

The Quality of Potable Water in Rural Health Care Facilities

Report to the Water Research Commission

by

M du Preez

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EXECUTIVE SUMMARY

Background

A continuous source of clean water is one of the most important commodities for the prevention and minimization of nosocomial (hospital-acquired) infections at health care facilities. Water is used for consumption by health care workers, patients, and carers of patients and for washing and medical use (for example instrument cleaning, intravenous solutions, food preparation and preparation of baby foods). Nosocomial infection rates are higher among patients with increased susceptibility because of old age and severity of an underlying disease. Patients with decreased immunity due to AIDS and / or multi-drug resistant tuberculosis, chemotherapy and other autoimmune diseases are included in this group. These patients may need special water quality requirements not provided by bulk suppliers via a reticulated system.

The quality of the potable water used in health care facilities in rural areas in South Africa is not routinely monitored. Information is available on boreholes drilled and equipped for the use by some clinics, but no information is available on the quality of the water used inside these facilities. A small study conducted at twenty-one clinics in the Limpopo province in the north of South Africa was therefore designed to specifically determine the microbial water quality of the drinking water at these facilities.

Objective

The overall objective was to determine the microbial water quality used in health care facilities in a rural area of South Africa. This was done by determining the microbial quality of (a) drinking water used inside and outside selected rural clinics and (b) in their bulk water storage containers.

Study design

The project design included identifying and liaising with the relevant authorities to get permission to execute the project and gain access to health care facilities. An Information Sheet and a Project Summary were provided to clarify the details of the project and obtain consent from participants.

Twenty-one health care facilities in the Limpopo province were selected for the study. Water sampling took place from (a) taps inside the buildings, (b) taps on the outside of the buildings and (c) taps nearest to the bulk storage containers on the premises. The quality of the drinking water was established by analysing for coliform bacteria, *E. coli* and heterotrophic plate counts.

A questionnaire was also developed to obtain general information on various water-related issues and practices and included:

- Water sources, including on-site storage,
- Water availability,
- Water uses,
- Sanitation and basic hygiene,
- Solid waste disposal, and
- Waste water disposal.

It was completed by an assistant on the project team who spoke the local language, putting the individual questions to the nurse in charge and recording the responses.

Results

Table 1 summarises the questionnaire results pertaining to water-related issues and practices.

Water availability is one of the most pressing problems experienced by many of the clinics. In many cases this was blamed on inadequate technical support and maintenance. Generally, an adequate number of toilet facilities were available at each clinic. However, outside toilets usually did not have soap available for hand washing. Except in a few cases where solid wastes were disposed of in the vicinity of the clinic, removal of solid wastes from the remaining clinics took place at an acceptable frequency. In most cases waste water disposal was to the drain although in a few cases it was disposed of in the yard.

Table 2 shows the number of all the water samples that were tested for the presence of coliform, *E. coli* and heterotrophic plate count (HPC) that did not comply with the South African drinking water quality guidelines (SANS 241:2005, Edition 6) and its alert levels. Coliform counts exceeded counts of 10 per 100ml in 27 of the 49 samples (55%) from all sources (inside, outside and storage). Positive *E. coli* counts were found in 14 of the 49 samples (29%). HPC plate counts exceeded 5000/1ml in one of the 49 samples (2%).

Table 1: Summary of questionnaire results.

57%	of clinics use herehole water as their main source of water
38%	of clinics use borehole water as their main source of water.
	of clinics use reticulated water as their main source
14%	of clinics used other sources of water
26%	stated that water was readily available from their water source
33%	stated water was unavailable about 1 day/week
17%	stated water was unavailable about 1 day/month
18%	stated water was unavailable more often than 1 day/week
95%	of clinics have water storage tanks
	All tanks are plastic
	All tanks are 10 000 litre capacity
	All clinics have toilets inside the building
	All inside toilets are flush toilets
85%	of clinics had a special inside toilet for patients only
56%	of clinics had separate inside toilets for men and women
95%	of clinics had inside toilets used by clinic staff
76%	of clinics had inside toilets used by patients staying at the clinic
48%	of clinics had inside toilets used by day visitors
	All clinics had inside basins for washing hands
90%	of clinics had soap available for washing hands
15%	of clinics had inside toilets used by 1-5 people/day
5%	of clinics had inside toilets used by 6-10 people/day
80%	of clinics had inside toilets used by more than 10 people/day
	All clinics had an outside toilet
10%	of clinics had a outside flush toilet
90%	of clinics had a outside pit latrine
	At no clinic was the outside toilet used by clinic staff
80%	of clinics had the outside toilet used by patients
95%	of clinics had the outside toilet used by visitors
10%	of clinics had soap available for washing at the outside toilet
95%	of clinics had an outside tap on the premises
89%	of clinics used the outside tap for drinking
89%	of clinics used the outside tap for washing hands/clothes
89%	of clinics used the outside tap for drinking
	No clinics used the outside tap for washing clothes/bed sheets
95%	of clinics had their solid waste collected
	No clinics threw their solid waste in the yard
	No clinics buried their solid waste in the yard
5 0′	No clinics buried their solid waste outside the yard
5%	of clinics set their solid waste alight
050/	No clinics used any other means of disposing of their solid waste
25%	of clinics disposed of their solid waste weekly
75%	of clinics disposed of their solid waste monthly
= - /	No clinics disposed of their waste water by flushing down the toilet
5%	of clinics disposed of their waste water by throwing it in the yard
95%	of clinics disposed of their waste water down the drain

Table 2: Summary of number and percentage of non-compliant water samples tested for coliform, *E. coli* and heterotrophic plate count.

Microbial variable	N ¹	Coliforms N ≥ 10	<i>E. coli</i> > 0	HPC ≥ 5000	%Non- compliance
Coliform/100 ml Inside	18	9			50.0
Coliform/100 mł outside	19	11			57,9
Coliform/100 mł storage	12	7			58.3
E. coli/100 ml inside	18	4	5		27.7
E. coli/100 mł outside	19	5	7		37.8
E. coli/100 m² storage	12	1	2		16.7
HPC/1 ml inside	19			0	0.0
HPC/1 ml outside	19			1	5.3
HPC/1 ml storage	11			0	0.0

¹N = Number of samples analyzed

Conclusions

- A significant percentage of the clinics studied used water that did not comply with South African drinking water standards. This may in part be due to the variety of sources upon which they need to rely, particularly when their primary source fails.
- A number of clinics suffered from poor water availability. In some cases this was due to a lack of technical support.
- The number of toilet facilities available at each clinic was generally adequate. However, outside toilets facilities (mostly pit latrines) usually did not provide soap for hand washing.
- A generally efficient programme for solid waste collection exists.
- Waste water is usually disposed of adequately either to septic tanks or municipal sewage systems.

Recommendations

This study highlighted both inadequate microbial water quality and serious water availability problems at rural clinics.

The microbial water quality problems could be addressed through simple in-house monitoring and the use of liquid bleach when necessary.

Solutions to the water availability problems (which, to some extent cause the water quality problems) lie within the existing institutional infrastructure. It is recommended that nosocomial infections relating to water at health care facilities should initially be addressed generically on a nationwide basis. National water quality guidelines for this context may also need to be developed if significant exposure occurs through mechanisms other than drinking, for example washing of wounds. Roles and responsibilities at all levels should be clarified. Monitoring programmes should be designed and implemented to assess the degree of compliance. Management options should also be developed for instances when non-compliance is detected. A detailed capacity creation plan should also be developed and implemented to ensure the overall institutional environment is sufficiently enabling.

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Miss Wendy Limani University of Venda

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CHAPTER 1: BACKGROUND

1.1 INTRODUCTION

Health care facilities include hospitals, health centres and hospices, residential care, dental offices and dialysis units (WHO, 2004). The quality of potable water used at such facilities is critically important for hygiene and patient care. Unsafe and unhygienic health care settings can contribute significantly to nosocomial or hospital acquired infections. It is therefore important that health care centres should have access to safe drinking water and basic sanitation in order to avoid the spread of disease. Many health care facilities in South Africa, however, do not have adequate access to safe water (Duse et al., 2003). To gather information on the extent of the problem in the Limpopo province of South Africa a small survey was conducted to determine the microbial quality of water at health care facilities. The results of that study are presented in Chapter 2. This Chapter provides some general background information on the status of primary health care in South Africa and the Limpopo province in particular.

1.2 STATUS OF RURAL PRIMARY HEALTH CARE

1.2.1 South Africa

1.2.1.1 Types of facilities

The facilities providing primary health care in rural South Africa consist of three types:

Fixed facilities: These are primary health care clinics or community health centres with permanent staff and equipment providing an 8 to 24 hour service per day for five or more days per week. No facilities for in-patients exist although a few beds and care are available to mothers in need of preor antenatal care.

Satellite clinics: These are primary health care clinics drawing staff and / or equipment and / or drugs and supplies from a source facility.

Mobile clinics: These are vehicles equipped for primary health care provision transporting health workers from a source facility to stopping points where services are rendered.

1.2.1.2 Expenditure

Primary health care in South Africa varies from the most basic primary health care, offered free by the state, to highly specialised private sector health services available to the more affluent. About 11% of the government's total budget is allocated and spent by the nine provinces on public health. Vast inequalities exist among the nine provinces with regard to health's share of adjusted provincial expenditure compared to the national average (van Rensburg et al., 2000). Hence primary health care standards are highly variable among provinces.

1.2.1.3 Water

A survey conducted by van Rensburg et al., (2000) included 334 fixed clinics, 40 satellite clinics and 92 mobile clinics in South Africa. This sub-section and the following sub-sections summarise their findings.

About 67% of municipal hospitals and fixed clinics and 75% of the satellite clinics in South Africa have access to municipal water. Five percent of the satellite clinics depend on river or dam water, 17.5% on borehole water, 12.4% on rain water and 9.7% on water from tankers. Non-municipal water users were more evident in the more rural provinces such as Mpumalanga, Free State, Northern Cape and North West. Water has to be purified on site in 14.3% of the clinics in the Northern Province and in about a third of the clinics in Mpumalanga. Interruptions of water supply were recorded for periods ranging from 1 to 21 days. Figure 1.1 shows percentages of fixed clinics relying on various types of water source.

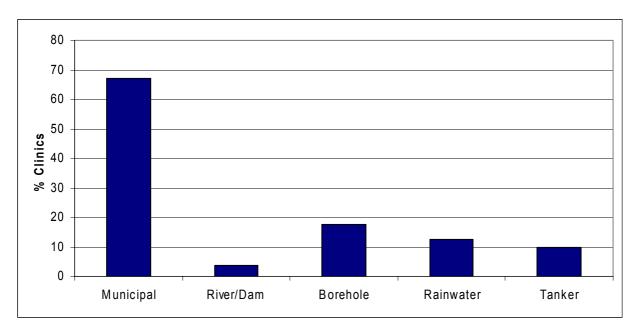


Figure 1.1: Percentage of clinics using municipal, river or dam, borehole, rainwater or water delivered by tanker for drinking purposes at 334 fixed clinics in South Africa. (Adapted from van Rensburg et al., 2000).

1.2.1.4 Sanitation

In the Free State, Gauteng, Mpumalanga, Northern Cape and Western Cape all fixed clinics have been provided with flush toilets. In the Eastern Cape 18.7 % were without flush toilets and 12.9% in the North West were without flush toilets. Special sanitary facilities for the disabled were available at only 20.5% of fixed clinics. Sanitation at satellite clinics, especially in Northern Province and Mpumalanga, was less satisfactory than at fixed clinics.

1.2.1.5 Electricity

The primary health care survey of van Rensburg et al., (2000) showed that availability of electricity has increased from 65% in 1997 to 92% in 2000. Five provinces have 100% availability in fixed clinics. North West has 21.9%, Eastern Cape 14.3% and Limpopo province only 12.5% availability. Information on fixed clinics in Mpumalanga was not available.

Interruptions were widespread and frequent at both fixed and satellite clinics. Nationwide, one third of the sampled facilities reported electrical interruptions in the month preceding the survey (van Rensburg et al., 2000)

1.2.2 Limpopo province

Limpopo province is in the north of South Africa. The population was estimated by the 2000 ASSA to be 5 277 432 people, 11.7% of South Africa's population. The population density was 43

persons per square kilometre. It is a typical developing area with a large population practising subsistence farming. Among the employed (15-65 years of age) the wholesale and retail trade, personal services, agriculture, forestry and hunting were the largest economic sector activities (SSA, 2003).

There are 105 clinics in the Vhembe district, 73 in the Mopani district and the 5 in the Giyani municipal area (SSA, 2003). The average number of patients seen per nurse per clinical work day in the Vhembe and Mopani districts is 55.8 and 57.3, respectively (SSA, 2003).

In 2000, electricity was available at 87.5% of the fixed clinics in Limpopo and at 42.9% of the satellite clinics. Only 58.2% of the fixed clinics and 28.6% of the satellite clinics reported no electricity interruption in the month before the survey conducted by van Rensburg et al. (2000).

Flush toilet facilities were available in 28.6% of the clinics in Limpopo. The remaining clinics made use of pit latrines and other means for sanitation.

A number of other services were surveyed by van Rensburg et al. (2000). In Figure 1.2 the percentage availability of some services at fixed clinics in the Limpopo province is shown.

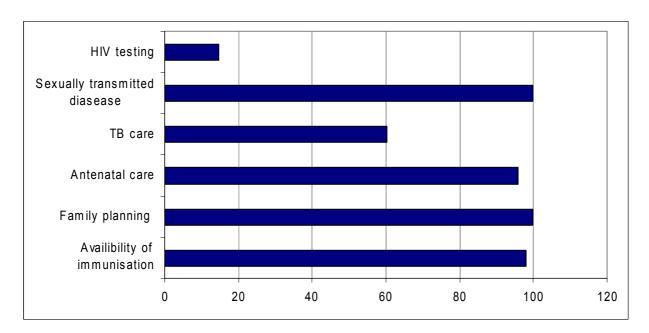


Figure 1.2: Percentage of fixed clinics in the Limpopo province providing HIV testing, sexually transmitted disease testing, TB sputum testing, antenatal care, family planning and availability of immunisation. (Adapted from van Rensburg et al., 2000).

1.3 GUIDELINES

1.3.1 International

1.3.1.1 Water Safety Plans

The 2004 drinking water quality guidelines issued by the World Health Organisation address the quality of water intended for the use in health care facilities in general (WHO, 2004). In health care facilities water must be suitable for human consumption, domestic use and personal hygiene. However because of the nature of many illnesses, water should be of a higher quality than that required for drinking water. Thus further treatment and processing may be required. For example, microfiltration or sterilization is recommended for drinking water used for washing burns or medical instruments.

The World Health Organisation recommends countries put together water safety plans (WSPs) that specifically address the quality of water used in health care facilities. These plans should deal with water quality for drinking, washing of burn wounds and medical equipment as well as for dialysis units (Muscarella, 2004; WHO, 2004). European countries such as the United Kingdom France, Germany and the US Centers for Disease Control and Prevention have also developed new guidelines for water quality in health care facilities (CDCP, 2003; Ministere de la Solidarite's, de la Sante' et de la famille de la France, 2004).

1.3.1.2 Target microorganisms

Total coliforms, faecal coliforms, *Escherichia coli* and heterotrophic plate count (HPC) are used as indicator bacteria for water quality. Zero *E. coli* per 100 ml of water is the goal for all drinking water supplies. For rural clinics, depending on a water source other than municipal water, these bacteria should be closely monitored to ensure that water does at least meet requirements for drinking water quality (WHO, 2004).

Most of the heterotrophic plate count bacteria in drinking-water are not human pathogens but some of them are opportunistic pathogens that can pose a threat to individuals with weakened immune systems (Hall et al., 2004; Pedley et al., 2004; WHO, 2003; Glasmacher et al., 2003; Villegas 2003). Microorganisms implicated in causing waterborne infections in hospital settings, mostly in immuno-compromised patients, are listed in Table 1.1.

Table 1.1: Microorganisms implicated in causing waterborne infections in hospital settings.

Type of Organism	Species
Bacteria	Legionella pneumophilia
	Acinetobacter spp.
	Moraxella spp.
	Xanthomonas spp.
	Pseudomonas aeruginosa
	Mycobacterium avium
Parasites	Crypotosporidium parvum
	Giardia lamblia
Viruses	Norwalk virus
Fungi	Candida spp.
	Aspergillus spp.
	Fusarium spp.

Rusin et al. (1997) found the probability of infection from drinking water contaminated with *Pseudomonas aeruginosa, Acinetobacter spp., Moraxella spp* and *Stenotrophomonas maltophilia* to be major causes of hospital-acquired infections with a high mortality rate.

1.3.2 South Africa

Currently no water quality guidelines exist specifically for health care facilities in South Africa. However, the South African National Standard (SANS 241:2005) specifies the quality of acceptable drinking water for consumption based on microbial, physical, organoleptic and chemical parameters defined for use at point of delivery. Table 1.2 shows the microbial safety requirements. SANS also recommends (a) sampling frequency per population served, and (b) compliance frequency targets in terms of microbiological and chemical requirements that have health implications.

Turbidity, residual chorine heterotrophic plate count, total coliform bacteria, somatic coliphages, cytopathogenic viruses and protozoan parasites are categorised by SANS as "operational water quality alert values". Immediate remedial action is required when alert values are exceeded.

The heterotrophic plate count is described as a process indicator that provides information on treatment efficiency and aftergrowth (WHO, 2003; SANS 241:2005. Edition 6). An alert level of 5000/ml has been set.

Table 1.2: Microbial safety requirements (SANS 241:2005 Edition 6)

1	2	3	4	5
		Allowa	able compliance contri	bution
Determinant	Unit	95% of samples, min.	4% of samples max.	1% of samples, max.
			Upper limits	
<i>E.coli</i> ^b or	Count/100ml	Not detected	Not detected	
Thermotolerant (faecal) coliform bacteria ^c	Count/100mใ	Not detected	1	10

^a The allowable compliance contribution shall be at least 95% of the limits indicated in column 3, with a maximum of 4% and 1%, respectively, to the limits indicated in column 4 and column 5. The objective of the disinfection should, nevertheless, be to obtain 100% compliance to the limits indicated in column 3.

1.4 CONCLUSION

A number of enquiries at clinics in the Limpopo province revealed that no official drinking water monitoring programme exists in the province. *Ad hoc* investigations are however conducted when water contamination problems are suspected at individual clinics. Against this background a small study was initiated aimed at determining the status of the microbial drinking water quality used in health care facilities in the Limpopo Province, South Africa. Additional information on sanitation facilities, availability of water and some hygiene factors were also gathered.

^b Definitive, preferred indicator of faecal pollution.

^c Indicator of unacceptable microbial quality could be tested instead of *E. coli* but is not the preferred indicator of faecal pollution. Also provides information on treatment efficiency and aftergrowth in distribution networks.

CHAPTER 2 RURAL HEALTH CARE CENTRE SURVEY

2.1 INTRODUCTION

This chapter describes a limited survey of the following water-related issues and practices in twenty-one rural clinics in the Limpopo Province of South Africa:

- · Microbial water quality,
- Water sources, including on-site storage,
- Water availability,
- Water uses,
- Sanitation and basic hygiene,
- · Solid waste disposal, and
- Waste water disposal.

2.2 STUDY OBJECTIVE

The objective was:

• To determine the microbial water quality used in health care facilities in a rural area of South Africa

2.3 SCOPE OF STUDY

The primary focus of the study was the microbial quality of drinking water used inside and outside the selected health care facilities and in their storage tanks. Routine (regular) monitoring was not undertaken. The study was entirely based on a snapshot of samples taken over a period of a few days at the twenty-one clinics.

In order to be able place the microbial water quality in context, information was also collected (using a questionnaire) on basic water management practices at the clinics.

2.4 STUDY PRELIMINARIES

2.1.1 Liaison with authorities

A key principle of community liaison is to work within existing structures. Information obtained about administration structures in the region assisted the project team in identifying critical contact persons within the local, regional and national authorities. Written permission to conduct the study was first obtained from the Department of Health and Social Development, Limpopo province.

Government officials at district level were then engaged. The District Manager of Health, in particular, assigned Environmental Health Practitioners who were active in the Vhembe and Mopani districts and the Giyani municipality. They spoke the local language and were familiar with the local culture. They performed the valuable function of introducing the research project and researchers to clinic staff.

2.1.2 Existing projects

A project, undertaken by the Department of Health (which commenced in 2002), is still underway that (a) provides boreholes to clinics in the Limpopo province and (b) tests their water quality. The project plan of the current survey was structured so that the outcomes also supplemented that work. For example, emphasis was given to choosing clinics supplied with boreholes in that project. This study was able to establish the current status of the boreholes in terms of equipment and water availability. This information will be made available to the project leader of the borehole project.

2.5 METHODOLOGY

2.1.3 Area and clinic site selection

Twenty-one clinics in the Giyani municipality, Vhembe and Mopani districts of the Limpopo province were selected mainly on the basis of the following factors:

- Boreholes had been supplied by the project mentioned above.
- Availability of local Environmental Health Practitioners to provide (a) directions to the locations of the clinics and (b) introductions to clinic staff, and
- The accessibility of the clinics within the allocated period for the field work (three days).

Clinics included in the study can be categorised as small health care facilities providing outpatient care.

2.1.4 At the clinic

On arrival at each clinic the Environmental Health Practitioners explained to the staff (a) the objective of the project, (b) what the project entailed, and (c) what was expected of the clinic staff. A Project Summary was provided and an Information Sheet was signed by the nurse in charge at each clinic (see Appendices). Water samples were only collected once the objectives had been explained and the person in charge had agreed to participate.

A questionnaire (see Appendix) was completed by an assistant on the project team who spoke the local language, putting the individual questions to the nurse in charge and recording the responses.

2.1.5 Water sampling

Water samples were collected in 500ml sterile bottles from (a) a tap used inside the clinic building, (b) a tap used on the outside the building, and (c) from the tap (if one was fitted) closest to the bulk storage containers on the property. Taps were flamed before sample collection. Samples were kept on ice. Analyses began within eight hours of sampling.

2.1.6 Microbial analysis

Water samples were analysed for the presence of coliforms and *E. coli* using the Colilert-18® system and heterotrophic plate count (HPC) using Yeast Extract agar (DIFCO) and incubation at 37°C for 48 hours.

2.6 RESULTS AND DISCUSSION

2.1.7 Infrastructure

2.1.1.1 Summary results

The results of the questionnaire are summarised in Table 2.1. The questionnaire sometimes allowed more than one response to an individual question. The total percentage of responses for those questions may therefore exceed 100%.

2.1.1.2 Water sources

Water sources consisted of borehole water (57%), reticulated water provided by the local municipality (38%) and other sources (14%) which were mostly mobile water tankers.

2.1.1.3 Water availability

Water availability is one of the most pressing problems experienced by clinic staff. Only 26% of the clinics reported that water was readily available from their water source. Eighteen percent of the respondents reported interruptions more often than one day a week. A third of the clinics experienced interruptions about one day per week and 17% one day per month. Interruptions could last up to a week.

Interruption of water supply means that alternative arrangements and procedures are often necessary. However, resource constraints sometimes preclude such alternative arrangements and the clinic simply remains without water.

Poor technical support and borehole maintenance was evident at some clinics. In one instance, the breakdown of a borehole pump had been reported five years previously without any response. In another instance, a stolen pump had not been replaced in three years.

 Table 2.1: Summary of questionnaire results.

57%	of clinics use borehole water as their main source of water.
38%	of clinics use reticulated water as their main source
14%	of clinics used other sources of water
26%	stated that water was readily available from their water source
33%	stated water was unavailable about 1 day/week
17%	stated water was unavailable about 1 day/month
18%	stated water was unavailable more often than 1 day/week
95%	of clinics have water storage tanks
	All tanks are plastic
	All tanks are 10 000 litre capacity
	All clinics have toilets inside the building
	All inside toilets are flush toilets
85%	of clinics had a special inside toilet for patients only
56%	of clinics had separate inside toilets for men and women
95%	of clinics had inside toilets used by clinic staff
76%	of clinics had inside toilets used by patients staying at the clinic
48%	of clinics had inside toilets used by day visitors
	All clinics had inside basins for washing hands
90%	of clinics had soap available for washing hands
15%	of clinics had inside toilets used by 1-5 people/day
5%	of clinics had inside toilets used by 6-10 people/day
80%	of clinics had inside toilets used by more than 10 people/day
	All clinics had an outside toilet
10%	of clinics had a outside flush toilet
90%	of clinics had a outside pit latrine
	At no clinic was the outside toilet used by clinic staff
80%	of clinics had the outside toilet used by patients
95%	of clinics had the outside toilet used by visitors
10%	of clinics had soap available for washing at the outside toilet
95%	of clinics had an outside tap on the premises
89%	of clinics used the outside tap for drinking
89%	of clinics used the outside tap for washing hands/clothes
89%	of clinics used the outside tap for drinking
	No clinics used the outside tap for washing clothes/bed sheets
95%	of clinics had their solid waste collected
	No clinics threw their solid waste in the yard
	No clinics buried their solid waste in the yard
	No clinics buried their solid waste outside the yard
5%	of clinics set their solid waste alight
	No clinics used any other means of disposing of their solid waste
25%	of clinics disposed of their solid waste weekly
75%	of clinics disposed of their solid waste monthly
	No clinics disposed of their waste water by flushing down the toilet
5%	of clinics disposed of their waste water by throwing it in the yard
95%	of clinics disposed of their waste water down the drain

2.1.1.4 Sanitation

All the facilities had inside flush toilets. Toilets for the use of patients only were available at 85% of the clinics. Separate toilet facilities for men and women were available at 56% of the clinics. Inside toilets were used by more than 10 people per day at 85% of the clinics. Outside toilets, of which the majority were pit latrines, were available at 90% of the clinics. They were not used by clinic staff but rather by visitors, patients and carers.

2.1.1.5 Hand hygiene

Basins for hand washing were available at all the clinics. They were mostly used by clinic staff. Ninety percent of the respondents reported that soap was available for washing hands but the availability was limited to clinic staff in most instances. Only 10% of the clinics had soap available at the outside toilets.

Cloth towels and paper towel were used for drying hands after washing at 52% of the clinics. Waterless alcohol-based handrubs were not available at any of the clinics.

Outside taps and basins were present at 95% of the clinics. Water from these taps was used for drinking, washing hands and clothing (not hospital linen) and irrigation of vegetables grown on the premises.

2.1.1.6 Solid waste disposal

A reasonably efficient system exists for the collection of solid waste (including needles, syringes, bandages, empty medicine vials, etc.). Solid waste was not buried or simply thrown away at any of the clinics. Solid waste was set alight at 5% of the clinics. Frequency of collection was weekly at 25% of the clinics and monthly for 75% of the clinics.

2.1.1.7 Waste water disposal

The majority of the clinics have septic tanks for disposal of grey water and sewage. These systems are used for disposal of waste water at 95% of the clinics. Five percent reported that waste water is disposed of by throwing it in the yard.

2.1.1.8 Microbial water quality

The survey provides a snapshot of the microbial drinking water quality on the day of the visit only. It was established that water quality monitoring is not undertaken routinely by local Environmental Health Practitioners. However, *ad hoc* water quality investigations are conducted when increased numbers of diarrhoeal cases or other illnesses are reported.

Samples were taken in three locations:

- "Inside" = A tap inside the clinic building.
- "Outside" = A tap outside but against, or close to, the clinic building.
- "Storage" = The tap (if any) nearest the outside storage containers.

The measured water quality is given in Table 2.2 and the results are summarised in tables 2.3 and 2.4.

Table 2.2: Microbial water quality data.

	Col	iforms/100	me e	E	. coli/100	mℓ	HPC/1 mℓ				
Clinic	Inside	Outside	Storage	Inside	Outside	Storage	Inside	Outside	Storage		
1	91.3	65.7	69.1	<1	<1	<1	59	45.5	81		
2	328.8	258.4	1	25	61.3	<1	193	201			
3	17.5	59.1		<1	<1		50.7	77.3			
4	<1	5.2		<1	<1			232			
5	3.1	5.2		<1	<1		120	37			
6	1119.9	648.8		30.5	19.7		507	397			
7	<1	<1		<1	<1		1.7	1.5			
8	>2419.2	>2419.2		<1	<1		4000	4000			
9	3.1	4.1	3.1	<1	<1	<1	242.5	511	435		
10	101.9	172.2	238.2	<1	2	<1	94.5	126	4000		
11	1	<1		<1	<1		243	233			
12		>2419.2			>2419.2		2500	5000			
13	>2419.2	>2419.2		21.3	24		1750	2500			
14	1	1	3.1	<1	<1	<1	93	166	111		
15			>2419.2			<1			3000		
16	<1		2	<1		<1	283		3000		
17	8.5	4.1	20.3	1	<1	<1	65.7	77.7	309		
18		3	<1		<1	<1	323	440	155		
19	1986.3	1986.3	1299.7	<1	1	1	416.5	390	258		
20	1119.9	1553.1	1413.6	248.9	154.1	193.5	3500	4000	500		
21	<1	22.8	33.1	<1	<1	<1	1	147	156		

The Colilert-18® method, used for coliforms and *E. coli*, has certain limitations. Very low, and even zero counts, are recorded as "<1" while counts greater that 2149.2 are recorded as ">2149.2".

Table 2.3: Summary of coliforms, E. coli and heterotrophic plate count (HPC) results.

Microbial variable	N ¹	N ² <1	N ³ > 2419.2	N ⁴ 1 <x<2419.2< th=""><th>Min</th><th>Max</th></x<2419.2<>	Min	Max
Coliform/100 ml Inside	18	4	2	12	<1	>2419.2
Coliform/100 mł outside	19	2	3	14	<1	>2419.2
Coliform/100 mł storage	12	1	1	10	<1	>2419.2
E. coli/100 ml inside	18	13	0	5	<1	248.9
E. coli/100 ml outside	19	12	1	6	<1	>2419.2
E. coli/100 mł storage	12	10	0	2	<1	193.5
HPC/1 m² inside	19				1	4000
HPC/1 ml outside	19				1.5	5000
HPC/1 mł storage	11				81	4000

Table 2.4: Summary of number and percentage of non-compliant samples in respect of coliforms, E. coli and heterotrophic plate count.

Microbial variable	Coliforms N ≥ 10	<i>E. coli</i> > 0	HPC ≥ 5000	%Non- compliance
Coliform/100 ml Inside	9			50.0
Coliform/100 ml outside	11			57,9
Coliform/100 ml storage	7			58.3
E. coli/100 ml inside	4	5		27.7
E. coli/100 ml outside	5	7		37.8
E. coli/100 ml storage	1	2		16.7
HPC/1m { inside			0	0.0
HPC/1m { outside			1	5.3
HPC/1m { storage			0	0.0

¹N = Number of samples analyzed ²N <1 = Number of samples with counts recorded as <1

³N>2419.2 = Number of samples with counts recorded as >2419.2

⁴N 1<x<2419.2= Number of samples with counts from 1 to 2419.2

Drinking water quality did not meet national standards in many instances. Alert levels for coliform bacteria (SANS 241:2005) were exceeded in 50.0, 57.9 and 58.3% in samples from inside, outside taps and the storage containers respectively. *E. coli* counts exceeded the limits set by SANS 241:2005 for 27.7, 36.8 and 16.7% of the same samples. Heterotrophic plate counts were generally high. This suggests long storage times and the uncertain quality of the water delivered by tanker to backup storage tanks.

There was anecdotal evidence at some clinics suggesting that water provided by tankers is occasionally collected from raw water sources with high turbidity such as rivers. Significant layers of sediment collect at the bottom of these storage tanks. When the water level in these tanks is low, water drawn from taps is turbid. However, the heterotrophic plate count alert level of 5 000 (SANS 241:2005) was recorded for only one sample (Table 2.3).

Attempts to disinfect water were not encountered in any clinic in spite of easy availability of liquid bleach in retail outlets. Clinics did not keep liquid bleach in stock. The team was informed that liquid bleach usually is used for purposes other than water disinfection. The taste of water treated with liquid bleach is one of the main reasons for its use as a disinfectant being unpopular.

2.7 CONCLUSIONS

- A significant percentage of the clinics studied used water that did not comply with South African drinking water standards. This may in part be due to the variety of sources upon which they need to rely, particularly when their primary source fails.
- A number of clinics suffered from poor water availability. In some cases this was due to a lack of technical support.
- Toilet facilities were generally adequate. However, outside toilets facilities (mostly pit latrines) usually did not provide soap for hand washing.
- A generally efficient programme for solid waste collection exists.
- Waste water is usually disposed of adequately either to septic tanks or municipal sewage systems.

2.8 RECOMMENDATIONS

This study highlighted not only inadequate microbial water quality in many of the selected clinics but also serious water availability problems.

Microbial water quality can potentially be addressed by:

- In-house monitoring (using simple tests for indicator bacteria), and
- Applying a disinfectant such as liquid bleach (e.g. Jik) when necessary.

Of more fundamental importance is water availability. It is beyond the scope of this study to recommend very specific solutions to this problem. Solutions are likely to relate primarily to the institutional support that is outside the immediate control of clinic staff.

The fact that individual clinics are merely a small part of a large national institution, suggests that preventing nosocomial infections relating to water at health care facilities should initially be addressed generically on a nationwide basis. Ideally, water safety plans and national guidelines need to be compiled. These must aim at achieving minimum standards for water, sanitation and hygiene, and solid- and waste-water management. Furthermore, they should target the whole spectrum of South African health care facilities (rural, peri-urban, district hospitals and larger facilities).

Such an undertaking would typically involve the following tasks:

- 1) A countrywide assessment of the status quo regarding water quality, water supply, sanitation, solid waste and waste water management.
- 2) Clarification of roles and responsibilities at (a) sectoral and intersectoral levels and (b) national, regional and local levels.
- 3) Development of national guidelines.
- 4) Design and implementation of monitoring programmes aimed at assessing compliance with guidelines.
- 5) Implement action plans aimed at identifying causes of non-compliance.
- 6) Implement management plans for intervention when non-compliance occurs, including in particular technical support for mechanical installations.
- 7) Development of a capacity development plan and an associated costing study to create and maintain a suitably enabling institutional environment.

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APPENDIX A:

PROJECT INFORMATION SHEET

PROJECT INFORMATION SHEET

Title of research study: A survey of the potable water quality used at various types of health care facilities in a rural area in South Africa

Short Title: Potable quality of water at health care facilities

Introduction:

We are researchers of the Council of Scientific and Industrial Research (CSIR), the University of Pretoria and the University of Venda.

This research is funded by the Water Research Commission of South Africa.

Name of Researcher/s:

Contact number/s:

Purpose of the study:

To determine the microbial quality of drinking water used in health care facilities in a rural area of South Africa

Taking part: What it involves

If the person charge at a clinic/hospital agrees to participate the following things will happen:

- Questions about the sanitation facilities, the type of water source, availability of water and how it is stored will be asked.
- Water samples will be collected from the storage tank, from a tap on the inside of the building and from a tap on the outside of the building.
- Taking part in the study cannot harm anyone in any way.
- Each clinic/hospital will be visited once only.

Benefits:

There may be no benefit for the clinic/hospital except that the information gained will be shared with those in charge.

APPENDIX B:

PROJECT SUMMARY

Project title:

A survey of the potable water quality used at various types of Health Care Facilities in a rural area in South Africa

AIM

To determine the microbial water quality used in health care facilities in a rural area of South Africa

BACKGROUND

Quality of potable water used at health care facilities or clinics plays an important role in hygiene and patient care. Unsafe and unhygienic health care settings can make a significant contribution to nosocomial infections. It is therefore of great importance that health care facilities should have access to safe drinking water and basic sanitation to avoid the spread of disease within these settings. According to health care workers and institutions such as the World Health Organisation many clinics do not have adequate access to safe water. To investigate the extent of the problem in rural clinics in South Africa a survey of the microbial water quality available at these clinics will be performed.

METHODOLOGY

Liaison with authorities: Permission to carry out the study will be obtained from the Department of Health in the Limpopo Province. District Environmental Health Officers will be engaged during sample collection.

Water samples: Will be collected from 20 health care facilities ranging from rural clinics to district hospitals. Sampling will take place at (a) taps inside the buildings, (b) taps on the outside the buildings and (c) taps nearest to the bulk storage containers on the premises.

Source water type: Information on the source and type of water supply will be collected.

Sanitation: A survey of the sanitation facilities will be carried out at each facility.

Water collection and analysis: Water samples will be collected using standard procedures. Analysis will be conducted at an accredited laboratory. Analysis will include heterotrophic plate count, total coliform and *E. coli*.

Results: These will be assessed against applicable guidelines.

FEEDBACK

Authorities and clinics/hospitals will be informed of the results.

APPENDIX C:

QUESTIONNAIRE

QUESTIONNAIRE

Date:			Nam	e of interviewer:					
Person inte	erviewed	J:							
GPS Wayp	ooint nar	ne:		GPS coordinates: East:					
South:			_						
		=:0.:							
1 Clinic no		MATION							
2 Name of									
3 Number	of peopl	e usually o	on duty o	on a day					
WATER S	OHECE								
4. What is			f water						
Rain				Borehole	Standpi	ре	С	ther	
4.1	4.2	4.3		4.4	4.5		4	.6	
5. Is water				source?	YES				NO
6. How ofte				T =					
6.1 1 day p				6.2 1 day per n					er(describe)
7. What alt	ernative	sources a	are avail	able when the no	rmal source	is una	availal	ole	
WATER S				Lv					
8. Does th	ne clinic	: have a s	storage	Yes				No	
tank What is the	etorage	a tank mar	de off						
Plastic		Metal	ue on	Fibreglass	Stainles	Stainless steel Other		Other	
8.1		8.2		8.3	8.4	0 0100		8.5	
		<u> </u>		0.0					
9. What is	the volu	ıme of the	storage	tank	•		<u> </u>		
500 liter				1000 litre				10 000	litre
9.1				9.2				9.3	
HYGIENE	AND SA	ΔΝΙΤΔΤΙΩ	N						
10. Is there				ıα	Yes				No
				side the building	1.00				110
12.What ty				<u> </u>					
Flush					Bucket				
12.1					12.2				
				by patients	Yes				No
14. Are toil					Yes				No
14.Who ma		e or the tor		s staying at the c	linic	Ī	Day	vicitors	to the clinic
14.1	Office		14.2	3 Staying at the c	лппс		14.3	VISILOIS	s to the chine
15. Is the	ere a b	asin for	Yes				No		
washing h	ands in	side the							
building									
16. Is so		able for	Yes				No		
washing ha		dried offe	r waahin	~					
II.⊓∪W are	e manus	uneu ane	ı wasıııı	<u>y</u>					
18. Approximately how many people use the toilet inside the building every day									
1-5 6-10 More than 10									
						Mor		า 10	
18.1						Mor 18. 3	e thar	10 	
18.1 19. Is there		side toilet	Росріс	6-10		_	e thar	n 10	
18.1 19. Is there 20.What ty		side toilet		6-10 18.2		18.3	e thar	n 10	
18.1 19. Is there 20.What ty Flush		side toilet		6-10 18.2 Bucket		18.3	re thar	n 10	
18.1 19. Is there 20.What ty	pe of toi	side toilet ilet is it		6-10 18.2		18.3	re thar	n 10	

Quality of potable water in rural health care facilities

Clinic staff Patients				Visitors			
21.1	21.2			21.3			
22. Is soap available for washing	Yes			No			
hands at the outside toilet							
23. How are hands dried after washir	ng						
24.Does the clinic have an outs	side tap on the	Yes			No		
premises							
25.What is the outside tap used for							
Drinking Wate	ering the garden		Washing han	ds/clothes		Washing bed sheets	clothes/
25.1 25.2			25.3			25.4	

SOLID WASTE DISPOSAL

26 How is solid waste disposed of								
Collected	Throw away in the yard	Buried in the yard	Thrown outside yard	the	Bury outside the yard	Set alight	Other	
26.1	26.2	26.3	26.4		26.5	26.5	26.6	
271 For how long is solid waste kept before collection								
One day	One wee	One week			One month			
27.1	27.2	27.2			27.3			

WASTE WATER DISPOSAL

281 How is waste water disposed of					
Flushed down the toilet	Thrown out in the yard	Thrown down the drain			
28.1	28.2	28.3			

Thank the respondents sincerely for his/her/their contribution and cooperation.