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Summertime *Bacillus cereus* colonization of hospital newborns traced to contaminated, laundered linen

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SUMMARY

Background: Routine screening of premature newborns for haemolytic streptococci, *Staphylococcus aureus* and enteric Gram-negative bacteria done at birth using umbilical swabs identified clustering of babies colonized with *Bacillus cereus* in summers of 2009 and 2010 at a 400-bedded UK general hospital.

Aim: To determine the source of this organism by focusing on the clinical environment.

Methods: Umbilical swab screening was extended to all newborns and the labour ward environment, including construction-related dust, was sampled for *B. cereus*.

Findings: During the summer of 2009, 65% of newborns had umbilical swabs which were culture positive for *B. cereus*. Blood agar and *B. cereus* selective agar impression plates of unused labour ward linen, and freshly received linen from the hospital's external laundry, gave mainly confluent growth of *B. cereus* in >85% of items sampled. In-use and exposed healthcare products including liquid handwashing agents, paper hand-towels, vaginal lubricants, labour ward dust and air were culture negative. Linen contamination and umbilical swab culture positivity both approached zero in autumn. *B. cereus* colonization of newborn umbilici recurred in summer 2010 and unused laundered linen was again found to be as contaminated. Washing linen at the laundry in a washer-extractor, with higher dilution than the continuous tunnel washer normally used, coincided with lowering of detectable *B. cereus* numbers in unused washed linen and no clustering in newborns the following summer (2011).

Conclusion: Freshly laundered linen can be contaminated with *B. cereus* with subsequent spread and colonization of newborns. This contamination appears to be associated with low-dilution washing and high ambient temperatures.

Introduction

Bacillus cereus is ubiquitous in the natural environment; this fact, coupled with its low virulence, has led to the widespread practice of regarding most isolates from clinical samples as contaminants. Other than in food poisoning, *B. cereus* behaves as an opportunistic pathogen with infections described mainly

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in immunocompromised, trauma and intensive care patients; however, Hoffmaster *et al*. reported severe pneumonia similar to anthrax in healthy individuals.[1–4] Pseudo- and real outbreaks have been linked to contaminated healthcare products, environmental contamination from construction-related dust and to inadequately reprocessed medical equipment.[3,5–9] Birch *et al*. detected an outbreak with *B. cereus* in neonates on a maternity unit from routine umbilical swabs and attributed this to re-laundered nappies, though the underlying source of contamination was not determined.[10] Dohmae *et al*. described increased nosocomial infections with *B. cereus* in summers in Japan from 2000 to 2005 from contaminated, laundered hospital towels.[11] Their laundry facility was in-house and the problem ceased once the hospital's re-usable linen was sent to an external laundry. By contrast, Barrie *et al*. described two cases of *B. cereus* postoperative meningitis following neurosurgery and attributed this to high counts of *B. cereus* in externally laundered hospital linen.[12] In that study, the only measure found to coincide with a decrease in *B. cereus* numbers in the laundered linen was an increase in water flow through the in-use continuous tunnel washing machine. In another study from Japan, Sasahara *et al*. described an outbreak of *B. cereus* bacteraemia with a summer peak attributed to contaminated hospital linen arising from contamination of the washing machine used from poor maintenance and use of recycled water.[13]

Outbreak description and investigation

At the North Middlesex University Hospital, premature newborns are screened routinely at birth with umbilical swab culture for haemolytic streptococci, *S. aureus* and enteric Gram-negative bacteria. This policy had been introduced in 2002 following concerns about enteric Gram-negative bacterial colonization of babies on the special care baby unit.

In the first two weeks of August 2009, umbilical screening swabs from three newborn babies showed colonization with *B. cereus* with moderate–heavy growth on blood agar plates. The laboratory database comprising results from clinical samples throughout the hospital was immediately reviewed for any further isolates of this organism, and the labour ward was also visited. The database showed sporadic (about one per month) *B. cereus* isolation in umbilical swabs as far back as March of the same year (2009) with four further newborns with this organism. There was visible dust contamination of the labour ward environment, thought to be from external and internal hospital building works with insufficient dust control measures. We therefore developed a working hypothesis of dust-derived *B. cereus* environmental contamination leading to colonization of the newborns: controls initiated are summarized in Box 1. The labour ward air was sampled using an Oxoid air sampler (Oxoid, Basingstoke, UK). Dust, in-use or exposed healthcare products and equipment on the labour ward including gloves, liquid handwashing agents, vaginal lubricants and neonatal resuscitation equipment were sampled and the hospital policy of screening only premature newborn babies was extended to include all newborns. Pre-moistened, sterile cotton-tipped swabs (Medical Wire, Corsham, UK) used for environmental sampling of dry surfaces were plated directly on to blood agar plates and *B. cereus* selective medium (*Bacillus cereus* MYP-Agar, E&O Laboratories, Bonnybridge, UK).[13] In-use containers

Box 1
Immediate controls following cluster of *B. cereus* in newborns detected by umbilical swab culture in early August 2009

- Cleaning of labour ward to remove dust
- In-use handwashing liquids were replaced with new bottles
- In-use vaginal lubricating creams were replaced with new containers
- Reinforcement of hand hygiene
- All exposed hand-drying towels were discarded and replaced with new batches
- Non-sterile gloves (in open boxes) were discarded; instructions were given to use sterile gloves only when handling newborns
- All internal building works were temporarily stopped to implement better dust controls with more plastic sheeting
- All windows to the labour ward were shut and temporary, portable ventilation units were installed because of the hot weather

of handwashing liquids were sampled by swirling sterile dry swabs in the containers; vaginal lubricants were sampled by placing dry swabs into the lubricants; swabs were then plated directly as above. Loose soil outside the labour ward windows was sampled by moving two pre-moistened, sterile swabs within an area of 10 cm^2 at a 1 cm depth. Linen in the labour ward storage cupboard was sampled since the cupboard walls were visibly dusty and the top linen items had traces of dust on them: we sampled the top and middle of linen stacks. This was undertaken by using sterile gloves and pressing an area of linen (about 8 cm × 8 cm) on to blood agar plates as validated and described in a previous study.[12] In the first few days of the investigation we used blood agar impression plates only for sampling linen but subsequently this also included *B. cereus* selective agar (as above) to expedite laboratory processing of cultures. Isolates that were mannitol negative and lecithinase positive were further identified as *B. cereus* by standard laboratory methods. The supply of hospital linen was from an external laundry which used continuous tunnel washing machines as their standard wash process. This is a rapid, low water consumption washing machine in which batches of dirty linen flow countercurrent to clean water, with detergent and heat added at specific stages. Linen was received in 2.0 m × 1.5 m × 1.5 m metal mesh crates which were themselves enclosed in protective plastic sheeting applied at the laundry. Sampling of the freshly received linen was undertaken as above by impression on to blood agar and *B. cereus* selective agar using sheets selected from the middle of linen stacks to avoid the possibility of environmental contamination in the sampling process. We were also able to visit the external laundry and obtain both blood agar and *B. cereus* selective agar impression plates of freshly washed and dried linen which was ready for dispatch. Following our alert to them, the external laundry reviewed the maintenance programme for washing machines and also commenced its own monitoring for *B. cereus* in washed linen in August 2009. To detect *B. cereus* contamination, the laundry used five 100 cm^2 samples aseptically cut from washed linen eluted in phosphate-buffered saline by vortexing; aliquots for enumeration were then plated on to a *B. cereus* selective medium (Oxoid Chromogenic Bacillus Agar, Oxoid). The routine umbilical screening of all newborns at birth continued until *B. cereus* was no longer detected in umbilical swabs