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COMPARISON OF A HEATED HUMIDIFIER WITH A HEAT AND MOISTURE EXCHANGER FOR CONDITIONING THE GASES INSPIRED BY CHILDREN WITH TRACHEOSTOMIES.

DAVID MCNAMARA

Abstract

**Background:** Children with chronic tracheostomies should have the gases they inspire conditioned through warming and humidifying. The degree and most appropriate method of conditioning is debated.

**Methods:** Two randomised cross-over studies with partial observer-blinding were conducted comparing the use of a heated humidifier (HH) to a heat and moisture exchanger (HME) during sleep: a short-term study involving 20 hours of each treatment and a long-term study involving ten weeks of each treatment. The short-term study was conducted to investigate immediate treatment difference and the long-term study to investigate whether short-term differences translated into long-term differences in major clinical outcomes. At the time of assessment children in the short-term study were wearing the assigned treatment whereas in the long-term study all children were wearing the HME. Children were assessed in both studies for changes on clinical examination, airway secretion characteristics, airway inflammatory cytokine levels and occurrence of clinical events. Children in the long-term study also underwent mucociliary clearance (MCC) scans via inhaled radioaerosol. A parallel qualitative interview study was incorporated into the long-term study as well as assessment of parental and child quality of life.

**Results:** Fifteen children were enrolled in the short-term study. In this study children had improved clinical examination findings when treated with HH compared to HME for respiratory rate (p = 0.038), oxygen saturations (p = 0.012), retractions (p= 0.011), wheeze (p = 0.020) and summary examination score (p < 0.001). However, there was no difference in airway secretion characteristics, inflammatory cytokines or the frequency of required suctioning. Fourteen children were enrolled in the long-term study with two withdrawing prior to assessment. Fewer children in the long-term study had major clinical events (5 vs. 12, p =
0.005) when treated with HH compared to HME with trends toward fewer experiencing acute respiratory admissions (1 vs. 5, \( p = 0.069 \)) and chest infections (4 vs. 9, \( p = 0.061 \)). No significant differences between treatments were observed for MCC scans, clinical examination, airway secretion characteristics, inflammatory cytokines or quality of life questionnaires. Interviews revealed how parents managed their child’s health and balanced the difficulties of using technology against the benefits of treatment.

**Conclusion:** The use of a HH compared to a HME resulted in short-term improvements in clinical examination findings and long-term improvements in the incidence of major clinical events.
Acknowledgements

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<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>ARDS</td>
<td>Acute Respiratory Distress Syndrome</td>
</tr>
<tr>
<td>ASL</td>
<td>Airway surface liquid</td>
</tr>
<tr>
<td>ATP</td>
<td>Adenosine triphosphate</td>
</tr>
<tr>
<td>Avidin-HRP</td>
<td>Avidin-Horseradish Peroxidase</td>
</tr>
<tr>
<td>°C</td>
<td>Degrees Celsius</td>
</tr>
<tr>
<td>cAMP</td>
<td>Cyclic adenosine monophosphate</td>
</tr>
<tr>
<td>CBF</td>
<td>Cilia beat frequency</td>
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<tr>
<td>CF</td>
<td>Cystic fibrosis</td>
</tr>
<tr>
<td>CFTR</td>
<td>Cystic fibrosis transmembrane conductance regulator</td>
</tr>
<tr>
<td>Cl'</td>
<td>Chloride</td>
</tr>
<tr>
<td>COPD</td>
<td>Chronic obstructive pulmonary disease</td>
</tr>
<tr>
<td>CPAP</td>
<td>Continuous positive airway pressure</td>
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<tr>
<td>CXR</td>
<td>Chest radiograph (x-ray)</td>
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<tr>
<td>ELISA</td>
<td>Enzyme-linked immunosorbent assay</td>
</tr>
<tr>
<td>ENT</td>
<td>Ear Nose and Throat</td>
</tr>
<tr>
<td>ETT</td>
<td>Endotracheal tube</td>
</tr>
<tr>
<td>GT</td>
<td>Grounded theory</td>
</tr>
<tr>
<td>H₂O</td>
<td>Water</td>
</tr>
<tr>
<td>HCH</td>
<td>Hygroscopic condenser humidifier</td>
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<tr>
<td>HCH-HME</td>
<td>Hygroscopic condenser humidifier heat and moisture exchanger</td>
</tr>
<tr>
<td>HH</td>
<td>Heated humidifier</td>
</tr>
<tr>
<td>HME</td>
<td>Heat and moisture exchanger</td>
</tr>
<tr>
<td>HRQOL</td>
<td>Health-related quality of life</td>
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<tr>
<td>ICU</td>
<td>Intensive care unit</td>
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<tr>
<td>IFN-γ</td>
<td>Interferon-gamma</td>
</tr>
<tr>
<td>Ig</td>
<td>Immunoglobulin e.g. IgA or IgG</td>
</tr>
<tr>
<td>Abbreviation</td>
<td>Definition</td>
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<tr>
<td>--------------</td>
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<tr>
<td>IL</td>
<td>Interleukin e.g. IL-8</td>
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<tr>
<td>ISB</td>
<td>Isothermic saturation boundary</td>
</tr>
<tr>
<td>ISO</td>
<td>International Organization for Standardization</td>
</tr>
<tr>
<td>L/min</td>
<td>Litres per minute</td>
</tr>
<tr>
<td>LRTI</td>
<td>Lower respiratory tract infection</td>
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<tr>
<td>MCC</td>
<td>Mucociliary clearance</td>
</tr>
<tr>
<td>mg</td>
<td>Milligram</td>
</tr>
<tr>
<td>mL</td>
<td>Millilitre</td>
</tr>
<tr>
<td>MMD</td>
<td>Mass median diameter</td>
</tr>
<tr>
<td>mSv</td>
<td>Millisieverts</td>
</tr>
<tr>
<td>Na</td>
<td>Sodium</td>
</tr>
<tr>
<td>NICU</td>
<td>Neonatal intensive care unit</td>
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<tr>
<td>NIV</td>
<td>Non-invasive ventilation</td>
</tr>
<tr>
<td>Nm</td>
<td>Nanometres</td>
</tr>
<tr>
<td>PA</td>
<td>Posterior-anterior</td>
</tr>
<tr>
<td>PaCO₂</td>
<td>Partial pressure of carbon dioxide in arterial blood</td>
</tr>
<tr>
<td>PaO₂</td>
<td>Partial pressure of oxygen in arterial blood</td>
</tr>
<tr>
<td>PBS</td>
<td>Phosphate-buffered saline</td>
</tr>
<tr>
<td>PCD</td>
<td>Primary ciliary dyskinesia</td>
</tr>
<tr>
<td>PCL</td>
<td>Periciliary liquid</td>
</tr>
<tr>
<td>PEEP</td>
<td>Positive end-expiratory pressure</td>
</tr>
<tr>
<td>PI</td>
<td>Penetration index</td>
</tr>
<tr>
<td>PICU</td>
<td>Paediatric intensive care unit</td>
</tr>
<tr>
<td>PID</td>
<td>Primary immune deficiency</td>
</tr>
<tr>
<td>PTHSI</td>
<td>Pediatric Tracheostomy Health Survey Index</td>
</tr>
<tr>
<td>QOL</td>
<td>Quality of life</td>
</tr>
<tr>
<td>RCT</td>
<td>Randomised controlled trial</td>
</tr>
<tr>
<td>ROI</td>
<td>Region of interest</td>
</tr>
</tbody>
</table>
SF36v2  |  Short Form-36 questionnaire version 2  
---|---  
TMV  |  Tracheal mucus velocity  
TNFα  |  Tumor necrosis factor-alpha  
μg  |  Microgram  
μm  |  Micrometre  
μL  |  Microlitre  
UTP  |  Uridyl triphosphate  
VAP  |  Ventilator associated pneumonia  
vs.  |  Versus