

Water use and patterns of contamination in rural north-east Thailand

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This study indicates that preventing household cross-contamination may increase health benefits more effectively than improving water quality at source. These findings are used to develop a hygiene intervention study which will be published in the next issue.

RECENT ISSUES OF *Waterlines* have focused on the need to improve the quality of drinking water for rural communities in developing countries. WHO¹ provides guidelines for the bacteriological quality of drinking-water to help eliminate water-borne disease, especially the diarrhoeal diseases. Faecal coliforms in drinking water do not demonstrate disease transmission *per se*, however, but indicate that there is a risk of pollution by excreted pathogens which may cause disease. Piped water supplies are generally treated to prevent the transmission of pathogenic organisms to peoples' homes. Rural water treatment schemes are more expensive in terms of unit cost, however, and difficult to implement because

most householders carry water from discrete sources to their homes.

If a health benefit is desired, then the problem facing planners and organizations involved in water supply is how to make the most effective use of their limited resources. Many studies suggest that increasing the quantity of water available for domestic use has a greater impact on diarrhoeal disease than just improving its quality. But it has 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.² Only when the water is supplied in the house or yard does consumption increase further, but then it rises

by a factor of three or more. Providing more convenient water sources has an obvious benefit to householders by saving the time and effort required in water collection. But if planners also want to achieve a substantial increase in water consumption, then this would normally require expensive household supplies.

A case study conducted in rural north-east Thailand selected ten households from one typical Thai village named Ban Sahart ('Clean village'), and these provided the basis for an intensive investigation lasting six months.³ During this period, information on socio-economic status, water users' practices, water sources, and other pertinent factors was obtained by questionnaire and observation. Water samples and the fingertip rinses of householders were examined for faecal bacteria.

The north-east is the poorest region of Thailand and for the most part it relies on subsistence agricultural production of glutinous rice. Most of the rural population live in compact settlements of forty to



All households in this study owned large rain-jars with taps. The rainwater in the jars was usually uncontaminated.

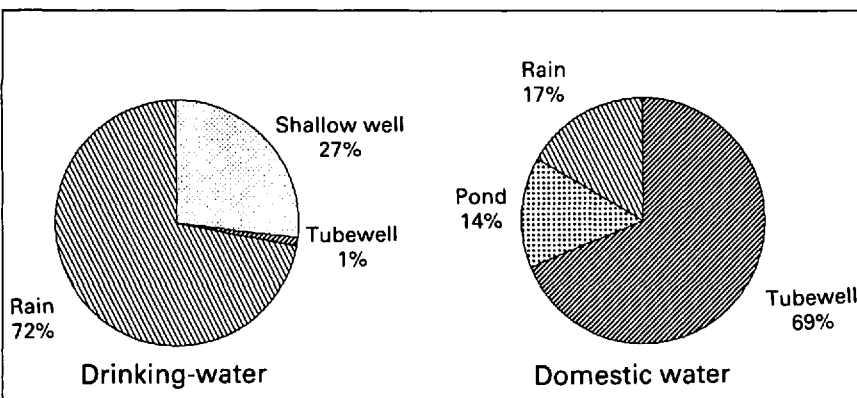


Figure 1. Water source by water use in Ban Sahart.

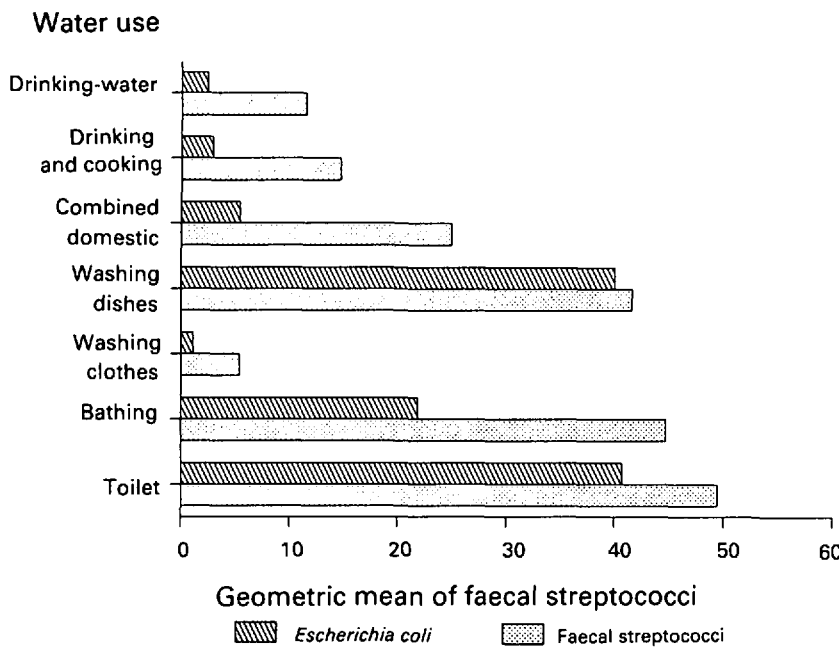


Figure 2. Stored water contamination by water use.

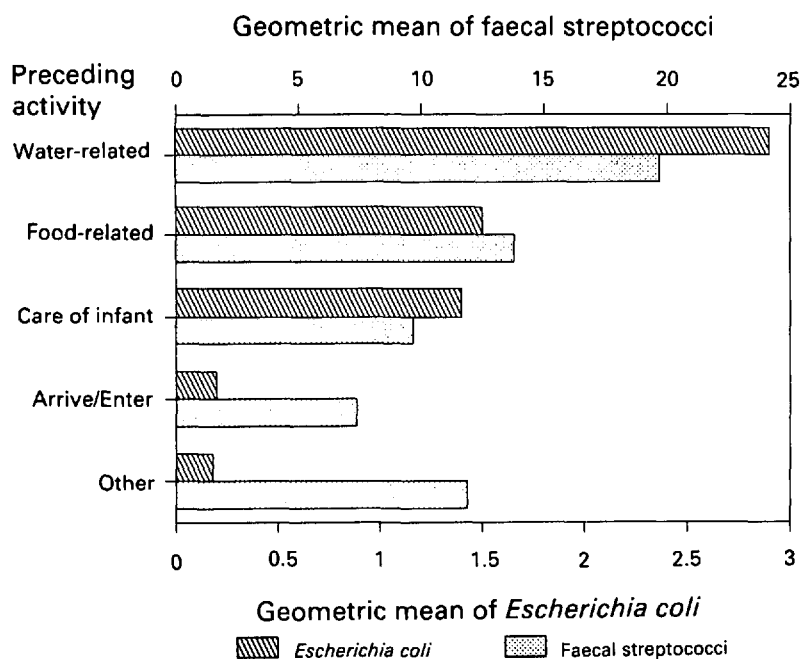


Figure 3. Fingertip contamination by activity.

several hundred households. These villages, shaded by their trees, are usually located on the uplands, and form a sharp contrast with the surrounding paddy fields. There are three typical seasons during the year, which are cool/dry, hot/dry and the rains.

Water sources

The groundwater in this region is often contaminated with dissolved salts which render it unacceptable for drinking, not in terms of water quality standards but by the local inhabitants' keen sense of taste. Thus villagers obtain water from a variety of sources and adhere to a strict regime of water usage. Typical water sources are rainwater collection, shallow wells (not contaminated with dissolved salts), tubewells, and ponds.

All households in this study owned large rain-jars, and rain-water was used for both drinking and domestic purposes when available. When this became scarce, a shallow well (lined but not covered) located 1.5km outside the village was preferred for drinking-water. Many tubewells and two ponds were conveniently located within the village, and these provided water for domestic purposes (Figure 1). Apart from the taste criterion, the selection of a water source followed a pattern of convenience and availability.

Water contamination

A common problem with water testing in warm climates is that many non-faecal coliforms can mimic *E. coli* when standard methods of detection are used. What then is a faecal coliform? Some say that only confirmed *E. coli* should be classed as faecal coliforms, while others suggest that any lactose-fermenting coliform incubated at elevated temperature (44°C) is faecal. Our results show that the majority of presumptive faecal coliforms from water samples close to the surface, (i.e. rain, shallow well and pond), were not in fact *E. coli* when subjected to a confirmation test. Water from tubewells was usually clean but, when contaminated (those located next to latrines), most colonies were *E. coli*.

In general, stored water was much more contaminated than water sources were, but the levels of contamination varied quite considerably. Householders stored

water in a selection of containers which were used for different water activities. Water to be used for anal cleaning was stored in the toilet (most householders owned pour-flush toilets), water for bathing in a bathing area or toilet, water for washing dishes and cooking-related activities in the kitchen area, and water for drinking and cooking (non-domestic) in living/kitchen areas. Once the stored water is classified by use then a clear pattern of contamination emerged (Figure 2). Water used for drinking and cooking was significantly less contaminated than that used for domestic activities. As may be expected, water stored in the toilet was the most contaminated but, surprisingly, water used for washing dishes was a very close second.



Dishes and utensils left to soak in a bowl next to the container used to hold water for washing dishes.

Fingertip contamination

During part of the study an observation chart was used to record the activities of individuals immediately before their fingertips were sampled. The variation between these activities and fingertip contamination was highly significant for *E. coli* but not for faecal streptococci (Figure 3). Laboratory experiments indicate that *E. coli* do not survive well on skin, the majority dying within minutes, whereas faecal streptococci could survive for several hours. This implies that *E. coli* should be largely influenced by activities conducted immediately before sampling, and so child care,

and food and water-related activities produced much higher levels than other activities.

Cross-contamination

The majority of faecal bacteria found in stored water are most likely transferred from the environment through water-related activities by the method of water handling. Evidence to support this was provided by detailed observation of individual households.

- The main method of obtaining water from a container was by use of a 'dipper' (usually a plain

metal bowl). The dippers, and the water therein, often come into contact with surfaces, fingers and objects related to a particular water activity. Water used for drinking was handled in a more hygienic manner than domestic water, however, and in some cases mugs or wooden ladles were used.

- The only containers that were an exception to the above were rain-jars fitted with taps. Their levels of water contamination were unaffected by water activity because water was drawn through taps; in fact, the sheer size of these containers made it difficult to obtain water any other way.

Other expected risk factors such as the presence of animal faeces, location of container, lids, and vessels for collecting water did not show any clear association with water contamination.

Dangers to health

Attention was focused on cooking and food-related activities because of the high risk of ingestion, particularly as only a proportion of bacteria would be expected to be transferred to stored water. It was noticed that most householders left dishes and utensils to soak in bowls before the next use, and this soak-water was found to be grossly contaminated (up to 10^9 *E. coli*/100ml) due to bacterial growth. This is also important where the unrefrigerated storage of prepared foods is common, since certain bacterial pathogens



Sampling the finger tips of a young girl. On the bench is the membrane filtration equipment used for bacteriological analysis.

will be able to use the nutrients to multiply. Although the cooking process should eliminate most pathogens, the main problem lies in the subsequent cross-contamination to foods. This study did not have the resources to test for a range of pathogens, but *Salmonella* spp. was found significantly more often in samples of water used for washing dishes (22 per cent) than that used for drinking and cooking (7 per cent).

A number of likely health hazards arise from the practices observed within these households:

- Although the observed method of washing dishes would dilute the soak-water, the washed utensils would still be grossly contaminated, and in some cases scraps of food particles were still present after washing.
- Cooked and leftover food was often stored on these dishes, thus providing the necessary ingredients for possible bacterial re-growth.
- Persons responsible for washing dishes usually prepared and served the food, thereby providing a good opportunity for cross-

contamination.

- Cross-contamination by fingertips was positively associated with activities relating to water, food, and child care, all of which provide the potential for faeco-oral disease transmission.

It was common practice for mothers to leave their infants or babies in the care of friends, neighbours or relatives, thereby providing the potential for disease transmission between households. Moreover, meals were usually shared with others, and food was often distributed between households or bought from vendors.

Cost-effective strategies

In this particular area, it was rare to find highly contaminated drinking-water sources (>100 *E. coli*/100ml) and most samples contained <10 *E. coli*/100ml. The results suggest that there is a far greater risk of ingesting faecal micro-organisms which have arisen from cross-contamination occurring within the household than from the faecal pollution of drinking-water sources. In fact, given the facilities and

conditions in these households, it is highly unlikely that the cross-contamination by faecal bacteria and potential pathogens can be completely eliminated. Therefore, the level of faecal bacteria ingested from cross-contamination, particularly via food substances, will always be higher than the levels recommended in the WHO drinking-water quality guidelines.

Given the limited resources available for water and sanitation activities, it makes sense to use resources wisely and attempt to provide the most cost-effective service. These results imply that for this particular area, initiatives designed to prevent cross-contamination may be more effective at reducing the amount of faecal micro-organisms ingested than improving water quality at source. Even though water stored for drinking and cooking purposes was handled in a hygienic manner overall, this water was still more contaminated than the water sources. In countries where stored water is not separated by water use, there will be an even greater danger of contaminating drinking-water by the other water-related activities.

This is not to say water quality improvements should be ignored, but rather that they should be assessed in terms of the cost and feasibility of intervening further in comparison to the potential benefit. In north-east Thailand there has been a gradual improvement in drinking-water quality as a result of simple developments such as large rainwater jars fitted with taps. But to provide water treatment in order to comply with the WHO guidelines would be both expensive and difficult to implement. Changes in water-related practices alone, without improving water quantity, may provide a cheaper way of helping to reduce faeco-oral disease transmission. The findings from this study have been used to develop a hygiene intervention study which will be described in the next issue.

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