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The impact of sepsis education quality improvement interventions for intensive care units' healthcare workers: A systematic review

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Abstract

Background and aim: Sepsis mortality is one of the significant, preventable public health issues worldwide. Although there has been increased focus on sepsis education and training for healthcare professionals and students, the effectiveness of various educational methods in promoting the adoption of best sepsis care practices has been less thoroughly evaluated, especially in critical care settings. Thus, the aim of this review was to explore the impact of sepsis education quality improvement interventions on intensive care units healthcare workers.

Methods: This systematic review followed PRISMA guidelines and involved a comprehensive search of PubMed, Scopus, Embase, and Cochrane Library using keywords related to sepsis education and training. The search included English-language articles published after 2010, focusing on randomised and non-randomized trials, interventional studies, and quality improvement projects. Studies were screened by title, abstract, and full text to evaluate eligibility. Data extraction covered study design, objectives, healthcare staff involved, intervention types, outcomes, and methods.

Results: A total of 660 records were initially identified through the electronic database search. Resulting in the inclusion of seven studies in this review. Educational interventions across various studies showed mixed results in sepsis management. No significant impact was on late-onset sepsis rates despite improved clinical outcomes. Improved knowledge and competence was reported but no link between knowledge and overall competence. Better compliance and a trend towards reduced mortality was achieved. Both simulation and self-study were found to improve sepsis knowledge. Educational interventions also increased clinician confidence and guideline adherence in paediatric sepsis. They also improved knowledge and practices among ICU nurses. Moreover, comprehensive training significantly reduced sepsis mortality and costs.

Conclusion: This review highlights the effectiveness of educational interventions in improving sepsis management, noting significant enhancements in knowledge and practice. Various methods, from high-fidelity simulations to multimodal approaches, show improvements in sepsis care and outcomes, such as reduced mortality and better adherence to care bundles. However, challenges remain in optimising these strategies and ensuring their impact on patient outcomes. Future research should focus on overcoming adherence barriers, evaluating direct effects on outcomes, and exploring cost-effective, sustainable educational methods.

Keywords: Sepsis Education; Intensive Care Units; Healthcare Workers; Quality Improvement Interventions.

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1. Introduction

Sepsis mortality is one of the significant, preventable public health issues worldwide [1-3]. Globally, there are approximately 15–19 million cases of sepsis annually, in the United States of America for example, Sepsis is linked to approximately 28.6%–30% of mortality rates [4]. In paediatric populations, Sepsis is a leading cause of death globally, claiming over 6 million lives annually. In developed countries, mortality rates for paediatric severe sepsis and septic shock range from 10% to 17% [5-7].

It is widely recognized that the prompt administration of basic interventions, such as antibiotics and intravenous fluids, can substantially reduce both mortality and morbidity [8]. Additionally, Patients managed according to clinical practice guidelines are less likely to develop sepsis. Lower sepsis incidence also reduces the risk of complications like sepsis-induced acute respiratory distress syndrome, prolonged hospital stays, and mortality [9]. Furthermore, Implementing bundled interventions can improve sepsis care and reduce mortality by 14% [10]. The Surviving Sepsis Campaign (SSC), led by the European Society of Intensive Care Medicine and the Society of Critical Care Medicine, has outlined essential care elements for sepsis management and resuscitation in sepsis care bundles [11].

Despite evidence that implementing SSC-guided sepsis care bundles improves patient outcomes, adherence to these bundles remains suboptimal, and sepsis continues to be underdiagnosed and undertreated [12]. Although there has been increased focus on sepsis education and training for healthcare professionals and students, the effectiveness of various educational methods in promoting the adoption of best sepsis care practices has been less thoroughly evaluated, especially in critical care settings. Thus, the aim of this review was to explore the impact of sepsis education quality improvement interventions on intensive care units healthcare professionals.

2. Methods

This systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines [13]. A comprehensive search was performed across four electronic databases: PubMed, Scopus, Embase, and the Cochrane Library. The search strategy employed a variety of keywords specific to the topic, including “sepsis”, “education”, “educational intervention”, “training”, “learning”, “intensive care units”, “ICU”, “critical care”, “healthcare professionals”, “healthcare staff”, “nurses”, “physicians”, “clinicians”, “health personnel”.

Boolean operators were used to combine these terms, and MeSH terms, along with other database-specific filters, were applied to ensure the retrieval of relevant studies. The search was restricted to English-language articles, records published after 2010, and excluded commentaries, editorials, letters, and conference proceedings. Relevant studies were initially screened based on their titles and abstracts. Following this, the selected articles underwent a full-text review to assess their eligibility. Randomised and non-randomized clinical trials, as well as other interventional studies, and quality improvement projects that assessed the impact of sepsis education interventions were included. No restriction was applied in terms of the outcomes measured by individual studies and the definition of sepsis.

For the included studies, a data extraction sheet was developed to collect information on the study's country, design, objectives, duration, number of institutions involved, type and number of healthcare staff included in the education interventions, type of the healthcare department included (surgical/medical/ and paediatrics), outcomes and their measures, educational interventions content, education methods, non-educational interventions conducted, impact of sepsis education interventions as they were reported in the included studies.

3. Results and Discussion

A total of 660 records were initially identified through the electronic database search. After the title and abstract screening, 18 records remained for further evaluation. The full texts of these 18 studies were then assessed for eligibility, resulting in the inclusion of seven studies in this review. The study selection process is illustrated in Figure 1. Of the seven included studies, four were conducted in the United States of America. Furthermore, four of these studies used a pre- and post-interventional design based on quality improvement methodologies, while the rest had a Quasi-experimental design. The duration of the studies differed among the studies, ranging from 4 to 48 months. The majority of the studies involved multiple institutions, as detailed in Table 1, which outlines the characteristics of the included studies.

Table 1 Basic information about the included studies

Study	Design	Country	Study duration	Number of participating institutions	Department	Participating healthcare staff	Sepsis Educational interventions
Gilbert 2014 [14]	Pre-post interventional study	Brazil	36 months	One	paediatrics NICU	Nurses (298)	The educational intervention, called "POINTS of care" (PoC), focused on pain control, optimal oxygenation, infection control, nutrition interventions, temperature control, and supportive care.
Delaney 2015 [15]	Quasi-experimental study	USA	N.S	Five	Critical care units and emergency departments.	Nurses (82)	The TSEP Educational Program aimed to improve sepsis knowledge and treatment skills through interactive online modules covering IHI bundles, sepsis staging, health literacy, and teamwork, complemented by high-fidelity medical simulations and debriefing sessions.
Siontis 2015 [16]	Pre-post interventional study	USA	6 months	One	Medical ICU	Internal Medicine residents doctors (170)	The educational interventions included a slide set on early resuscitation for sepsis, pocket cards detailing sepsis criteria and order set use, and bi-monthly feedback sessions on compliance with resuscitation practices and CPOE order sets.
Serrano-smith 2016 [17]	Quasi-experimental study	USA	N.S	Seven	Medical ICU	Nurses and doctors (69)	The education interventions included a Simulation Group, where participants engaged in a high-fidelity sepsis management scenario followed by a debriefing, and a Self-Study Group, where participants reviewed the Cleveland Clinic Care Path Guide on severe sepsis management.
Stewart 2017 [18]	Pre-post interventional study	UK	N.S	Five	paediatrics ICU	Doctors and allied health professionals (79)	The teaching program included a 1-hour session focused on addressing identified learning needs and existing guidelines, such as ACCM and Pediatric Sepsis Six, emphasising the urgency of sepsis

							management and building confidence in handling cases.
Hlungwane 2021 [19]	Quasi-experimental study	South Africa	4 months	Five	Medical ICU	Nurses (101)	The educational intervention was developed based on the 2016 SSC guidelines and "The Sepsis in Resource Limited Nations Initiative," featuring a 20-minute PowerPoint presentation, printed materials, and bi-monthly monitoring visits for one intervention group, while another group received only the educational materials, and the control group received no intervention.
Sreeramoju 2021[20]	Pre-post interventional study	USA	48 months	One	paediatrics/medical/surgical ICUs	Managerial staff, nurses, chief doctors, and others (550+)	The educational interventions included quality and safety training for over 550 leaders and personnel through in-person sessions and a 9-day clinical safety program, alongside disease-targeted prevention measures using bundles and checklists to reduce CLABSI, CAUTI, SSI, and sepsis mortality.

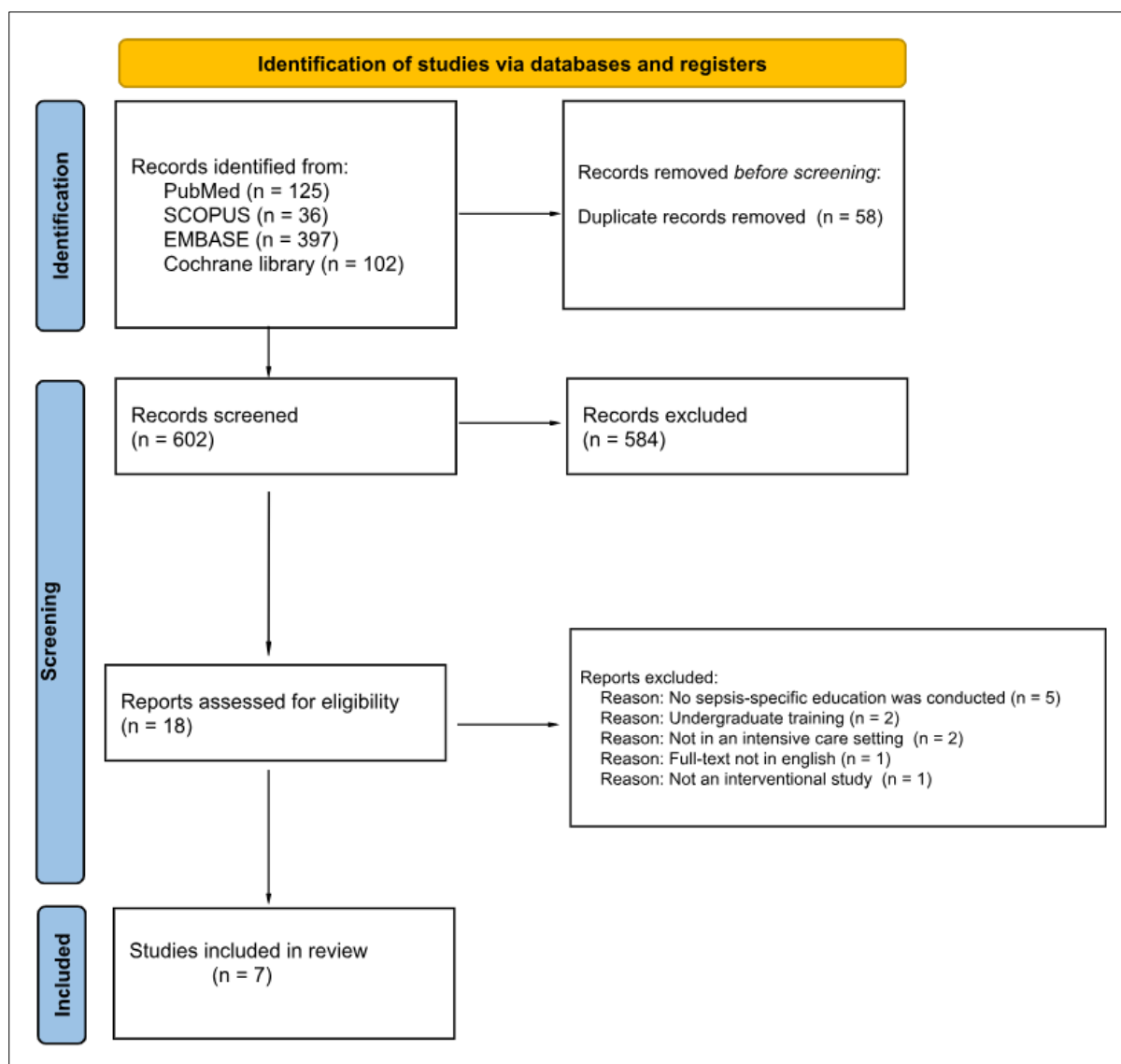


Figure 1 PRISMA flowchart of the study selection process.

Gilbert et al study aimed to evaluate the impact of an educational intervention for nurses on outcomes in neonatal intensive care units (NICUs), particularly focusing on survival, infection control, and other clinical outcomes in preterm infants. The primary outcome was survival to discharge for infants with a birth weight $\leq 1,500$ grams or gestational age ≤ 34 weeks. Secondary outcomes included rates of Retinopathy of Prematurity, Bronchopulmonary Dysplasia, Late-Onset Sepsis, Necrotizing Enterocolitis, days to regain birth weight, and NICU arrival temperature. The educational intervention, called "POINTS of care" (PoC), focused on pain control, optimal oxygenation, infection control, nutrition interventions, temperature control, and supportive care [14].

Nurse tutors provided practical demonstrations for each PoC module, and nurses were required to complete all six PoC learning modules within a 3-month period, with ongoing supportive supervision from the nurse tutors. Besides education, staff helped develop daily 'tick sheets,' received ongoing supervision, and were observed during unannounced visits for adherence to best practices. The interventions, including educational components, did not significantly reduce late-onset sepsis rates in the NICUs, with rates showing no substantial difference between pre- and post-intervention periods (11.3 versus 12.3 cases per 1,000 infant days) [14].

In Delaney et al study the objective was to evaluate the impact of a multimodal sepsis educational program for critical care and emergency department nurses on knowledge acquisition and self-assessed competence in early sepsis recognition and treatment. The outcomes measured included knowledge scores, self-assessed competence using a 73-item scale, and sepsis-specific competency through three statements added to the NCS, which evaluated self-reported

abilities in recognizing sepsis signs, managing sepsis-related conditions, and coordinating early goal-directed therapy. The TSEP Educational Program aimed to improve sepsis knowledge and treatment skills through interactive online modules covering IHI bundles, sepsis staging, health literacy, and teamwork, complemented by high-fidelity medical simulations and debriefing sessions [15].

The education methods included interactive online modules with case studies, video vignettes for practical demonstrations, high-fidelity medical simulations for hands-on practice, and debriefing sessions for reflection. These were aimed at improving both theoretical knowledge and practical skills in sepsis management. The interventions, including education, led to significant improvements in knowledge scores for sepsis-related topics and self-assessed competence in areas like identifying sepsis signs, managing sepsis conditions, and coordinating early therapy. However, there was no significant correlation between the improved knowledge scores and overall competence scores [15].

As for Siontis et al study, the aim was to identify barriers among resident physicians to comply with resuscitation bundle elements, implement interventions to improve compliance, and thereby reduce hospital/ICU length of stay (LOS) and 30-day mortality for patients with severe sepsis/septic shock. Outcomes measured included compliance with resuscitation bundle elements, assessed by reviewing orders for severe sepsis or septic shock patients; hospital and ICU length of stay, compared between pre- and post-intervention periods using database data; and 30-day mortality rates, tracked and compared for the same periods. The educational interventions included a slide set on early resuscitation for sepsis, pocket cards detailing sepsis criteria and order set use, and bi-monthly feedback sessions on compliance with resuscitation practices and CPOE order sets [16].

Educational methods included interactive online materials for sepsis management, visual aids such as pocket cards for quick reference, and regular feedback sessions to review compliance and emphasise the importance of following resuscitation bundle elements. The interventions significantly improved compliance with resuscitation bundle elements, increasing from 43% to 68% ($p = 0.0295$), which is likely to enhance patient outcomes. The median ICU length of stay decreased from 2.03 days to 1.55 days ($p = 0.085$), demonstrating more efficient patient management. Although the 30-day mortality rate reduced from 25% to 12% ($p = 0.14$), this reduction was not statistically significant, but it suggests a trend towards improved survival rates [16].

Serrano-smith et al's objective was to compare the clinical knowledge of critical care healthcare providers who received sepsis education via simulation versus those who received it through a self-study article. The study aimed to determine the effectiveness of these two teaching methods in improving and retaining sepsis knowledge. The primary outcome measured was clinical knowledge of sepsis. This was assessed using a 13-item multiple-choice test, which was validated by critical care experts with a Content Validity Index (CVI) of 0.97. Additionally, a sepsis simulation scenario was developed and validated, achieving a CVI of 0.96 after revisions [17].

The education interventions included a Simulation Group, where participants engaged in a high-fidelity sepsis management scenario followed by a debriefing, and a Self-Study Group, where participants reviewed the Cleveland Clinic Care Path Guide on severe sepsis management. Education methods included interactive simulations with hands-on practice and debriefing, as well as self-study through reviewing an educational article on sepsis. The simulation group demonstrated significant and sustained improvements in sepsis knowledge immediately and at 3 months, suggesting long-term retention. Similarly, the self-study group also showed notable knowledge gains, but there was no significant difference between the effectiveness of simulation and self-study [17].

Regarding Stewart et al study, the objective was to ascertain clinician awareness of sepsis and septic shock management guidelines and identify common concerns. To increase understanding and knowledge of sepsis and septic shock management in children by delivering a targeted teaching session. Outcomes measured included awareness of guidelines, knowledge improvement, confidence in management, and changes in practice. These were evaluated using post-course questionnaires to assess sepsis management knowledge, and confidence surveys rated on a scale from 1 to 10. The teaching program included a 1-hour session focused on addressing identified learning needs and existing guidelines, such as ACCM and Pediatric Sepsis Six, emphasising the urgency of sepsis management and building confidence in handling cases [18].

The 1-hour teaching session was delivered in person. The educational sessions significantly increased awareness and understanding of sepsis guidelines among clinicians, improving their confidence in managing paediatric sepsis from an average rating of 3.3/10 to 7.1/10. Additionally, 88% of participants reported that the program would influence their future practice, and most found the guidelines useful, highlighting the program's practical impact and addressing a critical need for structured guidelines [18].

As for Hlungwane et al study, the aim was to investigate the effect of an educational intervention on nurses' sepsis-related knowledge and practices in mechanically ventilated adult patients in public ICUs. Knowledge about sepsis in mechanically ventilated adult patients was evaluated using self-administered pretest and posttest questionnaires based on Surviving Sepsis Campaign guidelines, which included demographic information and true/false questions on sepsis. Practices related to sepsis were assessed with similar questionnaires, focusing on guideline adherence, diagnostic practices, and implementation, using a 5-point Likert scale. The educational intervention was developed based on the 2016 SSC guidelines and "The Sepsis in Resource Limited Nations Initiative," featuring a 20-minute PowerPoint presentation, printed materials, and bi-monthly monitoring visits for one intervention group, while another group received only the educational materials, and the control group received no intervention [19].

A PowerPoint presentation was used to explain sepsis guidelines and management, complemented by printed materials for reference based on Surviving Sepsis Campaign guidelines. Monitoring visits were conducted for Intervention Group 1 to reinforce learning and assist with implementation. The educational intervention improved sepsis knowledge among nurses, with better posttest scores and some practice improvements, especially in the group receiving both education and monitoring. The control group showed no significant changes in knowledge or practices [19].

Sreeramaju et al aimed to improve the quality of care by reducing hospital-acquired infections (HAIs), including central line-associated bloodstream infections (CLABSI), catheter-associated urinary tract infections (CAUTI), surgical site infections (SSI), and sepsis mortality. The study measured CLABSI, CAUTI, SSI, and sepsis mortality. Data were collected via electronic records and included both retrospective and prospective information. Measurements included sepsis bundle adherence, hand hygiene, and safety culture, with data gathered through observations, records, and safety assessments. The educational interventions included quality and safety training for over 550 leaders and personnel through in-person sessions and a 9-day clinical safety program, alongside disease-targeted prevention measures using bundles and checklists to reduce CLABSI, CAUTI, SSI, and sepsis mortality [20].

Education methods included biweekly lunch-and-learn sessions for staff, individual interviews and focus groups with clinicians, a communication campaign with various media, and in-person training programs for leaders and clinical safety. Additionally, to address sepsis mortality, an electronic early warning system was implemented for early detection and care standardisation, clinical decision support tools generated alerts for best practices, workflows were streamlined with local antibiotic access and expedited lactate turnaround, and a sepsis worksheet ensured compliance with the bundle within the first six hours. The interventions, including education, led to a 69% reduction in sepsis mortality from 2013 to 2017, saving an estimated 526 lives and avoiding over \$17 million in healthcare costs associated with infections [20].

The direct impact of educational interventions on patient care processes and outcomes remains unclear due to the numerous and complex confounding variables involved. However, the role of educational intervention in augmenting other sepsis intervention bundles is clearly evident [21]. Due to increasing demands for alternatives to traditional didactic teaching, the blended learning approach—combining online and face-to-face activities—has become increasingly popular in health professions education [22].

Interprofessional teamwork is crucial for recognizing and managing sepsis, a complex and time-sensitive emergency. Patient outcomes depend significantly on the care team's coordination and timely implementation of treatment. Yet, only seven studies in this review incorporated interprofessional teamwork and communication into their educational programs [23, 24]. High-fidelity simulation is recognized as an effective method for team-based training, but logistical challenges and the cost of removing participants from clinical duties pose significant barriers [25]. Therefore, further research is needed to explore more cost-effective team-based training methods in sepsis education that deliver similar or better outcomes than high-fidelity simulation.

4. Conclusion

This review underscores the critical role of educational interventions in enhancing sepsis management across various healthcare settings. Despite varying methodologies, including high-fidelity simulations, self-study, and multimodal approaches, evidence consistently indicates that targeted education improves knowledge and practice related to sepsis care. While some studies demonstrate significant improvements in clinical outcomes, such as reduced mortality and better adherence to sepsis bundles, others reveal the need for ongoing refinement of educational strategies and their implementation. The review highlights the importance of integrating interprofessional teamwork, cost-effective training methods, and real-time feedback to optimise sepsis care. Future research should focus on addressing barriers to adherence, evaluating the direct impact of educational interventions on patient outcomes, and exploring innovative, sustainable approaches to sepsis education.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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