LACTATE/PCT

Tests I Wished You Never Ordered

OCTOBER 30, 2019

Martin C. Burke, DO
Chief Scientific Officer
CorVita Science Foundation

www.corvitascience.org
COI DISCLOSURES

• I have received lecture and proctoring honoraria from Spectranetics.

• I have been funded by and NIH/SBIR grant to AJ Medical Devices, Inc. (AJMD) and research grants from Boston Scientific, Medtronic, St. Jude Medical, Guidant, Inc. and Cameron Health, Inc.

• I am or have been a consultant to AJMD, Boston Scientific and Cameron Health.

• I have an equity stake in AtaCor Medical, Inc. and am Chief Medical Officer.
Case Study:

• 76 year old male with prostatism who recently underwent a TURP presents with syncope and shock.

• **The patient presents with anorexia and weight loss after repeated, and difficult to eradicate UTIs.** The patient has been given doxycycline and ciprofloxacin sequentially over the last month.

• The patient has known asymptomatic Mobitz I 2nd degree AV block perioperatively. He was evaluated and decided on monitoring as an outpatient due to his lack of symptoms. He was seen within a week, monitored with no change clinically.
Physical Exam:

- AFEBRILE
- BP 90/55 mm Hg
- HR 45 bpm
- RR 16
- Malaise, cachectic, No JVD, bradycardic
- Heart rate slow and regular
- Lungs clear; Abdomen benign
- No edema
Home Medications/Selected Labs:

- Lisinopril 2.5 mg daily
- Metoprolol 25 mg daily
- Glimepiride 2 mg daily
- Metformin 1000 mg BID
- Crestor 10 mg daily
- Flomax 0.4 mg BID
- Aspirin 81 mg daily

Sodium: 127
Potassium: 6.7
Chloride: 100
CO2: 18
BUN: 53
CR: 2.4
GFR: 26
Troponin: 0.01
WBC: 10.8
Lactate: 2.2, 3.5, 3.3
Can this cause shock?
Admitted to the ICU with Septic Shock and Hyperkalemia

• It smells like an HCC designation
Sepsis Diagnosis

**FIG. 1.** Third International Consensus Definitions for Sepsis and Septic Shock (Sepsis-3): (a) Original Sepsis-2 definitions; (b) New Sepsis-3 definitions.

**FIG. 2.** Quick Sequential Organ Failure Assessment (qSOFA) score for sepsis.
# Predictability of Mortality

<table>
<thead>
<tr>
<th>Test</th>
<th>AUROC Curve</th>
<th>Sensitivity for mortality</th>
<th>Specificity for mortality</th>
</tr>
</thead>
<tbody>
<tr>
<td>SIRS ≥2</td>
<td>0.76</td>
<td>64%</td>
<td>65%</td>
</tr>
<tr>
<td>SOFA ≥2</td>
<td>0.79</td>
<td>68%</td>
<td>67%</td>
</tr>
<tr>
<td>qSOFA ≥2</td>
<td>0.81</td>
<td>55%</td>
<td>84%</td>
</tr>
</tbody>
</table>

AUROC = area under the receiver operating curve; SIRS = systemic inflammatory response syndrome; SOFA = Sequential Organ Failure Assessment score; qSOFA = quick Sequential Organ Failure Assessment score.
Lactate is the weaker metric

<table>
<thead>
<tr>
<th>Group</th>
<th>Hypotension after fluids</th>
<th>Vasopressors</th>
<th>Lactate &gt;2 mmol/L</th>
<th>Prevalence, Surviving Sepsis Campaign Database (n=18,840 patients)</th>
<th>Hospital mortality</th>
</tr>
</thead>
<tbody>
<tr>
<td>1a</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>8,520 (45.2%)</td>
<td>42.3%</td>
</tr>
<tr>
<td>2b</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>3,985 (21.2%)</td>
<td>30.1%</td>
</tr>
<tr>
<td>3</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>223 (1.2%)</td>
<td>28.7%</td>
</tr>
<tr>
<td>4</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>3,266 (17.3%)</td>
<td>25.7%</td>
</tr>
<tr>
<td>5</td>
<td>Never (pre)</td>
<td>No</td>
<td>Yes</td>
<td>2,696 (14.3%)</td>
<td>29.7%</td>
</tr>
<tr>
<td>6</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>150 (0.8%)</td>
<td>18.7%</td>
</tr>
</tbody>
</table>

aMeets criteria for new Sepsis-3 septic shock definition.
bMeets criteria for old Sepsis-2 septic shock definition.


Sepsis-3 = Third International Consensus Definitions for Sepsis and Septic Shock.
Sensible Metrics - Single Score?

### Table 4. The Modified Early Warning Score (MEWS), and National Early Warning (NEWS) Scores

<table>
<thead>
<tr>
<th>Modified Early Warning Score (MEWS)</th>
<th>Score</th>
<th>3</th>
<th>2</th>
<th>1</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Respiratory rate (min⁻¹)</td>
<td>≤8</td>
<td></td>
<td></td>
<td>9–14</td>
<td></td>
<td>15–20</td>
<td></td>
<td>21–29</td>
</tr>
<tr>
<td>Heart rate (min⁻¹)</td>
<td>≤40</td>
<td>41–50</td>
<td>51–100</td>
<td></td>
<td>101–110</td>
<td></td>
<td>111–129</td>
<td></td>
</tr>
<tr>
<td>Systolic BP (mmHg)</td>
<td>≤70</td>
<td>71–80</td>
<td>81–100</td>
<td>101–199</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urine output (ml/kg/h)</td>
<td>Nil</td>
<td>&lt;0.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temperature (°C)</td>
<td>≤35</td>
<td>35.1–36</td>
<td>36.1–38</td>
<td>Alert</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neurological</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### National Early Warning Score (NEWS)

<table>
<thead>
<tr>
<th>Physiological parameters</th>
<th>Score</th>
<th>3</th>
<th>2</th>
<th>1</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Respiration rate</td>
<td>≤8</td>
<td></td>
<td>9–11</td>
<td></td>
<td>12–20</td>
<td></td>
<td>21–24</td>
<td>≥25</td>
</tr>
<tr>
<td>Oxygen saturations</td>
<td>≤91</td>
<td>92–93</td>
<td>94–95</td>
<td></td>
<td>≥96</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Any supplemental oxygen</td>
<td>Yes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temperature</td>
<td>≤35.0</td>
<td>35.1–36.0</td>
<td>36.1–38.0</td>
<td>Alert</td>
<td>38.1–39.0</td>
<td></td>
<td>≥39.1</td>
<td></td>
</tr>
<tr>
<td>Systolic BP</td>
<td>≤90</td>
<td>91–100</td>
<td>101–110</td>
<td>111–219</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heart rate</td>
<td>≤40</td>
<td>41–50</td>
<td>51–90</td>
<td></td>
<td>91–110</td>
<td>111–130</td>
<td></td>
<td>≥131</td>
</tr>
<tr>
<td>Level of consciousness</td>
<td>A</td>
<td>V.P. or U</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*The NEWS initiative flowed from the Royal College of Physicians’ NEWSDIG, and was jointly developed and funded in collaboration with the Royal College of Physicians, Royal College of Nursing, National Outreach Forum and NHS Training for Innovation.*

Napolitano, L Surgical Infections 2018; 19(2): 117-125
Normal
SA & AV Node Function
Normal
His-Purkinje System Function
Moore’s Law in healthcare

Microprocessor Transistor Counts 1971-2011 & Moore’s Law

Transistor count


Date of introduction

IEEE 2012
Digitalization of SICD Charge Events Identifies Pre-Charge Electrogram Variants Leading to Oversensing

Erik Mersereau, Brett Breshears, Justin Figueroa, Martin C. Burke, DO
Midwestern University & CorVita Science Foundation, Chicago, IL
European Heart Journal 2018 abstract (ESC)
ECG Classification With Deep Learning

Joris Galema, Christopher Buch Madsen, Flavio Miceli, Abel Oakley & Florian Schroevers

2nd July 2018

Figure 3: Fourier Approximation

Figure 12: Accuracy and Loss per Epoch