Tom Ahrens PhD RN FAAN

- Research Scientist at Barnes-Jewish Hospital, St. Louis, MO
- Co Developer of NovEx education program
Three Major Challenges (and opportunities) in Severe Sepsis Management

- Timely and accurate diagnosis to ensure patients get appropriate care
- Consistent application of the evidence to improve survival rates, length of stay and other outcomes
- Appropriate documentation and coding to ensure proper reimbursement
Challenges with Appropriate Documentation and Coding

- Due to challenges associated with diagnosing severe sepsis, it often goes undiagnosed. As a result, an infection and organ dysfunction are often coded without severe sepsis or septic shock, resulting in lost revenue from CMS and Third Party payers.

  - E.g.: Failure to appropriately code sepsis (ICD-9 code 995.91) in a case of pneumonia can result in a loss of > $2,000 in revenue.
  - Failure to add severe sepsis (ICD-9 995.92) to a case of pneumonia can result in a loss of > $3,000 in revenue.
Assessing the Impact of Severe Sepsis at Large Midwest Hospital

Severe sepsis and septic shock cases were derived from codes for infection and acute organ dysfunction as reported by the Hospital.
## Were Patients Missed with Severe Sepsis - Methodology

<table>
<thead>
<tr>
<th></th>
<th>2012</th>
<th>2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>Any organ failure</td>
<td>13,287</td>
<td>13,937</td>
</tr>
<tr>
<td>Any infection diagnosis (not counting sepsis)</td>
<td>15206</td>
<td>14741</td>
</tr>
<tr>
<td>Organ failure + infection</td>
<td>6003</td>
<td>6081</td>
</tr>
<tr>
<td>Sepsis diagnosis</td>
<td>2503</td>
<td>2841</td>
</tr>
<tr>
<td>Organ failure + infection and no sepsis dx</td>
<td>4700</td>
<td>4650</td>
</tr>
</tbody>
</table>
Opportunity to Increase Revenue with Improved Coding

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td># of Admissions in FY 2013</td>
<td>58,120</td>
</tr>
<tr>
<td># of Severe Sepsis Cases not Coded</td>
<td>4,650</td>
</tr>
<tr>
<td>#Surgical cases (30%)</td>
<td>1395</td>
</tr>
<tr>
<td>Total cases with improved reimbursement</td>
<td>3255</td>
</tr>
<tr>
<td>Average Improved Payment Per Case</td>
<td>$4,500</td>
</tr>
<tr>
<td>Potential Annual Revenue Improvement (3255) * $4,500</td>
<td>$14,647,500</td>
</tr>
</tbody>
</table>

Key Assumptions:
• Payment as a result of coding severe sepsis as principal rather than infection
• $4,500 improved reimbursement needs confirmation with our coding experts
• Surgical cases not included in improved reimbursement due to higher reimbursement rates for surgical patients compared to severe sepsis.
How to Achieve Best Outcomes
Sepsis Team

- APN's
- Registered Nurses
- Nurse Educator
- Data Abstractors
- Outreach Coordinator
- IS Analyst
- Sepsis Program Manager
- Adm Champion
- PharmD
- Physician Champion
- Administrative Assistant
Measure Description: This measure will focus on patients aged 18 years and older who present with symptoms of severe sepsis or septic shock. These patients will be eligible for the 3 hour (severe sepsis) and/or 6 hour (septic shock) early management bundle.

Numerator Statement: If:

- measure lactate level
- obtain blood cultures prior to antibiotics
- administer broad spectrum antibiotics
- administer 30 ml/kg crystalloid for hypotension or lactate >=4 mmol/L
What is sepsis?

- Sepsis is the body’s immune system response to an infection
  - Bacteria, virus, protozoan
- Instead of a localized response to an infection (like a pneumonia), sepsis is a systemic response that can be catastrophic
- Highest cost to US hospitals (AHRQ)
- Leading cause of death in hospitals
New Definitions
New Sepsis Definition
qSOFA

- An alteration in mental status (not the GCS)
- A decrease in SBP of less than 100 mm Hg
- A respiratory rate > 22 bpm
Table 1. Sequential [Sepsis-Related] Organ Failure Assessment Score\(^a\)

<table>
<thead>
<tr>
<th>System</th>
<th>Score</th>
<th>(0)</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Respiration</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(\text{Pao}_2/\text{FiO}_2), mm Hg (kPa)</td>
<td>(\geq 400) (53.3)</td>
<td>(&lt; 400) (53.3)</td>
<td>(&lt; 300) (40)</td>
<td>(&lt; 200) (26.7) with respiratory support</td>
<td>(&lt; 100) (13.3) with respiratory support</td>
<td></td>
</tr>
<tr>
<td>Coagulation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Platelets, (\times 10^3/\mu\text{L})</td>
<td>(\geq 150)</td>
<td>(&lt; 150)</td>
<td>(&lt; 100)</td>
<td>(&lt; 50)</td>
<td>(&lt; 20)</td>
<td></td>
</tr>
<tr>
<td>Liver</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(\text{Bilirubin, mg/dL (}\mu\text{mol/L}))</td>
<td>(&lt; 1.2) (20)</td>
<td>(1.2-1.9) (20-32)</td>
<td>(2.0-5.9) (33-101)</td>
<td>(6.0-11.9) (102-204)</td>
<td>(&gt; 12.0) (204)</td>
<td></td>
</tr>
<tr>
<td>Cardiovascular</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MAP (\geq 70) mm Hg</td>
<td>MAP (&lt; 70) mm Hg</td>
<td>Dopamine &lt;5 or dobutamine (any dose)(^b)</td>
<td>Dopamine 5.1-15 or epinephrine (\leq 0.1) or norepinephrine (\leq 0.1)(^b)</td>
<td>Dopamine &gt;15 or epinephrine &gt;0.1 or norepinephrine &gt;0.1(^b)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Central nervous system</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Glasgow Coma Scale score(^c)</td>
<td>15</td>
<td>13-14</td>
<td>10-12</td>
<td>6-9</td>
<td>(&lt; 6)</td>
<td></td>
</tr>
<tr>
<td>Renal</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Creatinine, mg/dL ((\mu\text{mol/L}))</td>
<td>(&lt; 1.2) (110)</td>
<td>(1.2-1.9) (110-170)</td>
<td>(2.0-3.4) (171-299)</td>
<td>(3.5-4.9) (300-440)</td>
<td>(&gt; 5.0) (440)</td>
<td></td>
</tr>
<tr>
<td>Urine output, mL/d</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(&lt; 500)</td>
<td>(&lt; 200)</td>
</tr>
</tbody>
</table>

Abbreviations: \(\text{FiO}_2\), fraction of inspired oxygen; MAP, mean arterial pressure; \(\text{Pao}_2\), partial pressure of oxygen.
\(^a\) Adapted from Vincent et al.\(^{27}\)
\(^b\) Catecholamine doses are given as \(\mu\text{g/kg/min}\) for at least 1 hour.
\(^c\) Glasgow Coma Scale scores range from 3-15; higher score indicates better neurological function.
Key Differences in New Definition

- Sepsis as infection and 2 or more SIRS is now just an infection
- Severe sepsis is now sepsis
- Septic shock is
  - Blood lactate > 2 mmol/L despite volume resuscitation
  - Hypotension that persists after fluid resuscitation and requires vasopressors
- Sepsis definition now will carry a higher risk of death and increased ICU LOS
Controversies with New Definition

- Not a screening tool
- A better sepsis definition
- Concern is a delay in sepsis identification
Can your staff recognize sepsis?

Sepsis can be subtle until it is so obvious you can’t miss it.
62 year old admitted to hospital with hip infection

- On admission
  - T – 38.5
  - RR – 24
  - P – 104
  - WBC – 19,000

- Where should he be admitted?
36 hours post admission

Urine output drops – What should be done?
48 hours post admission

Pulse oximeter drops and becomes difficult to read – what should be done?
Any Organ Can be Affected by Sepsis. If any organ shows signs of dysfunction related to the infection, sepsis is now called severe sepsis.

**CNS**
- Altered consciousness
- Confusion

**Cardiovascular**
- Tachycardia
- Hypotension
- Altered CVP and PAOP

**Respiratory**
- Tachypnea
- $\downarrow$ PaO$_2$
- $\downarrow$ PaO$_2$/FiO$_2$ ratio

**Hepatic**
- Jaundice
- $\uparrow$ Liver enzymes
- $\downarrow$ Albumin

**Metabolic**
- Metabolic acidosis
- $\uparrow$ Lactate level
- $\downarrow$ Lactate clearance

**Renal**
- Oliguria
- Anuria
- $\uparrow$ Creatinine

**Hematologic**
- $\downarrow$ platelets, $\uparrow$ PT/INR/ $\uparrow$ aPTT
- $\downarrow$ protein C
- $\uparrow$ D-dimer
### Difference between Sepsis States

<table>
<thead>
<tr>
<th>Sepsis / ICD 995.91</th>
<th>Severe Sepsis/ ICD 995.92</th>
<th>Septic Shock/ ICD 785.52</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Pulse ≥ than 90 beats per minute</em></td>
<td><em>Pulse ≥ than 90 beats per minute</em></td>
<td><em>Pulse ≥ than 90 beats per minute</em></td>
</tr>
<tr>
<td><em>Respiratory rate ≥ than 20 breaths per minute</em></td>
<td><em>Respiratory rate ≥ than 20 breaths per minute</em></td>
<td><em>Respiratory rate ≥ than 20 breaths per minute</em></td>
</tr>
<tr>
<td><em>Temperature &gt; 38.3°C or &lt; 36.0°C</em></td>
<td><em>Temperature &gt; 38.3°C or &lt; 36.0°C</em></td>
<td><em>Temperature &gt; 38.3°C or &lt; 36.0°C</em></td>
</tr>
<tr>
<td><em>WBC &lt; 4,000 or &gt; 12,000; or bands &gt; 10%</em></td>
<td><em>WBC &lt; 4,000 or &gt; 12,000; or bands &gt; 10%</em></td>
<td><em>WBC &lt; 4,000 or &gt; 12,000; or bands &gt; 10%</em></td>
</tr>
<tr>
<td>Real or suspected infection:</td>
<td>Real or suspected infection:</td>
<td>Real or suspected infection:</td>
</tr>
<tr>
<td>Organ dysfunction:</td>
<td></td>
<td>Organ Dysfunction</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hypotension</td>
</tr>
</tbody>
</table>
Key to Success in Sepsis Management

- Prevent infections! Don’t let sepsis start
- **Rapid Identification**
- If sepsis is present, rapid treatment is needed
Pathophysiology of Sepsis

What do we need to know
5 second rule
The Power of Our Immune System

“Our arsenals for fighting off bacteria are so powerful, and involve so many different defense mechanisms, that we are more in danger from them than from the invaders.

“We live in the midst of explosive devices; we are mined!”

Lewis Thomas - 1972
Germs, New England Journal Of Medicine
“Except on few occasions, the patient appears to die from the body's response to infection rather than from it.”

Sir William Osler – 1904
The Evolution of Modern Medicine
Impact of Vaccines
Measles Example

Measles—United States, 1950-2001

Cases (thousands)

Vaccine Licensed

But few bacteria are dangerous

- Only a small amount of bacteria and viruses are dangerous
- Those are not likely to be on the floor
- But they can be on your hands or in the air
- Protecting yourself
Coagulation and Impaired Fibrinolysis In Severe Sepsis

Reprinted with permission from the National Initiative in Sepsis Education (NISE).
The Response to Pathogens, Involving "Cross-Talk" among Many Immune Cells, Including Macrophages, Dendritic Cells, and CD4 T Cells
Determining if your Patient is In Danger

- Establishing urgency – use of Lactate
  - A measure of tissue hypoxia
  - Normal 1-2 mmol
  - > 4 mmol with metabolic acidosis suggests tissue hypoxia
- Lactate measurements need to be repeated to evaluate if therapy is effective and if the patient is improving
<table>
<thead>
<tr>
<th>Lactate N= 529</th>
<th>&lt; 2 (N=219)</th>
<th>2-4 (N=177)</th>
<th>&gt; 4 (N = 104)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SBP &gt; 90</td>
<td>158/219 (72%)</td>
<td>116/177 (65%)</td>
<td>64/104 (62%)</td>
</tr>
<tr>
<td>SBP &lt; 90</td>
<td>61/219 (28%)</td>
<td>61/177 (34%)</td>
<td>40/104 (38%)</td>
</tr>
</tbody>
</table>
Sepsis will morph and change during its course. Begins like hypovolemic shock.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blood pressure</td>
<td>102/52 mm Hg</td>
</tr>
<tr>
<td>Pulse</td>
<td>108 beats/min</td>
</tr>
<tr>
<td>Stroke volume</td>
<td>44</td>
</tr>
<tr>
<td>Cardiac output</td>
<td>4.75</td>
</tr>
<tr>
<td>$\text{ScvO}_2$</td>
<td>0.37</td>
</tr>
</tbody>
</table>
Later Sepsis changes from hypovolemia to hyperdynamic

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Blood pressure</strong></td>
<td>100/56 mm Hg</td>
</tr>
<tr>
<td><strong>Pulse</strong></td>
<td>104 beats/min</td>
</tr>
<tr>
<td><strong>Stroke volume</strong></td>
<td>105</td>
</tr>
<tr>
<td><strong>Cardiac output</strong></td>
<td>10.9</td>
</tr>
<tr>
<td><strong>SvO₂</strong></td>
<td>0.87</td>
</tr>
</tbody>
</table>
Microvascular Blood Flow Is Impaired in Severe Sepsis
Sepsis often progresses when the host cannot contain the primary infection

- A problem most often related to
  - characteristics of the microorganism,
    - such as a high burden of infection
  - the presence of super antigens and other virulence factors,
  - resistance to phagocytosis
  - antibiotic resistance.
Cell dysoxia

- Epithelial cells have diminished oxygen consumption
  - due to a depletion of nicotinamide adenine dinucleotide (NAD)
- Concept of cell stunning or hibernation
Case Example – Is Action Needed?

- 29 year old male with history of Crohn’s disease is admitted from ED with perirectal abscess.

- Lactate 5.9
- SpO2 - .94
- BP – 108/50
- HR – 81
- RR – 20
- T – 38.3
- UO – 1 ml/kg/hr (55 ml/hr)
How do We Identify Sepsis Now?

In absence of biomarkers, must rely on crude physical indicators
SIRS AND SEPSIS

Sepsis is defined as an infection plus ≥2 SIRS criteria

- Temperature
  - >38.3°C or <36°C
- HR >90 beats/min
- Respirations >20/min
- WBC count >12,000/mm³ or <4,000/mm³ or >10% immature neutrophils
How Do We Treat Sepsis?

Sadly, little has changed in actual treatment of sepsis in decades. The key steps are:

1. Identify the infectious organism
2. Blood and site cultures
3. Remove the source of the infection if possible
4. Obtain lactate
5. Initiate Antibiotics
6. If severe sepsis is present, give fluids
7. If fluids do not restore hemodynamic stability, give vasopressors
8. If pressors do not improve hemodynamics, add steroids
The New Surviving Sepsis Campaign Bundles – April 2015

TO BE COMPLETED WITHIN 3 HOURS OF TIME OF PRESENTATION*:

1. Measure lactate level
2. Obtain blood cultures prior to administration of antibiotics
3. Administer broad spectrum antibiotics
4. Administer 30ml/kg crystalloid for hypotension or lactate ≥4mmol/L
   * “Time of presentation” is defined as the time of triage in the emergency department or, if presenting from another care venue, from the earliest chart annotation consistent with all elements of severe sepsis or septic shock ascertained through chart review.

Remains the Same

TO BE COMPLETED WITHIN 6 HOURS OF TIME OF PRESENTATION:

5. Apply vasopressors (for hypotension that does not respond to initial fluid resuscitation) to maintain a mean arterial pressure (MAP) ≥65 mmHg
6. In the event of persistent hypotension after initial fluid administration (MAP < 65 mm Hg) or if initial lactate was ≥4 mmol/L, re-assess volume status and tissue perfusion and document findings according to Table 1.
7. Re-measure lactate if initial lactate elevated.
TABLE 1

DOCUMENT REASSESSMENT OF VOLUME STATUS AND TISSUE PERFUSION WITH:

EITHER

• Repeat focused exam (after initial fluid resuscitation) by licensed independent practitioner including vital signs, cardiopulmonary, capillary refill, pulse, and skin findings.

OR TWO OF THE FOLLOWING:

• Measure CVP
• Measure ScvO₂
• Bedside cardiovascular ultrasound
• Dynamic assessment of fluid responsiveness with passive leg raise or fluid challenge
History of Treating Severe Sepsis

Clinical tx – fluids, vasopressors & antibiotics

Afelimomab
Anti TNF F monoclonal antibody fragment
The Sepsis Trilogy

ProCESS
Protocolized Care for Early Septic Shock (ProCESS) – 31 ED's in US

ARISE
Australasian Resuscitation in Sepsis Evaluation (ARISE) – 51 ED's in Australia, New Zealand

ProMISE
The Protocolised Management in Sepsis (ProMISE) Trial

Dr Salim Rezaie Clinical Assistant Professor of EM and IM at

UB
ProMise, ProCess and ARISE Trials

Key points
- Fluid administration similar in both control and experimental groups
- Vasopressor use similar in both groups
- Antibiotics administered similarly in both groups
- Lactates obtained in both groups
- Mortality rates (<20%) is not as common outside centers with well designed sepsis recognition/management programs

Problems– Antibiotics and fluids given in both control and experimental groups within 3 hours.
- Hawthorne Effect Likely
- Contamination of practice
Hemodynamics of Sepsis

- Concept of early resuscitation
  - Establishing urgency – use of Lactate
  - Normal 1-2 mmol
  - > 4 mmol with metabolic acidosis suggests tissue hypoxia

- Fluids with a goal
  - The role of mixed venous oxyhemoglobin (ScvO₂)
## Methods of Measuring SV

<table>
<thead>
<tr>
<th>Uses</th>
<th>Ease of use</th>
<th>Accuracy</th>
<th>Professional Reimbursement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Doppler - USCOM</td>
<td>Good</td>
<td>Good</td>
<td>-</td>
</tr>
<tr>
<td>Doppler (EDM)</td>
<td>Excellent</td>
<td>Excellent</td>
<td>$$$$$</td>
</tr>
<tr>
<td>ECON</td>
<td>Good</td>
<td>Fair</td>
<td>-</td>
</tr>
<tr>
<td>Bioimpedance</td>
<td>Good</td>
<td>Fair</td>
<td>$</td>
</tr>
<tr>
<td>Pulse contour (FloTrac, LiddCo, PICCO)</td>
<td>Difficult</td>
<td>Fair</td>
<td>-</td>
</tr>
<tr>
<td>NICO</td>
<td>Difficult</td>
<td>Fair</td>
<td>-</td>
</tr>
<tr>
<td>PAC</td>
<td>Difficult</td>
<td>Good</td>
<td>$$$$$</td>
</tr>
<tr>
<td>Bioreactance</td>
<td>Good</td>
<td>Good</td>
<td>$</td>
</tr>
</tbody>
</table>
Why are we not measuring SV?
Measuring SV in Pediatrics
Non invasive CO/SV measurement
Setting Goals

- Discuss goals of care and prognosis with patients and families (grade 1B).
  - Sepsis has a high mortality rate. Families should understand and recognize that determining what the patient’s wishes are may help dictate the aggressiveness of therapy.

- Incorporate goals of care into treatment and end-of-life care planning, utilizing palliative care principles where appropriate (grade 1B).

- Address goals of care as early as feasible, but no later than within 72 hours of ICU admission (grade 2C).
Case Study 1
Case Study 1

- 63 year old male in MICU with CAP, pneumothorax
- Progressing well but on day 4
  - Develops spontaneous pneumothorax
  - RLL infiltrate
- Temp increases to 39.1
  - P – 122
  - BP – 82/52 (following EGDT)
- WBC 16,500
- Is SOB, requires intubation, 50% FIO2, AMV
  - 12/14, Vt – 500 ccs, PEEP +10
- Day 4
  - SpO2 - .92, PaO2 64 (P/F ratio > 100), pH 7.28, PaCO2 32, HCO3 - 17
- Sepsis is suspected with treatment rapidly started
  - Has received EGDT
  - 4 L NS
- Lactate 6.2
- Platelets – 110,000
Chest x-ray Day 3 AM
Day 3 PM
What to do?

- What is happening?
- Any therapies missing?
- Family communication issues?
Case Study 2

- 33-year-old, 150 kg female with failed gastric bypass
  - Bowel was nicked during surgery
  - 4 days post-op develops wound infection
  - 8 liters of fluids over past 48 hours
  - On cefotaxime and gentamicin
  - Norepinephrine at 10 µg/min
  - Hydrocortisone 200 mg IV daily
  - PEEP 12 cm H₂O, FiO₂ 90%
  - Sedated (RASS – -2)
  - Lactate 5.9
Education

New Evidenced based education method
Impact of Our Program

Clinical and Economic Impact
Study of Our Program
In Hospital 1
Impact on Mortality
Early Study (2010-2011)

Mortality

Pre NovEx | Post NovEx
--- | ---
34 | 25
33 | 28
32 | 29
31 | 30
30 | 31
29 | 32
28 | 33
27 | 34
26 | Mortality
25 |
Impact on Compliance to Bundles

![Bar chart showing impact of NovEx on compliance to bundles. The chart compares pre-NovEx and post-NovEx compliance for 3 Hour and 6 Hour bundles.](chart.png)
NovEx Impact on Revenue

Economic Impact of NovEx

- NovEx & Staff Cost
- Reduced LOS
- Increase in Reimbursement

Economic Impact of NovEx
NovEx Impact on Mortality and Bundle Compliance in 2 Community Hospitals (200 & 400 Bed hospitals)

2014-2015

NovEx Program

- Bundle Compliance CDH
- Mortality CDH

CHS 67
NovEx Sepsis Program Impact on Revenue

ROI

<table>
<thead>
<tr>
<th>NovEx Cost</th>
<th>Improved Reimbursement After NovEx Implementation</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1,400,000</td>
</tr>
<tr>
<td>200,000</td>
<td>1,200,000</td>
</tr>
<tr>
<td>400,000</td>
<td>1,000,000</td>
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<tr>
<td>600,000</td>
<td>800,000</td>
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<td>800,000</td>
<td>600,000</td>
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<tr>
<td>1,000,000</td>
<td>400,000</td>
</tr>
<tr>
<td>1,200,000</td>
<td>200,000</td>
</tr>
<tr>
<td>1,400,000</td>
<td>0</td>
</tr>
</tbody>
</table>
Summary

- Develop a staffing system that will address sepsis

- This staff will
  - Lead all clinicians development in sepsis education
  - Directly Identify sepsis early
  - Aid in Preventing Infections
  - Ensure optimal coding
  - Ensure compliance with treatment core measure
  - Assist in Setting goals for end of life
  - Measure impact of program to ensure ROI