Advance Pulse Oximetry: Settings, Data and Downloads

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UCONN School of Medicine
Attending Neonatologist
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Hartford, CT

Dr. Hagadorn graduated from the School of Medicine at the University of North Carolina at Chapel Hill, trained in Pediatrics at the University of Virginia and in Neonatal-Perinatal Medicine at Stanford University. He was on the faculty of the Dartmouth Medical School and at the Tufts University School of Medicine before taking his current position in the Division of Neonatology at the University of Connecticut/Connecticut Children's Medical Center. Dr. Hagadorn has served as principal investigator or senior investigator on multicenter studies examining maintenance of desired oxygen saturation range in extremely low birth weight infants, mathematical modeling of risk for development or progression of retinopathy of prematurity, trends in treatment and mortality for congenital diaphragmatic hernia, and use of Vr human breast milk. He has taught study design, database programming, data management, statistical analysis and ethics of human subjects research to undergraduates, medical students, and physicians at all levels of training.

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U Conn School of Medicine
Attending Neonatologist
Connecticut Children’s Medical Center
Hartford, CT

David Sink MD is an Assistant Professor of Pediatrics at the U Conn School of Medicine and Connecticut Children’s Medical Center where he serves as Medical Director of the U Conn Health Center NICU. He is board certified in Neonatal Perinatal Medicine and General Pediatrics by the American Board of Pediatrics. His interests include clinical research and quality improvement. He has conducted single and multicenter studies using continuous electronic oximetry data to examine the relationships between oxygen saturation targeting success and modifiable clinical practices, such as nurse staffing and clinical alarm management. He has also led quality improvement initiatives in multiple NICUs using alarm audit data and electronic oximetry data from a variety of clinical monitors. He is currently serving on the Alarm Fatigue Committee at Connecticut Children’s, working with nurses, respiratory therapists, pharmacists, biomedical engineers, and information technologists to improve clinical alarm management throughout the medical center.

Annual Quality Congress Breakout Session, Sunday, October 4, 2015
Advance Pulse Oximetry: Settings, Data and Downloads
Objective: Develop 3 pragmatic strategies to manage pulse oximetry settings and increase your access to real-time data downloads to improve success with oxygen saturation goals at the bedside.
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Jim Hagadorn MD, MS / David Sink MD

Disclosure
Dr Sink has received funding for research from the Masimo Foundation.
We will be discussing the use of two commonly used stand alone oximeters to obtain raw continuous oxygen saturation data.

Hands-on Session Agenda
- Introduction to oximeter settings and data 1:30 – 1:45
- How to access oximeter data 1:45 – 1:55
- Analysis of downloaded data 1:55 – 2:10
- Wrap up Q/A 2:10 – 2:20
- Session Adjourn 2:20 – move to General Session Closing Plenary

Oximeter Hardware Configurations – Data Trail
Central Monitor Station
Pulse Oximeter Monitor
Bedside Multi-parameter Monitor
EHR

Stand-Alone Oximeters
(Handheld units in docking station)

Oximeter Alarm Settings

Multiparameter Monitors + Oximeter

- Inline stand-alone oximeter may be used with multiparameter monitor
  - More data review, storage and retrieval options
  - Requires additional hardware, configuration
    - Interface Alarms (avoid double audible alarming)
    - Visual alarms generally continue on oximeter
    - Double signal averaging?
    - Double viewing – SpO2 on both monitors (benefits?)

Multiparameter Monitor Oximeter Settings

- Alarm delay time (also consider averaging effect)
- Priority levels (ie red, yellow)
- Alarm tone/volume, interval escalation
- Acknowledgement/Silencing, duration, ReAlarm
- “Latching” – unacknowledged alarms either stop or continue after patient condition ends
- Turn off Alarms/Pause, duration
- Alarm Limits

Alarm Default Settings

<table>
<thead>
<tr>
<th>Setting</th>
<th>Values (default)</th>
<th>60</th>
<th>120</th>
<th>150</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heart rate</td>
<td>Beats per minute</td>
<td>Low</td>
<td>60</td>
<td>50</td>
</tr>
<tr>
<td>SpO2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Options to Reduce # of Oximeter Alarms

- Extend the Alarm Delay
  - So brief episodes outside thresholds do not lead to alarms
- Widen Alarm Thresholds
  - According to patients condition, risk of lower or higher SpO2 (ie ROP risk, NEC risk?)
- Extend Averaging Time
  - May depend on stability of patient
- Take off the Oximeter?!

Change in Alarm Threshold

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Before Intervention</th>
<th>After Intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heart rate, bpm</td>
<td>Low</td>
<td>60</td>
</tr>
<tr>
<td>SpO2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Combining Alarm Reduction Options

<table>
<thead>
<tr>
<th>Alarm Limits</th>
<th>Alarm Delay</th>
<th>Averaging Time</th>
<th>Alarm Frequency</th>
<th>SpO2 Stability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wide</td>
<td>Long</td>
<td>Long</td>
<td>Lowest</td>
<td>Lowest(?)</td>
</tr>
<tr>
<td>Narrow</td>
<td>Short</td>
<td>Short</td>
<td>Highest</td>
<td>Highest(?)</td>
</tr>
<tr>
<td>Narrow</td>
<td>Long</td>
<td>Long</td>
<td>?</td>
<td>?</td>
</tr>
<tr>
<td>Narrow</td>
<td>Short</td>
<td>Long</td>
<td>?</td>
<td>?</td>
</tr>
<tr>
<td>Wide</td>
<td>Short</td>
<td>Short</td>
<td>?</td>
<td>?</td>
</tr>
<tr>
<td>Wide</td>
<td>Short</td>
<td>Long</td>
<td>?</td>
<td>?</td>
</tr>
<tr>
<td>Wide</td>
<td>Long</td>
<td>Short</td>
<td>?</td>
<td>?</td>
</tr>
</tbody>
</table>

Graham and Ovch, Am J Crit Care 2010
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#### Minimum Averaging, No Delay

<table>
<thead>
<tr>
<th>Averaging: 2 seconds</th>
<th>Alarm Delay: 0 seconds</th>
<th>Alarm Thresholds: 85 and 95</th>
</tr>
</thead>
<tbody>
<tr>
<td>Event Frequency: 14 Alarms</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Moderate Averaging, No Delay

<table>
<thead>
<tr>
<th>Averaging: 8 seconds</th>
<th>Alarm Delay: 0 seconds</th>
<th>Alarm Thresholds: 85 and 95</th>
</tr>
</thead>
<tbody>
<tr>
<td>Event Frequency: 11 Alarms</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Moderate Averaging, Short Delay

<table>
<thead>
<tr>
<th>Averaging: 8 seconds</th>
<th>Alarm Delay: 5 seconds</th>
<th>Alarm Thresholds: 85 and 95</th>
</tr>
</thead>
<tbody>
<tr>
<td>Event Frequency: 8 Alarms</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Long Averaging, Short Delay

<table>
<thead>
<tr>
<th>Averaging: 16 seconds</th>
<th>Alarm Delay: 5 seconds</th>
<th>Alarm Thresholds: 85 and 95</th>
</tr>
</thead>
<tbody>
<tr>
<td>Event Frequency: 5 Alarms – Late response?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Averaging Time and Desaturation Duration and Frequency

- Variable effect of averaging time on event frequency
- For short events, prolonging averaging time reduced event frequency
- Frequency of prolonged events increased with longer averaging time
- Suggests similar relationship between averaging time and alarm delay on alarm events

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[Figure 1: Linear relationships between the desaturation rate logarithms (N_des) and the averaging time logarithms (T_des) at a desaturation threshold of 85% for seven different minimal desaturation durations (>0 s, 5 s, 10 s, 15 s, 20 s, 25 s, 30 s) are shown. Jan Vagedes et al. Arch Dis Child Fetal Neonatal Ed 2012 2013;98:F265-F266]

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**OXIMETER DOWNLOADS AND DATA EXTRACTION**

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Sample Download Files

- Open raw data files in Excel
- Optional – Eliminating unwanted columns
  - SpO2 = 0
  - Alarm codes
- Adding clinical data
  - Supplemental oxygen Yes/No
  - Nurse, nurse:patient ratio
  - Alarm settings
  - Postmenstrual age

Analysis of Downloaded Data

- Compiling hourly histogram data
  - Complimentary histogram calculator for newer and older Excel versions
  - Adjusting the histogram intervals
- Correlating SpO2 and oximeter alarm data