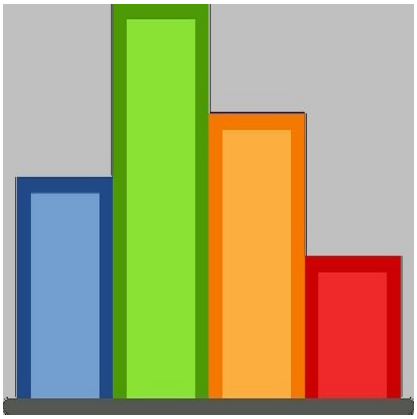
ICU
MANAGEMENT & PRACTICE

Does Higher ICU Volume Lead to Lower Mortality?



Large multi-speciality intensive care units (ICUs) are emerging in response to increasing demand for critical care. Consolidation of resources through regionalisation of services aims to contain costs and optimise demand management and operational synergies. Higher patient volumes in ICU have been associated with improved outcomes. Limited evidence exists, however, to suggest an optimal volume of patients in terms of risk-adjusted mortality. A recent study by Abbenbroek et al., published in *Australian Critical Care*, aimed to explore the association between patient volume in ICUs and risk-adjusted mortality. Results show that risk-adjusted mortality is increased in low-volume ICUs. While patient mortality may be improved in large capacity ICUs, the association is not consistent across all diagnostic groups.

As Abbenbroek et al. noted, "There appears to be a high-volume threshold at which point the risk adjusted mortality benefit is also lost, suggesting a window of optimal ICU organisational performance exists between low and high volumes."

Materials and Methods

Data for this integrative literature review were sourced from EMBASE, PubMed, and the Cumulative Index to Nursing and Allied Health Literature (CINAHL) electronic databases. The search included all available studies published in English from 1995 to 2012. All study types were considered, including cross-sectional, cohort studies, case-control and randomised control trials.

Inclusion criteria required that studies were: (1) conducted in ICU; (2) involved only adult ICU patients; (3) studied patient mortality against volume; and (4) included risk adjustment of the patient population to control for potential confounding. Studies were excluded if not available in English, consisted of a review or editorial or studied paediatric and/or neonatal populations. Elective procedural sub-populations were also excluded due to pre-operative anaesthetic screening for suitability to undergo surgery and post-operative admission to ICU.

A total of 94 studies were retained from the initial search with 72 excluded following abstract review. Of the remaining 22 articles, a further two studies were excluded due to one study being on the impact of ICU occupancy and the other a study of patient outcomes related to the intensity of care received in closed vs. open medical staffing models.

Exploration of key concepts, and interdependencies, related to patient volume, volume definitions, ICU case-mix, risk adjustment and risk adjusted mortality was undertaken. Methodological quality and statistical significance was then assessed to determine validity and generalisability of study results.

Variation in volume definition, time that mortality was measured, patient heterogeneity and differing study methods prevented a formal meta-analysis from being undertaken.

Results and Discussion

Twenty quantitative observational studies were included in this review. These studies reported on a combined total of 1,012,783 patients in 2843 ICUs from a broad range of countries, including the U.S., UK, Canada, Australia and Taiwan. Studies were primarily retrospective with three conducted prospectively. Nine studied mechanically ventilated patients, six included all admissions to ICU, three reported on patients with sepsis and one study each on patients post cardiac arrest and those receiving renal replacement therapy.

The definition of mortality as the primary outcome measure varied considerably, encompassing mortality occurring in ICU, hospital mortality, 30-day mortality and mortality at one year. Despite the different mortality definitions used, 16 of the 20 studies reported a significant association, although the association was not consistent across all diagnoses.

High-risk, complex and mechanically ventilated patients demonstrated the greatest mortality benefit in high-volume ICUs. The assumption that high-risk ventilated and/or complex patients are best managed in high-volume ICUs underpins the requirement for consolidated larger ICUs with sophisticated infrastructure, technology, clinical support services and expertise.

One factor that may explain improved patient outcomes is the impact on the caseload of medical staff. In a large retrospective study involving over 87,000 ICU patients suffering from pneumonia, the mortality of patients managed by high-volume ICU physicians was found to be half that observed in low-volume ICU physicians. This is attributed to increased physician experience, enhanced clinical training and the adoption of evidence-based standardised clinical practice in an environment with concentrated resources and systematised organisational processes.

A non-linear relationship observed in two studies noted no mortality benefit occurring above a volume threshold of 450 cases annually per diagnostic category and above 711 cases not specific to a diagnostic group. While there may be no benefit to mortality observed above a certain volume threshold there may be secondary detrimental effects associated with organisational fatigue. In particular increased medical and nursing workload has been reported repeatedly to be associated with worse outcomes. Explanations for this include less time for each patient, fewer hygienic measures, more infections, and increased adverse events as care processes break down.

Conclusions

It is evident that there is an association between the volume of patient sub-groups treated in ICU and risk adjusted mortality. Studies suggest patients with higher severity of illness benefit most. A lack of consistent findings across different patient types suggests other factors need to be considered in addition to volume, in particular structural characteristics of the organisation, such as staffing models.

The relationship between volume and mortality is not entirely linear, with low and high thresholds observed at which the volume mortality relationship reverses. This observation is central to understanding the impact of alternative ICU organisational models on patient outcomes, and infers that bigger ICUs may be better but only to a volume threshold. Prospective studies are required to explore this phenomenon further to inform future health policy and capital planning for new and redeveloped intensive care services.

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