Benchmark Data From More Than 240,000 Adults That Reflect the Current Practice of Critical Care in the United States

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The expanding use of critical care services and their substantial cost to society have prompted critical assessments of the diversity of practice and organization and the relation of these elements to outcomes. Unfortunately, large databases describing the range of critical care practice matched to acuity-adjusted outcomes are lacking. The evolution of the electronic record provides clinical information recorded as discrete data elements, allowing more efficient and uniform collection of clinical practice information than was possible with older medical records.

Background: Nationwide benchmarks representing current critical care practice for the range of ICUs are lacking. This information may highlight opportunities for care improvement and allows comparison of ICU practice data.

Methods: Data representing 243,553 adult admissions from 271 ICUs and 188 US nonfederal hospitals during 2008 were analyzed using the eICU Research Institute clinical practice database. Participating ICUs and hospitals varied widely regarding bed number, community size, academic status, geographic location, and organizational structure.

Results: More than one-half of these critically ill adults were <65 years old, and most patients returned to their homes after hospital discharge. Most patients were admitted from an ED, had a medical admission diagnosis, and received antimicrobial therapy. Intensive treatment was common, including 27% who received mechanical ventilation, 7.5% who were supported with noninvasive ventilation, 24.3% who were treated with vasoactive infusions, >20% who received a blood product, and 4.4% who agreed to a care limitation order during their ICU stay. Forty percent of cases had a <10% mortality risk and did not have an intensive treatment documented.

Conclusions: Admission to an ICU in 2008 involved active treatments that often included life support and counseling for those near the end of life and was associated with favorable outcomes for most patients.
Materials and Methods

ICU Data Elements

The data for this study are derived from patients contained in the eICU Research Institute (eRI) data repository who were discharged from the hospital during 2008 (Fig 1). The data concepts and elements were identical for each record. Patient admission, discharge, and demographic data; laboratory data; and medication data were received from hospital information systems through automated interfaces uniformly mapped in the eRI database. Physiologic data from bedside monitors were imported directly from gateway servers as 5-min median values into the database. Patient diagnoses and specific treatments were selected from a discrete menu mapped to International Classification of Diseases, 9th ed. terms. Observations entered by clinicians or transferred from a clinical information system were mapped to equivalent concepts in the eRI database. Consistent physiologic, laboratory, diagnosis, treatment, and physical examination elements and nursing flow sheet data were included in the electronic record for every ICU patient for the duration of his or her ICU stay.

The eRI Data System

All data were initially stored at each participating health-care system and later aggregated centrally in the eRI database. Data use and sharing were guided by business associate agreements among 32 participating programs in accord with eRI governance documents. Data from the operational database of each participating site were merged with administrative acuity (Acute Physiology and Chronic Health Evaluation [APACHE]) software sublicensed from Cerner, Inc; Kansas City, Missouri), and best practice databases to create the eRI database.

Privacy Protection

Health Insurance Portability and Accountability Act-defined personal health identifiers and free text entries were not loaded into the research database, and other potentially identifying data were transformed as previously described. The security schema for the eRI was analyzed, and reidentification risk was certified as meeting safe harbor standards by Privacert, Inc (Pittsburgh, Pennsylvania). Each electronically transferred element in the data set was screened with artifact exclusion rules to eliminate nonphysiologic and erroneous entries. The study protocol was submitted to the University of Maryland Baltimore Institutional Review Board and was deemed exempt under 45 CFR 46.101(b). Data processing and analysis were performed by the University of Maryland Baltimore Pharmaceutical Research Computing Center.

Best Practice Adherence

Explicit criteria for ICU clinical practice measures were developed using evidence-based standards and national reporting standards. The criteria for best practice for venous thromboembolism prophylaxis, stress ulcer prophylaxis, low tidal volume ventilation in ARDS or acute lung injury (ALI) (ARDS/ALI), glycemic control, and β-blocker use are described in e-Appendix 1.

Statistical Analyses

Central tendency is reported as the mean or median value with variance expressed as standard deviation, 95% CI, or interquartile range (IQR). Group comparisons for categorical data were performed with χ² tests, and continuous variables were compared with analysis of variance or analysis of variance based on ranks. Significance was set at the .05 level using two-sided distributions.

Results

Study Patient Characteristics

This study includes records from 243,553 admissions to 5,321 adult ICU beds in 271 ICUs, located in 188 hospitals, 32 health-care systems, from 31 states and Guam. Patient demographic characteristics are presented in Table 1. The age and APACHE IV acuity scores were similar among ICUs that classified themselves as medical, surgical, mixed, coronary care, and cardiovascular surgical units and were greater than for patients cared for in trauma or neuroscience units. There was considerable variability of acuity scores among the types of ICU, with an overall median APACHE IV score of 52.4 (IQR, 49.1-56.0). The ethnicity distribution was similar to the US Census for the year 2000. The most common primary admission diagnosis was myocardial infarction, followed by respiratory failure; seven of the eight most frequent diagnoses were related to cardiovascular disease (Table 2). The most common admission source for adult critically ill patients was the ED (45.2% of cases), followed by another hospital inpatient location (16.5%), an operating room (16.4%), an outpatient location including home (6.5%), another ICU (4.1%), a recovery room (3.8%), another hospital (3.7%), a step-down unit (1.5%), and a chest pain center (0.7%). Postoperative patients represented 20.3% of all cases, and 10.2% of operative cases were for an emergency procedure.

ICU Organizational and Institutional Characteristics

The ICU locations were geographically dispersed, with 46% of ICUs in the Midwest, 22% in the Southwest, 18% in the Southeast, 12% in the Northeast, and 2% in the Northwest. These ICUs served communities of diverse size and description; 14% of the ICUs served communities of > 1 million persons, 51% served communities of 100,000 to 999,999, and 34% served communities of < 100,000. The community was described as rural in 20%, suburban in 33%, and urban in 47% of ICUs. The ICUs also varied with respect to resident coverage for patients, with 13% providing resident coverage for all patients, 33% providing coverage for some, and 54% not providing resident...
coverage for patients. These ICUs used a variety of on-site physician staffing models: 14% had an intensivist-led closed-unit model, 15% required intensivist consultation, 68% had intensivist consultation available, and 3% of the ICUs did not have access to an on-site intensivist. There was considerable diversity in the time committed by ICU medical directors, with 10% of ICUs supported by a full-time director, 16% dedicating 50% to 99% of effort to the ICU, 29% dedicating 15% to 49% of their effort, and 39% dedicating <15% of their effort; 5% of ICUs did not have a medical director.

The hospitals that support these ICUs were relatively evenly distributed with regard to size: 5% served hospitals of ≥1,000 beds, 13% served hospitals with 800 to 999 beds, 16% served hospitals with 500 to 799 beds, 7% served hospitals with 400 to 499 beds, 10% served hospitals with 300 to 399 beds, 15% served hospitals with 200 to 299 beds, 21% served hospitals with 100 to 199 beds, and 12% served hospitals with <100 licensed beds. The hospitals included university-affiliated academic teaching hospitals (17%), teaching hospitals without university affiliation (35%), and nonteaching hospitals (48%).

Critical Care Treatments

The use of vasoactive medications, mechanical ventilation, and blood product support was common (Table 3). Conventional mechanical ventilation supported 27% of patients, varying from 18.4% to 30.1% by ICU type, and 7.5% of patients were supported with noninvasive ventilation. There was substantial variability among ICUs in the use of mechanical ventilation, with a median of 22.4% (IQR, 14.4%-32.3%). The APACHE IV model accurately predicted the duration of mechanical ventilation in this population. Continuous-infusion vasoactive medications were also common, with 24.3% of patients treated with at least one vasopressor, with a median of 20.8% (IQR, 15.0%-26.0%). Nearly 20% of the patients received at least one unit of transfused packed RBCs, with a median of 18.3% (IQR, 12.8%-23.5%). Renal replacement therapy was used to support a smaller fraction of patients (Table 3).

Antimicrobial agents were prescribed within the first 72 h for two-thirds of patients admitted to an ICU. Coverage for resistant organisms or polymicrobial infections was common among critically ill adults; use of combination antimicrobials (28.6% of cases) was similar to single-agent therapy (27.3%). The most common class of antimicrobial prescription was a single-agent first-generation cephalosporin for patients in every ICU type except for those in medical ICUs who were most likely to receive a fluoroquinolone (14.4% of patients) (e-Table 1).

Of 166,824 patients, 114,688 (68.8%) had an APACHE IV predicted hospital mortality of <10%. Among 40,933 patients who had complete data, 40.1% had a mortality risk of <10% and documentation indicating that they did not receive any of the following critical care treatments: mechanical ventilation, blood product administration, renal replacement therapy, or treatment with a vasoactive medication.

Critical Care Best Practices and End-of-Life Care

Rates of adherence to critical care best practice were high for stress ulcer and venous thrombosis prevention and were slightly lower for β-blocker usage (Table 4). Adherence to low tidal volume ventilation for cases meeting ARDSNet (ARDS Network) criteria for ARDS/ALI was only 66.5% using the less stringent criteria of <8 mL/kg and was 28.2% when using a cutoff of 6 mL/kg. Glycemic control was similar among the types of ICUs; the percentage of patient days with a (time-weighted) average daily glucose <150 mg/dL was 63.4%, and 16.8% of the patient-days had an average value greater than 180.

Few patients had limitation-of-care orders at the time of ICU admission, and a greater fraction had these at the time of discharge (Table 5). Care limitation orders were more frequent in patients who died than those who survived, suggesting that these orders were targeted to dying patients. There was a threefold increase in the proportion of patients with...
The average length of stay (LOS) in the ICU was just over 3 days, with neuroscience and trauma patients having slightly longer stays (Table 6). For every day spent in the ICU, the typical patient spent 1.5 days in a non-ICU bed. The ICU LOS was accurately predicted and hospital LOS was slightly overpredicted by the APACHE IV model.

Most adult ICU patients were discharged directly home from the hospital (Table 6). The next most common location was a skilled nursing facility or nursing home, with relatively few patients discharged to rehabilitation or other inpatient post-acute care services.

### Discussion

We report specific treatments and outcomes for a large sample of adult patients discharged from a US adult ICU in 2008. The 5,321 ICU beds included in this report represent 7.2% of the 73,406 adult intensive care, coronary care, surgical, and trauma ICU beds from nonfederal US hospitals tabulated in the Health Care Cost Reporting Information System data set for the year 2005. These ICUs represent every geographic region of the United States; however, some regions are underrepresented. The ICUs are

### Table 1—Patient Characteristics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>All (N = 243,553)</th>
<th>Medical (n = 17,154)</th>
<th>Surgical (n = 15,993)</th>
<th>Mixed (n = 115,977)</th>
<th>Coronary Care (n = 56,138)</th>
<th>CV Surgical (n = 27,839)</th>
<th>Trauma (n = 861)</th>
<th>Neuro (n = 9,591)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, mean (SD), y</td>
<td>62.9 (17)</td>
<td>62.2 (18)</td>
<td>62.0 (18)</td>
<td>62.5 (18)</td>
<td>64.2 (16)</td>
<td>64.5 (15)</td>
<td>48.3 (10)</td>
<td>59.4 (19)</td>
</tr>
<tr>
<td>Gender, % female</td>
<td>45.6</td>
<td>49.0</td>
<td>43.8</td>
<td>47.0</td>
<td>44.2</td>
<td>41.6</td>
<td>32.6</td>
<td>46.3</td>
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<tr>
<td>APACHE IV; mean (SD)</td>
<td>52.9 (24.8)</td>
<td>54.0 (25.3)</td>
<td>51.3 (24.1)</td>
<td>53.9 (25.3)</td>
<td>52.8 (24.4)</td>
<td>51.3 (23.6)</td>
<td>47.1 (24.2)</td>
<td>46.8 (23.6)</td>
</tr>
<tr>
<td>Ethnicity/race, %</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>74.3</td>
<td>74.6</td>
<td>77.6</td>
<td>71.2</td>
<td>77.4</td>
<td>78.8</td>
<td>78.6</td>
<td>72.8</td>
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<td>16.1</td>
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<td>10.0</td>
<td>10.8</td>
<td>9.4</td>
<td>7.9</td>
<td>9.8</td>
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<td>3.4</td>
<td>3.3</td>
<td>6.5</td>
<td>4.5</td>
<td>4.5</td>
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<td>8.7</td>
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<tr>
<td>Asian</td>
<td>1.9</td>
<td>1.5</td>
<td>2.0</td>
<td>1.8</td>
<td>2.4</td>
<td>1.7</td>
<td>0.3</td>
<td>1.5</td>
</tr>
<tr>
<td>Native American</td>
<td>0.5</td>
<td>0.3</td>
<td>0.3</td>
<td>0.7</td>
<td>0.2</td>
<td>0.3</td>
<td>0.6</td>
<td>0.9</td>
</tr>
<tr>
<td>Other/unknown</td>
<td>3.9</td>
<td>3.7</td>
<td>5.0</td>
<td>3.4</td>
<td>3.9</td>
<td>4.4</td>
<td>7.0</td>
<td>6.1</td>
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<tr>
<td>Missing</td>
<td>3.4</td>
<td>0.4</td>
<td>0.6</td>
<td>6.4</td>
<td>0.8</td>
<td>0.9</td>
<td>1.3</td>
<td>0.2</td>
</tr>
<tr>
<td>Admission source, %</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ED</td>
<td>45.2</td>
<td>56.5</td>
<td>29</td>
<td>49.2</td>
<td>43.9</td>
<td>33.4</td>
<td>42.4</td>
<td>46.1</td>
</tr>
<tr>
<td>Hospital ward</td>
<td>16.5</td>
<td>18</td>
<td>12.6</td>
<td>18</td>
<td>16.1</td>
<td>14.7</td>
<td>6.4</td>
<td>11.2</td>
</tr>
<tr>
<td>Operating room</td>
<td>16.4</td>
<td>4.8</td>
<td>32</td>
<td>13.3</td>
<td>17.7</td>
<td>24.7</td>
<td>8.6</td>
<td>16.6</td>
</tr>
<tr>
<td>Direct admit</td>
<td>6.5</td>
<td>8.7</td>
<td>4.9</td>
<td>4.9</td>
<td>6.2</td>
<td>11.1</td>
<td>26.2</td>
<td>10.5</td>
</tr>
<tr>
<td>Other ICU</td>
<td>4.1</td>
<td>4</td>
<td>7.9</td>
<td>3.5</td>
<td>3.5</td>
<td>5.5</td>
<td>5</td>
<td>4.4</td>
</tr>
<tr>
<td>Other hospital</td>
<td>3.7</td>
<td>4.6</td>
<td>4.6</td>
<td>2.3</td>
<td>5.9</td>
<td>3.1</td>
<td>7.1</td>
<td>4.9</td>
</tr>
<tr>
<td>Recovery room</td>
<td>3.8</td>
<td>1.7</td>
<td>6.9</td>
<td>4.1</td>
<td>2</td>
<td>5.4</td>
<td>1.9</td>
<td>4.8</td>
</tr>
<tr>
<td>Step down</td>
<td>1.5</td>
<td>0.8</td>
<td>0.9</td>
<td>1.7</td>
<td>1.8</td>
<td>1.1</td>
<td>0.7</td>
<td>0.2</td>
</tr>
<tr>
<td>Chest pain center</td>
<td>0.7</td>
<td>0</td>
<td>0.1</td>
<td>0.9</td>
<td>0.8</td>
<td>0.6</td>
<td>0.0</td>
<td>0.1</td>
</tr>
<tr>
<td>Missing</td>
<td>1.7</td>
<td>1</td>
<td>1.1</td>
<td>1.1</td>
<td>2</td>
<td>2.2</td>
<td>0.5</td>
<td>1.7</td>
</tr>
<tr>
<td>BMI (SD)</td>
<td>29.5 (20.6)</td>
<td>29.1 (15.6)</td>
<td>28.6 (10.7)</td>
<td>29.8 (23.6)</td>
<td>29.2 (12.9)</td>
<td>30.4 (28)</td>
<td>29.4 (13.8)</td>
<td>28 (11.4)</td>
</tr>
<tr>
<td>Median</td>
<td>27.2</td>
<td>26.8</td>
<td>27</td>
<td>27.1</td>
<td>27.5</td>
<td>27.8</td>
<td>26.8</td>
<td>26.6</td>
</tr>
<tr>
<td>IQR</td>
<td>23.3-32.2</td>
<td>22.7-32.3</td>
<td>23.3-31.7</td>
<td>23.1-32.2</td>
<td>23.6-32.3</td>
<td>24-32.6</td>
<td>23.1-31.6</td>
<td>23-31.2</td>
</tr>
</tbody>
</table>

APACHE = Acute Physiology and Chronic Health Evaluation; CV = cardiovascular; IQR = interquartile range; neuro = neuroscience.

*Among 176,302 cases for which APACHE IV data were available.

1214,191 cases with valid height and weight measurements.

“comfort measures only” ordered at ICU discharge compared with admission. Among ICU patients who died during their hospitalization, 61% died in the ICU (median, 58%; IQR, 49%-65%).

### Outcomes

Acuity-adjusted mortality by type of ICU is presented in Table 6. Most critically ill adults survived their illness, as hospital mortality was 9% and ICU mortality was 5.6%. Unadjusted mortality rates were lower for nontrauma surgical or mixed ICUs than medical or neuroscience ICUs. Unadjusted mortality rates also varied by ICU as the median ICU and hospital mortality rates were 5.0% (IQR, 3.1%-6.9%) and 8.8% (IQR, 6.4%-11.1%), respectively. The APACHE IV model overpredicted hospital and ICU mortality for all types of ICUs. Compared with APACHE IV predicted mortality, actual ICU mortality was 81% and hospital mortality was 78%. We observed considerable variability of standardized mortality ratios (SMR; calculated as actual divided by predicted mortality) for each type of ICU, with a median SMR for ICU mortality of 79% (IQR, 61%-99%) and a median SMR for hospital mortality of 80% (IQR, 66%-102%).

The average length of stay (LOS) in the ICU was just over 3 days, with neuroscience and trauma patients having slightly longer stays (Table 6). For every day spent in the ICU, the typical patient spent 1.5 days in a non-ICU bed. The ICU LOS was accurately predicted and hospital LOS was slightly overpredicted by the APACHE IV model.

Most adult ICU patients were discharged directly home from the hospital (Table 6). The next most common location was a skilled nursing facility or nursing home, with relatively few patients discharged to rehabilitation or other inpatient post-acute care services.
Table 2—Most Frequent Primary Admission Diagnoses

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>All</th>
<th>Medical</th>
<th>Surgical</th>
<th>Mixed</th>
<th>Coronary Care</th>
<th>CV Surgical</th>
<th>Trauma</th>
<th>Neuro</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acute MI</td>
<td>9,065</td>
<td>5,481</td>
<td>6,124</td>
<td>43,187</td>
<td>22,487</td>
<td>14,902</td>
<td>448</td>
<td>4,836</td>
</tr>
<tr>
<td>Respiratory—medical, not otherwise categorized</td>
<td>7,773</td>
<td>4,306</td>
<td>5,351</td>
<td>31,666</td>
<td>13,677</td>
<td>10,687</td>
<td>305</td>
<td>1,561</td>
</tr>
<tr>
<td>CABG alone</td>
<td>6,665</td>
<td>4,209</td>
<td>4,873</td>
<td>25,061</td>
<td>13,061</td>
<td>9,041</td>
<td>188</td>
<td>860</td>
</tr>
<tr>
<td>CHF</td>
<td>5,930</td>
<td>3,573</td>
<td>4,039</td>
<td>21,273</td>
<td>11,613</td>
<td>7,023</td>
<td>164</td>
<td>890</td>
</tr>
<tr>
<td>Angina, unstable</td>
<td>4,650</td>
<td>2,782</td>
<td>2,660</td>
<td>12,790</td>
<td>7,619</td>
<td>4,030</td>
<td>91</td>
<td>472</td>
</tr>
<tr>
<td>CVA/stroke</td>
<td>4,630</td>
<td>2,800</td>
<td>2,030</td>
<td>11,860</td>
<td>7,003</td>
<td>3,800</td>
<td>93</td>
<td>499</td>
</tr>
<tr>
<td>Rhythm disturbance (atrial, supraventricular)</td>
<td>4,594</td>
<td>2,806</td>
<td>2,088</td>
<td>11,820</td>
<td>6,988</td>
<td>3,798</td>
<td>92</td>
<td>487</td>
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<tr>
<td>Cardiovascular, medical, not otherwise categorized</td>
<td>4,233</td>
<td>2,477</td>
<td>1,956</td>
<td>10,556</td>
<td>6,089</td>
<td>3,399</td>
<td>84</td>
<td>437</td>
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<tr>
<td>Diabetic ketoacidosis</td>
<td>3,478</td>
<td>2,120</td>
<td>1,620</td>
<td>8,512</td>
<td>4,761</td>
<td>2,581</td>
<td>57</td>
<td>292</td>
</tr>
<tr>
<td>Cardiac arrest (with or without respiratory arrest)</td>
<td>3,014</td>
<td>1,829</td>
<td>1,685</td>
<td>7,380</td>
<td>4,288</td>
<td>2,348</td>
<td>49</td>
<td>239</td>
</tr>
<tr>
<td>Sepsis, pulmonary</td>
<td>2,973</td>
<td>1,745</td>
<td>1,378</td>
<td>6,893</td>
<td>3,880</td>
<td>2,100</td>
<td>48</td>
<td>236</td>
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<tr>
<td>Pneumonia, bacterial</td>
<td>2,472</td>
<td>1,455</td>
<td>1,117</td>
<td>5,267</td>
<td>3,046</td>
<td>1,646</td>
<td>34</td>
<td>171</td>
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<tr>
<td>Hemorrhage/hematoma, intracranial</td>
<td>2,418</td>
<td>1,415</td>
<td>1,003</td>
<td>5,166</td>
<td>2,964</td>
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<td>156</td>
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<tr>
<td>Sepsis, pulmonary</td>
<td>2,307</td>
<td>1,398</td>
<td>1,009</td>
<td>5,107</td>
<td>2,901</td>
<td>1,501</td>
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<td>138</td>
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<tr>
<td>Sepsis, pulmonary</td>
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<td>1,398</td>
<td>1,009</td>
<td>5,107</td>
<td>2,901</td>
<td>1,501</td>
<td>28</td>
<td>138</td>
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<tr>
<td>Pneumonia, other</td>
<td>2,307</td>
<td>1,398</td>
<td>1,009</td>
<td>5,107</td>
<td>2,901</td>
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<td>28</td>
<td>138</td>
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<td>Coma/change in level of consciousness</td>
<td>2,249</td>
<td>1,349</td>
<td>950</td>
<td>5,059</td>
<td>2,799</td>
<td>1,449</td>
<td>25</td>
<td>127</td>
</tr>
</tbody>
</table>

Diagnoses among 176,302 cases for which APACHE IV data were available. CABG = coronary artery bypass grafting; CHF = congestive heart failure; CVA = cerebrovascular accident; MI = myocardial infarction; PRBC = packed RBC. See Table 1 for expansion of other abbreviations.

Table 3—Treatments

<table>
<thead>
<tr>
<th>Treatment</th>
<th>All</th>
<th>Medical</th>
<th>Surgical</th>
<th>Mixed</th>
<th>Coronary Care</th>
<th>CV Surgical</th>
<th>Trauma</th>
<th>Neuro</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blood product usage, No.</td>
<td>97,465</td>
<td>5,481</td>
<td>6,124</td>
<td>43,187</td>
<td>22,487</td>
<td>14,902</td>
<td>448</td>
<td>4,836</td>
</tr>
<tr>
<td>PRBCs</td>
<td>18,062</td>
<td>1,200</td>
<td>1,618</td>
<td>9,441</td>
<td>5,546</td>
<td>2,806</td>
<td>69</td>
<td>392</td>
</tr>
<tr>
<td>FFP</td>
<td>3,250</td>
<td>2,150</td>
<td>2,000</td>
<td>10,250</td>
<td>5,125</td>
<td>2,562</td>
<td>54</td>
<td>321</td>
</tr>
<tr>
<td>Platelets</td>
<td>2,825</td>
<td>1,650</td>
<td>1,380</td>
<td>7,615</td>
<td>4,195</td>
<td>2,295</td>
<td>46</td>
<td>275</td>
</tr>
<tr>
<td>PRBC units/transfused patient</td>
<td>2.9</td>
<td>3.0</td>
<td>3.0</td>
<td>3.0</td>
<td>2.8</td>
<td>2.7</td>
<td>2.9</td>
<td>2.9</td>
</tr>
<tr>
<td>Maximum</td>
<td>102</td>
<td>43</td>
<td>102</td>
<td>102</td>
<td>30</td>
<td>28</td>
<td>47</td>
<td>102</td>
</tr>
<tr>
<td>Vasopressor use, No.</td>
<td>81,467</td>
<td>4,114</td>
<td>4,844</td>
<td>34,949</td>
<td>23,519</td>
<td>11,379</td>
<td>448</td>
<td>2,353</td>
</tr>
<tr>
<td>None</td>
<td>61,693</td>
<td>3,304</td>
<td>3,996</td>
<td>20,996</td>
<td>12,096</td>
<td>6,596</td>
<td>188</td>
<td>1,078</td>
</tr>
<tr>
<td>1 Vasopressor</td>
<td>11,505</td>
<td>613</td>
<td>735</td>
<td>4,640</td>
<td>2,560</td>
<td>1,330</td>
<td>34</td>
<td>220</td>
</tr>
<tr>
<td>2 Vasopressor</td>
<td>5,475</td>
<td>284</td>
<td>338</td>
<td>1,878</td>
<td>1,088</td>
<td>588</td>
<td>13</td>
<td>95</td>
</tr>
<tr>
<td>3 Vasopressor</td>
<td>2,028</td>
<td>106</td>
<td>119</td>
<td>609</td>
<td>359</td>
<td>189</td>
<td>5</td>
<td>43</td>
</tr>
<tr>
<td>&gt;3 Vasopressors</td>
<td>775</td>
<td>41</td>
<td>47</td>
<td>247</td>
<td>137</td>
<td>72</td>
<td>2</td>
<td>13</td>
</tr>
<tr>
<td>Renal replacement therapy, No.</td>
<td>97,465</td>
<td>5,481</td>
<td>6,124</td>
<td>43,187</td>
<td>22,487</td>
<td>14,902</td>
<td>448</td>
<td>4,836</td>
</tr>
<tr>
<td>No. (%)</td>
<td>2,821</td>
<td>178</td>
<td>137</td>
<td>1,417</td>
<td>830</td>
<td>194</td>
<td>15</td>
<td>47</td>
</tr>
<tr>
<td>Duration, mean (SD), d</td>
<td>2.5</td>
<td>3.6</td>
<td>2.2</td>
<td>2.5</td>
<td>2.9</td>
<td>2.1</td>
<td>2.1</td>
<td>1.8</td>
</tr>
<tr>
<td>Mechanical ventilation, No.</td>
<td>243,553</td>
<td>17,154</td>
<td>15,993</td>
<td>115,977</td>
<td>56,138</td>
<td>27,839</td>
<td>961</td>
<td>9,591</td>
</tr>
<tr>
<td>No. (%)</td>
<td>65,829</td>
<td>3,691</td>
<td>3,061</td>
<td>15,641</td>
<td>8,941</td>
<td>4,541</td>
<td>158</td>
<td>8,271</td>
</tr>
<tr>
<td>Duration, mean (SD), d</td>
<td>3.6</td>
<td>6.2</td>
<td>3.6</td>
<td>4.2</td>
<td>3.5</td>
<td>2.4</td>
<td>8.5</td>
<td>4.7</td>
</tr>
<tr>
<td>Noninvasive</td>
<td>18,267</td>
<td>1,397</td>
<td>1,111</td>
<td>7,360</td>
<td>4,180</td>
<td>2,270</td>
<td>45</td>
<td>25</td>
</tr>
<tr>
<td>A:P ratio</td>
<td>1.03</td>
<td>0.97</td>
<td>0.99</td>
<td>1.05</td>
<td>1.04</td>
<td>0.92</td>
<td>0.99</td>
<td>1.24</td>
</tr>
</tbody>
</table>

Data are given as No. (%) unless otherwise indicated. Cases with complete information. A:P = APACHE IV actual to predicted duration of mechanical ventilation; FFP = fresh frozen plasma; PRBC = packed RBC. See Table 1 for expansion of other abbreviations.
Table 4—Best Practice Adherence

<table>
<thead>
<tr>
<th>Practice</th>
<th>All</th>
<th>Medical</th>
<th>Surgical</th>
<th>Mixed</th>
<th>Coronary Care</th>
<th>CV Surgical</th>
<th>Trauma</th>
<th>Neuro</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(N = 243,553)</td>
<td>(n = 17,154)</td>
<td>(n = 15,993)</td>
<td>(n = 115,977)</td>
<td>(n = 56,138)</td>
<td>(n = 27,839)</td>
<td>(n = 861)</td>
<td>(n = 9,591)</td>
</tr>
<tr>
<td>Stress ulcer prevention (No. = at risk)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treated, No. (% adherent)</td>
<td>33,168</td>
<td>2,567</td>
<td>1,886</td>
<td>17,487</td>
<td>6,786</td>
<td>3,058</td>
<td>71</td>
<td>1,313</td>
</tr>
<tr>
<td>VTE prevention (No. = at risk)</td>
<td>151,297</td>
<td>10,505</td>
<td>10,096</td>
<td>73,528</td>
<td>33,415</td>
<td>15,923</td>
<td>473</td>
<td>6,912</td>
</tr>
<tr>
<td>Treated, No. (% adherent)</td>
<td>131,393</td>
<td>10,054</td>
<td>8,864</td>
<td>63,693</td>
<td>28,206</td>
<td>13,543</td>
<td>430</td>
<td>6,603</td>
</tr>
<tr>
<td>Medication</td>
<td>37,500</td>
<td>2,910</td>
<td>1,079</td>
<td>18,948</td>
<td>8,639</td>
<td>5,349</td>
<td>180</td>
<td>395</td>
</tr>
<tr>
<td>Device</td>
<td>50,611</td>
<td>3,905</td>
<td>4,569</td>
<td>23,276</td>
<td>10,432</td>
<td>3,495</td>
<td>113</td>
<td>4,821</td>
</tr>
<tr>
<td>Both</td>
<td>43,282</td>
<td>3,239</td>
<td>3,216</td>
<td>21,469</td>
<td>9,135</td>
<td>4,699</td>
<td>137</td>
<td>1,387</td>
</tr>
<tr>
<td>Within 24 h</td>
<td>121,339</td>
<td>9,395</td>
<td>8,357</td>
<td>58,468</td>
<td>26,064</td>
<td>12,425</td>
<td>367</td>
<td>6,263</td>
</tr>
<tr>
<td>24-48 h</td>
<td>6,800</td>
<td>474</td>
<td>331</td>
<td>3,479</td>
<td>1,445</td>
<td>781</td>
<td>35</td>
<td>255</td>
</tr>
<tr>
<td>After 48 h</td>
<td>3,254</td>
<td>185</td>
<td>176</td>
<td>1,746</td>
<td>697</td>
<td>337</td>
<td>28</td>
<td>85</td>
</tr>
<tr>
<td>β-Blocker use</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ACS, treated/at-risk (% adherent)</td>
<td>12,577/15,920</td>
<td>313/454 (68.9)</td>
<td>195/248 (78.6)</td>
<td>4,297/5,512 (78)</td>
<td>5,242/6,748 (77.7)</td>
<td>2,449/2,862 (85.6)</td>
<td>...</td>
<td>81,96 (84.4)</td>
</tr>
<tr>
<td>Vascular surgery, treated/at-risk</td>
<td>3,411/5,023 (69.6)</td>
<td>23/32 (7.1)</td>
<td>851/1,094 (77.8)</td>
<td>1,150/1,909 (60.2)</td>
<td>431/630 (70.4)</td>
<td>431/630 (88.4)</td>
<td>...</td>
<td>33/46 (71.7)</td>
</tr>
<tr>
<td>Nonvascular surgery, treated/at-risk</td>
<td>1,480/2,127 (67.9)</td>
<td>33/48 (19.9)</td>
<td>260/351 (74.1)</td>
<td>630/925 (68.1)</td>
<td>204/295 (64.6)</td>
<td>204/295 (69.1)</td>
<td>...</td>
<td>10/124 (83.9)</td>
</tr>
<tr>
<td>Low tidal volume ventilation</td>
<td>12,466</td>
<td>931</td>
<td>1,022</td>
<td>6,489</td>
<td>3,131</td>
<td>595</td>
<td>195</td>
<td>103</td>
</tr>
<tr>
<td>(&lt; 6 mL/kg). No. (% of ABGs)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6-8 mL/kg. No. (% of ABGs)</td>
<td>4,760 (38.2)</td>
<td>374 (40.2)</td>
<td>361 (35.3)</td>
<td>2,582 (39.8)</td>
<td>1,193 (38.1)</td>
<td>147 (24.7)</td>
<td>82 (42.1)</td>
<td>21 (20.4)</td>
</tr>
<tr>
<td>≥ 8 mL/kg. No. (% of ABGs)</td>
<td>4,194 (33.6)</td>
<td>281 (30.2)</td>
<td>270 (26.4)</td>
<td>1,993 (30.7)</td>
<td>1,232 (39.3)</td>
<td>280 (47.1)</td>
<td>56 (28.7)</td>
<td>82 (79.6)</td>
</tr>
<tr>
<td>Glycemic control (No. = patient days)</td>
<td>378,959</td>
<td>26,923</td>
<td>24,576</td>
<td>179,470</td>
<td>86,270</td>
<td>45,525</td>
<td>1,286</td>
<td>14,909</td>
</tr>
<tr>
<td>Average daily glucose ≤ 110 mg/dL</td>
<td>101,781</td>
<td>7,434</td>
<td>6,021</td>
<td>48,157</td>
<td>23,199</td>
<td>12,666</td>
<td>463</td>
<td>3,841</td>
</tr>
<tr>
<td>Average daily glucose 111-150 mg/dL</td>
<td>138,287</td>
<td>9,134</td>
<td>9,608</td>
<td>64,062</td>
<td>31,920</td>
<td>17,348</td>
<td>456</td>
<td>5,697</td>
</tr>
<tr>
<td>Average daily glucose 151-180 mg/dL</td>
<td>75,060</td>
<td>5,357</td>
<td>5,060</td>
<td>35,641</td>
<td>16,899</td>
<td>8,763</td>
<td>215</td>
<td>3,125</td>
</tr>
<tr>
<td>Average daily glucose &gt; 180 mg/dL</td>
<td>63,831</td>
<td>4,998</td>
<td>3,827</td>
<td>31,610</td>
<td>14,252</td>
<td>6,748</td>
<td>150</td>
<td>2,246</td>
</tr>
</tbody>
</table>

Data are given as No. (%) unless otherwise indicated. ... = qualifying case numbers not sufficient. ABG = arterial blood gas; ACS = acute coronary syndrome; ALI = acute lung injury. See Table 1 legend for expansion of other abbreviations.

Adherent/at risk after exclusion of cases with contraindications (%); cases ventilated for > 24 h were considered at risk.
hospital discharge\textsuperscript{17,18} but lower than the 2005 National Committee for Quality Assurance data for patients with an acute coronary syndrome.\textsuperscript{19} Adherence rates to recommended glycemic control targets were imperfect for all types of ICUs. Earlier recommendations for maintaining blood glucose levels in the 80 to 110 mg/dL range for critically ill patients\textsuperscript{20,21} have been revised, with 110 to 180 mg/dL as the target range.\textsuperscript{22} Only 56% of average daily glucose values were in this broader target range, with 16.8% of values being >180 mg/dL and 26.9% of values being <110 mg/dL.

Rates of adherence for low tidal volume ventilation for ARDS cases were low\textsuperscript{23}; only 28% of cases were adherent to the 6 mL/kg ideal body weight cut point, and only 67% were adherent to the less restrictive 8 mL/kg standard. Poor compliance with low tidal volume guidelines for ARDS/ALI is well recognized and studied,\textsuperscript{24} and the rates we observed are slightly higher than reported for traditional educational outreach (adherence rates of 1%-26% for the 6 mL/kg cut point\textsuperscript{25-27} and 16%-54% for the 8 mL/kg cut point\textsuperscript{28-29}) and similar to preintervention levels of cost-effectiveness studies.\textsuperscript{30}

Most patients (55.9%) were treated with antimicrobial agents, and coverage for resistant organisms or polymicrobial infections was common among critically ill adults. Use of combination antimicrobials (28.6% of cases) was similar to single-agent therapy (27.3%). The most common antimicrobial prescription for nonmedical ICU cases was a single-agent first-generation cephalosporin, suggesting that antimicrobial prescription to prevent postoperative infection was common.

Mechanical ventilation was common, with 31.5% of patients supported by a form of mechanical ventilation. Standard mechanical ventilation through an artificial airway supported 27% of patients, and 7.5% received noninvasive ventilation. Similarly, 24.3% of patients were supported with a continuous vasoactive infusion for treatment of hypoperfusion or hypotension, 18.5% were treated with packed RBCs, and 2.9% received renal replacement therapy.

Table 5—End-of-Life Care in the ICU

<table>
<thead>
<tr>
<th>End-of-Life Care Status</th>
<th>All (N = 243,553)</th>
<th>Medical (n = 17,154)</th>
<th>Surgical (n = 15,993)</th>
<th>Mixed (n = 115,977)</th>
<th>Coronary Care (n = 56,138)</th>
<th>CV Surgical (n = 27,839)</th>
<th>Trauma (n = 861)</th>
<th>Neuro (n = 9,591)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DNR at time of admission</td>
<td>6.4 (15,560)</td>
<td>8.4 (1,440)</td>
<td>4.3 (693)</td>
<td>7.0 (8,069)</td>
<td>6.2 (3,480)</td>
<td>4.7 (3,131)</td>
<td>2.3 (20)</td>
<td>5.7 (545)</td>
</tr>
<tr>
<td>DNR at ICU discharge</td>
<td>10.8 (26,194)</td>
<td>14.5 (2,494)</td>
<td>7.9 (1,268)</td>
<td>11.6 (13,427)</td>
<td>10.2 (5,738)</td>
<td>8.0 (2,219)</td>
<td>6.3 (54)</td>
<td>10.4 (994)</td>
</tr>
<tr>
<td>DNR at time of death</td>
<td>54.6 (7,519)</td>
<td>59.5 (664)</td>
<td>51.4 (371)</td>
<td>55.1 (3,885)</td>
<td>54.8 (1,687)</td>
<td>49.6 (592)</td>
<td>62.2 (28)</td>
<td>52.2 (312)</td>
</tr>
<tr>
<td>CMO at time of admission</td>
<td>0.5 (1,167)</td>
<td>0.5 (82)</td>
<td>0.3 (49)</td>
<td>0.5 (594)</td>
<td>0.5 (270)</td>
<td>0.3 (85)</td>
<td>1.3 (11)</td>
<td>0.8 (76)</td>
</tr>
<tr>
<td>CMO at ICU discharge</td>
<td>1.6 (3,944)</td>
<td>1.7 (295)</td>
<td>1.2 (198)</td>
<td>1.7 (1,975)</td>
<td>1.6 (1,918)</td>
<td>1.1 (309)</td>
<td>3.6 (31)</td>
<td>2.3 (218)</td>
</tr>
<tr>
<td>CMO at time of death</td>
<td>15.0 (2,060)</td>
<td>14.8 (160)</td>
<td>12.5 (90)</td>
<td>14.8 (1,041)</td>
<td>15.8 (487)</td>
<td>13.8 (165)</td>
<td>46.7 (21)</td>
<td>16.1 (96)</td>
</tr>
</tbody>
</table>

Data are given as % (N). Cases with complete data. CMO = comfort measures only; DNR = do not resuscitate. See Table 1 legend for expansion of other abbreviations.

Among patients who died during their hospital stay, a do not resuscitate (DNR) order was more common than a resuscitation attempt, a finding that is consistent with a recently published smaller study.\textsuperscript{31} Despite evidence that a DNR order is associated with lower probability of referral to an ICU\textsuperscript{32} and a lower OR for acceptance to a medical ICU,\textsuperscript{33} DNR orders were not uncommon among the critically ill adults of this study. Nearly 7% of patients had DNR orders at ICU admission, similar to the rate of 6.9% reported for DNR orders written within the first week of ICU stay in a 1996 study of 42 ICUs.\textsuperscript{34} Rates of care limitation orders at the time of admission were similar among all ICU types but were slightly higher in medical, neurosciences, and mixed ICUs than in surgical or trauma ICUs. It appears that ICUs offer services other than resuscitation that may not be available to these patients outside of an ICU. New DNR orders during an ICU stay nearly matched the rate on admission (Table 5), suggesting that end-of-life counseling frequently occurs during an ICU stay. This counseling appeared to target dying patients, as the rates of DNR and comfort measures-only orders are nearly 10-fold higher among patients who died than among all patients at ICU admission. Nearly 1% of adult ICU admissions included patients with an active comfort measures only order. This suggests that there is a gap in either the availability or use of end-of life care outside of ICUs. We noted a high comfort measures-only order rate for dying patients from this order among patients approaching brain death. The typical adult patient remained in the ICU for slightly more than 3 days, and in the hospital for almost 5 additional days before returning to their home. Hospital and ICU LOS was accurately predicted for this population by the APACHE IV model, suggesting that its predictions reflect US outcomes.\textsuperscript{35} Most adult critically ill patients returned directly home; however, those admitted to medical and neurosciences ICUs were more likely to require rehabilitation or chronic care than those admitted to a cardiovascular, mixed, or surgical ICU.
Table 6—Outcomes

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>All</th>
<th>Medical</th>
<th>Surgical</th>
<th>Mixed</th>
<th>Coronary Care</th>
<th>CV Surgical</th>
<th>Trauma</th>
<th>Neuro</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ICU outcomes</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No.</td>
<td>175,567</td>
<td>12,918</td>
<td>9,426</td>
<td>83,839</td>
<td>39,303</td>
<td>22,096</td>
<td>293</td>
<td>7,692</td>
</tr>
<tr>
<td>Actual deaths, No. (%)</td>
<td>9,804 (5.6)</td>
<td>763 (5.9)</td>
<td>422 (4.5)</td>
<td>5,129 (6.1)</td>
<td>2,027 (5.1)</td>
<td>952 (4.3)</td>
<td>16 (5.5)</td>
<td>495 (6.4)</td>
</tr>
<tr>
<td>Predicted deaths, No. (%)</td>
<td>12,080 (6.9)</td>
<td>931 (7.2)</td>
<td>598 (6.4)</td>
<td>6,186 (7.4)</td>
<td>2,550 (6.5)</td>
<td>1,193 (5.4)</td>
<td>17 (5.7)</td>
<td>605 (7.9)</td>
</tr>
<tr>
<td>SMR</td>
<td>0.81</td>
<td>0.82</td>
<td>0.71</td>
<td>0.83</td>
<td>0.79</td>
<td>0.80</td>
<td>0.96</td>
<td>0.82</td>
</tr>
<tr>
<td>Actual LOS, No. (95% CI)</td>
<td>3.28 (3.26-3.30)</td>
<td>3.35 (3.27-3.42)</td>
<td>3.52 (3.41-3.62)</td>
<td>3.28 (3.25-3.31)</td>
<td>3.12 (3.08-3.17)</td>
<td>3.19 (3.13-3.25)</td>
<td>6.25 (4.95-7.55)</td>
<td>3.90 (3.78-4.02)</td>
</tr>
<tr>
<td>Predicted LOS, No. (95% CI)</td>
<td>3.17 (3.16-3.18)</td>
<td>3.17 (3.14-3.20)</td>
<td>3.34 (3.30-3.38)</td>
<td>3.28 (3.26-3.29)</td>
<td>3.04 (3.02-3.06)</td>
<td>2.85 (2.83-2.87)</td>
<td>3.43 (3.22-3.65)</td>
<td>3.43 (3.30-3.47)</td>
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<tr>
<td>Standardized LOS ratio</td>
<td>1.03</td>
<td>1.04</td>
<td>1.05</td>
<td>1.00</td>
<td>1.02</td>
<td>1.11</td>
<td>1.77</td>
<td>1.13</td>
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<tr>
<td><strong>Hospital outcomes</strong></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>No.</td>
<td>166,824</td>
<td>12,316</td>
<td>8,866</td>
<td>79,285</td>
<td>37,259</td>
<td>20,964</td>
<td>280</td>
<td>7,311</td>
</tr>
<tr>
<td>Actual deaths, No. (%)</td>
<td>15,037 (9.0)</td>
<td>1,169 (9.5)</td>
<td>629 (7.1)</td>
<td>7,814 (9.8)</td>
<td>3,312 (8.6)</td>
<td>1,465 (7.0)</td>
<td>22 (7.9)</td>
<td>726 (9.9)</td>
</tr>
<tr>
<td>Predicted deaths, No. (%)</td>
<td>19,385 (11.6)</td>
<td>1,519 (12.3)</td>
<td>926 (10.5)</td>
<td>9,944 (12.5)</td>
<td>4,116 (11.1)</td>
<td>1,903 (9.1)</td>
<td>26 (9.4)</td>
<td>949 (13.0)</td>
</tr>
<tr>
<td>SMR</td>
<td>0.78</td>
<td>0.79</td>
<td>0.68</td>
<td>0.79</td>
<td>0.78</td>
<td>0.77</td>
<td>0.83</td>
<td>0.76</td>
</tr>
<tr>
<td>Actual LOS, No. (95% CI)</td>
<td>8.05 (8.00-8.10)</td>
<td>7.60 (7.45-7.75)</td>
<td>9.07 (8.86-9.28)</td>
<td>8.18 (8.11-8.25)</td>
<td>7.76 (7.67-7.85)</td>
<td>7.74 (7.62-7.86)</td>
<td>9.53 (7.95-11.11)</td>
<td>8.42 (8.20-8.63)</td>
</tr>
<tr>
<td>Standardized LOS ratio</td>
<td>0.86</td>
<td>0.84</td>
<td>0.87</td>
<td>0.84</td>
<td>0.87</td>
<td>0.87</td>
<td>0.89</td>
<td>0.89</td>
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<tr>
<td><strong>Discharge location</strong></td>
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<tr>
<td>No.</td>
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<td>12,922</td>
<td>9,430</td>
<td>84,272</td>
<td>39,384</td>
<td>22,303</td>
<td>293</td>
<td>7,698</td>
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<tr>
<td>Home, No. (%)</td>
<td>103,906 (58.9)</td>
<td>5,756 (44.5)</td>
<td>5,865 (62.2)</td>
<td>51,477 (61.1)</td>
<td>23,125 (55.7)</td>
<td>13,808 (62.2)</td>
<td>34 (11.6)</td>
<td>3,781 (49.1)</td>
</tr>
<tr>
<td>SNF, No. (%)</td>
<td>16,280 (9.2)</td>
<td>1,233 (9.5)</td>
<td>838 (8.9)</td>
<td>8,607 (10.2)</td>
<td>3,544 (9.0)</td>
<td>1,563 (6.4)</td>
<td>2 (0.7)</td>
<td>553 (7.2)</td>
</tr>
<tr>
<td>Rehabilitation, No. (%)</td>
<td>5,118 (3.1)</td>
<td>332 (2.6)</td>
<td>441 (4.7)</td>
<td>3,059 (3.7)</td>
<td>874 (2.2)</td>
<td>187 (0.9)</td>
<td>0 (0)</td>
<td>555 (7.6)</td>
</tr>
<tr>
<td>External, No. (%)</td>
<td>5,987 (3.4)</td>
<td>242 (1.9)</td>
<td>105 (1.1)</td>
<td>3,783 (4.5)</td>
<td>974 (2.5)</td>
<td>550 (2.5)</td>
<td>0 (0)</td>
<td>333 (4.3)</td>
</tr>
<tr>
<td>Other hospital, No. (%)</td>
<td>7,740 (4.4)</td>
<td>642 (5.0)</td>
<td>325 (3.4)</td>
<td>4,140 (5.1)</td>
<td>1,849 (4.7)</td>
<td>443 (2.0)</td>
<td>1 (0.3)</td>
<td>340 (4.4)</td>
</tr>
<tr>
<td>Other, No. (%)</td>
<td>20,196 (11.5)</td>
<td>3,436 (26.6)</td>
<td>1,147 (12.2)</td>
<td>4,495 (5.3)</td>
<td>5,476 (13.9)</td>
<td>4,085 (18.3)</td>
<td>232 (79.2)</td>
<td>1,325 (17.2)</td>
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<tr>
<td>Death, No. (%)</td>
<td>16,675 (9.5)</td>
<td>1,281 (9.9)</td>
<td>709 (7.5)</td>
<td>8,671 (10.3)</td>
<td>3,542 (9.0)</td>
<td>1,667 (7.5)</td>
<td>24 (8.2)</td>
<td>781 (10.1)</td>
</tr>
</tbody>
</table>

L.0S = length of stay; SMR = standardized mortality ratio; SNF = skilled nursing facility or nursing home; other hospital including higher level of care; external facility offering psychiatric, detox, or other postacute care services. See Table 1 legend for expansion of the other abbreviations.

*Cases with an APACHE IV score > 0 with vital status or LOS recorded.

*Location of care after discharge from the hospital.
Hospital mortality was consistently and substantially higher than ICU mortality, which likely reflects patients discharged from the ICU who decline resuscitation or further care in an ICU and those who fail resuscitation efforts outside the ICU. Actual mortality was substantially less than that predicted by the APACHE IV model. This overprediction of mortality may relate to advances in critical care that occurred between the time the model was developed and when this population was treated. Another factor may be the high (97%) rate of critical care specialists at the bedside and the support of off-site intensivists using information technology tools to identify and care for physiologically unstable patients that was not widely available to patients during the APACHE IV development.

Centers providing the information presented in this report were not randomly selected and some US regions were underrepresented; this should be taken into account before generalizing the findings. Comparison with a 1991 one-day “snapshot” survey of 25,000 US ICU patients and a smaller 2004 sample demonstrates both similarities and differences. The surveys reported that 34% and 39% of patients were supported with mechanical ventilation, which is similar to the combination of the 27% and 7.5% noninvasive ventilator usage of our enumeration, and the 20% and 23% of cases reported to use vasopressors were similar to the 24.5% rate measured in this study. The most frequent admission diagnoses reported in the surveys were ischemic heart disorder and respiratory insufficiency, which are similar to the diagnoses of this report. The proportion of patients with DNR orders noted in the survey is nearly identical to the rate measured at the time of admission for this study. On the other hand, the 1991 survey reported that 55% and the 2004 survey reported that 50.6% of patients were older than 65 years, whereas more than one-half of the patients of this report are younger than 65 years. To investigate whether the study population may have a higher proportion of low-acuity cases than a representative sample, we compared the fraction of low-acuity cases to those of the APACHE IV validation sample. Sixty to seventy percent of the APACHE IV population had a predicted mortality of <10% compared with 68.8% of the patients of this report. Despite these similarities, it remains unknown whether this population is representative of the adult US critically ill population.

This report provides detailed information about the current practice of critical care in the United States, including treatments provided, adherence to best practices, and acuity-adjusted outcomes. The report is based on detailed clinical practice data gathered from geographically dispersed health-care systems that serve communities of diverse size and includes hospitals with varying administrative structures and affiliations. These practice patterns and acuity-adjusted outcomes provide benchmarks that are not available from financial or administrative databases or prior survey reports. Mortality rates, LOS, acuity scores, treatments administered, and predicted values stratified by ICU type may be useful to monitor changes in ICU practice and to evaluate performance of a specific ICU. The report also suggests that many patients with a low mortality risk may not receive any critical care therapies during their ICU stay; future studies to confirm these findings and reliably identify patients who will not require intensive treatments appears warranted.

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Author contributions: Dr Lilly had full access to the data and takes responsibility for its integrity and the accuracy of the analyses. Dr Lilly: contributed to study concept and design; acquisition, analysis, and interpretation of data; the writing of the first draft of the manuscript; and all revisions.
Dr Zuckerman: contributed to study concept; design, analysis, and interpretation of data; and the writing and revision of the manuscript.
Dr Bednarczyk: contributed to study concept and design; acquisition, analysis, and interpretation of data; and the writing and revision of the manuscript.
Dr Riker: contributed to study concept and design, acquisition, analysis, and interpretation of data; and the writing and revision of the manuscript.

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Role of sponsors: The sponsor had no role in the design of the study or the collection and analysis of the data.

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Additional information: The e-Appendix and e-Table can be found in the Online Supplement at http://chestjournal.chestpubs.org/content/140/5/1232/DC1.

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Benchmark Data From More Than 240,000 Adults That Reflect the Current Practice of Critical Care in the United States

Craig M. Lilly, MD, FCCP; Ilene H. Zuckerman, PharmD, PhD; Omar Badawi, PharmD; and Richard R. Riker, MD, FCCP

e-Appendix 1.

Best Practice Adherence Criteria

VTE Prophylaxis
The venous thromboembolism (VTE) prophylaxis criteria is consistent with those endorsed by The Joint Commission and the National Quality Forum (NQF) for ICU patient (NQF #0372).

Inclusion Criteria: For each ICU patient stay, a patient was considered at-risk for VTE when their ICU length of stay was greater than 24 hours.

Exclusion Criteria: Patients were excluded if there was documentation in the medical record indicating they were not at-risk for VTE. Reasons for exclusion from risk included: patient ambulating; patient coagulopathic; or patient already fully anticoagulated.

Treatment Criteria: Documentation of an order for VTE prophylaxis with a compression device, IVC filter, VTE preventive anti-coagulant medication, or combination of a device and medication. The timing of first recorded treatment was reported as within 24 hours, between 24 and 48 hrs or more than 48 hours after ICU admission.

Low Tidal Volume Ventilation
The low tidal volume ventilation criteria evaluated patients with acute lung injury (ALI) and/or ARDS for adherence with low tidal volume ventilation strategies were those used for the ARDSnet randomized trial.23

Inclusion Criteria: Arterial blood gas (ABG) measurements which contained both tidal volume and oxygenation ratio data. Only ABGs from patients with both an oxygenation ratio < 300 and a documented diagnosis of ALI or ARDS were assessed.

Treatment Criteria: Based on ideal body weight, the tidal volume for each ABG was calculated and classified as either < 6 cc/kg, 6 – 8 cc/kg or > 8 cc/kg. The proportion of ABGs in each category was reported.

Stress Ulcer Prophylaxis
The stress ulcer prophylaxis criteria evaluated patients with prolonged mechanical ventilation.

Inclusion Criteria: Patients were considered at-risk once they reached 24 hours of mechanical ventilation.

Treatment Criteria: Patients were considered treated with stress ulcer prophylaxis if there was an active order for a qualifying medication in the 24 hour time period before or after the 24th hour of mechanical ventilation. Qualifying medications included proton pump inhibitors, histamine-2 receptor antagonists, sucralfate, antacids or any combination.
Beta-Blocker Administration

Cases were classified as treated with a systemic beta-blocker when an active order for a qualifying beta blocking medication was recorded in the required time frame.

Inclusion Criteria: Beta blockers were considered indicated for three categories of patients: vascular surgery, non-vascular surgery with high risk for myocardial ischemia, and those with acute coronary syndromes (ACS). 36 High risk non-vascular surgery patients were defined by a past medical history of angina, myocardial infarction or an active diagnosis of coronary artery disease, or ischemic cardiomyopathy.

Exclusion Criteria: Patients with contraindications to beta-blockers such as allergies, asthma, bronchospasm, bradycardia or hypotension. Beta-blockers administered through the ophthalmic route were excluded. Patients undergoing coronary artery bypass graft patients (CABG) were not included in the at-risk categories.

Treatment Criteria: Patients were considered adherent with the criteria if an order for a beta-blocker medication was active within 24 hours of the time the risk factor was recorded in the medical record or ICU admission in at-risk patients without contraindications.

Glycemic Control

The glycemic control criteria evaluated patients by calculating an average daily glucose value for each patient day utilizing a time-weighted average technique. 37

Inclusion Criteria: All patients with at least one documented glucose value.

Exclusion Criteria: Any glucose value documented within the first 24 hours of admission for a patient admitted with diabetic ketoacidosis (DKA) or diabetic hyperglycemic hyperosmolar nonketotic coma (HHNC).

Treatment Criteria: The time-weighted average daily glucose for each patient day was categorized as either $\leq 110$ mg/dL, 111 - 150 mg/dL, 151 - 180 mg/dL or $>180$ mg/dL. The proportion of patient days in each category was reported.
e-Table 1. Antimicrobial usage in the first 72 hours of admission.

<table>
<thead>
<tr>
<th>SUMMARY</th>
<th>N</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antimicrobial free</td>
<td>72,141</td>
<td>44.1</td>
</tr>
<tr>
<td>Single agent antimicrobial therapy</td>
<td>44,654</td>
<td>27.3</td>
</tr>
<tr>
<td>Combination antimicrobial therapy</td>
<td>46,795</td>
<td>28.6</td>
</tr>
<tr>
<td>Total</td>
<td>163,590</td>
<td>100</td>
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</table>

<table>
<thead>
<tr>
<th>Antimicrobial class and combination</th>
<th>N</th>
<th>Percent*</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st generation cephalosporin alone</td>
<td>15886</td>
<td>17.37</td>
</tr>
<tr>
<td>Fluoroquinolone alone</td>
<td>8561</td>
<td>9.36</td>
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<tr>
<td>Glycopeptide alone</td>
<td>4657</td>
<td>5.09</td>
</tr>
<tr>
<td>2nd generation cephalosporin alone</td>
<td>4648</td>
<td>5.08</td>
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<tr>
<td>Extended spectrum penicillin alone</td>
<td>3984</td>
<td>4.36</td>
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<td>Extended spectrum penicillin-Glycopeptide</td>
<td>2889</td>
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<td>3rd generation cephalosporin</td>
<td>2510</td>
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<tr>
<td>Fluoroquinolone-Glycopeptide</td>
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<td>Extended spectrum penicillin-Fluoroquinolones-Glycopeptide</td>
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<td>1.88</td>
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<td>3rd generation cephalosporin-Macrolide</td>
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<td>1st generation cephalosporin-Glycopeptide</td>
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<td>Extended spectrum penicillin-Fluoroquinolone</td>
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<td>Fluoroquinolone-Metronidazole</td>
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<tr>
<td>Lincosamide alone</td>
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<td>1.25</td>
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<td>Carabapenem alone</td>
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<td>Macrolide alone</td>
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<td>Metronidazole</td>
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<td>1st generation cephalosporin-Fluoroquinolones</td>
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<td>Sulfa derivative alone</td>
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<td>4th generation cephalosporins alone</td>
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<td>1st generation cephalosporin-Extended spectrum penicillin</td>
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<tr>
<td>Fluoroquinolones-Lincosamide</td>
<td>453</td>
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* Percentage of antimicrobial prescriptions among 165,667 cases for which complete prescribing data was available.