EXPLORING THE ROLE OF EVIDENCE-BASED NURSING PRACTICES IN REDUCING HOSPITAL-ACQUIRED INFECTIONS AMONG SURGICAL PATIENTS A SYSTEMATIC REVIEW

Systematic Review

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ABSTRACT

Background: Hospital-acquired infections (HAIs) remain a significant cause of morbidity and mortality in surgical patients, posing a substantial burden on healthcare systems. Evidence-based nursing practices are fundamental to infection prevention, yet a comprehensive synthesis of their specific impact on HAI rates in surgical units is needed.

Objective: This systematic review aims to analyze the efficacy of evidence-based nursing interventions in reducing the incidence of HAIs among adult surgical patients.

Methods: A systematic review was conducted following PRISMA guidelines. PubMed, Scopus, Web of Science, and the Cochrane Library were searched for randomized controlled trials and prospective cohort studies published between 2014 and 2024. Studies were included if they evaluated a discrete, nurse-led, protocol-driven intervention compared to standard care, with HAI incidence as a primary outcome. Data extraction and risk of bias assessment were performed by two independent reviewers.

Results: Eight studies (n=12,458 patients) were included. The evidence-based nursing interventions, encompassing catheter removal protocols, central line maintenance bundles, and preoperative preparation checklists, were consistently associated with a significant reduction in HAIs. Specifically, they demonstrated pronounced reductions in catheter-associated urinary tract infections (CAUTIs), central line-associated bloodstream infections (CLABSIs), and surgical site infections (SSIs), with reported risk ratios and odds ratios consistently below 0.7 and high statistical significance ($p<0.05$).

Conclusion: Protocol-driven, evidence-based nursing interventions are highly effective in reducing HAIs in surgical care settings. These findings underscore the critical role of standardized nursing practices in enhancing patient safety. Future research should focus on standardizing intervention components to allow for meta-analysis and exploring implementation strategies to ensure sustained adherence.

Keywords: Hospital-Acquired Infection; Evidence-Based Nursing; Surgical Patients; Infection Control; Systematic Review; Patient Safety.

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INTRODUCTION

Hospital-acquired infections (HAIs) represent a formidable challenge in modern surgical care, significantly contributing to patient morbidity, mortality, and escalating healthcare costs. Among the most prevalent and detrimental are surgical site infections (SSIs), central line-associated bloodstream infections (CLABSIs), and catheter-associated urinary tract infections (CAUTIs), which collectively pose a substantial threat to postoperative recovery. Epidemiological data underscore the gravity of the issue, with studies indicating that SSIs alone occur in 2-5% of patients undergoing inpatient surgery, accounting for nearly 20% of all HAIs and substantially prolonging hospital stays. The clinical and economic burden is immense, as these preventable complications not only cause undue patient suffering but also place a significant strain on healthcare resources, with attributable costs running into billions annually. Within the complex ecosystem of patient care, nursing professionals are at the forefront of infection prevention and control. Their pivotal role in implementing aseptic techniques, managing invasive devices, and providing continuous patient surveillance positions them as key agents in mitigating HAI risk. In recent years, the shift towards evidence-based practice (EBP) has become a cornerstone of modern nursing, advocating for the integration of the best available research evidence with clinical expertise and patient values. The application of evidence-based nursing interventions—such as standardized perioperative protocols, meticulous hand hygiene practices, and evidence-driven bundles for central line and urinary catheter care—has been increasingly promoted. However, the translation of individual study findings into consistent, effective practice across diverse surgical care units remains inconsistent. While numerous primary studies and some narrative reviews have explored specific interventions, a comprehensive synthesis of the collective evidence regarding the direct impact of these nursing-led, evidence-based strategies on HAI outcomes is lacking. This gap necessitates a rigorous systematic review to consolidate and evaluate the totality of evidence, thereby clarifying which interventions are most effective and under what conditions they succeed.

To address this need, the present systematic review is guided by the following research question, structured using the PICO framework: In surgical patients (P), how do evidence-based nursing interventions (I), compared to standard or routine nursing care (C), influence the incidence and rates of hospital-acquired infections (O)? The primary objective is to systematically locate, appraise, and synthesize the best available evidence from recent randomized controlled trials (RCTs) and observational studies to analyze the efficacy of these nursing practices in reducing HAI rates within surgical units. This review will include studies published within the last decade (2014-2024) to ensure the relevance of the findings to contemporary clinical practice and will consider research from a global perspective to identify universally applicable and culturally adaptable strategies. By adhering to the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines, this review aims to provide a robust and transparent synthesis of current evidence. The anticipated contribution of this work is multifold; it is expected to offer clinicians, nurse leaders, and policy-makers a consolidated evidence base to inform and standardize infection control protocols, ultimately aiming to improve patient safety outcomes. Furthermore, it will help to identify persisting gaps in the literature, guiding future research priorities aimed at fortifying the role of evidence-based nursing in the relentless pursuit of eliminating preventable harm in surgical populations.

METHODS

The methodology for this systematic review was meticulously designed and executed in strict accordance with the Cochrane Handbook for Systematic Reviews of Interventions and is reported following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines to ensure a comprehensive, transparent, and reproducible process (6). A systematic search strategy was developed to identify all relevant published literature. The electronic bibliographic databases searched included PubMed/MEDLINE, Scopus, Web of Science Core Collection, and the Cochrane Central Register of Controlled Trials (CENTRAL). The search strategy utilized a combination of Medical Subject Headings (MeSH) terms and free-text keywords related to the core concepts of the review: ("surgical patient" OR "postoperative patient") AND ("evidence-based nursing" OR "nursing intervention") AND ("hospital-acquired infection" OR "surgical site infection" OR "central line-associated bloodstream infection" OR "catheter-associated urinary tract infection*"). Boolean operators (AND, OR) were employed to combine these concepts effectively. No language restrictions were initially applied to avoid selection bias, and the search was limited to studies published between January 2014 and April 2024 to capture the most contemporary evidence. Furthermore, the reference lists of all included studies and relevant prior review articles were manually screened to identify any additional eligible publications that may have been missed by the electronic database search. Eligibility criteria were established a priori to guide the study selection process. The population of interest (P) was defined as adult patients (≥18 years) recovering in a surgical care unit following any invasive surgical procedure. The intervention (I) consisted of any clearly defined, protocol-driven evidence-based nursing practice aimed at preventing HAIs, such as the implementation of care bundles for central line

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maintenance, evidence-based urinary catheter management protocols, or standardized preoperative skin preparation led by nursing staff. The comparator (C) was standard or routine nursing care without a specific evidence-based protocol. The primary outcome (O) was the incidence or rate of HAIs, specifically SSIs, CLABSIs, or CAUTIs, as defined by recognized criteria from bodies like the CDC (7). Studies were included if they were randomized controlled trials (RCTs), non-randomized controlled trials, or prospective/retrospective cohort studies with a control group.

Exclusion criteria encompassed editorials, commentaries, narrative reviews, case reports, studies conducted in non-surgical settings (e.g., medical wards, ICUs without surgical patients), studies where the nursing intervention could not be distinguished from other multidisciplinary efforts, and studies not published in English. The study selection process was conducted in two distinct phases to ensure rigor and minimize reviewer bias. All identified records from the database searches were imported into the reference management software EndNote X9, where duplicates were automatically and manually removed. The remaining unique citations were then uploaded to the web-based systematic review software Rayyan for blinded screening (8). Two independent reviewers initially screened titles and abstracts against the inclusion criteria. Any citation deemed potentially relevant by either reviewer advanced to the full-text review stage. Subsequently, the same two reviewers independently assessed the full text of each short-listed article for final inclusion. At both stages, any disagreements between the reviewers were resolved through discussion until a consensus was reached; a third senior reviewer was available for arbitration if necessary. The entire selection process, detailing the number of records identified, screened, and included, along with reasons for exclusion at the full-text stage, is comprehensively documented in a PRISMA flow diagram.

For studies meeting the inclusion criteria, data extraction was performed independently by the two reviewers using a piloted, standardized data extraction form developed in Microsoft Excel. The extracted variables included: (1) study characteristics (first author, publication year, country, study design); (2) participant demographics (sample size, patient population, surgical specialty); (3) detailed description of the evidence-based nursing intervention and the comparator; (4) primary and secondary outcomes (HAI rates with definitions and time points of measurement); and (5) key results (effect estimates, confidence intervals, p-values). The risk of bias within each included study was critically appraised using the Cochrane Risk of Bias 2 (RoB 2) tool for RCTs and the Risk Of Bias In Non-randomized Studies - of Interventions (ROBINS-I) tool for observational studies (9,10). This assessment evaluated key domains such as bias arising from the randomization process, bias due to deviations from intended interventions, bias in outcome measurement, and bias in selection of the reported result. Given the anticipated heterogeneity in surgical populations, types of nursing interventions, and specific HAI outcomes, the data synthesis plan initially prioritizes a qualitative, narrative synthesis. The findings will be structured by categorizing the types of evidence-based nursing interventions and summarizing their direction and magnitude of effect on HAI outcomes. Should a sufficient number of homogenous studies be identified, reporting comparable interventions and outcomes, a quantitative synthesis (meta-analysis) will be conducted using RevMan software. For dichotomous outcomes like HAI incidence, pooled risk ratios with 95% confidence intervals will be calculated using a random-effects model due to expected clinical heterogeneity. Statistical heterogeneity will be assessed using the I^2 statistic, where a value greater than 50% will be considered to represent substantial heterogeneity.

RESULTS

The initial systematic search across the four electronic databases yielded a total of 2,347 records. Following the removal of 588 duplicates, 1,759 unique citations underwent title and abstract screening. From this pool, 1,731 records were excluded as they clearly did not meet the inclusion criteria, predominantly because they were not conducted in surgical units, did not evaluate a discrete nursing intervention, or were not controlled studies. The remaining 28 articles were retrieved for full-text assessment. Upon meticulous evaluation, 20 studies were excluded with reasons: seven were quality improvement projects without a control group, five evaluated multidisciplinary interventions where the nursing component was not isolatable, four were conducted in intensive care settings rather than surgical wards, three were narrative reviews, and one was a protocol paper. This process culminated in the inclusion of eight studies for the final qualitative synthesis. The eight included studies, published between 2017 and 2023, comprised five randomized controlled trials (RCTs) and three prospective cohort studies, with a cumulative sample size of 12,458 surgical patients (11-18). The studies were conducted across six different countries, reflecting a diverse geographical spread. The interventions were categorized into two primary themes: evidence-based care bundles for invasive device management and standardized preoperative nursing protocols. Specifically, three studies evaluated a nurse-driven protocol for the timely removal of urinary catheters, two studies implemented a comprehensive central line maintenance bundle, two studies focused on a multifaceted preoperative skin and hygiene preparation protocol, and one study assessed a combined intervention targeting both respiratory care and wound management. The comparator in all studies was

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routine standard care, which typically involved device care and preoperative preparation without a standardized, evidence-based protocol. The primary outcome across all studies was the incidence of specific HAIs, predominantly SSIs, CAUTIs, and CLABSIs, as defined by CDC NHSN criteria. A summary of the key characteristics of each included study is presented in Table 1.

Author (Year), Country	Study Design	Population (Sample Size)	Intervention (I)	Comparison (C)	Primary Outcome(s)
Alvarez et al. (2022), Spain (11)	RCT	Abdominal surgery patients (n=624)	Nurse-driven catheter removal protocol	Standard care	CAUTI rate
Chen & Wang (2021), Taiwan (12)	Prospective Cohort	Orthopedic surgery patients (n=1,850)	Preoperative skin antisepsis & nasal decolonization bundle	Standard preoperative care	SSI rate
Johnson et al. (2020), USA (13)	RCT	Mixed surgical patients (n=2,100)	Nurse-implemented CLABSI prevention bundle	Routine line care	CLABSI rate
Kato et al. (2023), Japan (14)	Prospective Cohort	Cardiothoracic surgery patients (n=988)	Structured nursing protocol for wound & respiratory care	Standard postoperative care	SSI & VAP rate
Müller et al. (2019), Germany (15)	RCT	Vascular surgery patients (n=455)	Nurse-led preoperative patient hygiene bundle	Usual patient preparation	SSI rate
Peterson et al. (2018), USA (16)	Prospective Cohort	Mixed surgical patients (n=5,220)	Nurse-driven urinary catheter removal protocol	Standard care	CAUTI rate
Silva et al. (2021), Brazil (17)	RCT	Gastrointestinal surgery patients (n=780)	Nurse-implemented perioperative glycemic & warming protocol	Conventional care	SSI rate
Williams et al. (2017), UK (18)	RCT	Urological surgery patients (n=441)	Protocol for aseptic catheter insertion & maintenance	Standard aseptic technique	CAUTI rate

The assessment of methodological quality revealed a variable risk of bias across the included studies. For the five RCTs, evaluation using the Cochrane RoB 2 tool indicated that two studies were judged to have a low overall risk of bias (11,1 7). The main concerns in the other three RCTs arose from performance bias, as blinding of nursing staff to the intervention was inherently challenging, and from detection bias regarding the assessment of outcome measures (13, 15, 18). For the three prospective cohort studies, assessment using the Newcastle-Ottawa Scale found that all three achieved a high quality score, demonstrating good representativeness of the cohorts, comparability of groups on key confounders, and secure ascertainment of outcomes (12, 14, 16). A common potential bias across several studies was the Hawthorne effect, where the knowledge of being observed in a study may have influenced the behavior of nursing staff in both intervention and control groups.

Regarding the primary outcome of HAI incidence, the synthesis of results demonstrated a consistent trend favoring the evidence-based nursing interventions. A meta-analysis was not conducted due to significant clinical heterogeneity in the interventions and patient

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populations; however, a qualitative narrative synthesis provides clear insights. All three studies focusing on nurse-driven catheter removal protocols reported a statistically significant reduction in CAUTI rates. Alvarez et al. reported a 55% reduction (IRR 0.45, 95% CI 0.28-0.71, p<0.001) (11), a finding strongly supported by the larger cohort study by Peterson et al. (OR 0.51, 95% CI 0.39-0.67) (16). Similarly, the two studies implementing central line maintenance bundles demonstrated a clinically important decrease in CLABSI rates. Johnson et al. reported a 62% reduction in the intervention group (IRR 0.38, 95% CI 0.18-0.79) (13). In the domain of SSI prevention, the results were equally compelling. Chen & Wang observed a significant decrease in SSI rates following the implementation of their preoperative bundle (OR 0.57, 95% CI 0.40-0.82) (12), and Silva et al. reported a pronounced reduction in SSIs with their perioperative protocol (RR 0.48, 95% CI 0.29-0.79, p=0.004) (17). The study by Kato et al. on a combined wound and respiratory protocol also showed a significant decrease in both SSI and ventilator-associated pneumonia (VAP) rates (14). The consistency in the direction and statistical significance of these effects across different surgical contexts and geographical settings underscores the potent role of protocolized, evidence-based nursing care in enhancing postoperative patient safety.

DISCUSSION

This systematic review provides a robust synthesis of evidence from eight studies, collectively demonstrating that the implementation of structured, evidence-based nursing interventions is associated with a significant reduction in the incidence of hospital-acquired infections among surgical patients. The findings consistently revealed that nurse-driven protocols, particularly those targeting catheter-associated urinary tract infections, central line-associated bloodstream infections, and surgical site infections, yielded statistically significant improvements in patient outcomes. The strength of this evidence is bolstered by the preponderance of randomized controlled trials and high-quality prospective cohorts within the review, all of which reported effect estimates with narrow confidence intervals that did not cross the line of null effect. This convergence of results across diverse geographical settings and surgical specialties suggests that the efficacy of these nursing interventions is not merely context-specific but represents a universally applicable principle in postoperative care. When contextualized within the broader landscape of existing literature, these findings both corroborate and extend previous knowledge. The results align with the conclusions of a prior meta-analysis by Loveday et al. (2019), which emphasized the critical role of care bundles in preventing HAIs, though that review focused on multidisciplinary teams rather than isolating the distinct contribution of nursing (19). The present review strengthens this evidence base by specifically quantifying the impact of nurse-led initiatives. Furthermore, the significant reduction in SSIs through preoperative skin and hygiene protocols echoes the findings of a large observational study by Zywot et al. (2021), which highlighted the underutilization of such evidence-based practices (20). However, a point of divergence emerges when comparing the magnitude of effect sizes.

The reductions in CAUTI rates observed in this review were more pronounced than those reported in an earlier systematic review by Meddings et al. (2019), potentially attributable to the more recent and rigorously protocolized nature of the nursing interventions included in the present analysis (21). This suggests that the evolution of evidence-based practice in nursing is continuously refining and enhancing the effectiveness of these critical interventions. A principal strength of this systematic review lies in its methodological rigor, which was meticulously maintained throughout the process. The comprehensive search strategy, executed across multiple databases without language restrictions, minimizes the likelihood of having missed significant relevant studies. The adherence to PRISMA guidelines and the use of dual, independent reviewers for study selection, data extraction, and risk of bias assessment significantly reduce the potential for selection and measurement bias within the review process itself (6). Furthermore, the decision to include only controlled studies—RCTs and prospective cohorts—ensures that the synthesized evidence resides high on the hierarchy of evidence, providing a firm foundation for the conclusions drawn. The explicit focus on interventions that were clearly nurse-led and protocol-based allows for a precise interpretation of the results, directly linking improved patient outcomes to the standardization of nursing practice. Notwithstanding these strengths, several limitations warrant careful consideration. The most notable limitation is the clinical heterogeneity observed across the included studies, which precluded a quantitative meta-analysis. Variations in the specific components of the interventions, the surgical patient populations, and the precise definitions of outcomes, while clinically realistic, introduce a degree of uncertainty when generalizing the findings. Secondly, the inherent challenge of blinding nursing personnel to the intervention in most studies introduces a potential for performance bias, as caregivers' knowledge of their participation in a study may influence their behavior (the Hawthorne effect). While the objective nature of the primary outcome (laboratory-confirmed HAI) mitigates some concern for detection bias, it does not eliminate it entirely.

Furthermore, despite the comprehensive search, the possibility of publication bias remains, as negative studies or those with non-significant results are historically less likely to be published. The small number of studies (n=8) also limits the ability to conduct formal

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statistical tests for such bias. The implications of these findings are substantial for both clinical practice and future research. For frontline clinicians and nurse leaders, this review provides compelling evidence to advocate for the development, implementation, and strict adherence to evidence-based nursing protocols for infection prevention in surgical units. Hospital administrators and policy-makers should consider these results when allocating resources for nursing education and training, recognizing that investing in evidence-based practice directly translates to improved patient safety and reduced healthcare costs associated with HAIs. From a research perspective, future studies should aim to standardize intervention components and outcome measurements to facilitate more robust meta-analyses. There is also a pressing need for high-fidelity economic evaluations to quantify the cost-effectiveness of implementing these nursing protocols on a wider scale. Finally, research should explore the implementation science aspects—identifying the most effective strategies for overcoming barriers to adoption and ensuring the sustained fidelity of these nursing interventions over time, thereby ensuring that these significant benefits are realized consistently in real-world clinical settings (22).

CONCLUSION

In conclusion, this systematic review robustly demonstrates that the implementation of evidence-based nursing practices, specifically protocol-driven interventions such as nurse-driven catheter removal, central line maintenance bundles, and standardized preoperative protocols, is consistently associated with a significant reduction in the incidence of hospital-acquired infections among surgical patients. The clinical significance of these findings is profound, as they translate directly into tangible improvements in patient safety, reduced postoperative morbidity, and considerable alleviation of the economic burden placed on healthcare systems by preventable complications. While the reliability of this evidence is strengthened by the inclusion of high-quality controlled studies, the observed clinical heterogeneity underscores the necessity for future research employing standardized intervention frameworks and outcome measures to facilitate a more precise quantitative synthesis and to further elucidate the most effective components of these nursing-led strategies for optimizing surgical outcomes.

AUTHOR CONTRIBUTION

Author	Contribution
Muhammad Saeed*	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Muhammad Abdullah*	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published
Nagina Yasmin	Substantial Contribution to acquisition and interpretation of Data Has given Final Approval of the version to be published
Shahnaz Sughra	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Muhammad Majid Kanwar	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Uzma Asif	Substantial Contribution to study design and Data Analysis Has given Final Approval of the version to be published

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