EDITORIAL

Evidence supports the superiority of closed ICUs for patients and families: No

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In “closed” intensive care units (ICUs), primary responsibility for admitted patients is transferred to an intensivist. In “open” units, the attending physician of record is typically a non-intensivist from another service who may have a longitudinal relationship with the patient and who may or may not consult an intensivist for assistance with management. Open staffing models are much more common in North America [1], whereas closed models predominate in Europe [2].

On its face, it seems obvious that a trained intensivist would provide higher quality intensive care than a physician trained in a different area. Yet, perhaps surprisingly, there exists no compelling evidence that this premise is true. As a result, clinicians, policymakers, patients, and families cannot be sure which models to advocate. Most of the available research comes from North America where full implementation of “high intensity” staffing (closed and/or 24-h intensivist coverage) staffing models has proved impractical given workforce limitations. More than a decade ago, the Leapfrog group recommended mandatory intensivist management of all critically ill patients [3], yet recent guidelines from the American College of Critical Care Medicine are more circumspect [4]. What can we make of the available evidence?

Initial evidence in support of closed ICUs was based on the single-center, before–after study performed by Carson and colleagues [5]. The systematic review by Pronovost et al. in 2002 [6] provided even stronger support for closed ICUs. However, this review did not distinguish between closed models and open models with mandatory intensivist consultation. And because outcomes were

compared between ICUs that chose to adopt high-intensity models versus not to do so, differences among ICUs and hospitals beyond the chosen physician staffing model likely contributed to the results.

A more recent systematic review and meta-analysis examining the relationship between intensivist staffing models and mortality included a much larger number of studies [7]. In this review, the observed mortality benefit associated with “high intensity” staffing was concentrated in surgical rather than medical units, and was not consistent across all decades of analysis. The benefit was strongest during the 1980s, disappeared in the 1990s, re-occurred in the 2000s, and then disappeared again beginning in 2010. The lack of temporal consistency undermines the argument that high-intensity staffing models causally contribute to mortality benefits in the modern era.

Indeed, in the one large observational study to surmount the limitations of among-ICU analyses, those patients for whom management by trained intensivists was chosen experienced higher mortality than those who were never treated by an intensivist [8]. Although we strongly suspect that this apparent harm was attributable to unmeasured confounding by indication, the study certainly casts doubt on the notion that evidence supports a benefit for the type of staffing found in closed ICUs.

In the most robust analysis of this question to date, Nagendran et al. [9] asked whether ICUs experience declines in risk-adjusted mortality after transitioning from open to closed staffing models. This study overcomes many of the center-level and patient-level confounders that plagued prior studies by using a longitudinal difference-in-difference approach in which each ICU serves as its own control. Further, because different ICUs adopted the closed model at different time points, the design mitigates temporal biases associated with simpler before–after designs. Thus, it is notable that

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Table 1 Study designs to assess the influence of intensive care unit organizational or process-of-care characteristics on patient-centered outcomes

Study design	Examples	Advantages	Disadvantages
Randomized trial	Kerlin et al. [16]	Address residual confounding and misclassification bias inherent in observational studies	Expensive
	Huang et al. [17]	Randomization with experimental design isolates causal effect of the exposure	Difficult to enroll sufficient ICUs to examine multiple characteristics simultaneously Typically cannot blind the intervention At risk for selection bias in ICU participation and enrollment
Quasi-experimental design	Nagendran et al. [9]	Accounts for time-dependent, secular trends with a control group	Assessment of time-varying trends dependent on “common shocks” assumption, which is typically not provable
	Garland et al. [14]	Avoids confounding by indication at the patient level	“Parallel trends” assumption may not hold across multiple, heterogeneous hospitals and ICUs
Instrumental variable approach	Kahn et al. [18]	The “pseudo-randomized” design may surmount the problem of confounding by indication	Often difficult to find a strong instrument that meets the verifiable assumptions Even strong instruments cannot be shown to meet the assumption of no relation with unmeasured confounders
Individual-patient observational design with propensity score adjustment or matching	Levy et al. [8]	Adjusts for individual patients’ risks	Unmeasured confounders, such as confounding by indication (to be exposed) cannot be eliminated
		With appropriate modeling, can avoid confounding by differences among centers	
Among-hospital/among-ICU design	Pronovost et al. [6]	Pools data from multiple sites and patient populations, thereby increasing generalizability	Heterogeneity in definitions across studies limits ability to combine studies
	Wilcox et al. [7]		Inability to address confounding by ICU or hospital characteristics
Pre-post design	Carson et al. [5]	Highly feasible, particularly as a research addition to a quality improvement initiative	No control group to account for secular, time-dependent trends or regression to mean At risk for unmeasured confounding without randomization

ICU, Intensive care unit

this study found that hospitals with “always intensivist” models (which could include both closed ICUs and open units with mandatory intensivist consultation) had lower mortality at baseline, but ICUs that transitioned to intensivist-led models did not achieve improvements in risk-adjusted mortality in either medical or surgical units. Furthermore, the observation that intensivist-staffed hospitals were more likely to be large, urban, academic centers suggests that hospital characteristics other than ICU staffing models may underlie the mortality benefits observed in the prior among-ICU analyses [6, 7].

In addition to the absence of compelling evidence in favor of closed models, some evidence suggests weaknesses with closed staffing models in certain circumstances. For example, when ICUs get busy, or strained, risk-adjusted mortality increases in closed ICUs, but not in open units [10]. Similarly, when closed ICUs are strained, rates of adherence to venous thromboembolism prophylaxis administration decline, whereas open ICUs appear to be relatively immune to such breakdowns in processes of care [11].

Another potential pitfall of closed staffing models is the increased number of handoffs required when a patient enters and leaves the ICU. Handoffs are associated with increased rates of medical errors and adverse events [12]. The known risks of handoffs may be mitigated under open staffing models, as they promote continuity of care for patients and families.

Finally, it is clear that many outcomes beyond mortality are important to patients and family members. Unfortunately, few studies have compared non-mortal outcomes like trust, communication, and shared decision-making across different ICU staffing models. One study examined family satisfaction in an ICU with “on-demand” versus “24-h” intensivist presence in a single, academic ICU, and found it was excellent regardless of the intensivist staffing model [13]. Similarly, a small crossover pilot study in two Canadian ICUs found no difference in mortality or family satisfaction between low- and high-intensity staffing models at night [14]. We suspect that staffing models do impact patient- and family-centered outcomes, but as yet there is no compelling evidence to support closed ICUs on such bases. Further, it may be that nursing rather than physician staffing patterns make a greater difference [15].

In summary, there is currently no compelling evidence that closed ICUs are superior to open ICUs for any patient- or family-centered outcome. This is a case of an absence of compelling evidence of benefit, not of compelling evidence of the absence of benefit. The available literature is limited by (1) the absence of multicenter, prospective, experimental studies, (2) the difficulties of

surmounting confounding by ICU or patient characteristics in observational studies, and (3) the paucity of evidence regarding how organizational characteristics of ICUs impact non-mortal outcomes (Table 1). Until such limitations to the evidence base are surmounted, it is reasonable for different institutions to make different decisions regarding how best to staff their individual ICUs.

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Acknowledgments

Sources of support: NIH/NHLBI T32-HL098054 (GEW).

Compliance with ethical standards

Conflicts of interest

On behalf of all authors, the corresponding author states that there is no conflict of interest.

Received: 14 June 2016 Accepted: 30 June 2016

Published online: 1 September 2016

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