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Impact of institutional case volume on intensive care unit mortality

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The primary aim of this review is to explore current knowledge on the relationship between institutional intensive care unit (ICU) patient volume and patient outcomes. Studies indicate that a higher institutional ICU patient volume is positively correlated with patient survival. Although the exact mechanism underlying this association remains unclear, several studies have proposed that the cumulative experience of physicians and selective referral between institutions may play a role. The overall ICU mortality rate in Korea is relatively high compared to other developed countries. A distinctive aspect of critical care in Korea is the existence of significant disparities in the quality of care and services provided across regions and hospitals. Addressing these disparities and optimizing the management of critically ill patients necessitates thoroughly trained intensivists who are well-versed in the latest clinical practice guidelines. A fully functioning unit with adequate patient throughput is also essential for maintaining consistent and reliable quality of patient care. However, the positive impact of ICU volume on mortality outcomes is also linked to complex organizational factors, such as multidisciplinary rounds, nurse staffing and education, the presence of a clinical pharmacist, care protocols for weaning and sedation, and a culture of teamwork and communication. Despite some inconsistencies in the association between ICU patient volume and patient outcomes, which are thought to arise from differences in healthcare systems, ICU case volume significantly affects patient outcomes and should be taken into account when formulating related healthcare policies.

Key Words: institutional case volume; mortality; patient outcome

Review Article

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INTRODUCTION

According to the 2021 National Health Insurance Service data, Korea has 9,174 beds in 863 intensive care units (ICUs), excluding neonatal ICUs. Approximately half of these ICU beds are located in and around the capital, Seoul. The latest report on the Improvement Study on Assessment of the Appropriateness of Intensive Care Units, commissioned by the Health Insurance Review and Assessment Service (HIRA), revealed significant disparities in the quality of care and services provided depending on the region and hospital. Several hospitals reported substandard clinical outcomes, such as ICU mortality, when compared to other hospitals in Korea and international standards [1]. In 2020, HIRA reported an overall ICU mortality rate of 14.2% in Korea [2], which was higher than the 9% rate in Canada [3] and the 11.3% rate in the US [4].

Numerous factors are associated with ICU mortality, such as age, sex, comorbidities, the utilization of mechanical ventilation, renal replacement therapy (RRT), and vasopressors. From a healthcare system perspective, ICU case volume plays a crucial role in patient outcomes, in conjunction with admission route, the degree of critical care nursing, and a multidisciplinary ICU team. Critically ill patients require specialized and intensive treatment/management, which is provided by professionals with expertise in various relevant fields. Common diagnoses in the ICU, such as sepsis, acute respiratory distress syndrome, and circulatory shock, often demand continuous patient monitoring, mechanical ventilation, continuous

RRT, and even extracorporeal membrane oxygenation, sometimes all simultaneously. To optimize the management of critically ill patients, intensivists should be well-trained and familiar with the most recent clinical practice guidelines. In order to maintain a consistent and reliable quality of patient care, an efficiently functioning unit with adequate patient throughput is ideal, which can be assessed as case volume. Numerous studies have examined the impact of hospital case volume for various procedures and settings, including high-risk surgical procedures [5], emergent procedures [6], solid organ transplantation [7,8], and trauma [9]. These studies have consistently reported improved patient outcomes with higher institutional case volumes. The precise mechanism underlying this association remains unclear, but it is thought to result from the cumulative experience of providers and selective referral to institutions with better outcomes. Although the reasons behind the association between ICU patient volume and mortality are not fully understood, the majority of studies have reported a positive correlation between institutional ICU patient volume and patient survival.

METHODS

A PubMed search was conducted using the terms "intensive care," "critical care," "case volume," "outcome," and "mortality" to identify relevant papers on this topic up until February 13, 2023. Additionally, the reference lists of review papers and published systematic reviews were examined to ensure that no pertinent articles were missed during the electronic search.

KEY MESSAGES

- Higher intensive care unit case volume is associated with improved patient mortality.
- Healthcare system policies should take into account the impact of case volume on the outcomes of critically ill patients.

THE IMPACT OF INSTITUTIONAL CASE VOLUME ON VARIOUS CRITICALLY ILL PATIENT POPULATIONS

Tables 1-3 summarized studies that evaluated the impact of ICU case volume on patient outcome in general critically ill patients (Table 1) [10-13], sepsis and septic shock patients (Table 2) [14-19], and mechanically ventilated patients (Table 3) [20-26].

Critically Ill Patients in General

A prospective study published in 2004 analyzed 12,615 patients across 89 European ICUs over a four-month period to determine whether a correlation existed between ICU case volume and mortality. The results revealed an inverse relationship between ICU volume and in-hospital mortality (odds ratio [OR], 0.97; 95% confidence interval [CI], 0.95–0.99; P<0.0005), although the clinical relevance was small. A sub-analysis of patients with a Simplified Acute Physiology Score (SAPS) II higher than 32 demonstrated a stronger association between ICU case volume and in-hospital mortality (OR, 0.83; 95% CI, 0.78–0.89; P<0.0001). The study's most important finding was that in-hospital mortality was notably higher in ICUs with an average occupancy rate exceeding 80% than in those with occupancy rates below 80% (OR, 1.32; 95% CI, 1.13–1.55; P<0.0004) [10]. The authors concluded that a high volume of high-risk patients might be a prerequisite for higher-quality care, provided that the occupancy rate remains reasonable.

A study of 83,259 ICU patients in 40 ICUs in Austria between 1988 and 2005 revealed that a higher patient turnover was associated with a reduced risk of in-hospital mortality (OR, 0.960; 95% CI, 0.946–0.974; P-value, not provided). Additionally, an increased patient-to-nurse ratio (more assigned patients per nurse) was also associated with an increased risk of in-hospital mortality (OR, 1.30; 95% CI, 1.21–1.39, P-value, not provided) [11]. The authors proposed a non-linear relationship between ICU volume and mortality improvement; specifically, they

Table 1. The impact of ICU volume on critically ill patients in general

Study	Published year	No. of patients	No. of centers and ICUs	Outcome	Volume category (case/year)	Suggested cut-off threshold	Impact of case volume
Lapichino et al. [10]	2004	12,615	Not reported, 89 ICUs	In-hospital mortality	Not reported	None	Significant
Metnitz et al. [11]	2009	83,259	Not reported, 40 ICUs	In-hospital mortality	Not categorized	420 Patients per year	Significant
Glance et al. [12]	2006	70,757	76 Centers, 92 ICUs	In-hospital mortality	Low, <134 Medium, 134–216 High, 217–295 Very high, >295	None	Significant (for high risk patients)
Sasabuchi et al. [13]	2015	596,143	>1,000 Centers, not reported	In-hospital mortality	Low, < 497 Intermediate, 497–748 High, >747	None	Significant (12.3% vs. 7.5%)

ICU: intensive care unit.

Table 2. Impact of ICU volume on patients with sepsis and septic shock

Study	Published year	No. of patients	No. of centers and ICUs	Outcome	Volume category (case/year)	Suggested cut-off threshold	Impact of case volume
Peelen et al. [14]	2007	4,605	Not reported, 28 ICUs	In-hospital mortality	Not specified	None	Significant
Zuber et al. [15]	2012	3,437	Not reported, 41 ICUs	ICU and hospital mortality	Low, <5 Medium, 5–12 High, >12	None	Significant (ICU mortality, 64.9% vs. 57.6%)
Shahin et al. [16]	2012	30,727	170 Centers, 170 ICUs	In-hospital mortality	Q1, 59–75 Q2, 95–103 Q3, 121–138 Q4, 168–206	None	Insignificant (42.7% in Q1 vs. 39.0% in Q4)
Maharaj et al. [17]	2021	273,001	Not reported, 231 ICUs	ICU and hospital mortality	Q1, 12–177 Q2, 178–242 Q3, 243–334 Q4, 335–744	215 Patients per year	Significant (ICU mortality, 23.4% in Q1 vs. 21.5% in Q4)
Chen et al. [18]	2022	134,046	1,902 Centers, not reported	In-hospital mortality	Q1, 1–13 Q2, 14–32 Q3, 33–75 Q4, >75	40 patients per year	Significant (24% in Q1 vs. 18% in Q4)
Naar et al. [19]	2022	10,716	Not reported	ICU mortality	(Total volume) High, 6,758 Medium high, 2,608 Medium low, 1,078 Low, 272	None	Insignificant

ICU: intensive care unit; Q: quartile.

suggested a U-shaped relationship, where mortality rates initially decrease as patient volume increases, but beyond a certain point (n=450), mortality rates begin to increase again. This implies that an excessive number of patients cared for, even in highly experienced institutions, may result in worse outcomes, offsetting the positive impact of higher case volume.

A retrospective cohort study of 70,757 patients admitted to ICUs in the US from 2001 to 2003 reported an overall mortality rate of 14.6%. While the impact of institutional case volume could not be determined, institutions that managed a higher number of severely critically ill patients (>295 patients per year with SAPS II scores above 30) demonstrated better outcomes than centers with a lower volume of high-risk patients (OR, 0.77; P=0.047) [12].

Table 3. Impact of ICU volume on mechanically ventilated patients

Study	Published year	No. of patients	No. of centers and ICUs	Outcome	Volume category (case/year)	Suggested cut-off threshold	Impact of case volume
Kahn et al. [20]	2006	20,241	37 Centers, 104 ICUs	In-hospital mortality	Q1, 87–150 Q2, 151–275 Q3, 276–400 Q5, 401–617	None	Significant (33% in Q1 vs. 37% in Q4, P<0.001)
Moran et al. [21]	2012	208,810	136 Centers, 136 ICUs	In-hospital mortality	(In decile) Lowest, 12–101 Highest, 801–932	None	Insignificant
Dres et al. [22]	2013	14,440	Not reported, 31 ICUs	ICU and in-hospital mortality	Low, <26 Medium, 26–47 High, >47	None	Significant (ICU mortality, 18.3% vs. 16.0%)
Dres et al. [23]	2018	8,383	22 Centers, 31 ICUs	ICU mortality	Low, <30 Medium, 30–64 High, >65	None	Insignificant
Needham et al. [24]	2006	20,219	126 Centers, not reported	30-Day mortality	(5 Categories) <100, 100–199, 200-299, 300–699, >700	None	Insignificant
Gopal et al. [25]	2011	17,132	Not specified	ICU mortality	Not specified	None	Insignificant
Lee et al. [26]	2019	158,712	55 Centers, not reported	In-hospital, 1, 2, 5-year mortality	Low, <300 Medium, 300–500 High, >500	None	Significant (in-hospital mortality, 39.2% vs. 32.6%)

ICU: intensive care unit; Q: quartile.

A similar study involving 596,143 ICU patients from 2007 to 2012 reported overall ICU and hospital mortality rates of 4.8% and 9.9%, respectively. The ICU volume was categorized into high (≥748 patients per year), intermediate (497–747 patients per year), and low (≤496 patients per year) volume groups. Both a higher ICU volume (OR, 0.77; 95% CI, 0.66–0.89; P=0.001) and a higher ICU-to-hospital bed ratio (OR, 0.82; 95% CI, 0.71–0.94; P=0.005) were significant factors in reducing hospital mortality. When the subgroup analysis was stratified by the ICU-to-hospital bed ratio, the volume-mortality relationship was significant only in the high ICU-to-hospital bed ratio group (high, ≥2.96% vs. low, ≤1.74%; OR, 0.74; 95% CI, 0.58–0.93; P=0.009) [13]. In this study, the group with the lowest ICU-to-hospital bed ratio exhibited the highest illness severity (patients requiring mechanical ventilation, RRT, or vasopressor use) compared to the high ratio group. Due to a shortage of ICU beds, only severely ill patients could be admitted to the ICU, which may have led to worse outcomes and minimized the overall effect of ICU volume.

Sepsis and Septic Shock Patients

Patients requiring intensive care for sepsis and septic shock also exhibit a similar inverse relationship between institutional ICU case volume and mortality. In 2021, a cohort study involving 273,001 sepsis patients from 231 ICUs in the UK demonstrated that ICUs with higher annual sepsis case volumes had significantly lower hospital mortality rates compared to centers with lower case volumes (OR, 0.89; 95% CI, 0.82–0.96; P=0.002) [17]. The study suggested an annual sepsis ICU patient case volume threshold of 215 patients per ICU per year for favorable outcomes, without specifying an upper threshold value [17]. A similar relationship between ICU volume and mortality benefits has been observed in cancer patients suffering from septic shock. A 12-year (1997–2008) retrospective cohort study, which included 3,437 septic shock patients with malignancies across 41 ICUs, revealed that high-volume units (>12 patients per year, median of 614 total ICU patients per year) had a significantly lower ICU mortality rate than low-volume units (<5 patients per year, median of 407 total ICU patients per year) (OR, 0.63; 95% CI, 0.46–0.87; P=0.002) [15].

An analysis of 134,046 septic shock patients from 1,902 hospitals in China during a 1-year study in 2020 revealed that, although there was no significant difference in overall ICU mortality between septic shock volume quartiles, hospital mortality for septic shock cases was significantly reduced in the highest quartile of septic shock case volume (β=–0.86; 95% CI, –0.98 to –0.74; P<0.001) [18]. Study participants were divided into quartiles based on their annual septic shock case volume in the ICU. The fourth quartile group had a mean ICU case volume of 1,463 ± 2,119 per year and a septic shock volume of >75 cases per year, while the first quartile group had a mean ICU volume of 414±1,509 per year and a septic shock volume of 1–13 cases per year. The suggested volume threshold associated with a favorable hospital mortality rate was 40 septic shock cases per year, which differs from the previously mentioned UK results, which had a volume threshold of 215 cases per year.

In line with previous studies, an evaluation of 4,065 severe sepsis patients across 28 ICUs in the Netherlands demonstrated a significant association between the annual number of severe sepsis patients and risk-adjusted in-hospital mortality (OR, 0.97; 95% CI, 0.94–0.99; P=0.029) [14]. Although there was a positive relationship between volume and outcome, the authors argued that due to the weak correlation compared to elective surgical procedures, it may not be feasible or beneficial to plan admissions for severe sepsis or transfer patients to higher volume centers [14]. A meta-analysis of 11 studies involving septic ICU patients found a significant association between a higher annual case volume and lower mortality (OR, 0.76; 95% CI, 0.65–0.89; P=0.001) [27]. A subsequent dose-response analysis suggested that the mortality benefit plateaus at an annual case volume of 400 cases [27].

The reported ICU and hospital mortality rates for patients with sepsis are 25.8% and 35.3%, respectively, with relevant independent risk factors for in-hospital mortality including the use of mechanical ventilation and RRT [15,28]. A study of ICUs in Finland found a similar association among 1,558 patients who underwent RRT in 23 ICUs. Patients were classified into tertiles based on the annual case volume of RRT: low (18 [16–22]), medium (28 [25–30]), and high (54 [56–77]) volume. In-hospital mortality was significantly higher in low-volume ICUs than in high-volume ICUs (OR, 2.06; 95% CI, 1.49–2.84; P<0.001) [29].

In the UK, a study of 33,538 adult severe sepsis patients from 2008 to 2009 was conducted, involving 170 ICUs in 170 centers. These patients were categorized into quartiles and evaluated for differences in mortality [16]. The annual median volume of severe sepsis patients was 70 (59–75) in quartile 1, 98 (95–103) in quartile 2, 130 (121–138) in quartile 3, and 190 (168–206) in quartile 4. No relationship was found between the annual severe sepsis patient volume and in-hospital mortality (P=0.65). A more recent study in the US reported conflicting results. An analysis of 10,716 sepsis patients showed that ICU and hospital mortality was similar between centers with lower volume (136 cases of sepsis per year) and centers with high volume (3,379 cases of sepsis per year) (OR, 0.98; 95% CI, 0.46–2.08; P=0.962). Centers with lower volume ICUs were less likely to utilize RRT (OR, 0.57; 95% CI, 0.44–0.73; P<0.001) [19]. It can be speculated that high-volume centers are more likely to care for critically ill patients with greater disease severity.

Patients Requiring Mechanical Ventilation

During the 10 years between 2007 and 2016, 158,712 adult ICU patients who required mechanical ventilation for at least 48 hours were treated in 55 centers across Korea. These patients were divided into three groups based on the annual number of patients at each center: low volume (<300), medium volume (300–500), and high volume (>500). The in-hospital mortality rates for the low-, medium-, and high-volume groups were 39.2%, 35.8%, and 32.6%, respectively (P<0.01). After adjusting for covariates, the low-volume centers exhibited a significantly higher mortality rate than the high-volume centers (OR, 1.33; 95% CI, 1.30–1.37; P<0.001) [26]. A similar inverse relationship between case volume and long-term mortality was observed when comparing 5-year mortality rates between low- and high-volume centers (OR, 1.26; 95% CI, 1.20–1.31; P<0.001).

A study analyzing 20,214 patients in medical ICUs who received mechanical ventilation between 1988 and 2010 was conducted. After adjusting for relevant risk factors, it was found that higher hospital volume (>400 patients per year) was significantly associated with lower ICU and hospital mortality (OR, 0.63; 95% CI, 0.50–0.79; P<0.001 and OR, 0.66; 95% CI, 0.52–0.83; P<0.001) compared to lower hospital volume (<150 patients per year). The risk-adjusted, predicted ICU and hospital mortality rates were 14.5% and 25.5%, respectively, in higher volume centers, and 21.2% and 34.2%, respectively, in lower volume centers [20]. The impact of case volume on 14,440 acute exacerbation of chronic obstructive pulmonary disease (AECOPD) patients in 31 medical ICUs was assessed. ICU and hospital mortality rates were lower in higher-volume units (16.0% and 21.2%, respectively, in units with more than 47 admissions per year) compared to lower-volume units (18.3% and 22.7%, respectively, in units with fewer than 25 admissions per year), with an OR of 0.90 (95% CI, 0.75–1.09; P-value, not provided) [22]. The use of non-invasive ventilation (NIV) in AECOPD patients also varied according to case volume. Admission to higher volume units was associated with a greater likelihood of using NIV (OR, 1.17; 95% CI, 1.07–1.28; P-value, not provided) [22]. The authors suggested that the mortality benefit in higher volume units could be attributed to the increased use of NIV in these units and possibly differences in the nurse-to-bed ratio, despite the lack of data on this aspect in the study.

Several studies from countries with different healthcare systems have reported conflicting results. A retrospective cohort study of 208,810 mechanically ventilated patients from 136 ICUs in Australia and New Zealand demonstrated that the risk of in-hospital mortality was higher in centers with the highest volume (801–932 patients per year) compared to centers with the lowest volume (12–101 patients per year) (OR, 1.26; 95% CI, 1.06–1.50; P=0.009) [21]. In contrast, a Canadian study that included both medical and surgical patients requiring mechanical ventilation did not show a significant volume-mortality association. Instead, it found a less significant increase in mortality in the lowest-volume centers (<100 cases per year) compared to the highest-volume centers (> 700 cases per year) (OR, 1.13; 95% CI, 0.87–1.47; P-value, not provided) [24].

DISCUSSION

Most studies on ICU patients have suggested that an increase in case volume positively impacts mortality outcomes for patients who are generally ill in the ICU, including those with sepsis, septic shock, and those requiring mechanical ventilation. Several studies have proposed a threshold volume at which the lowest mortality is achieved; however, both below and above this threshold, mortality begins to increase, demonstrating a U-shaped relationship between case volume and mortality. Interestingly, a few countries with different healthcare systems, such as the UK, Australia, and Canada, have not shown similar impacts of volume on mortality improvement.

Traditionally, the volume-mortality effect has been attributed to the accumulation of clinical experience and selective referral. High-volume institutions are more likely to employ experienced personnel who can readily detect patient deterioration and have access to the various resources needed to manage critically ill patients. The presence of trained intensivists and high-intensity ICU staffing has already been associated with improved mortality rates and reduced ICU and hospital lengths of stay [30]. In 2015, Korea implemented a mandate requiring doctor presence and reimbursement incentives for intensivist presence in ICUs at tertiary centers. Prior to this implementation, fewer than one-third of ICUs had intensive care specialists working a 5-day week [31]. However, by 2020, this number increased to 46.7% [2]. A study examining the implementation of intensivists in 441 Korean ICUs found significant decreases in both ICU and 90-day mortality rates (11.7% to 6.3%, respectively, P=0.047; 18.6% to 10.3%, respectively, P=0.012) and a hazard ratio for 90-day mortality of 0.39 (95% CI, 0.23–0.67; P=0.001) [32]. Despite the improved mortality rates following the implementation of intensivist-led teams, the proportion of ICUs with full-time intensivists remains significantly lower than international standards. A 2011 study of ICUs in Asia found that 66% of the 150 ICUs surveyed had 24-hour intensivist coverage [33], while only 26.9% of Korean ICUs in 2020 were fully staffed by intensivists [2]. As a result, discrepancies in clinical outcomes by region and hospital persist in Korea. Depending on hospital volume, tertiary, general, and primary hospitals in Korea have demonstrated 5-year mortality rates for mechanically ventilated patients of 37%, 55%, and 82%, respectively. Hospitals with the presence of intensivists or those located in the capital tend to exhibit lower mortality rates [2].

Selective referral is a phenomenon where patients are more likely to be referred to high-volume centers, particularly for complex surgical procedures, pediatric surgery, and trauma. However, it has been suggested that more complex organizational factors may be associated with improved outcomes in critically ill patients. Factors such as multidisciplinary rounds, ICU nurse staffing and education, the presence of a clinical pharmacist, protocols for weaning and sedation, and a culture of teamwork and communication may all contribute to enhancing ICU patient outcomes [34,35]. Clinical pharmacists can offer valuable consultation in developing plans for drug dosing and monitoring, as well as assisting in medication reconciliation upon patient discharge [36-38]. In a database review of 199,082 Medicare patients treated in 961 hospitals with vancomycin and aminoglycosides, hospitals where pharmacists monitored the use of these drugs demonstrated lower mortality rates, shorter lengths of stay, and fewer adverse events [39].

The design of Korea's healthcare system does not provide adequate reimbursements for managing critically ill patients. When comparing results from different healthcare systems, caution should be exercised, as the impact of relevant factors may be biased or obscured. One prime example is ICU case volume, as the suggested cut-off may differ between densely populated regions or countries (such as Korea) and sparsely populated countries (such as Australia). Measures proven to improve patient outcomes, such as dedicated intensivists, higher nurse-to-patient ratios, and multidisciplinary care teams that include nutritionists, pharmacists, and physical therapists, are often overlooked. The discrepancy in the results of the Australian/New Zealand data [21] from previous studies of volume-mortality association may stem from differences in health system jurisdictions, which was also identified in results from countries in similar situations, such as Canada [24] and the UK [25]. The authors of the 2021 UK study suggest that the unique nature of the US healthcare system, which has complex funding sources compared to the publicly funded healthcare systems of Canada, Finland, or the UK, may contribute to disparities in access to care and thereby lead to weak or nonexistent associations between sepsis patient volume and clinical outcomes [17]. Private-sector US hospitals are primarily funded through fee-for-service and prospective payment charges, which are reimbursed by private insurance companies, Medicare, state Medicaid programs, and other government funds. This contrasts with Canada and other countries that have publicly funded single-payer healthcare insurance. After adjusting for clustering and the procedure or condition studied, the relative odds of Canada showing a significant volume-outcome association compared to the US were substantially low (OR, 0.23; 95% CI, 0.07–0.76; P=0.01) [40].

The observed center volume effect on specific types of surgeries and patient populations, which demonstrates improved patient mortality, has prompted discussions about whether these procedures should be limited to high-volume centers with favorable outcomes [41,42]. The significant volume effect on mortality in solid organ transplantation and trauma centers has led to policy changes requiring minimum case volumes for center accreditation. In some countries, an enhanced patient referral system that clusters low- and high-volume centers in close proximity is already being implemented [16]. However, it remains debatable whether a similar volume effect exists in critically ill patients, as volume effects have shown inconsistent results. A possible explanation for this inconsistency may be that institutions with higher patient volumes are more likely to adopt newly accredited best practices. For example, the previously mentioned study regarding ICU-admitted AECOPD patients [22] showed that units with higher volumes were more likely to implement NIV, which was associated with improved survival rates. When institutions with higher volumes demonstrate better outcomes by implementing new evidence-based practices, it becomes more likely that these practices will be adopted across all hospitals, leading to an attenuation of the volume and outcome association [20,43].

There is considerable diversity among patients admitted to the ICU. The current inconsistencies in the relationship between ICU case volume and outcomes necessitate a multi-layered study focusing on ICU patients with specific diagnoses. Another aspect that warrants a thorough analysis is the intensivist-to-patient ratio. A recent US study on intensivist-to-patient ratios examined the outcomes of 51,656 patients under the care of 246 intensivists. The average caseload was 11.8 patients per day, with no evident association between the intensivist-to-patient ratio and mortality (hazard ratio for each additional patient: 0.987; 95% CI, 0.97–1.01; P=0.2) [44]. In Korea, the average caseload per intensivist was 44.7 patients per day in 2014, which steadily decreased to 22.2 patients per day in 2021 [1]. Further prospective studies are needed to assess the impact of the intensivist-to-patient ratio.

In conclusion, despite a few inconsistencies, a higher ICU case volume has been demonstrated to positively impact mortality rates. Given the significant effect on patient outcomes, institutional ICU case volume should be taken into account when developing healthcare policies related to this area.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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