Errors in Monitoring

BWH Clinical Conference
10/06/04

© Copyright 2004, James H Philip, all rights reserved.
Technology Block 2004

10/06/04 James Philip MD
Low flow & closed circuit safety & danger

10/06/04 James Philip MD
Errors with clinical monitoring

10/13/04 David Lubarsky MD
AIMS (Anes Info Mgt Systems)

10/13/04 David Lubarsky MD
AIMS inferences

10/20/04 James Philip MD
Physiology and physics of fluid flow

10/20/04 Neil Ray & J Philip
Patient Warming and other consid’s
Errors in Monitoring

James H Philip ME(E), MD, CCE
Monitors can fool us

No Graphic Trends -
Can’t see the big picture
You can’t either, if you do not know how to control the monitor to show all the screens

Know every Button
Know every Screen
Know every Alarm
Know where to find the primary data

Consider this homework for the Block
Nitrous Oxide Anomalies

Nitrous Oxide readings are often incorrect. Manufacturers assume $E = I$. They display and graph one measurement. They report Mean $N_2O$. We interpret this as Expired.

Examples
End of long case you see this screen; Patient is still asleep.
Display $\text{N}_2\text{O}$ Graph

Wave -> Graph Label-> $\text{N}_2\text{O}$ -> Trend-> Scale -> 5, 10, 20
Look closely at Trend
N₂O Again
Take a deep breath
Clinical Case

9/16/03

Otherwise healthy 40 F for hysterectomy; OR 22

After uneventful Induction, Tracheal Tube Placement, Mechanical Ventilation

We see the following display
Ohmeda CD ADS Primary Screen

What is abnormal on this screen?

Phase IV (4) bump

What is abnormal on this screen?
Four phases of exhalation

Anatomic Dead Space

Alveolar Transition

Alveolar Emptying

Dx Period

Inspire

Exp

Insp

This case - Phase IV problem
Observe timing

Pressure rise
Ph 4 rise

Vent
Positive Pressure Ventilation

Pressure rise

2 seconds

CO₂ Absorbant

FGF
Blow CO2 around suspected leak
CO₂ wave with surrounding CO₂
Connection leak corrected
Elusive leaks

July 20, 1999

Two sequential previous patients had emphysema and underwent thoracoscopic lung reduction surgery.

All three had similar capnograms

Dual plateau Capnogram

Phase 4 with a second peak

Dr. Body asked me to drop by and help analyze
Dual Plateau Capnogram
Behaved like sample gas leak nr monitor

Anes Team
Changed Tubing
Changed Filter

What next?
Look behind Door for Gas Conditioning
Water handling system
Water Trap Adapter looked OK
But, it was cracked
during the initial phase of expiration, aspiration of the gas sample by the analyzer produced a negative pressure at the cracked sample filter that aspirated room air. With commencement of inspiration, positive pressure in the anesthesia circuit reduced the negative pressure at the sample filter and eliminated or reduced the aspiration of ambient air, thus allowing a second plateau that more accurately reflected alveolar PCO2.

Did you know?
Monitor and screen are separable
Another Case…..

03/22/04  7:30A C.P. ROOM27  3:00  SD  PLA
50 YO M for BILATERAL BREAST REDUCTION
OBEROI, Jasmeet   KRENIS,L
03/22/2004 08:53AM   27341

Interesting shape of ETCO2 curve?? re-breathing (faulty unidir. valve?). Value 115 mmHg, Please woodshed with me.

Larry Krenis
OR 27 Capnogram with Dual Plateau
Wave blow-up
Krenis/Oberoi Considerations

R/O Overproduction
   Hyper metabolism (e.g., MH)
   No Tachycardia. Normal Esoph Temp

R/O hypoventilation
   BBS, Good TV, MV

R/O Failed CO2 Absorption
   White granules, absorber warm to touch,
   Connections all correct

Further Tests - ABGs

Immediate action - High minute ventilation
Get help
<table>
<thead>
<tr>
<th>Date</th>
<th>PO2</th>
<th>SO2</th>
<th>PH</th>
<th>PCO2</th>
<th>TCO2</th>
<th>BASE X</th>
<th>Hct</th>
<th>HgB</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/22/04</td>
<td>293*</td>
<td>99.4*</td>
<td>7.38</td>
<td>42</td>
<td>25</td>
<td>-1</td>
<td>42</td>
<td>14.2</td>
</tr>
</tbody>
</table>
**ABGs**

---

**ARTERIAL BLOOD GASES**

<table>
<thead>
<tr>
<th></th>
<th>PO2</th>
<th>SO2</th>
<th>PH</th>
<th>PCO2</th>
<th>TCO2</th>
<th>BASE X</th>
<th>Hct</th>
<th>HgB</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/22/04</td>
<td>293*</td>
<td>99.4*</td>
<td>7.38</td>
<td>42</td>
<td>25</td>
<td>-1</td>
<td>42</td>
<td>14.2</td>
</tr>
</tbody>
</table>

**Conclusion - Something Technical**
Change tubing, filter; tighten cuvette
Check little O-Rings. All OK

Both O-rings in place
Measure reliable source gas

Breathe into Gas Sample Tubing
ETpCO₂ = 40 mmHg
Just like my exhaled gas always is!
And, the Monitor read the correct result
Likely Explanation

Dual plateau suggests a leak modulated by ventilator pressure

Second plateau $\text{ETpCO}_2 >> \text{ABG } p_a \text{CO}_2$. Physiology always goes the other way ($\text{ET} < a$)
Alveolar Dead Space dilutes Expired toward Inspired

If leak was inside and present during calibration

During Calibration
Cal Gas was diluted (e.g., to 20 mmHg)
Monitor was made to read 40 mmHg

During Use
Monitor would read twice what it should
Except when patient gases are diluted by leak during Phase 3 plateau
Pathologist (actually Technologist)
Internal Gas Sample Tube was detached
Tube was reattached and secured
Manufacturer was notified
Last words?
To OR
Thank you
Next Week - AIMS
Anesthesia Information Management Systems

David Lubarski, MD, MBA
Emanuel M. Papper Professor and Chair
Department of Anesthesiology, Perioperative Medicine, and Pain Management
University of Miami/Jackson Memorial Medical Center

Professor, Department of Management
University of Miami School of Business
10/06/04 James Philip MD Low flow & closed circuit safety & danger
10/06/04 James Philip MD Errors with clinical monitoring
10/13/04 David Lubarsky MD AIMS (Anes Info Mgt Systems)
10/13/04 David Lubarsky MD AIMS inferences
10/20/04 James Philip MD Physiology and physics of fluid flow
10/20/04 Neil Ray & J Philip Patient Warming and other consid’s
End