet.
Limitations	Definition of exposure variable done according the mother's report. The adjusted OR included the unity, the association might be due to sampling variation
Main message	It could be expected a 25% reduction in the rate of diarrhoea (1.34-1/1.34) among those children whose mother are currently engaged in unsanitary practices, if there were an improvement in disposal of faeces.

3) Clemens & Stanton (1987); Dhaka, urban Bangladesh	
Methods	For three months fortnightly, histories of diarrhoea were taken for all the children < 6 years among 1,350 families to estimate diarrhoea incidence. 247 randomly sampled families were visited for prolonged observation of water-sanitation practices. Cases= children with at least 1.7 times the rate of expected diarrhoea, controls= children without diarrhoea.
Main risk factors	-Handwashing before preparing food observed in 82% of controls and 53% of cases. -Ambulatory children defecating in the family's living area were 33% of controls and 80% of cases. -Children observed to place garbage in their mouth were fewer in controls (30%) than cases (47%).
Limitations	31% of the eligible sentinel families were excluded because of incomplete history of diarrhoea incidence. One single observation not enough to pick up variable behaviours, neither to determine the level of exposure
Main message	Study on risky behaviours is essential before implementing an intervention. The case-control method provide a feasible means of arriving at a "community diagnosis" for water-sanitation practices.

4) Daniel et al (1990); Mohale's hoek, rural Lesotho	
Methods	Primarily designed to investigate the impact of improved sanitation on diarrhoea. Data collection through questionnaire; a random example of cases and controls was visited at home. Their guardian were re-interviewed and general condition observed. Total of 806 cases (incident case of diarrhoea in under 5) and 814 controls (children with respiratory infections or trauma).
Main risk factors	Cases were less likely than controls to come from latrine-owner household (OR=0.76 95%CI=0.58-1.01 after adjustment). But evidence of effect modification by hygiene behaviour. Testing for that, results consistent with the hypothesis that latrine ownership or handwashing after defecation alone has little or no effect on the incidence of diarrhoea (OR=1.28 and 0.98 respectively), while a combination of both may lead to a reduction in its incidence (OR=0.70).
Limitations	It is not clear which hygiene risk factors were observed. The validity of questionnaire interview is questionable: e.g. 84% of cases were reported to pass blood and/or mucous in the stool. Mothers seem anxious to impress the attending nurse.
Main message	The practice of handwashing may modify the impact of latrine ownership on reduction of diarrhoea incidence.

5) Dikassa et al (1993); Kinshasa, urban Zaire	
Methods	107 cases of diarrhoea in under 3 admitted to 2 hospital were matched on age and neighbour status to 107 controls. Personal interviews and observation were used to assess knowledge and behaviours related to hygiene.
Main risk factors	1) Improper disposal of child faeces and 2) household garbage and 3) mother's knowledge that poor caretaker cleanliness were the items more significantly related to diarrhoeal disease.
Limitations	Lack of correlation between reported and observed behaviour: the items involving hygienic practices during supervision showed no relationship with diarrhoea. Sample size very small to draw conclusion on so many risk factors. Conclusion of the authors appear naive.
Main message	Synergistic or exponential relationship between behavioral risks. Assuming a causal association (!) between the three risk factors individuated and diarrhoea, up to 70% of the severe diarrhoea in this study population might be prevented removing them.

6) Ekanem et al (1991); Lagos, urban Nigeria	
Methods	273 cases and 672 controls among children aged 6 to 36 months were identified through bi-weekly surveillance during three and half months. Cases had two or more diarrhoea episodes registered. Detailed observation on food hygiene, water sanitation and sanitary condition (each household was visited twice for 3-4 hours).
Main risk factors	Presence of faeces in and around the toilet area (RR=1.79), habit of defecating and urinating in chamber pots in dwelling units (RR=1.80) and indiscriminate disposable of waste (RR=2.48) were the main factors significantly associated with acute diarrhoea disease. No association between any of the observed food hygiene behaviours (including handwashing before preparing meals) and diarrhoea.
Limitations	Sample size very small. To satisfy the sample size requirement also some children (15/67) with only one episode of diarrhoea were considered cases. Observation data obtained 3 to 4 months after the diarrhoea surveillance. The visits for observation were announced, and the observers had no access inside the house.
Main message	Handwashing before handling food may be less important than handwashing at other critical moments (after defecation, after handling children's faeces, before eating). Confirmed importance of sanitary disposal of faeces.

7) Ekanem et al (1994); Lagos, urban Nigeria	
Methods	Evaluation of hygiene practices as risk factors for persistent diarrhoea. 22 cases and 206 randomly selected controls (no diarrhoea) were compared. For details on methods and observation see precedent study.
Main risk factors	No association was found between domestic, environmental and personal hygiene practices and persistent diarrhoea. Significant association claimed for "feeding children with food bought in the street" and "having maize pap as weaning food".
Limitations	Too few cases to draw any firm conclusion. Low proportion of persistent diarrhoea in study population (2.4%) suggest that severe cases were referred and so missed.
Main message	Vendors could play an important role in superimposing the repeated occurrence of diarrhoea leading to prolonged duration.

8) Knight et al (1992); Tumpact, rural Malaysia	
Methods	Ninety-eight pairs of children aged 4-59 months, matched on age, sex and time of attendance were recruited from health centres. Controls were children with ARI. Data on risk factors collected in a home visit (40-50 minutes) performed within 2 weeks, through questionnaire and direct observation.
Main risk factors	The absence of a container of water in the latrine was associated with diarrhoea (OR=2.8 95% CI:1.02-7.72). Houses without a latrine, as compared to houses with latrines with washing water had a similar OR for diarrhoea, 2.97 (95% CI:1.02-8.62). Other significant risk factors were: drinking unboiled water, bottle feeding, storage of cooked food before consumption. Referred handwashing not associated with reduction in diarrhoea.
Limitations	Sample size limited; power of the study was 80% for detecting an OR of 3.0. (with prevalence of 20-60% of risk factor). No correspondence between reported handwashing practices and observed presence of washing water in latrines.
Main message	Risk factors for diarrhoea vary in different communities; a case-control study would enable the formulation of a hierarchy of the most important before the development of any intervention.

9) Menon et al (1990); Apache reservation, rural USA	
Methods	Children under 2 with diarrhoea recruited at hospital, positive for rotavirus antigen were cases; controls selected from record, at the same hospital and matched for age and sex. Data collection through questionnaire and environmental survey of the yard surrounding the house.
Main risk factors	Poor environmental sanitation associated with increase rotavirus morbidity (adjusted OR=3.0; 95% CI=1.03-8.9). Scoring system of "sanitation" related to presence of animal, animal stools, standing water, dirty diapers and unprotected garbage bin in the yard.
Limitations	Environmental survey means walking around for 5 minutes; it doesn't seem sufficient for objective evaluation of hygiene practices. Sample size too small (50 cases). Only 50 out of 78 eligible cases were traced and interviewed.
Main message	Poor disposal of animal and human faeces may contribute to high diarrhoea morbidity even in more contexts.

10) Mertens et al (1992); Kurunegala, rural Sri Lanka	
Methods	2458 under 5 children were recruited as clinic cases from 5 hospitals. Control both from hospitals (4140) and community (1659). Questionnaire used for interview, but a subsample of cases and control were visited at home for further questioning and brief observation.
Main risk factors	Poor methods of excreta disposal associated with diarrhoea morbidity ((OR=1.68 95% CI=1.25-2.27); this protective effect was greatest in households with reported handwashing. After adjusting for confounders, risk retains significance (OR=1.42; 95% CI=1.01-1.98). No evidence that latrine ownership alone is associated with reduction in diarrhoea.
Limitations	Not clear whether safe disposal of faeces was recorded also during observations.
Main message	Attributable risk estimated in 25%; i.e., if the observed proportion (91%) of improper excreta disposal could be reduced to 50%, 12% of childhood diarrhoea episodes would be prevented. Diarrhoea morbidity in Sri Lanka may only be reduced if behavioral changes take places concomitant with the construction of sanitation facilities.

APPENDIX B

Description of cohort studies

11) Bukenya & Nwokolo (1991); Port Moresby, urban Papua New Guinea	
Methods	Children under five were monitored for one year through regular alternate-day visits for episodes of diarrhoea. Data on environmental conditions was done in one point in time during the follow up
Main risk factors	Presence of faeces in the compound associated with a 48% increase in diarrhoea morbidity; presence of pigs in the compound associated with a 69% increase; presence of standpipe in the compound associated with a 56% decrease. No association found for anal cleansing methods, methods of removal of children's faeces from the compound and utensil washing habits.
Limitations	One point in time observation is extremely weak for determination of exposure status to a certain behaviour. Nothing is said on how this observation was done (how long it took, who did it, when and where it was done).
Main message	The effect of presence of faeces, animals and standpipe on the incidence of diarrhoea was not dependent on whether or not mothers were literate. In this study, money and not education seems to determine the strategies available to the mother.

12) Han et al (1986); Rangoon, urban Burma	
Methods	Incidence of acute diarrhoea and dysentery among under-five was monitored daily for 1 month in a community of 386 people. Methods of cleaning the anus after defecation determined using a questionnaire. The degree of hand contamination determined in a sub-sample of eight mothers.
Main risk factors	The incidence of diarrhoea was lowest in those children whose mothers used paper. The risk to water users was 3.8 times that of paper users, but the RR not significant. Hand contamination higher in water users but significantly reduced after experimental washing with soap. Use of paper directly associated with degree of mother education.
Limitations	Sample size very small, data collection time extremely short. Only 23 cases of diarrhoea recorded all together. No firm conclusion can be drawn
Main message	Hands are easily contaminated when anal cleansing is done with only water. Handwashing more important when economic constrain prevent the use of paper.

13) Han & Moe (1990); Rangoon, urban Burma	
Methods	Twice-weekly monitoring scheme for determining diarrhoea in a cohort of 240 children 0-17 months aged during two years. An household faecal contamination index (HFCI) was developed using three factors collected during observation: going about without footwear, indiscriminate defecation near or under the house, and absence of latrines. Dynamic cohort maintained by taking in 60-70 new children every six months to replace those who had reached 24 months of age
Main risk factors	The crude risk of diarrhoea significantly associated to an increase of HFCI. But, after controlling for confounders (maternal education and socio-economic status, the adjusted diarrhoea rate ratios for the three levels of HFCI were not statistically significant.
Limitations	The collection of contamination data (exposure) was done at the end of the study, after the development of outcome. No clarification about methods of observation used. Handwashing not controlled because reported in only 20% of study population.
Main message	Role of not wearing footwear claimed to be important source of house faecal contamination.

14) Henry & Rahim (1989); Dhaka, peri-Bangladesh	
Methods	Diarrhoea incidence in 137 children aged 1-6 years obtained through fortnightly home visits during one year. 56 children in an area with latrines and tubewells, 81 in an area without facilities. Degree of hand and water contamination measured microbiologically.
Main risk factors	No significant association between water contamination and diarrhoea, which instead was significantly correlated with the degree of hand contamination (RR 3.38 95% CI 1.20-9.48).
Limitations	RR adjusted only for age and sex; no attempt to control for education and socio-economic status. Samples for hand contamination collected only in two following days.
Main message	Handwashing is a key element in the multi-factorial improvements necessary to control diarrhoeal disease. Confirmation that water quantity is more important than quality. The impact of handwashing might be dependent on the pre-existing level of sanitary facilities and hygiene.

15) Thongkrajai et al (1990); Amphur, rural Thailand	
Methods	Houses of 1,117 women (and 1,364 children under 5) were visited every two weeks during 4 months to monitor incidence of diarrhoea disease. Data on risk factors collected in a baseline survey, questionnaire based.
Main risk factors	Handwashing before giving milk associated with 25% of reduction in the prevalence of diarrhoea. Other protective mother's behaviours were giving food immediately after cooking and warming food each time before meals. Mothers exposed to national health programme showed higher proportions of hygiene behaviours.
Limitations	Not clear how diarrhoea incidence was measured and how is presented. No definition of diarrhoea is given. All the information collected through questionnaire. No mention of confounding. All the behaviours studied are reported behaviours.
Main message	Exposure to health programmes showed significant relationship with selected maternal preventive behaviours

16) Wright et al (1991); Bilbeis, rural Egypt	
Methods	Incidence of diarrhoea ascertained by twice-weekly home visits over one year in 317 newborn. Data collection through questionnaire-based interview.
Main risk factors	Out of the total incidence explained by environmental factors, household structure accounted for 28%, toilet and bathing area for 12%, ownership of animals for 11%, food preparation for 10%. Hygiene-related variables explained only 3.1% of the variance of diarrhoea incidence. Two practices involving interaction with the environment appeared to be protective: butchering of cattle by the family for home consumption and protection of the infants from flies by a veil during napping.
Limitations	Difficult to sort out the effect of the numerous risk factors studied (> 40). About of 75% of diarrhoea variance remained unexplained. No measure of relative risk is given for different levels of exposure.
Main message	The combined environmental variables explained 25% of the variance in the total incidence of diarrhoea. Changes in a single variable would not have a marked effect on the incidence of diarrhoea.

17) Yeager et al (1991); Lima, urban Peru	
Methods	Incidence of diarrhoea ascertained by twice-weekly home visits over 27 months in a dynamic cohort of 677 children under 3 years. Data collection through questionnaire-based interview.
Main risk factors	Defecation of children outside (OR=1.00) rather than in a latrine (OR=0.35) or diaper/bucket (OR=0.43) associated with higher rates of diarrhoea. Presence of tank without faucet carried a OR=1.97 for diarrhoea related to tank with faucet. Children seen eating faeces (by the mothers) OR=2.71, eating dirt OR=1.36. Neither water use per capita was nor handwashing with soap showed significant association with diarrhoea.
Limitations	The classification of exposure for behavioural risks is done only on mothers report.
Main message	In settings with high rates of diarrhoea and pervasive faecal contamination, there are many transmission pathways operating simultaneously. Thus, reduction in diarrhoeal incidence may depend on a widespread in domestic and personal hygiene rather than elimination of one critical transmission pathways.

APPENDIX C

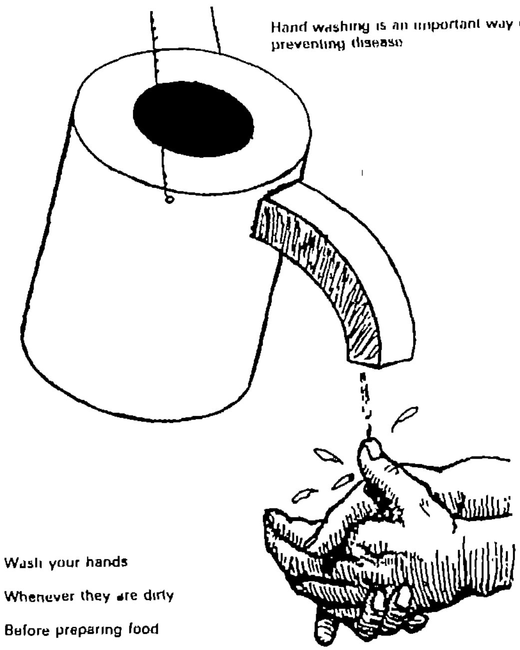
Examples of simple home-made container for handwashing

a) The Mukombe (Zimbabwe)

A leaflet used in campaigns to promote handwashing in rural communities The mukombe is a suitable vehicle on which to promote campaigns of this type It removes bacteria from the hands very efficiently with small amounts of water and is in fact more effective than the method used with bowls

WASH YOUR HANDS

Hand washing is an important way of preventing disease



Wash your hands

Whenever they are dirty

Before preparing food

Before and after eating

After using the toilet

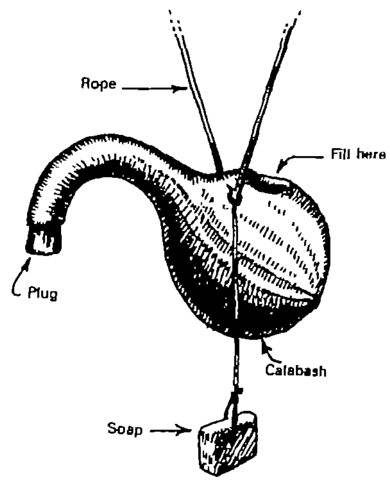
After cleaning children

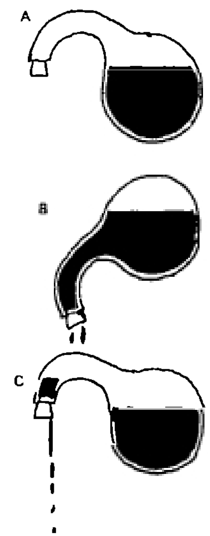
Try to use soap

The mukombe

One of the simplest and most elegant hand-washing devices was designed by Dr Jim Watt of the Salvation Army in Chiweshe. This simple device is cheap to make, effective and economical in its use of water and has been called the 'mukombe' In its simplest form it is the 'mukombe' fruit that is taken straight from the land from a trailing plant Often it is dried out and used as a water bottle, cup or gourd.

The mukombe





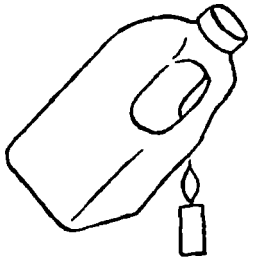
The mukombe is the fruit of an indigenous plant and can have many uses in the rural setting of Zimbabwe It is often used as a cup or spoon It is very common in many areas of Zimbabwe and can be formed into a hand-washing implement very easily The idea is very simple and elegant and was first demonstrated by Dr Jim Watt of the Salvation Army in Chiweshe Many vessels can also be used in the same way What is important is that people have a simple means to wash their hands easily
Illustration by Jim Watt

b) "Tippy tap" (Guatemala)

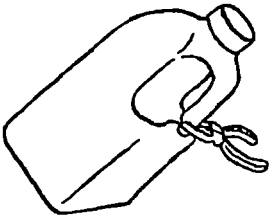
How to make a 'tippy tap'

You will need

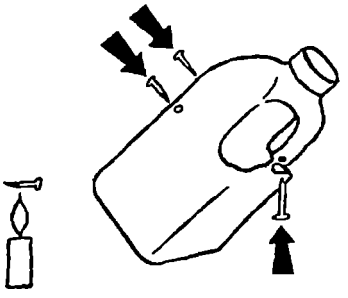
■ a plastic bottle ■ a nail ■ a small empty tin can ■ string ■ a stick ■ a pair of pliers ■ a candle ■ matches ■ a bar of soap



1 Take a plastic container with a hollow handle Gently warm the base of the handle over a candle, turning the handle around until the base of the handle is shiny and soft all the way around

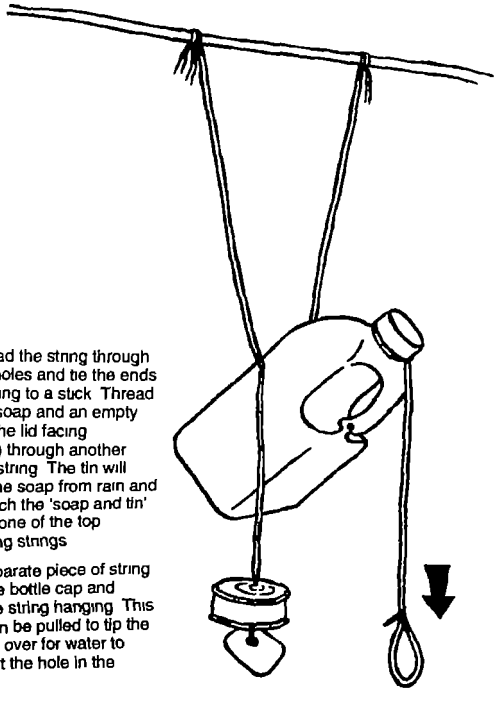


2 Remove the candle and quickly 'pinch' the soft base of the handle with pliers so that the base is sealed tight to prevent water flowing through it Hold the pliers there until the plastic cools, ensuring that the seal is completely closed



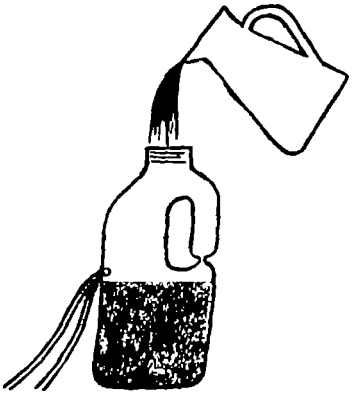
3 Heat the point of a small nail over a candle Use the hot nail to make a small hole on the outside edge of the handle, just above the sealed area.

Heat the nail again and make two larger holes on the back of the bottle The holes should be about half way up the bottle and about a thumb-width apart These holes will be used to thread string to hang the tippy tap The holes need to be wide enough apart to hold the string and to be positioned so that the 'full' bottle hangs at a 45° angle



4 Thread the string through the two holes and tie the ends of the string to a stick Thread a bar of soap and an empty tin can (the lid facing upwards) through another piece of string The tin will protect the soap from rain and sun Attach the 'soap and tin' string to one of the top supporting strings

Tie a separate piece of string to the the bottle cap and leave the string hanging This string can be pulled to tip the tippy tap over for water to come out the hole in the handle



5 Pour water into the tippy tap until the water is almost level with the holes in the back of the bottle Use the stick to hang the tippy tap in the bathroom or outside in a tree The tippy tap is now ready for use

The original gourd tippy tap was designed by Dr Jim Watt and Jackson Masawi at the University of Zimbabwe's rural centre. The plastic tippy tap was designed by Ralph Garnet and Dr Jim Watt in Canada

Drawings by Ingrid Emsden

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