Intensive Care Unit Admitting Patterns in the Veterans Affairs Health Care System

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Background: Critical care resource use accounts for almost 1% of US gross domestic product and varies widely among hospitals. However, we know little about the initial decision to admit a patient to the intensive care unit (ICU).

Methods: To describe hospital ICU admitting patterns for medical patients after accounting for severity of illness on admission, we performed a retrospective cohort study of the first nonsurgical admission of 289,310 patients admitted from the emergency department or the outpatient clinic to 118 Veterans Affairs acute care hospitals between July 1, 2009, and June 30, 2010. Severity (30-day predicted mortality rate) was measured using a modified Veterans Affairs ICU score based on laboratory data and comorbidities around admission. The main outcome measure was direct admission to an ICU.

Results: Of the 31,555 patients (10.9%) directly admitted to the ICU, 53.2% had 30-day predicted mortality at admission of 2% or less. The rate of ICU admission for this low-risk group varied from 1.2% to 38.9%. For high-risk patients (predicted mortality >30%), ICU admission rates also varied widely. For a 1-SD increase in predicted mortality, the adjusted odds of ICU admission varied substantially across hospitals (odds ratio = 0.85-2.22). As a result, 66.1% of hospitals were in different quartiles of ICU use for low- vs high-risk patients (weighted κ = 0.50).

Conclusions: The proportion of low- and high-risk patients admitted to the ICU, variation in ICU admitting patterns among hospitals, and the sensitivity of hospital rankings to patient risk all likely reflect a lack of consensus about which patients most benefit from ICU admission.


Critical care resource use accounts for almost 1% of US gross domestic product and almost 15% of all hospital costs.1 Wide hospital variation in critical care resource use2-5 has implications for the quality and cost of acute inpatient care. Underuse of critical care, as exemplified by high-acuity patients not admitted to the intensive care unit (ICU) in a timely manner, is associated with high mortality rates and greater resource use.6,7 On the other hand, unnecessary use of critical care wastes valuable resources. Better triage decisions on admission, that is, choices about the first hospital unit to which a patient is admitted, could aid in efforts to improve the quality and decrease the cost of acute inpatient care. Previous research has explored the characteristics of patients referred to the ICU8-11 and the severity of illness of patients once admitted to the ICU.12-16 However, to our knowledge, no one has described what proportion of all the medical patients presenting for admission at a broad sample of hospitals in a national health care system are sent to the ICU or how this proportion varies across hospitals at all levels of patient severity. Given current efforts to increase health care efficiency, it is important to better understand variation in hospital admitting patterns (at the time of triage) and, ultimately, how to target use of the ICU to those who will benefit the most.

We used data from the Veterans Health Administration, the largest health care system in the United States and one that in 2009 provided care to almost 6 million US military veterans, to examine ICU admitting patterns for patients at their initial presentation to the hospital. With data from the Veterans Affairs (VA) Inpatient Evalu-
a modified VA ICU severity score.\textsuperscript{20-22} The score is derived from
the Veterans Affairs Ann Arbor Healthcare System institutional review board.

DATA

We used diagnosis, laboratory, and clinical data collected by the VA Inpatient Evaluation Center. We supplemented this information with data from the American Hospital Association and the Veterans Affairs Bed Control Database.

SAMPLE

We sought to construct a cohort of patients for whom ED, outpatient clinic, and ICU physicians made triage decisions based largely on presenting patient severity. Therefore, we excluded admissions in which surgery was performed within 24 hours of presentation, as surgery acutely changes patient severity, and triage to the ICU for such patients may anticipate that change rather than reflect admission severity. Similarly, we excluded transfers because admitting decisions for these patients may be influenced by earlier severity assessment via telephone triage. We also excluded admissions missing patient identifiers (0.2% of remaining admissions). For each patient, we included only the first admission during the study period. We further excluded 2 sites missing ICU bed data and 1 site with an unadjusted ICU admission rate greater than 50%. The final sample included 2 sites missing ICU bed data and 1 site with an unadjusted ICU admission rate greater than 50%. The final sample included 289,310 patients, each with a single admission at 1 of 118 hospitals (eTable 1; http://www.archinternmed.com). In total, 92.6% of all patients (66,271 of 71,543) who went to the ICU when first arriving at the hospital came from the ED or the outpatient clinic.

COVARIATE ADJUSTMENT

The adjusted models included patient severity, diagnosis, and ICU occupancy (all at the time of admission), along with the level of specialty care offered at the hospital. We adjusted for these factors because they are not completely under hospitals’ control yet may affect ICU admission rates.

Patient severity would seem to be the most obvious determinant of ICU use given that “[i]ntensive care units (ICU) are places in the hospital where the most seriously ill patients are cared for by specially trained staff.”\textsuperscript{18} We estimated patient severity (defined as the predicted 30-day mortality rate on admission conditional on not being admitted to the ICU)\textsuperscript{20-22} using a modified VA ICU severity score.\textsuperscript{20-22} The score is derived from a model similar in principle to the APACHE (Acute Physiology, Age, Chronic Health Evaluation) ICU model\textsuperscript{23} and includes age on admission, 1 of 73 mutually exclusive diagnostic groups, comorbid disease burden adapted from the study by Elixhauser et al,\textsuperscript{24} admission source, and the worst values in the 24 hours surrounding hospital admission of 11 laboratory tests (sodium, serum urea nitrogen, glucose, albumin, and bilirubin levels, glomerular filtration rate, white blood cell count, hematocrit, pH, Paco\textsubscript{2}, and Paco\textsubscript{3}).\textsuperscript{20-22}

We included indicators for the 6 most common diagnoses among ICU and non-ICU admissions using the Angus definition of sepsis\textsuperscript{25} and 5 other VA diagnostic cohorts defined by grouped International Classification of Diseases, Ninth Revision, Clinical Modification, codes.\textsuperscript{20} As common diagnoses for ICU and non-ICU admissions overlapped, we were left with 10 diagnostic categories (including the reference category of all the other diagnoses). We defined ICU occupancy for each patient as the proportion of ICU beds that were occupied by any VA patient (not only those in this sample) at the exact time of admission. Each VA hospital is assigned a type (1-4 included as dummy variables) representing a level of complexity based on the Society of Critical Care Medicine framework (eg, at level 1 hospitals, cardiology, neurosurgery, interventional cardiology, and radiology services are offered; at level 4 hospitals, more limited services are offered).\textsuperscript{30}

ICU ADMISSION ANALYSIS

We modeled the patient-level probability of admission to the ICU using multilevel models with random effects to account for the clustering of patients in hospitals.\textsuperscript{27} For the primary analysis, we fit 2 random intercept models. The first model was adjusted for severity of illness and case mix (admitting diagnosis). In the second model, we added ICU occupancy and level of complexity. We generated hospital-specific ICU admission rates using empirical Bayesian prediction, which accounts for hospital volume and accordingly shrinks less reliable estimates toward the overall mean.\textsuperscript{26}

In a third model, we used a random slope to investigate whether the relationship between patient severity and triage to the ICU might differ across hospitals. We used the weighted $\kappa$ of agreement\textsuperscript{29} with squared difference weights to describe the stability of hospital quartile rankings of ICU admission rates for patients with the lowest vs highest severity.

MORTALITY ANALYSIS

Ultimately, one of the most important questions is whether any variation in ICU use translates into differences in patient outcomes, the most compelling of which would be 30- and 90-day mortality rates. To attempt to control for the nonrandom selection of patients into the ICU, we used a generalized propensity approach,\textsuperscript{30} which ensures the balance of observed covariates and any highly correlated unobserved covariates when estimating a treatment effect of ICU hospitalization conditional on severity (eAppendix).

Although a protective effect of ICU hospitalization would be of interest, if ICU hospitalization is associated with increased mortality, we would have to infer that this might reflect increased unmeasured severity in individuals initially hospitalized in the ICU. We, thus, also examined an interaction of ICU hospitalization and severity as we hypothesized that we might detect a relative benefit of ICU use for patients of higher severity. We conducted all the analyses using a commercially available software program (STATA, version 11.0; StataCorp LP) and R 2.12.1.\textsuperscript{31}
RESULTS

HOSPITAL AND PATIENT CHARACTERISTICS

Of the 289,310 patients admitted from the ED or the outpatient clinic to 1 of 118 hospitals in 48 states, 31,555 (10.9%) were admitted directly to the ICU. Patients admitted to the ICU had higher mean predicted (and observed) 30-day mortality rates than did patients admitted to the non-ICU ward (7.5% [7.7%] vs 3.5% [3.5%]) (Table 1). Both populations had a relatively low predicted mortality rate at admission (median mortality of ICU and non-ICU patients of 1.7% and 1.0%, respectively). Compared with admissions to the ICU, the distribution of severity for non-ICU admissions was shifted toward lower severity (Figure 1).

VARIATION IN HOSPITAL ADMITTING DECISIONS FOR PATIENTS WITH MEDIAN PREDICTED MORTALITY

Hospitals varied widely in the proportion of patients admitted to the ICU, even after adjusting for predicted mortality and diagnosis on admission (Table 2). Adjusted rates of admission to the ICU ranged from 1.6% to 29.5% across hospitals for patients with median predicted mortality. The median ICU admission rate was 6.9% (interquartile range, 4.7%-10.0%).

After further adjusting for occupancy and hospital type, rates of admission to the ICU still varied from 1.2% to 38.9% across hospitals. The median rate was 7.3% (interquartile range, 4.4%-10.7%) (Figure 2). Almost 10% of the total variation in probability of ICU admission was explained by patient severity and diagnosis, and an additional 0.4% was explained by ICU occupancy and the facility’s complexity level (eTable 2).

SENSITIVITY OF HOSPITAL ADMITTING PATTERNS TO CHANGES IN PREDICTED MORTALITY

Sicker patients were more likely to be admitted to the ICU (odds ratio [OR] for a 1-SD increase, 1.50; 95% CI, 1.44-1.55). However, for high-risk patients (predicted mortality >30%), ICU admission rates still varied widely (Figure 3). We found significant variation (SD of random slope, 0.18; 95% CI, 0.16-0.21) in the change in odds of ICU admission associated with a 1-SD increase in severity (ranging from a 15% decrease [OR = 0.85; 95% CI, 0.75-0.98] to a 122% increase [OR = 2.22; 95% CI, 1.93-2.55]) (represented by the varying slopes in Figure 3). From the median severity of 1.1%, a 1-SD increase in severity on the log-odds scale would correspond to an in-

Table 1. Patient Characteristics by Type of Admitting Unit

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>ICU (n = 31,555)</th>
<th>Non-ICU (n = 257,755)</th>
</tr>
</thead>
<tbody>
<tr>
<td>30-d Predicted mortality, %</td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤2</td>
<td>16,780 (53.2)</td>
<td>172,828 (67.1)</td>
</tr>
<tr>
<td>&gt;2-5</td>
<td>5,910 (18.7)</td>
<td>44,768 (17.4)</td>
</tr>
<tr>
<td>&gt;5-10</td>
<td>3,190 (10.1)</td>
<td>20,114 (7.8)</td>
</tr>
<tr>
<td>&gt;10-30</td>
<td>3,430 (10.9)</td>
<td>14,905 (5.8)</td>
</tr>
<tr>
<td>&gt;30-100</td>
<td>2,245 (7.1)</td>
<td>5,140 (2.0)</td>
</tr>
<tr>
<td>Age, y</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;55</td>
<td>5,757 (18.2)</td>
<td>47,754 (18.5)</td>
</tr>
<tr>
<td>55-64</td>
<td>12,061 (38.2)</td>
<td>89,944 (33.3)</td>
</tr>
<tr>
<td>65-74</td>
<td>6,301 (20.0)</td>
<td>50,113 (19.5)</td>
</tr>
<tr>
<td>≥75</td>
<td>7,436 (23.6)</td>
<td>69,944 (26.8)</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>30,187 (95.7)</td>
<td>245,407 (95.2)</td>
</tr>
<tr>
<td>Female</td>
<td>1,368 (4.3)</td>
<td>12,348 (4.8)</td>
</tr>
<tr>
<td>Race/ethnicity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>19,490 (61.8)</td>
<td>165,798 (64.3)</td>
</tr>
<tr>
<td>Black</td>
<td>6,158 (19.5)</td>
<td>45,068 (17.5)</td>
</tr>
<tr>
<td>Hispanic</td>
<td>1,645 (5.2)</td>
<td>13,429 (5.2)</td>
</tr>
<tr>
<td>Other</td>
<td>1,220 (3.9)</td>
<td>9,520 (3.7)</td>
</tr>
<tr>
<td>Unknown</td>
<td>304 (0.9)</td>
<td>2,940 (1.1)</td>
</tr>
<tr>
<td>Diagnosis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>15,524 (49.2)</td>
<td>171,329 (66.5)</td>
</tr>
<tr>
<td>Sepsis</td>
<td>4,025 (12.8)</td>
<td>14,869 (5.8)</td>
</tr>
<tr>
<td>Acute MI</td>
<td>2,511 (8.0)</td>
<td>26,068 (1.0)</td>
</tr>
<tr>
<td>CAD</td>
<td>2,479 (7.9)</td>
<td>14,127 (5.5)</td>
</tr>
<tr>
<td>Dysrhythmia</td>
<td>2,273 (7.2)</td>
<td>8,895 (3.5)</td>
</tr>
<tr>
<td>CHF (nonhypertensive)</td>
<td>1,071 (3.4)</td>
<td>9,652 (3.7)</td>
</tr>
<tr>
<td>GI hemorrhage</td>
<td>1,070 (3.4)</td>
<td>3,156 (1.2)</td>
</tr>
<tr>
<td>Chest pain</td>
<td>1,024 (3.3)</td>
<td>14,974 (5.8)</td>
</tr>
<tr>
<td>COPD</td>
<td>897 (2.8)</td>
<td>9,241 (3.6)</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>681 (2.2)</td>
<td>8,906 (3.5)</td>
</tr>
<tr>
<td>ICU occupancy on admission, %</td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤25</td>
<td>2,466 (7.8)</td>
<td>24,070 (9.3)</td>
</tr>
<tr>
<td>&gt;25-50</td>
<td>8,889 (28.2)</td>
<td>71,955 (27.9)</td>
</tr>
<tr>
<td>&gt;50-75</td>
<td>13,853 (43.9)</td>
<td>108,515 (42.1)</td>
</tr>
<tr>
<td>&gt;75-100</td>
<td>6,909 (19.3)</td>
<td>50,904 (19.8)</td>
</tr>
<tr>
<td>&gt;100</td>
<td>252 (0.8)</td>
<td>2,111 (0.9)</td>
</tr>
</tbody>
</table>

Abbreviations: CAD, coronary artery disease; CHF, congestive heart failure; COPD, chronic obstructive pulmonary disease; GI, gastrointestinal; ICU, intensive care unit; MI, myocardial infarction.

a Due to rounding, percentages do not always sum to 100.

Figure 1. Distribution of predicted mortality rates in medical patients admitted from the emergency department or the outpatient clinic. Density represents the likelihood of different values of patient severity among medical patients admitted from the emergency department or the outpatient clinic to the intensive care unit (ICU) (n = 31,555) or non-ICU (n = 257,755). The total area under each curve equals 1 when the x-axis is transformed to the log-odds scale.

Figure 2. Variation in hospital admitting decisions for patients with median predicted mortality.

Figure 3. Sensitivity of hospital admitting patterns to changes in predicted mortality.
crease to 4.8% in severity. Three hospitals had negative slopes; sensitivity analyses with and without these hospitals did not change the results.

### DEPENDENCE OF HOSPITAL COMPARISONS ON PATIENT RISK

Given that hospitals’ admitting patterns were not uniformly sensitive to changes in predicted mortality, 66.1% of hospitals were in different quartiles of ICU admission for patients with the lowest (30-day predicted mortality ≤2%) vs highest (30-day predicted mortality >30%) severity (weighted κ = 0.50) (Figure 3).

### MORTALITY ANALYSIS

After adjusting for severity at admission, patients admitted to the ICU had a higher odds of death at 30 days (OR = 1.10; 95% CI, 1.03-1.17) but not at 90 days (OR = 0.96; 95% CI, 0.90-1.02; P = .16). However, when the treatment effect was estimated as a function of severity at admission, admission to the ICU was protective against death at 30 days for patients with expected mortality greater than 18.4% at admission (and protective against death at 90 days for patients with expected mortality >8.8%).

### COMMENT

With growing focus on the nation’s rising health care costs, understanding use of one of the most costly components of inpatient care—critical care—has become more important. In this context, this study had 4 key findings. Approximately half of the patients admitted to the ICU had 30-day predicted mortality of 2% or less. In more than half the cases, patients with predicted mortality greater than 30% were not admitted to the ICU. At all levels of patient risk, hospitals varied widely in the proportion of patients admitted to the ICU. Comparisons of hospital admitting patterns were not stable for patients of differing risk.

Critical care units proliferated in the 1960s32 to offer life-sustaining therapy and closer monitoring for the sickest patients. However, the high costs associated with this level of care and finite ICU beds make the decision to send a patient to the ICU one that merits renewed attention. Ultimately, there are 3 possible outcomes of the triage de-

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### Table 2. Hospital Characteristics by Quartile of ICU Admission Rate for the Typical Patient

<table>
<thead>
<tr>
<th>Hospital Characteristic</th>
<th>All (n = 118)</th>
<th>Q1 (n = 30)</th>
<th>Q2 (n = 29)</th>
<th>Q3 (n = 29)</th>
<th>Q4 (n = 30)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICU admission rates, range, %&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.6-29.5</td>
<td>1.6-4.7</td>
<td>4.7-6.9</td>
<td>6.9-10.0</td>
<td>10.0-29.5</td>
</tr>
<tr>
<td>Male sex, %</td>
<td>95.3</td>
<td>95.6</td>
<td>95.4</td>
<td>95.3</td>
<td>94.8</td>
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<tr>
<td>Predicted 30-d mortality, %</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤2</td>
<td>65.0</td>
<td>65.1</td>
<td>63.2</td>
<td>65.9</td>
<td>65.9</td>
</tr>
<tr>
<td>&gt;2-5</td>
<td>17.8</td>
<td>17.8</td>
<td>18.4</td>
<td>17.7</td>
<td>17.4</td>
</tr>
<tr>
<td>&gt;5-10</td>
<td>8.2</td>
<td>8.4</td>
<td>8.8</td>
<td>7.9</td>
<td>7.8</td>
</tr>
<tr>
<td>&gt;10-30</td>
<td>6.4</td>
<td>6.3</td>
<td>6.9</td>
<td>6.2</td>
<td>6.3</td>
</tr>
<tr>
<td>&gt;30</td>
<td>2.6</td>
<td>2.5</td>
<td>2.8</td>
<td>2.3</td>
<td>2.6</td>
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<td>Race/ethnicity, %</td>
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<td></td>
<td></td>
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<tr>
<td>Black</td>
<td>16.1</td>
<td>9.4</td>
<td>13.9</td>
<td>18.3</td>
<td>22.8</td>
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<tr>
<td>White</td>
<td>67.7</td>
<td>74.2</td>
<td>72.5</td>
<td>60.9</td>
<td>63.0</td>
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<td>5.3</td>
<td>5.0</td>
<td>2.9</td>
</tr>
<tr>
<td>Other</td>
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<td>4.0</td>
<td>2.6</td>
<td>4.4</td>
<td>3.9</td>
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<td>Unknown</td>
<td>8.5</td>
<td>9.6</td>
<td>5.7</td>
<td>11.4</td>
<td>7.4</td>
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<tr>
<td>Income, %</td>
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<td></td>
<td></td>
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<tr>
<td>Q1 (&lt;$7800)</td>
<td>25.0</td>
<td>24.4</td>
<td>24.4</td>
<td>25.4</td>
<td>25.6</td>
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<tr>
<td>Q2 ($7801-$15 468)</td>
<td>24.9</td>
<td>24.3</td>
<td>24.9</td>
<td>25.7</td>
<td>24.9</td>
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<tr>
<td>Q3 ($15 469-$32 076)</td>
<td>26.8</td>
<td>27.2</td>
<td>26.8</td>
<td>26.6</td>
<td>26.6</td>
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<tr>
<td>Q4 (&gt;32 076)</td>
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<td>24.2</td>
<td>23.9</td>
<td>22.3</td>
<td>22.9</td>
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<td>Hospital beds, mean, No.</td>
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<td>285.1</td>
<td>274.1</td>
<td>275.5</td>
<td>295.6</td>
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<td>ICU beds, mean, No.</td>
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<td>13.3</td>
<td>13.8</td>
<td>17.4</td>
<td>15.7</td>
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<tr>
<td>ICU complexity level, %</td>
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<tr>
<td>1 (high)</td>
<td>43.2</td>
<td>46.7</td>
<td>37.9</td>
<td>51.7</td>
<td>36.7</td>
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<tr>
<td>2</td>
<td>16.9</td>
<td>10.0</td>
<td>24.1</td>
<td>10.3</td>
<td>23.3</td>
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<tr>
<td>3</td>
<td>26.3</td>
<td>23.3</td>
<td>24.1</td>
<td>27.6</td>
<td>30.0</td>
</tr>
<tr>
<td>4 (low)</td>
<td>13.6</td>
<td>20.0</td>
<td>13.8</td>
<td>10.3</td>
<td>10.0</td>
</tr>
<tr>
<td>Urban location, %</td>
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<td></td>
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<tr>
<td>Black</td>
<td>84.7</td>
<td>83.3</td>
<td>86.2</td>
<td>82.8</td>
<td>86.7</td>
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<tr>
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<td>53.3</td>
<td>44.8</td>
<td>64.0</td>
<td>48.3</td>
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<tr>
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<td>51.3</td>
<td>47.8</td>
<td>52.6</td>
<td>53.5</td>
<td>58.5</td>
</tr>
</tbody>
</table>

Abbreviations: COTH, Council of Teaching Hospitals; ICU, intensive care unit.

<sup>a</sup> Adjusted for patient severity and diagnosis using a model that allows hospitals to have varying baseline rates of ICU admission (ie, random intercepts). Rates are shown for patients at the median severity (1.1%) and with diagnoses that were not separately modeled.

<sup>b</sup> ICU occupancy is the proportion of ICU beds that were occupied by any Veterans Affairs patients (not only those in this sample) at the exact time of admission. Mean ICU occupancy averages across admissions for patients included in this sample.
appropriate environment for low-risk patients would be severely ill patients, it seems that reevaluation of the evidence that the value of ICU care may be limited for less risk compared with high-risk patients (eg, a low-risk patient with diabetic ketoacidosis compared with a moderate-risk patient with congestive heart failure, chronic kidney disease, and pneumonia). However, given evidence that the value of ICU care may be limited for less severely ill patients, it seems that reevaluation of the appropriate environment for low-risk patients would be timely and valuable.

Guidelines for the selection of patients to the ICU by the American College of Critical Care Medicine recommend that the lowest priority should be given to patients who are “too sick to benefit” or “too well to benefit” from ICU care. Although the present results suggest that we need to better understand who might be too well to benefit, similar conclusions might be made regarding ICU care for the sickest patients. Across all the hospitals in this sample, 69.6% of patients with predicted mortality of 30% or greater were not admitted to the ICU. We were unable to determine whether these patients were too sick to benefit or had changed their goals of care or whether the ICU might have provided added value for these patients.

The present findings on hospital rankings should be interpreted in the context of increasing efforts to improve hospital efficiency through the development of efficiency metrics. We found that hospitals most likely to use the ICU for low-risk patients frequently differed from hospitals most likely to use the ICU for high-risk patients. This finding suggests that ranking hospitals by their rates of ICU use would be misleading in the absence of stratification by severity.

In evaluating the mortality benefit of ICU treatment, we would not expect to see a constant protective effect of being treated in the ICU at all levels of severity. In fact, one would most reasonably expect that at low levels of severity, the ICU would confer little benefit, whereas it would add the most value for the severely ill. We found evidence supporting this general pattern because a clear benefit of ICU treatment was seen for the sickest patients. Although the likely selection effects of nonrandomized assignment to the ICU make it unwise to infer from these findings the precise threshold below which ICU admission confers more harm than benefit, the pos-
sibility that there might be such a threshold is provocative and provides further incentive to understand wide variation in ICU use.

The seemingly paradoxical finding that admission to the ICU confers a slightly higher risk of death at lower levels of severity may well reflect unmeasured factors used by physicians in selecting patients for ICU admission, although, again, propensity scores should ensure balance in the observed covariates and any unobserved covariates correlated with the severity measure. Better understanding of the factors used to select patients for ICU care or identification of instrumental variables that determine selection for treatment could help elucidate this apparent paradox.

This study has several limitations. Because we did not have information about patient preferences, patients who had declined ICU care or who were enrolled in hospice were included in the sample. In addition, although the measure of predicted mortality has been shown to have excellent predictive validity,20 we did not have vital sign data, and, thus, the mortality risk of patients who were evaluated with significant changes in vital signs but before organ decline might be underestimated. However, to undermine the present findings, these and any other unmeasured risk factors would have to be distributed across hospitals in very different ways than all the extensive comorbidity and physiology variables that we collected. The data set also lacked physician-level characteristics, so we could not make any conclusions about whether differing physician characteristics within and across hospitals might contribute to hospital admitting patterns. Finally, because we studied admitting patterns in a single health care system (albeit the largest one in the United States), caution should be used before generalizing these findings to other health systems.

In summary, we found that many high-risk patients were not directly admitted to the ICU but that approximately half of all medical patients directly admitted to the ICU were at low risk. Hospital admitting patterns varied widely for patients at every level of severity. These findings suggest that there may be a considerable lack of consensus about when to use the ICU. As a next step, it would be important to better understand (1) the value of ICU care for patients stratified by risk and (2) factors other than patient severity that are associated with hospital admitting patterns. This work could form the basis for validating standards for ICU admission that are tailored to different risk groups and that are sensitive to hospital-specific environments. Such standards could inform policymakers seeking to look beyond simple but incomplete hospital comparisons based only on aggregate rates of ICU use.

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REFERENCES

Addressing the Growth in Intensive Care

More than 50,000 patients receive intensive care each day in the United States, and the need for critical care is expected to increase with the aging population. But this growth in critical illness is not without consequences. When intensive care units (ICUs) are full, sick patients in the emergency department or ward may experience admission delays, and considerable evidence suggests that these delays are associated with attributable morbidity and mortality. Full ICUs may also strain intensivist physicians, leading to burnout and preventable medical errors.

To this point, the primary response to the increase in demand for intensive care has been to increase the supply of beds. Between 2000 and 2005, the total number of US critical care beds increased by 5%, from approximately 88,000 to 94,000, even as the number of hospital beds decreased from approximately 665,000 to 628,000. Overall occupancy also increased during the same period. Although this supply-based solution to the growth of intensive care may relieve strain in the short term, it may also substantially increase health care costs. Adding ICU beds increases the fixed costs of hospital care. The proportion of the US gross domestic product attributable to critical care is already as high as 1.0%. As hospital costs increase, it is unclear whether the marginal benefit of ICU care outweighs the inherent fixed costs of building more ICU beds. This question of the true value of ICU admission is particularly salient since hospitals vary in the types of patients they admit to the ICU, with some hospitals admitting a higher percentage of patients than others, even after controlling for patient characteristics.