Adherence to Early Resuscitation Bundle for Severe Sepsis; a multi-hospital system review

Rosemarie P. Linton, MPH
Kevin D. Masick, PhD
Carol Cross, MBA
Marcella De Gennimo, MS
Anne M. Fried, RN, DNP
Yosef D. Dlugacz, PhD

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Presenter Disclosures

Rosemarie P. Linton, MPH

The following personal financial relationships with commercial interests relevant to this presentation existed during the past 12 months:

No relationships to disclose

Objectives

1. Discuss implementation of Sepsis Initiative at North Shore-LIJ Health System
   - Intervention: Institution of IHI Modified Severe Sepsis 3-Hour Resuscitation Bundle

2. Describe the development of a standardized database for evaluation of process and outcomes data

3. Share results of a 2 year observational review of compliance rates and its effects on mortality and length of stay
Patients aged 65 years and older represent 2/3 of all sepsis or septicemia discharges in the United States (1).

According to the National Center for Health Statistics, annual hospitalizations with septicemia or sepsis surpassed 1,000,000 in 2008 (1).

Aging population – in 2000 persons 65 years and older represented 12.4% of population but by 2030 elderly population is expected to grow to 19% of total population (2).

(1) National Center for Health Statistics (http://www.aoa.gov/Aging_Statistics/).
(2) Administration of Aging (www.cdc.gov/nchs/data/databriefs/db62.htm).

According to a study published in Critical Care Medicine (2001), severe sepsis incidence rates were projected to increase by 1.5% per annum.(3)

Analysis on the Nationwide Inpatient Sample (NIS) between 1993 and 2003 however, revealed that the hospitalization rate of severe sepsis outpaced the prediction (4)

Prior to 2004, in-hospital mortality rates of severe sepsis ranged between 30% - 50% (3,5)

Public Health concern


Surviving Sepsis Campaign (SSC) and Institute for Healthcare Improvement (IHI)

CEO of North Shore-LIJ Health System, Michael Dowling, prioritized sepsis mortality reduction as a performance improvement initiative

North Shore-LIJ Health System
- Health System serving 7 million people in Long Island, Queens, Manhattan, and Staten Island
- 11 hospitals: 5 tertiary / 6 community
- Over 4,200 beds
- Over 250,000 inpatient discharges per year
- Over 500,000 ED visits per year
Introduction

Sepsis / Severe Sepsis / Septic Shock

- Suspected infection accompanied by presence of 2 systemic inflammatory response syndrome (SIRS) conditions

Severe Sepsis

- Vital organ dysfunction accompanies sepsis
- The result of an excess of normal antimicrobial host defense mechanisms

Septic Shock

- Form of severe sepsis with associated hypotension (low blood pressure) despite adequate fluid resuscitation

Sepsis Initiative at Health System

Timeline

- Multidisciplinary Sepsis Task Force Initiated - Charged with deploying a uniform algorithm for early recognition and prompt resuscitation
- The result of an excess of normal antimicrobial host defense mechanisms severe sepsis with associated hypotension (low blood pressure) despite adequate fluid resuscitation

Sepsis Initiative at Health System

Highlights

- Sepsis Task Force was established in March 2009, comprised of over 30 members meeting monthly.
  - Multidisciplinary team
  - Defined sepsis/severe sepsis/septic shock and reviewed principles of Surviving Sepsis Campaign (SSC)
  - Sepsis bundles and time limits (6-hour, 24-hour) were defined (and redefined according to SSC updates)
  - Initial focus in recognizing sepsis in ED before patient admitted to critical care unit.

- By end of 2009, clinicians and the quality management team developed uniform sepsis metrics to be captured in central database.

- Database developed in early 2010, training immediately followed.

- A major milestone in August 2011 was the start of our strategic partnership with IHI that concentrated on reducing sepsis mortality.

- January 2012 - present severe sepsis 3-hour bundle elements were finalized.
Institute for Healthcare Improvement Partnership

Collaboration with IHI provided extensive education of clinicians

To quickly recognize sepsis and severe sepsis

To successfully implement the Severe Sepsis Resuscitation Bundle

Regarding the bundle, IHI trained our staff by:

- providing clinical evidence for use of bundle elements
- discussing key barriers to delivering treatment in specified time frames
- providing possible solutions to these barriers.

Recognition of Severe Sepsis/Septic Shock in Inpatients

Identification of Severe Sepsis (Time Zero):

- Probable Severe Sepsis: 2 SIRS
- Lactate ≥ 2.2 mmol/L
- OR
- Probable Severe Sepsis: 2 SIRS
- Hypotension (SBP < 90 mmHg) or MAP < 60 mmHg
- OR
- Probable Severe Sepsis: 2 SIRS
- Any other end organ dysfunction

Systemic Inflammatory Response Syndrome Criteria

- Temperature ≥ 101.0°F or Temperature ≤ 96.8°F
- Pulse ≥ 90/minute
- Respiratory rate ≥ 20/min or PaO2 < 32mmHg
- White blood count > 12,000 cells/mm³ or > 10% bands or White blood count < 4,000 cells/mm³

Identification of Severe Sepsis in ED (Time Zero): "Code Sepsis"

Probable Severe Sepsis:

- 2 Super SIRS
- Lactate ≥ 2.2 mmol/L
- OR
- New end organ dysfunction criteria met

"Super" Systemic Inflammatory Response Syndrome (SIRS) Criteria

- Temperature ≥ 101.0°F or History of Recent Fever
- Systolic Blood Pressure ≤ 90 mmHg or Mean Arterial Pressure < 60 mmHg
- Heart Rate ≥ 120 beats per minute
- Respiratory Rate ≥ 24 breaths per minute
- New unexplained altered mental status
### Severe Sepsis Resuscitation Bundle

<table>
<thead>
<tr>
<th>Process</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blood culture assessed before antibiotics administered</td>
<td>within 180 minutes</td>
</tr>
<tr>
<td>Serum lactate values obtained within 90 minutes of order time</td>
<td>within 30 minutes</td>
</tr>
<tr>
<td>Administer broad-spectrum antibiotics</td>
<td>within 180 minutes</td>
</tr>
</tbody>
</table>

### Measuring Adherence to Bundle

- Monitoring the 4 separate processes for the health system required uniform data collection of associated key metrics
- Various data systems throughout health system (Electronic Medical Record/paper)
- **Krasnoff Quality Management Institute (KQMI)**, a division of North Shore-LIJ Health System charged with developing a central database

### Standardized Database Development

- Data elements related to diagnosis and administration of the bundle were delineated by clinical members of Sepsis Task Force to **KQMI**
- Expert staff at KQMI developed a user friendly web tool with an Oracle database as a back end to capture demographics, clinical data elements, process and outcome measures
- Logic was built into the web tool to aid in accurate and clean data entry
Database allows statistical analysis

- Bundle Adherence
  - Changes from 2012 to 2013
  - Chi-square tests

- Association of Adherence with mortality, LOS
  - Z-Test for Independent Proportions
  - Independent Samples Student’s t-Test
  - Chi-Square Trend and Chi-Square Linearity
  - Logistic Regression for Adjusted Odds Ratios
Severe Sepsis Bundle Adherence Study

- Retrospective 2-year observational cohort of patients 65 years or older discharged (2012-2013) with severe sepsis or septic shock
- Elderly population - 70% of all severe sepsis cases
- Exclusions:
  - Transfer patients
  - Cases with documented goals of care at the time of Sepsis identification that precluded compliance with the treatment bundle

- N=8,059. 7,753 (96.2%) admitted via the ED
- All-or-none bundle compliance computed as binary variable for each patient with severe sepsis.

### Bundle Adherence Results

<table>
<thead>
<tr>
<th>Component of Severe Sepsis Bundle</th>
<th>2012-2013</th>
<th>2012</th>
<th>2013</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blood culture component adherence</td>
<td>90.1%</td>
<td>88.3%</td>
<td>91.3%</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Antibiotic component adherence</td>
<td>85.1%</td>
<td>81.8%</td>
<td>87.4%</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Lactate component adherence</td>
<td>84.5%</td>
<td>83.2%</td>
<td>85.3%</td>
<td>0.016</td>
</tr>
<tr>
<td>Fluid bolus component adherence</td>
<td>58.4%</td>
<td>53.8%</td>
<td>61.1%</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

### All-or-One Bundle Adherence Results

- **All-or-none compliance with severe sepsis bundle**
  - **11 Health System hospitals (N=5,405)**
    - 41.9%
    - 35.2% in 2012 and 45.7% in 2013 (p<0.001)
  - **6 Tertiary hospitals (N=3,567)**
    - 40.3%
    - 32.6% in 2012 and 44.5% in 2013 (p<0.001)
  - **6 Community hospitals (N=1,838)**
    - 44.9%
    - 39.9% in 2012 and 48.0% in 2013 (p=0.001)

Significant difference in Community and Tertiary rates, Chi-Square Difference p<0.01
**Mortality and Bundle Adherence Results**

**Primary Objective: To examine if an association existed between adherence to system’s severe sepsis bundle and mortality**

- Mortality rate for non-adherent set – 25.6%
- Mortality rate for adherent set – 22.2%
- Mortality rate reduction - 3.4% (95% CI=1.1%,5.7%)
- Difference in proportions tested with Z-test for independent proportions (p=0.00385)

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**Mortality and Bundle Components Results**

Results of five separate logistic regression models of hospital mortality each adjusted for age, weight (kg), and admission unit (Inpatient, Intermediate, Critical, or Other).

<table>
<thead>
<tr>
<th>Variable</th>
<th>Value</th>
<th>Adjusted Odds Ratio (95% confidence interval)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blood cultures before antibiotics</td>
<td></td>
<td>Non-Adherent Adherent: 0.97 (0.79, 1.21)</td>
<td>0.811</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Referent</td>
<td></td>
</tr>
<tr>
<td>Broad spectrum antibiotics within 180 minutes</td>
<td></td>
<td>Non-Adherent Adherent: 1.29 (1.10,1.52)</td>
<td>0.002</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Referent</td>
<td></td>
</tr>
<tr>
<td>Lactate result within 90 minutes</td>
<td></td>
<td>Non-Adherent Adherent: 1.18 (1.01, 1.38)</td>
<td>0.038</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Referent</td>
<td></td>
</tr>
<tr>
<td>Fluid bolus within 30 minutes</td>
<td></td>
<td>Non-Adherent Adherent: 1.02 (0.90, 1.17)</td>
<td>0.717</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Referent</td>
<td></td>
</tr>
<tr>
<td>Complete Severe Sepsis Resuscitation Bundle</td>
<td></td>
<td>Non-Adherent Adherent: 1.22 (1.06, 1.40)</td>
<td>0.007</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Referent</td>
<td></td>
</tr>
</tbody>
</table>

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**Mortality and Time to Antibiotic Administration**

Chi-Square Trend significant, no departure from linearity

- Pearson Chi-Square = 25.402, 9 df, p=0.003
- Chi-Square Trend = 11.905, 1 df, p=0.001
- Chi-Square Linearity = 13.497, 8 df, p=0.096
Secondary Objective: To examine if morbidity was improved via adherence to severe sepsis bundle, evidenced by significant reduction in length of stay

- ALOS for non-adherent set = 10.3
- ALOS for adherent set = 9.1
- ALOS reduction = 1.2 days (95% CI=0.6, 1.9)

- Difference in ALOS tested with independent samples Student’s t-test (p<0.001)

Exploratory Analysis: Mortality and Blood Cultures for Patients on Antibiotics at Sepsis Diagnosis

<table>
<thead>
<tr>
<th>Blood Culture Component of Bundle</th>
<th>Expired</th>
<th>Survived</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not received</td>
<td>49 (41.2%)</td>
<td>70 (58.8%)</td>
<td>119</td>
</tr>
<tr>
<td>Received</td>
<td>114 (26.0%)</td>
<td>324 (74.0%)</td>
<td>438</td>
</tr>
<tr>
<td>Total</td>
<td>163 (29.3%)</td>
<td>394 (70.7%)</td>
<td>557</td>
</tr>
</tbody>
</table>

- Odds ratio=1.99 (1.30, 3.04), p=0.001
- Adjusted odds ratio=1.92 (1.22, 3.02), p=0.005

Based on these findings, all patients even those with a pre-hospital administration of antibiotics should have a culture taken prior to administering antibiotics.

Limitations

- As an observational study only association between bundle completion and mortality can be assessed. Causal relationship cannot be inferred.
- Missing date/time values
- Would be best not to include patients that had clinical reasons for exclusions from analysis, and note reasons for exclusions
Conclusion

- Analysis not a pre-post intervention study but observational review of all-or-none adherence, 2012-2013
  - Intervention of clinical education of bundle ongoing process throughout cohort period
- Severe sepsis/septic shock mortality at the Health system was over 30% in 2010. In 2013, the overall in-hospital mortality rate was 22.6%
- Complete adherence associated with lower mortality and LOS
- For patients on pre-hospital administration of antibiotics, hypothesis is that they are on inappropriate antibiotic entering hospital
- While examination is underway, recommended to obtain blood cultures on all patients meeting severe sepsis criteria

Questions?

Contact: Rosemarie P. Linton, MPH
Research Statistics Analyst
RLinton2@nshs.edu
Krasnoff Quality Management Institute, a division of North Shore-LIJ Health System

Thank you!