Effect of swimming pools on antibiotic use and clinic attendance for infections in two Aboriginal communities in Western Australia

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ABSTRACT

Objective: To determine whether installation of swimming pools in remote Aboriginal communities reduces infection-related outpatient attendances and prescription of antibiotics.

Design and setting: Swimming pools were opened in Jigalong and Mugarinya, Western Australia, in September 2000. We examined local clinic records to document illnesses occurring in children and adolescents under 17 years of age between 1998 and 2005. In Jigalong, we examined records of those enrolled in an ongoing study evaluating the effect of swimming pools on health. In Mugarinya, we examined clinic records of those residing there permanently.

Main outcome measures: Clinic attendance rates for skin, middle-ear and respiratory tract infections and trauma, and prescription rates for antibiotics were analysed by using a community-based selection method in Jigalong, and a clinic-based selection method in both communities for comparison of the two communities and the two methods.

Results: We examined records of 131 children in Jigalong and 128 children in Mugarinya. After the pools had been installed, clinic attendance rates for skin infections declined by 68% in Jigalong and by up to 77% in Mugarinya. In Jigalong (where the pre-pool prevalence of infections was higher than in Mugarinya), rates of antibiotic prescription declined by 45%, as did clinic attendance for middle-ear infections (61% reduction) and respiratory tract infections (52% reduction).

Conclusion: Swimming pools in remote communities are associated with reduced prevalence of skin infections. Where disease prevalence is high, pools are also associated with reduced rates of antibiotic prescriptions and middle-ear and respiratory tract infections. In communities with resident health staff, examination of clinic records is an efficient method of monitoring the effects of public health interventions on the burden of infectious diseases.

MJA 2008; 188: 594–598

Aboriginal children are seriously disadvantaged and suffer very high rates of infections.[1-4] In Western Australia, hospital admission rates for children under the age of 2 years for any infection, for skin infections and for pneumonia are, respectively, five, 12 and 13 times higher in Aboriginal than non-Aboriginal children.[2] Prevalence as high as 91% for otitis media and 70% for pyoderma have been documented in remote Aboriginal communities.[5-7] Of further concern is the steady increase in Australia in the resistance of respiratory pathogens to antibiotics, making infections more difficult to treat.[8]

In 2000, swimming pools were installed in four remote Aboriginal communities in WA, with the aim of reducing the burden of disease and to provide social and recreational opportunities for children. The Royal Life Saving Society managed all the pools and ensured standardised testing of water quality, supervision, and regulations on access to the pools, including showering before entering the pool, exclusion of people with certain medical conditions (eg, gastroenteritis), and limiting the number of people using the pool at any one time. Six-monthly surveys in two of the communities before and after installation of the pools showed a reduction in the prevalence of pyoderma and otitis media.[6]

We hypothesised that attendances for infections at local clinics and the number of prescriptions written for antibiotics would decrease after the installation of the swimming pools.

1 Locations of Jigalong and Mugarinya, two Aboriginal communities in Western Australia

METHODS

Swimming pools were opened in Jigalong and Mugarinya in September 2000 and have generally been open from September to April each year. Both communities are in a semi-arid environment, over 1200 km north of Perth (Box 1). During the summer, daily temperatures range from 15°C to 45°C, falling to freezing at night in the winter months. In 2001, the census recorded 275 people in Jigalong and 188 in Mugarinya.[9]

Morbidity data collection

We collected morbidity data by examining medical records for children and adolescents (< 17 years) held at the local clinics. After the swimming pools opened in September 2000, we calculated annual morbidity rates from episodes occurring between 1 October and 30 September. All prescriptions for systemic antibiotics were recorded, and all episodes of ear, skin and respiratory tract infections (listed in Box 2) were documented. For comparison, we also documented changes in the rates of clinic visits for trauma, an illness category that we would not expect to decline after installation of a pool. We have previously reported a low incidence of pool-related trauma.[6] Multiple attendances for treatment of an illness were counted as a single episode. However, if antibiotics were changed during the course of a single episode of illness, they were recorded as separate courses of antibiotics.

Inclusion criteria

Two different methods of data selection were used:

The community-based selection method: This was used at Jigalong, where there was an ongoing study that has been described in detail.[6] Our research team visited Jigalong every 6 months between September 2000 and February 2005 and examined the children who were present. For the current analysis, we used Jigalong clinic data for an individual child only if that child had been seen by the research team during one of its routine 6-monthly visits during the 12-month period, October to September. If the child had not been seen by the research team during one of the 12-month periods, clinic-based morbidity data for that year were recorded as "missing". We considered the community-based selection method the most reliable assessment of which children were present during a 12-month period.

The clinic-based selection method: There was no ongoing study in Mugarinya, so a different method of data selection had to be used. We extracted clinic attendance records for children identified by the local nurse (who had worked there for many years and did so throughout the study period) as being resident in the community. A child's period of residence was defined as being between the start of the 12-month period (1 October) that included the child's first clinic record and the end of the 12-month period (30 September) that included their last clinic record.

To compare morbidity rates between communities and the results obtained from the two different selection methods, we also analysed Jigalong data by the clinic-based method of selection.

Data analysis and statistical methods

Data were entered into a database (FileMaker Pro, version 6; FileMaker Inc, Santa Clara, Calif, USA). Analyses compared annual morbidity and antibiotic prescription rates before and after the construction of the pool.

Poisson regression was used to calculate morbidity rate ratios for the years 2000–2001 through to 2004–2005 relative to the pre-pool year, 1999–2000, for the following categories: systemic antibiotic prescriptions, middle-ear infections, skin infections, respiratory tract infections, and trauma. Log-linear trends for each disease category were estimated by Poisson regression. Loss of independence due to repeated observations on the same individuals was accounted for by using generalised estimating equations with an auto-regressive covariance structure. The models were adjusted for sex and age, with linear dependence of morbidity on age assumed. Effects were denoted as significant where $P < 0.05$. SAS, version 9 (SAS Institute, Cary, NC, USA) was used for the analyses.

Permission and ethical approval

Written permission to access medical records had been obtained from parents or guardians in Jigalong when they gave consent for their children to participate in the regular surveys.[6] Approval for investigators to access the medical files of children in Mugarinya was given by the local community council and the local public health authority. Ethical approval to conduct the study was given by the Western Australian Aboriginal Health Information and Ethics Committee and the Princess Margaret Hospital Ethics Committee (Perth, WA). The Confidentiality of Health Information Committee of the Health Department of WA approved access to clinic data.

2 Diagnoses included in infection categories,* recorded between 1998 and 2005 in Jigalong and Mugarinya

Middle ear

Otitis media, acute otitis media, chronic suppurative otitis media, glue ear, cholesteatoma, mastoiditis

Skin

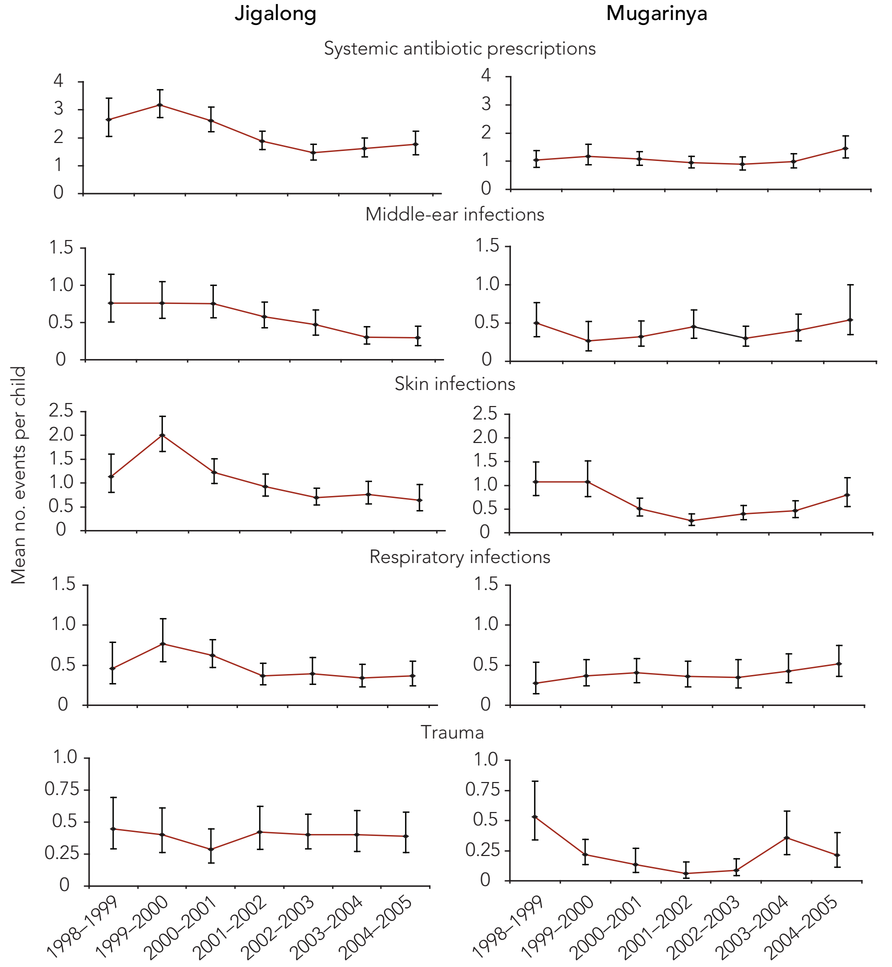
Pyoderma (skin sores), infected lesion, fungal lesion, scabies, scalp sepsis, ulcer, paronychia, abscess, cellulitis

Respiratory

Upper respiratory tract infection, lower respiratory tract infection, pneumonia, pharyngitis, nasal discharge, rhinitis, sinusitis, tonsillitis, bronchitis, pertussis

*Excluded were otitis externa, earache, foreign body, head lice, laceration, cough and asthma. ◆

3 Mean rates, per child, of antibiotic prescriptions, infections and trauma, adjusted for age and sex, in two remote Western Australian Aboriginal communities, 1998–2005*



* The clinic-based method of selection was used. ◆

4 Morbidity rate ratios (95% CIs), adjusted for age and sex, 2000–2005 relative to pre-pool year (1999–2000) in two remote Western Australian Aboriginal communities

	Jigalong						Mugarinya		
	Community-based method			Clinic-based method			Clinic-based method		
Reason for attendance	*n**	Events	Rate ratio	*n*†	Events	Rate ratio	*n*‡	Events	Rate ratio
Systemic antibiotics									
1999–2000	60	220		90	334		65	79	
2000–2001	39	138	0.9 (0.7–1.2)	99	283	**0.8** (0.7–1.0)	69	81	0.9 (0.7–1.3)
2001–2002	46	88	**0.6**§ (0.5–0.8)	108	205	**0.6** (0.5–0.7)	68	71	0.8 (0.6–1.1)
2002–2003	61	93	**0.5** (0.4–0.6)	112	159	**0.5** (0.4–0.6)	72	72	0.8 (0.5–1.1)
2003–2004	51	77	**0.5** (0.4–0.7)	102	153	**0.5** (0.4–0.7)	69	71	0.8 (0.6–1.2)
2004–2005	37	67	**0.5** (0.4–0.8)	79	122	**0.6** (0.4–0.7)	57	89	1.2 (0.9–1.8)
Middle-ear infection									
1999–2000	60	58		90	102		65	19	
2000–2001	39	54	1.5 (0.9–2.3)	99	99	1.0 (0.7–1.3)	69	27	1.2 (0.6–2.6)
2001–2002	46	23	0.7 (0.5–1.1)	108	73	0.8 (0.6–1.0)	68	38	1.7 (0.9–3.4)
2002–2003	61	42	0.8 (0.4–1.4)	112	57	**0.6** (0.4–1.0)	72	27	1.1 (0.5–2.5)
2003–2004	51	15	**0.4** (0.2–0.8)	102	30	**0.4** (0.3–0.6)	69	33	1.5 (0.7–3.4)
2004–2005	37	15	**0.5** (0.3–0.9)	79	20	**0.4** (0.2–0.6)	57	36	2.0 (0.9–4.6)
Skin infection									
1999–2000	60	138		90	203		65	67	
2000–2001	39	56	**0.6** (0.5–0.8)	99	131	**0.6** (0.5–0.8)	69	36	**0.5** (0.3–0.8)
2001–2002	46	44	**0.5** (0.3–0.8)	108	101	**0.5** (0.4–0.6)	68	18	**0.2** (0.1–0.4)
2002–2003	61	36	**0.3** (0.2–0.4)	112	76	**0.4** (0.3–0.5)	72	30	**0.4** (0.2–0.6)
2003–2004	51	37	**0.4** (0.3–0.6)	102	73	**0.4** (0.3–0.5)	69	32	**0.4** (0.3–0.7)
2004–2005	37	26	**0.3** (0.2–0.6)	79	43	**0.3** (0.2–0.5)	57	45	0.7 (0.5–1.2)
Respiratory infection									
1999–2000	60	85		90	104		65	27	
2000–2001	39	44	0.8 (0.6–1.2)	99	82	0.8 (0.6–1.2)	69	33	1.1 (0.7–1.8)
2001–2002	46	17	**0.4** (0.2–0.6)	108	49	**0.5** (0.3–0.8)	68	30	1.0 (0.6–1.7)
2002–2003	61	20	**0.3** (0.2–0.4)	112	48	**0.5** (0.3–0.9)	72	32	1.0 (0.5–1.7)
2003–2004	51	16	**0.3** (0.2–0.7)	102	36	**0.4** (0.3–0.7)	69	34	1.2 (0.6–2.1)
2004–2005	37	18	**0.4** (0.2–0.8)	79	26	**0.5** (0.3–0.8)	57	36	1.4 (0.8–2.4)
Trauma									
1999–2000	60	31		90	35		65	14	
2000–2001	39	20	0.9 (0.5–1.6)	99	29	0.7 (0.4–1.3)	69	9	0.6 (0.3–1.4)
2001–2002	46	27	1.1 (0.5–2.2)	108	47	1.1 (0.6–1.9)	68	4	**0.3** (0.1–0.8)
2002–2003	61	24	0.8 (0.4–1.3)	112	48	1.0 (0.6–1.8)	72	6	**0.4** (0.2–1.00)
2003–2004	51	25	0.8 (0.4–1.7)	102	44	1.0 (0.6–1.8)	69	25	1.7 (0.8–3.3)
2004–2005	37	14	0.7 (0.3–1.5)	79	33	1.0 (0.6–1.7)	57	12	1.0 (0.4–2.3)

* Number of children enrolled in the community-based survey who were seen by the research team during the 12 months (October–September) in each year. † Number of children resident during the 12 months who were enrolled in the community-based survey. ‡ Number of children resident during the 12 months. § Statistically significant ratios ($P < 0.05$) are shown in bold. ◆

RESULTS

Over the 6 years, 131 children were enrolled into the study in Jigalong, and morbidity data from 128 children residing in Mugarinya were analysed. At first enrolment, 40% of the study participants in Jigalong and 55% in Mugarinya were aged < 5 years; 56% in Jigalong and 50% in Mugarinya were boys. In Jigalong, 37–61 children were included in each year's analysis when we used the community-based selection method, and 79–112 children when we used the clinic-based selection method; in Mugarinya 57–72 children were included each year.

The mean number of middle-ear and respiratory infections per child at the start of the study was lower in Mugarinya than in

5 Morbidity trends (95% CIs), showing fitted annual percentage change in morbidity rate, adjusted for age and sex, for children and adolescents in remote Western Australian Aboriginal communities, 1998–2005

	Jigalong		Mugarinya
Type of event	Community-based method	Clinic-based method	Clinic-based method
Systemic antibiotics	**–13*** (–18 to –8)	**–11** (–15 to –7)	2 (–3 to 7)
Middle-ear infection	**–16** (–22 to –8)	**–15** (–21 to –8)	4 (–7 to 16)
Skin infection	**–17** (–23 to –10)	**–15** (–20 to –10)	**–11** (–20 to –1)
Respiratory infection	**–16** (–22 to –8)	**–10** (–16 to –3)	8 (–1 to 17)
Trauma	–7 (–16 to 4)	0 (–9 to 10)	–10 (–24 to 5)

* Statistically significant trends ($P < 0.05$) are shown in bold. ◆

Jigalong, but skin infections and trauma attendances were similar (Box 3).

In Jigalong, the rates of infectious diseases (adjusted for age and sex) declined significantly from the pre-pool year to 2004–2005 (Box 3, Box 4). With the clinic-based method, middle-ear infections decreased by 61%, skin infections by 68%, and respiratory infections by 52%. The community-based selection method gave similar reductions in morbidity. Antibiotic prescription rates decreased significantly 2 years after the pool was opened and remained low thereafter. The prescription rate decreased by 45% from the pre-pool year to 2004–2005.

The rate of antibiotic prescription was lower in Mugarinya than in Jigalong for the entire study period. The number of prescriptions per child per year ranged from 1.4 to 3.0 in Jigalong and 0.8 to 1.4 in Mugarinya. In Mugarinya, the adjusted antibiotic prescription rates changed little after the opening of the pool, and rates of respiratory tract and middle-ear infections increased, but not significantly. There was a significant reduction in rates of skin infections relative to the pre-pool year of between 53% and 77% annually until 2003–2004, but no reduction in 2004–2005. Trauma rates were significantly lower in 2001–2002 and 2002–2003 than in 1999–2000. For all disease categories except trauma, the morbidity rate in 2004–2005 was the highest since the pool was opened.

Log-linear trend analyses (Box 5) confirmed a significant decline in antibiotic prescriptions and infections in Jigalong from 1998 to 2005, irrespective of the selection method. In Mugarinya, trend analysis showed a decline in all skin infections, but no significant changes in rates of other infections, trauma-related events or antibiotic prescriptions.

There were 16 reports in Jigalong and 12 in Mugarinya of otitis externa (“swimmers ear”), a recognised problem among regular users of swimming pools,[10,11] with no increase in prevalence over the course of the study.

DISCUSSION

Clinic attendances for skin infections in both Jigalong and Mugarinya declined after the installation of swimming pools. There was also a significant decline in attendance for middle-ear and respiratory infections in Jigalong, where attendance rates for these illnesses were higher in the pre-pool period than in Mugarinya. The reduction in middle-ear and skin infections in Jigalong confirms and extends our earlier findings over a 7-year period.[6]

The 45% reduction in antibiotic prescriptions in Jigalong is consistent with the reduction in clinic visits for infections, but we found little change in antibiotic prescription rates in Mugarinya.

There were differences in health services available in the two communities. Two doctors and nursing staff lived in Jigalong throughout the study period. By contrast, in Mugarinya there were no resident doctors or nurses, but a nurse with extensive local knowledge had been providing a service for more than 20 years and stayed there 4 days each week. At other times, people had to travel from Mugarinya to Port Hedland for treatment. The fact that medical staff were not always available in Mugarinya to see sick children and to document illness episodes may in part explain the lower clinic attendance rates in Mugarinya. There may also have been differences in prescribing practices between staff in the two communities. However, there may also be a real difference in disease burden between these two communities (a subjective impression of the visiting researchers), which needs to be explored further.

The two methods we used have potential biases. The clinic-based method of selection may have excluded healthy children and hence resulted in an overestimate of morbidity rates. In fact, the morbidity rates in Mugarinya were lower than in Jigalong. In contrast, one might expect the community-based method to underestimate morbidity, because sick children might have remained at home and not been seen by the research team. However, a paediatrician being part of the research team and the team’s request to see sick children during 6-monthly visits may have encouraged people to bring sick children for examination. It is reassuring that the morbidity and antibiotic prescription rates found by the two analytical methods in Jigalong produced remarkably similar results. We aimed to ensure we had the most complete and reliable information on children, but we are unable to determine whether highly mobile teenagers, who might be at greatest risk of illness, might have benefited least from the intervention as they were less likely to use the pool.

In this observational study, attendance at clinics could have declined independently of installation of the pools. In Jigalong, the decline in rates of attendance for infections was not accompanied by reductions in attendance for injuries. The morbidity reductions at Jigalong are therefore unlikely to be the result of changes in overall clinic attendance. We cannot explain the reduction in clinic attendances for trauma at Mugarinya during 2001–2002 and 2002–2003, but this reduction did not coincide with any declines in attendance for infections.

However, in July 2001 pneumococcal conjugate vaccine was introduced in WA for children aged < 5 years, and by 2002 there was > 90% uptake in Jigalong and Mugarinya (Sally Connelly, Regional Immunisation Coordinator, Pilbara Population Health, personal communication, 2007). The vaccine program may have contributed to a reduction in pneumococcus-related respiratory illness, but is unlikely to have influenced attendance rates for middle-ear infections, because studies in the Northern Territory have not detected any effect of pneumococcal conjugate vaccine on the burden of severe middle-ear infections in Aboriginal communities.[12] In our study, the reduction in possibly pneumococcus-related infections and other infections (eg, skin infections) actually began before a vaccine could have significantly affected morbidity rates. Furthermore, the reduction in disease burden was not equivalent in the two communities.

In view of high rates of infectious and chronic diseases, swimming pools in remote Aboriginal communities can have short-term and long-term advantages. Fewer prescriptions for antibiotics will reduce costs and antibiotic resistance, both of which are of concern in Aboriginal communities.[13] Pyoderma is generally the result of group A streptococcal infections, and has been associated with rheumatic heart disease and glomerulonephritis.[5,14-16] Aboriginal Australians have the highest documented rates of these illnesses worldwide.[17,18] By reducing pyoderma, swimming pools may lower the incidence of the streptococcus-related chronic illnesses and the associated costs of renal dialysis and heart valve replacements.

Population mobility between Aboriginal communities is high and this can affect the interpretation of study results.[19] Nevertheless, in Jigalong, community-based or clinic-based selection methods produced similar results. Therefore, we propose that evaluation of public health interventions for infectious diseases in children is possible using the clinic-based method in communities with resident staff and enough staff to ensure well kept clinic records.

CONCLUSIONS

The introduction of swimming pools is associated with a reduction in skin, ear and respiratory infections where documented outpatient attendance rates are high, thereby reducing antibiotic prescription rates and clinic workload. The effect on health of swimming pools being built elsewhere in Australia may be monitored efficiently by examining clinic records.

ACKNOWLEDGEMENTS

We thank Helen Wright and Jenny Smith for assistance with data extraction from the notes and data entry, and Kirsten Alpers for editorial assistance. We thank the nursing and medical staff at Jigalong and Mugarinya and Kylie Carville for assisting us in obtaining the clinic records. This study was funded by the Western Australian Department of Housing and Works and the Western Australian Health Promotion Foundation (Healthway). Peter Jacoby and Deborah Lehmann are funded through National Health and Medical Council program grant 353514.

COMPETING INTERESTS

None identified.

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(Received 8 Jun 2007, accepted 13 Dec 2007) ❑

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