Drinking Tank Water: How Safe Is It?

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For generations, those of us who live in urban areas have enjoyed high-quality town water. Sourcing water from publicly-funded dam projects, this system was introduced to overcome public health problems in previous centuries, and has been highly successful. In these early years of the 21st. Century, some things are changing. A more environmentally-aware population is increasingly concerned about the environmental effects of building new dams. At the same time, governments are less willing to take on the borrowings, or impose the huge tax bills involved in major works. Happily, there is a groundswell of opinion in the community that we should all take more responsibility for reducing our water use- capturing what we can, and re-using our waste water. A huge increase in interest in water tanks has been one result.

As I stood at the Canberra Show in the middle of a display of Tankmasta water tanks, I knew that the filtration system they provided was unmatched on the Australian market. I also knew that most of my enquiries would come from customers wanting to instal a tank to provide water for their gardens and lawns when water restrictions were in force. But what about people who were looking ahead? Those who intended to make a real dent in their water usage, and use their tank water inside the house, including for drinking? How would they feel about using tank water for drinking? Frankly, I expected that a common attitude would be *"I'll use tank water for other things in the house, but I'll use mains water for drinking."* (For all my confidence in the product, it may have been a thought lurking in my own subconscious.) I was wrong.

I was not only wrong, I was surprised. Not only did I fail to get the negative response I expected, but quite the reverse happened. Over the course of the 3 days of the Show, I spoke to many people who had lived on the land. A common theme emerged. *"If we are connected to town water, and water is short, we'll use the town water on the garden, and drink the tank water."*

Whatever doubt I had about drinking tank water pretty much evaporated that weekend. Obviously, a healthy (pun intended) proportion of the Australian population in the bush already drank tank water, and loved it. Yet I wanted to go one step further. I wanted some scientific data on the subject, preferably Australian, that I could provide to potential customers. Some Google web searches, and a couple of emails and phone calls later, I had a copy of an epidemiological study done in South Australia. (The study was presented at the International Rainwater Conference in Germany 2001.) Surprisingly, **in South Australia, more of the population use tank water than town water.**

The study followed two groups of school children. One group almost exclusively drank town water, the other almost exclusively tank water. They were followed for three months, and any gastro-intestinal symptoms were noted. When the numbers were first crunched, the result was surprising. Those drinking tank water had less GI symptoms than those who drank town water! The researchers went back through the results, made

some further allowances for confounding factors, and crunched the numbers again. This time, **the results simply showed *no statistically significant difference* between the health of the two groups. Tank water or town water; there was no discernable difference**. Yet there was still one more surprise in store.

Town water is obviously treated to a very high standard, very close to the time we drink it. For tank water to be as healthy, it was obvious that the children in the study must be drinking from well-maintained water tanks. Right? Wrong! The researchers carrying out the study had asked respondents to provide information on the age of their water tank, how often gutters were cleaned, tanks cleaned out, etc. In terms of the study results, the answers were surprising, to say the least.

Were the tanks shiny new? No. 43% were over 10 years old.
Did they use first-flush diverters*?* No. Only 7% said 'yes'.
Did they have a screened inlet to the tank? Only 40% did.
When did they last clean the gutters? 50% answered between '6 months' and 'never'.
When did they last clean sludge from the tank? 41% said 'never'! Only 25% had cleaned their tank anytime inside the last 5 years.

When you look at the lack of maintenance of the tanks in the survey, it's very comforting to consider that water from them proved to be just as healthy as town water.

I am now doubly confident about the value and safety of rainwater tanks in general as an alternative supply to town water for all purposes, including drinking. I'm even more confident when the tanks have an advanced screening and filtration system, such as Tankmasta.

Please read the Study for yourself. We have presented the information in exactly the form we received it from the researchers, for your information. The author of the study, Jane Heyworth, says, *"…this presents a preliminary analysis of this study data and since then I have reanalyzed these data. In the reanalysis there is no significant difference in risk between tank rainwater and public mains water whereas the earlier analysis indicated that the risk was significantly lower. I am happy for you to use this paper if you indicate that it is a presentation of draft results which are subject to change."*

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A Diary Study Of Gastroenteritis And Tank Rainwater Consumption In Young Children In South Australia

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Introduction

Tank rainwater is an important source of drinking water in South Australia. More households (42%) use tank rainwater as their main source of drinking water than use public mains (40%) (Heyworth et al.1998). The community preference for consumption of this untreated water supply has highlighted the need for policy on its safe use. The longitudinal study reported here, the tank rainwater diary study, was undertaken to provide epidemiological data in support of a risk assessment of tank rainwater consumption.

An earlier prevalence study of 9,500 children, indicated that there was a slight, but non-significant, increase in risk of gastroenteritis associated with consumption tank rainwater in rural South Australia. This longitudinal study was undertaken to investigate more fully the temporal relationship between risk of gastroenteritis and exposure to tank rainwater.

Aims

The aim of the tank rainwater diary study was to investigate whether or not the incidence of episodes of *highly credible gastro-intestinal symptoms* (HCGI) is increased amongst 4-6 year old children who consume tank rainwater as their main source of drinking water compared with children who consume public mains supply water as their main source of drinking water.

Methods

Sample Selection

In the earlier prevalence survey conducted in 1998, parents were asked if they were willing to be involved in a further study. Among the 3413 rural participants, 1960 (57%) indicated their willingness to do so. From these, a pool of 1163 children were identified as eligible for the diary study. To be eligible, the child's main source of drinking water had to be either (1) tank rainwater or (2) public mains water that was chlorinated and filtered. Children who had an ongoing illness for which diarrhoea and vomiting were symptoms were excluded as were children of Aboriginal or Torres Strait Islander descent (n=106).

During recruitment, a further 72 children were excluded because they had moved, their main source of drinking water had changed, their rainwater tank had been topped up with other water, etc. Forty-nine children were no longer contactable. Only 27 parents (2.3%) refused to

participate. Thus, of the 1163 parents who were approached, 1015 (97%)agreed or were able to participate.

To reach the requisite sample of 1000 it was necessary in the rainwater group to include some children for whom public mains was used only for cooking, and in the public mains group, to include some children who also drank bottled water.

Survey Instruments

There were four components to the tank rainwater diary study; the baseline questionnaire, the daily diary, 3-week telephone interview and a final telephone interview at 6 weeks. The baseline questionnaire included questions on demographic and household characteristics, personal and home hygiene, food consumption, perception of risk, point-of-use water treatment, and for those drinking rainwater, tank and roof collection construction and maintenance.

The daily diary included questions on gastrointestinal and respiratory symptoms, antibiotic use, beef mince consumption and the amount and type of water drunk each day. Beef mince (ground beef) was included because the prevalence survey had indicated an increased risk of gastroenteritis associated with regular consumption of beef mince.

At the three- and six-week interviews, further data on activities and food consumption within the previous three weeks were collected as well as any action taken as a result of a gastroenteritis episode. While ideally some of these data would have been best collected on a daily basis this would have unduly increased the length of the diary. The six- week telephone interview also included questions the parents' ability to complete the diary accurately, the frequency of diary completion and any impacts of the study on the child's drinking behaviour.

The children were divided into five groups. A parent completed the diary for a six-week period between February and June, 1999. The diary periods were arranged so that school holiday periods and Easter holidays were avoided. Figure 1 shows the study time line for groups 1 and 2.

Definition of Gastroenteritis

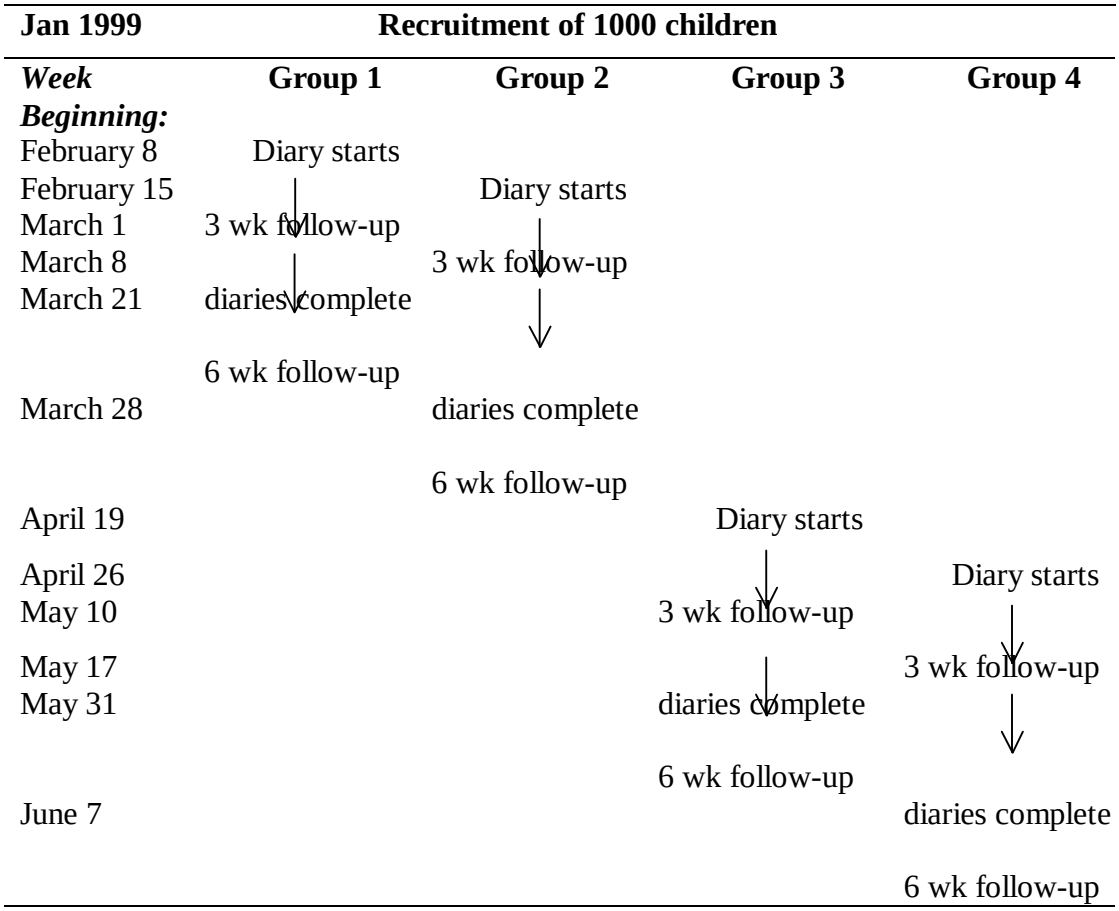
The definition of gastroenteritis used in this study was based upon that used by Payment et al (1991) in their drinking water studies. In turn this was based on work in the 1970s by Cabelli et al (1979) who established the use of highly credible gastrointestinal symptoms (HCGI) as a measure of gastroenteritis. An episode of gastroenteritis (HCGI) was defined as vomiting; or liquid bowel actions; or nausea with cramps; or soft bowel actions with cramps; on one or more days. A new episode of gastroenteritis was designated if there were seven symptom free days since the last day of symptoms.

Data Analysis

Random effects logistic regression was used to model the incidence of gastroenteritis. The model was developed from the following potential confounding factors: sore throat; earache; antibiotic use; contact with persons who had gastroenteritis; socio-economic status; pets in the home; consumption of meats; takeaway and café food; unpasteurised milk; home food hygiene; and hand washing. A variable indicating water source was added to this model allowing estimation of the effect of water source, after adjustment for confounding.

Backwards elimination of variables was then undertaken to remove variables that did not improve the fit of the model. Odds ratios (OR) and 95% confidence intervals (CI) were estimated using Stata®.[33] The modeling presented here is work –in-progress and may be subject to variation.

Figure 1: Study time line, tank rainwater diary study 1999



Results

Response

Of the 1015 parents who agreed to participate, 982 (96.8%) completed one or more components of the study and 965 parents (95.1%) completed part or all of the diary components. Overall there were 39, 949 daily records of gastroenteritis and water consumption among the 965 children over the six-week diary period.

Water consumption

Parents were asked about their child's source of drinking water at recruitment to determine eligibility, in the baseline questionnaire and on a daily basis in the diary. There was some

variation between the responses. Among the tank rainwater drinkers, the number of parents who underestimated their child's exposure to public mains water was substantial. Only five percent of parents indicated that their child drank tank rainwater and public mains in the baseline questionnaire but, when able to record daily water consumption, this proportion increased to 32.8 per cent. As a result both the number of tank rainwater drinkers only and public mains water only was reduced (Table 1).

Among the children who drank tank rainwater, 94% had drunk tank rainwater for at least 2 years.

Table 1 Main Source Of Drinking Water- Tank Rainwater Diary Study.

Water type	Diary	
	n	%
Tank rainwater only	398	41.3
Tank rainwater & public mains	316	32.8
Public mains only	144	14.9
Public mains & spring or bottled water	30	3.1
Tank rainwater & spring or bottled water	19	2.0
Tank rainwater, public mains and spring or bottled water	57	5.9
Total	964[1]	100

1.One child drank only fruit juice or milk during the diary period.

The mean daily consumption of water was 4.2 cups per day. Children drinking either rainwater alone or public mains alone, on average drank a similar daily amount, 4.2 cups per day and 4.4 cups per day respectively.

Incidence of gastroenteritis

Over the six-week diary period there were 414 episodes of HCGI among 965 children. Thirty-three per cent of 965 children (n=317) had one episode, nine per cent had two episodes (n=84) and one per cent had three episodes (n=3).

The incidence of HCGI among 4-6 year-olds was 4.9 per child-year (95%CI 4.5-5.4). The majority of episodes were of a short duration; 63% were episodes lasting only one day.

The unadjusted risk of HCGI was significantly less among children drinking tank rainwater alone compared with those drinking chlorinated and filtered public mains water (Table 2). When the full model was developed, adjusting for other potential risk factors for gastroenteritis, the risk associated with tank rainwater water was still significantly reduced (Table 3).

Table 2 Unadjusted risk of HCGI by water source- Tank Rainwater Diary Study.

Water Source	Odds ratio	95 % Confidence Interval	P-value
Public mains alone	1 (reference)		
Rainwater alone	0.68	0. 53 – 0.87	<0.01*
Rainwater plus public mains	0.84	0.62 – 1.13	0.24
Public mains plus spring/bottled water	0.67	0.33 – 1.32	0.24
Rainwater, public mains plus spring/bottled water	0.56	0.34 – 0.93	0.03

Table 3 Risk of HCGI by water source, adjusted for confounding factors- Tank Rainwater Diary Study.

Risk Factor	Odds ratio	95 % Confidence Interval	P-value
Water Source			
Public mains alone	1 (reference)		0.04*
Rainwater alone	0.69	0.53 – 0.90	
Rainwater plus public mains	0.85	0.62 – 1.16	
Public mains plus spring/bottled water	0.73	0.36 -1.49	
Rainwater, public mains plus spring/bottled water	0.56	0.33 – 0.94	
Sore throat			<0.01*
No	1 (reference)		
Yes	2.59	2.05 – 3.27	
Earache			<0.01*
No	1 (reference)		
Yes	2.62	1.41 – 4.89	
Gastro contact in the home			<0.01*
No	1 (reference)		
Yes	3.53	2.55 – 4.90	
Don’t know	2.04	1.09 – 3.80	
Gastro contact outside the home			<0.01*
No	1 (reference)		
Yes	3.64	2.50 – 5.31	
Don’t know	1.21	0.99 – 1.49	
Beef mince two days prior#			0.04*
No	1 (reference)		
Yes	1.27	1.01 – 1.59	
Takeaways			0.02*
Rarely or never	1 (referenc		
1-2 times/month	1.05	0.79 – 1.39	

1/ week or more	1.40	1.06 – 1.96	
Swimming			0.17
Did not swim	1 (reference)		
Public Pool	1.03	0.80 – 1.34	
Private pool	1.66	1.12 – 2.47	
Beach	0.99	0.50 – 1.97	
Other	1.04	0.79 – 1.37	
Leftovers			
Refrigerate immediately	1 (reference)		
Cool then refrigerate	0.73	0.58 – 0.96	0.02*
Leave on bench	0.91	0.46 – 1.79	0.70

also known as ground beef

The perceived risk to health resulting from different water types varied among the parents of children participating in this study. Bottled or spring water was considered a low risk to health among 80% of parents compared with 65% who believed tank rainwater to a be a low risk and only 50% who believed public mains water to be a low risk. Conversely 12% thought public mains to be a high risk to health whereas 1 % thought bottled or spring water to be a high risk. Nine per cent thought tank rainwater to be a high risk to health. This may have influenced reporting of gastrointestinal symptoms and will be further investigated.

Rainwater Tank Environment

Table 4 presents the data on the construction and maintenance of rainwater tanks and roof catchments for those children who drank tank rainwater.

The majority of rainwater tanks in this study were constructed of galvanized iron. The roof catchments were also predominantly constructed of galvanized iron, followed by colourbond. Forty-three per cent of tanks were at least 10 years old. Few tanks had first flush diverters (7.5 per cent) but most had sealed roofs (82.5 per cent). Just under half had a screened inlet. For those tanks that were more than two years old, the sludge had not been removed in 41.5 per cent of these tanks. A high proportion of respondents, 25.7 per cent weren't aware of whether or not the sludge had ever been removed.

With regard to the roof catchments, three-quarters were free of overhanging trees and 65 per cent of gutters had been cleaned in the last year.

Conclusion

The incidence of gastroenteritis among children is high. This study found that on average children suffered 4.9 episodes of HCGI per year. In South Australia, young children drinking tank rainwater were not at greater risk of gastroenteritis than children drinking treated public mains water. In fact the data suggest that those children drinking treated public mains water were at increased risk of gastroenteritis. This warrants further investigation.

Further analyses of these data will investigate the relationship between gastroenteritis and levels of consumption and treatment of tank rainwater, and the impact of perception of risk on reporting of gastrointestinal symptoms.

The implications of the findings with regard to tank rainwater beyond South Australia, depend upon local conditions such as maintenance and construction of rainwater tanks and catchments, as well as carriage of pathogens by local fauna.

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The Ian Potter Foundation kindly provided a travel grant to enable Jane Heyworth to attend Rainwater International 2001.

Table 4 Rainwater tank and catchment area- Tank Rainwater Diary Study (n= 709)

Factor[1]	n	%
Tank constructed from:		
Concrete	109	15.4
Galvanized Iron	419	59.3
Plastic	38	5.4
Fibreglass	35	4.9
Other	14	2.0
Combination (> 1 tank)	91	12.9
Don't know	1	0.1
Roof catchments:		
Tile	135	19.1
Galvanized iron	330	46.5
Colourbond	165	23.3
Other	23	3.2
Combination	53	7.5
Don't know	3	0.4
Age of tank rainwater tank		
Less than 2 years	64	9.0
2 to 3 years	67	9.4
4 to 9 years	182	25.7
10 or more years	306	43.2
Don't know	90	12.7
First flush diverter		
No	576	81.6
Yes	52	7.4
Don't know	78	11.0
Tank has sealed roof		
No	89	12.6
Yes	583	82.5
Don't know	35	4.9
Screened inlet		
No	316	45.2
Yes	281	40.2
Don't know	102	14.6
Overhanging trees		
No	543	76.7
Yes	161	22.7
Don't know	4	0.6
Gutters last cleaned:		
Never	59	8.4
More than 1 year ago	110	15.7
6 months to 1 year ago	178	25.4
Less than 6 months ago	280	40.0
Combination	3	0.4
Don't know	71	10.1
Time since sludge last removed[2]		
Never	268	41.5
Less than 6 months ago	16	2.5
6 months to 2 years	83	12.9
More than 2 yrs to 5 years	63	9.8
More than 5 years	37	5.7
Don't know	166	25.7

Combination	12	1.9

1. Some may not add to 709 due to missing data
2. Only for tanks aged 2 years or more, n=645

Table 5 Final Model: HCGI and Drinking Water Source (n= 8,552)

Variable	Odds Ratio	SE	95% CI	p-value
Drinking Water Source				0.07
Public mains	1	-	-	
Rainwater only	0.77	0.12	0.57 - 1.03	
Rainwater and public mains	0.86	0.13	0.64- 1.16	
Public mains and bottled/spring water	0.54	0.17	0.28-1.02	
All three	0.56	0.14	0.33 - 0.93	
Rating of risk to health from rainwater				<0.01
Low/medium risk	1	-	-	
High risk	1.60	0.28	1.13 – 2.25	
Not sure	1.71	0.31	1.19, 2.46	