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Interprofessional Staffing Pattern Clusters in U.S. ICUs

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OBJECTIVES: To identify interprofessional staffing pattern clusters used in U.S. ICUs.

DESIGN: Latent class analysis.

SETTING AND PARTICIPANTS: Adult U.S. ICUs.

PATIENTS: None.

INTERVENTIONS: None.

ANALYSIS: We used data from a staffing survey that queried respondents (n = 596 ICUs) on provider (intensivist and nonintensivist), nursing, respiratory therapist, and clinical pharmacist availability and roles. We used latent class analysis to identify clusters describing interprofessional staffing patterns and then compared ICU and hospital characteristics across clusters.

MEASUREMENTS AND MAIN RESULTS: We identified three clusters as optimal. Most ICUs (54.2%) were in cluster 1 ("higher overall staffing") characterized by a higher likelihood of good provider coverage (both intensivist [onsite 24 hr/d] and nonintensivist [orders placed by ICU team exclusively, presence of advanced practice providers, and physicians-in-training]), nursing leadership (presence of charge nurse, nurse educators, and managers), and bedside nursing support (nurses with registered nursing degrees, fewer patients per nurse, and nursing aide availability). One-third (33.7%) were in cluster 2 ("lower intensivist coverage & nursing leadership, higher bedside nursing support") and 12.1% were in cluster 3 ("higher provider coverage & nursing leadership, lower bedside nursing support"). Clinical pharmacists were more common in cluster 1 (99.4%), but present in greater than 85% of all ICUs; respiratory therapists were nearly universal. Cluster 1 ICUs were larger (median 20 beds vs. 15 and 17 in clusters 2 and 3, respectively; $p < 0.001$), and in larger (> 250 beds: 80.6% vs. 66.1% and 48.5%; $p < 0.001$), not-for-profit (75.9% vs. 69.4% and 60.3%; $p < 0.001$) hospitals. Telemedicine use 24 hr/d was more common in cluster 3 units (71.8% vs. 11.7% and 14.1%; $p < 0.001$).

CONCLUSIONS: More than half of U.S. ICUs had higher staffing overall. Others tended to have either higher provider presence and nursing leadership or higher bedside nursing support, but not both.

KEYWORDS: intensive care units; nurse practitioners; nurses; pharmacists; physician assistants; physicians

ICU clinicians work together in teams. Yet, ICU staffing is often considered in silos (e.g., physicians, nurses, etc.). While we know that high-functioning ICU teams provide better patient care (1–3), interprofessional evaluations of ICU team staffing are sparse.

In this study, we sought to characterize interprofessional staffing patterns across U.S. ICUs and determine ICU and hospital characteristics associated with them. We hypothesized that there would be a relatively small set of staffing patterns employed across U.S. ICUs and that certain patterns would be more common in certain ICU and hospital settings.

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KEY POINTS

Question: What interprofessional staffing patterns are used in U.S. ICUs?

Findings: Using data from an ICU staffing survey, we identified three staffing pattern clusters: 54.2% of units had “higher overall staffing” (characterized by a higher likelihood of good provider coverage, nursing leadership, and bedside nursing support); 33.7% had “lower intensivist coverage & nursing leadership, higher bedside nursing support”; and 12.1% had “higher provider coverage & nursing leadership, lower bedside nursing support.”

Meaning: More than half of U.S. ICUs had higher staffing overall; the remainder had either higher provider presence and nursing leadership or higher bedside nursing support, but not both.

METHODS

We used data from a described ICU staffing survey in the United States (4). In brief, the survey queried respondents on provider (intensivist and nonintensivist), nursing, respiratory therapist, and clinical pharmacist availability and roles. It was conducted in late 2022-early 2023 but asked for information about ICU staffing in 2019. Responses were linked to the 2020 American Hospital Association Annual Survey Database to obtain hospital characteristics for each ICU.

We used latent class analysis to identify interprofessional staffing clusters. We considered: provider factors (intensivist: the presence of an onsite intensivist 24 hr/d during the weekdays, whether the intensivist every had simultaneous clinical responsibilities outside of their primary ICU; nonintensivist: the presence of advanced practice providers [APPs; nurse practitioners or physician assistants], the presence of physicians-in-training [fellows, residents, or interns], and placement of orders exclusively by the ICU team); bedside nursing factors (whether all ICU nurses had a registered [vs. a licensed practical] nursing degree, the patient-to-nurse ratio for patients receiving invasive mechanical ventilation, and the presence of nurse aides); nursing leadership factors (separately, the presence of a charge nurse, a rapid response team [RRT] nurse, a nurse educator, a nurse manager, and a resource nurse); and the presence of clinical pharmacists. We did not consider respiratory therapist presence as this was nearly universal. We did not consider telemedicine as our intent was to understand onsite staffing patterns. We aimed to allow for 1–5 clusters with plans to select the best fit based on minimization of the Akaike and Bayesian information criteria (5); however, the model for five clusters did not converge and was not considered. We primarily assigned ICUs to a cluster based on their having a probability of being in that cluster of greater than 50%; we performed a sensitivity analysis using a probability cutoff of greater than 90%. ICU and hospital characteristics across clusters were then compared using the chi-square and Kruskal-Wallis tests as appropriate, and adjustments for multiple comparisons were made with Sime’s false discovery rate method (6).

All analyses were conducted STATA 16 (StataCorp, College Station, TX) and Microsoft Excel (Microsoft, Redmond, WA). Ethics approval was obtained from the University of Miami (No. 20201473; study title: “Optimizing Intensive Care Unit Staffing in the United States”; approval date: July 22, 2022). All study procedures were in accordance with the ethical standards of the responsible committee on human experimentation and with the Helsinki Declaration of 1975.

RESULTS

The cohort consisted of 596 ICUs of variable size (median [interquartile range]: 20 beds [12–25 beds]). Most cared for a mixed population (414 [69.5%]), yet medical (55 [9.2%]), surgical (70 [11.7%]), and specialty (57 [9.6%]) ICUs were well represented (4).

We identified three staffing clusters to be optimal (**Table E1**, http://links.lww.com/CCX/B384). Most ICUs (54.2%) were part of cluster 1 (“higher overall staffing”) characterized by a higher likelihood of good provider coverage (both intensivist [onsite 24 hr/d] and nonintensivist [orders placed by ICU team exclusively, presence of APPs, and physicians-in-training]), nursing leadership (presence of charge nurse, nurse educators, and managers), and bedside nursing support (nurses with registered nursing degrees, fewer patients per nurse, and nursing aide availability; **Fig. 1**). One-third (33.7%) were part of cluster 2 (“lower intensivist coverage & nursing leadership, higher bedside nursing support”) and 12.1% were part of cluster

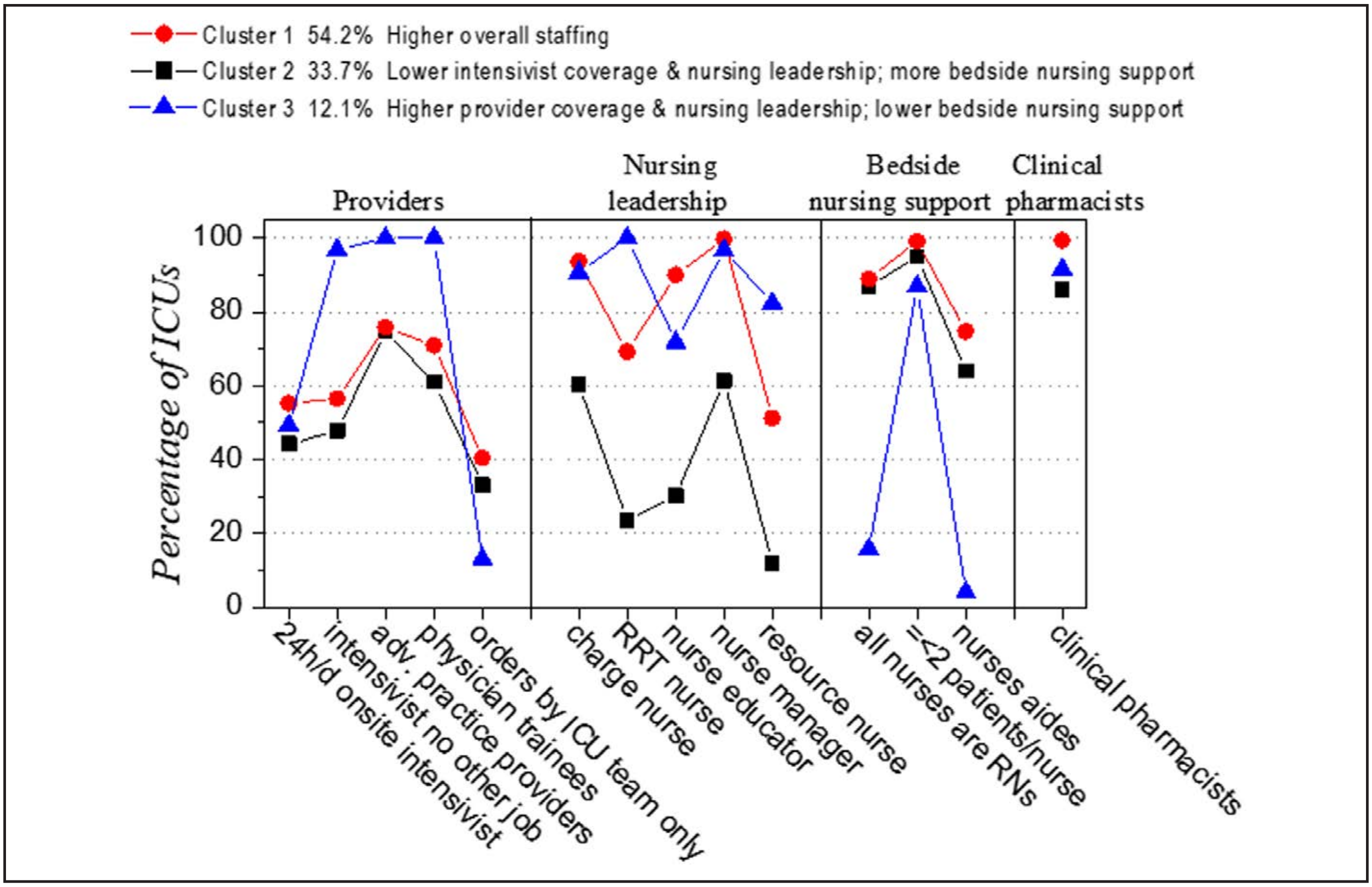

Figure 1. Staffing characteristics used to construct the three-cluster model. adv. = advanced, h/d = hr/d, RNs = registered nurses, RRT = rapid response team.

3 ("higher provider coverage & nursing leadership, lower bedside nursing support"). Clinical pharmacists were more common in cluster 1 (99.4%), but present in greater than 85% of all ICUs.

ICUs with higher overall staffing (cluster 1) tended to be larger (median [interquartile range]: 20 beds [16–28 beds] vs. 15 beds [10–22 beds] and 17 beds [12–25 beds] in clusters 2 and 3, respectively; $p < 0.001$), and were in larger (> 250 beds: 80.6% vs. 66.1% and 48.5%; $p < 0.001$), not-for-profit (75.9% vs. 69.4% and 60.3%; $p < 0.001$) hospitals (**Table 1**). ICUs with higher provider coverage and nursing leadership but lower bedside nursing support (cluster 3) were more commonly in ICUs with 24 hr/d telemedicine coverage (71.8% vs. 11.7% and 14.1%; $p < 0.001$) in smaller, for profit (16.2% vs. 5.3% and 11.5%) or government (23.5% vs. 18.8% and 19.1%) hospitals ($p = 0.010$). ICUs with lower intensivist coverage and nursing leadership, but higher bedside nursing support (cluster 2) tended to be smaller units; ICU telemedicine use mirrored cluster 1 ICUs while hospital characteristics (size and type) were more akin to cluster 3 units. We found no significant association of ICU type (specialty, medical, surgical, or mixed) or geographic region with cluster. These findings were robust to sensitivity analyses assigning ICUs to clusters only if their probability of membership was greater than 90% (**Table E2**, http://links.lww.com/CCX/B384).

DISCUSSION

We identified three patterns of staffing used by U.S. adult ICUs which were characterized by availability of providers (intensivists and/or nonintensivists), nursing leadership, and bedside nursing support. More than half of U.S. ICUs had higher overall staffing, while another third had lower provider coverage and nursing leadership, but higher bedside nursing support. One in eight had higher provider coverage and nursing leadership, but lower bedside nursing support. As hypothesized, certain ICU and hospital characteristics were more common among ICUs in each staffing cluster.

TABLE 1.
ICU and Hospital Characteristics Across Clustersa

Characteristics	Cluster 1, No. of ICUs (%)	Cluster 2, No. of ICUs (%)	Cluster 3, No. of ICUs (%)	p[b]
Cluster description	Higher overall staffing	Lower intensivist coverage & nursing leadership, higher bedside nursing support	Higher provider coverage & nursing leadership, lower bedside nursing support	
No. of ICUs, row %	332 (56.5)	185 (31.5)	71 (12.1)	
ICU characteristics				
ICU type				0.40
Specialty	33 (9.9)	15 (8.1)	8 (11.3)	
Medical	36 (10.8)	13 (7.0)	6 (8.5)	
Surgical	44 (13.3)	18 (9.7)	6 (8.5)	
Mixed	219 (66.0)	139 (75.1)	51 (71.8)	
ICU bed number, median (interquartile range)	20 (16,28)	15 (10,22)	17 (12,25)	< 0.001
Telemedicine				< 0.001
Not used	259 (78.0)	130 (70.3)	17 (23.9)	
Overnight only	18 (5.4)	18 (9.7)	2 (2.8)	
24 hr/d	39 (11.7)	26 (14.1)	51 (71.8)	
Other	16 (4.8)	11 (5.9)	1 (1.4)	
Hospital characteristics[c]				
American Hospital Association region				0.17
1 + 2 + 3	117 (36.6)	70 (38.3)	19 (27.9)	
4 + 7	57 (17.8)	44 (24.0)	15 (22.1)	
5 + 6	73 (22.8)	43 (23.5)	16 (23.5)	
8 + 9	73 (22.8)	26 (14.2)	18 (26.5)	
Hospital bed number				< 0.001
< 100	14 (4.4)	25 (13.7)	13 (19.1)	
100–250	48 (15.0)	37 (20.2)	22 (32.4)	
> 250	258 (80.6)	121 (66.1)	33 (48.5)	
Teaching hospital[d]	209 (65.3)	105 (57.4)	36 (52.9)	0.09
Metropolitan	304 (95.0)	165 (90.2)	60 (88.2)	< 0.001
Hospital type				0.015
Not for profit	243 (75.9)	127 (69.4)	41 (60.3)	
For profit	17 (5.3)	21 (11.5)	11 (16.2)	
Government	60 (18.8)	35 (19.1)	16 (23.5)	

[a]Inclusive of ICUs with > 50% probability of being in a given cluster—$n = 588$ (98.7% of 596 cohort ICUs matched to a cluster).
[b]Using χ^2 and Kruskal-Wallis tests as appropriate with adjustments for multiple comparisons made with Sime's false discovery rate method.
[c]Evaluated among 571 (97.1%) of 588 ICUs, which were in hospitals that could be matched to hospitals in the American Hospital Association survey.
[d]Defined as hospitals reporting the presence of any full-time equivalent residents in the American Hospital Association survey (7).

An unexpected finding was that ICUs appear to focus on one or more broad groups of staff as a unit (e.g., providers or nursing leadership or bedside nursing). It was conceivable that ICUs would aim to offset relative inadequacies in staffing by strengths within the same broad group (e.g., have APPs or physicians-in-training available, but ask the intensivist to provide simultaneous care outside the ICU). Or, recognizing that ICU clinicians function as a team, it was plausible that ICUs would "up-staff" in select (but not all) aspects of each clinician group (i.e., have APPs, but not onsite 24 hr/d intensivists, have charge nurses but not RRT nurses, or have fewer than two patients per nurse but no nursing aides to assist). Yet, what we found was that ICUs tended to be more "all-in" (or not) for each clinician group. While our data do not support exploration of why this approach is used, we hypothesize it may be because different clinician groups: 1) are overseen by different administrators (e.g., Chief Nursing Officers vs. Chief Medical Officers) who may differently prioritize allocation of scarce resources and 2) may face different external pressures (e.g., nursing unions, state policies, or physician medical groups) that affect staffing levels.

Perhaps not surprisingly, ICUs with higher overall staffing tended to be larger and in larger, not-for-profit hospitals. Interestingly, while ICUs in both clusters 2 and 3 (each with lower staffing in 1+ clinician group) included smaller ICUs in smaller, more commonly for profit or government hospitals, ICUs with higher onsite provider coverage (cluster 3) were also more likely to employ telemedicine 24 hr/d than those with lower onsite provider presence (both intensivist and nonintensivist, cluster 2). We typically think of telemedicine as a replacement for absent or suboptimal onsite services (8); however, these cluster 3 ICUs appear to be further enhancing already good provider availability with remote assistance, a further example of the "all-in" approach to clinician staffing as a whole.

Our study is novel in its characterization of multidisciplinary ICU staffing patterns in U.S. ICUs. Zampieri et al (9) performed a cluster analysis of organizational characteristics (including staffing) across Brazilian ICUs and also identified three clusters. While differences in staffing data between their study and ours make comparing clusters between studies difficult, it is interesting to note that they found patient outcomes differed across clusters in their cohort. Whether our U.S. ICU staffing clusters are also associated with different patient outcomes is unknown.

Our study has limitations. We were only able to include staffing variables measured within the survey. Thus, details about nonintensivist clinician roles (above and beyond mere availability) were unavailable. Our cohort was a large sample of ICUs, but was skewed toward more academic, urban units. Finally, we cannot define optimal staffing patterns, as having more clinicians is not necessarily better and we did not have access to patient outcomes.

In sum, we found that three patterns of staffing are employed by ICUs across the United States and that these patterns are based on staffing availability of three broad groups—providers, nursing leadership, and bedside nursing support. Why individual ICUs may focus on one group preferentially over others remains to be understood, as does the impact of these decisions on patient outcomes. However, simply understanding that "clinician group up-staffing" is the approach commonly taken may allow ICU and hospital administrators to more carefully assess their existing staffing strategies and consider whether better balancing staffing deficiencies across clinician groups might be preferred.

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