Society of Critical Care Medicine
The Intensive Care Professionals

U.S. ICU Resource Availability for COVID-19

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SCCM Ventilator Taskforce

With the onset of COVID-19,[1] the Society of Critical Care Medicine (SCCM) has updated its statistics[2] on critical care resources available in the United States to answer common questions regarding care for an overwhelming number of critically ill patients, many of whom may require mechanical ventilation.[1] In this report, we address the most current data and estimates on the number of acute care, intensive care unit (ICU), and step-down (i.e., observation, progressive) beds; mechanical ventilators and staffing. We also seek to provide context to the data.

Acute care hospitals, ICU, step-down, and burn beds: The American Hospital Association (AHA) maintains a proprietary dataset of most hospitals in the United States. Data is gathered by voluntary survey. In April 2019, a study published in *Critical Care Medicine* analyzed the 2015 AHA dataset.[3] The document presents the most currently available AHA data from 2018.[4] These data show minimal changes from 2015. The 2018 AHA data indicate that there are 5256 AHA-registered community hospitals in the United States. Of these, 2704 (51.4%) deliver ICU services and have at least 10 acute care beds and at least one ICU bed (**Figure 3**). They have 534,964 acute care beds, including 96,596 ICU beds (**Table 1**), with a median ICU-to-hospital bed ratio of 16.7%. The ICU beds can be categorized as adult, pediatric, or neonatal. There are 68,558 adult beds (medical-surgical 46,795, cardiac 14,445, and other ICU 7318), 5137 pediatric ICU beds, and 22,901 neonatal ICU beds. Additionally, there are 25,157 step-down beds, and 1183 burn beds. The AHA does not include data on negative pressure capability in the rooms with these beds. The purpose of a negative pressure room is to confine pathogens to a single closed environment and to prevent the release of pathogens into other adjacent spaces. Negative pressure is strongly recommended with heavily communicable diseases such as COVID-19. When negative pressure rooms are not available, HEPA filters are installed in exhaust ducts leading from rooms with infected patients or patients are cohorted to separate facilities for care.[5]

Acute care hospitals by core-based statistical area (CBSA): Of the 2704 hospitals, 74% (1996) are in metropolitan areas (> 50,000 population), 17% (464) in micropolitan areas (10,000-49,999 population), and the remaining 9% (244) in rural areas (< 10,000 population) (**Table 2**). Concomitantly, 91% (489,337) of acute care beds and 94% (90,561) of ICU beds are in metropolitan hospitals. Only 7% (36,453) of hospital beds and 5% (4715) of ICU beds are in micropolitan areas. The remainder are in rural areas.

Contingency and crisis beds for critically ill patients: We have focused on documented ICU, step-down, and burn beds above. In an emergency, when contingency plans are implemented, additional monitored hospital beds including post-anesthesia care unit beds or operating rooms (with ventilators) can be used as elective surgeries are cancelled.[6] At crisis levels, even non-monitored beds may be mobilized for use but these should be secondary to the aforementioned beds.

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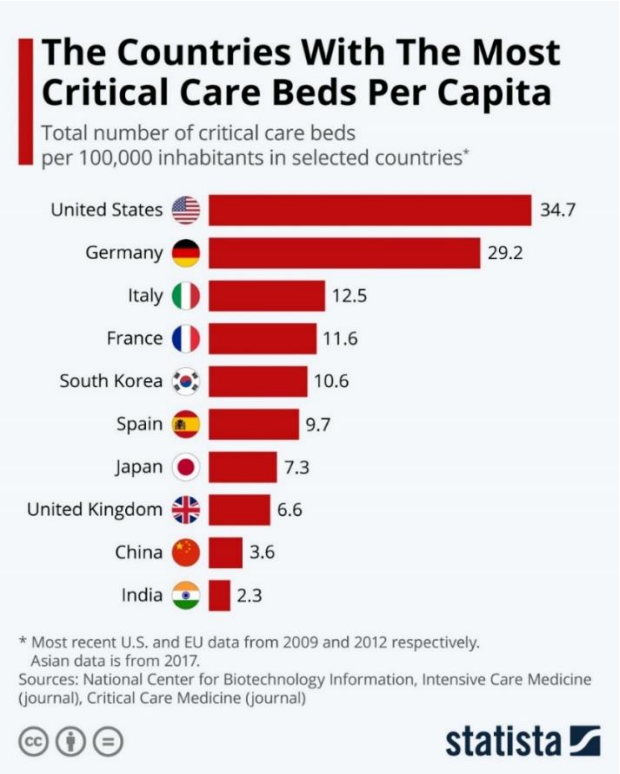
Comparison of U.S. critical care beds to other countries. The United States has a significant number of critical care beds per capita when compared to other countries (**Figure 1**).

Figure 1. Countries With The Most Critical Care Beds Per Capita



Mechanical ventilators: Reports from ICUs worldwide suggest that the most common reason for COVID-19 patient admission to the ICU is severe hypoxic respiratory failure requiring mechanical ventilation.

Supply of mechanical ventilators in U.S. acute care hospitals: Based on a 2009 survey of AHA hospitals, U.S. acute care hospitals are estimated to own approximately 62,000 full-featured mechanical ventilators.[7] Approximately 46% of these can be used to ventilate pediatric and neonatal patients. Additionally, some hospitals keep older models for emergency purposes. Older models, which are not full featured but may provide basic functions, add an additional 98,738 ventilators to the U.S. supply.[7] The older devices include 22,976 noninvasive ventilators, 32,668 automatic resuscitators, and 8,567 continuous positive airway pressure (CPAP) units.

Centers for Disease Control and Prevention Strategic National Stockpile (SNS) and other ventilator sources: The SNS has an estimated 8,900 ventilators for emergency deployment. These devices are not full featured but offer basic ventilatory modes. Accessing the SNS requires hospital administrators to request that state health officials ask for access to this equipment. SNS can deliver ventilators within 24-36 hours of the federal decision to deploy them.[8,9] States may have their own ventilator stockpiles as well. Respiratory therapy departments also rent ventilators from local companies, further expanding the supply. Additionally, many modern anesthesia machines are capable of ventilating patients and can be used to increase hospitals' surge capacity.

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The addition of older hospital ventilators, SNS ventilators, and anesthesia machines increases the absolute number of ventilators to possibly above 200,000 units. Many of the additional and older ventilators, however, may not be capable of adequately supporting patients with severe acute respiratory failure. Supplies for these ventilators may also not be available due to interruptions in the international supply chain. Moreover, an analysis of the literature suggests that U.S. hospitals could absorb between 26,000 and 56,000 additional ventilators at the peak of a national pandemic, as safe use of ventilators requires trained personnel.[10]

Estimates of hospitalized patients requiring critical care and mechanical ventilation: The U.S. Department of Health and Human Services (HHS) estimated in 2005 that 865,000 U.S. residents would be hospitalized during a moderate pandemic (as in the 1957 and 1968 influenza pandemics) and 9.9 million during a severe pandemic (as in the 1918 influenza pandemic).[11] A recent AHA estimate for COVID-19 projected that 4.8 million patients would be hospitalized, 1.9 million of these would be admitted to the ICU, and 960,000 would require ventilatory support.[4, 12]

Staffing to care for critically ill patients: As large numbers of critically ill patients are admitted to ICU, step-down, and other expansion beds, it must be determined who will care for them. Having an adequate supply of beds and equipment is not enough. Based on AHA 2015 data, there are 28,808 privileged and 19,996 full-time equivalent intensivists in the United States; however, 48% of acute care hospitals have no intensivists.[3] An intensivist is a board-certified physician who provides special care for critically ill patients. Also known as a critical care physician, the intensivist has advanced training and experience in treating this complex type of patient. Based on our analysis, the intensivist deficit will be significant. Additionally, there are an estimated 34,000 critical care advanced practice providers (APPs) available to provide care for critically ill patients.[13] Other physicians (e.g., pulmonologists, surgeons, anesthesiologists, etc) may be pressed into service as outpatient clinics and elective surgery are suspended. In addition to intensivists, all other ICU staff (advanced practice providers, nurses, pharmacists, respiratory therapists, etc) will also be in short supply. Without these key members of the ICU team, critical care cannot be adequately delivered. Moreover, an indeterminate number of experienced ICU staff may become ill, further straining the system as need and capacity surge.

At the crisis levels forecast above, we estimate that the shortage of ICU physicians, advanced practice providers, respiratory therapists, and nurses trained in mechanical ventilation would limit the maximum number of ventilated patients to approximately 135,000, well within the supply of currently available equipment.[10] Therefore, priority should focus on expanding the number of trained professionals, for both the near and longer term, who will be needed to both mechanically ventilate patients with COVID-19 as well as to care for other critically ill patients who would normally require ICU care.

Augmenting critical care staffing: To deal with this issue, SCCM encourages hospitals to adopt a tiered staffing strategy in pandemic situations such as COVID-19 (**Figure 2**). Hospitals with telemedicine capacity may also use the technology to connect with expert resources at other locations.

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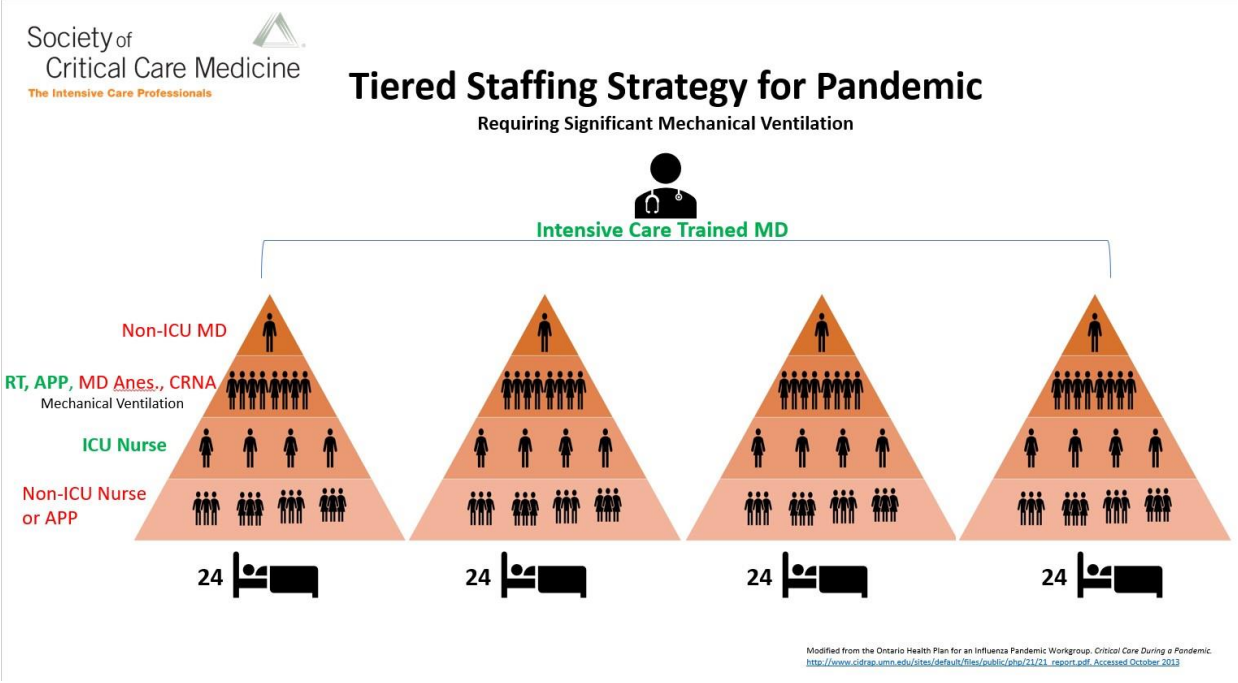
Figure 2. Tiered Staffing Strategy for Pandemic



Using this model, non-ICU trained inexperienced physicians, certified registered nurse anesthetists, operating room nurses, general ward nurses, non-ICU advanced practice providers and others (noted in red) greatly augment the trained and experienced ICU staff (noted in **green**). While the ratios shown in the figure depict generally accepted models of critical care staff augmentation, each hospital will need to adjust both to the demands for critical care using the available supply of personnel. SCCM offers free online training resources to help these non-typical ICU staff as they prepare to care for critically ill patients during the crisis. While the level of care may not be the same as in the typical ICU in non-crisis times, having the care directed by trained and experienced members of the ICU team is an effective way to maximize care for large numbers of critically ill patients.

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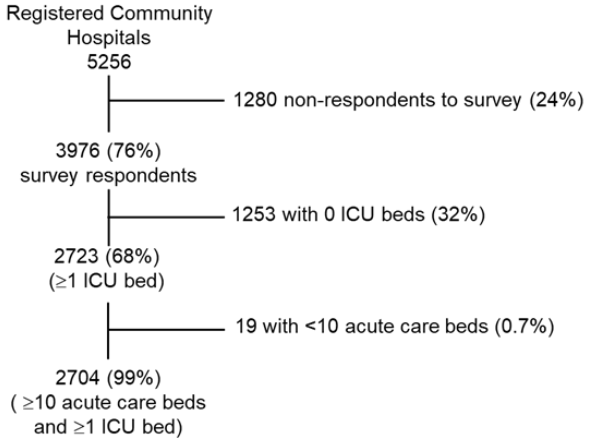
Figure 3. AHA 2018 Data



In 2018, there were 5256 AHA-registered community hospitals. Of these, 3976 (76%) responded to the AHA survey. Of these, 2704 met our criteria for acute care hospitals that deliver critical care services. Only a minority of Department of Veterans Affairs and Department of Defense hospitals participate in the AHA survey; none were included in this report as they were not classified as community hospitals by the AHA.

Table 1. Acute Care Hospitals (2018 AHA Data)

	Hospitals Combined (n = 2704)
Aggregate across all hospitals, n (%)	
Number of acute care hospital beds[a]	534,964
Number of ICU beds	96,596
Number of ICU units[b]	5039
Number of ICU beds by unit type[a]	
Medical-surgical	46,795
Cardiac	14,445
Other	7318
Pediatric	5137
Neonatal	22,901
Number of burn beds[c]	1183
Number of other special care (observation, step-down, or progressive) beds[c]	25,157

a. Acute care hospital beds include general medical and surgical adult, pediatric, obstetric, neonatal intermediate, ICU, step-down, and burn beds. Rehabilitation, alcohol/drug abuse or dependency, psychiatric, skilled nursing facility, intermediate nursing, and other long-term beds are excluded.
b. Units refers to the number of hospitals reporting more than one bed per ICU type. Each hospital can have a maximum of five AHA-designated ICU types.
c. Burn and other special care beds (observation, step-down, progressive) are not commonly counted in the ICU bed totals.

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Table 2. Acute Care Hospitals and Beds by Core-Based Statistical Area (AHA 2018 Data)

	Hospitals Combined (n = 2704)
Number of hospitals by location, n (%):[a]	
Metropolitan	1996 (74%)
Micropolitan	464 (17%)
Rural	244 (9%)
Aggregate across all hospitals, n (%)	
Number of hospital beds by location:	
Metropolitan	489,337 (91%)
Micropolitan	36,453 (7%)
Rural	9174 (2%)
Number of ICU beds by location:	
Metropolitan	90,561 (94%)
Micropolitan	4715 (5%)
Rural	1320 (1%)

a. Metropolitan areas: > 50,000 population, micropolitan areas: 10,000-49,999 population, rural areas: < 10,000 population.

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