Supplementary Online Content


eFigure 1. Patient flow diagram.

eFigure 2. Association of Patient-to-Intensivist Ratio and Ultimate and Original Intensive Care Unit and Original Hospital Mortality.

eFigure 3. Association of Patient-to-Intensivist Ratio Definitions which Pertain to Workload on the Day of a Patient’s ICU Admission and Ultimate Hospital Mortality.

eTable 1. Cohort Characteristics Stratified by Patient-to-Intensivist Ratios.

eTable 2. Cohort Characteristics Stratified by ICU Size.

eFigure 4. Association of Patient-to-Intensivist Ratio and Ultimate Hospital Mortality Stratified by ICU Size Tertiles.

eFigure 5. Association of Patient-to-Intensivist Ratio and Ultimate Hospital Mortality Stratified by ICU Size by Individual Bed Number.

eFigure 6. Association of Patient-to-Intensivist Ratio and Hospital and Intensive Care Unit Mortality for Patients in Units with More Than One Intensivist during the Daytime.

This supplementary material has been provided by the authors to give readers additional information about their work.

This supplementary material has been provided by the authors to give readers additional information about their work.
Patients in CMP ICUs from January, 2010 - December, 2013
N = 586,129
# ICUs: 233

In ICUs with survey responses
N = 578,401
# ICUs: 227

In ICUs with 1 daytime intensivist
N = 56,673
# ICUs: 147

In closed ICUs with 1 daytime intensivist
N = 200,758
# ICUs: 94

Admitted during daytime (0800-1559) to closed ICUs with 1 daytime intensivist
N = 60,107
# ICUs: 94

Adults admitted during daytime (0800-1559) to closed ICUs with 1 daytime intensivist
N = 59,683
# ICUs: 94

Adults admitted as 1st ICU admission during daytime (0800-1559) to closed ICUs with 1 daytime intensivist
N = 56,840
# ICUs: 94

FINAL

Adults admitted as 1st ICU admission (complete data) during daytime (0800-1559) to closed ICUs with 1 daytime intensivist
N = 49,686
# ICUs: 94

Exclusion

No responses to survey about daytime staffing
N = 7,728
# ICUs: 6

More than one daytime intensivist:
N = 271,728
# ICUs: 80

Not known to be a closed unit:
- Open: N = 15,820; # ICUs: 8
- Unknown: N = 96,789; # ICUs: 45

Admitted 1600-0759:
N = 140,651

<16 years old:
N = 424

Admission not 1st in hospitalization:
N = 2,843

Data on 1st admission not complete:
- Transferred from other ICU: N = 2,251
- Ultimate ≠ Original ICU LOS: N = 4,903

CMP: case mix programme; LOS: length of stay; ICU: intensive care unit

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* sensitivity analysis cohort of patients in ICUs with greater than 1 daytime intensivist includes 30,409 patients in 42 ICUs in 41 hospitals after exclusions for non-closed ICU, non-daytime admission, age<16 years, admission not 1st of hospitalization, and data of 1st ICU admission not complete
eFigure 2. Association of Patient-to-Intensivist Ratio and Ultimate and Original Intensive Care Unit and Original Hospital Mortality.*

A. Ultimate ICU †

![Graph A](image)

B. Original ICU ‡

![Graph B](image)

C. Original hospital §

![Graph C](image)

* The plotted curves depict the effect on mortality for an “average patient”—defined as having the average of all non-patient-to-intensivist ratio covariates—as a function of patient-to-intensivist ratio. Definition of patient-to-intensivist ratio is the primary definition = total number of patients in the unit daily from 0800-1559 averaged over the patient’s stay. Black circles = point estimates; gray bands = 95% confidence intervals.

† there is an association between patient-to-intensivist ratio and ultimate ICU mortality (p<0.001); and the association is non-linear (p<0.001)

‡ there is an association between patient-to-intensivist ratio and original ICU mortality (p<0.001); and the association is non-linear (p<0.001)
§ there is an association between patient-to-intensivist ratio and original hospital mortality (p=0.010); and the association is non-linear (p=0.006)
eFigure 3. Association of Patient-to-Intensivist Ratio Definitions which Pertain to Workload on the Day of a Patient’s ICU Admission and Ultimate Hospital Mortality.*

A. Total patients (0800-1559)

B. New patients (0800-1559)

C. Total patients during rounds (0800-1059)

D. New patients during rounds (0800-1059)

E. Severity of illness of all patients (0800-1559), #1

E. Severity of illness of all patients (0800-1559), #2

* The plotted curves depict the effect on mortality for an “average patient”—defined as having the average of all non-patient-to-intensivist ratio covariates—as a function of patient-to-intensivist ratio. Black circles = point estimates; gray bands = 95% confidence intervals.

† Definition of patient-to-intensivist ratio = total number of patients on the day of an index patient’s ICU admission (0800-1559); there is no association between patient-to-intensivist ratio and ultimate hospital mortality (p=0.376)

‡ Definition of patient-to-intensivist ratio = number of new patients on the day of an index patient’s ICU admission (0800-1559); there is no association between patient-to-intensivist ratio and ultimate hospital mortality (p=0.758)

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§ Definition of patient-to-intensivist ratio = total number of patients in the unit on the day of an index patient’s ICU admission during daily rounding period (0800-1059); there is no association between patient-to-intensivist ratio and ultimate hospital mortality (p=0.783)

‖ Definition of patient-to-intensivist ratio = number of new patients on the day of an index patient’s ICU admission during daily rounding period (0800-1059); there is no association between patient-to-intensivist ratio and ultimate hospital mortality (p=0.603)

¶ Definition of patient-to-intensivist ratio = severity of illness by ICNARC model of all patients in the unit on the day of an index patient’s ICU admission (0800-1559); there is no association between patient-to-intensivist ratio and ultimate hospital mortality (p=0.285)

** Definition of patient-to-intensivist ratio = severity of illness by average level of care over their ICU stay of all patients in the unit on the day of an index patient’s ICU admission (0800-1559); there is no association between patient-to-intensivist ratio and ultimate hospital mortality (p=0.903)
### eTable 1. Cohort Characteristics Stratified by Patient-to-Intensivist Ratios.

<table>
<thead>
<tr>
<th>Patient characteristics*</th>
<th>Quartile 1†</th>
<th>Quartile 2†</th>
<th>Quartile 3†</th>
<th>Quartile 4†</th>
<th>p-value‡</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients, n</td>
<td>12444</td>
<td>13030</td>
<td>11767</td>
<td>12445</td>
<td></td>
</tr>
<tr>
<td>PIR, range</td>
<td>1-6.9</td>
<td>6.9-8.5</td>
<td>8.5-10.8</td>
<td>10.8-23.5</td>
<td></td>
</tr>
<tr>
<td>Age (years), median (IQR)</td>
<td>67 (53.77)</td>
<td>67 (53.77)</td>
<td>67 (52.77)</td>
<td>65 (49.75)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Female, %</td>
<td>44.7</td>
<td>44.4</td>
<td>45.7</td>
<td>45.6</td>
<td>0.11</td>
</tr>
<tr>
<td>Comorbidities, %</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>83.5%</td>
<td>83.2%</td>
<td>81.9%</td>
<td>79.8%</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Liver disease</td>
<td>2.4%</td>
<td>2.6%</td>
<td>2.5%</td>
<td>2.6%</td>
<td>0.88</td>
</tr>
<tr>
<td>Cardiovascular disease</td>
<td>1.9%</td>
<td>1.7%</td>
<td>1.6%</td>
<td>1.6%</td>
<td>0.17</td>
</tr>
<tr>
<td>Respiratory disease</td>
<td>3.3%</td>
<td>2.8%</td>
<td>2.9%</td>
<td>2.9%</td>
<td>0.08</td>
</tr>
<tr>
<td>Renal disease</td>
<td>1.9%</td>
<td>1.7%</td>
<td>2.0%</td>
<td>2.4%</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Hematologic malignancy</td>
<td>1.8%</td>
<td>1.9%</td>
<td>2.0%</td>
<td>3.2%</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Metastatic cancer</td>
<td>2.1%</td>
<td>2.9%</td>
<td>3.2%</td>
<td>3.7%</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Immunocompromised state</td>
<td>6.3%</td>
<td>6.6%</td>
<td>7.4%</td>
<td>9.3%</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Functional status prior to</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>No assistance needed</td>
<td>73.7%</td>
<td>74.8%</td>
<td>74.4%</td>
<td>76.9%</td>
<td></td>
</tr>
<tr>
<td>Assistance needed for some</td>
<td>20.3%</td>
<td>19.4%</td>
<td>19.9%</td>
<td>17.3%</td>
<td></td>
</tr>
<tr>
<td>Assistance needed for most</td>
<td>5.1%</td>
<td>4.8%</td>
<td>4.7%</td>
<td>5.0%</td>
<td></td>
</tr>
<tr>
<td>Assistance needed for all</td>
<td>0.9%</td>
<td>1.0%</td>
<td>1.0%</td>
<td>0.8%</td>
<td></td>
</tr>
<tr>
<td>Predicted mortality (IM2013), mean % (standard deviation)</td>
<td>24.2 (26.7)</td>
<td>24.4 (27.1)</td>
<td>23.8 (26.5)</td>
<td>24.1 (26.7)</td>
<td>0.37</td>
</tr>
<tr>
<td>Medical patient, %</td>
<td>62.1%</td>
<td>61.7%</td>
<td>61.3%</td>
<td>63.4%</td>
<td>0.006</td>
</tr>
<tr>
<td>Admitting diagnosis, %</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Cardiovascular</td>
<td>17.6%</td>
<td>19.3%</td>
<td>17.1%</td>
<td>17.4%</td>
<td></td>
</tr>
<tr>
<td>Dermatologic</td>
<td>0.7%</td>
<td>0.6%</td>
<td>1.0%</td>
<td>1.3%</td>
<td></td>
</tr>
<tr>
<td>Endocrine/metabolic/poisoning</td>
<td>7.7%</td>
<td>7.3%</td>
<td>7.8%</td>
<td>8.9%</td>
<td></td>
</tr>
<tr>
<td>Gastrointestinal</td>
<td>22.8%</td>
<td>23.8%</td>
<td>26.0%</td>
<td>21.3%</td>
<td></td>
</tr>
<tr>
<td>Genitourinary</td>
<td>12.2%</td>
<td>11.7%</td>
<td>11.2%</td>
<td>10.8%</td>
<td></td>
</tr>
<tr>
<td>Hematologic/immunologic</td>
<td>1.4%</td>
<td>1.2%</td>
<td>1.2%</td>
<td>1.8%</td>
<td></td>
</tr>
<tr>
<td>Musculoskeletal</td>
<td>6.4%</td>
<td>4.9%</td>
<td>4.1%</td>
<td>4.1%</td>
<td></td>
</tr>
<tr>
<td>Neurologic</td>
<td>8.2%</td>
<td>8.6%</td>
<td>8.0%</td>
<td>8.4%</td>
<td></td>
</tr>
<tr>
<td>Respiratory</td>
<td>22.9%</td>
<td>22.6%</td>
<td>23.6%</td>
<td>25.9%</td>
<td></td>
</tr>
<tr>
<td>Organ failures in first 24h in the ICU, %</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.08</td>
</tr>
<tr>
<td>0</td>
<td>15.0%</td>
<td>15.3%</td>
<td>15.0%</td>
<td>14.8%</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>32.0%</td>
<td>31.4%</td>
<td>32.3%</td>
<td>31.4%</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>27.7%</td>
<td>27.8%</td>
<td>28.0%</td>
<td>28.5%</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>16.3%</td>
<td>15.7%</td>
<td>15.7%</td>
<td>15.4%</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>7.6%</td>
<td>8.1%</td>
<td>7.5%</td>
<td>8.0%</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>1.4%</td>
<td>1.6%</td>
<td>1.5%</td>
<td>1.9%</td>
<td></td>
</tr>
<tr>
<td>Advanced respiratory support during ICU stay§, %</td>
<td>41.9%</td>
<td>43.2%</td>
<td>42.9%</td>
<td>47.0%</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Level of care required‖</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Highest in the first 24h, %</td>
<td>1.0%</td>
<td>1.1%</td>
<td>1.2%</td>
<td>1.0%</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>2</td>
<td>53.5%</td>
<td>52.9%</td>
<td>53.5%</td>
<td>50.8%</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>45.5%</td>
<td>45.9%</td>
<td>45.3%</td>
<td>48.2%</td>
<td></td>
</tr>
<tr>
<td>Average over ICU stay, median (IQR)</td>
<td>2.0 (2.0,2.7)</td>
<td>2.0 (2.0,2.7)</td>
<td>2.0 (2.0,2.7)</td>
<td>2.0 (2.0,2.8)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Treatment withheld/withdrawn, %</td>
<td>12.9%</td>
<td>13.8%</td>
<td>12.4%</td>
<td>12.4%</td>
<td>0.003</td>
</tr>
<tr>
<td>Hospital Type, %</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Non-university</td>
<td>66.8%</td>
<td>63.1%</td>
<td>60.5%</td>
<td>38.7%</td>
<td></td>
</tr>
<tr>
<td>University</td>
<td>15.3%</td>
<td>16.5%</td>
<td>19.9%</td>
<td>37.9%</td>
<td></td>
</tr>
<tr>
<td>University-affiliated</td>
<td>17.8%</td>
<td>20.4%</td>
<td>19.5%</td>
<td>23.4%</td>
<td></td>
</tr>
</tbody>
</table>

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**eTable 1. Cohort Characteristics Stratified by Patient-to-Intensivist Ratios.**

<table>
<thead>
<tr>
<th>Outcomes*</th>
<th>Quartile 1†</th>
<th>Quartile 2†</th>
<th>Quartile 3†</th>
<th>Quartile 4†</th>
<th>p-value‡</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ultimate hospital mortality, %</td>
<td>25.8</td>
<td>26.0</td>
<td>24.4</td>
<td>26.4</td>
<td>0.002</td>
</tr>
<tr>
<td>Original hospital mortality, %</td>
<td>25.1</td>
<td>25.3</td>
<td>23.7</td>
<td>25.8</td>
<td>0.002</td>
</tr>
<tr>
<td>Ultimate ICU mortality, %</td>
<td>18.9</td>
<td>19.5</td>
<td>17.9</td>
<td>20.1</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Original ICU mortality, %</td>
<td>18.6</td>
<td>19.3</td>
<td>17.6</td>
<td>19.9</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Original ICU length of stay (days), median (IQR)</td>
<td>2.2 (1.0,5.1)</td>
<td>2.1 (1.0,4.4)</td>
<td>2.3 (1.1,5.1)</td>
<td>2.2 (1.1,5.0)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Physician Coverage of ICUs*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Intensivist Responsible</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Exclusively for ICU</td>
<td>41.9</td>
<td>62.0</td>
<td>73.6</td>
<td>95.4</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td># of rounds per week, mean</td>
<td>11.6 (4.3)</td>
<td>12.7 (4.8)</td>
<td>13.9 (4.6)</td>
<td>15.0 (3.8)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td># of handovers in 24 hours,</td>
<td>2.2 (0.5)</td>
<td>2.2 (0.5)</td>
<td>2.2 (0.5)</td>
<td>2.1 (0.5)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>mean (sd)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Base Specialty of Intensivists</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Anesthesiology</td>
<td>97.4</td>
<td>97.2</td>
<td>96.2</td>
<td>89.3</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Emergency medicine</td>
<td>0.5</td>
<td>0.8</td>
<td>0.9</td>
<td>0.6</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Medicine</td>
<td>2.1</td>
<td>2.0</td>
<td>2.9</td>
<td>10.1</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Surgery</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Dedicated Nighttime Intensivist Coverage</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>None</td>
<td>57.7</td>
<td>42.4</td>
<td>33.3</td>
<td>5.9</td>
<td></td>
</tr>
<tr>
<td>On-Call</td>
<td>4.7</td>
<td>2.7</td>
<td>2.0</td>
<td>11.9</td>
<td></td>
</tr>
<tr>
<td>In-Hospital</td>
<td>37.6</td>
<td>54.9</td>
<td>64.7</td>
<td>82.2</td>
<td></td>
</tr>
<tr>
<td>Nighttime Physician Coverage</td>
<td>&lt;0.001</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intensivist In-Hospital (dedicated/cross-cover); Fellow (dedicated)</td>
<td>2.6</td>
<td>4.4</td>
<td>5.4</td>
<td>0.7</td>
<td></td>
</tr>
<tr>
<td>Intensivist On-Call (exclusively for ICU); Fellow (dedicated)</td>
<td>19.0</td>
<td>24.3</td>
<td>32.9</td>
<td>71.2</td>
<td></td>
</tr>
<tr>
<td>Intensivist On-Call (not exclusively for ICU); Fellow (cross-cover)</td>
<td>13.3</td>
<td>7.1</td>
<td>1.2</td>
<td>0.9</td>
<td></td>
</tr>
<tr>
<td>Intensivist On-Call (exclusively for ICU); Fellow (cross-cover)</td>
<td>12.1</td>
<td>23.1</td>
<td>27.3</td>
<td>4.4</td>
<td></td>
</tr>
<tr>
<td>Intensivist On-Call (not exclusively for ICU); Senior/Junior Resident</td>
<td>38.4</td>
<td>30.6</td>
<td>25.4</td>
<td>3.6</td>
<td></td>
</tr>
<tr>
<td>Intensivist On-Call (exclusively for ICU); Senior/Junior Resident</td>
<td>10.7</td>
<td>8.3</td>
<td>7.5</td>
<td>16.2</td>
<td></td>
</tr>
<tr>
<td>Intensivist On-Call (not exclusively for ICU)</td>
<td>3.8</td>
<td>2.1</td>
<td>0.3</td>
<td>2.9</td>
<td></td>
</tr>
</tbody>
</table>

ADLs: activities of daily living; ICU: intensive care unit; IM2013: ICNARC model, 2013 recalibration; IQR: interquartile range; PIR: patient-to-intensivist ratio using primary definition = total number of patients in the unit daily from 0800-1559 averaged over the patient's stay

* data were missing for: comorbidities, n=233 (0.5%); functional status prior to hospitalization n=235 (0.5%); patient type, n=5 (0.01%); predicted mortality (IM4), n=12 (0.02%); level of care required, first 24 hours, n=191 (0.4%); level of care averaged over ICU stay, n=20 (0.04%); treatment withheld/withdrawn, n=1 (<0.01%); ultimate hospital mortality, n=127 (3%); original hospital mortality n=2 (<0.01%); ultimate ICU mortality n=248 (0.5%); base specialty for intensivists, n=1168 (2%); dedicated nighttime intensivist coverage, n=4675 (9%); nighttime physician coverage pattern, n=1826 (4%)
† Quartiles defined from full cohort of N=49,868 patients
‡ p-values calculated as Chi-square and ANOVA as appropriate
§ defined as receipt of invasive mechanical ventilation and/or extracorporeal respiratory support

1 = risk of their condition deteriorating, or those recently relocated from higher levels of care, whose needs can be met on an acute ward with additional advice and support from the critical care team; 2 = requiring more detailed observation or intervention including support for a single failing organ system or post-operative care and those 'stepping down' from higher levels of care; 3 = requiring advanced respiratory support alone or monitoring and support for two or more organ systems including all complex patients requiring support for multi-organ failure
### eTable 2. Cohort Characteristics Stratified by ICU Size.

<table>
<thead>
<tr>
<th>Patient characteristics*</th>
<th>Tertile 1 (Small ICUs)</th>
<th>Tertile 2</th>
<th>Tertile 3 (Large ICUs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients, n</td>
<td>16119</td>
<td>12948</td>
<td>20619</td>
</tr>
<tr>
<td>ICUs, n</td>
<td>44</td>
<td>19</td>
<td>31</td>
</tr>
<tr>
<td>ICU bed number, median (IQR)</td>
<td>8 (7,8)</td>
<td>10 (9,10)</td>
<td>14 (12,16)</td>
</tr>
<tr>
<td>Age (years), median (IQR)</td>
<td>66 (52,76)</td>
<td>68 (55,78)</td>
<td>65 (50,75)</td>
</tr>
<tr>
<td>Female, %</td>
<td>44.6</td>
<td>44.5</td>
<td>45.8</td>
</tr>
<tr>
<td>Comorbidities, %</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>83.8</td>
<td>84.4</td>
<td>79.4</td>
</tr>
<tr>
<td>Liver disease</td>
<td>2.6</td>
<td>2.1</td>
<td>2.7</td>
</tr>
<tr>
<td>Cardiovascular disease</td>
<td>1.9</td>
<td>1.4</td>
<td>1.8</td>
</tr>
<tr>
<td>Respiratory disease</td>
<td>3.1</td>
<td>2.7</td>
<td>3.1</td>
</tr>
<tr>
<td>Renal disease</td>
<td>1.8</td>
<td>1.5</td>
<td>2.4</td>
</tr>
<tr>
<td>Hematologic malignancy</td>
<td>1.7</td>
<td>1.8</td>
<td>2.9</td>
</tr>
<tr>
<td>Metastatic cancer</td>
<td>2.1</td>
<td>2.8</td>
<td>3.8</td>
</tr>
<tr>
<td>Immunocompromised state</td>
<td>6.2</td>
<td>6.4</td>
<td>8.9</td>
</tr>
<tr>
<td>Functional status prior to hospitalization, %</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No assistance needed</td>
<td>74.7</td>
<td>75.0</td>
<td>75.1</td>
</tr>
<tr>
<td>Assistance needed for some ADLs</td>
<td>19.8</td>
<td>18.6</td>
<td>19.1</td>
</tr>
<tr>
<td>Assistance needed for most ADLs</td>
<td>4.6</td>
<td>5.3</td>
<td>4.9</td>
</tr>
<tr>
<td>Assistance needed for all ADLs</td>
<td>0.9</td>
<td>1.1</td>
<td>0.8</td>
</tr>
<tr>
<td>Predicted mortality (IM2013), mean % (standard deviation)</td>
<td>25.2 (27.3)</td>
<td>23.3 (26.8)</td>
<td>23.8 (26.3)</td>
</tr>
<tr>
<td>Medical patient, %</td>
<td>64.7</td>
<td>56.9</td>
<td>63.4</td>
</tr>
<tr>
<td>Admitting diagnosis, %</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cardiovascular</td>
<td>18.9</td>
<td>19.4</td>
<td>16.1</td>
</tr>
<tr>
<td>Dermatologic</td>
<td>0.6</td>
<td>0.7</td>
<td>1.2</td>
</tr>
<tr>
<td>Endocrine/metabolic/poisoning</td>
<td>8.0</td>
<td>6.6</td>
<td>8.6</td>
</tr>
<tr>
<td>Gastrointestinal</td>
<td>21.5</td>
<td>26.0</td>
<td>23.3</td>
</tr>
<tr>
<td>Genitourinary</td>
<td>12.5</td>
<td>10.4</td>
<td>11.4</td>
</tr>
<tr>
<td>Hematologic/immunologic</td>
<td>1.4</td>
<td>1.0</td>
<td>1.7</td>
</tr>
<tr>
<td>Musculoskeletal</td>
<td>5.0</td>
<td>6.0</td>
<td>4.1</td>
</tr>
<tr>
<td>Neurologic</td>
<td>8.8</td>
<td>8.5</td>
<td>7.9</td>
</tr>
<tr>
<td>Respiratory</td>
<td>23.2</td>
<td>21.3</td>
<td>25.7</td>
</tr>
<tr>
<td>Organ failures in first 24h in the ICU, %</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>15.3</td>
<td>15.6</td>
<td>14.5</td>
</tr>
<tr>
<td>1</td>
<td>30.6</td>
<td>32.7</td>
<td>32.1</td>
</tr>
<tr>
<td>2</td>
<td>27.7</td>
<td>27.6</td>
<td>28.5</td>
</tr>
<tr>
<td>3</td>
<td>16.7</td>
<td>14.9</td>
<td>15.6</td>
</tr>
<tr>
<td>4</td>
<td>8.1</td>
<td>7.8</td>
<td>7.6</td>
</tr>
<tr>
<td>5</td>
<td>1.6</td>
<td>1.4</td>
<td>1.7</td>
</tr>
<tr>
<td>Advanced respiratory support during ICU stay†</td>
<td>45.0</td>
<td>39.9</td>
<td>45.2</td>
</tr>
<tr>
<td>Level of care required§</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Highest in the first 24h, %</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>1.4</td>
<td>0.9</td>
<td>0.9</td>
</tr>
<tr>
<td>2</td>
<td>49.8</td>
<td>56.7</td>
<td>52.3</td>
</tr>
<tr>
<td>3</td>
<td>48.7</td>
<td>42.3</td>
<td>46.8</td>
</tr>
<tr>
<td>Average over ICU stay, median (IQR)</td>
<td>2.0 (2.0, 2.8)</td>
<td>2.0 (2.0, 2.7)</td>
<td>2.0 (2.0, 2.7)</td>
</tr>
<tr>
<td>Treatment withheld/withdrawn, %</td>
<td>14.0</td>
<td>12.9</td>
<td>12.0</td>
</tr>
<tr>
<td>Hospital Type, %</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-university</td>
<td>68.6</td>
<td>66.8</td>
<td>42.5</td>
</tr>
<tr>
<td>University</td>
<td>12.3</td>
<td>19.1</td>
<td>32.3</td>
</tr>
<tr>
<td>University-affiliated</td>
<td>19.1</td>
<td>14.0</td>
<td>25.2</td>
</tr>
</tbody>
</table>

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### eTable 2. Cohort Characteristics Stratified by ICU Size. (continued)

<table>
<thead>
<tr>
<th>Outcomes*</th>
<th>Tertile 1 (Small ICUs)</th>
<th>Tertile 2</th>
<th>Tertile 3 (Large ICUs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ultimate hospital mortality, %</td>
<td>27.4</td>
<td>24.7</td>
<td>24.9</td>
</tr>
<tr>
<td>Original hospital mortality, %</td>
<td>26.6</td>
<td>24.1</td>
<td>24.3</td>
</tr>
<tr>
<td>Ultimate ICU mortality, %</td>
<td>20.5</td>
<td>18.1</td>
<td>18.6</td>
</tr>
<tr>
<td>Original ICU mortality, %</td>
<td>20.2</td>
<td>18.0</td>
<td>18.4</td>
</tr>
<tr>
<td>Original ICU length of stay (days), median (IQR)</td>
<td>2.1 (1.0,4.4)</td>
<td>2.1 (1.0,4.4)</td>
<td>2.3 (1.1,5.3)</td>
</tr>
</tbody>
</table>

ADLs: activities of daily living; ICU: intensive care unit; IM2013: ICNARC model, 2013 recalibration; IQR: interquartile range

* all comparisons have p<0.05; data were missing for: comorbidities, n=233 (0.5%); functional status prior to hospitalization n=235 (0.5%); patient type, n=5 (0.01%); predicted mortality (IM4), n=12 (0.02%); level of care required, first 24 hours, n=191 (0.4%); level of care averaged over ICU stay, n=20 (0.04%); treatment withheld/withdrawn, n=1 (0.01%); ultimate hospital mortality, n=127 (3%); original ICU mortality n=248 (0.5%)

† defined as receipt of invasive mechanical ventilation and/or extracorporeal respiratory support

§ 1 = risk of their condition deteriorating, or those recently relocated from higher levels of care, whose needs can be met on an acute ward with additional advice and support from the critical care team; 2 = requiring more detailed observation or intervention including support for a single failing organ system or post-operative care and those 'stepping down' from higher levels of care; 3 = requiring advanced respiratory support alone or monitoring and support for two or more organ systems including all complex patients requiring support for multi-organ failure
eFigure 4. Association of Patient-to-Intensivist Ratio and Ultimate Hospital Mortality Stratified by ICU Size Tertiles.*

A. Smallest ICUs (lowest tertile bed number, ≤8) †

B. Middle-sized ICUs (mid-tertile bed number, 9-11) †

C. Largest ICUs (highest tertile bed number, ≥12) †

* The plotted curves depict the effect on mortality for an “average patient”—defined as having the average of all non-patient-to-intensivist ratio covariates—as a function of patient-to-intensivist ratio. Definition of patient-to-intensivist ratio is the primary definition = total number of patients in the unit daily from 0800-1559 averaged over the patient’s stay. Black circles = point estimates; gray bands = 95% confidence intervals.

† there is an association between patient-to-intensivist ratio and ultimate hospital mortality (p<0.001); and the association is non-linear (p<0.001)

‡ there is no association between patient-to-intensivist ratio and ultimate hospital mortality (p=0.147)
§ there is an association between patient-to-intensivist ratio and ultimate hospital mortality ($p=0.001$); and the association is non-linear ($p=0.012$)
eFigure 5. Association of Patient-to-Intensivist Ratio and Ultimate Hospital Mortality Stratified by ICU Size by Individual Bed Number.*

A. 4-6 Beds

B. 7-8 Beds

C. 9-10 Beds

D. 11-12 Beds

E. 13-14 Beds

F. 15-16 Beds

F. ≥17

* The plotted curves depict the effect on mortality for an "average patient"—defined as having the average of all non-patient-to-intensivist ratio covariates—as a function of patient-to-intensivist ratio. Definition of patient-to-intensivist ratio is the primary definition = total number of patients in the unit daily from 0800-1559 averaged over the patient’s stay. Black circles = point estimates; gray bands = 95% confidence intervals.

† there is an association between patient-to-intensivist ratio and ultimate hospital mortality (p=0.032); and the association is non-linear (p=0.013)

‡ there is an association between patient-to-intensivist ratio and ultimate hospital mortality (p=0.004); and the association is non-linear (p=0.003)

§ there is no association between patient-to-intensivist ratio and ultimate hospital mortality (p=0.147)

‖ there is no association between patient-to-intensivist ratio and ultimate hospital mortality (p=0.348)

¶ there is an association between patient-to-intensivist ratio and ultimate hospital mortality (p=0.011); and the association is non-linear (p=0.045)

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** there is no association between patient-to-intensivist ratio and ultimate hospital mortality ($p=0.160$)

*** there is no association between patient-to-intensivist ratio and ultimate hospital mortality ($p=0.439$)
eFigure 6. Association of Patient-to-Intensivist Ratio and Hospital and Intensive Care Unit Mortality for Patients in Units with More Than One Intensivist during the Daytime.*

A. Ultimate hospital †

B. Primary hospital †

C. Ultimate ICU ‡

D. Primary ICU

* The plotted curves depict the effect on mortality for an “average patient”—defined as having the average of all non-patient-to-intensivist ratio covariates—as a function of patient-to-intensivist ratio. Definition of patient-to-intensivist ratio is the primary definition = total number of patients in the unit daily from 0800-1559 averaged over the patient’s stay; it is assumed that the burden of patients is divided evenly between intensivists on all days such that the total number of patients in the unit daily for each intensivist is the total number of patients in the unit daily for all intensivists divided by the number of intensivists; including only patients with PIR≤10.

Black circles = point estimates; gray bands = 95% confidence intervals.

† there is no association between patient-to-intensivist ratio and ultimate hospital mortality (p=0.514)

‡ there is no association between patient-to-intensivist ratio and ultimate hospital mortality (p=0.486)

§ there is no association between patient-to-intensivist ratio and ultimate hospital mortality (p=0.385)

‖ there is no association between patient-to-intensivist ratio and ultimate hospital mortality (p=0.465)