The Effect of Patient Warming during Cesarean Delivery on Maternal and Neonatal Outcomes: A Meta-analysis

P Sultan, A Habib, Y Cho, B Carvalho

University College Hospital, London, UK
Duke University, Durham, North Carolina, USA,
Stanford University School of Medicine, California USA
Disclosures

• Received research capability funding from National Institute of Health Research

• No conflicts of interest to declare
Introduction

• Normothermia recommended for surgery under general and regional anaesthesia\(^1\)

• No recommendations regarding warming for caesarean delivery

• Aim: determine efficacy of active warming on maternal and neonatal outcomes following elective caesarean delivery

1. NICE clinical guideline 65: Inadvertent perioperative hypothermia: intraoperative phase. 2014
Methods for Meta-analysis

- Literature search
  - RCTs utilising forced air warming or warmed fluid
- Primary outcome:
  - maximum temperature change
- Secondary outcomes:
  - maternal (temperature at the end of surgery, shivering, thermal comfort, hypothermia)
  - neonatal (temperature, umbilical cord pH and Apgar scores)
- SMD/MD/RR and 95% CI calculated using random effects modelling (CMA, version 2, 2005)
Results

• 13 studies included

• 789 patients (416 warmed and 373 controls) were analysed for the primary outcome
Warming was associated with reduced temperature change
SMD -1.27°C [-1.86, -0.69]; p=0.00002
Results - Maternal Outcomes

- Warming was associated with:
  - higher temperatures at end of surgery
    MD 0.43 °C [0.27, 0.59]; p<0.00001
  - less shivering
    RR 0.58 [0.43, 0.79]; p=0.0004; NNT = 7
  - improved thermal comfort
    MD 0.98 [0.24, 1.72]; p=0.01
  - lower incidence of hypothermia
    RR 0.66 [0.50, 0.87]; p=0.003; NNT = 5
Results - Neonatal Outcomes

• Umbilical artery pH was higher in the warmed group MD 0.02 [0, 0.05]; p=0.04
Limitations

• Heterogeneity among studies for primary outcome:
  – anaesthesia technique / drugs / doses
  – fluid / Forced air
  – ambient temperatures
  – temperature measurement techniques and sites

• Blinding almost impossible in these studies
Conclusion

• Active warming for elective caesarean delivery prevents:
  - perioperative temperature reduction
  - hypothermia
  - shivering

• 16% of UK obstetric anaesthesia units warm women during caesarean delivery²

• Forced air warming or warmed fluid should be utilised for elective caesarean delivery

Questions
Subgroup Analysis

• Fluid warming (n=8; 300 patients per group)
  – Reduced maximum temperature change
  – Reduced shivering
  – Reduced hypothermia

• Forced air warming (n=5; 100 patients per group)
  – Maximum temperature change not different
  – Shivering and hypothermia not different

• Fluid warming and FAW not directly compared

• Heterogeneity not affected by:
  – Warming technique
  – Anaesthetic technique
Figure 1 – Literature search outlining included and excluded studies

**Literature Search** – 683 articles

- Other source – 6 articles

**Total** – 689 articles

- 653 articles excluded based on title/abstract

**Detailed review** – 36 articles

- 23 excluded: Review article – 2, Systematic review – 1, Editorial – 1, Infant warming – 1, Case report – 2, Audit – 1, Letter – 2, Retrospective – 1, Survey – 1, Article in Arabic – 1

- Temperature perception – 1, General anaesthesia study – 1, Opioid dose effect on temperature – 1, Ambient temperature – 2, LA Temperature – 1, Shivering treatment postoperatively – 1, Leg wrapping and shivering – 1, Anaesthesia technique and NT – 1, Sites of temperature measurement – 1

**Forced Air Warming** – 2 articles

**Fluid warming** – 8 articles

**Fluid and air warming** – 3 articles

NT = neonatal temperature; LA = local anaesthetic
Figure 3: Risk of bias figure for primary outcome of maximum temperature change
Figure 4: Contour-enhanced funnel plot for primary outcome of maximum temperature change
Forest plot: Shivering

<table>
<thead>
<tr>
<th>Study or Subgroup</th>
<th>Warming Events</th>
<th>Control Events</th>
<th>Total Events</th>
<th>Weight</th>
<th>Risk Ratio M-H, Random, 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.1.1 Fluid warming vs control for prevention of shivering</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chan</td>
<td>11</td>
<td>21</td>
<td>13</td>
<td>19</td>
<td>15.1%</td>
</tr>
<tr>
<td>Chung</td>
<td>0</td>
<td>15</td>
<td>5</td>
<td>15</td>
<td>1.1%</td>
</tr>
<tr>
<td>Goyal</td>
<td>8</td>
<td>32</td>
<td>10</td>
<td>32</td>
<td>9.4%</td>
</tr>
<tr>
<td>Jorgensen</td>
<td>8</td>
<td>57</td>
<td>14</td>
<td>56</td>
<td>9.5%</td>
</tr>
<tr>
<td>Paris</td>
<td>9</td>
<td>73</td>
<td>26</td>
<td>76</td>
<td>11.2%</td>
</tr>
<tr>
<td>Smith</td>
<td>11</td>
<td>35</td>
<td>10</td>
<td>32</td>
<td>10.7%</td>
</tr>
<tr>
<td>Woolnough</td>
<td>16</td>
<td>50</td>
<td>11</td>
<td>25</td>
<td>13.0%</td>
</tr>
<tr>
<td>Workhoven</td>
<td>3</td>
<td>22</td>
<td>14</td>
<td>22</td>
<td>5.9%</td>
</tr>
<tr>
<td>Subtotal (95% CI)</td>
<td>305</td>
<td>277</td>
<td>78</td>
<td>0.60 [0.42, 0.85]</td>
<td></td>
</tr>
<tr>
<td>Total events</td>
<td>66</td>
<td>103</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heterogeneity: Tau² = 0.10; Chi² = 11.74, df = 7 (P = 0.11); I² = 40%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test for overall effect: Z = 2.85 (P = 0.004)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| 8.1.2 Active air-warming vs control for prevention of shivering | | | | | |
| Butwick | 3 | 15 | 5 | 15 | 4.8% | 0.60 [0.17, 2.07] |
| Chung | 2 | 15 | 5 | 15 | 3.6% | 0.43 [0.09, 1.75] |
| Fallis | 10 | 32 | 10 | 30 | 10.5% | 0.94 [0.46, 1.93] |
| Horn 2002 | 2 | 15 | 9 | 15 | 4.2% | 0.22 [0.06, 0.86] |
| Horn 2014 | 0 | 19 | 5 | 21 | 1.1% | 0.10 [0.01, 1.70] |
| Subtotal (95% CI) | 96 | 96 | 24.2% | 0.50 [0.25, 1.00] |
| Total events | 17 | 34 | | | |
| Heterogeneity: Tau² = 0.18; Chi² = 5.73, df = 4 (P = 0.22); I² = 30% |
| Test for overall effect: Z = 1.96 (P = 0.05) |

| Total (95% CI) | 401 | 373 | 100.0% | 0.58 [0.43, 0.79] |
| Total events | 83 | 137 | | | |
| Heterogeneity: Tau² = 0.09; Chi² = 17.58, df = 12 (P = 0.13); I² = 32% |
| Test for overall effect: Z = 3.51 (P = 0.0004) |
| Test for subarous differences: Chi² = 0.19, df = 1 (P = 0.66), I² = 0% |
Forest plot: Hypothermia