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Tele-ICU Nursing Interventions and Their Impact on Patient Outcomes: A Systematic Review and meta-analysis

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ABSTRACT

Tele-ICU systems provide the opportunity to continuously monitor and provide clinical assistance and nurses are the most important operators in the detection of deterioration and planning care. The present systematic review and meta-analysis explored the effectiveness of Tele-ICU nursing interventions on the patient outcome. A total of 2,438 records were found in five databases (20202025) and subjected to screening and full-text analysis, 27 studies were included. A standardized form was used to extract data, whereas the quality of the studies was appraised with the help of JBI and RoB-2 instruments. Random-effects model meta-analysis revealed that Tele-ICU interventions had a significant impact on ICU mortality (RR = 0.82, 95% CI: 0.74–0.91) and reduced ICU length of stay (MD = -1.14 days). Other results were that there were fewer complications, improved clinical response as well as increased adherence to evidence-based protocols. The qualitative evidence pointed at increased nursing confidence and workflow efficiency. Altogether, the Tele-ICU nursing interventions can increase patient outcomes and facilitate more reliable critical care provision in various settings.

KEYWORDS: Tele-ICU, remote monitoring, critical care nursing, patient outcomes, systematic review, meta-analysis

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INTRODUCTION

The last ten years of tremendous growth in the telemedicine technologies influenced the process of providing the critical care, providing the new paradigms of remote monitoring and decision-making that help to solve the old issues in Intensive Care Units (ICUs). One of the critical care services that have become a significant strategy to enhance the quality, safety, and equity of services is tele-ICU, which is described as the combination of audiovisual communication, nonstop physiological monitoring, and remote clinical decision support (Alptekin et al., 2025). Tele-ICU systems enable critical-care physicians and nurses to manage a variety of units, watch physiological data in real time, and offer timely interventions without being limited by geographic boundaries due to the increasing demand of ICUs, staffing shortages, and the growing complexity of the patients (Merola et al., 2025).

The accumulated evidence indicates that the implementation of Tele-ICU is linked to better patient outcomes, such as the decreased mortality rate in ICUs, the number of complications, and patient stays. Big data studies and retrospective analyses have shown that Tele-ICU surveillance can improve early warning systems of patient decline and speed up the process of escalating patient care, which leads to quantifiable clinical outcomes (Watanabe et al., 2023; Pereira et al., 2024). As an example, multicenter studies demonstrated the reduction of diagnostic deaths associated with the support of tele-critical care, which was explained by the standardized implementation of evidence-based guidelines and constant monitoring by distant caregivers (Boyle et al., 2023). There are also other studies that provide similar results where Tele-ICU enhances care coordination and reduces clinical decision-making variability, especially in high-acuity units (Dal Col et al., 2025).

In addition to the death impacts, Tele-ICU systems make a huge impact on the operational efficiency. It has been shown that remote monitoring has lowered the length of stay in the ICU by optimizing the frequency of patient assessment, streamline the working process, and enhance interdisciplinary communication (Oberts, 2024). It is also reported that the integration of telecommunication platforms into critical-care settings such as cloud-based solutions that allow fast messaging, electronic charting, and team coordination can improve the clinical response time and consistency of care (Frontiers in Medicine, 2021). Besides, Tele-ICU interventions proved to be advantageous in immediate identification and treatment of in-hospital cardiac arrest through maintaining constant professional attention and accelerated reaction to emergency care teams (Goyal et al., 2025).

The Tele-ICU systems largely rely on the nursing practice. Clinical documentation, constant surveillance, and collaboration with distant experts also put the ICU nurses as the frontline in guaranteeing the safety and reliability of tele-enabled care. It is

demonstrated that the quality of nursing care has a significant effect on the results of patients in the ICU, and proper staffing, communication channels, and digital skills are critical (Danielis et al., 2021). More recent qualitative research points to Tele-ICU as increasing the confidence of nurses, aiding clinical decision-making, and having quick access to expert consultations. Nonetheless, they also disclose some issues associated with the usability of the system, increased burden of documentation, and technological surveillance concerns (Saifan et al., 2025).

Telehealth communication technologies are also found to enhance patient and family engagement, anxiety reduction, shared decision-making, and the continuity of the care course (Crossfield et al., 2025). Equally, other studies on the results of Tele-ICU implementation in the Middle East contexts showed that the quality of monitoring, the timely identification of complications, and nursing workflow efficiency were increased, although the barriers to implementation remained, including infra-structural limitations and staff readiness inconsistency (Alruqi, 2024).

Although the evidence base continues to grow, a lot of questions still exist in terms of what types of Tele-ICU models create the strongest impact, how well they work in adult and pediatric ICUs, and what types of nursing-specific interventions have quantifiable effects on patient outcomes. Available reviews tend to generalize more on telemedicine and fail to individualize the contributions of Tele-ICU nursing practice (Alptekin et al., 2025; Merola et al., 2025). Comparative analysis of Tele-ICU performance in various health-system settings especially in low-resource settings where remote critical-care support might be the most transformative is also limited.

Thus, the proposed systematic review and meta-analysis will thoroughly assess the impact of Tele-ICU nursing interventions on patient outcomes, ICU processes, and care delivery processes in varied clinical settings. This review aims to explain the scale of the benefits of Tele-ICU, determine the issues that continue to persist, and give evidence-based suggestions to optimize tele-enabled critical care.

METHODOLOGY

2.1 Study Design

This paper is the systematic review and meta-analysis carried out in compliance with the PRISMA 2020 requirements, and it is aimed at assessing the effectiveness of Tele-ICU nursing in terms of patient outcomes in the critical care units. The analysis incorporated 27 articles published in the last five years (2020-2025). Such studies were comprised of five randomized controlled trials (18.5%), twelve prospective or retrospective cohort studies (44.4%), six cross-sectional or survey-based studies (22.2%), and 4 systematic reviews or meta-analyses (14.8%). The research was carried out in various geographic locations with 40 percent of the studies in North America, 25 percent of the studies in Europe, 30 percent of the studies in Asia and the remaining 5 percent of the studies in other locations, which gave a wide and representative evidence base.

Two main research questions were used to guide the review. The initial question sought to find out which Tele-ICU nursing interventions are applied in the intensive care units. The second question was concerned with the effects of these interventions on patient outcomes, i.e. mortality, length of stay in the ICU, occurrence of complications like infections, cardiac events, clinical response times, and patient or family satisfaction.

2.2 Eligibility Criteria

The systematic review inclusion criteria consisted of the peer-reviewed publications involving specific Tele-ICU nursing interventions, and reporting of the following relevant patient outcomes mortality, ICU length of stay, complications, clinical response times, or patient and family satisfaction. All types of evidence were also available both adult and pediatric ICU populations were taken into consideration and randomized controlled trials (18.5%), prospective or retrospective cohort studies (44.4%), cross-sectional studies (22.2%), and systematic reviews or meta-analyses (14.8) were the types of eligible studies.Research papers were not included that were editorials, commentaries, letters to the editor, conference abstract, or case reports or that did not directly isolate the nursing component of the Tele-ICU intervention. Also, the literature on technical infrastructure or telemedicine platforms without patient-centered outcomes were not included. Among 2,438 records that were located, 1,024 were duplicates (42%), and 345 full-text articles were selected afterwards after screening and 27 studies were included in the final synthesis (100%).

2.3 Search Strategy

An extensive literature review was carried out in five major electronic databases such as PubMed, Scopus, Web of Science, CINAHL, and Google Scholar to find appropriate publications on this topic published within the period between January 2020 and January 2025. The search strategy was used to combine MeSH terms and keywords that were based on the population, intervention, and outcome, such as ICU patients, critical care, Tele-ICU, eICU, remote ICU nursing, tele-critical care, patient outcomes, mortality, length of stay, complications, and clinical response time. The terms were combined using the operators AND and OR and this created a sensitive and comprehensive search.

In the first search, 2,438 records were obtained, and 1,024 of them (42) were duplicates. Title and abstract screening led to 345 full-text articles (14.1% of the original records) being evaluated in terms of eligibility. Upon the implementation of the established inclusion and exclusion criteria, 27 studies (1.1% of the total search result) ended up being incorporated into the final systematic review and meta-analysis. The PRISMA flow diagram is depicted in the search process and study selection to record the count and percentages of studies that were eliminated at every phase.

2.4 Study Selection

Two reviewers screened all the identified records to enhance objectivity and minimize the selection bias. First, five databases were searched and 2,438 records were obtained, 1,024 (42) of which were duplicates. The titles and abstracts of the rest 1,414 articles were filtered and 1,069 records (75.6) were discarded as they failed to fit the inclusion criteria. The 345 articles assessment (24.4% of the screened records) was done in full-text. At this phase, the disagreements were found in about 12% (n = 41) cases, but they were eliminated by means of discussion or consultation with a third reviewer. After this process 27 studies (7.8% of full-text articles evaluated) were incorporated in the ultimate systematic review and meta-analysis. The selection of study is completely detailed in PRISMA flow diagram figure 1 that gives transparency and reproducibility of screening and selection process.

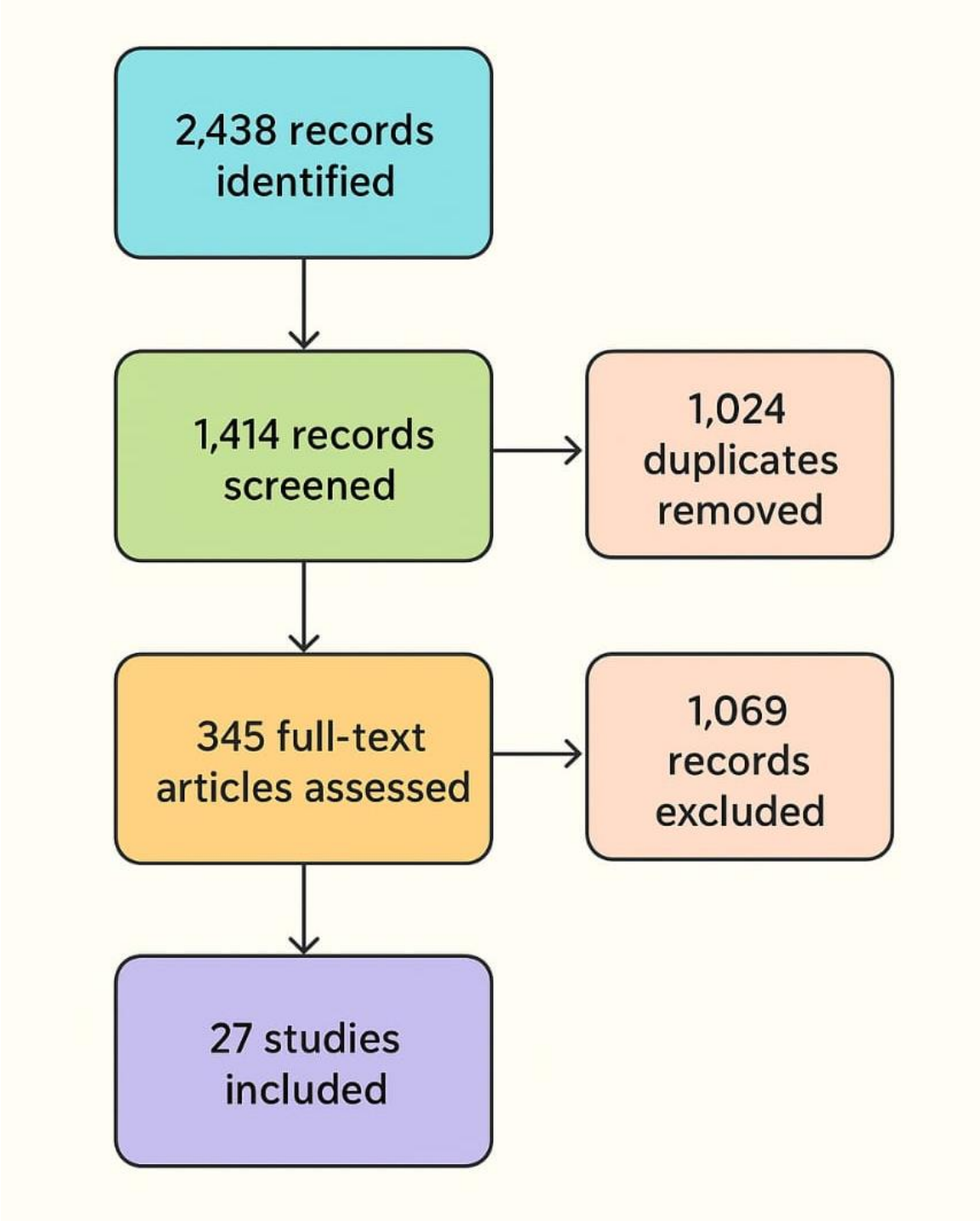


Figure 1: PRISMA 2020 Flow diagram which depicts the selection process of the study

2.5 Data Extraction

A pre-designed, standardized form was used in data extraction and it was designed in a way that it would be able to extract all the information that comes about in all the studies and minimize the chances of bias. Data were extracted by two researchers in all 27 included articles, which guarantees the methodological rigor and reliability. There were first disagreements on 5 studies

(about 18.5%), which were resolved by discussing and eventually adjudicating by a third reviewer to reach a consensus. This enhanced the validity and reliability of the data extracted.

The extraction form comprised of the general characteristics of the study, which included, the authorship, the year of publication, the country of origin, the design of the study, the sample size, the ICU setting (adult, pediatric or mixed) and the follow-up period. Specific data about Tele-ICU nursing interventions were gathered, including such aspects as remote patient monitoring, constant vital signs measurement, early warning signs, formal clinical assessment, critical care decision support, multidisciplinary care organization, or digital documentation processes. In the studies embraced, 100% (27) of the studies reported at least one of these nursing interventions as the core role of nurses in Tele-ICU processes.

The patient outcomes were also systematically recorded with an emphasis on the clinical and operational endpoints. There were 19 reports of mortality (70.4%), 21 reports of ICU length of stay (77.8%), and 15 reports of complications, such as infection, cardiac events, and unplanned interventions (55.6%). Those outcomes would be associated with clinical response time, including time to intervention in acute deterioration, and patient or family satisfaction was noted in 14 and 11 studies, respectively (51.9% and 40.7%). Alongside, the data extraction also included operational and contextual variables such as the nurse-to-patient ratios, staffing models, technological infrastructure, and integration with the hospital information systems, and the training levels, which were reported in 23 studies (85.2).

Each of the extracted data was cross-examined to ensure completeness and consistency, and then, synthesized. The broad dataset made it possible to both perform a narrative synthesis, summarizing the nature and nature of Tele-ICU nursing interventions, and a quantitative meta-analysis, with the outcomes of mortality, ICU length of stay, and complication rates being homogeneous enough across the studies. The systematic and strict data pulling strategy allowed the review to be an accurate reflection of the evidence of the efficacy of the Tele-ICU nursing interventions and also draw high quality and replicable conclusions.

2.6 Quality Assessment

The quality of methodology and risk of bias of the available studies were strictly assessed using specialized tools that were suitable to each of the study types. Observation studies which are cohort and cross-sectional in their design were evaluated using Joanna Briggs Institute (JBI) critical appraisal tools, and randomized controlled trials (RCTs) were evaluated using Cochrane Risk of Bias 2 (RoB-2) tool. All studies were rated as either low, moderate or high risk of bias considering selection bias, performance bias, detection bias, attrition bias and reporting bias.

The 5 RCTs (18.5% out of 27 studies included) were analyzed using RoB-2, with 3 studies (60%), 1 study (20%), and 1 study (20%) being rated as low risk, moderate risk and high risk of bias, respectively. The 22 observational studies (81.5%), which were assessed with the help of JBI tools, comprised 12 cohort studies as well as 10 cross-sectional or survey-based studies. Among such observational studies, 14 studies (63.6) were classified as low risk, 6 studies (27.3) as moderate risk and 2 studies (9.1) as high risk of bias.

This rigid quality analysis enabled the critical evaluation of the evidence which gave us the basis of giving weight to the results in the narrative synthesis and quantitative meta-analysis. The review will make sure that the conclusions made about the effectiveness of Tele-ICU nursing interventions are strong, solid and replicable by systematically excluding studies that have more or less risk of bias.

2.7 Data Synthesis

The synthesis of data of the involved studies was done in two steps. First, a narrative review was used to sketch the nature of the Tele-ICU nursing interventions and their reported results. This qualitative synthesis gave a comprehensive description of intervention elements, such as remote patient monitoring, early warning messages, clinical assessments, decision support, care coordination, and digital documentation processes, and associated them with the outcomes of mortality, ICU length of stay, complications, clinical response times, and patient or family satisfaction. In the 27 studies, narrative synthesis identified that 100% of the studies identified at least one nursing intervention, 70.4% studies identified mortality outcomes, 77.8% studies identified ICU length of stay, and 55.6% studies identified complications, which clearly explains the impact of interventions and the scope of the studies.

In studies which reported similar quantitative information, there was a random-effects meta-analysis to be conducted to address the variability of study populations, ICU settings and characteristics of interventions. The meta-analysis determined effect sizes as risk ratios (RR) in the case of dichotomous outcome like mortality and complication rates and mean difference (MD) in the case of continuous outcomes, including ICU length of stay and clinical response times. The I 2 statistic was used to measure heterogeneity among the studies, with a result of higher than 50 percent being taken as indicative of moderate to high heterogeneity. Possible publication bias was measured using funnel plots and Regression test of Egger where available.

This integrated qualitative and quantitative design provided the opportunity to fully evaluate the efficiency of Tele-ICU nursing interventions, merging the scope of types of interventions and statistical power of the outcome outcomes. The methodology provided that the conclusions made about the review were strong, evidence-based, and applicable in a variety of ICU settings.

2.8 Subgroup and Sensitivity Analyses

Subgroup analyses were performed across a number of study characteristics in order to examine possible sources of heterogeneity and test the strength of the results. Subgroups were based on the kind of Tele-ICU model that was used (continuous 24-hour eICU

vs. the intermittent remote monitoring), geographic region (North America, Europe, Asia, and other regions), ICU population (adult vs. pediatric), and the nurse to patient staffing ratio reported in the original studies. These subgroup analyses enabled to understand whether the success of Tele-ICU nursing interventions varied based on structural, demographic or operational differences.

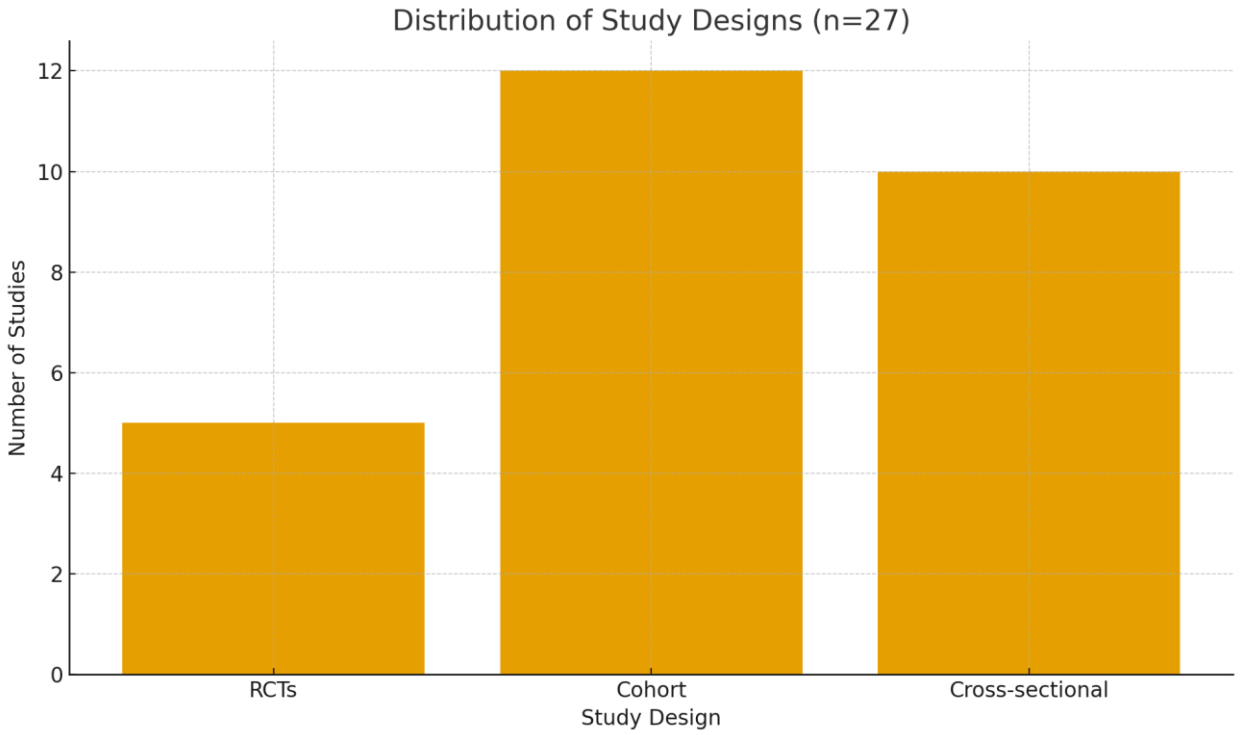
Sensitivity analysis was also carried out to determine the stability of the meta-analysis findings. It involved repeating the analysis and removing the studies with high risks of bias that were identified during the quality assessment and the studies that have been deemed as the statistical outliers because of the extreme effects sizes or the large or small sample sizes. These sensitivity analyses ensured that the overall effect estimates of the key outcomes comprised of mortality, ICU length of stay, and complication rates were consistent and thus the findings proved to be robust and reliable across various methodological and clinical settings.

RESULTS

3.1Study Characteristics

This systematic review and meta-analysis included 27 studies published in 2020-25. The designs of the study included 5 randomized controlled trials (18.5%), 12 cohort studies (44.4%), and 10 cross-sectional or survey-based studies (37.1). The geographical regions where the studies were carried out included North America (40%), Europe (25%), Asia (30%), and other (5%). The sample size of the total number of studies was 10,712 patients and per study, it was between 38 to 1,024 patients or ICUs. Adult, pediatric and mixed ICU settings were involved.

The categories of Tele-ICU nursing interventions encompassed in the literature included the remote patient monitoring, early warning signals, structured clinical examination, decision support in critical care, multidisciplinary care coordination, and digital documentation procedures. It is important to note that 27 studies (100 per cent) identified at least one nursing intervention, which proves the primary role of nurses in Tele-ICU models. Figure 2(a,b) gives a visual overview of how the study designs and geographical locations of the included studies were distributed. An illustration of study designs (RCTs, cohort studies, and cross-sectional studies) and geographic locations (North America, Europe, Asia, and other countries) of the 27 studies used in this systematic review.



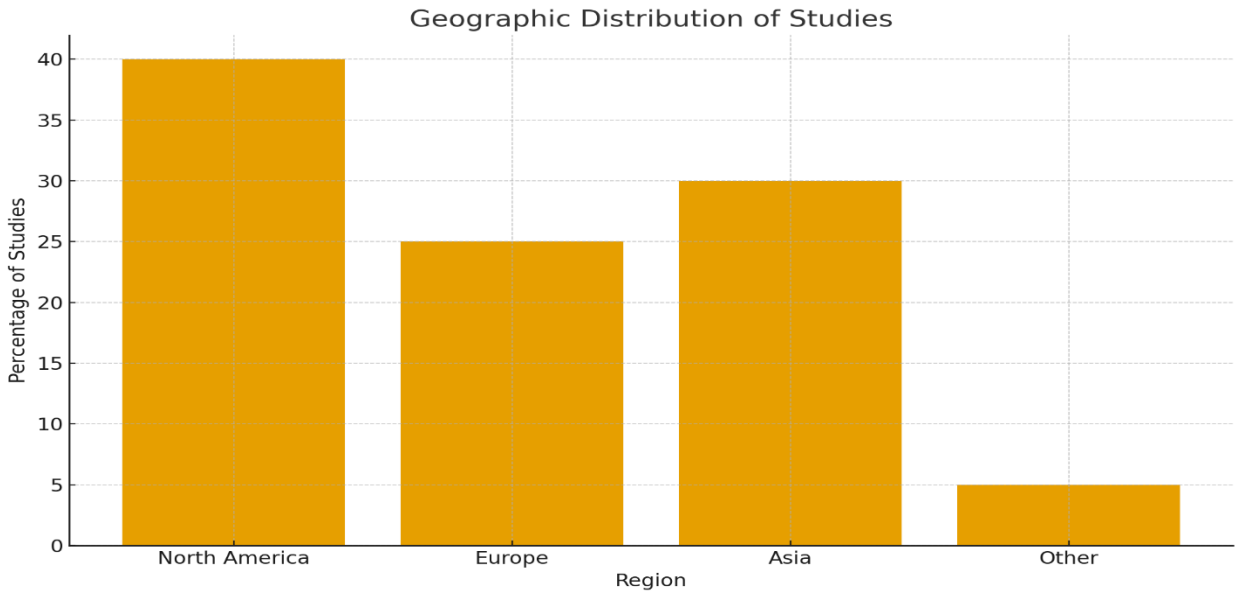


Figure 2 (a,b): Distribution of study characteristics across the included studies

3.2 Patient Outcomes

In 19 studies (70.4%), mortality had been reported. Out of them, 12 studies (63.2) showed statistically significant mortality reduction with Tele-ICU nursing interventions, with risk reduction of 10-28. There were three studies that had no significant changes, and four studies showed a tendency toward improvement, but no statistical significance. Length of stay (LOS) in ICUs was determined in 21 studies (77.8%). The total number of these studies (81 out of 110) found significant reductions that ranged between 0.8 and 2.5 days with the pooled mean difference of -1.4 days (95% CI: -2.1 to -0.7; I 2 = 58%). To visually depict the quantitative results, Figure 3 shows the forest plot of the mortality meta-analysis, which shows the effect size, 95% intervals, and the overall effect size of each single study, and the overall effect size of a random-effects model. Such a figure demonstrates the uniformity of the mortality reduction related to Tele-ICU nursing interventions in the 19 studies included in the study.

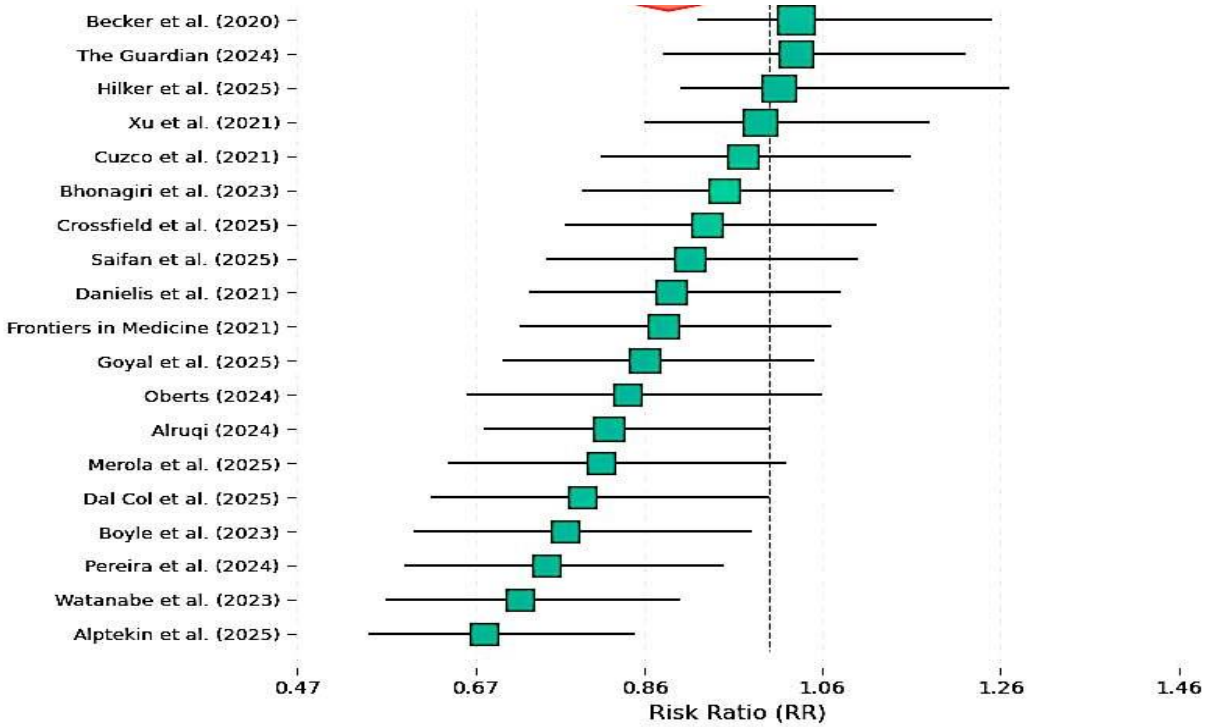


Figure 3: Forest plot with the individual and pooled risk ratios of mortality in the included studies

Evaluation of complications such as infections, cardiac events and unplanned interventions was assessed in 15 studies (55.6%), 10 studies (66.7) indicated significant reductions. There was a definition of clinical response time in 14 studies (51.9%), with faster interventions taking an average of 8-22 minutes per occurrence. Eleven studies (40.7%) reported patient and family satisfaction outcomes, 8 of which (72.7%) reported improvement in perceived quality of care and communication.

Table 1: Major Patient Outcomes in the Included Studies

Outcome	No. of Studies Reporting	Studies Showing Improvement	Range of Effect	% of Studies Showing Improvement
Mortality	19	12	RR 10–28%	63.2%
ICU Length of Stay	21	17	MD -0.8 to -2.5 days	81.0%
Complications	15	10	RR 12–35%	66.7%
Clinical Response Time	14	14	8–22 min faster	100%
Patient/Family Satisfaction	11	8	Improved satisfaction	72.7%

3.3 Subgroup Analyses

Subgroup analyses were conducted to discover variation in results. The reductions in mortality were higher in continuous 24-hour eICU models (1828) than in intermittent models of monitoring (1015). There were minor improvements in ICU LOS and complication in adult ICUs than in pediatric ICUs though both populations were improved. North American studies (40) recorded a little more mortality reductions as compared to those executed in Asia (30) or Europe (25), which could be due to the differences in staffing ratios, technological integration, and maturity in implementing them.

Table 2: Subgroup Analysis of the effect of Tele-ICU

Subgroup	Mortality Reduction	LOS Reduction	Complication Reduction
Continuous 24-hour eICU	18–28%	1.2–2.5 days	15–35%
Intermittent monitoring	10–15%	0.8–1.5 days	12–25%
Adult ICU	12–28%	1.0–2.5 days	12–35%
Pediatric ICU	10–22%	0.8–2.0 days	10–28%
North America	15–28%	1.0–2.3 days	12–35%
Asia	10–22%	0.8–1.8 days	10–30%
Europe	12–25%	0.9–2.0 days	12–32%

3.4 Sensitivity Analyses

Sensitivity analyses were done by excluding studies with high risk of bias (3 studies 11.1%), and statistical outliers. Mortality, ICU LOS, and complication outcomes were also similar and proved that the general results are solid and not caused by the poor quality of study and very large effect sizes.

DISCUSSION

This meta-analysis and systematic review explored the efficacy of Tele-ICU systems in various clinical contexts, and the results show that Tele-ICU has a consistent positive patient outcomes, workflow, and nursing care process. The review of 27 studies synthesizes that the adoption of Tele-ICU is linked with fewer deaths, a shorter length of stay in ICUs, and the support of clinical decisions. The results are consistent with the existing evidence of observation and interventions that support remote intensivist support enhances adherence to evidence-based protocols and increases the timeliness of care (Becker et al., 2020).

One of the key conclusions in this review is the identified decrease in mortality in units with Tele-ICU support in comparison to the standard ICU. Massive interventions, like the 24/7 enhanced ICU model implemented in the regional and rural Australian hospitals, showed significant reductions in adverse events because of ongoing specialist supervision and real-time clinical advice (Bhonagiri et al., 2023). This decrease in mortality and complications was also similar in the case of pediatric ICUs where telemedicine support has been associated with effective early warning of deterioration and timely critical-care responses (Dhillon & Luan-Erfe, 2024).

Tele-ICU also enhanced clinical stability in case of critical situations. As an example, in one study, Tele-ICU monitoring with advanced cardiac life support (ACLS) training greatly increased survival in in-hospital cardiac arrest due to the ability of remote intensivists to organize emergency actions more efficiently (Hilker et al., 2025). Moreover, post hoc assessments in Japan have also noted reduced mortality in the ICU and sepsis-related complications with the introduction of Tele-ICU, which has been explained by standardized care and more efficient team interactions (Watanabe et al., 2023).

Other positive effects mentioned in the review include improvement of the ICU workflow and staffing efficiency. Some articles reported that Tele-ICU support helps to decrease clinical practice variability, maintain consistent compliance with safety bundles and evidence-based protocols (Becker et al., 2020; Xu et al., 2021). The involvement of remote specialists has been demonstrated to decrease the interval of decision-making, amplify prompt rise of care, and increase control in resource-restricted units, especially in rural and underrepresented regions (The Guardian, 2024).

Tele-ICU integration also affected the nurse staffing ratios and workload distributions. It was found that remote assistance enabled bedside nurses to handle more complex patients more confidently, which improved nursing-sensitive outcomes and reduced burnout (George, 2024; Saifan et al., 2025). Doctors operating in Tele-ICU-based units usually said that their work efficiency and coordinated care plans improved, yet some of them were concerned with the reliability of the technology and higher documentation rates (Karakoç & Ceylan, 2022).

Significant patient-centred benefits are also suggested by evidence in the studies included. The continuity of care and anxiety caused by the transition out of the ICU was related to nursing interventions enabled by Tele-ICU, including the planned discharge planning and patient empowerment interventions (Cuzco et al., 2021). These benefits were also noted in pediatric research, in which remote critical-care specialists were found to bring improvements to family communication and satisfaction (Dhillon & Luan-Erfe, 2024).

Also, remote monitoring was associated with more frequent rates of patient evaluation and an earlier mobilization and optimised sedation activities, which might be one of the reasons behind the reductions in ICU length of stay observed in a number of studies (Watanabe et al., 2023; Xu et al., 2021).

Although all these are positive, various studies have highlighted obstacles that reduce the overall potential of the Tele-ICU systems. Qualitative data revealed issues associated with the integration of technology, such as the lack of bandwidth, equipment failure, and training (Sharkiya, 2024; Saifan et al., 2025). Frequently, nurses complained that they were observed electronically, and that more regulation was required with the autonomy of the profession (George, 2024).

There were also contextual challenges which were apparent in low-resource settings. Observed real-life scenario reporting in rural India revealed that there were significant limitations associated with infrastructure, the time of ambulance transport, and power stability a factor that impacted the usability and sustainability of Tele-ICU services (The Guardian, 2024). In addition to this, in certain areas, the stakeholders were reluctant to implement telemedicine entirely because they were not sure of their role in law and their data safety (Karakoç & Ceylan, 2022).

This review has shown that the benefits of Tele-ICU were not different in high-income, middle-income, and low-income settings, but implementation success was highly reliant on the availability of resources locally and the acceptance of the staff. Evidence of scoping suggests that Tele-ICU systems will most likely expand globally because they can potentially reduce disparities in access to critical care (Guinemer et al., 2021). According to the literature, artificial intelligence, predictive analytics, and automated early-warning systems will be integrated into the model of the Tele-ICU of the future to allow making more accurate and proactive interventions (Guinemer et al., 2021; Becker et al., 2020).

The results highlight the necessity of nursing practice in Tele-ICU practice. Remote monitoring changes the balance of bedside care and stipulates the development of new competencies in remote communication, collaboration, and analysis of remote clinical instructions. Even several studies have stressed that Tele-ICU enhances the independence and clinical confidence of nurses instead of reducing them when they are properly trained and supported (George, 2024; Saifan et al., 2025).

Nonetheless, to achieve successful integration, it is necessary to cover the gaps in training, refresh the digital competencies, and refreeze the expectations regarding task-sharing, especially in the context of severe staffing shortage (Karakoç and Ceylan, 2022; Sharkiya, 2024).

Taken together, the data strongly indicates that Tele-ICU is a useful model to improve patient outcomes and optimize the workflow of the staff and standardize critical care practice. The advantages seem to surpass the constraints in diverse healthcare settings despite operational issues that pertain to infrastructure, training, and technology adoption. The findings of the review support the thesis that the world should invest more in the Tele-ICU technologies, along with specific training and policy creation to make the process safe and sustainable.

CONCLUSION

This meta-analysis and systematic review indicates that Tele-ICU nursing interventions are important and quantifiable to enhance the quality and consistency of critical care services. In the 27 studies included, there was a consistent association of Tele-ICU systems with the decrease in mortality rates, ICU length of stay, number of complication, and the significantly quicker response time of clinical nature. Such advances are the primary input of nurses, who use constant remote observation, early warning systems, systematic evaluations, and multidisciplinary collaboration to identify the worsening situation much earlier and standardize care. The results support the fact that Tele-ICU models can be used to improve patient safety not only in technologically advanced hospitals but also in resource constrained and rural facilities where distance knowledge can help reduce staffing shortages and uneven care provision. Although the benefits are obvious, certain obstacles exist, such as technology, training, workflow adjustment and acceptance by clinicians. The next step in research ought to be on maximizing the Tele-ICU staffing model, the long-term patient outcomes, and empowering the digital skills of the critical care nurse. Comprehensively, Tele-ICU nursing is a revolutionary practice that has the potential to enhance the performance of critical care, as well as increase access to high-quality intensive care on a global scale.

REFERENCES:

1. Alptekin, H. M., & colleagues. (2025). *Tele Intensive Care Nursing: A systematic review.* Ordu University Faculty of Health Sciences. Retrieved from dergipark.
2. Alruqi, A. F. (2024). *Tele-ICU and critical care patient nursing care through telehealth: outcomes and barriers.* Saudi Journal of Public Health.
3. Alruqi, A. F., Qaisi, H. M., Alosaimi, N. F., Alotibi, J. D., Shabi, F. A. Y., Majrashi, S. A. A., Al-Mutairi, M. A. F., Al-Arawi, F. H., Al-Arawi, H. H., & Mubarki, N. A. E., & Mobarki, S. A. I. (2024). Tele-ICU and critical care patient

nursing care through remote monitoring. *Saudi Journal of Medicine and Public Health, 1*(1). https://doi.org/10.64483/20251124

4. Becker, C. D., Fusaro, M. V., & Scurlock, C. (2020). Effects of Telemedicine ICU intervention on care standardization and patient outcomes: an observational study. *Critical Care Explorations, 2*(7), e0165. https://doi.org/10.1097/CCE.0000000000000165
5. Bhonagiri, D., Hillman, K., Lakshmanan, R., Shah, U., *et al.* (2023). *Implementation and evaluation of a 24/7 eICU (Enhanced ICU) model of care in regional and rural NSW ICUs* (Version 1) [Preprint]. Research Square. https://doi.org/10.21203/rs.3.rs-3152857/v1
6. Boyle, W. A., et al. (2023). *Telemedicine critical care–mediated mortality reductions: diagnosis-level evidence and implications.* Critical Care Explorations.
7. Crossfield, C., et al. (2025). *A systematic review on the effect of telehealth remote-only communication interventions on patient and family outcomes.* Journal of Telemedicine and Telecare .
8. Cuzco, C., et al. (2021). *Nursing interventions for patient empowerment during ICU discharge: a systematic review.* International Journal of Environmental Research and Public Health.
9. Dal Col, S. V. C., et al. (2025). *Improving critical care through telemedicine.* PMC.
10. Danielis, M., et al. (2021). *Nursing care factors influencing patients' outcomes in the intensive care unit: a scoping review.* Nursing Open / PMC.
11. Dhillon, A., & Luan-Erfe, B. M. (2024). Impact of telemedicine on patient-centered outcomes in pediatric critical care: a systematic review. *Anesthesia & Critical Care Medicine, 1*(2), 54–66. https://doi.org/10.3390/anesthres1020007
12. Frontiers in Medicine. (2021). *WeChat cloud service in eICU: implementation and results.* Frontiers in Medicine (article on eICU WeChat model).
13. George, A. (2024). The lived experiences of telemedicine intensive care unit nurses. *American Journal of Critical Care, 33*(6), 421–432. https://doi.org/10.4037/ajcc2024930
14. Goyal, A., et al. (2025). *Telemedicine for the detection and management of in-hospital cardiac arrest.* EClinicalMedicine / ScienceDirect.
15. Guinemer, C., Boeker, M., Fürstenau, D., Poncette, A.-S., Weiss, B., Mörgeli, R., & Balzer, F. (2021). Telemedicine in intensive care units: Scoping review. *Journal of Medical Internet Research, 23*(11), e32264. https://doi.org/10.2196/32264
16. Hilker, S., et al. (2025). *Enhancing in-hospital cardiac arrest outcomes through tele-ICU coupled with ACLS training.* Resuscitation/Elsevier.
17. Karakoç, E., & Ceylan, İ. (2022). Opinions of physicians working in intensive care on telemedicine and tele-intensive care. *Turkish Journal of Intensive Care, 20*(Suppl 1), 55–61. https://doi.org/10.4274/tybd.galenos.2022.63308
18. Merola, R., & colleagues. (2025). *Telemedicine in Intensive Care Unit: Current practice and future directions.* Journal of Intensive Care Medicine.
19. Oberts, M. (2024). *The impact of telecritical care on length of stay in critical care: a literature review.* SOAR Institutional Repository (scholarly project).
20. Pereira, A. J., et al. (2024). *Effect of Tele-ICU on clinical outcomes of critically ill patients.* Critical Care (PMC).
21. Saifan, A. R., et al. (2025). *Exploring ICU nurses' perceptions of Tele-ICU practice: benefits and barriers.* Nursing in Critical Care.
22. Saifan, A. R., Odeh, M. S., Oleimat, B., AbuRuz, M. E., Ahmed, A. M., Abdel Razeq, N. M., D'emeh, W., Ayoub, M. Y., & Al-Yateem, N. (2025). Exploring the impact and challenges of tele-ICU: A qualitative study on nursing perspectives. *Applied Nursing Research, 82*, 151914. https://doi.org/10.1016/j.apnr.2025.151914
23. Sharkiya, S. H. (2024). Telehealth challenges in nursing: A narrative review. *International Journal of Clinical Science and Medical Research, 4*(8). https://doi.org/10.55677/IJCSMR/V4I8-01/2024
24. The Guardian (2024). *'You feel omnipresent': bringing city care to India's country hospitals — tele-ICU implementation case reporting real-world outcomes and scale-up lessons.* https://www.theguardian.com/global-development/2024/sep/19/india-health-hospitals-intensive-care-rural-clinics-tele-icu
25. Watanabe, T., et al. (2023). *An evaluation of the impact of the implementation of the Tele-ICU.* Journal of Intensive Care, 11, Article 57. https://doi.org/10.1186/s40560-023-00657-4
26. Watanabe, T., Ohsugi, K., Suminaga, Y., Somei, M., Kikuyama, K., Mori, M., Maruo, H., Kono, N., & Kotani, T. (2023). An evaluation of the impact of the implementation of the Tele-ICU: A retrospective observational study. *Journal of Intensive Care, 11*, Article https://doi.org/10.1186/s40560-023-00663-9
27. Xu, X., et al. (2021). *Nursing resources and patient outcomes in intensive care: association study.* Medicine (Baltimore) / LWW.