Innovative approaches to reducing costs and improving quality in sepsis management: extraordinary ED, ICU and in-patient results.

Todd L. Allen MD
Salt Lake City, UT
March 14, 2013

Disclosures

• Former site Co-PI, the ProCESS Trial
  • www.processtrial.net
  • Registered at www.clinicaltrial.gov
    • NCT00510835
    • Actively recruiting
  • Sponsored by NIGMS
• No trade names will be used in this presentation
To Begin

- This is not about importing Intermountain
- Do these ideas translate to other systems?
- Professional values need to provide the theoretical and operational foundation
Objectives

- Discuss Intermountain’s enterprise approach to a bundle for severe sepsis and septic shock
- Establish mortality rates for patients with septic shock across a healthcare enterprise
- Demonstrate an association between sepsis bundle compliance and improved mortality and lower costs in ED patients with severe sepsis and septic shock

Clinical Integration

- Our business is clinical medicine
- You manage what you measure
- Shifts the management paradigm
  - From an administrative and financial model
  - To a clinical practice model
Clinical Integration

• 1996: Developed vision and conducted key process analysis
• 1997: Integrated management information systems
• 1998: Integrated clinical and operations management structure
• 1999: Integrated incentives
• 2000: Full roll-out and administrative integration

Organize Around Patient Care

• Our business is clinical medicine
• Understand the KEY PROCESSES (Baldrige approach)
  • Clinical programs
  • Clinical support services
  • Patient service (PPQ and HCAHPS)
  • Administrative support services
Clinical Integration Criteria

- Number of patients affected
- Risk to the patient
  - Intensity of care = cost per case
- Variation in clinical practice
- Fit with clinical work groups
- Equity
- Balance
Managing Clinical Knowledge

• Initial development phase
  • Generate initial EBM best-practice guideline (flowchart)
  • Blend the guideline into clinical workflow
  • Design outcomes tracking reports
  • Design and coordinate decision support
  • Design professional and patient education materials

• Maintenance phase
  • Keep the CPM current
  • Academic detail comes from front-line teams
  • Review on schedule

Measurement and Deployment of the Intermountain Sepsis Bundle

• Title: Development, deployment and integration of a sepsis bundle for the Intensive Medicine Clinical Program of Intermountain Healthcare
• Project leaders: Terry C. Clemmer MD, Nancy Nelson RN, and Todd L. Allen MD
• Start date: July 2004 to present
International Background

- Of the 750,000 Americans that severe sepsis and septic shock strike every year, about 215,000 die. Cost estimates reach almost $17 billion. In spite of aggressive research and technology development, mortality in septic shock decreased only slightly between 1970 and the late 1990s. It remains the most frequent cause of death in the non-cardiac intensive care unit — and the 11th leading cause of death overall.

Sepsis in the ER

- 114 million adult ED visits per year
- 571,000 for suspected severe sepsis
- 20.6% of these to a low volume ED
- 53.5% of these to hospitals without medical school affiliations
- Patient spent about 5 hours in the ED

Mortality in Severe Sepsis

Surviving Sepsis

- In the past 10 years, several specific strategies for managing sepsis and its sequellae have proven their ability to decrease the risk of death. These therapies include improved screening for sepsis, early goal-directed therapy, intensive insulin therapy, and protective ventilation, among others. These therapies appear to yield greater benefits than even thrombolytics in acute myocardial infarction.
Early Goal Directed Therapy

• Landmark study in 2001
• Protocol carried out over 6 hours
• Specific screening protocol
• Maximize CVP
• Maximize MAP
• Maximize O2 delivery

Rivers E. NEJM 2001; 345:1368-77

Intermountain Background

• Key process analysis
  • Number of patients affected
  • The health risk to patients (intensity of care, cost)
  • Internal variability (c, of intensity of care)
  • Amenable to clinical workgroups (microsystems)
  • Equity and balance
• Founding of Intensive Medicine Clinical Program
  • Critical care development team
  • Emergency medicine development team
## Screening for Sepsis in the ER

- Suspected infection
- Two of four SIRS criteria
  - Temp $> 38^\circ C$ or $< 35.5^\circ C$
  - RR $> 20$ or PaCO$_2 < 32$
  - HR $> 90$
  - WBC $> 12$ or $< 4$ or $> 10\%$ band forms
- Sepsis = infection + SIRS criteria
- Severe sepsis = sepsis + organ dysfunction
- Septic shock = sepsis + hypotension after fluids

## Background

- Since the landmark Rivers “Early Goal Directed Therapy” study many large studies have demonstrated that EGDT significantly reduces mortality.
- Surviving Sepsis Campaign in 2002
- Adopted as an Intermountain Board Goal in late 2003
In truth, there was no identifiable and institutionalized method for screening patients with possible sepsis in the ED in 2007. We could only use specific markers as surrogates that screening may have taken place:

- Lactate measurement, blood cultures done, antibiotics given, and fluid resuscitation
Sepsis Screening P-Chart

Sepsis Screening Rate in the ED

Quarter and Year

Sepsis Screening Rate in the ED

Intermountain Healthcare 2007

Sepsis Bundle Compliance
ER and ICU Bundle
LDS

% Compliance

http://ihcweb-dev.co.ihc.com/enterprise/clinical_programs/int_med/ed/reporting/testme.html
Team Structure

• Team leader: Todd L. Allen MD
• Facilitator: Nancy Nelson RN
• Sponsor: Intensive Medicine Clinical Program, Brent Wallace MD, Nancy Nowak NR (CMO and CNO)
• Team members: Anne Marie Bickmore RN, Alan H. Morris MD, Peter Haug MD, Jeffrey Ferraro, Terry Clemmer MD, Ryan Black, Ben Briggs, Lisa Bagley RN

Aim Statement

• Aim statement: To lower the mortality rate of ED patients who present with severe sepsis and septic shock who require admission to the ICU of any Intermountain hospital by improving compliance with the 11-point “sepsis bundle” to $\geq 80\%$ during 2008 and 2009.
Project Structure

- Inclusion criteria: Patients > 18 with a final diagnosis of severe sepsis or septic shock who presented to the ER and were admitted to the ICU
- Exclusion criteria: Transferred patients, patients admitted to the floor
- Outcome measures: Cost, Quality, Service

Sepsis Key Process Analysis and Data

- How did we go about using data to identify key processes?
- How was the data selected?
  - Align with workflow
  - Align with key medical interventions
- How was the data used?
Workflow Analysis

Data Analysis
Evidence Based CPM Development

• How was the first draft of the CPM developed?
• How was it maintained and modified?
• How is its success (or failure) measured/monitored?
• Dashboard development

The Intermountain Bundle 2010

• Resuscitation Bundle
  • Serum lactate
  • Blood cultures
  • Broad-spectrum antibiotics
  • Fluid resuscitation
  • Vasopressors
  • CVP and CvO2 measurement
  • Inotropes and/or PRBCs

• Maintenance Bundle
  • Steroids
  • Glucose control
  • rAPC use in eligible patients
  • Lung protective ventilator strategy
Dashboard Development

Sepsis Bundle System
13 Nov 2008

Tests of Change

Severe Sepsis Screening Tool

1. Is the patient’s history suggestive of a new infection? ___ Yes ____ No
   □ Fever
   □ Chills
   □ sweats
   □ New onset or change in heart rate
   □ New onset or change in respiratory rate

2. Are any of the following signs or symptoms of infection present? ___ Yes ____ No
   □ Hypertension > 90 mm Hg
   □ Tachycardia > 100 bpm
   □ Hypotension requiring 20mL/kg/h of crystalloid or 30mL/kg/h of colloid

If the answer is “Yes” to both question 1 and 2, Suspicion of Infection is Present.

3. Are any of the following organ dysfunction criteria present at a site remote from the
   site of the infection that are not considered to be septic conditions? ___ Yes ____ No
   □ Acute renal failure
   □ SIRS or diffuse end-organ dysfunction
   □ SpO2 < 90% on room air or supplemental O2
   □ Creatinine > 2 mg/dL or serum lactate > 4 mg/dL
   □ INR > 1.5
   □ Platelet count < 100,000
   □ Lactate > 2 mEq/L

If Suspicion of Infection is Present and there is any Organ Dysfunction present patient
   meets the criteria for SCARE-2 and should be enrolled into the Sepsis Bundle pathway.

Patient Name: ____________________________
Date of ED Admission: ______/____/____
Time of ED Adm: ______ AM or PM
Antimicrobial:

Antiphlogistic:

Antimicrobial: ____________________________

Antiphlogistic: ____________________________
Outcomes

- Quality improvement is the science of process management
- Process improvement results in parallel outcomes
  - Clinical outcomes (physical outcomes)
  - Cost outcomes
  - Service outcomes

Successes: Compliance

Sepsis Bundle Compliance (4 elements removed as of 2010 Q4)
ER and ICU Bundle System

% Compliance

<table>
<thead>
<tr>
<th>Year</th>
<th>Q1</th>
<th>Q2</th>
<th>Q3</th>
<th>Q4</th>
<th>Q1</th>
<th>Q2</th>
<th>Q3</th>
<th>Q4</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>76</td>
<td>79</td>
<td>78</td>
<td>80</td>
<td>81</td>
<td>82</td>
<td>83</td>
<td>85</td>
</tr>
<tr>
<td>2009</td>
<td>80</td>
<td>81</td>
<td>82</td>
<td>83</td>
<td>84</td>
<td>85</td>
<td>86</td>
<td>88</td>
</tr>
<tr>
<td>2010</td>
<td>88</td>
<td>89</td>
<td>90</td>
<td>91</td>
<td>92</td>
<td>93</td>
<td>94</td>
<td>95</td>
</tr>
<tr>
<td>2011</td>
<td>96</td>
<td>97</td>
<td>98</td>
<td>99</td>
<td>100</td>
<td>101</td>
<td>102</td>
<td>103</td>
</tr>
</tbody>
</table>

Legend:
- Black: System
- Blue: ER
- Red: ICU

Legend:
- FTE (%): 76, 79, 78, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91
- ICU (%): 58, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73
- All (%): 45, 55, 65, 75, 85, 95, 105, 115, 125, 135, 145, 155, 165, 175, 185

Legend:
- Total: 216, 198, 180, 162, 144, 126, 108, 90, 72, 54, 36, 18, 0

Confidential: Report for Improvement of Hospital, Facility and Patient Care—Not Part of Medical Record and Not to be Used in Litigation—Prepared Pursuant to Utah Code Ann. § 66-25-1 et seq., and Idaho Code Ann. § 19-1362 et seq.

Copyright © Intermountain Healthcare

Data Source: Enterprise Data Warehouse
### Apache II Scores

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Mortality %</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004-2005</td>
<td>20.22</td>
<td>7.26</td>
<td>18.0</td>
</tr>
<tr>
<td>2006-2007</td>
<td>21.53</td>
<td>7.35</td>
<td>17.8</td>
</tr>
<tr>
<td>2008-2010</td>
<td>21.44</td>
<td>7.72</td>
<td>10.3</td>
</tr>
</tbody>
</table>

### Successes: Mortality

![Mortality Rate graph]

Source: Enterprise Data Warehouse

**Mortality Rate**
Sepsis Patients - ER to ICU Transfers Only

Legend:
- **Blue Line**: System
- **Shaded Area**: 95% Confidence Interval

<table>
<thead>
<tr>
<th>Year</th>
<th>Proportion</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>0.12</td>
</tr>
<tr>
<td>2008</td>
<td>0.13</td>
</tr>
<tr>
<td>2009</td>
<td>0.11</td>
</tr>
<tr>
<td>2010</td>
<td>0.09</td>
</tr>
<tr>
<td>2011</td>
<td>0.08</td>
</tr>
<tr>
<td>2012</td>
<td>0.07</td>
</tr>
</tbody>
</table>
Successes: Mortality

<table>
<thead>
<tr>
<th>Year Range</th>
<th>N</th>
<th>Mortality (%)</th>
<th>Hazard Ratio (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004-2005</td>
<td>234</td>
<td>18.0</td>
<td>-</td>
</tr>
<tr>
<td>2006-2007</td>
<td>224</td>
<td>17.8</td>
<td>1.09 (0.70, 1.68)</td>
</tr>
<tr>
<td>2008-2010</td>
<td>564</td>
<td>10.3</td>
<td>0.58 (0.38, 0.87)</td>
</tr>
</tbody>
</table>
Procedural Costing Overview

• Process of assigning costs, both direct and indirect, to each procedure within a hospital
• Costs are determined at the charge code level
• Costs must be fully allocated to the procedures that generate those costs
• Each hospital is unique and will therefore have a unique costing structure

Reasons for Procedural Costing

• Cost per Case information
  • Able to compare costs to reimbursement, and to different cases
  • Allows us to know the cost of each case
• Pricing procedures
  • Allows for more accurate decisions in setting prices
• Comparing
  • Compare costs of providing services between facilities and over time
Reasons for Procedural Costing

- **Contracting**
  - Necessary for effective HMO/PPO contracting
- **Business Analysis**
  - Help calculate incremental cost of adding or abandoning services
- **Understanding Costs**
  - Provides managers with a better understanding of their departmental processes

**COSTING SYSTEM LINKS**

- Budget System
- General Ledger
- Chargemaster
- Revenues/Stats
- A/R Transactions
- Casemix
- Fixed/Variable Actual Costs
- Procedural Costing System
Cost Per Case

• Knowing the cost of procedure codes (charge codes) allows the calculation of Cost per Case
• How is Cost per Case calculated?
  • Sum procedure costs
  • Group by facility, time, and sub-process (payer, APRDRG, etc.)

Cost Per Case

• Why calculate Cost per Case?
  • Another measure of productivity
  • Board goal
  • To calculate an average cost and charge per inpatient case to compare hospital services across time or across Intermountain Healthcare.
Results: Length of Stay

Median Length of Stay (Hours)
(For AVH, LDS, IMC Patients - Excluding Deaths)

Note: All ED to ICU admits excludes sepsis patients
Results: Cost of Care

Median Total Cost per Patient ($)
(AVH, LDS, IMC Patients - Excluding Deaths)

<table>
<thead>
<tr>
<th></th>
<th>Sepsis Compliant</th>
<th>Sepsis Non-Compliant</th>
<th>ALL ED to ICU Admits</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>$15,119</td>
<td>$18,087</td>
<td>$10,059</td>
</tr>
<tr>
<td>2009</td>
<td>$14,003</td>
<td>$16,356</td>
<td>$10,488</td>
</tr>
<tr>
<td>2010</td>
<td>$15,007</td>
<td>$17,646</td>
<td>$11,437</td>
</tr>
</tbody>
</table>

AVH, LDS, IMC Observations (Excludes Patients Who Expired)

<table>
<thead>
<tr>
<th></th>
<th>Sepsis Compliant</th>
<th>Sepsis Non-Compliant</th>
<th>ALL ED to ICU Admits</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>120</td>
<td>161</td>
<td>2,529</td>
</tr>
<tr>
<td>2009</td>
<td>233</td>
<td>147</td>
<td>2,652</td>
</tr>
<tr>
<td>2010</td>
<td>233</td>
<td>108</td>
<td>2,762</td>
</tr>
<tr>
<td>Total</td>
<td>586</td>
<td>416</td>
<td>7,957</td>
</tr>
</tbody>
</table>

Median ICU Costs

Median ICU Cost per Patient ($)
(AVH, LDS, IMC Patients - Excluding Deaths)

<table>
<thead>
<tr>
<th></th>
<th>Sepsis Compliant</th>
<th>Sepsis Non-Compliant</th>
<th>ALL ED to ICU Admits</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>$3,519</td>
<td>$5,000</td>
<td>$2,746</td>
</tr>
<tr>
<td>2009</td>
<td>$3,972</td>
<td>$5,096</td>
<td>$2,943</td>
</tr>
<tr>
<td>2010</td>
<td>$4,323</td>
<td>$5,648</td>
<td>$3,247</td>
</tr>
</tbody>
</table>

AVH, LDS, IMC Observations (Excludes Patients Who Expired)

<table>
<thead>
<tr>
<th></th>
<th>Sepsis Compliant</th>
<th>Sepsis Non-Compliant</th>
<th>ALL ED to ICU Admits</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>120</td>
<td>161</td>
<td>2,529</td>
</tr>
<tr>
<td>2009</td>
<td>233</td>
<td>147</td>
<td>2,652</td>
</tr>
<tr>
<td>2010</td>
<td>233</td>
<td>108</td>
<td>2,762</td>
</tr>
<tr>
<td>Total</td>
<td>586</td>
<td>416</td>
<td>7,957</td>
</tr>
</tbody>
</table>
### Lives Saved

<table>
<thead>
<tr>
<th>Year</th>
<th>Number System</th>
<th>Observed Mortality Rate</th>
<th>Lives Saved versus baseline mortality 20%</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>764</td>
<td>12.9</td>
<td>54.2</td>
</tr>
<tr>
<td>2009</td>
<td>940</td>
<td>8.85</td>
<td>104.8</td>
</tr>
<tr>
<td>2010</td>
<td>974</td>
<td>8.86</td>
<td>108.5</td>
</tr>
<tr>
<td>2011</td>
<td>865</td>
<td>9.02</td>
<td>95</td>
</tr>
<tr>
<td>Totals</td>
<td><strong>3543</strong></td>
<td></td>
<td><strong>362</strong></td>
</tr>
</tbody>
</table>

### Challenges and Opportunities

- To succeed with complex care processes you must start and end with the front line clinician
- Real time data, delivered in real time to the clinician is also key
- Screening is hard, we were fortunate to have the resources to develop tools to assist with screening
- Constant nagging reminders are important
Central Leadership (Not Management)

• Administration (Board Goal)
• Intensive Medicine Clinical Program
• Regions with leadership and unique approaches
• Clinical collaboration: nurses, doctors, phlebotomists, laboratory, ICU, ER etc.
• Re-iteration (PDSA) at the front line

4 Step Plan for Sepsis at Intermountain

• Step 1: Identify Severe Sepsis as an Institutional Priority
• Step 2: Implement Early Detection Screening Procedures
• Step 3: Implement Aggressive Treatment Policies/Standards
• Step 4: Track, Evaluate, and Report Outcomes
Next Steps

**PLAN**
- Develop criteria
- Educate
- Implement

**DO**
- Develop action steps to optimize care
- Assess consistency of implementation
- What changes can we make to improve?

**ACT**
- What are we trying to accomplish?
- Identify outcomes and set acceptable ranges of significance

**STUDY**
- Process & Outcome Measures

The 5 Axioms of Intermountain Healthcare

- Most treatments for a specific condition have similar characteristics
- There is still massive variation in clinician’s practices
- All have something to learn and something to teach
- Clinicians will lead most changes themselves
- Clinical integration is our strategic plan
The Principles Of Shared Baselines

• Select a high priority care process
• Generate an evidence-based best practice guideline
• Blend the guideline into the flow of clinical work
• Use the guideline as a shared baseline with clinicians free to vary based on individual patient needs
• Measure, learn from and (over time)
  • Eliminate variation arising from the professional
  • Retain variation arising from patients

The IOM on the Quality Chasm

“Between the healthcare we have and the care we could have lies not just a gap, but a chasm.”

“Health care does not yet reliably transfer best-known science into practice, and processes frequently fail, despite the best intentions of a dedicated and highly skilled workforce.”

According to the IOM, there exists a “chasm” between scientific practice and implementing evidence-based medicine at the bedside.
And So We Begin Again

"I am sorry for you, young men (and women) of this generation. You will do great things. You will have great victories, and standing on our shoulders, you will see far, but you can never have our sensations. To have lived through a revolution, to have seen a new birth of science, a new dispensation of health, reorganized medical schools, remodeled hospitals, a new outlook for humanity, is not given to every generation."


SSC Guidelines 2012

- Complete in 3 hours
  - 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

- Complete in 6 hours
  - Apply vasopressors if eligible to maintain MAP ≥ 65 mmHg
  - Measure CVP and SCv02 if eligible
  - Re-measure lactate if initial lactate was elevated

Dellinger RP et al. SSC International Guidelines 2012. CCM 2013; Feb 41: 580
Shared Accountability

• Better care for the patient, better health for the population – at the lowest necessary cost
• All are accountable: clinicians, staff, administration, patients
• Our job is to make it easy to do the right thing
  • Systems, teams, tools, data

Discussion

• Difficulty transitioning research protocols into routine clinical care
  • Not due to lack of interest/value
  • Time, resources, training, collaboration
• Generally medicine gets it right < 50% of the time
• Not being bad does not mean you are good
• QI processes are tough
Discussion 2

- To succeed with complex care processes you must start and end with the front line clinician
- Real time data, delivered in real time to the clinician is also key
- Screening is hard, we were fortunate to have the resources to develop tools to assist with screening
- Constant nagging reminders are important

Team Based Care

- Intensive Medicine Clinical Program
- Regions with leadership and unique approaches
- Clinical collaboration: nurses, doctors, phlebotomy, laboratory, ICU, ER etc
- Administration (Board Goal)
- Re-iteration (PDSA)
Questions and Discussion