The benefits of a closed ICU: A systematic review

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ABSTRACT

This study compared closed and open intensive care unit (ICU) models in terms of patient outcomes. Closed ICUs had reduced mortality rates, shorter lengths of stay, and lower healthcare-associated infection rates. Intensivists in closed ICUs contributed to better outcomes due to their expertise and competence. Enhanced interdisciplinary collaboration, improved communication, and coordination in closed ICUs led to higher patient and family satisfaction. In addition, closed ICUs were more cost-effective, with better resource use and reduced healthcare costs. Overall, closed ICU models have advantages in patient outcomes, better resource use, cost-effectiveness, and patient satisfaction compared to open ICU models.

Keywords: Intensive care unit, ICU, patient outcomes, resource utilization, quality of care

INTRODUCTION

The management of critically ill patients often demands multidisciplinary care coordination and support, yielding two types of commonly used intensive care unit (ICU) models differing by the degree of intensivist intervention. A closed ICU is one in which the intensivist is the admitting medical officer, and other specialty teams consult with the ICU personnel who are in charge of directing patient care for critically ill patients. Several studies have shown that many severe medical conditions require on site decisive management and support for optimal outcomes, and intensivists are important in the care of these patients.[1] In contrast, open ICUs are those in which any physician, such as surgeons or specialists, can admit patients under their care. They are responsible primarily for managing care while intensivists are available for consultation. Exploring the benefits of a closed over an open ICU model is valuable since many studies have demonstrated that a dedicated intensive care team offers positive clinical outcomes, such as reduced mortality and complications, that enhance the quality of critical care delivered.[2]

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The level of intensivist's involvement is pivotal in obtaining optimal clinical outcomes, as an intensivist specializes in the pathophysiology of critically ill patients who often require decisive management and continuous monitoring. Many studies have reported that closed ICU models have reduced mortality rates,[2,3] improved resource management,[4] reduced hospital-acquired infections, and decreased hospital length of stay (LOS).[5,6] In contrast, some studies indicate that open ICUs are more feasible and reliable in resource limited countries and result in fewer psychological complications, less emotional stress, and more pertinent social standards.[7]

Nevertheless, statistically significant differences in some clinical outcomes and parameters between open or closed ICUs vary widely in different studies. For example, in two separate studies by Yang and colleagues and Baik et al., a statistically significant decrease in mortality in closed ICUs compared to open ICUs was noted.[2,3] However, research by Adams et al. and Howell et al. reported no statistically significant reduction in mortality.[6,8] In addition, there were

differences in reintubation rates in open vs. closed ICUs, and some studies report statistically significant reductions in closed ICUs, and other studies report similar rates between the two ICU systems.[6,8]

Evaluating the advantages of a closed vs. an open ICU model on clinical outcomes is important consideration in the care of critically ill patients.[4] However, Cole and colleagues caution that the safety and effectiveness of each model remain controversial.[9] Currently, closed vs. open ICU studies have inconsistent results likely due to the various regional patient populations. While some studies report closed ICUs have lower mortality rates with less resource utilization, other studies found no significant difference between the two ICU models.[4] The inconsistency in information regarding the benefits of closed vs. open ICUs calls for additional research and investigation of the significant differences (if any) between the two models.

Methods

This study conducted a comprehensive systematic review of published studies examining clinical outcomes across diverse ICU systems. This investigation analyzed differences in in-hospital mortality, patient LOS, and associated factors. The search strategy used MeSH terms “care unit, intensive,” and other text-word searches, including “closed ICU,” “open ICU,” “clinical outcomes in closed and open ICUs,” and “ICU management,” to search databases, including PubMed, for pertinent articles. The study hypothesis proposes that a closed ICU system confers distinct advantages, thereby improving healthcare outcomes for patients undergoing critical care.

Results

Reduced mortality and improved patient outcomes in a closed ICU

Mortality rates and patient outcomes are key parameters used to compare the efficacy of a particular medical practice over another. Closed ICUs have been shown to contribute positively to both mortality rates, patient outcomes, and other vital healthcare parameters. Baik et al. used binary logistic regression analysis to demonstrate that closed ICUs reduce patient mortality.[2] Many attribute this to the intensivist’s experience in the management of critically ill patients due to understanding the pathophysiology of critically ill patients, using evidence-based management and systematic treatment protocols and being more proficient in high-level treatments.[2] Hackner et al. investigated patient outcomes in a closed ICU and noted a 5.5% decrease in mortality when compared to open ICUs.[10] In addition, closed ICUs had a 20% shorter LOS in the hospital.[10] Ogura et al. determined that the most critical aspect of the continued presence of an intensivist is early recognition of deteriorating patients, prompt interventions, and better critical care management.[1] The presence of an intensivist contributes to a reduced LOS due to better resource use, shorter duration of mechanical ventilation, and decreased hospital-acquired infections.[1,5] Of these hospital-acquired infections, central line-associated blood infections, catheter-associated urinary tract infections, and ventilator-associated pneumonia were all reduced in a closed ICU with prompt intensivist intervention.[1,5]

A study by Miller et al., which systematically evaluated a cohort of patients sharing similar demographic characteristics in a unified hospital system across the same time span, sought to determine the differential impact of a closed vs. an open ICU model on clinical outcomes. The preliminary analysis revealed an unadjusted in-hospital mortality rate of 9.6% and 8.9% in the open and closed units, respectively ($p = 0.42$).[11] Subsequent multivariable adjustment, however, indicated that admission to a closed unit was significantly linked to a reduced in-hospital mortality risk (odds ratio [OR]: 0.69; 95% confidence interval [CI]: 0.53–0.90; $p = 0.007$) and a decreased cardiovascular intensive care unit (CICU) mortality risk (OR: 0.70; 95% CI: 0.52–0.94; $p = 0.02$). Subgroup analyses indicated that admissions for cardiac arrest (OR: 0.42; 95% CI: 0.20–0.88; $p = 0.02$) and respiratory failure (OR: 0.43; 95% CI: 0.22–0.82; $p = 0.01$) were also significantly associated with reduced in-hospital mortality in the closed ICU.[11]

Enhanced interdisciplinary collaboration in closed ICUs

Effective interdisciplinary collaboration can optimize clinical outcomes, especially in the management

of critically ill patients due to their complex conditions.[12] Specifically, clear and consistent interprofessional communication is integral to preventing medical errors and misunderstandings that compromise patient safety.[13] Closed ICUs offer the leadership of the chief admitting intensivist, allowing for enhanced care coordination and management among the many healthcare professionals involved as a result of improved team performance.[14] This model has been shown to enhance team members' confidence in the clinical judgment of the intensivist and reduce conflict among team members.[15] Furthermore, the leadership based role of the intensivist in the closed ICU system can prevent members from misunderstanding their specific roles and making inappropriate assumptions regarding their level of responsibility in patient care. Maximizing the benefits of a closed ICU requires open communication among team members as this is associated with the degree to which they understand patient care goals.[16]

Katz et al. focused on a single ICU and analyzed patient and staff data both prior to and subsequent to the transition from an open ICU model to a closed ICU. Their results indicated that resident physicians reported an enhanced professional experience following the transition, with a Likert score of 4.0 (open ICU) compared to 4.3 (closed ICU) ($p = 0.03$).[17] This improvement can be attributed, in part, to perceived enhancement in opportunities for refining their teaching skills, increased time for comprehensive patient understanding and care plan implementation, reduced fragmentation of care within the CICU, enhanced team collaboration, and reduced fatigue.

Similar to the resident experience, the nursing staff at their institution expressed significantly greater satisfaction with the closed unit model, as supported by their Likert score of 3.3 compared to 4.1 ($p < 0.001$). Furthermore, they thought that patients received superior care following the transition from the open to closed CICU, with Likert scores of 4.0 (open ICU) and 4.5 (closed ICU), respectively ($p = 0.01$).[17] These findings suggest that these improvements can be, at least in part, attributed to enhanced nurse-physician communication, better collaboration in patient care, and increased opportunities for learning and autonomy.

Lower rates of healthcare-associated infections in closed ICUs

It is evident that intensivists have a distinct advantage in managing critically ill patients in a closed ICU system in comparison to an open ICU system. This advantage stems from their in-depth knowledge and application of pathophysiology, evidence-based management, systemic protocols, and proficiency in the use of complex patient support equipment, such as mechanical ventilators. Consequently, the implementation of a closed system can result in a considerable difference in patient mortality compared to an open system.[2] Furthermore, Sharayah et al. reported that in a hospital open system that recently transitioned to the closed ICU system, a significant reduction in hospital-acquired infection rates occurred.[5] For example, there was a 19.3% reduction in central line-associated bloodstream infections and a 100% reduction in catheter-associated urinary tract infections and ventilator-associated pneumonia.[5]

In patients admitted with sepsis, the closed ICU model leads to significant improvements in survival rates at discharge, overall survival rates, and decreased LOS compared to the open model.[1] Although the frequency of patients requiring central lines is notably higher in the closed model, another study also revealed measurable differences in mortality rates when a closed model was used instead of an open one.[2,3] However, the frequency of patients requiring mechanical ventilation, arterial lines, and pulmonary arterial catheters appears to be similar in both open and closed settings.[3] A similar study by Howell et al. recorded slightly different but comparable results, particularly higher rates of central and arterial lines and lower rates of intubation in the closed model. In addition, there were trends toward increased severity of illness and decreased LOS in the closed ICU.[8]

Optimized resource utilization in closed intensive care units

The cost of intensive care is one of the highest costs in the healthcare industry; van der Sluijs et al. reviewed the literature and reported that from 2000–2010 the annual cost of critical care in the United States nearly doubled from $56 to $108 billion.[18] As a result of the aging population in western society, both the number

of critically ill patients and overall hospital admissions are expected to continue to increase.[18] Thus, improvements in the function of ICUs is vital. Recently, many ICUs nationwide have transitioned into a closed ICU model to improve organization and ultimately mitigate cost requirements. As a result of the organizational adjustments from implementing a closed ICU system, studies suggested a 36%–61% reduction in cost.[18] This reduction in cost stems from improved resource utilization relating to reduced ventilator duration and lower rates of re-intubation.[4,6,8] Furthermore, van der Sluijs et al. attribute a fraction of this cost reduction to reduced intensive care LOS and overall hospital LOS through a closed ICU system.[18] In a study by Baik and colleagues that implemented both closed and open ICUs in their hospital, the bed turnover rate was 85.48% in the closed ICU and 78.87% in the open ICU system.[2] This same study concluded that the ICU readmission rate within 48 hours in the closed ICU system was 1.43% in the closed ICU while it increased to 2.0% in the open ICU setting.[2] Therefore, the evidence supporting the efficiency of a closed ICU system with regard to cost-effectiveness is substantial. The cost-effectiveness of closed ICU systems seen in several studies can be attributed to the reliance on a chief admitting intensivist. The increased intensivist involvement in the closed ICU system has shown to provide reduced patient LOS, hospital- acquired infections, and re-intubation rates. These result from a more methodical use of resources, which contributes to increased cost-efficiency in closed ICUs.

Improved patient and family satisfaction in closed ICUs

Quality of care depends on adequate communication with accurate transmission of information and is one of the factors contributing to patient and family satisfaction with intensive care.[15] Vincent reported that in an open ICU setting with multiple personnel in charge of patient care, patients reported receiving mixed and confusing messages.[15] Furthermore, surgeons have reported significantly more conflicts with their intensivist colleagues in an open ICU. These conflicts can lead to varying evaluations and prognoses that may increase patient/family tension if the patient's health deteriorates.[15] A particular study comparing "relatives' satisfaction with the courtesy, respect and compassion" they received throughout their care yielded higher percentages of patients reporting complete satisfaction in a closed ICU over an open ICU.[15] Carson and colleagues reported that compared to an open system, closed ICUs have demonstrated that communication between the patients' families and the physician felt easier.[19] Evidence supports that a closed ICU model operates more efficiently and effectively than an open ICU system. This model affirms that patients and their families receive skilled quality of care based on an objective approach, timely management, and honest disclosure of information.

Discussion

Closed ICUs not only enhance patient satisfaction but also improve clinical outcomes. The closed ICU provides better care coordination, has fewer complications, and can improve overall critical care management. Closed ICUs are cost-efficient, making them highly effective and advantageous for both patients, physicians, and healthcare systems. In the emotionally charged environment of an ICU, maximizing patient and family reassurance is of paramount importance. Closed ICUs foster positive communication practices. This emphasis on communication not only enhances patient satisfaction but also acts as a preventive measure against conflicts and miscommunications within the medical team. Substantive communication can increase the trust that patients and families place in the medical decisions being made on their behalf.

However, despite the favorable structure of closed ICUs, healthcare organizations that plan to adopt this model can encounter certain limitations. Weissman et al. report that one notable hurdle is the issue of limited intensivist staffing,[20] a challenge that demands attention and innovative solutions. Furthermore, a significant consideration is the patients' and families' interest in continuity of care from their primary attending physician.[20] This preference reflects the long-term relationship that often exists, which might not be replicated with the intensivist who takes over patient care following a handoff. Addressing this preference requires careful thought and exploration, highlighting the need for qualitative analyses that examine patient

Table 1. Summaries of Prospective and Retrospective Studies

Study	Type of Study Type of ICU	ICU Patient Population	Summary
Adams [6]	Retrospective cohort Closed	Population: 285 patients in the pre-closure cohort and 264 patients in the post-closure cohort USA 2014–2016.	No change in mortality rates, Reduced duration of mechanical ventilation, decreased ICU and hospital length of stay, fewer patient complications, and reduced direct hospital costs.
Baik [2]	Retrospective cohort Both	Population: 751 patients categorized in the open cohort (191 patients) and closed cohort (560 patients) Location: Not Specified. Feb 2020	Significant reduction in all-cause mortality in the CSICU group compared to the OSICU group.
Carson [19]	Prospective cohort Both	Population: 124 patients in the open cohort and 121 patients in the closed cohort USA Oct–Nov 1993; April–May1994	Patients in the closed ICU were generally sicker but had better-than-expected clinical outcomes compared to those in the open ICU. The average length of stay for survivors was similar in both ICU formats, and there were no significant differences in patient charges for various medical resources.
Cole [9]	Prospective multicenter, observational study Closed	Population: 19 ward patients and 116 adult ICU patients with severe ARF Australia Sept–Nov 1996	In the closed ICU system, the actual mortality rate for patients with severe ARF was lower than the predicted mortality rate.
Hackner [10]	Retrospective cohort Both	Population: 2602 total patient admissions Location: Not specified Jan 2006–Dec 2007	Notable improvements in patient outcomes in the closed ICU compared to the open unit, particularly in terms of lower mortality rates and shorter hospital stays. However, the length of stay specifically in the ICU and the overall costs, when adjusted for the severity of the patients' conditions, showed no significant differences between the two unit types.
Howell [8]	Retrospective cohort Closed	Population: 141 in the open cohort and 152 patients in the closed cohort USA May and Jun 2006–2007	The transition to a closed ICU system resulted in more central and arterial lines being placed and lower rates of re-intubation. There were trends indicating increasing severity of illness and a reduced length of stay, though no significant difference in survival rates between open and closed models was noted.

Table 1. Summaries of Prospective and Retrospective Studies (*Continued*)

Study	Type of Study Type of ICU	ICU Patient Population	Summary
Katz [17]	Prospective cohort Both	Population: 332 in the open cohort and 338 in the closed cohort USA Nov 2012–March 2014	No effect of the unit structure on patient outcomes in terms of CICU or hospital mortality. However, the length of stay was shorter in the closed CICU, and nurses and resident trainees reported better communication, collaboration, and education in the closed model.
Kim [13]	Retrospective cohort Not specified	Population: 107,324 patients in 112 hospitals USA Jul 2004–Jun 2006.	Multidisciplinary care, characterized by daily team rounds, was significantly associated with lower mortality rates among these ICU patients. However, it did not specify whether the ICUs were open or closed models.
Miller [11]	Retrospective cohort Both	Population: 2,226 treated in the open cohort and 1,770 in the closed cohort USA Sep 2013–Oct 2017	Admission to the closed CICU was associated with a lower in-hospital mortality and CICU mortality. There was no significant difference in CICU length of stay, total hospital charges, or post-discharge 30-day and 1-year mortality between the open and closed units.
Multz [4]	Prospective and Retrospective cohort Both	Population: 280 patients in the prospective investigation (185 in the closed cohort and 95 in the open cohort and 306 patients in the retrospective study (154 in the closed cohort and 152 in the open cohort). USA May–August 1993, for the prospective analysis, Feb 1992–Apr 1993, for the retrospective analysis	Patient care was more efficient in a closed ICU model, with lower ICU and hospital lengths of stay and fewer days on mechanical ventilation, no effect on mortality.
Ogura [1]	Post hoc analysis Both	Population: 979 treated in 17 open cohorts and 1,516 in 18 closed cohorts Location: Not Provided. Jan 2011–Dec 2013	Treatment in a closed ICU was significantly associated with improved survival at discharge and a 20% decrease in ICU stay length.
Sharayah [5]	Retrospective cohort Both	Population: Not specified Location: Not specified July 2014–2016 for the open cohort, July 2016–2018 for the closed cohort	A decrease in CLABSI, CAUTI, and VAP rates in the closed ICU setting with no significant reduction in *C. diff* infections.

CLABSI–central line-associated blood stream infection; CAUTI–catheter-associated urinary tract infection; VAP–ventilator-associated pneumonia.

perceptions and satisfaction rates within closed ICUs compared to open ICUs.

The importance of effective communication and improved outcomes in critical care cannot be overstated. The ability of closed ICUs to streamline coordination, minimize complications, and optimize critical care management becomes particularly valuable. Patients and their families benefit from the structured approach that these closed systems provide, in which a sense of collaboration and clear communication supports the medical team's interactions. Furthermore, the benefits extend beyond individual patient experiences to the broader healthcare network. By reducing complications, enhancing outcomes, and containing costs, closed ICUs provide a strong foundation for sustainable and effective healthcare delivery.

In conclusion, closed ICUs can provide well-coordinated care and communication in the critical care setting. The advantages they offer, including increased patient satisfaction, improved clinical outcomes, and efficient resource management, make closed ICUs worthy of consideration and implementation. The Table 1 summarizes the prospective and retrospective studies used in this review. While challenges like limited staffing and patient preferences for continuity of care persist, the potential benefits of closed ICUs warrant more investigation and innovative strategies to meet these challenges. As healthcare systems evolve, the lessons and successes of closed ICUs could have a pivotal role in shaping the future of critical care.

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