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Population trends in intensive care unit admissions in the United States among Medicare beneficiaries, 2006 - 2015

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Introduction

Admission to the intensive care unit (ICU) is costly and strains health system resources (1). Accurate estimates of population-level ICU admission rates could aid in disaster planning, training a suitable critical care workforce, and targeting policy interventions to reduce low-value or preference-discordant admissions. We sought to overcome limitations of prior estimates of ICU utilization (2) by using nationally representative data and examining geographic differences in admission incidence.

Methods

Using the 100% Medicare Provider Analysis and Review (MedPAR) file, we counted all acute-care hospitalizations and hospitalizations with ICU care – including cardiac intensive care but not intermediate care (3) – from 2006 through 2015 among Medicare fee-for-service (FFS) beneficiaries 65 years and older. Person-years of coverage were tabulated using the MedPAR Denominator file.

Using data from all 50 states, Washington, DC, and Puerto Rico, we assessed the relationship between ICU admission incidence and total ICU beds (medical, surgical, and cardiac), estimated using the American Hospital Association Annual Survey Database. For

among-state comparisons, we adjusted rates of ICU admission for each states' age and gender distributions using 2010 US Census data. We tested changes over time for counts and proportions using simple Poisson regression and the chi-squared test for trend, respectively. Confidence intervals (CIs) around count estimates were reported using 95% two-sided Poisson values. Analyses were performed using SAS (SAS Institute Inc., Cary, NC) and the R programming language (R Foundation for Statistical Computing, Vienna, Austria).

The Institutional Review Board of the University of Pennsylvania approved this study. This work was supported by grants from the National Institute on Aging and the National Heart, Lung, and Blood Institute, which had no role in the study.

Results

We analyzed claims from 88,402,008 hospitalizations, of which 14,787,690 (16.7%) were associated with ICU care during 289,391,446 person-years of coverage. The ICU admission rate was 6,117 (95% CI 5,965 to 6,272) per 100,000 person-years in 2006, which declined to 4,247 (95% CI 4,120 to 4,377) in 2015 ($P<0.001$). The proportion of hospitalizations that included ICU care declined during this period from 17.0% to 16.3% ($P<0.001$).

We observed a three-fold difference among state-level ICU admission rates, ranging from 2,117 (95% CI 2,027 to 2,209) in Hawaii to 6,312 (95% CI 6,157 to 6,470) in Mississippi. All states experienced a decline in the ICU admission rate except Nebraska, where it increased from 3,798 (95% CI 3,678 to 3,921) in 2006 to 3,992 (95% CI 3,869 to 4,118) in 2015.

The state-level ICU admission rate in 2006 was positively associated with available beds up to approximately 20 ICU beds per 100,000 person-years (Figure 1), with no clear association at greater bed capacities. In 2015, ICU admissions and beds were more strongly positively associated, with a monotonically increasing relationship except for two regions (Washington, DC, and North Dakota) with many beds and few admissions.

Although the national ICU bed count increased 11.4% from 2006 to 2015, state-level changes ranged from -38.1% (Rhode Island) to 54.4% (Washington). There was no observed association between the percentage changes in ICU beds and admissions across states (Figure 2).

Discussion

This nationally-representative study shows that ICU admission rates among Medicare FFS beneficiaries have declined in the past decade. We observed that large state-level differences in ICU admission rates are partially associated with ICU bed availability while temporal changes in admission rates are not associated with bed growth. This observation is consistent with previously reported state- (4) and hospital-level (5) heterogeneity in bed growth and occupancy.

Limitations of this study include the use of MedPAR data which does not represent populations enrolled in other insurance plans or those without insurance. Additionally, we

did not adjust for patient-level factors such as comorbidities, clinician practice patterns, or market competition, which are likely to explain some differences in ICU admission rates.

Policy and population-health strategies to promote high-value care for Medicare FFS beneficiaries requiring ICU services are likely to vary between states. Although the U.S. has more ICU beds per capita than many peer nations (2), bed availability is not the sole driver of ICU admissions, and its effects vary across states. Thus, federal policies governing critical care workforce training and reimbursements for critical care services, and state-level approvals of “certificates of need,” will require more local and granular data.

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Figure 1:

ICU admissions and beds by state over time. Relationship between age- and gender-adjusted ICU admission rates among Medicare fee-for-service beneficiaries at least 65 years of age in each state and available intensive care unit (ICU) beds in 2006 and 2015. Dotted lines represent a locally weighted regression (LOESS) curve with shaded 95% confidence intervals. Spearman's ρ is reported with 95% bootstrapped confidence intervals (10,000 replicates). The correlation between ICU admissions and beds increased between 2006 ($\rho = 0.28$ [95% CI 0.01 to 0.52]) and 2015 ($\rho = 0.58$ [95% CI 0.30 to 0.77]).

Figure 2:

Percentage changes in ICU beds and admissions. Percentage change in intensive care unit (ICU) admissions per 100,000 people at least 65 years old vs percentage change in total ICU beds per 100,000 in each state. Dotted lines represent a locally weighted regression (LOESS) curve with shaded 95% confidence intervals. Spearman's ρ is reported with 95% bootstrapped confidence intervals (10,000 replicates). The percentage changes in ICU beds and admissions from 2006 to 2015 were not correlated ($\rho = 0.03$ [95% CI -0.24 to 0.30]).