Topical Products and Fire Safety in Neonate High Oxygen Environments

Abstract
Skin care product selection may be essential to improving fire safety in oxygen-enriched, neonatal environments. Independent studies were conducted comparing the oxygen compatibility of the industry standard, Aquaphor Healing Ointment® from Beiersdorf AG, more than five times greater than silicone-based Nutrashield™ and Skin Repair Cream™. From Medline Industries Aquaphor® had a heat of combustion value of 10869 calories/gram, ranking near gasoline at 10400 cal/g and mineral oil at 10930 cal/g. Subsequently, Skin Repair Cream™ and Nutrashield™ received an Acceptability Index rating approximately 20 times and 25 times better than Aquaphor®, respectively. The application of flammable, petrolatum-based products in neonatal intensive care environments enriched with 23-100% oxygen may impose significant risks associated with ignition and fire. Further studies are recommended to determine which products can provide proper neonatal skin care while maintaining fire safety standards.

Background
Table I. Enclosure systems combine oxygen to obtain the oxygen saturation required for infant survival. The system provides an enriched oxygen atmosphere with an oxygen concentration most commonly between 25-90%, although the system is capable of achieving concentrations of 100%. Application of petrolatum-based products containing highly flammable hydrocarbons may endanger infants being treated in confined neonatal enclosure systems.

<table>
<thead>
<tr>
<th>MATERIAL</th>
<th>AUTOGENOUS IGNITION TEMP (°C)</th>
<th>OXYGEN INDEX (%)</th>
<th>HEAT OF COMBUSTION (CALORIES/GRAM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aquaphor®</td>
<td>186</td>
<td>25</td>
<td>10869</td>
</tr>
<tr>
<td>Nutrashield™</td>
<td>224</td>
<td>55</td>
<td>2111</td>
</tr>
<tr>
<td>Skin Repair Cream™</td>
<td>179</td>
<td>50</td>
<td>1989</td>
</tr>
</tbody>
</table>

Table II. Two of the most common endotracheal tube materials are polyvinylchloride and red rubber. Both materials have surprisingly low indices of flammability. The low indices in conjunction with petrolatum-based product application may impose significant risks in neonatal intensive care units. Endotracheal tubes are utilized in low-flow, high-flow and reservoir systems.

Results
Table III. Autogenous ignition temperature indicates a substance’s propensity for ignition; oxygen index indicates a substance’s flammability; heat of combustion is an absolute value of a material’s energy release upon burning. Oxygen compatible Nutrashield™ and Skin Repair Cream™ maintain a high autogenous ignition temperature and oxygen index, and a low heat of combustion.

Discussion
The application of petrolatum-based products to neonatal skin in oxygen-enriched environments may impose significant fire risks. However, introducing highly ignitable and extremely flammable petrolatum materials into infant care systems is avoidable. New silicone technologies allow for oxygen compatible products that provide proper neonatal skin care while diminishing risks associated with fire safety. Each of the following components is considered necessary for combustion to occur under standard conditions. Reducing or eliminating one or more of the components may diminish fire risks:

• Presence of combustible material (petrolatum, etc.)
• Source of ignition (electrical systems, etc.)
• Oxygen

Conclusions
The heat of combustion value of the petrolatum-based product tested was more than five times greater than the silicone-based products tested. The petrolatum product had a heat of combustion value of 10869 calories/gram, ranking in between gasoline (10400 cal/g) and mineral oil (10930 cal/g). However, the manufacturer of the chosen petrolatum-based product may indeed offer an alternative skin care product that is oxygen compatible. The silicone-based products tested were determined to be highly compatible with oxygen-enriched environments. The chosen silicone-based products achieved Acceptability Indexes of 1282 and 1023, respectively. Additional studies are recommended to determine which products can provide proper neonatal skin care while maintaining strict fire safety standards.