LARGE GROUP: VENTILATOR MANAGEMENT 2
Case Examples in ARDS and Respiratory Failure

Friday, January 18, 2019 – 3:45 p.m. – 4:30 p.m.

Lance Pangilinan, RRT
UC San Francisco
Adult Critical Care Respiratory Therapist

Lance Pangilinan, RRT, is an Adult Critical Care Respiratory Therapist for the University of California San Francisco, Department of Anesthesia at Zuckerberg San Francisco General Hospital and Trauma Center (ZSFG). There, he currently serves as a bedside therapist and educator. Lance is a lecturer for the Critical Care Residency Program at ZSFG on the topics of Mechanical Ventilation Mechanics and ARDS management. He is a published researcher and has spoken nationally at a number of respiratory and critical care conferences on the subjects of strategic ventilation practices and the use of non-invasive end-tidal monitoring.

Justin Phillips, RRT
UC San Francisco
Adult Critical Care Respiratory Therapist

Justin Phillip, RRT, is an Adult Critical Care Respiratory Therapist for the University of California San Francisco, Department of Anesthesia at Zuckerberg San Francisco General Hospital and Trauma Center (ZSFG). There, he currently serves as a bedside therapist and educator. Justin is a lecturer for the Critical Care Residency Program at ZSFG on the topics of Mechanical Ventilation Mechanics and ARDS management. Additionally, he is Adjunct Faculty for the Respiratory Care Program at Ohlone College for Health Sciences and Technology. Justin is a published researcher and has spoken nationally at a number of respiratory and critical care conferences on the subjects of strategic ventilation practices and the use of non-invasive end-tidal monitoring.
Gregory Burns, RRT
UC San Francisco
Respiratory Care Practitioner

Gregory Burns, RRT, is a Respiratory Care Practitioner for the University of California San Francisco, Department of Anesthesia at Zuckerberg San Francisco General Hospital and Trauma Center (ZSFG). There, he currently serves as interim Equipment Manager. Gregory’s research interests include the effect of inhaled vasodilators on patients with the Acute Respiratory Distress Syndrome.

Vivian Yip, BS, RRTACCS
UC San Francisco
Adult and Neonatal Critical Care Respiratory Therapist

Vivian Yip, BS, RRT-ACCS, is a Adult and Neonatal Critical Care Respiratory Therapist for the University of California San Francisco, Department of Anesthesia at Zuckerberg San Francisco General Hospital and Trauma Center (ZSFG). There, she currently serves as a bedside therapist and educator. Vivian is a lecturer for the Critical Care Residency Program at ZSFG on the topics of Mechanical Ventilation Mechanics and ARDS management. Vivian is a published researcher and has spoken at a number of respiratory and critical care conferences on the subjects of spontaneous breathing trials and the impact of THAM in patients with severe acidosis in ARDS.

Rich Kallet, MS, RRT
UC San Francisco
Respiratory Therapist

Rich Kallet, MS, RRT received his baccalaureate degree in respiratory therapy from SUNY Upstate Medical University in Syracuse NY and his masters of sciences degree in health sciences from San Francisco State University. He spent the majority of his 42 year career working for the University of California, San Francisco Department of Anesthesia at San Francisco General Hospital and the UCSF Cardiovascular Research Institute. He was a research coordinator for NIH ARDS Network from 1996-2011 and has worked as a project manager and director of clinical research for the CVRI, the San Francisco Injury Center and both the Critical Care Management Group and the Respiratory Care Services at SFGH. He retired in 2018 and currently is section editor for the Respiratory Care Journal.
Live Ventilator Management Workshop
A Case Example in ARDS and Respiratory Failure

Lance Pangilinan, RRT
Vivian Yip, RRT
Gregory Burns, RRT
Justin Phillips, RRT
Rich Kallet, MS RRT

Respiratory Care Services
UCSF Department of Anesthesia
Zuckerberg San Francisco General Hospital & Trauma Center

Disclosure of Conflict of Interest

- We have no relevant financial relationships with commercial interests to disclose
Overview

- Forty-five (45) minute interactive panel discussion and case review on Acute Respiratory Distress Syndrome (ARDS), integrating recreated live simulated clinical scenarios via a high-fidelity lung model to a live audience

Introduction

- Present an ARDS case study that illustrates current concepts in ARDS management
- Illustrate the effects of prone positioning on respiratory system mechanics using a live simulator
- Clinical application and interpretation of driving pressure (∆P)
Background

- 34 y/o male with a PMH of pancreatitis (Dx 4 months prior)
- Chief complaint:
  - Epigastric pain and nausea
- Exam: Abdomen distended, hypertensive, tachycardic, febrile
- Admitting Dx: alcoholic pancreatitis
  - Admitted to MICU
Background

- Transferred to surgical service due to development of acute abdominal compartment syndrome & sepsis
- Developed acute respiratory failure during initial fluid resuscitation
- Intubated for Type I & II respiratory failure
- As his hospitalization progressed, he further developed ARDS & multi-organ system failure
- ECMO referral service declined intervention due to lack of supporting clinical outcome evidence in acute pancreatitis (2014)

Day 1

Exam & Imaging

- **Physical**
  - Elevated bladder pressure, 26 mm Hg
- **CVS**
  - Labile, vasoactive gtt support
- **Pulm**
  - Hypoxemic, increased WOB on 3L NC
  - Impending respiratory failure, intubated
- **Neuro**
  - Altered mental status
- **GI**
  - Abdomen distended
- **Radiology Reading**
  - "Low lung volumes are noted. Slight increase in basilar opacities identified, may represent worsening atelectasis. No pneumothorax."
### Day 1

#### Vital Signs
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blood Pressure</td>
<td>114/63 (72)</td>
</tr>
<tr>
<td>Heart Rate</td>
<td>143</td>
</tr>
<tr>
<td>Temp</td>
<td>39.7</td>
</tr>
<tr>
<td>SPO2</td>
<td>93%</td>
</tr>
<tr>
<td>Respiratory Rate</td>
<td>14</td>
</tr>
</tbody>
</table>

#### Laboratory Data
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Na⁺</td>
<td>138</td>
</tr>
<tr>
<td>Cl⁻</td>
<td>104</td>
</tr>
<tr>
<td>K⁺</td>
<td>3.9</td>
</tr>
<tr>
<td>BUN</td>
<td>35</td>
</tr>
<tr>
<td>Creatinine</td>
<td>1.17</td>
</tr>
<tr>
<td>Glucose</td>
<td>204</td>
</tr>
<tr>
<td>ABG</td>
<td>7.25/50/86/21.9/5.3</td>
</tr>
<tr>
<td>WBC</td>
<td>8.6</td>
</tr>
<tr>
<td>HBG</td>
<td>12.1</td>
</tr>
<tr>
<td>HCT</td>
<td>36.5</td>
</tr>
<tr>
<td>PLT</td>
<td>143</td>
</tr>
</tbody>
</table>

#### Pulmonary Data
- **P/F Ratio**: 86
- **ΔP**: 20
- **CSTAT**: 26
- **P_{ETCO2}**: 46
- **Vd/Vt**: N/A

#### Adjunctive Therapies Considered

**Tx's considered**
- ARDSnet (alveoli grid)
  - BERLIN? (P/F = 86)
  - SEVERE
- NMBA
- Adaptive pressure control
- Judicious levels of PEEP,
  - 16 - 24 cm H₂O in effort to improve Ces and P/F ratio
  - PEEP level relative to hemodynamic instability
- RM
  - Aborted due to associated hypotension
- PGI2- ↔ PaO2/FiO2
Day 1: Summary of Interventions

- Admitted to the MICU
- Intubated due to AMS and hypoxemia
- Quickly transitioned to lung protective ventilation via ARDS Network Protocol
  - Severe ARDS by Berlin Definition
- Adjunctive therapies (NMBA, Mode change, PEEP titration, RMV, PGI2)
- Abd Decompression → 2 L of fluid removal, positive initial improvement in $C_{RS}$
  - $C_{RS}$ subsequently worsened shortly after

Pre-Prone CXR
Prone Positioning
Prone Positioning (PP) Day 1 – x 5 hours

**ABG Pre-Prone**
7.31 / 54 / 66 / 27.2 / +0.9

Pulmonary Data

<table>
<thead>
<tr>
<th>$\Delta P$</th>
<th>C$_{STAT}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>13</td>
<td>30</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PetCO2</th>
<th>$V_{d}/V_T$</th>
</tr>
</thead>
<tbody>
<tr>
<td>45</td>
<td>0.56</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PaO2/FiO2</th>
<th>FiO2</th>
</tr>
</thead>
<tbody>
<tr>
<td>66</td>
<td>1.0</td>
</tr>
</tbody>
</table>

**ABG Post prone x 5 hours (PP)**
7.31 / 57 / 82 / 28.7 / +2.4

Pulmonary Data

<table>
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<th>C$_{STAT}$</th>
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<tr>
<td>15</td>
<td>26</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PetCO2</th>
<th>$V_{d}/V_T$</th>
</tr>
</thead>
<tbody>
<tr>
<td>44</td>
<td>N/A</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PaO2/FiO2</th>
<th>FiO2</th>
</tr>
</thead>
<tbody>
<tr>
<td>82</td>
<td>1.0</td>
</tr>
</tbody>
</table>

First Supine Trial

**ABG post supine x 1.5 hours**
7.34 / 51 / 72 / 27.5 / +1.7

Pulmonary Data

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<th>$\Delta P$</th>
<th>C$_{STAT}$</th>
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<td>14</td>
<td>28</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>PetCO2</th>
<th>$V_{d}/V_T$</th>
</tr>
</thead>
<tbody>
<tr>
<td>43</td>
<td>N/A</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PaO2/FiO2</th>
<th>FiO2</th>
</tr>
</thead>
<tbody>
<tr>
<td>80</td>
<td>0.9</td>
</tr>
</tbody>
</table>
First supine CXR post PP

Day 15 in ICU

- Pt. has been through various prone : supine regimens
  - 4:1, 8:1, 12:1, 7:5
  - With Reverse Trendelenburg positioning during supine
  - Current regimen as of day 15 in ICU = 7:5, additional...
    - Remains on NMBA
    - PGI2
    - ARDSnet ventilation goals/parameters
Day 15 in ICU

At this time, pt. has been supine half-way through the 5 hour allotted time period

Current supine ABG (x2.5 hours)

7.36 / 63 / 88 / 35.6 / +10.2

<table>
<thead>
<tr>
<th>$\triangle P$</th>
<th>$C_{STAT}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>27</td>
</tr>
</tbody>
</table>

PetCO2

40

$V_d/V_T$

N/A

PaO2/FiO2

88

FiO2

1.0

Current prone ABG (x3.5 hours)

7.41 / 54 / 203 / 34.2 / +9.6

<table>
<thead>
<tr>
<th>$\triangle P$</th>
<th>$C_{STAT}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>14</td>
<td>29</td>
</tr>
</tbody>
</table>

PetCO2

39

$V_d/V_T$

N/A

PaO2/FiO2

226

FiO2

0.9

Pt. proned after the allotted supine time period

Pt. remained proned until 7 hour time marker

Summary Prone/Supine Day 1 v. Day 15
Day 30 in the ICU

- Pt. has been through various prone: supine regimens
- Supine time has been reflective of tolerance in that position
  - Reverse Trendelenburg position during Supine
  - Current regimen as of day 30 in ICU = 7:3, additional...
    - Remains on NMBAs
    - PGI2
    - ARDSnet ventilation goals/parameters
Day 30 in ICU

At this time, pt. has been supine for the full 3 hour allotted time period prior to returning to the PP

Current supine ABG (x3 hours)
7.37 / 55 / 97 / 31.8 / +6.5

<table>
<thead>
<tr>
<th>ΔP</th>
<th>CSTAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>40</td>
</tr>
</tbody>
</table>

PetCO2
47

Vd/Vt
N/A

PaO2/FiO2
176

FiO2
0.55

No prone ABG available (x6 hours)

<table>
<thead>
<tr>
<th>ΔP</th>
<th>CSTAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>36</td>
</tr>
</tbody>
</table>

PetCO2
44

Vd/Vt
N/A

PaO2/FiO2
N/A

FiO2
0.55

Summary Prone/Supine Day 15 v. Day 30

[Diagram showing comparison between Day 15 and Day 30 for various parameters such as Pplat, Driving Pressure, %O2, and PEEP]
Day 50 in the ICU

- Last day of PP (ICU day 50)
- Prone : supine duration as of day 50 in ICU = 8:4
- Reverse Trendelenburg position while supine
- Additional…
  - Remains on NMBA
  - PGI2
  - ARDSnet ventilation goals/parameters

Current prone ABG (x4 hours)
7.39/57/93/34.5/+9.5

Current supine ABG (x1 hours)
7.42/49/78/31.8/+7.3

ΔP 11 CSTAT 37
PetCO2 56 Vd/Vt N/A
PaO2/FiO2 233 FiO2 0.4

ΔP 10 CSTAT 37
PetCO2 47 Vd/Vt N/A
PaO2/FiO2 195 FiO2 0.4

Prone positioning discontinued, pt. remained supine for the remainder of his mechanical ventilation course
Summary of ICU Stay

- NMBA off day 52 in ICU
- PGI2 off ICU day 53
- First pressure support ICU day 54 after patient became severely asynchronous and hyperdynamic.
  - SBT/DSI continued for a long wean.
- ICU day 62: PEEP = 8 cmH2O, FiO2 = 0.50
- Last ABG on vent: 7.41 / 48 / 80 / 30.4 / +5.8
  - Vent settings: PS = 6 cmH2O, PEEP = 5 cmH2O, FiO2 = 0.40
  - Vent measures: Rate = 16, $V_T = 535$ (8.3 ml/kg), MV = 9.13 PetCO2 = 48
- Patient extubated to HFNC on ICU day 66
- D/C from ICU on day 68
LP2  I deleted the previous slide which was also "Day 52 in ICU" but had abc's and vent measures.

Lance Pangilinan, 1/5/2019
Summary of Hospital Course

- 66 days of MV
- 48 days of prone positioning
- 53 days to spontaneous breathing
- 12 days of spontaneous breathing pre extubation
Prone Position Summary
A lower FiO2 is required in the prone position

![Bar chart showing comparison of FiO2 values between supine and prone positions.]

Prone Position Summary
A lower driving pressure and plateau pressure are maintained in the prone position

![Bar chart showing comparison of driving pressure and plateau pressure values between supine and prone positions.]

Zuckerberg San Francisco General