Learning from a Pseudomonas outbreak in a tertiary neonatal unit

Clifford Mayes
Consultant Neonatologist, Royal Maternity Hospital, Belfast HSC Trust
clifford.mayes@belfasttrust.hscni.net

Amar Asokkumar
Consultant Neonatologist, University Hospitals of North Staffordshire; previously Specialist Registrar, Royal Maternity Hospital, Belfast HSC Trust
amarkmr@doctor.com

Neonatal infection is an important cause of morbidity and mortality[1]. A large UK neonatal study showed that the incidence of late onset sepsis (LOS; >48 hr of age) was 3/1000 live births and 29/1000 neonatal admissions[2].

Pseudomonas aeruginosa (PA) is a gram negative rod which accounts for 5% of neonatal LOS[2]. It is commonly found in wet and humid environments. It can produce a biofilm which creates a protective layer when it grows in a water system. Pseudomonas is particularly likely to grow on plastic or rubber components within the system rather than copper piping. PA has been a known cause of outbreaks in neonatal care settings for over 50 years[3].

In November 2011, a Turkish neonatal intensive care unit published details of an outbreak affecting 12 babies. The host was thought to be contamination of electronic sensor taps[4]. Investigations of outbreaks have linked causes to different factors including contaminated equipment[5] and contaminated feeding bottles[6].

The current neonatal intensive care unit in Belfast was opened in 1993. The building itself dates back to the 1930s. There are 31 cots, with 16 intensive care and high dependency, about 550 admissions and 120 very low birthweight infants per year. It functions as the regional centre. Four other neonatal units offer intensive care in Northern Ireland without a formal managed network. Between August 2011 and October 2011 the main NICU room was refurbished including installation of new wash sinks and sensor taps.

The Belfast unit benchmarks its outcomes through the Vermont Oxford Network. As a result of this benchmarking a quality improvement initiative called CSI (clearing serious infection) commenced in January 2011. In addition the neonatal unit runs monthly multidisciplinary risk meetings held in the unit to review all incident reporting. On 11 January 2012 a "neonatal review" was held attended by neonatal staff and service managers. At this meeting relevant issues were reviewed including data on occupancy and nosocomial infection.

In early December 2011 a known case of PA was transferred to the regional unit in Belfast from a large district general hospital. Later in December 2011 that district general hospital declared an outbreak of PA. Full details of the sequence of events across a number of hospitals are available in the interim and final reports by the Regulation and Quality Improvement Authority (RQIA). The reports concluded that the different hospitals had separate outbreaks or clusters.

On 17 January 2012 the Belfast Trust declared an outbreak based on two identical strains of PA. These isolates had occurred 31 days apart. Case 1 was from early December (but distinct from the strain transferred in from the district general hospital) and case 2 from early January.

A further case (case 3) was identified eight days after the second but was later confirmed to be a separate PA strain associated with a third hospital. Case 4 developed symptoms two days after the third. Cases 2, 3 and 4 died. Cases 1, 2 and 4 were caused by identical strains of PA.

At the meeting at which the outbreak was declared the plan included:

- Restriction of admissions with plans to transfer patients *in utero* out of region to access regional services as necessary. Total numbers of inpatients were reduced over the next four days to allow the main intensive care room to undergo vaporised hydrogen peroxide treatment.
- Environmental screening.
- Design of information leaflets for parents about PA.
- Parents were informed verbally that their baby was being screened by skin swabbing for Pseudomonas. Patients with positive results were then co-located with dedicated staff. Initially twice weekly skin swabs continued, later relaxed to weekly.
- Routine practice was to use tap water for nappy changing but sterile water for face care. Subsequently sterile water only was used for nappy changing.
- Unit practice had also been to defrost frozen breast milk with tepid tap water. This was stopped.
- Hand alcohol gel was in routine use after hand washing. Its use was re-enforced.

Subsequent case findings across Northern Ireland detected several babies who had been cared for in the Belfast Unit in November 2011 and found to be colonised with PA *after* transfers to other units. In December an infant cared for in Belfast developed a PA bacteraemia with the "Belfast" strain in late December *after* transfer to another unit. There was no formal arrangement in place to ensure this information was shared between relevant neonatal units.

It became clear that three neonatal units in Northern Ireland hospitals had had unlinked problems with PA within about six weeks of each other. Two hospitals found a tap or taps to be the host of a relevant strain. A single case in two of these hospitals was caused by a strain which originated from another hospital.

The Belfast Trust arranged a 'root cause analysis' and the Northern Ireland Health Minister ordered an independent review by the RQIA. Both came to very similar conclusions and recommendations. The root cause in Belfast was identified to be five out of six sensor taps in the main intensive care room. The taps were most heavily contaminated at the tip, ie the flow straightening rosette. How the taps first became contaminated is unknown. All taps and sinks in the intensive care room were replaced and regular water testing commenced.

The root cause analysis concluded that the most likely method of spread to the babies was through use of tap water for nappy changes. The use of tap water to defrost breast milk previously frozen for storage may also have contributed. It was recommended that PA is identified as an alert organism for neonatal intensive care and high dependency units.

Previous to the Pseudomonas outbreak The British Institute of Cleaning Sciences (BICS) instructed staff to clean sinks from the bottom, cleaning the taps last. Interim guidance on cleaning sinks now recommends starting at the taps and cleaning down.

Prior to release of a press statement on 19 January 2011 the bereaved parents were all contacted by consultant staff either by telephone or in face to face meetings and informed of the fact that their baby had died in the context of an outbreak which was likely to feature in the press.

The following week parents of inpatients were invited to a parents' meeting on 24 January. This was very well attended by parents, managerial and clinical staff. Bereaved parents were offered separate private meetings. At the meeting the sequence of events was explained by clinical staff and estate staff also talked about the investigation of the unit. Maintaining confidentiality was challenging. Parents expressed concern that staff had not informed them of the deaths before the details appeared in the press. Psychology staff attended the meeting and their support was offered. A second update meeting was arranged eight days later.

Water safety has largely developed around experience of Legionella. Sources of Legionella can exist within a water system, eg in blind-ended pipes, however Pseudomonas appeared with heavy contamination at the end of the tap suggesting contamination from outside. Sensor taps can contain internal components on which Pseudomonas can form a biofilm. Current Belfast practice still includes the use of sensor taps, which now contain a UV chamber. These taps are auto-clavable and do not contain a flow straightening rosette. After the refurbishment in August 2011 the sensors were positioned at the end of the tap beside the rosette. They are now adjacent to but not part of the taps themselves. Water sampling in neonatal intensive care continues on a weekly basis. If a sample is positive for PA the sink will be decommissioned, the tap and sink analysed and the tap autoclaved or replaced.

Learning points

- It was not the sensor taps but the internal component, ie the flow straightening rosette which became the host. (http://www.dhsspsni.gov.uk/tapstudyreport290512.pdf)
- It is not appropriate to assume a single case of PA is sporadic. A single case of PA should prompt testing of all sinks in rooms in which the patient has been nursed in any unit from birth requiring reporting of results to previous units. This could identify a sink/tap which is the host leading to the case OR importantly identify a sink/tap which has become contaminated and is a future risk.
- The lack of an agreed surveillance system for PA led to delays in sharing information. In retrospect the first signs of an outbreak began in November 2011 but in early January 2012 this information was not available.
- A meeting for parents just before the initial press release on the evening of 19 January would have allowed parents to hear about the deaths from Trust staff rather than the press.
- A major infection outbreak such as this will lead to scrutiny of governance procedures within any unit. Evidence was readily available of international benchmarking, multidisciplinary quality improvement initiatives related to infection and to work around risk and incident reporting.
- The outbreak was contained by identification of the host and stopping long standing practices involving patient contact with tap water.
- Infection control practices within the Belfast unit meant that cross infection was not an issue.

The RQIA made 32 recommendations including a formal established neonatal network and suggested that a new regional intensive care unit should be expedited. Plans for these projects are underway.

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