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Systematic review

Diagnostic imaging precision, medication safety, and clinical nursing interventions in hospital care: a systematic review of primary research involving radiology, pharmacy, and nursing professionals

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Abstract

Hospital safety depends on accurate imaging interpretation, reliable medication management, and effective nursing interventions. These activities address sources of preventable harm in diagnosis, treatment, and bedside care. This review examined primary research evaluating interventions delivered by radiology professionals, pharmacists, and nurses. Publications available through May 2026 were considered. Nine primary studies were organized into imaging, medication safety, and nursing domains. Findings were synthesized narratively because designs, populations, comparators, and outcome definitions differed. Immediate radiographic reporting reduced interpretive discordance from 7.9% to 2.9%. Double reading produced clinically important changes in 14% of abdominal computed tomography reports and 9% of chest reports. Pharmacist participation in clinical rounds was associated with reductions in preventable adverse drug events, whereas a randomized discharge intervention produced no significant reduction in clinically important medication errors. Nursing studies reported lower fall rates with individualized prevention toolkits, with a large cluster randomized trial reporting no significant benefit from the 6-PACK programme. Data addressed separate professional

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interventions rather than a combined multidisciplinary pathway. Targeted professional interventions improved selected safety outcomes, with effects varying between settings and intervention designs. Imaging report changes represented potential clinical relevance rather than confirmed reductions in patient harm. Hospital implementation requires responsibilities, timely communication, patient engagement, and outcome monitoring. Direct evaluation of integrated radiology, pharmacy, and nursing pathways remains a research priority.

Keywords: Diagnostic imaging; medication safety; nursing care; pharmacists; diagnostic errors; patient safety; hospital care; systematic review.

Introduction

Hospital care involves interdependent diagnostic and therapeutic decisions, making safety sensitive to professional expertise and the organization of clinical work. In radiology, interpretive discrepancies arise from perceptual limitations, reasoning processes, communication failures, and working conditions, with disagreement requiring distinction from an unequivocal diagnostic error. This distinction matters because an amended report identifies a change in interpretation without automatically establishing improved diagnostic truth or prevention of patient harm. Evaluations of diagnostic imaging precision require attention to reference standards, clinical importance, reporting timeliness, and the subsequent actions taken by treating teams (1).

Double reading offers a structured opportunity to identify overlooked findings and reconsider uncertain interpretations, particularly when examinations receive subspecialist assessment. A systematic review reported substantial variation in discrepancy rates across settings, emphasizing that the value of additional interpretation depends on examination selection and reader expertise. The same evidence identifies a resource tradeoff, since routine second interpretation requires professional time that competes with other reporting responsibilities (2). Imaging quality improvement involves selecting appropriate examinations for additional review and establishing communication arrangements that connect corrected findings with clinical decisions (1,2).

Medication safety presents a related challenge because prescribing, dispensing, administration, and monitoring involve multiple information transfers during hospitalization (3). Prospective investigation of adverse drug events established a substantial preventable component, supporting interventions directed toward medication processes rather than reliance on individual vigilance alone (3). Systems analysis subsequently identified deficiencies in drug knowledge and access to patient information as prominent contributors to medication errors (4).

Nursing care adds continuous patient observation and bedside prevention, with staffing research demonstrating associations between workload, mortality, and failure to rescue among surgical patients (5). Longitudinal analysis of individual exposure to understaffed hospital shifts further linked inadequate staffing with inpatient mortality, reinforcing the importance of operational capacity when assessing interventions (6). Across professions, a Cochrane review found heterogeneous effects of collaboration interventions and limited certainty, preventing an assumption that teamwork alone guarantees better outcomes (7). The present review examined primary studies of imaging interpretation, medication safety, and nursing prevention in hospital care, distinguishing profession-specific findings from evidence about integrated delivery and identifying the outcome measures needed to assess their clinical relevance.

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Methods

This review used a structured narrative synthesis organized according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses framework. The review question addressed hospital-based interventions involving radiology professionals, pharmacists, or nurses and their relationship with diagnostic interpretation, medication safety, or nursing-sensitive outcomes. Eligible publication dates extended from database inception through 31 May 2026, including online-first articles available within that period.

PubMed/MEDLINE, Scopus, Web of Science Core Collection, and the Cochrane Central Register of Controlled Trials were searched. Separate searches addressed imaging interpretation and reporting, pharmacist-led medication safety, and nursing interventions, avoiding a requirement for all three professions within one publication. Search concepts combined hospital terms with diagnostic accuracy, radiology reporting, double reading, medication errors, adverse drug events, medication reconciliation, nursing care, and fall prevention. Database-specific subject headings and free-text terms were applied, and reference lists supplemented electronic retrieval.

Randomized trials, cluster randomized trials, controlled before-and-after studies, and comparative observational studies were eligible. Participants received hospital care, including emergency assessment and hospital-initiated discharge interventions with subsequent follow-up. Studies required an identifiable professional intervention, an appropriate comparison, and a quantitative safety outcome. Reviews, editorials, protocols, isolated case reports, technical phantom studies, and algorithm-only evaluations were excluded from the primary synthesis. Background reviews informed interpretation without contributing primary outcome data.

Two authors screened titles and abstracts, assessed full-text eligibility, and extracted data using a standardized form. Disagreements were resolved through discussion and agreement between the two authors. Extracted variables included publication details, country, setting, design, sample denominator, professional role, intervention, comparator, outcome definition, follow-up, and effect estimates. Patient counts, admissions, examinations, and patient-days were recorded separately. Multiple publications from the same investigation were checked for overlapping participants and outcomes.

Two authors independently evaluated methodological limitations using design-appropriate domains covering allocation, confounding, selection, outcome ascertainment, missing data, and selective reporting. Imaging studies received additional consideration of examination selection, reader independence, reference standards, and the distinction between interpretive disagreement and diagnostic error. Findings were grouped into the three clinical domains and tabulated without statistical pooling because intervention mechanisms and outvome were incompatible. Original effect measures and confidence intervals were retained where available, and non-significant findings were reported with favorable results. The synthesis separated process outcomes from patient harm and interpreted associations from nonrandomized studies without assigning causality. No combined effect in the three professions was calculated. All comparisons were interpreted within their original setting, with attention to baseline risk and intervention delivery.

Results

The imaging data comprised a multicentre reporting trial and two observational investigations of computed tomography double reading, each evaluating interpretation within hospital diagnostic services (8-10). Hardy and colleagues analyzed

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1,502 patients undergoing 1,688 radiographic examinations, with discordance occurring in 24/839 immediately reported examinations and 67/849 examinations receiving delayed reporting (8). The abdominal study identified clinically important revisions in 146/1,071 reports (9). The chest study identified 91/1,023 clinically important revisions, comprising three critical, 15 major, and 73 intermediate changes (10). These imaging outcomes described interpretive concordance and assessed clinical importance rather than independently verified mortality benefits (8-10).

Three pharmacy investigations evaluated different intervention opportunities and produced contrasting results in inpatient prescribing and discharge care (11-13). In the intensive care study, preventable ordering-related adverse drug events decreased from 10.4 to 3.5 per 1,000 patient-days after pharmacist participation in rounds, while the comparison unit showed no corresponding reduction (11). The general medicine study reported rates of 26.5 versus 5.7 preventable adverse drug events per 1,000 hospital-days and acceptance of 147/150 pharmacist recommendations (12). The discharge trial analyzed 851 participants and found no significant reduction in clinically important medication errors, with an incidence rate ratio of 0.92 and 95% confidence interval of 0.77-1.10 (13).

The nursing data comprised two cluster randomized trials and one nonrandomized evaluation of individualized fall prevention, with substantial differences in programme content and implementation (14-16). Dykes and colleagues reported adjusted fall rates of 3.15 versus 4.18 per 1,000 patient-days across intervention and control units, without a significant reduction in fall-related injuries (14). The 6-PACK trial included 46,245 admissions and found no significant difference in falls or fall injuries despite increased intervention use (15). The later patient-centered toolkit evaluation included 37,231 patients and reported adjusted rate ratios of 0.85 for falls and 0.66 for injurious falls following implementation (16).

The studies differed in denominators, preventing a meaningful combined patient total or direct comparison of absolute intervention effects across professional domains (8-16). Imaging investigations counted examinations, pharmacy studies expressed harm relative to hospitalization exposure or individual patients, and nursing trials evaluated falls using patient-days or occupied bed-days (8-16). Their comparators also differed, ranging from delayed reporting and usual nursing care to contemporaneous control units and preintervention periods (8,11-16). These differences justified presentation of original estimates within separate clinical categories rather than a pooled multidisciplinary effectiveness estimate (8-16).

Interpretive limitations were particularly relevant to selected double-read examinations, nonrandom allocation, and intervention-associated changes in outcome documentation (9-12,16). The imaging studies assessed the clinical significance of report revisions without demonstrating that every revision corrected an objectively verified error (9,10). The pharmacy and nursing evidence also included favorable nonrandomized findings alongside randomized null results, limiting conclusions about universal effectiveness (11-16). None of these nine studies directly tested a single combined radiology, pharmacy, and nursing intervention, so the synthesis supported domain-specific conclusions rather than demonstrated synergy among all three professions (8-16). These studies involved professional practice rather than a uniform comparison of certified specialists against non-specialist clinicians.

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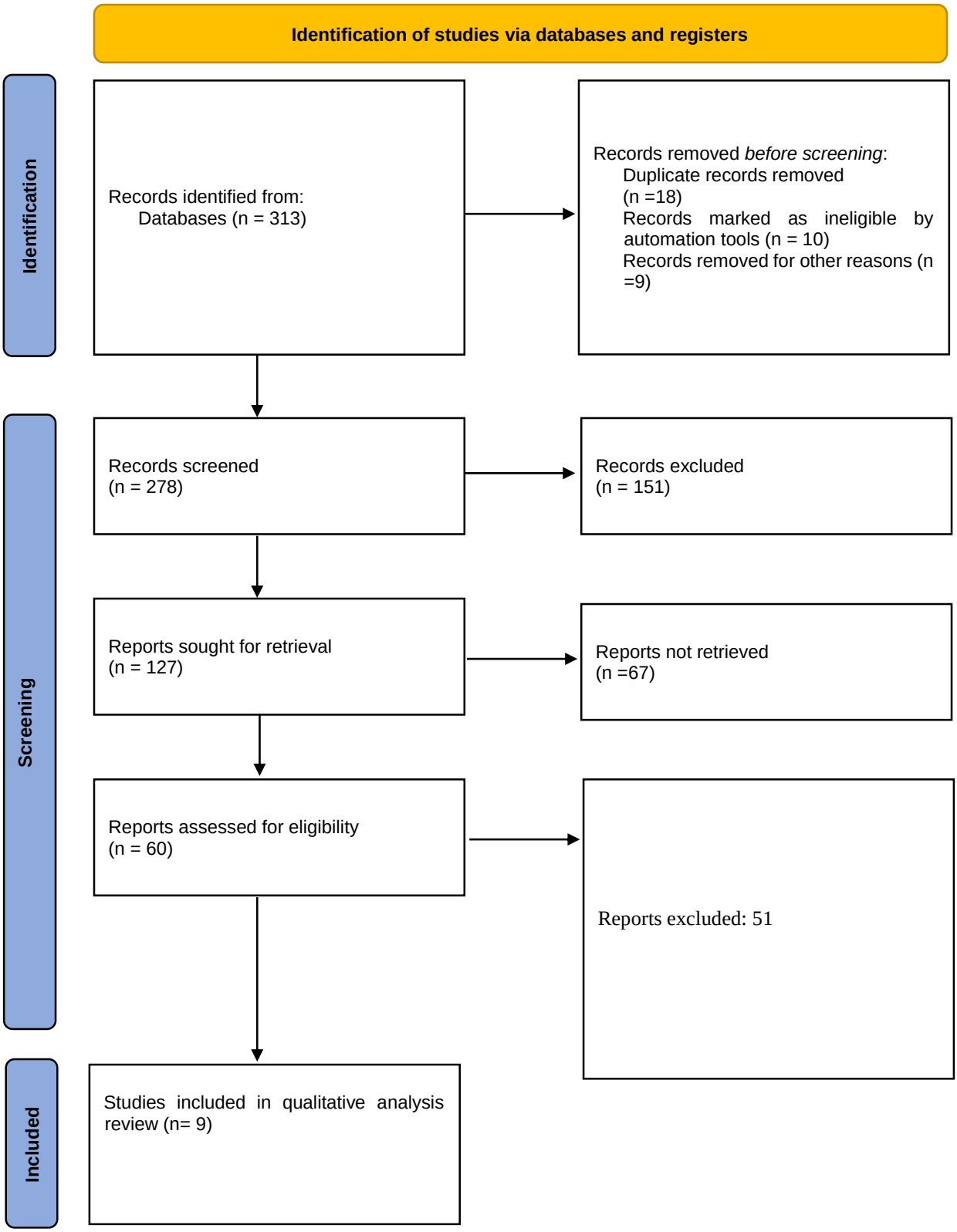


Fig 1: PRISMA consort chart

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Table 1. Characteristics of the nine studies

Study	Setting and design	Sample	Intervention and comparator
Hardy et al., 2013	UK emergency departments; randomized trial	1,502 patients; 1,688 examinations	Immediate versus delayed musculoskeletal radiograph reporting (8)
Lauritzen et al., 2016	Five Norwegian hospitals; retrospective analysis	1,071 abdominal CT examinations	Preliminary versus final double-read reports (9)
Lauritzen et al., 2016	Five Norwegian hospitals; retrospective cross-sectional study	1,023 chest CT examinations	Preliminary versus final double-read reports (10)
Leape et al., 1999	US intensive care; controlled before-after study	275 sampled records	Pharmacist rounds versus baseline and control-unit care (11)
Kucukarslan et al., 2003	US general medicine; controlled study	165 patients	Rounding team with versus without pharmacist participation (12)
Kripalani et al., 2012	Two US hospitals; randomized trial	851 analyzed participants	Pharmacist reconciliation, counseling, aids, and follow-up versus usual care (13)
Dykes et al., 2010	Four US hospitals; cluster randomized trial	10,264 patients	Individualized prevention toolkit versus usual fall prevention (14)
Barker et al., 2016	Six Australian hospitals; cluster randomized trial	46,245 admissions; 31,411 individuals	Nurse-led 6-PACK versus usual care (15)
Dykes et al., 2020	Three US academic centers; nonrandomized controlled study	37,231 patients	Patient-centered, nurse-led toolkit versus preimplementation care (16)

Table 2. Principal findings and their interpretive boundaries

Study	Principal finding	Interpretive boundary
Hardy	Discordance: 2.9% immediate versus 7.9% delayed reporting	Reporting concordance; overall disposition unchanged (8)
Lauritzen, abdominal	Clinically important changes: 146/1,071; critical changes: 3/1,071	Selected examinations; clinical importance judged retrospectively (9)
Lauritzen, chest	Clinically important changes: 91/1,023; critical changes: 3/1,023	Revisions do not establish independent diagnostic truth (10)
Leape	Preventable ordering ADEs: 10.4 to 3.5 per 1,000 patient-days	Nonrandomized unit comparison (11)
Kucukarslan	Preventable ADEs: 26.5 versus 5.7 per 1,000 hospital-days	Controlled design with residual confounding concerns (12)
Kripalani	Medication-error IRR: 0.92; 95% CI 0.77-1.10	No statistically significant reduction (13)
Dykes, 2010	Adjusted falls: 3.15 versus 4.18 per 1,000 patient-days	No significant injury reduction (14)
Barker	Falls IRR: 1.04 (0.78-1.37); injury IRR: 0.96 (0.72-1.27)	Improved intervention delivery without demonstrated clinical benefit (15)
Dykes, 2020	Adjusted rate ratios: falls 0.85 (0.75-0.96); injurious falls 0.66 (0.53-0.88)	Nonrandomized implementation; residual temporal confounding (16)

Discussion

The findings indicate that hospital safety interventions require interpretation according to their mechanisms, target populations, and measured outcomes rather than professional category alone. The strongest common feature was the placement of relevant expertise close to a

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clinical decision, through immediate reporting, pharmacist participation in rounds, or individualized bedside prevention (8,11,12,14,16). This interpretation accords with broader medication-safety identifying benefits from several targeted interventions while documenting substantial variation in study design and clinical significance (17). It explains why successful process changes in one setting do not establish an equivalent benefit for different interventions elsewhere (15,17).

Imaging findings support attention to reporting timeliness and selective second interpretation, particularly for examinations requiring subspecialist expertise (2,8-10). The diagnostic significance of a revised report depends on the validity of the second interpretation and the consequences for patient management (1,2). Selected examinations enrich the likelihood of discrepancies, limiting extrapolation of the reported 9% and 14% revision proportions to all hospital computed tomography examinations (9,10). Clinical assessments of report changes therefore provide useful quality information without constituting proof of improved sensitivity, specificity, survival, or freedom from diagnostic harm (1,2,9,10).

Pharmacy findings distinguish prevention during inpatient prescribing from the broader challenges of care after discharge (11-13). A systematic review of hospital medication reconciliation identified heterogeneous interventions and evidence that reductions in discrepancies did not consistently translate into improved clinical outcomes (18). A subsequent meta-analysis reported reduced hospital utilization with pharmacist-led reconciliation programmes, alongside heterogeneity and no significant mortality difference (19). The randomized discharge trial in this synthesis consequently represents clinically important counterevidence to an unrestricted claim of pharmacy effectiveness, reinforcing the need to distinguish medication discrepancies, potential harm, actual injury, and subsequent healthcare use (13,18,19).

Nursing findings show that increased intervention delivery does not guarantee fewer adverse events, as illustrated by the 6-PACK trial (15). Cochrane data identified uncertainty for several hospital fall-prevention approaches and differences between acute and subacute settings (20). More recent synthesis associated patient and staff education with reduced falls, while alarms, sensors, and scored assessment tools lacked significant pooled benefits (21).

The proposed connection between the three domains supported indirectly by research associating structured handoff implementation with fewer medical errors (22). Staffing capacity also matters, since prospective policy evaluation linked improved nurse staffing with better mortality, readmission, and length-of-stay outcomes (23). These studies do not show effectiveness of an integrated radiology-pharmacy-nursing package, and the present synthesis retains that distinction (8-16,22,23). Reporting limitations include heterogeneous endpoints, historical practice environments, selective imaging samples, and residual confounding in nonrandomized evaluations (8-16). PRISMA-consistent reporting requires transparent search methods, documented selection, and explicit appraisal, while future comparative studies need shared patient-level outcomes to establish whether integration adds benefit beyond separate professional interventions (24).

Conclusion

Hospital-based interventions involving radiology professionals, pharmacists, and nurses produced variable improvements in interpretation, medication safety, and fall prevention. Immediate reporting and selected double reading addressed imaging discrepancies, while pharmacist

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participation in rounds was associated with fewer preventable drug events. Nursing toolkits improved selected fall outcomes, although a large randomized programme showed no significant benefit. The evidence supports targeted implementation with clearly defined responsibilities, patient engagement, and monitoring of actual harm. Differences in study design and outcome definitions restrict comparisons across domains.

Abbreviations

Abbreviation	Definition
ADE	Adverse drug event
CENTRAL	Cochrane Central Register of Controlled Trials
CI	Confidence interval
CT	Computed tomography
IRR	Incidence rate ratio
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
UK	United Kingdom
US	United States

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