# Experiences with Implementing the $H_2S$ method for Testing Bacterial Quality of Drinking Water in Remote Aboriginal Communities in Australia

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**Abstract**

1. Water quality is a major problem in rural areas of both developed and developing countries. One of the reasons is remoteness which makes it difficult to collect samples for transport and testing in a laboratory usually located in cities. Only an onsite method that is affordable and simple to conduct will be suitable for remote locations. The $H_2S$ method meets both these criteria. Many Aboriginal communities in Australia are in very remote locations and only some communities receive regular testing of their drinking water. This paper describes the procedure adopted for introducing the $H_2S$ method to Aboriginal communities, the outcome and the challenges involved in its implementation. The $H_2S$ water test kit was prepared containing information materials, $H_2S$ bottles, disinfectant, data recording sheets and accessories. Information materials included a video and a booklet. The Aboriginal communities were contacted to obtain their support, willingness to participate in the study and for permission to conduct the study. The trials were conducted in 15 communities. Initial visits to communities in Western Australia were conducted to explain the method, and for those in other States, it was done by the Aboriginal Health Workers of the respective communities. The communities were asked to test their drinking water fortnightly and send the results to Murdoch University. All communities showed great interest initially which slowly faded. Regular testing depended on the Health Worker. The communities that had a Health Worker who is aware of the importance of regular tests conducted the tests and results

were sent. But for all other communities constant follow-ups were required. The study suggests ways of improving implementation of routine water testing in these communities.

**Keywords: Remote communities, $H_2S$ method, implementation, on-site water test kit.**

## Introduction

Microbial quality of drinking water is a major problem in rural areas of both developed and developing countries. In Australia, many Aboriginal communities are located at very remote locations such that accessibility is a major problem. Low quality water is often continually consumed in these communities. Isolation and severe unpredictable weather patterns as well as distance from laboratories affects the frequency of tests. Western Australia has about 260 discrete Aboriginal communities; many of these have satellite communities which are often called outstations. Of these communities 56 have regular bacteriological testing carried out at least once a month. From among the communities in Western Australia, 64% do not receive monthly bacteriological testing from Government funded sources and 75% do not have water disinfection facilities (EHNCC, 1998). This testing is usually carried out by a trained service provider, contracted by the State Government. There are four such service providers in Western Australia because of the vastness and differences between the areas in the State. Western Australia covers 2,500,000 sq km with an estimated population of 1,832,008 out of which 58,496 are indigenous people (ABS, 2001). Previous studies have shown that inadequate living conditions and poor hygiene standards in indigenous communities

around Western Australia resulted in infectious water related diseases being quite prevalent (EHNCC, 1997, Healthabitat, 1999, Nganampa Council Inc, 1987). In Western Australia it has been reported that Aboriginal children who are under five years of age are hospitalised for gastroenteritis at a rate seven times higher than that of non-Aboriginal children (EHNCC, 1997). Regular testing of drinking water for the microbial quality would help to identify any contamination at an early stage so that some action could be taken to prevent a disease outbreak. Only an onsite method that is affordable and simple to conduct will be suitable for such locations. The $H_2S$ method meets both these criteria.

The $H_2S$ method of drinking water testing has recently received wide interest as it has many advantages than any other method for microbial testing of drinking water currently available. Because of the use of sulphate reducing bacteria as an indicator organism rather than the standard coliform bacteria (WHO, 1997), comparison between these two methods can be confusing. The main constraint lies in the fact that both organisms have disadvantages as an ideal indicator organism. The presence of coliform bacteria does not give a true indication of contamination from faecal origin particularly in warm tropical waters (Townsend, 1992) and the absence of coliform bacteria does not provide complete safety indication as to the absence of many human enteric pathogens (Peterson and Schorsch, 1980). Similar is the case with the $H_2S$ method. The presence of both coliform and the sulphate reducing bacteria in the natural environment can interfere with the use of these indicator organisms.

However in spite of all these differences it has been noted that in treated and maintained drinking water supply systems the $H_2S$ method correlates well with the coliform method (Nair *et al.*, 2001). The requirement for an on-site and easy testing method is more for the remote areas where normal laboratory and standard test methods could not be economically affordable for routine testing. It is in these cases that we need to weigh the benefits and drawbacks of the method. The $H_2S$ method, as it currently stands is not as sensitive as the coliform test. Sensitivity and specificity studies show, however, that it gives a reasonably good indication of the presence or absence of faecal contamination and can be used for routine testing in places and conditions where other methods are not feasible (Nair *et al.*, 2001).

The $H_2S$ method is a suitable on-site method to test the bacteriological quality of drinking water in remote areas (Nair *et al.*, 2001). The main advantages of the test are it is cheaper and simpler than other on-site methods such as Colilert, Colisure and Del Aqua, and the medium could be prepared and stored without refrigeration. The test can be conducted by a local person in the remote community giving economic benefit in terms of avoiding the cost of transport, salary of technical persons and others involved in taking the sample to the laboratory within the required 24 hours apart from the more expensive laboratory procedures. The Aboriginal communities in Australia especially in Western Australia because of the geographical condition are located in very remote places. Servicing all the 260 communities and out stations in Western Australia with routine drinking water testing, for example, would be a huge unattainable commitment from the government. A project was designed to field trial the $H_2S$ method to understand its acceptance by the community and confidence by the community in

conducting the test. This was based on laboratory studies on the sensitivity of the $H_2S$ method to test Aboriginal Community water samples compared to the standard coliform method (Nair *et al*., 2001).

A National study was carried out as part of a project funded by the National Health and Medical Research Council to study the efficiency of the $H_2S$ method for testing water in remote areas. In order to implement such a project a detailed program needs to be established to ensure its smooth running which includes a scheme of negotiation with local communities, training, management, feedback and record keeping.

This paper describes the procedure adopted for introducing the $H_2S$ method to Aboriginal communities in Australia, the outcome and the challenges involved in its implementation.

## Procedure

### *Negotiation with communities*

*Selection of communities:* The field trial was designed with the aim to trial the method in at least 5 communities each in Western Australia, Queensland, Northern Territory and New South Wales. The Health Departments of the States and Territory were contacted to obtain their support, willingness to participate in the study, selection of communities and for permission to conduct the study in respective communities. The communities were selected based on the technical advantages of accessibility as well as interests from the communities. The study was explained to the person responsible to facilitate drinking water testing in Aboriginal communities in the respective States.

Individual communities were then contacted to explain the project and the benefits they could receive from the study. Permission was sought and obtained from each community before conducting the trial.

Initially it was planned to conduct trials in 5 communities in each State/Territory. There was, however another trial going on in several communities with another on-site method, the Colilert. The Health Departments did not want to create confusion in the communities with two different procedures introduced. Finally the $H_2S$ trials were conducted in 2 communities in New South Wales, 1 in Queensland, 5 in Northern Territory and 7 in Western Australia. It was agreed that each community would be given the $H_2S$ kit and 12 months supply of chemicals with no additional cost to the community. If they wish to continue to utilise the method the $H_2S$ bottles can be supplied at a cost of $2/ test.

**Training**

*Information package and test kit*

Information package included a booklet with largely graphic description of the procedure to follow to conduct the test and a video explaining step by step the procedure of testing. The information package was prepared in simple language so that any community member who was interested in testing would be able to understand. The kit included all the essential items to conduct the test.

Incubator: Previous study has shown that a constant temperature incubation is not required if the room temperature is above $28^oC$ and below $42^oC$ (Pillai *et al*., 1999).

However as a precaution for the winter months and cold nights when the temperature drops below 28$^{o}$C in inland and desert places, a simple incubator that would keep the temperature above 35$^{o}$C was provided to the communities by modifying a yogurt maker (Ian's Yogurt Maker, 12V, 240 Watt) that can accommodate 5 sample bottles.

$H_2S$ bottles: The $H_2S$ medium was prepared as described in Pillai *et al*. (1999). The sterile medium (5ml) was dispensed into 120ml labelled bottles. The bottles were sealed to prevent any leak. The kit contained 12 $H_2S$ bottles sufficient to conduct monthly testing for one year.

The complete $H_2S$ water test kit (Figure 1) consisted of a video, a booklet, the incubator, 12 $H_2S$ bottles, disinfectant, towel, pen, match box, data recording and result faxing sheets in a 32 litre plastic storage container. Methylated spirit was prohibited in many communities therefore they were asked to heat the water tap with candle for some time before sample collection.

**Management**

The communities were visited and the procedure was demonstrated either by one of the members in the group or by the person responsible from Health Department. We encouraged as many people in the community to attend this demonstration so that people would be aware of the water testing practice. The Environmental Health Worker in each community was asked to test the water sample every month and results faxed to Murdoch University. If any contamination was noted they were asked to let the authorities know and have the problem resolved. It was also suggested that if a

contamination was noted more frequent tests should be done and the people advised to use only boiled and cooled water until the problem was fixed. It was also agreed that additional bottles would be supplied if required free of cost for one year.

**Results**

The feedback obtained from the communities is presented in Table 1. In a one year trial in 16 communities across Australia, a total of 71 reports were obtained. All communities that were explained of the method appreciated its convenience and simplicity. Most communities showed much interest initially which slowly faded. Monthly reports were rarely obtained even after much follow up. The total number of tests included testing water from different points at the same period.

At the end of six months a general feedback was asked about the method. The communities were confident about conducting the test by their own and agreed that it was a simple and affordable method. The communities who responded were those who sent regular test results. They indicated that they would be happy to continue with the testing however there was a general confusion about the reliability of the method compared to the tests conducted by the Health Department.

**Discussion**

The Remote Areas Development Group (RADG) at Murdoch University tested a few onsite methods for their efficiency for use in remote Aboriginal communities. Gawthorne and Mathew (1994) reported an unpublished work conducted in 1991 by Turner and Mathew when they compared Colilert, Del Aqua, Millipore Oneuse unit and

Millipore dip slides for their applicability for use in remote Aboriginal communities. That study recommended Colilert as the most suitable as it is easy to use, interpret and equally reliable compared to the method conducted by State Health Laboratory, Western Australia. It is a most probable number method (MPN) designed to differentiate and enumerate total coliforms and *E.coli* from water samples in 24 hours. A colour change from clear to yellow indicates the presence of coliform bacteria. That work indicated that the Colisure method which is also a portable, most probable number method (MPN) had a potential to be used as a suitable method in remote communities. The advantage of Colisure is the drastic colour change from yellow to red which is easier to interpret.

A field trial of Colisure test, was conducted by RADG in 3 Aboriginal communities in Western Australia (Mathew and Ho, 1996). In spite of providing a training session with video and booklet, tests were not conducted at regular intervals. That was then ascertained to be due to the absence of operators in the community. The feedback obtained from this study also showed that regular testing depended on the interest of the Health Worker. The tests were conducted more regularly by the communities that had a Health Worker, who is aware of the importance of regular testing of drinking water quality. For all other communities constant follow-ups were required.

The main technical problem with Colilert and Colisure methods were the short shelf life of the media and the requirement of a constant degree incubator to conduct the test. The failure of the incubator due to various reasons affected routine water test in many communities. Therefore the $H_2S$ method, the medium of which can be stored indefinitely at room temperature and with a non critical incubation temperature was

considered as a better option for successful implementation of water testing program in remote Aboriginal communities.

The general feedback from the present study with the $H_2S$ method shows that all communities were very confident about the procedure and could conduct it without any external support once it was explained. There was community participation in the communities that tested the sample regularly as many people were aware of the test and its procedure. With the currently practiced Standard Method, the water sample is collected by personnel from (or contracted by) the Health Department, sent to and is tested in the State laboratory in the capital city. In most instances the people in the community are not aware about the importance, requirements or results of the tests. The participation of the people in the community in testing the drinking water will be beneficial when they become aware of the importance of keeping their drinking water uncontaminated. In most cases contamination normally occurs after it is distributed and there is no facility to check the quality at the point of use. The $H_2S$ method being affordable and easy to conduct can be used in individual households if any problem of contamination is suspected. The present trial faced many problems because of the remoteness of the communities. There is a need to make frequent visits at the early stages of the trial to encourage and inspire the community to conduct the test. Because of the extensive travel required and the financial expense involved, after the initial visit only follow ups in the form of fax, email or through telephone was feasible. This would have contributed to the reduced testing frequency.

The Remote Areas Development Groups at Murdoch University conducted a field trial of the Colilert method in 20 communities from July 1996 to June 1998 (Ryan *et al.*, 2000). The use of Colilert was influenced by the longer shelf life of test chemicals. That study received feed back from some communities occasionally with less than 10 reports over the trial period, of which 4 communities responded just once. Only one community responded very well with 22 reports. It was noted that even after repeated follow up no test results were obtained from 6 communities in that study.

Furthermore most of the test results showed negative results which gave them confidence about the safety of the drinking water quality and therefore reduced their interest in continued testing. In cases where positive results were obtained they were keen to take action and authorities were informed about the problem. Another reason for the slackness in regular testing may be because most communities where this trial was conducted had their drinking water tested by some other service agencies. The high number of positive results of samples tested in communities in New South Wales could be due to the heavy rains prevailing during the time of water sampling resulting in drinking water contamination. However, in most cases of positive results the communities informed the authorities about the contamination and remedial measures were taken.

Regular monthly testing as recommended was not conducted by any of the communities. The reasons noted were the people who were given the responsibility often moved from the communities during the period, or they lost interest after a few

initial tests. It was also noted that there was a general confusion about the sensitivity or comparability of the $H_2S$ results with the Coliform results obtained with other methods.

The implementation of the $H_2S$ method in remote and rural communities elsewhere in the world may face different problems depending on the local government policies, regulations, availability of other testing methods, commitments from the people and accessibility of the area. However in general the study revealed that in order to implement routine water testing facility in a rural or remote community, the following factors should be considered.

1. Water testing should be a paid job for a responsible person in the community.
2. The responsibility could be entrusted to different people in the order of availability such as the school teachers, Community Nurse or Health Worker so that if one person is unavailable test can still be done.
3. Continued communication with the communities to check whether regular testing is conducted.
4. Meeting with the water testing group in the community at least twice a year to discuss any issues of water quality problems and concerns.

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**Fig 1. The $H_2S$ water testing kit**

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**Table 1. Details of the $H_2S$ test conducted by Communities over one year**

| Community | Total tests conducted | Positive | Negative |
|---|---|---|---|
| **Western Australia** | **34** | **7** | **27** |
| Community A | 6 | 0 | 6 |
| Community B | 2 | 0 | 2 |
| Community C | 2 | 2 | 0 |
| Community D | 4 | 4 | 0 |
| Community E | 8 | 0 | 8 |
| Community F | 10 | 0 | 10 |
| Community G | 2 | 1 | 1 |
| **Northern Territory** | **22** | **0** | **22** |
| Community A | 7 | 0 | 7 |
| Community B | 6 | 0 | 6 |
| Community C | 3 | 0 | 3 |
| Community D | 1 | 0 | 1 |
| Community E | 5 | 0 | 5 |
| **Queensland** | **5** | **1** | **4** |
| Community A | 5 | 1 | 4 |
| **New South Wales** | **10** | **9** | **1** |
| Community A | 4 | 4 | 0 |
| Community B | 6 | 5 | 1 |

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