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Review

Application of Comprehensive Unit-Based Safety Programs in Adverse Events and Patient Safety Culture: A Scope Review

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Abstract: **Objective:** This review aims to explore the application of Comprehensive Unit-based Safety Programs (CUSP) in responding to adverse events, and evaluate its effectiveness in reducing medical errors, enhancing patient safety culture, and improving safety management in medical units. **Method:** This scope follows the five-stage framework of Arksey and O'Malley. A comprehensive literature search was conducted (from January 1, 2000 to April 15, 2025). Four databases were searched, and relevant references were systematically cataloged. Attention was focused on the general characteristics of the articles, the application scenarios of CUSP, and its impact on adverse events and patient safety culture. Descriptive statistics and narrative synthesis methods were used for data analysis. **Results:** Out of 1596 related studies, after strict screening, a total of 41 studies that met the criteria were finally included. These studies covered multiple countries (such as the United States, China, Saudi Arabia, India, etc.) and various medical scenarios, including intensive care units (32%), surgery (28%), pediatrics (15%), etc. CUSP is mainly applied to adverse events such as catheter-related bloodstream infections, medication safety, patient transfer, and patient safety culture and quality management. **Conclusion:** The conclusion of the scope review on the application of Comprehensive Unit-based Safety Programs (CUSP) in adverse events and patient safety culture reveals that CUSP is effective in improving safety culture, reducing adverse events, and enhancing healthcare quality. The study shows significant success in reducing medical errors, promoting a proactive safety culture, and improving teamwork, especially in ICUs, surgery, and pediatrics. However, more research is needed to explore the long-term effects and further improvements in CUSP implementation.

Keywords: Comprehensive Unit-based Safety Programs; CUSP; adverse events; patient safety culture

1. Introduction

Adverse events [1] in the healthcare environment pose a significant threat to patient safety, posing a major risk to individual well-being and overall care quality. These events include medication errors, infections, and surgical complications, which not only cause physical harm to patients but also increase medical costs and may damage the reputation of healthcare institutions. Given the global recognition of this issue, many strategies have been developed to effectively identify, prevent, and manage adverse events [2]. One such strategy that has attracted considerable attention is the implementation of the Comprehensive Unit Safety Program (CUSP) [3].

The establishment of the Comprehensive Unit Safety Program (CUSP) [3] originated from an adverse event that occurred at Johns Hopkins Hospital. It is a multi-faceted, proactive approach aimed at cultivating a safety culture at the unit level within healthcare organizations. This method combines evidence-based practices with strong employee involvement and a continuous quality improvement cycle [4]. Through empowering frontline healthcare providers (including doctors,

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nurses, and support staff) to actively identify safety hazards and take appropriate measures to address them, CUSP strives to prevent the occurrence of adverse events and improve patient treatment outcomes. The fundamental belief behind CUSP is that safety should be a shared responsibility, with each member of the team playing a key role in maintaining a safe and supportive environment for patients and healthcare providers [5].

The purpose of this systematic review is to conduct a comprehensive examination of existing research on the application of CUSP in reducing adverse events in healthcare. This review aims to systematically map the current literature, determine the key areas where CUSP has been implemented, assess its effectiveness in preventing adverse events, and reveal the knowledge gaps that require further exploration. By synthesizing the results of previous studies, this review will help to better understand how to optimize CUSP for wider use in the healthcare environment and provide information for future research aimed at improving patient safety.

2. Materials and Methods

The scope definition review used the framework of Arksey and O'Malley [6] in 2005.

Stage 1: Identifying the research question

This study aims to conduct a comprehensive review of existing literature on the application of the Comprehensive Unit Safety Program (CUSP) in reducing adverse events in healthcare and improving safety quality management. To achieve this goal, the following research questions were determined:

(a) What adverse events and scenarios are primarily applied by CUSP?

(b) How effective is CUSP in reducing different types of medical adverse events?

(c) How does CUSP change the safety culture perception of healthcare providers (such as willingness to report errors, teamwork, leadership support, etc.)?

(d) Are there differences in the effectiveness of CUSP in different medical units (such as ICU, surgery, pediatrics) or healthcare systems?

Stage 2: Identifying relevant studies

Systematic searches were conducted in four electronic databases from January 1, 2000 to April 15, 2025. The search strategy combined subject terms and free words, including Comprehensive Unit Safety Program, CUSP, adverse events, patient safety events, medical errors, etc.

Stage 3: Study selection

This review considered these studies based on the following inclusion and exclusion criteria. Inclusion criteria: (a) Studies published in English; (b) Studies focusing on the implementation and evaluation of CUSP and its relationship with the occurrence of adverse events in healthcare institutions; (c) Original research articles, including various research designs, such as randomized controlled trials, cohort studies, case-control studies, and qualitative studies, to provide evidence from different ranges.

Exclusion criteria: (a) Preprints; (b) Commentaries, editorials, reviews or studies unrelated to CUSP or adverse events; (c) Literature without complete content.

Stage 4: Draw data charts

Use a structured Microsoft Excel data extraction table to systematically collect data from each paper. Subsequently, two researchers carefully conducted a formal data extraction. The main information extracted includes each dimension: (a) the characteristics of the article, including the author, country of origin, and journal name; (b) the type of research, including cross-sectional, longitudinal, qualitative, experimental studies, reviews, etc.; (c) the central theme of the article.

Stage 5: Organize, summarize and report results

We conducted a qualitative analysis of the results of the systematic review. In itself, the qualitative analysis includes using content analysis to classify research objectives and grouping them by category.

3. Results

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3.1. Overview of the Included Studies

Through a systematic search of literature from January 2000 to April 2025, 1596 relevant studies were initially obtained. After strict screening, 41 studies that met the criteria were finally included . These studies covered multiple countries (the United States, China, Saudi Arabia, India, etc.) and medical scenarios, including ICUs (32%), surgery (28%), pediatrics (15%), etc. The research design was mainly cohort studies (45%) and pre-post control studies (35%), with randomized controlled trials (12%) and mixed-method studies (8%).

3.2. Application Scenarios and Adverse Event Types of CUSP

(a) Intensive Care Unit (ICU)

The ICU is the most widely used scenario for CUSP, mainly targeting two types of high-risk adverse events:

Catheter-Associated Bloodstream Infection (CLABSI): Multiple studies have confirmed that by implementing CUSP with core measures such as "catheter insertion checklist" and "daily extubation assessment", the incidence of CLABSI has significantly decreased. A study from Saudi Arabia showed that the incidence of CLABSI in mechanically ventilated patients decreased from 11.3 per thousand catheter days to 5.2 per thousand catheter days (a reduction of 54%)[7,8]. The Keystone project in Michigan, USA, even achieved a sustained 5-year reduction in infection rates, from 7.7 to 1.3 per thousand catheter days [9]. Ventilator-Associated Pneumonia (VAP): Chinese scholars implemented CUSP in mechanically ventilated patients (including measures such as elevating the bed head and oral care), reducing the incidence of VAP from 28.3% to 15.6% [10]. Notably, this study confirmed that even after adjusting for confounding factors, the risk in the CUSP group was still reduced by 43% [10].

(b) Surgical Unit

In the surgical field, CUSP mainly focuses on the prevention of surgical site infections (SSI):

Cesarean section surgery: A prospective study in Austria showed that by implementing CUSP with elements such as standardized preoperative skin preparation and temperature monitoring, the incidence of SSI decreased from 6.8% to 4.2%, with the most significant decrease in superficial infections (3.1% → 1.4%) [11]. Plastic surgery: After the application of CUSP in plastic surgery, the SSI rate decreased from 8.9% to 5.2%. This study particularly emphasized the role of improving team safety culture, with a significant correlation between the improvement of the Safety Attitude Questionnaire (SAQ) score and the decrease in infection rates [12]. Orthopedic surgery: Recent studies have confirmed that CUSP reduced perioperative complications in hip and knee joint replacement surgeries by 29%, with the deep vein thrombosis incidence decreasing from 4.1% to 2.3% [13].

(c) Oncology Department

The studies included in this report mainly focus on chemotherapy-induced nausea and vomiting (CINV). A study on Chinese ovarian cancer patients showed that the intervention based on CUSP (including risk stratification, optimization of preventive medication, etc.) reduced the incidence of grade III-IV CINV from 46.2% to 31.8%. It is worth noting that the control effect on delayed vomiting was more significant (a 52% reduction in incidence) [14].

(d) General wards

The application of CUSP in general wards presents a diversified characteristic:

Fall prevention: A study in the epilepsy monitoring unit showed that by implementing CUSP, which includes measures such as environmental modification and identification of high-risk patients, the incidence of falls decreased from 3.2 cases per 1,000 inpatient days to 2.4 cases. The prevention effect on nocturnal falls was particularly significant (a 41% reduction) [15]. Medication errors: After the application of CUSP in the American home care program, the rate of medication errors decreased from 5.7% to 3.4%. The reduction in transcription errors was the most significant (a 62% decrease), which was attributed to the introduction of a standardized electronic prescription system [16].

(e) Special application scenarios

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Inter-hospital transfer: A Chinese study showed that CUSP reduced adverse events during the transfer of critically ill patients from 18.3% to 9.7%, mainly improving abnormal blood gas (a 63% reduction) and equipment failures (a 71% reduction) [17].

The differences in the effects of various scenarios suggest that CUSP is more effective in controlling technical-dependent risks (such as CLABSI) than behavior-dependent risks (such as falls). This may be related to the fact that the former is more easily controlled through standardized processes, while the latter requires deeper cultural changes [18,19].

3.3. Impact of CUSP on Adverse Events and Safety Culture

(a) Effectiveness in reducing adverse events

CUSP has demonstrated significant results in reducing various medical adverse events, with characteristics of persistence and wide applicability. Multiple studies have confirmed that after implementing CUSP, the overall incidence of adverse events in medical institutions can be reduced by 36-58%[20,21], with particularly prominent improvements in specific types of adverse events. In the ICU environment, the incidence of catheter-related bloodstream infection (CLABSI) decreased by an average of 57% [22], and this effect was fully verified in the Michigan ICU project, with the improvement lasting for more than 5 years [9,23]. The surgical site infection rate in the surgical unit decreased by an average of 39% [24], and medication errors decreased by 42% [25]. These clinical improvements often began to manifest within 6 months of implementation and reached a stable level within 12 months [26]. Notably, approximately 75% of the implemented units were able to maintain an initial improvement rate of 80% or more for a long time, but the sustainability of the effect is affected by factors such as personnel turnover, and studies have shown that there may be a decline in the effect after 24 months of implementation, which is positively correlated with the personnel turnover rate [22].

(b) Improvement in safety culture

The enhancement of safety culture by CUSP is manifested in multiple dimensions, and the improvement in culture is significantly correlated with the reduction in adverse events. After implementing CUSP, the voluntary reporting rate of errors in medical institutions increased by an average of 2.3 times, from the baseline of 12% to 28% [27], and the quality of reporting improved significantly, with the proportion of reports including root cause analysis increasing from 18% to 47% [18]. The score for team collaboration increased by 41% [19], with the improvement in nurse-doctor collaboration being the most significant, which directly led to practical improvements such as a 54% reduction in delayed execution of medical orders [28]. The total score of the Safety Attitude Questionnaire (SAQ) increased by an average of 19 points, especially in the "safety climate" dimension, which increased by 23 points [24]. The recognition rate of medical staff for the leadership's emphasis on safety increased from 48% to 72% [29]. The research shows that for every 10-point increase in SAQ, the incidence of adverse events decreases by 14% (95% CI 11-17%) [30]. For every 1-point increase in team collaboration score, the risk of CLABSI decreases by 7% [30]. The collaborative improvement of these clinical and cultural indicators constitutes the core value of CUSP. The Michigan project not only achieved a reduction in infection rates, but also increased the total SAQ score for ICU participation from 58 points to 76 points (the national average is 62 points) [19], confirming the unique advantages of CUSP in building a safety culture.

3.4. Implementation Differences Among Different Medical Systems

Different medical systems exhibit significant differences in the implementation of CUSP. High-income countries can generally complete the comprehensive implementation of CUSP within 6-12 months [21], mainly relying on advanced means such as electronic monitoring systems and multidisciplinary collaboration teams [31], ultimately achieving a remarkable effect of reducing adverse events by 50-70% [32], but the issue of medical staffs' compliance remains a major challenge [33]. In contrast， middle- and low-income countries are limited by medical resources and the implementation period often requires 18-24 months [34], and they mostly adopt adaptive strategies

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such as basic training and simplified processes [35], with the reduction rate of adverse events remaining at 30-45% [11]. Specific cases show that China adjusted the CUSP plan to reduce the VAP incidence from 28.3% to 15.6% [11], while the neonatal ICU in India successfully reduced CLABSI by 48% through low-cost renovations [36]. These practices have confirmed the adaptability and effectiveness of CUSP in different resource environments，and also highlighted the necessity of local adjustments [17].

4. Discussion

4.1. The Effectiveness of CUSP in Adverse Event Management

This study demonstrates that CUSP has a significant effect in reducing medical adverse events, which is consistent with the results of previous numerous studies[20,21]. Particularly noteworthy is that CUSP's improvement effect on technical dependency risks (such as CLABSI) is better than that on behavioral dependency risks (such as falls), which may be related to its standardized process intervention characteristics. In the ICU environment, CUSP achieved a 57% reduction in the incidence of CLABSI through specific measures such as establishing a central venous catheter insertion checklist [37], and this effect became apparent within 6 months of implementation and has good sustainability [38]. However, the differences in effectiveness among different departments suggest that we need to develop more targeted intervention strategies, especially in non-technology-intensive departments such as general wards.

4.2. Improvement of Safety Culture

The impact of CUSP on the enhancement of safety culture cannot be ignored. Research shows that the error reporting rate of medical institutions increased by 2.3 times after the implementation of CUSP [18], and the team collaboration score increased by 41% [19]. This cultural change is significantly correlated with the improvement of clinical outcomes. The data from the Safety Attitude Questionnaire (SAQ) indicates that the improvement in the "safety climate" dimension is the most prominent [28], reflecting the unique value of CUSP in creating an non-punitive environment. It is worth noting that cultural changes often lag behind the improvement of clinical indicators, typically requiring 12-18 months to reach a stable state [18], which suggests that we need to maintain sufficient patience and continuous investment in safety culture construction.

4.3. Challenges and Success Factors in Implementation

The successful implementation of CUSP faces multiple challenges. In high-income countries, the compliance of healthcare workers is the main obstacle [38]; while in resource-limited regions, insufficient infrastructure becomes a constraint [27]. Through the analysis of successful cases, we have found the following key elements: (a) Continuous participation and support from the leadership [39];(b) Substantial collaboration of multidisciplinary teams [40]; (c) Continuous quality improvement mechanism based on data [41]. Particularly worth learning from is the low-cost "trainer" model adopted by the Indian project, which still achieved significant results in resource-constrained circumstances [42], providing valuable experience for implementation in similar environments.

4.4. Applicability in Different Medical Environments

The applicability of CUSP varies significantly in different medical settings. The electronic monitoring systems in high-income countries [43] contrast sharply with the basic training strategies in lower-middle-income countries [44]. The practical experiences in China and India [11,20] indicate that the core principles of CUSP are universally applicable, but specific measures need to be adjusted according to local resource conditions. For instance, in the absence of an electronic medical record

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system, using simplified paper verification forms can also achieve good results [45]. This flexibility and adaptability are important reasons for the global promotion of CUSP.

4.5. Research Limitations and Future Research Directions

This study has several limitations: Firstly, the included studies are mainly of observational design (accounting for 83%), which may affect the strength of the evidence; Secondly, there is insufficient long-term follow-up data, with only 32% of the studies tracking for more than 2 years [46]; Thirdly, the measurement tools for safety culture are not unified, and up to 7 different scales have been used [40], making it difficult to directly compare the results; Finally, most studies come from high-income countries, which may limit the applicability of the conclusions in lower-middle-income regions. Future research should strengthen randomized controlled designs, extend the follow-up time, and establish unified cultural assessment standards.

More rigorous randomized controlled trials (RCTs) are needed to verify the long-term effects of CUSP, strengthen the research on the applicability of CUSP in resource-limited environments, explore simplified versions of CUSP suitable for primary medical institutions, focus on developing low-cost intervention measures, and assess their implementation effects in primary health care centers. At the same time, it is necessary to conduct in-depth research on the dose-effect relationship between the improvement of safety culture and changes in clinical indicators. Finally, the integration of CUSP with emerging technologies should be explored. Innovative means such as artificial intelligence-assisted adverse event monitoring systems and blockchain technology to ensure data transparency are expected to enhance the efficiency and effectiveness of CUSP implementation.

5. Conclusions

In summary, the implementation of the Comprehensive Unit Safety Plan (CUSP) holds significant promise for improving patient safety and managing adverse events in the healthcare environment. This review highlights the wide application of CUSP, demonstrating its positive impact in reducing the occurrence of adverse events, strengthening the safety culture, and fostering a more proactive medical team. The evidence emphasizes the effectiveness of CUSP in creating a safer healthcare environment, where communication, leadership, and continuous learning play key roles in its success. However, the implementation of CUSP is not without challenges. Healthcare organizations face various obstacles, such as resistance to change, lack of resources, and difficulty in maintaining the long-term participation of staff. To fully realize the potential of CUSP, further research is necessary to improve implementation strategies, meet the changing needs of the medical team, and explore its application in different healthcare environments. By addressing these challenges and continuously adjusting the plan to adapt to the specific environment of each institution, organizations can maximize the impact of CUSP and ultimately enhance patient safety and comprehensively improve medical quality.

Author Contributions: Li Ziwei played a leading role in literature retrieval and data organization. Her meticulous work ensured the accuracy and completeness of the data, which was crucial for the validity of the research results. Fan Jing's contribution to the writing of the paper cannot be overlooked. She made thorough revisions and improvements, enhancing the language quality and ensuring logical clarity and structural rigor. Fan Jing’s efforts significantly improved the readability and academic value of the paper. Professor Xiao Mingchao’s contribution was also indispensable. He not only assisted in proofreading the manuscript but also provided valuable feedback on the overall structure and framework of the research. His professional guidance, particularly in language, terminology, and academic standards, greatly enhanced the quality of the paper.

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Informed Consent Statement: This study does not require the signing of an informed consent form.

Data Availability Statement: The data can be shared.

Conflicts of Interest: The authors declare no conflicts of interest.

Abbreviations

The following abbreviations are used in this manuscript:

CUSP	Unit-Based Comprehensive Safety Program
ICU	Intensive Care Unit
CLABSI	Catheter-Associated Bloodstream Infection
VAP	Ventilator-Associated Pneumonia
SSI	Surgical site infections
SAQ	Safety Attitude Questionnaire

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