The Delivery Room of the Future

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C0009
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Faculty Disclosure Information

• In the past 12 months, I have not had any financial relationships with the manufacturer of any commercial product and/or provider of commercial service discussed in this CME activity.

• *I do* intend to discuss an unapproved/investigative use of a commercial device in my presentation.
  - I will discuss the use of respiratory function monitors for research studies of delivery room resuscitation.
  - These devices are currently used in a research environment and not recommended for routine clinical use.
Overview

• Monitoring in the delivery room
• Delivery room monitoring
• Delivery room: getting closer to mom
• Delivery room: getting farther away
Overview

- Monitoring in the delivery room
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HOW DO WE ASSESS NEWBORN TRANSITION?
Accuracy of clinical assessment of infant heart rate in the delivery room


Clinical assessment of infant colour at delivery

Colm P F O’Donnell, C Omar F Kamlin, Peter G Davis, John B Carlin, Colin J Morley

Evaluation of Interobserver Agreement of Apgar Scoring in Preterm Infants

<table>
<thead>
<tr>
<th>Monitoring in the delivery room</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>NRP 2005</strong></td>
</tr>
<tr>
<td>• No monitors</td>
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<tr>
<td>• Pulse Oximetry</td>
</tr>
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</tr>
<tr>
<td>• Pulse Oximetry</td>
</tr>
<tr>
<td>• “Consider ECG”</td>
</tr>
</tbody>
</table>
Support for Lung Aeration After Birth

Lung Injury
- Pressure and volume
- Repeated collapse
- Inflammation

Support Lung Aeration
- Clear lung fluid
- Aerate the lung
- Allows for gas exchange
Non-invasive Respiratory Support

• Mask leak and airway obstruction are common
  – 30% Failure Rate: Mechanical ventilation
  – No tools to identify impediments

• Only pressure is monitored: Excessive volume
  – No tools to identify excessive inflations
A Potential Solution:
Respiratory Function Monitor (RFM)
RFM Display

Pressure
- PIP (cmH2O): 43
- PEEP (cmH2O): 0

Flow
- Flow (L/min): 1.1
- RR (BrPM): 45

Tidal Volume
- Vte (mL/kg): 5.0
- Vt1 (mL/kg): 6.0

Leak
- Leak (%): 39
## RFM: Manikin Studies

<table>
<thead>
<tr>
<th>Author</th>
<th>N</th>
<th>Primary Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wood</td>
<td>25</td>
<td>Less mask leak with RFM: 11% vs. 27%, p=0.002</td>
</tr>
<tr>
<td>Bowman</td>
<td>27</td>
<td>More PPV inflations with target tidal volume with RFM: 81% vs. 21%, p&lt;0.05</td>
</tr>
</tbody>
</table>

Respiratory Function Monitor Guidance of Mask Ventilation in the Delivery Room: A Feasibility Study

Georg M. Schmölzer, MD, PhD\textsuperscript{1,2,3,4}, Colin J. Morley, MD\textsuperscript{1,3,5}, Connie Wong, MBA\textsuperscript{1}, Jennifer A. Dawson PhD\textsuperscript{1,3,5}, Camille Omar F. Kamlin, DMedSci\textsuperscript{1}, Susan M. Donath, MA\textsuperscript{3,5}, Stuart B. Hooper, PhD\textsuperscript{2}, and Peter G. Davis, MD\textsuperscript{1,3,5}

- **Pilot RCT**
  - P: 49 infants <32 weeks gestation
  - I: Visible RFM
  - C: Masked RFM (but still recording)
  - O: Mask Leak
  - T: During PPV after birth

- **RFM-visible group with less:**
  - Mask leak: median 37\% vs. 54\%, $p=0.01$
  - Intubation in the delivery room: 27\% vs. 57\%, $p=0.04$
MONITOR Trial

• International multisite RCT
  – P: Preterm infants <28 weeks gestation who require PPV after birth
  – I: Visible RFM
  – C: Masked RFM (but still recording)
  – O: Proportion of Vte 4-8 mL/kg
  – T: During PPV after birth

• Sample Size: 286 Infants

• Leiden: Lead Site
  – Melbourne, Stockholm, Valencia, Milan, Philadelphia
<table>
<thead>
<tr>
<th>Year</th>
<th>Monitoring Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>NRP 2000</td>
<td>???</td>
</tr>
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<td>NRP 2005</td>
<td>No monitors</td>
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ONLINE FIRST

The Power of Video Recording
Taking Quality to the Next Level

Martin A. Makary, MD, MPH
Video Recording at UPenn
Video Recording at UPenn

Median time from ECG sensor to reliable HR signal: 117 seconds
Delay in time-critical data

Motion Artifact on ECG

Unreported Clinical Assessment

Unable to assess chest rise

Too many providers

Plastic Wrap

Wet Baby

Inexperienced provider

Plastic Wrap
Video Recording at UPenn

Leader (Hands off)

RT

RN

Airway Provider

2nd MD/FLC (Stethoscope)
Time from ECG sensor application to signal
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## Delayed Cord Clamping

<table>
<thead>
<tr>
<th>Organization</th>
<th>Year</th>
<th>Recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td>World Health Organization (WHO)</td>
<td>2012</td>
<td>In term or preterm babies <strong>who do not require PPV</strong>, the cord should not be clamped earlier than 1 minute after birth</td>
</tr>
<tr>
<td>Neonatal Resuscitation Program (NRP)</td>
<td>2015</td>
<td>DCC (&gt;30 seconds) for term and preterm infants <strong>who do not require resuscitation</strong></td>
</tr>
<tr>
<td>American College Obstetrics and Gynecology (ACOG)</td>
<td>2017</td>
<td>DCC (30-60 seconds) for <strong>vigorous</strong> term and preterm infants</td>
</tr>
<tr>
<td>American Academy of Pediatrics (AAP)</td>
<td></td>
<td>Endorsed 2017 ACOG statement</td>
</tr>
</tbody>
</table>
WHAT ABOUT NON-VIGOROUS INFANTS?
Clamping the cord before lung aeration

- Increased systemic vascular resistance
  - Arterial pressure increases
  - Afterload increases
  - Potential to impair cardiac output

- Decreased venous return
  - Decreased preload
  - Potential to impair cardiac output
## Ventilation with intact cord
The preterm experience

<table>
<thead>
<tr>
<th>Trial</th>
<th>Design</th>
<th>Population</th>
<th>Intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Katheria, 2016</td>
<td>Single site RCT</td>
<td>N=150 infants GA: 23 0/7 – 31 6/7 wk 125 C-Section 25 vaginal</td>
<td>60s DCC + respiratory support vs. 60 s DCC +/- stimulation</td>
</tr>
<tr>
<td>Winter, 2016</td>
<td>Single site feasibility trial</td>
<td>N=29 infants GA: 24-32 6/7 wk 21 C-Section 8 vaginal</td>
<td>Single Arm: 90s DCC plus respiratory support (CPAP or PPV)</td>
</tr>
<tr>
<td>Kattwinkel (ongoing)</td>
<td>Multi-site RCT</td>
<td>Target n=940 infants GA: 23-28 6/7 wk</td>
<td>120s DCC + CPAP or PPV vs. 30-60s DCC +/- stimulation</td>
</tr>
</tbody>
</table>

Katheria, J Pediatr 2016; Winter, Am J of Perinatol 2016; Kattwinkel Clinicaltrials.gov Identifier NCT02742454
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Emergency Video Telemedicine Consultation for Newborn Resuscitations: The Mayo Clinic Experience
Changes You May Wish to Make in Practice

- Implement a video recording program for delivery room resuscitation
Changes You May Wish to Make in Practice

• Implement a video recording program for delivery room resuscitation

Stay Tuned…

Future Changes that May Come

• Respiratory Function Monitoring
• Resuscitation with an Intact Cord
• Telemedicine for Neonatal Resuscitation
References

For more information, see the following publications:

- Kamlin, Resuscitation 2006
- O'Donnell, Arch Dis Child, FNE 2007
- Wood, Arch Dis Child FNE 2008
- Bashambu, Pediatrics 2012
- Bowman J Pediatr 2012
- Schmolzer, J Pediatr 2012
- Makary, JAMA 2013
- Wyckoff, Circulation 2015
- Katheria, J Pediatr 2016
- Winter, Am J of Perinatol 2016
- Fang, Mayo Clin Proc 2016