ASSESSMENT OF SANITATION CONDITIONS BY QUALITATIVE SANITATION MEASUREMENT

Amphorn Ittiravivongs[1], Chart Kasornkul[2], Raweewan Soyraya[2], Jaruspong Soyraya[3] and Junya Pattara arechachai[1]

[1]Department of Tropical Hygiene, Faculty of Tropical Medicine, Mahidol University; [2]Environmental Health Center Region II, Department of Health, Ministry of Public Health and [3]Thai Airways International Ltd, Bangkok, Thailand.

Abstract. Survey of sanitation conditions by qualitative sanitation measurement were carried out in three districts, Chachoengsao Province, Thailand. The sanitation of each household was assessed in terms of positive stool examination and scores of seven main sanitary activities which were used to classify each household's sanitation as hygienic or non-hygienic. Stool collections were made from each household's housewife and examined for pathogenic bacteria and parasites. It was found that in the qualitative measurement of the household's sanitation as hygienic or non-hygienic, most sanitary activities were highly associated with the results of stool examination. From consideration of the sensitivity, specificity and kappa coefficient of significant sanitary activities as predictors and the result of stool examination was used as gold standard, it was apparent that a package of all main sanitary activities was the most appropriate measurement in the survey to assess sanitation conditions in the community.

INTRODUCTION

Food and water related diseases are leading causes of mortality and morbidity in many developing countries. These diseases are normally associated with inadequate environmental sanitation. The most common association is that the pathogens causing the diseases leave an infected person by the way of feces and urine. These excreta are thus the direct source of infections by contamination of water or food, as well as the spreading of excreta by means of rodents, and insects such as cockroaches and flies (Echeverria *et al*, 1983). Because diarrheal diseases or gastrointestinal tract infections(GI tract infections) are related to environmental sanitation, they have been used as study outcomes to evaluate the application of various sanitary measures (Azurin and Alvero, 1974; van Zijl, 1966; Chandler, 1954; Sahba and Arfaa, 1967).

The coverage by specific sanitary facilities of 90% of total households in a community having latrines is commonly used as a parameter in survey of sanitation conditions. However survey of sanitation conditions in a community also requires qualitative measurement. Such qualitative parameters should be able to assess hygienic conditions in relation to sanitation associated GI tract infection. For example, the community with a high hygienic level would have a low prevalence of GI tract infections. Many attempts to develop qualitative parameters such as hygienic scores (Koopman, 1978) and sanitation quality index (Rabbani, 1978) have been made. Nevertheless these parameters were found to be impractical in surveys due to the complexity of the calculations required.

We have developed simple checklists for qualitative measurement of major sanitary activities with the aim of assessing sanitation associated GI tract infection. The present study sought to evaluate these checklists in relation to assessment of sanitation.

MATERIALS AND METHODS

Study area

The survey was carried out in Chachoengsao Province with the aim to study sanitation conditions of the area. Chachoengsao is a small province, 60 km east of Bangkok, comprised of 9 districts, 29 subdistricts and 72 villages. A multistage cluster sampling technique was used in the study. Out of a total of 9 districts, 3 were randomly selected as

the study area. These were Ban Pho District, Pha-nòm Sarakham District and Plang Yao District. From each study district, 30% of subdistricts were randomly selected. Furthermore 30% of total villages in each selected subdistrict were chosen. As the result 28 villages were obtained and every household in these villages (2,690 households) was surveyed.

Sanitation measurements

The sanitation conditions of all study households were measured by seven sanitary activities. These seven main sanitary activities were water supply, excreta disposal, solid waste disposal, food sanitation, rodent and insect control, housing sanitation and waste water disposal. Each activity had its own checklist which was used to score the sanitation condition of the household. The checklists for each activity developed by the research team are presented in Table 1. Each sanitary activity categorized the household sanitation into hygienic and non-hygienic status on the arbitrary basis of a score at 60% or higher as hygienic level. A score of 1 was given for each item provided at adequate standard level.

Table 1

Checklists of seven main sanitary activities.

Sanitary activity	Checklists
1. Water supply	- source of water supply - quality of water - purification of drinking water - storage of drinking water - type of small household containers for drinking water - quantity of drinking water for whole family
2. Excreta disposal	- having latrine or not - regularly use of latrine - location of latrine - condition of latrine - provision of water and soap in the latrine - cleanliness of latrine - excreta storage
3. Solid waste disposal	- having solid waste around the house or not - type of solid waste disposal - method of elimination solid waste - having domestic dung around the house or not - method of elimination domestic dung
4. Food sanitation	- cleanliness of kitchen - having food cupboard or not - type of fish sauce used in the kitchen - way of keeping preserved food - type of kitchen utensils - cleanliness of kitchen's utensils - cleanliness of housewife's finger nails
5. Rodent and insect control	- source of flies in and around the house - source of rodent and cockroach - rodent control measures - cockroach control measures - flies control measures - number of detected flies in the house
6. Housing sanitation	- ventilation system - light system - general cleanliness of the house - household tidiness - sources of physical hazard such as noise, bad smell, smoke
7. Waste water disposal	- method of treatment household waste water - household drainage system - condition of drainage system - stagnation of waste water

Table 2

Association between bacterial stool infection and households' hygienic condition assessed by various sanitary activities.

Sanitary activities	Bacterial infection		p-value
	positive	negative	
All sanitary activities :			0.0019
non-hygienic households	32	391	
hygienic households	6	272	
Water supply :			0.3369
non-hygienic households	18	262	
hygienic households	20	401	
Excreta disposal :			0.7709
non-hygienic households	10	189	
hygienic households	28	474	
Waste water disposal :			0.5766*
non-hygienic households	38	653	
hygienic households	0	10	
Solid waste disposal :			0.5272
non-hygienic households	18	349	
hygienic households	20	314	
Food sanitation :			0.2298
non-hygienic households	7	181	
hygienic households	31	482	
Rodent and insect control :			0.1445*
non-hygienic households	37	604	
hygienic households	1	59	
Housing sanitation :			0.0050
non-hygienic households	21	219	
hygienic households	17	444	

* Fisher's exact test

Data collection

The sanitation measurements were carried out by a group of sanitarians from Environmental Health Center Region II, Chon Buri Province, using the designed checklists under the supervision of the investigators. In order to standardize the scoring system the study checklists were pretested by the same survey team in two villages, Chachoengsao Province. On the basis of the results of this pre-test survey, guidelines for scoring the sanitation measurement were developed and used throughout the study. With the aim of testing reliability of sanitation measurement, 10% of study households were randomly selected for double checking by a senior sanitarian (KC) in the re-search team. It was decided among the investigating team that differences of total scores of 5 or less in sanitation measurement of each selected household for double checking was acceptable. Re-survey of sanitation measurement was done only on those households which had differences of total scores of greater than 5 by the same survey team. Only 1% of households selected for double checking had to be re-surveyed.

Laboratory investigation

It was decided to use positive stool examination as the outcome parameter. Out of a total of 2,690 study households, 26% (701) were randomly selected for stool collection. From each housewife of study

households stool specimen and rectal swab were collected. All rectal swabs were examined for pathogenic bacteria such as *Shigella, Salmonella, Vibrio cholerae,* NAG vibrios, *enteropathogenic Escherichia coli,* and *Aeromonas* species. The stool specimens were examined for the following parasites : *Entamoeba histolytica, Giardia intestinalis, Balantidium coli, Isospora belli, Strongyloides stercoralis, Capillaria philippinensis, Trichuris trichura, Ascaris lumbricoides* and hook worm. Individuals who were found to have either pathogenic bacteria or parasites were accounted as having positive stool examinations. The stool examination was done at the laboratory of Chon Buri Regional Hospital, Chon Buri Province. The persons who did the stool examinations and those who assessed household sanitation were blinded to each other's results.

Indices and statistical tests used in the analysis

Comparison between the level of hygienic sanitation conditions of study households classified by each category of sanitary activity and the results of stool and rectal swab examination were assessed. Two groups of indices were used : index of the validity of measurement sensitivity and specificity, and index of the reproducibility of measurement reliability using the kappa coefficient (Cohen, 1960). The statistics employed were Chi-square test (Mantel and Haenszel, 1959) and Fisher's exact test (Fisher, 1934; Irwin, 1935).

RESULTS

The association between stool/rectal swab examination for bacterial and parasitic infections and households' hygienic conditions assessed by each sanitary activity are shown in Tables 2 and 3, respectively. It was found that most sanitary activities were not associated with bacterial infection (p > 0.05); however two did shown a positive association : all sanitary activities and housing sanitation (p < 0.05). Conversely, Table 3 shows that most sanitary activities were associated with certain parasitic infections (p < 0.05). These parasites were hook worm, *Strongyloides stercoralis* larvae and *Trichuris trichura*. Only waste water disposal and food sanitation were not associated with parasitic infection (p > 0.05). Similar patterns were also noted in overall infections (either bacteria or

parasites): all sanitary activities except waste water disposal and food sanitation were statistically associated with overall infections (p < 0.05) (Table 4). Therefore it was decided to use overall infections as the disease outcome in the assessment of each sanitary acitivity.

Taking the result of stool examination as the gold standard, assessment of sensitivity, specificity and kappa coefficient were made among sanitary activities which were significantly associated with overall infections (Table 5). It was noted that rodent and insect control gave the highest sensitivity of 99.1%, followed by all sanitary activities at 89.1%. A high sensitivity means that a high proportion of households with positive stool examination were correctly identified as non-hygienic households. The next best indicators in terms of sensitivity were solid waste disposal (60.9%), water supply (54.5%), housing sanitation (53.6%) and excreta disposal (40.0%). On the other hand, the highest specificity was found in excreta disposal with a value of 73.8%. A high specificity means that only a small proportion of households with negative stool examination were wrongly identified as non-hygienic households. The following best indicators in terms of specificity were housing sanitation (69.4%), water supply (62.8%), solid waste disposal (49.2%), all sanitary activities (45.0%) and rodent and insect control (10.0%).

The kappa coefficient (K) is an index for the quantification of reproducibility. It has the important characteristic of correcting for chance agreement that would be expected to occur between two measurements. When the two measurements agree only by chance the value of K is zero. When the two measurements agree perfectly, the value of kappa is 100%. A high K value means that households with positive stool examinations would have a high chance of being correctly identified as non-hygienic households. Table 5 shows that all sanitary activities had the highest K value (15.8%), followed by housing sanitation (15.5%). The next best indicators in terms of K were water supply (10.6%), excreta disposal (10.3%), solid waste disposal (5.2%) and rodent and insect control (3.1%).

With the aim of selecting the most appropriate indicator (sanitary activity) for assessing the households' hygienic condition in term of positive stool examination based on sensitivity, specificity and kappa coefficient, each category was scored by

Table 3

Association between parasitic stool infection and households' hygienic condition assessed by various sanitary activities.

Sanitary activities	Parasitic infection		p-value
	positive	negative	
All sanitary activities :			0.0001
non-hygienic households	68	355	
hygienic households	7	271	
Water supply :			0.0011
non-hygienic households	43	237	
hygienic households	32	389	
Excreta disposal :			0.0001
non-hygienic households	36	163	
hygienic households	39	463	
Waste water disposal :			0.7090*
non-hygienic households	74	617	
hygienic households	1	9	
Solid waste disposal :			0.0173
non-hygienic households	49	318	
hygienic households	26	308	
Food sanitation :			0.2841
non-hygienic households	24	164	
hygienic households	51	462	
Rodent and insect control :			0.0180
non-hygienic households	74	567	
hygienic households	1	59	
Housing sanitation :			0.0006
non-hygienic households	39	201	
hygienic households	36	425	

* Fisher's exact-test

giving 6 points for the highest score and so on down (Table 5). It was found that the highest score of 13 points was in the package of all sanitary activities and rodent and insect control had the lowest score of 8 marks. Housing sanitation ranked second with a score of 12, followed by water supply (11), excreta disposal (10) and solid waste disposal (9).

DISCUSSION

It was unexpected that most household sanitation activities were not associated with bacterial stool infection. Whereas diarrhoea caused by parasites is generally mild and chronic, bacterial diarrhoea was usually acute and serious, so that any person who has bacterial diarrhea is more likely to receive treatment than in the case of parasitic diarrhea. This effect might confound the association between household sanitation assessment by various sanitary activities and bacterial infection. Those bacterial infections detected in the present study were likely to be asymptomatic cases or carriers which could not be related with the household sanitation. Sakdisawasdi *et al* (1982) reported that the carrier rates of *Salmonella* and *Shigella* were 3.3% and 0.8%, respectively, in a rural district in Central Thailand. The positive rate of bacterial infections in the stool specimens in the present study was 5.4%.

Nevertheless it was noted in the present qualitative assessment that most sanitary activities were highly associated with overall stool infections (most p-values ranged from 0.0001-0.0033). However it was surprising that waste water disposal

Table 4

Association between overall stool infection and households' hygienic condition assessed by various sanitary activities.

Sanitary activities	Overall infection		p-value
	positive	negative	
All sanitary activities :			0.0001
non-hygienic households	98	325	
hygienic households	12	266	
Water supply :			0.0007
non-hygienic households	60	220	
hygienic households	50	371	
Excreta disposal :			0.0033
non-hygienic households	44	155	
hygienic households	66	436	
Waste water disposal :			0.5180*
non-hygienic households	109	582	
hygienic households	1	9	
Solid waste disposal :			0.0504
non-hygienic households	67	300	
hygienic households	43	291	
Food sanitation :			0.7253
non-hygienic households	31	157	
hygienic households	79	434	
Rodent and insect control :			0.0018
non-hygienic households	109	532	
hygienic households	1	59	
Housing sanitation :			0.0001
non-hygienic households	59	181	
hygienic households	51	410	

* Fisher's exact-test

and food sanitation were not significantly associated with the stool infections. This may have been due to the possibility is that the cut off level of hygienic condition at the arbitrary score of 60% or higher might not be appropriate for waste water disposal and food sanitation.

As the housewife was the person who had most activities related with household sanitation, it was assumed that she would be the person most likely to get sanitation related infections within the household besides children, so that the stool examination of housewife would indicate the household sanitation condition. Despite all study villages having the same socioeconomic status, one potential problem which could confound the present result was the presence or not of children in family, because children are the population at greatest risk of getting diarrheal disease (Snyder and Merson, 1982). Families with small children are more likely to get stool infections than families without small children. Thus in surveys of sanitation conditions, stool examination of both housewives and their children would be preferred. However, in the present study, it was observed that most study households had children in their families.

In consideration of the sensitivity, specificity and kappa coefficient of significant sanitary activities as predictors, it was suggested that the package of all 7 sanitary activities was the most appropriate parameter in relation to overall positive stool examination. Moreover, the package of these sanitary activities was highly associated with either bacteria or parasitic infection ($p < 0.002$). This implies that the use of all sanitary activities is better than anyone individual sanitary activity in

Table 5

Comparison of the sensitivity, specificity and kappa coefficient among various sanitary activities when comparing with overall stool infection.

Sanitary activities	On the basis comparing with overall infection			
	Sensitivity (%)	Specificity (%)	K-coeff (%)	Sum of rank scores
All sanitary activities	89.1 (5)	45.0 (2)	15.8 (6)	13
Water supply	54.5 (3)	62.8 (4)	10.6 (4)	11
Excreta disposal	40.0 (1)	73.8 (6)	10.3 (3)	10
Solid waste disposal	60.9 (4)	49.2 (3)	5.2 (2)	9
Rodent and insect control	99.1 (6)	10.0 (1)	3.1 (1)	8
Housing sanitation	53.6 (2)	69.4 (5)	15.5 (5)	12

Figures in parentheses are the rank scores

survey of sanitation conditions which is in accord with the report of Degoma (1987).

REFERENCES

Azurin JC, Alvero M. Field evaluation of environmental sanitation measures against cholera. *Bull WHO* 1974; 51 : 19-26.

Chandler AC. A comparison of helminthic and protozoan infections in two Egyptian villages two years after the installation of sanitary improvements in one of them. *Am J Trop Med Hyg* 1954; 3 : 59-73.

Cohen J. A coefficient of agreement for nominal scales. *Educ Psych Meas* 1960; 20 : 37-46.

Degoma E. A system study on rural water supply and sanitation. Asian Institute of Technology 1987, Thailand. Master's Thesis.

Echerverria P, Harrison BA, Tirapat C, McFarland A.

Flies as a source of enteric pathogens in a rural village in Thailand. *Appl Environ Microbiol* 1983; 46 : 32-6.

Fisher RA. Statistical methods for research workers, 5th edition. Edinburgh: Oliver and Boyd 1934.

Irwin JO. Test of significance for differences between percentages based on small numbers. *Metron* 1935; 12 : 83-94.

Koopman JS. Diarrhea and school toilet hygiene in Cali, Colombia. *Am J Epidemiol* 1978; 107 : 412-20.

Mantel N, Haenszel W. Statistical aspects of the analysis of data from retrospective studies of disease. *Nat Cancer Inst* 1959; 22 : 719-48.

Rabbani KR. Sanitation education programmes in developing countries. Asian Institute of Technology 1978; Thailand. Master's Thesis.

Sahba GH, Arfaa F. The effect of sanitation on ascariasis in an Iranian village. *J Trop Med Hyg* 1967; 70 : 37-41.

Sakdisiwasdi O, Achananuparp S, Limsuwan A, Nanna P, Barnyen L. *Salmonella* and *Shigella* carrier rates and environmental sanitation in a rural district, Central Thailand. *Southeast Asian J Trop Med Public Health* 1982; 13 : 380-4.

Snyder JD, Merson MH. The magnitude of the global problem of acute diarrhoeal disease: a review of active surveillance data. *Bull WHO* 1982; 60 : 605-13.

van Zijl WJ. Studies on diarrhoeal diseases in seven countries by the World Health Organization Diarrhoeal Disease Advisory Team. *Bull WHO* 1966; 35 : 249-61.