Effect of humidification on inhalation induction with isoflurane in children

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Summary

A well practised technique is important in achieving quiet induction of anaesthesia in children, but the volatile agent used also influences the process. Isoflurane results in more airway problems than halothane but recent studies have described several ways of improving the acceptability of isoflurane for inhalation induction of anaesthesia. We have studied the effect of humidification of inspired gases on respiratory complications and hypoxic episodes during induction. Forty-one children undergoing inhalation induction of anaesthesia with isoflurane and nitrous oxide in oxygen were allocated randomly to receive either humidified or non-humidified gas. Humidification did not result in a lesser incidence of problems. These findings are contrary to the results in a similar study in a predominantly adult sample which demonstrated a significantly lower incidence of complications using humidified gases. (Br. J. Anaesth. 1994; 73: 587-589)

Key words


Several studies have shown that the use of isoflurane for inhalation induction of anaesthesia in children is associated with a high incidence of upper airway problems, including coughing, laryngospasm, breath-holding and episodes of arterial desaturation [1,2].

Many factors, some difficult to quantify, play a role in achieving smooth inhalation induction. The frequency of complications is reduced by premedication, adding 5% carbon dioxide to inspired gases and the use of 4% isoflurane in oxygen [2,3]. van Heerden and colleagues showed that humidification of inspired gases may significantly reduce the incidence of problems during inhalation induction [4]. Their study was conducted mainly in adults and did not allow any conclusions to be drawn about children. As reflex airway responses are more pronounced in children than in adults, the potential benefits of humidification may be greater.

We have conducted a double-blind, randomized, controlled study to see if we could reduce the frequency of complications and hypoxic episodes by humidifying inspired gases during inhalation induction with isoflurane in children.

Patients and methods

The study was approved by the District Ethics Committee. Informed consent was obtained from the parents of 41 children, all ASA I, aged 2-9 yr and weighing 11-35 kg. The children were given oral trimiprazine 3 mg kg⁻¹, 90 min before induction of anaesthesia and were allocated randomly to one of two groups. They were accompanied in the anaesthetic room by a parent and a paediatric nurse, and induction was begun promptly.

The 21 patients in the “non-humidified” group received inhalation induction with isoflurane and 67% nitrous oxide in oxygen delivered via an Ayre's T-piece with Jackson-Rees modification. Children in the “humidified” group received the same induction but the gases were first passed through a concealed Cape autoclavable hot water humidifier placed between the common gas outlet of Boyle's machine and the patient breathing system [3].

Anaesthesia was induced by one of the three authors and induction was assessed by a second. Neither anaesthetist knew if the humidifier was connected to the circuit. Induction of anaesthesia was started using 67% nitrous oxide in oxygen for five breaths at a fresh gas flow of 250 ml kg⁻¹ min⁻¹ or 6 litre min⁻¹, whichever was greater. Thereafter, the concentration of isoflurane was increased by 0.5% at intervals of five breaths until a concentration of 4% had been attained. The anaesthetist was allowed to prolong the time at a given isoflurane concentration if indicated clinically.

Anaesthetic gases were delivered initially via a cupped hand or a face mask, as judged clinically...
study, carried out largely in adults, the frequency of humidified rather than dry anaesthetic gases. In their during inhalation induction with isoflurane using means of reducing respiratory complications arrhythmias, myocardial depression and rarely, halothane hepatitis. A simple, safe and clinically effective associated with isoflurane induction would therefore provide no suggestion for using humidification as a means of reducing complications associated with inhalation induction of isoflurane in children.

References

Table 1  Patient data (mean (SD or range)) and complications (number) during induction of anaesthesia in humidified and non-humidified groups (n = 19). *P < 0.05

<table>
<thead>
<tr>
<th>Complication</th>
<th>Humidified (n = 20)</th>
<th>Non-humidified (n = 21)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yr)</td>
<td>5.7 (2-9)</td>
<td>5.1 (2-8)</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>22.4 (11-35)</td>
<td>20.3 (14-35)</td>
</tr>
<tr>
<td>Induction time (s)</td>
<td>292 (73)†</td>
<td>294 (62)</td>
</tr>
<tr>
<td>Inductions without complications</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coughing</td>
<td>7</td>
<td>5</td>
</tr>
<tr>
<td>Secretions</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td>Breath-holding</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Restlessness</td>
<td>10</td>
<td>4*</td>
</tr>
<tr>
<td>Laryngospasm</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>Desaturation to &lt; 95%</td>
<td>4</td>
<td>3</td>
</tr>
</tbody>
</table>

appropriate. If a cupped hand was used a face mask was substituted when the child’s eyelash reflex was absent. Induction was judged complete when the child was breathing regularly and had small central pupils.

The assessor recorded the presence of coughing, laryngospasm, sounds caused by secretions in the airway, breath-holding (apnoea greater than 15 s), restlessness requiring restraint, the lowest SpO2 value recorded using a Datex Satlite pulse oximeter and the time taken to complete induction. Data were analysed using the unpaired Student’s t test, the Mann–Whitney U test and chi-square test with Yates’ correction.

Results
The ages and weights of the children in the two groups were comparable. Restlessness was significantly more common in the humidified group (table 1). Other complications were similar in the two groups. In one patient in the humidified group, induction was abandoned because of airway obstruction caused by large tonsils. The induction sequence was prolonged in one child from each group because of laryngospasm.

Discussion
Irritation of the upper airway may be a serious problem during inhalation induction of anaesthesia with isoflurane. In children particularly, such irritation may activate upper airway reflexes resulting in airway complications, prolonged induction times and arterial desaturation [1, 2, 5]. Induction with halothane causes fewer respiratory problems but may be associated with other hazards, including arrhythmias, myocardial depression and rarely, halothane hepatitis. A simple, safe and clinically effective means of reducing respiratory complications associated with isoflurane induction would therefore be valuable in paediatric anaesthetic practice.

van Heerden and colleagues [4] achieved an eightfold reduction in the incidence of complications during inhalation induction with isoflurane using humidified rather than dry anaesthetic gases. In their study, carried out largely in adults, the frequency of **"complicated"** inductions also decreased with humidified isoflurane (from 45% to 9% of patients). Our study was designed to determine if humidification would produce a similar decrease in complications in children. The design anticipated an incidence of upper airway complications of 40–50% in the control group [1, 6] and 10% in the humidified group. The number of patients in the groups provided a power of 90% to detect a difference of this size when the probability level for rejecting the null hypothesis was 5%.

The results failed to show any clinically significant difference between the two groups and clearly do not support our hypothesis that humidification reduces upper respiratory tract irritation and airway complications. The data also do not suggest that humidification had a beneficial effect which might become apparent if a larger group were studied.

In keeping with common paediatric anaesthetic practice, we used an Ayre’s T-piece rather than the Magill breathing system used by van Heerden and colleagues [4]. It could be argued that this may have altered the temperature and humidity of the gases and that the studies are therefore not strictly comparable. The narrow bore fresh gas delivery tube of the T-piece has a lower thermal mass and a smaller surface area for heat loss than the large corrugated tubing of the Magill attachment and should cause less cooling of gases. We believe therefore that the use of the T-piece is unlikely to have reduced the temperature or humidity of the gases delivered to the patient and that the studies are comparable in this respect.

As with other aspects of paediatric anaesthesia, the lack of effect of humidification may represent a real difference between children and adults. It is also possible that because most of the children studied were undergoing ENT procedures, a proportion of the complications we observed was related to physical causes which may not have responded to humidification. Other factors could contribute to the different findings. Our overall incidence of individual complications was approximately 25% rather than the 50% found in other studies of isoflurane induction of unpremedicated children [1, 6]. We also noted a relatively low incidence of arterial desaturation; only 17% of our children had saturations less than 95% compared with other studies where saturations decreased to less than this value in approximately 50% of children [3, 6]. This may reflect the beneficial effect of trimazepine premedication [3].

Irrespective of the explanation, our findings provide no suggestion for using humidification as a means of reducing complications associated with inhalation induction with isoflurane in children.

