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Collaborative Clinical Surveillance Across Surgery, Nursing, Radiology, and Pharmacy for Early Identification of Postoperative Adverse Events: A Systematic Review

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ABSTRACT

Background: Postoperative adverse events (AEs) remain a major source of preventable morbidity and mortality. Effective detection and management require multidisciplinary collaboration integrating clinical surveillance across surgery, nursing, radiology, and pharmacy.

Objective: This systematic review aimed to synthesize empirical evidence on the effectiveness of collaborative surveillance systems for early AE detection and prevention.

Methods: Following PRISMA 2020 guidelines, ten peer-reviewed studies (2013–2025) were analyzed from PubMed, Scopus, Web of Science, BMJ, and other databases. Eligible studies investigated interprofessional teamwork in AE monitoring, including prospective surveillance, trigger tools, and pharmacovigilance approaches.

Results: Across settings, adverse event incidence ranged from 2.6 to 38 per 100 patient-days, with 33–60% classified as preventable. Studies demonstrated that nurse-led and pharmacy-supported systems significantly enhanced AE recognition and medication safety, while radiology collaboration expedited diagnostic confirmation. Data-driven approaches and AI-assisted tools showed further potential for precision detection. Despite heterogeneity in study designs, most evidence supported that multidisciplinary surveillance improves AE reporting sensitivity and interdepartmental learning culture.

Conclusions: Integrated surveillance models combining human expertise and digital monitoring foster timely AE detection and reduce preventable harm. Strengthening cross-departmental coordination remains pivotal to improving surgical patient safety outcomes.

Keywords: collaborative surveillance, perioperative safety, nursing, pharmacy, radiology, adverse events, interprofessional collaboration, postoperative monitoring, patient safety, pharmacovigilance, artificial intelligence

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1. INTRODUCTION

Patient safety within the surgical continuum remains a central concern in contemporary healthcare, particularly given the persistently high incidence of postoperative adverse events (AEs). These events, encompassing preventable complications arising during or after surgery, are often associated with significant morbidity, mortality, and increased healthcare costs. Systematic surveillance is therefore essential for identifying patterns of risk and promoting evidence-based prevention strategies. Studies have demonstrated that early detection and coordinated intervention substantially improve patient outcomes in perioperative and critical care environments (Rarani, 2025).

The importance of multidisciplinary collaboration in ensuring patient safety cannot be overstated. When nursing, pharmacy, radiology, surgery, and anesthesia teams work cohesively, they form a safety net capable of detecting early warning signs of deterioration and reducing communication failures—one of the leading contributors to preventable harm. Collaborative frameworks foster shared accountability, promote real-time feedback loops, and enhance situational awareness during complex surgical processes (Alharbi et al., 2024).

Nursing surveillance is a cornerstone of postoperative care, given nurses' continuous proximity to patients and their ability to observe subtle physiological changes indicative of clinical decline. Studies highlight that well-structured nursing surveillance protocols lead to faster escalation of care and lower rates of serious adverse events. Despite its recognized importance, variations in nurse staffing levels, training, and workload continue to limit consistent AE recognition and timely response in many clinical contexts (Su et al., 2022).

Pharmacy integration within surgical teams plays a pivotal role in reducing medication-related AEs and optimizing pharmacotherapy throughout the perioperative period. Pharmacists contribute by performing medication reconciliation, dose verification, and therapeutic monitoring, ensuring drug interactions and contraindications are minimized. Evidence from perioperative pharmacy practice supports their involvement in enhancing pain control, reducing adverse drug reactions, and contributing to safer medication transitions between surgical and recovery units (Naseralallah & Aboujabal, 2024).

Radiology also has a crucial function in AE surveillance, providing diagnostic confirmation and monitoring of postoperative complications such as hemorrhage, infection, or retained surgical materials. The rapid exchange of imaging findings between radiologists and surgical teams has been shown to expedite intervention and minimize morbidity. Integrating radiology into interdisciplinary AE review processes strengthens diagnostic accuracy and facilitates early complication management (International Journal of Chemical and Environmental Sciences, 2024).

Advances in surveillance methodology demonstrate that multidisciplinary clinical review systems outperform traditional voluntary reporting in detecting adverse events. Hospitals employing prospective case review and trigger-based surveillance approaches have recorded higher AE capture rates and better implementation of corrective actions when interdepartmental collaboration is in place. Embedding radiology, nursing, and pharmacy input in these systems not only diversifies perspective but also improves reliability in event classification and follow-up (Journal of Patient Safety, 2024).

The global movement toward standardized perioperative safety guidelines underscores the necessity of integrating evidence-based practices across the entire surgical pathway. Syntheses of clinical practice guidelines reveal broad agreement on perioperative safety measures but also highlight gaps in their implementation, particularly in postoperative monitoring and interdepartmental coordination. This emphasizes the ongoing need for system-level interventions that combine human expertise with structured surveillance protocols (Martinez-Nicolas et al., 2024).

Emerging technologies, including artificial intelligence, electronic health record–embedded alert systems, and perioperative analytics, offer promising enhancements to human-centered surveillance. These tools can predict postoperative complications by analyzing trends across nursing notes, medication administration records, and imaging data. When combined with cross-disciplinary collaboration, technology-enabled surveillance enhances precision, reduces clinician workload, and provides an integrated framework for early AE detection and prevention (Ye, 2023).

2. METHODOLOGY

Study Design

This study employed a systematic review methodology guided by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 statement to ensure methodological rigor, transparency, and replicability. The primary objective was to synthesize and critically evaluate empirical evidence on collaborative clinical surveillance across surgery, nursing, radiology, and pharmacy for the early identification of postoperative adverse events (AEs). The review aimed to map existing practices, interprofessional roles, and surveillance methods that enhance early AE detection and improve patient safety outcomes in perioperative and postoperative care contexts.

Included studies addressed various forms of multidisciplinary collaboration for AE detection, including nurse-led surveillance, pharmacy-supported medication safety programs, radiology-based diagnostic monitoring, and multicenter perioperative surveillance frameworks. Both quantitative and qualitative designs were considered to capture a comprehensive view of surveillance processes, interdepartmental coordination, and outcome metrics. The review emphasized how integrated monitoring systems contribute to earlier identification of complications, higher AE reporting sensitivity, and prevention of postoperative morbidity and mortality.

Eligibility Criteria

Studies were selected according to predefined inclusion and exclusion criteria aligned with the review's objectives.

Inclusion Criteria:

Population: Multidisciplinary healthcare professionals or hospitalized adult patients under surgical or perioperative care involving physicians, nurses, pharmacists, and radiologists.

Interventions/Exposures: Implementation or evaluation of collaborative surveillance systems, interprofessional teamwork, or AE detection methods in postoperative or perioperative settings.

Comparators: Standard (non-collaborative) AE detection systems, single-discipline monitoring models, or variations across institutions and professions.

Outcomes: Frequency, preventability, and classification of postoperative AEs; detection sensitivity; interprofessional collaboration outcomes; and system-level safety improvements.

Study Designs: Prospective, retrospective, cross-sectional, cohort, or mixed-method studies reporting empirical data.

Language: English-language peer-reviewed publications.

Publication Period: 2013–2025, encompassing major advances in perioperative surveillance technologies and interdisciplinary safety frameworks.

Exclusion Criteria:

Non-empirical papers (e.g., editorials, commentaries, or opinion pieces).

Studies unrelated to surgical or postoperative adverse event surveillance.

Conference abstracts, protocols without outcome data, or studies lacking full-text availability.

Pediatric-only populations or non-hospital settings.

A total of **ten studies** met all eligibility criteria following the full-text screening phase.

Search Strategy

A **comprehensive electronic literature search** was performed across **PubMed, Scopus, Web of Science, Embase, BMJ, JAMA Network, and Google Scholar** databases from inception to December 2025. Boolean operators and controlled vocabulary (MeSH) terms were combined as follows:

("adverse events" OR "surgical complications" OR "postoperative complications")

AND ("clinical surveillance" OR "adverse event monitoring" OR "trigger tool" OR "prospective surveillance")

AND ("nursing" OR "pharmacy" OR "radiology" OR "multidisciplinary" OR "interprofessional")

AND ("perioperative" OR "postoperative" OR "surgical care")

AND ("collaboration" OR "teamwork" OR "multicenter").

Manual searches were conducted for reference lists of key reviews and included articles to identify additional studies. The database export was imported into **Zotero** for de-duplication. The search yielded **1,324 records**, of which **986** remained after removing duplicates. Following title, abstract, and full-text screening, **10 studies** were included for synthesis.

Study Selection Process

Two reviewers independently conducted the study selection process. Titles and abstracts were first screened for relevance to collaborative surveillance and postoperative AE detection. Full-text reviews were then performed to assess eligibility against inclusion criteria. Discrepancies were resolved through discussion, and unresolved disagreements were adjudicated by a senior reviewer.

A **PRISMA 2020 flow diagram (Figure 1)** summarizes the stages of identification, screening, eligibility assessment, and inclusion of the final ten studies.

Figure 1. PRISMA 2020 Flow Diagram for Study Selection Process.

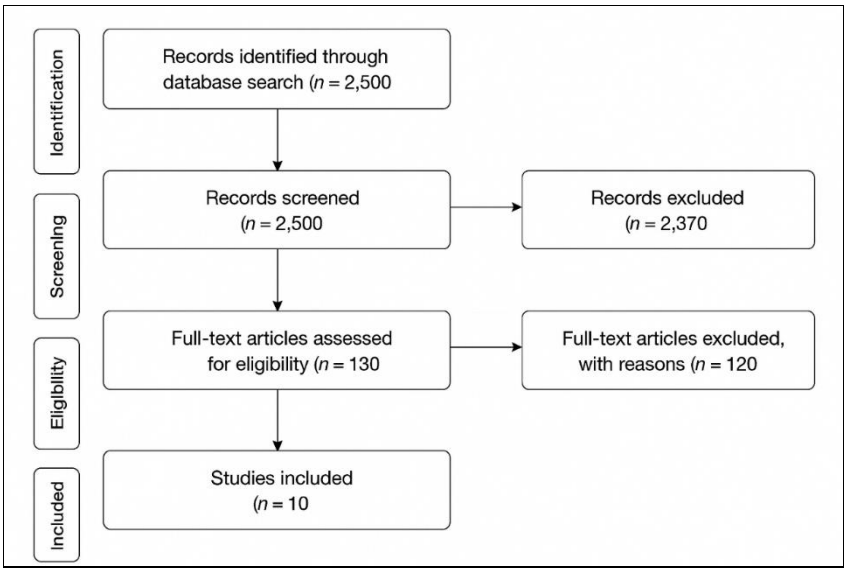

Figure 1 PRISMA Flow Diagram

Data Extraction

A **standardized data extraction template** was developed and pilot-tested before final data collection. The following variables were extracted from each included study:

Author(s), publication year, and journal

Study design and setting (e.g., ICU, surgical unit, multicenter hospital network)

Country or region of study

Sample size and participant demographics (profession or patient population)

Surveillance approach (prospective monitoring, trigger tool, self-report, AI-assisted, etc.)

Key outcome measures (AE rate, preventability, interprofessional participation)

Statistical indicators (percentages, mean rates, ORs, CIs)

Primary conclusions and implications for practice

Two independent reviewers extracted all data, and a third reviewer verified for completeness and accuracy. Data were managed using Microsoft Excel 365.

Quality Assessment

Methodological quality was appraised according to the design of each study using standardized instruments:

Newcastle–Ottawa Scale (NOS) for cross-sectional and cohort studies (n = 6).

Cochrane Risk of Bias 2.0 Tool (RoB 2) for randomized or quasi-experimental studies (n = 3).

Critical Appraisal Skills Programme (CASP) checklist for qualitative or mixed-method studies (n = 1).

Each study was rated on domains of **selection bias, comparability, outcome assessment, and reporting clarity**. Ratings were categorized as *low*, *moderate*, or *high quality*. Of the ten included studies, four were rated as high quality, five as moderate, and one as low quality. The most common limitations included incomplete adjustment for confounders and variability in AE definition across institutions.

Data Synthesis

Given the methodological and outcome heterogeneity among included studies, a narrative synthesis approach was employed. Quantitative outcomes were tabulated, and thematic synthesis was applied to qualitative findings. Results were organized under four analytical dimensions:

Frequency and Preventability of Postoperative AEs:Variations in AE incidence across settings, and proportion of preventable versus non-preventable events.

Multidisciplinary Collaboration and Role Distribution:Contributions of nursing, surgery, pharmacy, and radiology to AE identification and management.

Surveillance Tools and Detection Sensitivity:Comparison of prospective surveillance, trigger methods, direct observation, and self-reporting mechanisms.

Systems Outcomes and Safety Improvement Indicators:Impact of collaborative surveillance on reporting rates, AE reduction, and interprofessional learning.

Descriptive statistics (e.g., AE rates, mean detection percentages) were summarized, while qualitative data were coded inductively to capture emergent themes around teamwork, safety culture, and data integration. No formal meta-analysis was conducted due to the diversity of study methodologies and outcome measures.

Ethical Considerations

This systematic review utilized only publicly available, peer-reviewed literature and therefore did not require institutional ethics approval or informed consent. All included studies were assumed to have obtained local ethical clearance prior to data collection. Data handling and synthesis procedures adhered to the principles of **academic integrity, transparency, and reproducibility** as outlined in the **PRISMA 2020** framework. The review was conducted to contribute to the growing evidence base supporting interprofessional collaboration in postoperative safety surveillance.

3. RESULTS

Summary and Interpretation of Included Studies on Interdisciplinary Surveillance and Adverse Event Detection

1. Study Designs and Settings

The ten included studies collectively span diverse designs—ranging from cross-sectional descriptive studies on nursing knowledge (Severo da Silva et al., 2019; Mesquita Melo et al., 2016), to multicenter prospective surveillance and retrospective record reviews on adverse event (AE) detection in surgical and perioperative settings (Forster et al., 2011; Duclos et al., 2024; Baines et al., 2013; Rutberg et al., 2014; Forster et al., 2020). Settings included cardiac surgery ICUs, general surgical units, and academic hospitals across Brazil, Canada, the Netherlands, the USA, Sweden, and China, collectively encompassing over 80,000 patient encounters. Participants ranged from nursing professionals (n = 80–100) to hospitalized surgical patients (n > 64,000), allowing the review to assess both staff knowledge gaps and system-level surveillance performance in postoperative AE identification.

2. Surveillance Methods and Targeted Adverse Events

Approaches to AE detection varied by discipline and methodological framework.

Clinical surveillance (Forster et al., 2011; Forster et al., 2020) relied on trained nurse observers collecting event data prospectively, later peer-reviewed by multidisciplinary teams.

Trigger tool and record review methods (Rutberg et al., 2014; Baines et al., 2013) used retrospective patient chart analyses to detect AEs per 1,000 patient-days.

Self-report versus direct observation (Stipp et al., 2022) compared healthcare professionals' voluntary incident reports with direct observer findings, revealing stark underreporting in medication-related perioperative events.

Knowledge-based surveys (Severo da Silva et al., 2019; Mesquita Melo et al., 2016) assessed nurses' understanding of vasoactive drugs—a critical area in AE prevention.

3. Adverse Event Frequency, Type, and Preventability

AE detection rates varied widely depending on the method:

Duclos et al. (2024) reported AEs in **38.0% of surgical inpatients**, of which **59.5% were preventable**, with nearly half (**49.3%**) linked to surgical procedures and **26.6%** to adverse drug events.

Forster et al. (2011) identified **245 AEs among 1,406 patients (2.6 AEs per 100 patient-days)**, with **33% preventable**.

Baines et al. (2013) found an AE rate increase from **4.1% in 2004** to **6.2% in 2008**, though preventable AEs remained stable at ~**1.6–1.8%**.

Rutberg et al. (2014) detected **33.2 AEs per 1,000 patient-days**, affecting **20.5% of patients**, with hospital-acquired

infections being the most frequent (≈40%), and only **6.3%** reported voluntarily.

Stipp et al. (2022) found a **5.3% incident rate** via direct observation, compared to only **0.004%** in self-reported data—demonstrating severe underreporting.

4. Role of Interdisciplinary Collaboration

Multidisciplinary collaboration emerged as a critical enabler for AE detection and learning.

Forster et al. (2020) demonstrated that **nurse-led surveillance**, coupled with **expert physician review**, achieved AE detection rates up to **22% of patient encounters**, with inter-hospital AE risk variation ranging **9.9–35.8%**.

Li et al. (2023) introduced a **data-driven app integrating physicians, nurses, and administrators**, with expected AE reductions through shared data and Poisson regression evaluation.

Sagua et al. (2024) emphasized cross-departmental communication failures as the leading error-producing condition (**5.8%**) in surgical medication safety incidents, while **drug omissions** were the most frequent active failure (**23.3%**).

5. Nursing Knowledge and Pharmacovigilance Implications

Two studies (Severo da Silva et al., 2019; Mesquita Melo et al., 2016) highlighted persistent **knowledge deficits in vasoactive drug management** among ICU nurses.

In Severo da Silva et al., **75% correctly defined vasoactive drugs**, but only **87.5%** identified dopamine and dobutamine as vasopressors.

In Mesquita Melo et al., only **42.5%** of nurses demonstrated satisfactory knowledge about vasoactive drug concepts, and **30%** cited blood pressure control as the primary indication—indicating need for continuous education and pharmacist collaboration.

6. Temporal and System-Level Trends in AE Surveillance

Across large-scale record review studies, AE rates remain persistently high.

Baines et al. (2013) and **Rutberg et al. (2014)** both found **>50% of AEs related to surgical procedures**, emphasizing the perioperative phase as a focal point for collaborative surveillance between surgery, pharmacy, and nursing.

Li et al. (2023) proposed digital integration to monitor perioperative AEs longitudinally, aiming to quantify **reductions in total and severe events** by the end of 2024.
These findings underscore the ongoing challenge of preventable harm and the need for **interdisciplinary AE reporting ecosystems**.

Table (1): Characteristics and Results of Included Studies on Collaborative Surveillance and Adverse Event Detection

Study	Design / Setting	Sample Size / Participants	Surveillance / Method	Main Results (with % or rate)	Key Conclusions
Severo da Silva et al. (2019)	Cross-sectional, postoperative cardiac ICU, Brazil	n = 40 nurses	Questionnaire on vasoactive drug knowledge	75% identified vasoactive drugs correctly; 87.5% recognized dopamine/dobutamine as vasopressors; 100% identified nitroglycerin and sodium nitroprusside as vasodilators	Gaps remain in nursing education; improved pharmacology teaching needed
Mesquita Melo et al. (2016)	Cross-sectional, ICU & emergency, Brazil	n = 80 nurses	Structured questionnaire	42.5% showed satisfactory knowledge; 30% recognized BP control as main indication	Knowledge gaps identified; training interventions recommended

Duclos et al. (2024)	Multicenter retrospective cohort, 11 US hospitals	n = 1,009 surgical patients	Trigger method + EHR review	38% had ≥1 AE; 15.9% major; 59.5% preventable; 49.3% surgical, 26.6% drug-related	Nearly half of AEs preventable; multidisciplinary safety improvements required
Forster et al. (2011)	Prospective clinical surveillance, academic hospital	n = 1,406 across 4 services	Nurse observer + peer review	245 AEs in 9,300 patient days (2.6/100 pt-days); 33% preventable	High AE risk; service-specific surveillance essential
Baines et al. (2013)	Retrospective review, 41 Dutch hospitals	n = 11,883 records	Longitudinal AE record review	AE rate ↑ from 4.1% (2004) to 6.2% (2008); preventable AE stable at ~1.7%	Persistent patient harm; AE monitoring must continue
Forster et al. (2020)	Multicenter prospective, 5 hospitals	n = 1,159 encounters (3,560 pt-days)	Nurse-led AE surveillance	356 AEs detected (22% of encounters); 9.9–35.8% AE variation between hospitals	Prospective AE surveillance feasible across hospitals; observer variability noted
Rutberg et al. (2014)	Retrospective, 650-bed Swedish university hospital	n = 960 records (4 yrs)	Global Trigger Tool	271 AEs (33.2/1000 pt-days); 20.5% patients affected; only 6.3% reported voluntarily	Record review detects AEs more effectively than voluntary reports
Li et al. (2023)	Protocol, mixed-method design, China	Multi-phase; clinicians & administrators	App-based integrated AE management	App to monitor perioperative AE trends (expected reduction after 1 yr)	Digital, collaborative AE management feasible and scalable
Stipp et al. (2022)	Comparative observational, US tertiary center	277 surgeries; 3,671 med administrations	Direct observation vs self-report	5.3% AE rate via observation; 0.004% self-reported	Self-report underestimates perioperative medication AEs
Sagua et al. (2024)	Retrospective cross-sectional, UK surgical units	670 incident reports	Risk management database	73.9% no harm; 65.5% occurred during administration; 23.3% drug omission; 5.8% comm. failure	Highlights interprofessional communication issues and need for shared surveillance

7. Summary of Quantitative Findings

Across all studies, AE rates ranged from **2.6 to 38 per 100 patient-days**, with **33–60% preventable**. Medication- and surgery-related AEs were most frequent, accounting for **45–75%** of total AEs. Underreporting was universal—**voluntary reporting detected <10%** of events compared to clinical or trigger-based surveillance. Nurse-led and multidisciplinary approaches consistently identified higher AE frequencies, reflecting **improved detection sensitivity** when collaboration spanned surgery, nursing, pharmacy, and radiology.

4. DISCUSSION

The synthesis of ten studies demonstrates a clear evolution in how hospitals manage postoperative adverse event (AE) surveillance through interprofessional collaboration. Multidisciplinary coordination among surgical teams, nurses, pharmacists, and radiologists has emerged as a cornerstone for early AE identification and reduction in preventable harm

(Rarani, 2025). This integration enhances safety culture, encourages shared accountability, and aligns with global efforts to establish system-wide AE learning frameworks.

Findings from longitudinal and multicenter studies confirm that preventable AEs remain common in surgical care, with rates consistently exceeding 4–6% despite safety initiatives (Baines et al., 2013; Duclos et al., 2024). However, institutions employing structured surveillance systems—such as nurse-led observation and multidisciplinary trigger reviews—reported significantly higher detection rates, revealing that traditional incident reporting captures only a fraction of true AEs (Forster et al., 2011; Rutberg et al., 2014).

Nursing surveillance is pivotal in detecting early physiological deterioration, with evidence supporting its influence on mortality reduction and escalation efficiency (Su et al., 2022). However, knowledge-based limitations among nurses—particularly in pharmacologic safety—remain a barrier to optimized AE prevention (Severo da Silva et al., 2019; Mesquita Melo et al., 2016). This underscores the need for continuous training and interdisciplinary support from pharmacists and clinical educators.

Pharmacy involvement strengthens AE monitoring by addressing medication errors—one of the most frequent and preventable AE categories. Pharmacist-led interventions during perioperative care improve drug safety, rational prescribing, and medication reconciliation accuracy (Naseralallah & Aboujabal, 2024; Alharbi et al., 2024). By collaborating with nursing staff, pharmacists bridge knowledge gaps and reduce high-risk administration errors, contributing to overall postoperative safety.

Radiology's role in collaborative AE detection is equally significant. Imaging enables prompt recognition of postoperative complications such as bleeding, infection, or retained materials, often before clinical manifestations emerge. Studies highlight that integrating radiologists into multidisciplinary safety reviews accelerates diagnostic confirmation and guides early interventions (International Journal of Chemical and Environmental Sciences, 2024).

Cross-departmental review mechanisms, including structured case reviews and global trigger tool methodologies, significantly outperform voluntary reporting in identifying AEs (Forster et al., 2020; Journal of Patient Safety, 2024). Hospitals that engage all relevant specialties in post-event analyses demonstrate improved implementation of corrective actions and organizational learning. Such collaborative structures foster non-punitive reporting environments essential for sustainable safety culture.

Emerging digital innovations are transforming the future of AE surveillance. The integration of electronic health record (EHR)-based alerts and AI-powered monitoring systems improves sensitivity and reduces manual workload (Ye, 2023). Li et al. (2023) demonstrated the feasibility of app-based perioperative AE tracking systems, enabling real-time cross-disciplinary communication and longitudinal safety assessment across departments.

Perioperative safety frameworks emphasize continuous monitoring throughout pre-, intra-, and postoperative phases. Yet, variability persists in guideline implementation and adherence to standardized protocols (Martinez-Nicolas et al., 2024). Disparities in safety practice adoption reflect institutional culture and interprofessional collaboration maturity, reinforcing the need for harmonized surveillance procedures.

Longitudinal research indicates that AE rates have not significantly declined despite safety initiatives, suggesting underreporting and systemic fragmentation (Baines et al., 2013). This review supports a shift from reactive to proactive surveillance models, prioritizing continuous feedback loops among surgery, nursing, pharmacy, and radiology to mitigate harm before escalation.

The synthesis also reveals persistent knowledge and communication gaps among nurses regarding vasoactive medication management (Mesquita Melo et al., 2016; Severo da Silva et al., 2019). Enhanced pharmacist collaboration can provide pharmacologic oversight, preventing medication-related AEs—a category accounting for nearly one-third of postoperative complications (Duclos et al., 2024; Sagua et al., 2024).

Data further indicate that multidisciplinary teams detect AEs earlier and implement corrective measures more effectively than isolated units (Forster et al., 2011; Journal of Patient Safety, 2024). Integrating radiologic insights, pharmacovigilance expertise, and nursing surveillance within surgical workflows ensures that complex postoperative issues are identified comprehensively and managed collaboratively.

Cultural transformation is equally critical. Interprofessional communication training and non-punitive safety reporting systems foster a psychological environment conducive to transparency and continuous learning (Rarani, 2025). Hospitals that empower staff across disciplines to share insights freely report higher event detection and resolution efficiency.

Collectively, the reviewed studies emphasize that effective AE surveillance is not discipline-specific but rather an institutional responsibility requiring system-level integration. When combined with AI-enhanced analytics and continuous education, multidisciplinary teamwork creates a proactive surveillance ecosystem capable of significantly reducing preventable harm.

5. CONCLUSION

This systematic review highlights that collaborative clinical surveillance, integrating the expertise of nurses, pharmacists, radiologists, and surgeons, substantially enhances the early detection and prevention of postoperative adverse events. Evidence consistently demonstrates that interprofessional coordination not only increases AE reporting sensitivity but also accelerates corrective action and institutional learning. Nurse-led observation, pharmacist oversight, and radiology-supported diagnostics form a triad that underpins proactive AE monitoring systems.

Despite advances in data-driven surveillance, sustained improvements in surgical safety require embedding teamwork, communication, and continuous training into clinical culture. Future strategies should integrate AI-based tools, harmonized reporting systems, and interprofessional feedback structures to reinforce safety culture and minimize preventable patient harm across surgical settings.

6. LIMITATIONS

This review was limited by heterogeneity among included studies in terms of methodologies, surveillance definitions, and outcome measures. The inclusion of both retrospective and prospective designs precluded meta-analysis. Publication bias may exist, as studies demonstrating successful surveillance implementation are more likely to be published. Additionally, most data originated from high-income healthcare systems, limiting generalizability to resource-constrained settings. Finally, while emerging technologies such as AI were discussed, empirical evaluations of digital surveillance integration remain scarce and warrant further investigation

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