Resource differences and sepsis care

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University of Toronto

CCCF, 15 November 2011
Conflicts of interest

• none
Objectives

• Demonstrate that differential resources among countries affect sepsis care
  – Access
  – Delivery of recommended treatments
  – Complications
  – Outcomes

• Highlight some research and QI initiatives to improve sepsis care in resource-limited settings
Representative case

- 40 year old man, abdominal sepsis + shock; sick for 5d
- Bowel resection
- Fluids in OR
- Hemorrhage – PRBC x 1 available
- Ventilated in ICU
- PRBC x 2 after donors found

- Good outcome despite
  - Antibiotics and blood: variable availability
  - Only blood test: Hgb
  - Irregular supply of oxygen cylinders

Towey, Anaesthesia;62 (Suppl. 1):32–37
Challenges to comparative
Health spending around the world, 2007 *  
(share of gross domestic product, %)

Easy to measure

* Based on data updated in March 2010.

The boundaries and names shown and the designations used on this map do not imply the expression of any opinion whatsoever on the part of the World Health Organization concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. Dotted lines on maps represent approximate border lines for which there may not yet be full agreement.
Sepsis not counted in global burden data
Sepsis is more difficult...

- It is a syndrome
  - Current definition widely used, but validity and reliability under debate
- Brief prodrome and high short-term mortality
  - limits prevalent cases found in cross-sectional studies
- Incidence depends on availability and intensity of other health services
- Not well captured in administrative data in low-resource settings
- Risk adjustment models require data often not available in low-resource settings
Differential population burden of sepsis even with crude methods

- high-income countries
  - 20% of population
  - Sepsis: ~2.3 million cases/yr
  - Infection: 0.5 million deaths/yr

- low and middle-income countries
  - 80% of the population
  - Sepsis: ~15 million cases/yr (underestimate)
  - Infection: 13.3 million deaths/yr

Lancet 265:63-78; Crit Care Med 29:1303-10; Lancet 2010 Oct 09
Supported by data from specific infections

**Mortality**
- Pneumonia: 442,521
- Meningitis: 51,502
- “Other Infections”: 491,489

**DALYs lost**
- Pneumonia: 11,415,856
- Meningitis: 1,505,700
- “Other Infections”: 12,725,926

doi:10.1371/journal.pmed.0050175.g001

Resource variations – data from
A review and analysis of intensive care medicine in the least developed countries

Access among reasons for Delay in Presentation to ICU for Maternal Deaths in Nigeria

<table>
<thead>
<tr>
<th>Reason</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inability to obtain transportation in time</td>
<td>41.7%</td>
</tr>
<tr>
<td>Inability of the healthcare staff to detect an obstetric emergency early enough and refer to an appropriate center</td>
<td>33.3%</td>
</tr>
<tr>
<td>Inability of the referring hospital to perform cesarean section</td>
<td>33.3%</td>
</tr>
<tr>
<td>Fear of cesarean section</td>
<td>25%</td>
</tr>
<tr>
<td>Unwillingness of drivers to travel by night</td>
<td>25%</td>
</tr>
<tr>
<td>No money to pay for hospital costs</td>
<td>16.7%</td>
</tr>
</tbody>
</table>
A review and analysis of intensive care medicine in the least developed countries

Martin W. Dünser, MD; Inipavudu Baelani, MA; Lundeg Ganbold, MD

ICU Resources - Large Hospital in Goma, DR Congo

<table>
<thead>
<tr>
<th>ICU beds (n)</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ventilators (n)</td>
<td>0 (Ambu Bag)</td>
</tr>
<tr>
<td>Annual ICU admissions (n)</td>
<td>141</td>
</tr>
<tr>
<td>Age (yrs)</td>
<td>24.4 (range, 1–87)</td>
</tr>
<tr>
<td>Sex (% male)</td>
<td>44.6</td>
</tr>
<tr>
<td>Admission diagnoses</td>
<td>Brain trauma</td>
</tr>
<tr>
<td></td>
<td>Severe trauma</td>
</tr>
<tr>
<td></td>
<td>Military trauma</td>
</tr>
<tr>
<td></td>
<td>Severe malaria</td>
</tr>
<tr>
<td></td>
<td>Hypertensive crisis</td>
</tr>
</tbody>
</table>

| Mechanical ventilation (%) | 0–1 |
| Length of stay (days) | 7.3 (range, 1–19) |
| Mortality (%) | 7.8 |
Severe Sepsis in Two Ugandan Hospitals: a Prospective Observational Study of Management and Outcomes in a Predominantly HIV-1 Infected Population

Shevin T. Jacob¹, Christopher C. Moore², Patrick Banura³, Relana Pinkerton², David Meya⁴, Pius Opendi³, Steven J. Reynolds⁵, Nathan Kenya-Mugisha⁸, Harriet Mayanja-Kizza⁹, W. Michael Scheld², for the Promoting Resource-limited Interventions for Sepsis Management in Uganda (PRISM-U) Study Group⁵

Setting

Jacob et al, PLoS one, 2009

• Mulago
  – 1500 bed national referral hospital
  – 5-bed ICU (surgery and private)
  – 1 oxygen tank for 50-bed ED
  – Pulse oximeters ‘sparse’

• Masaka
  – 330 bed regional referral hospital
  – No ICU
  – No oxygen or oximeters for wards
Patients

- 380 patients with suspected infection
  - at least 2 SIRS signs
  - SBP <100 mmHg, mean BP 82/48 (60)
- Mean age 35, 59% female, 85% HIV+
- Admitted to medical ward
- Hospital mortality 24%
  - vs. general medical ward mortality 15%

Jacob et al, PLoS one, 2009
Processes of care: fluid

• Volume:
  – within 6h: median 500 mL (IQR 250–1000)
  – within 24 h: median 1000 mL (IQR 500–1500)

• Timing:
  – <1h: 53%
  – 1-6 h: 28%
  – >6h: 14%

Jacob et al, PLoS one, 2009
Processes of care: antibiotics

- Timing <1 h: 38%; <6 h: 61%
- 52 regimens due to variable drug availability
Resource variations – broader
Resource variation exists in HICs
e.g. ICU beds

Crit Care Med 36:2787-93
...and in LMICs

<table>
<thead>
<tr>
<th>Region</th>
<th>Number of ICUs</th>
<th>Number of ICU beds per 100 hospital beds</th>
<th>Number of ICU beds per 100,000 population</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Carribean and South America</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Colombia†</td>
<td>89</td>
<td>3.5</td>
<td>..</td>
</tr>
<tr>
<td>Trinidad and Tobago‡</td>
<td>6</td>
<td>..</td>
<td>2.1</td>
</tr>
<tr>
<td><strong>Africa</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>South Africa</td>
<td></td>
<td></td>
<td>308</td>
</tr>
<tr>
<td>Public sector</td>
<td>..</td>
<td>1.7</td>
<td>3.8</td>
</tr>
<tr>
<td>Private sector</td>
<td>..</td>
<td>8.9</td>
<td>5.1</td>
</tr>
<tr>
<td>Zambia**</td>
<td>29</td>
<td>0.2</td>
<td>..</td>
</tr>
<tr>
<td><strong>Australasia</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>China‡‡ (median, IQR)</td>
<td>..</td>
<td>1.8, 1.3–2.1</td>
<td>3.9, 2.8–4.6</td>
</tr>
<tr>
<td>Sri Lanka§§ (public sector)</td>
<td>52</td>
<td>..</td>
<td>1.6</td>
</tr>
</tbody>
</table>

Comparison: 8 to 25 ICU beds/100,000 in US/Europe (3.5 beds in UK)
Little ability to deliver SSC guidance in Africa

- Survey using convenience sample from conference (n=263)

Figure 1 Countries of practice of survey participants. Sub-Saharan African countries (n = 248) are marked in dark grey. South Africa, Mauritius and the Northern African countries (n = 15) are marked in light grey.
Less likely to have infrastructure

• Comparisons between respondents from African countries vs. HICs

• ED (86 vs. 98%)
• ICU (74 vs. 100%)
Less likely to have drugs

- Antibiotics (26-79 vs. 100%)
- Blood products (27 vs. 100%)
- Vasopressors/inotropes (29-51 vs. 100%)
  - Except for epinephrine (100%)
- Sedation/relaxants (53-80 vs. 100%)
  - Except for thiopentone, diazepam, succinylcholine

Crit Care 15:R10
Less likely to have equipment (1)

- Radiology
  - Echo, US (61-91 vs. 91-100%)
  - X-ray 91%

- Labs
  - C+S (70-75 vs. 100%)
  - ABG (44 vs. 100%)
  - Lactate (26 vs. 100%)
  - Thick smear (97 vs. 80%)

Crit Care 15:R10
Less likely to have equipment (2)

- Monitors
  - Oxygen sat (77 vs. 100%)
  - CVP monitoring (34 vs. 93%)
  - CO (12 vs. 84%)

- Therapeutic equipment
  - Ventilator (72 vs. 100%)
  - Syringe pump (54 vs. 100%)
  - Dialysis (43 vs. 98%)

- Disposables
  - Oxygen nasal prongs (82 vs. 100%)
  - Central line (49 vs. 100%)
Low ability to comply with SSC

- Very few able to implement all guidelines
  - 1.2% sub-Saharan; 6.7% other Africa
- Most grade 1 recommendations potentially implementable (81%, IQR 64-89%)
  - Early initial resuscitation
  - Fluids
  - vasopressors/ dobutamine
  - blood cultures
  - antibiotics, source control

Crit Care 15:R10
Implications?

• Focus on the SSC guideline recommendations with
  – strongest evidence base
  – least cost
somewhat fewer resource limitations in Asia

• Cohort study
  – 150 ICUs (not random sample)
  – 16 Asian countries
    • 3 low income
    • 5 middle income
    • 8 high income
  – 1295 adults with severe sepsis
  – Hospital mortality 44.5%

BMJ 342:d3245
8% adherence to resuscitation bundle
~10% adherence to management bundle
System-level factors associated with higher compliance

- High-income country
- University hospital
- Fellowship programme
- Surgical ICUs
Comparison to other cohorts

• Resuscitation bundle compliance
  – 10-14% in 4 European countries
  – 31% in SSC survey

• Management bundle compliance (includes APC)
  – 16% in Spain
  – 36% in SSC survey

Achieving simple targets may ↓ mortality

Table 7: Variables independently associated with hospital mortality on logistic regression analysis in study of Surviving Sepsis Campaign targets in patients admitted to Asian intensive care units (ICU)

<table>
<thead>
<tr>
<th>Variable*</th>
<th>Adjusted odds ratio (95% CI)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients’ characteristics:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>0.98† (0.98 to 0.99)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>APACHE II score</td>
<td>0.93‡ (0.92 to 0.95)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Location at diagnosis of severe sepsis:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ED v ward</td>
<td>0.68 (0.49 to 0.93)</td>
<td>0.01</td>
</tr>
<tr>
<td>ED v ICU</td>
<td>0.58 (0.40 to 0.83)</td>
<td>0.003</td>
</tr>
<tr>
<td>Achievement of bundle targets:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blood cultures</td>
<td>0.72 (0.54 to 0.95)</td>
<td>0.02</td>
</tr>
<tr>
<td>Broad spectrum antibiotics</td>
<td>0.76 (0.58 to 0.99)</td>
<td>0.049</td>
</tr>
<tr>
<td>CVP ≥8 mm Hg</td>
<td>0.67 (0.47 to 0.94)</td>
<td>0.02</td>
</tr>
</tbody>
</table>
ICUs with protocols more likely to meet some goals

Fig 4 | Achievement of specific bundle targets in intensive care units with and without corresponding protocols. CVP=central venous pressure; PBW=predicted body weight; ScvO\textsubscript{2}=central venous oxygen saturation; SvO\textsubscript{2}=mixed venous oxygen saturation
Implications

• Focus on the SSC guideline recommendations with
  – strongest evidence base
  – least cost
• Protocols may improve care delivery
Fewer resources lead to more
Healthcare associated infections

Figure 2: Number of studies reporting health-care-associated infection in developing countries, 1995-2008

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Healthcare-associated infection

LMIC: ↑ quality

USA

EUR

Lancet 377:228-41
How does the future look?
Urbanization – threat and opportunity

Figure 1: Evolution of urban and rural populations between 1950 and 2050²
Infectious diseases have the world’s attention (maybe sepsis can join)

<table>
<thead>
<tr>
<th>Global leadership</th>
<th>Infrastructure</th>
<th>Evidence for action</th>
<th>Health systems</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advocacy</td>
<td>Financial resources</td>
<td>Available data</td>
<td>HSS</td>
</tr>
<tr>
<td>Agenda</td>
<td>Human resources</td>
<td>Available cost-effective</td>
<td></td>
</tr>
</tbody>
</table>

- **MNCH**
  - Green = criteria are met.
  - Amber = criteria are partly met.
  - Red = criteria are unmet.

- **Infectious diseases**
  - Green = criteria are met.
  - Amber = criteria are partly met.
  - Red = criteria are unmet.

- **Chronic non-communicable diseases**

- **Global environmental changes**

- **Social determinants**

*Figure 3: Scorecard for global public health*

Green = criteria are met. Amber = criteria are partly met. Red = criteria are unmet. MNCH = maternal, neonatal, and child health. HSS = health system strengthening.

*Lancet 372:1988-96*
Can better care for sepsis be provided even if macroeconomic disparities remain static?
1. Solutions should be cost-
Cost-Effectiveness of Highly Active Antiretroviral Therapy in South Africa


<table>
<thead>
<tr>
<th>Survival Quartile</th>
<th>Group</th>
<th>Survival Time (d)</th>
<th>Scenario 2(^b)</th>
</tr>
</thead>
<tbody>
<tr>
<td>25%</td>
<td>Non-AIDS</td>
<td>HAART (1391)</td>
<td>$698 (676–701)</td>
</tr>
<tr>
<td></td>
<td>AIDS</td>
<td>HAART (739)</td>
<td>Cost-saving</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No-ART (523)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>No-ART (309)</td>
<td></td>
</tr>
<tr>
<td>Median 50%</td>
<td>Non-AIDS</td>
<td>HAART (2,641)</td>
<td>$675 (659–679)</td>
</tr>
<tr>
<td></td>
<td>AIDS</td>
<td>HAART (1,120)</td>
<td>Cost-saving</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No-ART (1,111)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>No-ART (510)</td>
<td></td>
</tr>
<tr>
<td>75%</td>
<td>Non-AIDS</td>
<td>HAART (3,891)</td>
<td>$608 (597–621)</td>
</tr>
<tr>
<td></td>
<td>AIDS</td>
<td>HAART (1,561)</td>
<td>Cost-saving</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No-ART (2,035)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>No-ART (980)</td>
<td></td>
</tr>
</tbody>
</table>
This is not the objective...
A sustainable ICU

– Trained and sufficient staff
– simple therapies + monitoring reliably delivered:
  • VS and U/O, IV fluids, blood transfusions, oxygen, pain management, +/- mechanical ventilation
2. Focus on pre-ICU care
Early supportive care may reduce complications and ITU referrals.
Triage and emergency care

- Move away from ‘first-come-first-served’ approach
- Quick identification of sickest patients
- Protocols for emergency treatments
- Nurses or clinical officers
- Some evidence for this approach in pediatrics
Management of adolescents and adults with febrile illness in resource limited areas

John A Crump *associate professor of medicine and pathology*¹²³⁴, Sandy Gove *team leader*⁵, Christopher M Parry *senior clinical consultant*⁶⁷

At district hospital level

Clinical features: Triage assessment by the nurse confirmed the patient is in shock with systolic blood pressure of 85 mm Hg.

Management: Initially in emergency section for septic shock: intravenous fluids; extended spectrum cephalosporin, or ampicillin plus gentamicin; supplemental oxygen titrated to oxygen saturation of 90% by pulse oximetry.

Laboratory investigations: Peripheral blood smear preparation and microscopy negative for malaria parasites; haemoglobin concentration 80 g/L; serum glucose concentration normal.

Further management: Clinical assessment and investigations to identify the source of infection while continuing resuscitation with close monitoring.

addition of ‘essential equipment list’ to essential medicines list?
Clinical management of adult patients with complications of pandemic influenza A (H1N1) 2009 influenza:

Emergency guidelines for the management of patients with severe respiratory distress and shock in district hospitals in limited-resource settings

Integrated Management of Adolescent and Adult Illness (IMAI)

Global Influenza Programme (GIP)

Global Alert and Response (GAR)

World Health Organization
Basic Assessment & Support in Intensive Care

The aim of the BASIC course is to teach participants to rapidly assess seriously ill patients and provide initial treatment and organ support.

For more information on the course click here.
For dates and venues of courses click here.
To register for a course click here.
To answer the pre-course MCQ (registered course participants only) click here.

Endorsements

International Pan Arab Critical Care Medicine Society
IPACCM

Asia Pacific Association of Critical Care Medicine

http://www.aic.cuhk.edu.hk/web8/BASIC.htm
3. train and keep health workers
<table>
<thead>
<tr>
<th>Dependent variables</th>
<th>Regressions without income poverty</th>
<th>Regressions with income poverty</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Maternal mortality</td>
<td>Infant mortality</td>
</tr>
<tr>
<td><strong>Independent variables</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>&lt;0.0001</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Gross national income per person</td>
<td>-0.776</td>
<td>-0.647</td>
</tr>
<tr>
<td></td>
<td>(-7.326)</td>
<td>(-9.307)</td>
</tr>
<tr>
<td></td>
<td>&lt;0.0001</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Income poverty</td>
<td>..</td>
<td>..</td>
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<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female adult literacy</td>
<td>-0.292</td>
<td>-0.245</td>
</tr>
<tr>
<td></td>
<td>(-1.351)</td>
<td>(-1.726)</td>
</tr>
<tr>
<td></td>
<td>0.1793</td>
<td>0.0872</td>
</tr>
<tr>
<td>Doctor density</td>
<td>-0.325</td>
<td>-0.183</td>
</tr>
<tr>
<td></td>
<td>(-4.450)</td>
<td>(-3.822)</td>
</tr>
<tr>
<td></td>
<td>&lt;0.0001</td>
<td>&lt;0.0002</td>
</tr>
<tr>
<td>Nurse density</td>
<td>-0.162</td>
<td>-0.062</td>
</tr>
<tr>
<td></td>
<td>(-2.034)</td>
<td>(-1.186)</td>
</tr>
<tr>
<td></td>
<td>0.0443</td>
<td>0.2380</td>
</tr>
</tbody>
</table>

| n       | 117 | 117 | 117 | 83 | 83 | 83 |
| R²      | 0.808 | 0.827 | 0.835 | 0.823 | 0.799 | 0.808 |
| F       | 117.628 | 133.807 | 141.218 | 71.695 | 61.331 | 64.855 |
| p       | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 |

All dependent and independent variables were transformed into natural logarithms for the regressions. The numbers in the cells are \( \beta \) (regression coefficient), \( t_{1} \) (t value of \( \beta \)), and \( p \) value.

**Table 3:** Multiple regression equations with doctors and nurses as separate independent variables.

*Lancet 2004; 364: 1603–9*
4. research and QI agenda
Improved oxygen systems for childhood pneumonia: a multihospital effectiveness study in Papua New Guinea

Improved triage and emergency care for children reduces inpatient mortality in a resource-constrained setting

Mortality after Fluid Bolus in African Children with Severe Infection

McLaughlin-Rotman Centre for Global Health
Inhaled Nitric Oxide for the Adjunctive Therapy of Severe Malaria: a Randomized Controlled Trial
Panel 2: Suggested schedule of research and programming priorities in sepsis in low-income and middle-income countries (LMICs)

1. Educate providers and clinicians throughout LMICs about the clinical signs, symptoms, and pathophysiology of sepsis.
2. Develop and validate sepsis management algorithms for LMICs either independently or extrapolated from established data.
3. Develop and validate cost-effective, easily used, and clinically appropriate diagnostic tests to identify ill patients and guide endpoints of resuscitation.
4. Develop clinical laboratory capacity including microbiological testing.
5. Develop regional recommendations regarding initial broad-spectrum antimicrobial coverage for patients with sepsis based on local ecology and resistance patterns.
6. Improve and augment LMIC critical-care systems and resources including referral systems and tertiary-care centres.
7. Develop systems to assure high quality, cost-effective, and affordable sepsis care.
Conclusions

• resource limitations easier to measure than sepsis epidemiology
• burden of sepsis higher in low-resource areas
• dramatic immediate improvements are unlikely…
• …but incremental progress being made
  • guidelines, protocols, and HCW training
  • Intervention studies tailored to low-resource areas
Acknowledgements

• Rob Fowler
• Gordon Rubenfeld
• Merrick Zwarenstein
• Satish Bhagwanjee
• Phil Hopewell
• Sandy Gove
• Janet Diaz
• Shevin Jacob
• Chizoba Efobi

• Homer Tien
• Andrew Beckett
• Alexandra Martiniuk
Anesthesia and Its Allied Disciplines in the Developing World: A Nationwide Survey of the Republic of Zambia


- 68/87 hospitals in Zambia

| Availability of an intensive care unit, n = 68 | 5 (7) |
| No. of ICU beds, n = 5 | 5 (4–8) |
| Physician present during 24 h, n = 5 | 1 |
| External training during last 5 yr, n = 63 | 2 |
| Availability of a contemporaray critical care textbook, n = 63 | 0 |
| Total no. of nurses per intensive care unit, n = 5 | 6 (5–17.5) |
| No. of patients treated per year, n = 5 | 160 (56–249) |
| Five most common admission diagnoses\textsuperscript{\textdagger}, n = 5 | |
| Intensive care after major surgery | 5 |
| Isolated traumatic brain injury | 4 |
| Malaria | 3 |
| Pre/eclampsia | 3 |
| Severe Trauma | 3 |
### Availability of monitoring equipment, $n = 5$
- Electrocardiogram 4
- Oscillatory noninvasive blood pressure monitor 2
- Oxygen saturation monitor 4
- Capnography/capnometry 1

### Availability of a mechanical ventilator, $n = 4$
- Oxygen Supply, $n = 5$ 5
  - Oxygen cylinders 5
  - Oxygen concentrator 2
  - Compressed gas/oxygen system 1

### Percentage of beds supplied with oxygen, $n = 5$ 50 (25–75)

### Compressed air supply, $n = 5$ 3

### Basic laboratory available during 24 h, $n = 5$ 5

### X-ray available in the intensive care unit, $n = 5$ 3

### Sonography available in the intensive care unit, $n = 5$ 1
**Fig 3** Proportion of emergency departments and intensive care units with protocols to achieve individual bundle targets. Emergency departments not surveyed for steroids, drotrecogin alfa, glucose measurements, and tidal volumes. CVP=central venous pressure; PBW=predicted body weight; \( \text{ScvO}_2 \)=central venous oxygen saturation; \( \text{SvO}_2 \)=mixed venous oxygen saturation
Absolute health spending in developed world is high

- $2 trillion US each year (16% US GDP)
- $142 billion Canada (9.5% CDN GDP)
- Critical care may cost ~0.5-1% of the GDP
Total expenditure on health per capita, 2007 *
(in US$)

The boundaries and names shown and the designations used on this map do not imply the expression of any opinion whatsoever on the part of the World Health Organization concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. Dotted lines on maps represent approximate border lines for which there may not yet be full agreement.

Data Source: National Health Accounts series, World Health Organization
Map Production: Public Health Information and Geographic Information Systems (GIS), World Health Organization

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Health Spending as a Percent of the GDP

- $2 trillion US each year (16% US GDP)
- $142 billion Canada (9.5% CDN GDP)
- Critical care may cost ~0.5-1% of the GDP
Health Spending as a Percent of the GDP

Highlights of Map

- The U.S. is the only country where healthcare accounts for more than 13 percent of the GDP, spending 16.5 percent in 2006.
- Health spending in Germany, France, Norway, Iceland and Cambodia accounts for between 10.1-13.0 percent of GDP.
- In Canada, Australia, and Sweden, health spending accounts for between 8.1-10.0 percent of GDP.
- In China, Japan, the United Kingdom, Spain and Finland spend 5.1-8.0 percent of GDP on healthcare.

International Health Spending as Percent of Gross Domestic Product

- Less Than or Equal to 3
- 3.1 - 5.0
- 5.1 - 8.0
- 8.1 - 10.0
- 10.1 - 13.0
- More Than 13
- No Data

Critical care and illness in the world’s least developed countries: a systematic

- Described “critically ill patients” / those with increased risk of near-term morbidity and mortality

- Publication originated in, or publication pertained to United Nations Defined Least Developed Countries; no restriction of publication type

Dhillon et al, ATS 2010
Critical care and illness in the world’s least developed countries: a systematic review


1635 citations

Screening of titles and abstracts

Selection of 358 manuscripts for further review (351 from Medline/Embase and 7 from African Index Medicus)

356 retrieved/reviewed and 204 publications selected for inclusion and described here

Dhillon et al, ATS 2010
<table>
<thead>
<tr>
<th>Patient/Disease Characteristics</th>
<th>N (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pediatric</td>
<td>89 (44%)</td>
</tr>
<tr>
<td>Maternal/Neonatal</td>
<td>73 (36%)</td>
</tr>
<tr>
<td>Sepsis/Infection</td>
<td>155 (76%)</td>
</tr>
<tr>
<td>Surgical</td>
<td>42 (21%)</td>
</tr>
<tr>
<td>Trauma</td>
<td>21 (10%)</td>
</tr>
<tr>
<td>Burns</td>
<td>12 (6%)</td>
</tr>
<tr>
<td>War/conflict related</td>
<td>6 (3%)</td>
</tr>
<tr>
<td>Poisonings</td>
<td>9 (4%)</td>
</tr>
<tr>
<td><strong>Systems of Care Delivery</strong></td>
<td>186 (91%)</td>
</tr>
<tr>
<td>Morale/Burnout</td>
<td>2 (1%)</td>
</tr>
<tr>
<td><strong>Access to Care</strong></td>
<td>113 (55%)</td>
</tr>
</tbody>
</table>

Dhillon et al, ATS 2010
Number of publications over time

- 2002 (20)
- 2003 (27)
- 2004 (27)
- 2005 (31)
- 2006 (39)
- 2007 (29)
- 2008 (31)
Countries of Origin

Africa (128):
- Senegal (28)
- Malawi (23)
- Uganda (20)
- Tanzania (11)
- Ethiopia (10)
- Benin (8)
- Burkina Faso (6)
- Sudan/Togo (5)

Other (69):
- Niger/Guinea/Somalia
- Mozambique (1)
- Nepal (34)
- Bangladesh (22)
- Afghanistan/Yemen (6)
- Cambodia (3)
- Laos (2)
- Haiti/Myanmar/Vanuatu (1)
<table>
<thead>
<tr>
<th></th>
<th>Avg of Top 5 Publishing Nations</th>
<th>Avg of 22 Nations with 0 Publications</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>GDP/capita</td>
<td>$565 USD</td>
<td>$2477 USD</td>
<td>0.46</td>
</tr>
<tr>
<td>Population</td>
<td>47,834,800</td>
<td>4,036,128</td>
<td>0.002</td>
</tr>
<tr>
<td>Health exp/capita</td>
<td>$86 USD</td>
<td>$144 USD</td>
<td>0.51</td>
</tr>
<tr>
<td>Life Exp M/F</td>
<td>56 yrs/59 yrs</td>
<td>55 yrs/58 yrs</td>
<td>0.84/0.84</td>
</tr>
<tr>
<td>Literacy rate</td>
<td>60%</td>
<td>69%</td>
<td>0.36</td>
</tr>
<tr>
<td>MDs/country</td>
<td>10,296</td>
<td>460</td>
<td>0.02</td>
</tr>
</tbody>
</table>
Critical care and illness in the world’s least developed countries: a systematic review

• There is limited literature describing critical illness and care from the world’s least developed countries despite a great burden of illness and high early mortality rate

• Largely Observational

• Unfunded

• Focused upon:
  • Infectious diseases
  • Illness involving children and mothers
  • Trauma and conflict

Dhillon et al, ATS 2010
International comparative
Global Burden of Disease (GBD)

Global Burden of Disease analysis provides a comprehensive and comparable assessment of mortality and loss of health due to diseases, injuries and risk factors for all regions of the world. The overall burden of disease is assessed using the disability-adjusted life year (DALY), a time-based measure that combines years of life lost due to premature mortality and years of life lost due to time lived in states of less than full health.

The WHO GBD project draws on a wide range of data sources to quantify global and regional effects of diseases, injuries and risk factors on population health. The latest assessment of GBD for 2004 is available, together with updated projections to the year 2030, and documentation of methods and data sources. Manuals, software and other resources are also provided for carrying out burden of disease studies.

NEW PUBLICATION: Global health risks

GENERAL INFORMATION
- About the Global Burden of Disease
- Data sources and methods

STATISTICS
- Disease and injury - country
- Deaths, DALYs, HALE, LE
<table>
<thead>
<tr>
<th>Region</th>
<th>Population in 2004 ($\times 10^8$)</th>
<th>Number of deaths in 2004 ($\times 10^8$)</th>
<th>Estimated potential burden of selected critical illnesses per year ($\times 10^8$)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
<td>Infection</td>
<td>Maternal conditions</td>
</tr>
<tr>
<td>High-income countries</td>
<td>949818</td>
<td>8008</td>
<td>468 (6%)</td>
</tr>
<tr>
<td>East Asia and Pacific</td>
<td>1892113</td>
<td>14000</td>
<td>1776 (13%)</td>
</tr>
<tr>
<td>Europe and central Asia</td>
<td>476096</td>
<td>5684</td>
<td>284 (5%)</td>
</tr>
<tr>
<td>Latin America and Caribbean</td>
<td>549187</td>
<td>3499</td>
<td>474 (14%)</td>
</tr>
<tr>
<td>Middle East and north Africa</td>
<td>324542</td>
<td>2114</td>
<td>299 (14%)</td>
</tr>
<tr>
<td>South Asia</td>
<td>1493430</td>
<td>13778</td>
<td>3993 (29%)</td>
</tr>
<tr>
<td>Sub-Saharan Africa</td>
<td>749269</td>
<td>11662</td>
<td>6475 (56%)</td>
</tr>
<tr>
<td>World</td>
<td>6436826</td>
<td>58772</td>
<td>13777 (23%)</td>
</tr>
</tbody>
</table>
Strategy 4: volunteering

- Usually short- to medium-term
- May be in disaster or conflict setting
- Many purposes
  - sabbatical,
  - Research
  - international public health
  - training
  - clinical experience
Strategy 5: increasing professional society involvement
WFPICCS
Role in the Care of the Critically Ill Infants and Children

Communication
- Education
- Research
- Ethics
- Liaison with other critical and intensive care societies
- Liaison with other organizations

Clinical Care
- Deployment of resources
- Advancement in pediatric critical care

Education
- Support health care personnel
- Political & Social strengths
- Administrators
- Cross fertilization of ideas
- Dissemination of knowledge
- Provide opportunities for training

Research
- Prioritizing critical care research agendas, promoting pediatric critical care related research, developing the networks of people with interests, questions and skills.

Working Groups
Sepsis
- International Pediatric Sepsis Initiative
- Ethics
- Research Ethics
- End of Life Care
- Resource allocation

Meetings/Societies
- World Congresses
- Support, advise and promote national/regional meetings
- Encourage growth & Development of regional societies

Fund Raising
- Includes funding resources for pediatric critical care. We need to bring the business, sense, skills, and ethics in funding various programs.

Figure 1. World Federation of Pediatric Intensive and Critical Care Societies' (WFPICCS) role in the care of critically ill infants and children.
Therapeutic hypothermia for birth asphyxia in low-resource settings: a pilot randomised controlled trial

- whole-body cooling with a mattress made of 3 commercially available water bottles (US$10) laid sideways in the cot
- filled with cool tap water (25–26°C with minimum diurnal or seasonal variation)
- Infants wore only a diaper
- core temperature was maintained within target range (33–34°C) by adding or removing sheets, blankets, or water bottles

Figure: Mean rectal temperature in standard care and therapeutic hypothermia groups during first 80 h after randomisation

Lancet 2008 372 801
<table>
<thead>
<tr>
<th>World Bank analytical income classification</th>
<th>No of units</th>
<th>No of enrolled patients with severe sepsis</th>
<th>% of all admissions in participating units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low income economies:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bangladesh</td>
<td>14</td>
<td>65</td>
<td>10.8</td>
</tr>
<tr>
<td>Nepal</td>
<td>2</td>
<td>62</td>
<td>53.9</td>
</tr>
<tr>
<td>Vietnam</td>
<td>3</td>
<td>49</td>
<td>10.7</td>
</tr>
<tr>
<td>Middle income economies:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>China</td>
<td>40</td>
<td>189</td>
<td>9.1</td>
</tr>
<tr>
<td>Indonesia</td>
<td>7</td>
<td>33</td>
<td>6.3</td>
</tr>
<tr>
<td>India</td>
<td>17</td>
<td>162</td>
<td>5.5</td>
</tr>
<tr>
<td>Malaysia</td>
<td>10</td>
<td>120</td>
<td>15.7</td>
</tr>
<tr>
<td>Pakistan</td>
<td>3</td>
<td>36</td>
<td>28.3</td>
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<tr>
<td>High income economies:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bahrain</td>
<td>1</td>
<td>11</td>
<td>21.2</td>
</tr>
<tr>
<td>Brunei</td>
<td>1</td>
<td>12</td>
<td>15.2</td>
</tr>
<tr>
<td>Hong Kong</td>
<td>6</td>
<td>102</td>
<td>17.5</td>
</tr>
<tr>
<td>Japan</td>
<td>1</td>
<td>3</td>
<td>8.8</td>
</tr>
<tr>
<td>Saudi Arabia</td>
<td>5</td>
<td>46</td>
<td>12.5</td>
</tr>
<tr>
<td>Singapore</td>
<td>10</td>
<td>128</td>
<td>25.2</td>
</tr>
<tr>
<td>South Korea</td>
<td>28</td>
<td>254</td>
<td>10.4</td>
</tr>
<tr>
<td>Taiwan</td>
<td>2</td>
<td>13</td>
<td>15.3</td>
</tr>
<tr>
<td>Total</td>
<td>150</td>
<td>1285</td>
<td>10.9</td>
</tr>
</tbody>
</table>
• Quality of inpatient hospital care in general needs more attention
  – Especially in district hospitals where the majority of inpatient care is delivered