Review of neonatal unit continuous positive airways pressure (CPAP) (with humidification)

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Introduction
Infections, in particular healthcare associated infections (HCAI), in the neonatal intensive care unit (NICU) are recognised as major causes of morbidity and deaths. The most common way bacteria are spread from patient-to-patient in hospitals is via the hands of staff (e.g. MRSA). Outbreaks and, on occasions, HCAIs are caused by bacteria associated with water (e.g. pseudomonas). A study by Freige estimated that infection with *Pseudomonas aeruginosa* results in approximately 1,400 deaths each year in the United States of America. Outbreaks of *P. aeruginosa* are linked to many sources but some of the more common have been contaminated respiratory equipment, antiseptics and tap water.

Study
Recently in our NICU there were two episodes of *P. aeruginosa* bacteraemia which led us to investigate potential causes, including whether a water source may have been responsible. We noted that neonates were being ventilated for a shorter duration followed by the increasing use of continuous positive airway pressure (CPAP) with humidification. With the current humidifier [Fisher and Paykel MR 730 or MR 850], the water is left in place for 6 days before being changed. Fisher and Paykel state on their product information that the circuits are not be elevated so as to keep the condensation away from the neonate. They further add that bacterial contamination is likely to be reduced with CPAP due primarily to the use of nasal cannula that maintains an intact airway with the mucociliary transport system. With this in mind, we undertook environmental surveillance (by culturing multiple humidifiers immediately following their use) and monitored for any infections that occurred in these neonates.

Method
Cultures were taken from the reservoir and humidifier pump and white (expiratory) and blue (intake) tube closest to the nosepiece (Figure 1). Sterile swabs were obtained for plating from the humidifier pump and the nose piece (Figure 2). The swabs were directly plated onto blood and MacConkey agar in the NICU. Then 0.5mls of water was withdrawn from the reservoir and directly plated onto blood and MacConkey agar. This process was initially undertaken by the infection control nurse or the microbiology

Figures 1 & 2. Use of the CPAP ventilator in the NICU.
registrar. After training from the infection control team, the remaining circuits were plated by the technician responsible for maintenance and monitoring of equipment in the NICU. The plates were then incubated and any growth quantified, identified and sensitivities read by standard techniques in the microbiology laboratory [Vitek system].

Results
Of the 33 CPAP circuits that were cultured, bacteria were grown in 12 circuits. However, in only one case were bacteria present at a level of >15 colonies. This organism was Klebsiella pneumoniae (25 colonies) and we also cultured the same organism from a neonate after the removal of the CPAP circuit from the same neonate. In this instance it was not a cause of infection and was considered to be colonisation. *K. pneumoniae* is an organism that is considered to cause colonisation.

Discussion
Outbreaks of infections occur relatively frequently in high dependency areas such as NICUs where the organisms identified are potentially from water sources (*e.g.* Pseudomonas spp, *Enterobacter* spp). We were somewhat concerned that warmed water was left in place for 6 days (topped up as required with distilled water) in the CPAP circuits used in our NICU as per the manufacturer's recommendations.

We did not, however, find any evidence in our relatively small sample size (*n=33*) that the water caused a problem for our neonates. While in one case we did grow large numbers of *K. pneumoniae*, which potentially could cause colonisation in a neonate's respiratory tract and subsequent infection, we found no evidence that this bacterium in that child caused infection. Overall, given the length of time the warmed water was left in place, we were surprised by the lack of growth from the circuits and reservoir of the CPAP. We presume this was secondary to good techniques being used by the staff looking after the circuits or some unknown inhibitory effects in the circuits (*e.g.* from the plastics in the circuit).

Conclusion
As far as we are aware, there have been very few studies in NICUs looking at the potential for humidifiers to grow organisms that could cause problems for the neonate*. We still have some concerns regarding the length of time that this warmed water remains in the reservoir and circuits. However, our relatively small study did not find convincing evidence that the manufacturer's instructions, practices or protocols should be changed at this time (Table 1).

Interpretation
Other than the Klebsiella, the low numbers of colonies present suggest contamination during the microbiology collection procedure or only very low level colonisation.

Acknowledgement
Thank you to Dr Jhumur Roy, Consultant Microbiologist, and Trish O'Rourke, NICU, for their valuable contribution to this project.

Table 1. Types of microorganisms isolated.

<table>
<thead>
<tr>
<th>Microorganism</th>
<th>No. CPAP circuits identified</th>
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<tbody>
<tr>
<td>Coagulate negative staph</td>
<td>9 (&lt;10 colonies)</td>
</tr>
<tr>
<td>Klebsiella pneumoniae</td>
<td>1 (25 colonies)</td>
</tr>
<tr>
<td>Bacillus spp</td>
<td>3 (1-2 colonies)</td>
</tr>
<tr>
<td>Group D Streptococcus</td>
<td>1 (2 colonies)</td>
</tr>
<tr>
<td>Micrococcus</td>
<td>1 (1 colony)</td>
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References
4. www.fphcare.com