

SHORT REPORT

An outbreak of *E. coli* O157 associated with a swimming pool: an unusual vehicle of transmission

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SUMMARY

Escherichia coli O157 causes a range of illnesses from mild diarrhoea to haemolytic uraemic syndrome (HUS) which carries a mortality rate of 3·7%. Infection is more common in the under-5s. Between 1995 and 2000, 106 outbreaks of *E. coli* O157 were reported in England and Wales. Recreational water is well documented as a transmission route for infectious diseases worldwide. In the United Kingdom there have been very few reported outbreaks associated with swimming pools due to the relative susceptibility of *E. coli* O157 to adequate levels of free chlorine. This report describes the investigation of an outbreak associated with a local leisure centre pool and makes recommendations about the safe management of such facilities.

In September 2004, the Greater Manchester Health Protection Unit (GMHPU) was notified by the local hospital microbiology laboratory of three possible isolates of *Escherichia coli* O157 in children from the Trafford area. This compared with no cases of *E. coli* O157 reported in Trafford residents during the whole of 2004 up until the first case was reported to GMHPU on Tuesday, 14 September by the microbiological laboratories at the local hospital.

All cases were interviewed using a standard questionnaire for *E. coli* O157 to identify all potential exposures in the 2 weeks prior to symptom onset. A fourth case was reported 2 days later. Analysis of the questionnaires established a link that all four cases had been swimming in the learners' pool of a local leisure centre on the morning of Sunday, 5 September 2004. An outbreak was declared and the local

outbreak control plan put into action. Cases and contacts were investigated by interview using a standardized questionnaire and microbiological investigation of faecal specimens. Cases were defined as:

Confirmed. Diarrhoea with demonstration of *E. coli* O157 of outbreak strain in stools or haemolytic uraemic syndrome (HUS) with onset within 9 days of attending the pool.

Possible. Diarrhoea in person epidemiologically linked to outbreak (e.g. onset within 9 days of exposure to pool) with further investigations awaited.

Secondary. Diarrhoea with demonstration of *E. coli* O157 outbreak strain in stools or HUS with contact with a case in the previous 9 days.

The management at the community leisure trust closed the pool voluntarily pending the outcome of the investigation. Advice was also sought from experts at the Communicable Disease Surveillance Centre (CDSC). An electronic message was sent to all GPs, A&E consultants, paediatricians and renal

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Table. Cases' age, time in swimming pool, and changing room used

Case no.	Age (yr)	Time (hours)	Changing room used
7*	2	10:00–11:15	Male
6	8	10:15–12:00	Male
2*	4	10:50–12:00	Male
1	3	11:00–11:45	Female
4	1	11:00–11:45	Female
3	<1	11:00–12:00	Female
5	34	11:00–12:00	Female
8	3	11:00–12:30	Male

* Developed HUS.

physicians across Greater Manchester, alerting them to the outbreak, and asking them to inform the Health Protection Unit of any patients with bloody diarrhoea and submit a faecal specimen. An electronic message was also sent to all microbiologists and infection control nurses requesting information on isolates of *E. coli* O157 linked to the outbreak.

Samples of pool water, sand from the filters, mops and swabs from changing areas were submitted for microbiological and chemical analysis. The Outbreak Control Team (OCT), Health and Safety Executive (HSE) and an independent pool consultant all visited the leisure facility to investigate the incident and review procedures. Infection control advice was given to the families and schools where cases attended to prevent onward transmission of infection.

Eight confirmed cases of *E. coli* O157 were identified in the outbreak (Table). Two children developed HUS. All had been swimming in the learners' swimming pool between 10:00 and 12:15 hours on Sunday, 5 September 2004. The time spent in the learners' pool varied from 20 to 90 min. Six parents reported that the children had probably swallowed water from the pool. There were no reports of faecal matter in the pool although two parents reported that the pool smelt differently and one parent stated that it was cloudy and warmer than usual. Only one case visited another pool in the preceding 14 days while on holiday in Lanzarote. There were no common exposures to food items, farms, animals, holidays abroad, schools/nurseries.

E. coli O157 was isolated from faecal specimens from all eight cases. These were identified as being phage type 2: verocytotoxin type 2 and were indistinguishable using pulse-field gel electrophoresis but were distinct from other strains of *E. coli* O157 phage

type 2 referred to the national reference laboratory. All environmental samples were negative for *E. coli* O157.

Approximately 53 individuals (31 adults and 22 children) attended the swimming pool that morning. It is not known what proportion of this group was swimming in the learners' pool only. However, many parents of cases reported that Sunday morning swimming is very popular with families with young children. The attack rate is 32% in children (7/22 confirmed cases) and 3% in adults (1/31 confirmed case).

Pool staff had reported a blockage to the chlorine dosing system on the morning of Sunday, 5 September. The level of free chlorine in the pool was recorded as 0.5 mg/l but following unblocking and hand dosing the level was back up to 2.0 mg/l by 14:00 hours. However, review of the pool water chemical monitoring forms revealed that the learners' pool water had been running at a free chlorine level of 0.5 mg/l from 08:00 hours on 4 September 2004 until 11:00 hours on 5 September 2004. There was no observed faecal event in the pool on the morning of Sunday, 5 September.

Control measures taken included voluntary closure of the learner's pool. Following the visit to the pool by members of the OCT, the recommendations were to keep the pool closed, the pool should be drained and cleaned and the Leisure Trust should commission an independent expert review. This would include investigating the water treatment processes, making recommendations on the establishment of rigorous practice and procedures to ensure that the water disinfection system and plant are operated in accordance with best practice. A subgroup of the OCT developed criteria for re-opening the pool based on investigations undertaken by HSE and the OCT and the report produced by the independent expert.

Implementation of these criteria was verified by the independent expert and the pool was re-opened on Monday, 4 October. All local schools, parents, GPs, primary care Trust staff, environmental health and microbiology laboratories received information and advice on the outbreak.

Local council environmental health officers are not required to routinely sample pool water for disinfection levels and microbiological contamination. However, periodic risk-based health and safety inspection visits are carried out. The legal duty to manage pool water quality rests with pool operators, as does the requirement to carry out risk assessments,

and to implement appropriate control measures to ensure that pool water quality is maintained. These control measures should include regular monitoring of microbiological and chemical quality of the pool water by the pool operator. Both the HSE and local authorities are the enforcing authorities for regulations governing disinfection and pool management [1, 2]. Food safety legislation relies on identification of critical control points (CCPs) that are closely monitored [3]. Similar measures need to be enforced for pool management to ensure that facilities are suitable for use.

Previous reports of outbreaks of *E. coli* O157 have occurred in chlorinated pools where levels of free chlorine have dropped to <1.0 mg/l [4–7]. An outbreak in 1993 was associated with paddling pools in two municipal parks in south-west London. Six children were affected, three developed HUS, one of whom died. Three of the cases had all been exposed to a paddling pool in a local park where disinfection procedures were found to be inadequate. Samples of water from the park contained *E. coli*, but not *E. coli* O157. A fourth case played at a different paddling pool.

An outbreak at a water park in Georgia, USA in June 1998 affected 26 people. All cases had been in the water where it was noted that babies with nappies had been playing in the pool [5]. The pool's water was tested for free chlorine and the concentration was found to be <1.0 mg/l.

Although no obvious source of *E. coli* O157 was found for the current outbreak, the epidemic curve, descriptive epidemiology and laboratory data are consistent with a single contamination event such as faecal incontinence on the morning of Sunday, 5 September. On that Sunday morning, the level of free chlorine in the pool was probably <0.5 mg/l which would have been inadequate to disinfect the pool. Although there was no report of a faecal incident in the pool, infection of cases probably resulted from swallowing inadequately chlorinated pool water which had been contaminated with a small amount of faeces.

Procedures for disinfection, monitoring and maintenance of equipment were inadequate at the leisure centre. The free chlorine level fell from 2.5 mg/l at 17:00 hours on Friday, 3 September to 0.5 mg/l at 08:00 hours on Saturday, 4 September indicating a rapid depletion of chlorine with no replacement.

The pool's monitoring equipment was unable to display levels <0.5 mg/l; therefore the readings from

the pool water were recorded as 0.5 mg/l throughout Saturday. It was not until Sunday morning, a period of 27 h, that remedial action was taken. This suggests that there would have been little, if any free chlorine in the pool by Sunday morning.

Pool water treatment guidelines are available from both HSE and the Pool Water Treatment Advisory Group (PWTAG) [1, 2]. These guidelines recommend that free chlorine levels should be maintained at 1 mg/l or below to an absolute minimum of 0.5 mg/l where the pool is engineered, designed and operated well and not overloaded.

On 8 September 2005, Trafford Community Leisure Trust entered a guilty plea to offences under the Health and Safety at Work etc. Act 1974, sections 3 (1) and 33 and the Management of Health and Safety at Work regulations 1999 – regulation 3. The Trust was fined £7500 as well as prosecution costs.

The OCT concluded that all cases were exposed on the morning of Sunday, 5 September 2004 when free chlorine levels were ≤ 0.5 mg/l after the chlorine dosing pump had become blocked. There was no reliable calibration of monitoring probes and staff did not respond to the low free chlorine levels until after the water had become contaminated with *E. coli* O157. This report demonstrates the importance of adequate chlorination of recreational water facilities, regular monitoring and the need for an adequate action plan if procedures fail to prevent further outbreaks of this potentially fatal organism.

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DECLARATION OF INTEREST

None.

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