Regionalized Critical Care in the United States

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DISCLOSURE

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Disclosures

• No financial conflicts of interest
• NIH NHLBI K12-HL109068
Objectives

- Understand the rationale for regionalized critical care
- Understand the mechanism of action for regionalized critical care
- List the core components of a regionalized care system
Overview

• Critical Care in the United States: 1980s-today
• Rationale for Regionalized Critical Care
• The IOM, ACA, NQF and Regionalized Critical Care
Question 1

Intensive care is regionalized in the United States.

1) True

2) False
Intensive care is regionalized in the United States.

A. True
B. False
Critical Care is Enormously Expensive

- $81.7 billion annually
- 13.4% of hospital costs
- 4.1% of national health expenditures
- 0.66% of the gross domestic product

Halpern, CCM (2009)
Critical Care Grew: 1985-2000

<table>
<thead>
<tr>
<th>Year</th>
<th>Hospital Beds</th>
<th>ICU Beds</th>
</tr>
</thead>
<tbody>
<tr>
<td>1985</td>
<td>890,000</td>
<td>69,000</td>
</tr>
<tr>
<td>2000</td>
<td>654,000</td>
<td>87,000</td>
</tr>
</tbody>
</table>

-26% decrease in Hospital Beds from 1985 to 2000
+26% increase in ICU Beds from 1985 to 2000

Halpern, CCM (2004)
Critical Care is Still Growing

Gooch (in preparation)
Wide Variation in ICU Use
Variation in ICU Admission for Patients with Heart Failure

Safavi, Circulation (2013)
Variation in ICU Admission for Patients with Diabetic Ketoacidosis

![Bar chart showing variation in ICU admission for patients with diabetic ketoacidosis.](Image)

Gershengorn, CCM (2012)
Variation in ICU Admission for Patients with AMI, Pneumonia, CHF or Colorectal Surgery

Seymour, HSR (2012)
Variation in ICU Admission for Patients with Low-Risk Conditions

Chen, Arch Intern Med (2012)
Wide Variation in ICU Outcome
There is Inter-Hospital Variation in Outcome after Mechanical Ventilation

Kahn, NEJM (2006)

<table>
<thead>
<tr>
<th>Quartile</th>
<th>Hospital Mortality</th>
<th>ICU Mortality</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>34.2</td>
<td>21.2</td>
</tr>
<tr>
<td>2</td>
<td>30.8</td>
<td>16.8</td>
</tr>
<tr>
<td>3</td>
<td>27.3</td>
<td>15.3</td>
</tr>
<tr>
<td>4</td>
<td>25.5</td>
<td>14.5</td>
</tr>
</tbody>
</table>

Kahn, NEJM (2006)
There is Inter-Hospital Variation in Outcome after Acute Upper GI Bleed

- 2004 National Inpatient Sample
- 80,745 admissions coded for upper GI bleed
- Adjustment for age, comorbidity and associated complications
- Patients treated in high-volume hospitals had lower mortality than low-volume hospitals: OR 0.85; (0.74-0.98)

Ananthakrishnan, Gastro Endoscopy (2009)
There is Inter-Hospital Variation in Outcome after AMI, CHF & Pneumonia

Ross, NEJM (2010)
The recent increases in critical care fellowship applications suggest that ICU physician supply will meet demand:

1) In 3-5 years
2) In 6-10 years
3) In 10-15 years
4) In your dreams
The recent increases in critical care fellowship applications suggest that ICU physician supply will meet demand:

1. In 3-5 years
2. In 6-10 years
3. In 10-15 years
4. In your dreams
Intensivist Supply Will Not Meet Demand
The Supply of Intensivists Will Not Meet Forecasted Demand

- In 1997, intensivists provided care to 38% of ICU patients
- Predicted shortfall of specialist hours to 22% of demand by 2020

Angus, JAMA (2000)
Critical Care in the US: 1980s-today

• Intensive care is expensive
• Intensive care is growing
• There is substantial variation in ICU use
• There is concerning variation in outcomes after critical illness
• The supply of intensivist physicians will not meet the forecasted demand
Intensive care is expensive

Intensive care is growing

There is substantial variation in ICU use

There is concerning variation in outcomes after critical illness

The supply of intensivist physicians will not meet the forecasted demand
Question 3

The mechanism(s) of action for regionalized critical care is/are:

1) Improved critical care quality
2) Improved critical care efficiency
3) Both
4) Neither
The mechanism(s) of action for regionalized critical care is/are:

1. Improved critical care quality
2. Improved critical care efficiency
3. Both
4. Neither

Bar graph showing:
- 0% for option 1
- 6% for option 2
- 86% for option 3
- 8% for option 4
Regionalized Critical Care

• System-level approach to health care delivery

• High-risk patients are directed to specialty referral centers

• Telemedicine, outreach, audit & feedback are implemented to simultaneously improve health care quality at referring hospitals

• Interest in this approach to health care delivery comes from observed *volume-outcome relationships* and *economies of scope & scale*
Underpinnings of Regionalized Critical Care

1. Anticipated *improved quality* through the volume-outcome relationship

2. Anticipated *improved efficiency* through economies of scale and scope
Volume-Outcome
Volume-Outcome Relationship

- Patients treated in high-volume facilities have improved outcomes
- Patients treated by high-volume providers have improved outcomes
Practice Makes Perfect

- Superb performance is associated with intensive practice
- Experts are made, not born
- “10,000-hour rule”

Bloom, *Developing Talent in Young People* (1985)
Selective Referral

- ICU Volume
- Outcome

• Patients and physicians will select high performing ICUs
• Intended effect of public outcome reporting
• Intended effect of hospital marketing
Volume-Outcome: High Risk Surgery

- 12 surgical procedures
- 1,498 hospitals
- 842,622 patients
- Mortality significantly lower among hospitals that performed more procedures

Luft, NEJM (1979)
High Risk Surgery: 1980s - today

- Volume outcome relationship repeatedly demonstrated for cancer surgery and selected cardiovascular procedures

- Insurers increasingly advocate for minimum volume thresholds for high risk procedures

- Operative mortality between 1999 and 2008 falls substantially, in the setting of increased market concentration and hospital volume

- Not “regionalized” strictly speaking, but highly concentrated care with improved outcome and reduced cost

Birkmeyer, JAMA (2003)
Birkmeyer, NEJM (2002)
Finks, NEJM (2011)
Volume-Outcome: Trauma Care

- 22 level 1 and 2 trauma centers
- Strong association between trauma center volume and outcome

Nathens, JAMA (2001)
Regionalized Trauma Care

- 1973 EMS Act
- 1990 Trauma Systems Development Act
- In-hospital mortality: 7.6 vs. 9.5%
- One-year mortality: 10.4 vs. 13.9%
- Benefit confined to most severely injured patients

Volume-Outcome: Acute Stroke

- 26,676 patients with ischemic stroke admitted to 606 hospitals
- High annual stroke volume associated with lower stroke mortality

Saposnik, Neurology (2007)
Regionalized Stroke Care

• Joint Commission initiative in September 2012

• 34 Comprehensive Stroke Centers

• Collect data for 8 core stroke measures and submit monthly quality data
Volume-Outcome: Mechanical Ventilation

Odds Ratio for Death

Hospital Mechanical Ventilation Volume

Kahn, NEJM (2006)
ICU Economics
Characteristics of Intensive Care

- High fixed costs
- Variable demand
Question 4

Economies of scope describe:

1) Cost advantages derived from size or throughput
2) Cost advantages derived from joint production of two different products
3) Both
4) Neither
Economies of scope describe:

1. Cost advantages derived from size or throughput
2. Cost advantages derived from joint production of two different products
3. Both
4. Neither
Economies of Scale

Economies of scale are cost advantages derived from size or throughput.
Economies of scope occur whenever it is possible to jointly manage two or more medical conditions at lower cost than if managed separately.
Economics of Regionalized Critical Care

- Regionalized care can distribute high fixed costs over more ICU patients
- Regionalized ICU care can harness economies of scope, further reducing cost of care
- Regional centers can more efficiently respond to variable demand through operative scheduling
Budget Constraint Model

Pounds of Everything Else

Pounds of Critical Care

Regionalized critical care
Regionalized Critical Care

1. The volume-outcome relationship for mechanical ventilation predicts improved quality at high volume centers.

2. Economies of scope and scale at high volume centers should translate into more efficient delivery and cost savings.

Maybe we need a randomized controlled trial of regionalized critical care?

We have one already.
Described as an RCT for ECMO
180 patients randomized to ECMO-center management or conventional management
Actually an RCT for referral center care
25% (22/90) patients randomized to ECMO-center care did not receive ECMO
Efficacy and economic assessment of conventional ventilatory support versus extracorporeal membrane oxygenation for severe adult respiratory failure (CESAR): a multicentre randomised controlled trial

- 6-month survival was 63% in referral vs. 47% in non-referral centers
- Number needed to treat = 6

Peek, Lancet (2009)
Regionalized Critical Care

- Explicit, top-down policy approaches are one way to achieve regionalized care.

- However, a top-down approach may not be necessary if high-risk patients are already receiving care in high-volume hospitals.
Do We Already Have Regionalized Critical Care?

• Are high-risk patients are already being treated in high-volume hospitals?

• 228,838 medical admissions with procedure codes for mechanical ventilation

• 46% of patient treated at low volume hospitals

• 26% of patients treated at low volume hospitals could have traveled a shorter distance to receive care in a high volume center

Kahn, AJRCCM (2008)
Do We Already Have Regionalized Critical Care?

- Are high-risk patients getting transferred to referral centers?
- 71,366 patients with AMI admitted to hospitals without PCI capability
- 44% of patients were transferred to other hospitals

Iwashyna, Circulation Outcomes (2010)
• Only 13% of transfers were to the best hospital in a 100 mile radius

• 39% of transfer bypassed a higher quality hospital en route to their destination

We are not transferring patients to the best hospitals

Iwashyna, Circulation Outcomes (2010)
Institute of Medicine Report

- Called for a “coordinated, regionalized, accountable system”
- Highlighted the fragmented nature of current emergency care delivery

National Academy of Sciences, Hospital-Based Emergency Care: At the Breaking Point (2006)
The Affordable Care Act

• Title III (Delivery System Reform) of the ACA calls for:
  – Value-based purchasing, linking payment to quality
  – Strengthened quality infrastructure, with a national strategy to improve health care delivery
  – Increase access to coordinated care
  – Best practices to improve the quality, safety and efficiency of health care delivery
Critical Care Regionalization is a Regional Contract

① High-risk patients will be managed in high performing regional centers

② ICU telemedicine will extend specialist expertise to areas where interhospital transfer is not practical

③ ICU telemedicine will provide a safety net for unplanned critical illness in hospitals that have downscaled their critical care capacity

④ Audit and feedback will be implemented comprehensively within the network of regional hospitals to provide continuous quality improvement
• ICU mortality dropped from 10.7 to 8.6% after ICU telemedicine adoption

Lilly, JAMA (2011)
Adoption of ICU Telemedicine

- Substantial ICU telemedicine adoption between 2003 and 2010
- Adoption slowing in recent years
- Further evaluation is important to target the best use of this technology

Kahn, CCM (2014)
Audit & Feedback in the NHS

• Negative study for volume-outcome relationship in severe sepsis
• Positive study that volume-outcome relationship can be overcome with best practices, audit & feedback and coordinated care

Shahin, BMJ (2012)
Important Questions

• What is the impact of regionalized critical care on referring ICUs?
• What do patients think about regionalized ICU care?
• How do we determine where the regions are?
Impact on Referring ICUs

- Regionalized ICU care will reduce ICU volumes at many hospitals
- Reducing ICU volumes may impact quality for the patients who continue to receive care at these hospitals
- Reducing ICU volumes may have economic impacts on hospitals that use mixed medical-surgical ICUs for post-operative care
- Reducing ICU volumes may affect medical education for house-staff in training at those sites
100 patients at a Veterans Affairs Medical Center
45/100 preferred surgery at a local hospital, even when operative mortality was twice the referral center (3% vs. 6%)

Finlayson, Medical Care (1999)
Where are the Regions in Regionalized Critical Care?

**States**
- Geopolitical boundaries
- Clear fiscal levers

**Dartmouth Atlas**
- Geosocial boundaries
- Show where people live and get health care
## Why are Accurate Regions Important?

**Evaluation**
- Quality
- Efficiency
- Access
- Accessibility
- Capacity

**Organization**
- Foundation of regionalized care
- Prehospital care
- Accountable Care Organizations (ACOs)?
• Identified major shortcomings in how regional health care geography is understood and evaluated in the United States

• Called for research to empirically define regional coalitions that take into account geography, local competition and regional demand for emergency services
• Drew specific attention to the potential for “white space” – defined as hospitals or regions that are not included in such health care coalitions, potentially leading to disparities in access to care.
Conclusions

• Critical care infrastructure continues to grow in the United States

• Hospital variation in critical care use and outcome signal opportunities to improve quality

• Accountable regionally coordinated care for high risk patients has the potential to improve outcomes and system efficiency

• The ACA, IOM and NQF will hopefully provide the necessary political will to advance regionalized critical care demonstration projects
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Geographic Access to High Capability Severe Acute Respiratory Failure Centers in the United States; PLoS ONE, April 4, 2014

Wallace, PLoS ONE (2014)
Geographic Access to High Capability Severe Acute Respiratory Failure Centers in the United States; PLoS ONE, April 4, 2014

ECMO Criteria

Mechanical Ventilation Criteria

Geographic Access
- Direct
- One-Hour Interhospital Transfer
- Two-Hour Interhospital Transfer
- None

Wallace, PLoS ONE (2014)
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