

## Outbreak of *Pseudomonas aeruginosa* folliculitis associated with a swimming pool inflatable

D. TATE<sup>1</sup>\*, S. MAWER<sup>2</sup> AND A. NEWTON<sup>1</sup>

<sup>1</sup> Health Protection Unit, Health House, Grange Park Lane, Willerby, UK

<sup>2</sup> Hull Public Health Laboratory, Hull Royal Infirmary, Analby Road, Hull, UK

(Accepted 9 December 2002)

### SUMMARY

On 18 February 2002, the Communicable Disease Unit was notified by the local Public Health Service Laboratory of a child with a positive skin swab for *Pseudomonas aeruginosa*. This child had attended the local swimming pool and played on an inflatable, subsequently presenting to a Primary Care Nurse Practitioner with folliculitis. A total of 35 cases was identified during the outbreak. This paper describes a case-control study and microbiological sampling of the cases, the suspected inflatable and a survey of 10 swimming pool inflatables in the local area. The odds ratio for developing folliculitis following use of the inflatable was 12 (95% CI 1.05–136.80). The strain of *P. aeruginosa* found on the inflatable was identical to that obtained from skin swabs of cases. Nine of 10 (90%) of the inflatables sampled were colonized by *P. aeruginosa*. Attention should be given to the problem of routine decontamination of swimming pool inflatables.

*P. aeruginosa* folliculitis needs to be considered in the differential diagnosis of skin rashes in children, especially in Primary Care.

### INTRODUCTION

*Pseudomonas aeruginosa* was first described as causing folliculitis associated with the recreational use of water facilities in 1975 by McCausland and Cox [1] who reported the skin condition following the use of a public whirlpool [2]. Since then pseudomonas folliculitis has been reported following use of whirlpools [3–7], hot tubs [8], swimming pools [8, 9], saunas [9] and water slides [10]. Many of these cases have been due to failure of the disinfection system [6, 8–10].

*Pseudomonas* folliculitis typically presents with a pruritic rash following the location of apocrine sweat glands affecting the buttocks, hips, axillae, arms and thighs, with the palms, soles and mucous membranes being unaffected [8]. Although the rash is described as self-limiting, resolving in 2–10 days [11], cases have been known to require hospitalization and intravenous antibiotics due to severe dermatitis and

axillary lymphadenopathy [10]. Other recognized symptoms include headache, sore throat, sore eyes, rhinitis, mastitis, nausea and vomiting [12]. The folliculitis typically heals without scarring although it may produce areas of desquamation or hyperpigmented macules, and rarely subcutaneous abscesses may form [8]. Otitis externa is also a recognized association with these outbreaks, typically those involving swimming pools [8, 10]. Cases of pneumonia [13] and urinary tract infections [14] have been reported following the use of infected whirlpools. Thus although recreational water facilities colonized with *P. aeruginosa* typically produce a self-limiting folliculitis, other conditions may occasionally be produced with more serious consequences.

### BACKGROUND

An outbreak was initially suspected when two brothers presented to a Nurse Practitioner at a local General

\* Author for correspondence.

Practitioner's practice. They presented with a rash of similar distribution and time of onset. The Nurse Practitioner had seen several cases of skin rashes in children that day but had not initially considered a common link between them. Given the similarities between the brothers' rashes a more detailed exposure history was taken where it was identified that both had attended a local swimming pool during a session in which a pool inflatable was being used and was the main attraction. Further questioning of the previous cases seen, revealed that they had also attended the inflatable session at the swimming pool.

The swimming pool was sampled by environmental health officers and preliminary results suggested that the inflatable was heavily contaminated with *P. aeruginosa*. The species was also detected on environmental swabs taken from tiles at the shallow end of the swimming pool. The log of the chlorination levels was examined on the initial visit and satisfactory levels of free chlorine had been maintained in the pool (> 1 ppm) [15].

The inflatable was approx. 18 m in length and was 3 months old. It is inflated in the pool and kept continually inflated during use by an air pump. It is an obstacle course in design with children (> 14 years of age are prohibited from using it) climbing on one end and traversing the various inflated obstacles to reach the other end which comprises a short slide by which the children enter the water and return to the start. The inflatable comprises the main attraction of the swimming pool at the times it is in use.

## METHODS

Three investigations were undertaken following the formation of the Outbreak Control Team. (1) A case-control study, (2) microbiological sampling of the inflatable and children affected, and (3) microbiological sampling of swimming pool inflatables in the local authority.

### Case-control study

The case definition at the initial meeting was, 'any person with a rash resembling folliculitis who used the swimming pool in the 72 h prior to the onset of the rash'. A letter was sent to all General Practitioners in the Health Authority advising them of the outbreak and requesting that details of any possible cases seen be sent to the Communicable Disease Unit for follow-up. The Nurse Practitioner from the original practice

was contacted and a list of cases obtained. Fortunately the swimming pool is located in a small town served by only two General Practitioner practices, thus it was easy to obtain a list of cases from the second practice.

The cases were sent a questionnaire enquiring about symptoms, usage of the pool, activities undertaken in the swimming pool and use of the inflatable. Child cases were sent the questionnaire via their parent/guardian who was asked to fill in the questionnaire on their child's behalf. Cases were asked to identify up to two adults and two children who were in the pool at the same time as them but had not developed a rash. The cases were sent the control questionnaires with the case questionnaire and asked to distribute these to the controls they had identified. In this way we hoped to identify the controls. The swimming pool holds no records of people who use the swimming pool in a particular session; thus, the usual means of identifying controls used in other outbreaks of this nature, e.g. motel records [9], were not available. A reminder letter was sent 2 weeks after the initial questionnaire to all the identified cases.

### Microbiological sampling of the inflatable and suspected cases

General Practitioners at the practices in the town were asked to swab the rash of possible cases. Swabs from cases were processed by standard microbiological methods. They were inoculated on to blood agar, Cysteine Lactose Electrolyte Deficient (CLED) with Andrade's indicator, incubated at 37 °C for 40–48 h and examined for growth of typical colonies of *P. aeruginosa*. Individual colonies were picked and identities confirmed by the Laboratory of Hospital Infection (LHI), Central Public Health Laboratory, who performed serotyping and genetic fingerprinting by pulsed-field gel electrophoresis (PFGE).

The inflatable was retested following thorough cleaning with a disinfectant containing benzalkonium chloride (domestic solution).

### Microbiological sampling of swimming pool inflatables in the local authority

Due to the unique nature of this outbreak the Outbreak Control Team considered it was necessary to sample inflatables in the area to determine the frequency of colonization with *P. aeruginosa*. Inflatables were sampled over a 2-day period in April 2002.

A 10 × 10 cm square was swabbed vigorously with a sterile cotton transport swab (Sterlin UK Ltd) at the middle, either end of the inflatable, and the inside of the inflatable via the inflation inlet. Details were collected of the frequency of use, type, age, cleaning regime and storage of the inflatable.

#### Microbiological methods for environmental samples

Water samples were examined for coliforms, *Escherichia coli* and *P. aeruginosa* by standard methods [16, 17].

The swabs from the inflatable and pool environment were plated on to CLED and cetrinide fucidin cephaloridine (CFC) agar (Oxoid Ltd). After incubation at 37 °C for 40–48 h the plates were examined for *P. aeruginosa* and isolates sent to LHI for typing.

## RESULTS

### Case-control study

The two practices in the same town as the swimming pool provided a list of 32 individuals meeting the case definition. No other cases were reported by General Practitioners in the Health Authority area. Questionnaires were received from 23 (72%) of the 'original' cases identified. One case contacted the Communicable Disease Unit directly following the media attention given to the outbreak and their General Practitioner was contacted directly to confirm clinical details. Two cases were identified when they completed the control group questionnaire sent to the 'original' cases. Due to the confidentiality promised on these questionnaires no contact was made with their General Practitioners. Thus in total we received 26 completed questionnaires from cases, 23 identified by the two General Practices and 3 who contacted the Communicable Disease Unit independently.

Only 4 controls were identified, 2 of whom used the inflatable and 2 who did not. Two of the 26 cases had also not used the inflatable. The Odds Ratio (OR) for developing folliculitis having used the inflatable was 12.0 (95% CI 1.05–136.80, using binomial distribution).

The questionnaire asked the cases to mark on an outline of the human body areas affected by the rash. This part of the questionnaire was completed by 21 (81%) of the cases. The chest and abdomen was affected in 19 (90%), buttocks 14 (67%), arms 15 (71%), legs 18 (86%), hands, feet and head and neck were spared. The patterns described did not fit any

particular distribution of swimwear worn and did not reflect differences in sex. Symptoms from the rash were described as follows, itching 17 (81%), discharge from the rash 10 (48%), pain from the rash 8 (38%), loss of appetite 2 (10%). None of the cases had a temperature, nausea or vomiting. No cases described symptoms such as earache or sore throat, which have previously been associated with *P. aeruginosa* in recreational water [12].

### Microbiological sampling of the swimming pool and inflatable

The pool water on the initial visit was negative for *P. aeruginosa* and coliforms and repeated testing produced no significant results. *P. aeruginosa* was isolated from five environmental swabs and all except one were serotype O11 and of an identical PFGE profile. These were taken from areas such as tiles on the floor of the ladies changing room or tiling at the shallow end of the pool. Three swabs from the inflatable yielded heavy growths of *P. aeruginosa* serotype O11 and of the identical PFGE profile to the environmental isolates. Further tests of the swimming pool following cleaning were negative for *P. aeruginosa*. However, the inflatable remained consistently colonized by a heavy growth of *P. aeruginosa* despite extensive cleaning and drying. The inflatable was retested 2 months after the outbreak, having been stored in a dry cold area well away from the swimming pool and *P. aeruginosa* serotype O11 was still present on its surface.

### Swabs from cases

*P. aeruginosa* was isolated from swabs of the rashes of 6/20 cases tested and all 6 were of serotype O11. PFGE profiles showed that these isolates were indistinguishable from those of the inflatable and other positive environmental swabs, indicating they were the same strain. One case had two different *P. aeruginosa* O11 PFGE profiles; the first being was identical to the other cases and the second was unique. It is unclear where this strain originated.

### Microbiological sampling of swimming pool inflatables in the local authority

Ten inflatables were sampled microbiologically during visits to seven local pools. The inflatables varied in size (6–18 m), age (0–6 years) and were from six different manufacturers (Table 1). They were used

Table 1. Contamination of inflatable pool devices with *Pseudomonas aeruginosa*

Inflatable	Swimming pool	Age of inflatable (Yr)	Manufacturer	Length (m)	Frequency of use	Frequency of cleaning	<i>P. aeruginosa</i> isolated	<i>P. aeruginosa</i> O11 isolated	Number of swabs positive for <i>P. aeruginosa</i>
1	A	<1	1	18	Weekly	Washed after use	Yes	Yes	1
2	B	<1	1	18	× 3 per week	None	Yes	Yes	2
3	C	<1	1	6	Weekly	None	Yes	No	2
4	C	2	UN	7	Weekly	None	No	No	0
5	D	2	2	18	Weekly	None	Yes	No	1
6	E	6	1	6	Weekly	Monthly + washed after use	Yes	No	1
7	E	3	3	18	Sat + Sun each week	Monthly + washed after use	Yes	Yes	4
8	F	UN*	4	18	Weekly	None	Yes	No	4
9	F	UN	5	10	Weekly	None	Yes	No	2
10	G	1	6	18	Weekly	After use	Yes	Yes	2

\* UN, unknown.

predominantly once a week, with one pool using the inflatable three times per week and another on both Saturday and Sunday. The number of children using the inflatables ranged from 30 to 150 and sessions lasted between 45 and 120 min. Only three of the pools regularly cleaned their inflatables, and in six pools they were stored by the pool side and exposed to splashing with pool water, making their drying more difficult due to the humid atmosphere of the pool.

*P. aeruginosa* was isolated from 9/10 inflatables with 2 being positive in 4/4 swabs, 4 positive in 2/4 swabs, 3 in 1/4 swabs and 1 negative in all 4. Serotype O11 was isolated from 4/9 of the inflatables. *P. aeruginosa* was isolated from inside of 3/10 inflatables tested.

## DISCUSSION

We believe that this community outbreak of folliculitis was caused by the presence of *P. aeruginosa* serotype O11 that was acquired from skin contact with a contaminated inflatable. The PFGE profile of the *P. aeruginosa* taken from the inflatable was identical to that found on the skin of those patients who developed folliculitis.

*P. aeruginosa* is a Gram-negative bacillus. In Britain O11 is the second commonest serotype accounting for 15% of isolates from all clinical material, O6 being the commonest accounting for 20% [18]. It is

highly adapted to survive in the environment and is able to withstand relatively high levels of chlorine making its eradication from swimming pools difficult [11], this may be due to its ability to produce a biofilm [19]. Skin entry is enhanced by minor abrasions [19], which may occur when the body rubs against the swimming pool inflatable. Initial outbreaks of *P. aeruginosa* folliculitis associated with recreational water use were attributed to serotype O11 [11]. However, serotype O4 [10] and O9 [5] have now also been implicated in causing folliculitis outbreaks.

What is unusual about our report is that there was no failure in the disinfection system of the swimming pool water as records demonstrated adequate levels of free chlorine throughout the outbreak. We have however highlighted the lack of cleaning of swimming pool inflatables and the practices identified at the 'original' pool were no different from those at other pools in the area, where the inflatable was washed down with pool water after use and stored by the poolside. Many of these inflatables are over 15 m in length and are not watertight. The inside of the inflatable remains out of reach of and, as we have demonstrated may also be colonized by *P. aeruginosa*. We observed water extruding through the seams when the inflatable is inflated, potentially contaminating the outside of the inflatable with bacteria growing on the inside during storage.

The case-control study suffered from the lack of controls and thus detailed analysis was not undertaken. It does however provide further evidence of the link between the inflatable and the folliculitis, although its value is of a descriptive nature. The lack in this outbreak of ear or systemic symptoms reported in previous studies where *P. aeruginosa* was found in the pool water, adds further weight to the infection being contracted from the inflatable and not the water. *P. aeruginosa* was isolated from only 6 of the 20 patients affected who were swabbed, which probably reflects difficulties in contacting patients and the delay in swabbing their rashes. The two cases who stated they had not used the inflatable both had negative skin swabs. The first, a child, had a different distribution of rash from those who had used the inflatable. This case had a rash on the elbows and buttocks with sparing of the trunk both front and back, a source of this infection may have been the tiles at the shallow-end, which were *P. aeruginosa* positive, which the child could have scraped against when pulling themselves out of the water. The other case, the only adult to be affected, developed a rash on his legs only and no explanation for this was found.

The case-control study provided further evidence that showering on exiting the swimming pool is not protective against developing folliculitis, all the cases and controls showered on leaving the swimming pool. This confirms findings of a previous study [5]. It also highlights that this is not a trivial condition: three (10%) children required time off school and several received unnecessary antibiotic treatment (mainly flucloxacillin which is ineffective against *P. aeruginosa*).

The question arises as to, why given that, all except one, of the inflatables sampled, were colonized by *P. aeruginosa* there were not more cases of folliculitis? Several explanations are possible. Firstly although two other inflatables were positive for serotype O11, these were not of the same PFGE profile as that in the original outbreak. It is therefore possible that the particular strain that colonized the original inflatable was more virulent than those found on other inflatables. A second explanation is the lack of recognition of this condition. In this outbreak two children were diagnosed initially as suffering from chickenpox and other children received penicillins presumably to treat a staphylococcal folliculitis. Furthermore, the outbreak occurred in a town served by only two practices and the lateral thinking of the Nurse Practitioner on seeing the original cases meant

that the initial cases were quickly identified and further case ascertainment occurred.

This study does highlight the fact that adequate chlorination of swimming pool water does not totally protect against users developing bacterial skin infections. Guidelines for cleaning swimming pool inflatables need to be developed. No current guidance exists and manufacturers' literature contains little information to the owner of an inflatable as to how it may be cleaned bacteriologically. The cleaning agent should not damage the inflatable nor react with other disinfection agents used in the swimming pool. It should also be safe in the water to the users and be effective at eliminating *P. aeruginosa*. At present it is unclear as to what to do with an inflatable, which is contaminated with *P. aeruginosa* especially serotype O11, but has not been associated with clinical illness.

#### ACKNOWLEDGEMENTS

We wish to thank Rosie Thompson (Nurse Practitioner) whose actions alerted us to the outbreak, Colin Wilson (East Riding of Yorkshire Council Leisure Services) whose efforts enabled us to sample the local swimming pool inflatables, Karen Baddeley and Paul Abbott (Environmental Health Officers) who conducted the initial sampling, Sam Ackland for doing most of the laboratory work, Mrs M. E. Kaufmann (LHI) for conducting the serotyping and PFGE profiling of the isolates and Dr G. Nichols (CDSC Colindale) for help and advice throughout the outbreak and comments on this paper.

#### REFERENCES

1. McCausland WJ, Cox PJ. *Pseudomonas* infection traced to motel whirlpool. *J Environ Health* 1975; **37**: 455-9.
2. Trueb RM, Gloor M, Wuthrich B. Recurrent *Pseudomonas* folliculitis. *Pediatr Dermatol* 1994; **11**: 35-8.
3. Washburn J, Jacobson MD, Marston E, et al. *Pseudomonas aeruginosa* rash associated with a whirlpool. *JAMA* 1976; **235**: 2205-7.
4. Feder HM, Grant-Kels JM, Tilton RC. *Pseudomonas* whirlpool dermatitis. Report of an outbreak in two families. *Clin Pediatr* 1983; **22**: 638-42.
5. Khabbaz RF, McKinley TW, Goodman RA, et al. *Pseudomonas aeruginosa* serotype O:9. New cause of whirlpool-associated dermatitis. *Am J Med* 1983; **74**: 73-7.
6. Breitenbach RA. *Pseudomonas* folliculitis from a health club whirlpool. *Postgrad Med J* 1991; **90**: 169-70.
7. Hollyoak V, Boyd P, Freeman R. Whirlpool baths in nursing homes: use, maintenance, and contamination with *Pseudomonas aeruginosa*. *CDR* 1995; **5**: 102-4.

8. Gregory GW, Schaffner W. *Pseudomonas* infections associated with hot tubs and other environments. *Infect Dis Clin North Am* 1987; **1**: 635–48.
9. Hopkins RS, Abbott DO, Wallace LE. Follicular dermatitis outbreak caused by *Pseudomonas aeruginosa* associated with a motel's indoor swimming pool. *Publ Health Rep* 1981; **96**: 2246–9.
10. Anonymous. An outbreak of *Pseudomonas* folliculitis associated with a waterslide – Utah. *MMWR* 1983; **32**: 425–7.
11. Berger RS, Seifert MR. Whirlpool folliculitis: a review of its cause, treatment, and prevention. *Cutis* 1990; **45**: 97–8.
12. Insler MS, Gore H. *Pseudomonas* keratitis and folliculitis from whirlpool exposure. *Am J Ophthalmol* 1986; **101**: 41–3.
13. Rose HD, Franson TR, Sheth NK, et al. *Pseudomonas* pneumonia associated with use of a home whirlpool spa. *JAMA* 1983; **250**: 2027–30.
14. Salmen P, Dwyer DM, Vorse H, et al. Whirlpool associated *Pseudomonas aeruginosa* urinary tract infections. *JAMA* 1983; **250**: 2025–6.
15. Pool Water Treatment Advisory Group. Swimming pool water-treatment and quality standards, 1999.
16. PHLS Water Working Group and Environmental Surveillance Unit. PHLS standard method for water, enumeration of coliforms and *Escherichia coli* by IDEXX Quantitray™, W18. CDSC 2000; 1.
17. PHLS Water Working Group and Environmental Surveillance Unit. PHLS standard method for water, enumeration of *Pseudomonas aeruginosa* by membrane filtration, W6. CDSC 1998; 1.
18. Pitt TL. *Pseudomonas*, *Burkholderia* and related genera. In: Barlow A, Duerden BI, eds. *Topley and Wilson's microbiology and microbial infections*. 9th edn. London: Arnold, 1998: 1109–38.
19. Chandraseker PH, Rolston KVI, Kannangara W, et al. Hot tub-associated dermatitis due to *Pseudomonas aeruginosa*. Case report and review of the literature. *Arch Dermatol* 1984; **30**: 329–31.