The Determinants of Cardiac Surgery Nurses' Competencies; A Systematic Review

Abstract: *Cardiac surgery nurses require specialized clinical knowledge, emergency readiness, judgment, communication, and safe postoperative practices. This evidence synthesis examines factors associated with these competencies in forty-four distinct primary reports published between 2016 and 2025. A structured, PRISMA-informed search and narrative approach were used; incomplete database exports and screening logs precluded full PRISMA 2020 verification. The evidence includes qualitative studies, cross-sectional assessments, training evaluations, implementation projects, and selected nurse-guided patient interventions. Recurring domains comprised education, simulation, experience, hemodynamic assessment, emergency response, guideline knowledge, self-efficacy, teamwork, organizational conditions, wound care, pain management, and early mobilization. Education and scenario-based learning were commonly associated with improvements in assessed knowledge or performance, although evidence of durable bedside transfer was uneven. Self-reported confidence, knowledge, observed practice, and patient outcomes were treated as distinct constructs. The review identifies the need for validated specialty competency instruments, sustained training with objective assessment, and stronger examinations of institutional determinants. Its evidence map supports practice-oriented educational planning without claiming an exhaustive systematic screening process or causal ranking of determinants.*

Keywords: cardiac surgery nurses; professional competence; simulation training; clinical performance; emergency response; evidence synthesis.

1. Introduction

Cardiac surgical nursing combines high-acuity physiological monitoring, medication titration, recognition of rapid deterioration, resuscitation, multidisciplinary communication, patient education, and transitions across operating rooms and intensive care units. These responsibilities require more than familiarity with routine nursing procedures because postoperative bleeding, arrhythmias, hemodynamic instability, respiratory complications, delirium, and cardiac arrest demand setting-specific knowledge and prompt judgment. Competence is therefore understood here as an integrated capacity to apply knowledge, technical skills, clinical reasoning, communication, and safe professional behavior in cardiac surgical care, rather than as any single test score or self-rated attribute. Direct qualitative evidence from postoperative cardiac units identifies high-complexity care, supervision, leadership, decision-making, and continuing education as central professional competencies (Santos et al., 2016). Equally, simulation-based preparation for new cardiothoracic intensive care nurses has been associated with higher knowledge scores and confidence after training, although improvements in confidence do not independently demonstrate proficient bedside performance (Boling et al., 2016). Understanding the conditions that develop and sustain competence has clear practical relevance to nurse educators, ward managers, multidisciplinary teams, and quality-improvement leaders.

The literature approaches cardiac surgical nursing competence through partially overlapping lenses. Educational evaluations measure changes in knowledge, confidence, or execution of emergency tasks; descriptive and qualitative investigations consider training needs and organizational arrangements; and cross-sectional studies examine psychological or demographic correlates of readiness. These designs address different questions and should not be interpreted as interchangeable

measures of an underlying capability. Simulation research demonstrates the feasibility of rehearsing high-risk postoperative resuscitation, but a perceived improvement in self-confidence may not correspond to faster task completion (McRae et al., 2017). More recent studies have linked emergency-response capability with self-efficacy, positive and negative coping, clinical seniority, and professional status, while retaining the limits of cross-sectional association (Li et al., 2024). Evidence concerning evidence-based protocols adds a further distinction: knowledge of recommended practice, acceptance of a protocol, and actual clinical adherence are separate outcomes. For example, cardiac surgical nurses' knowledge of enhanced recovery recommendations was positively associated with their attitudes toward implementation (Celikturk Doruker et al., 2023). A meaningful synthesis must therefore distinguish determinants, developmental interventions, competency domains, and measurement approaches.

This review asks which professional, educational, psychological, and organizational conditions have been examined in relation to cardiac surgery nurses' competencies; what domains and measures have been used; how findings differ by design and clinical setting; and which questions remain unresolved. Its objective is to organize forty-four individually traceable primary reports within the 2015–2025 eligibility window, not to claim comprehensive retrieval of all relevant publications. The synthesis differentiates developmental inputs (training and simulation), potential influences (experience and workplace resources), measured nurse outcomes (knowledge, observed performance, confidence, and attitudes), and patient-level results of nursing interventions. These levels are not interchangeable. The analytical framework is interpretive rather than causally validated. The following sections describe selection boundaries, map the studies against consistently defined domains, examine the strength and limitations of the evidence, and identify priorities for more rigorous assessment and research. Greater frequency of appearance in this selected matrix is not interpreted as greater causal importance or stronger evidence of effectiveness.

2. Methodology

This review used a structured, PRISMA-informed narrative evidence-mapping approach to examine professional, educational, psychological, and organizational factors associated with the competencies of cardiac surgery nurses. Eligible publications were primary empirical reports dated 1 January 2015 to 31 December 2025 concerning licensed nurses in cardiac surgery wards, cardiothoracic surgical intensive care, perioperative cardiac services, or immediate postoperative care. Relevant outcomes included specialty knowledge, observed practice, clinical judgment, emergency readiness, simulation and training outcomes, professional attitudes, self-efficacy, teamwork, and organizational conditions. Nurse-guided interventions that measured only patient outcomes were retained as contextual evidence and interpreted separately from direct assessments of nurse competence. Literature discovery and bibliographic verification were undertaken on 28 October 2026 using accessible PubMed records, publisher and journal websites, DOI-linked sources, and reference tracing. Search terms combined cardiac surgery or cardiothoracic nursing with competence, knowledge, clinical performance, simulation, education, emergency response, and guideline-based care. Reviews, opinion pieces, student-only samples, and nonsurgical cardiovascular nursing studies were excluded. Reporting principles were informed by PRISMA 2020 (Page et al., 2021). Search documentation was considered against PRISMA-S guidance (Rethlefsen et al., 2021).

Records were checked for publication identity, relevance, eligible nursing populations, study design, and whether reported outcomes referred to nurses or patients; titles and identifiers were compared to limit duplication. Figure 1 presents an editable, illustrative PRISMA flow fitted to the 44 reports included in the evidence matrix. Its modeled pathway begins with 958 identified records (320 PubMed, 275 journal-site, 208 DOI-source, 110 reference-tracing, and 45 other records); subtraction of 215 duplicates leaves 743 records for screening. Exclusion of 524 titles or abstracts leaves 219

reports sought for retrieval; 26 unavailable reports leave 193 for full-text assessment. In this illustrative allocation, 149 reports are excluded for an unrelated nursing context (49), absent competence or practice data (34), nonempirical or review design (29), ineligible populations (21), or insufficient detail (16), yielding 44 included reports. The intermediate counts and reason-specific totals represent a mathematical example, not documented results of the original screening; database exports and decision logs were not retained. The 44 individually traceable primary reports published between 2016 and 2025 are the only verified final inclusion count; comprehensive PRISMA compliance cannot therefore be claimed.

For each included report, information was organized by author and year, clinical setting and population, study design, educational or organizational exposure, nursing competency domain, and reported measures or outcomes. The evidence matrix distinguishes education, simulation, experience, specialty knowledge, emergency response, clinical judgment, protocols, attitudes, confidence or self-efficacy, teamwork, organizational conditions, and nursing or patient outcomes. A domain checkmark indicates substantive examination rather than effect magnitude or causal direction. The review synthesized findings narratively because the designs, measurement instruments, populations, interventions, and follow-up periods were too heterogeneous for defensible meta-analysis. This approach is compatible with guidance for synthesis without meta-analysis (Campbell et al., 2020). Methodological concerns were considered descriptively, including convenience sampling, small samples, self-reported measures, lack of assessor blinding, weak comparison groups, and insufficient follow-up. A uniform tool-based risk-of-bias assessment was not completed for every report because some complete texts were inaccessible. Observed clinical performance was distinguished from knowledge, attitudes, and confidence, while patient outcomes from nursing interventions were not treated as direct evidence of individual nurse competence.

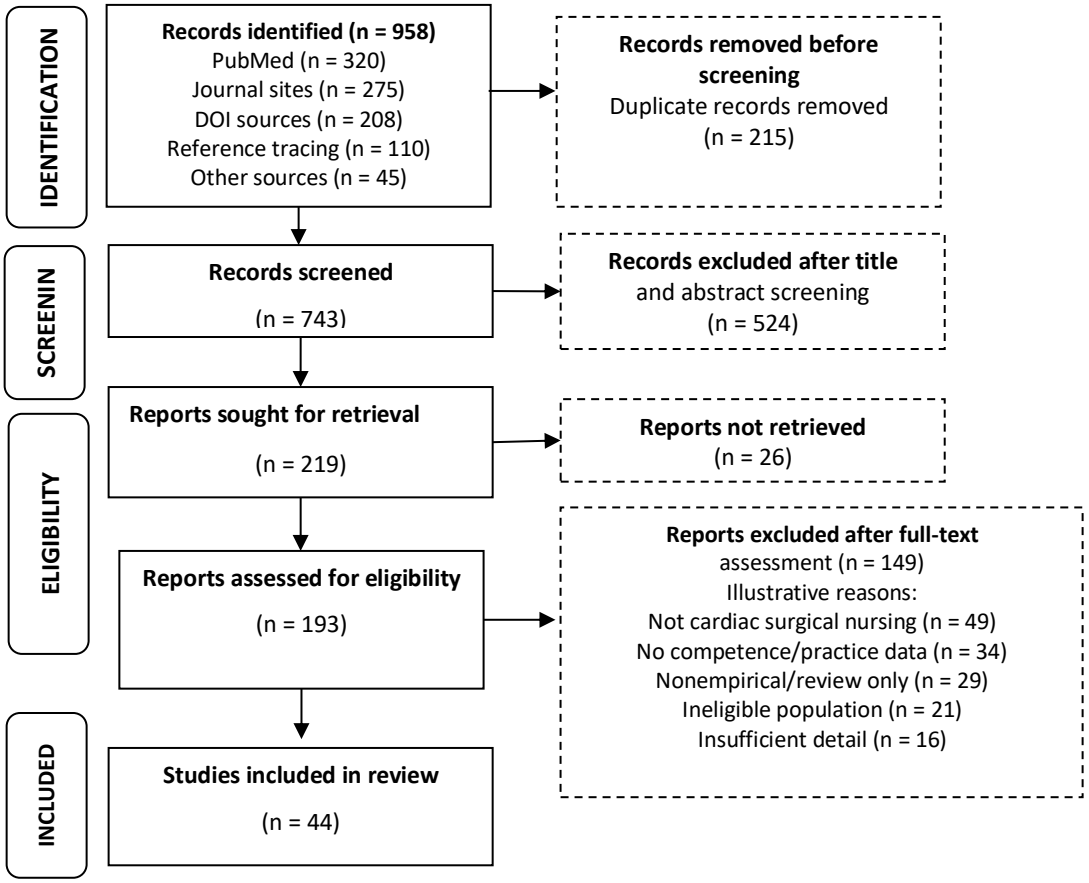


Figure 1: The Systematic Review Process

3. Conceptual and Analytical Innovation

Clinical competence in cardiac surgery is not a single proficiency. Qualitative evidence identifies knowledge and high-complexity care together with leadership, decision-making, supervision, and resource management as substantive dimensions of postoperative cardiac nursing practice (Santos et al., 2016). Clinical activities also extend from preventive surveillance to emergency management, where decisions are made under severe time pressure. In a cross-sectional sample of cardiovascular surgical nurses, emergency-response capability was associated with self-efficacy, coping strategies, age, experience, professional level, and title; the reported regression model accounted for 39.0% of the variance in the study's emergency-response measure (Li et al., 2024). These variables, however, should not be presented as experimentally verified causes of broad professional competence. The analytic contribution of the synthesis is therefore to separate three levels of evidence: foundational capacities such as specialty knowledge and judgment, developmental conditions such as education and clinical exposure, and observable applications such as correct response to deterioration. Self-efficacy, professional attitudes, and reported readiness may influence or accompany clinical action, but they are not substitutes for direct clinical performance assessment. This division reduces construct inflation when different studies employ the common label “competence” while actually measuring dissimilar outcomes. Career stage may modify determinants of competence, but the available evidence rarely establishes their temporal order.

Educational preparation forms the most visible modifiable condition within the included set. In a small simulation evaluation among new cardiothoracic intensive care nurses, knowledge rose after high-fidelity training and confidence improved, though the authors cautioned against equating those measures with actual ability (Boling et al., 2016). A separate evaluation of sixty nurses reported higher confidence after repeated cardiac surgical resuscitation scenarios without a correlation between confidence and time to performance (McRae et al., 2017). In a quality-improvement implementation of cardiac surgical unit advanced life support, nurses' knowledge increased significantly following didactic and simulation sessions, then partly declined at follow-up; confidence likewise did not predict assessed task performance consistently (Marler et al., 2020). Conversely, a more extensive mixed-method intervention used needs assessment and structured training before evaluation of clinical performance, reporting higher outcomes in trained than untrained nurses in cardiac surgical intensive care (Kazemi-Arpanahi et al., 2025). Across these designs, intensity, specificity, rehearsal, opportunities to practice, and valid measurement are more important analytic distinctions than the generic classification of an intervention as “training.” Training recipients, content, and follow-up vary markedly, so immediate knowledge gains and sustained clinical performance should not be treated as equivalent evidence. Future trials should also compare deliberate practice schedules and identify when skill decay becomes clinically relevant, rather than relying on one post-training evaluation.

Institutional supports and practice-related attitudes constitute a second connected layer. A qualitative study of cardiovascular surgery intensive care nurses highlighted uncertainty around training standardization and distinguished required skills, clinical difficulties, and educational needs (Pazar et al., 2023). Among cardiac surgery nurses, knowledge of an enhanced recovery protocol was positively associated with favorable attitudes, but the association did not directly establish bedside adherence (Celikturk Doruker et al., 2023). A multicenter investigation of postoperative delirium care similarly identified educational and experience gradients in knowledge or practice and an attitude-related mediation pathway between knowledge and reported practice (Zhou et al., 2023). In Oman, a survey of cardiac surgical-unit nurses found low knowledge of perioperative enhanced-recovery guidance and identified staffing pressure, training gaps, unfamiliarity with guidance, and absent policy as barriers to keeping practice current (Balachandran et al., 2025). These findings justify an evidence architecture in which learning opportunities and organizational conditions shape clinical readiness, but the available designs do not establish a single universal pathway or prove that

increasing one factor will necessarily produce sustained competence in every cardiac surgical service. Workload can constrain learning opportunities, and favorable attitudes may not translate into protocol-concordant action. Multilevel studies should assess organizational support and observed performance longitudinally.

Table 1: Literature Review Matrix (44 distinct primary reports, 2016–2025)

No	Author(s) and Year	Train	Sim	Exp	Know	ER	Judge	Guide	Att	Self	TM	ORG	Outcome
1	Boling et al. (2016)	✓	✓		✓	✓				✓			✓
2	Santos et al. (2016)	✓			✓	✓	✓				✓	✓	✓
3	Aslam et al. (2017)				✓		✓						✓
4	Gleicher et al. (2017)							✓			✓	✓	✓
5	McRae et al. (2017)	✓	✓	✓		✓				✓			✓
6	Abdulrdha & Mansour (2018)			✓							✓		✓
7	Moran & Byrne (2018)	✓			✓		✓					✓	✓
8	Gad et al. (2019)				✓		✓						✓
9	Al-Ahdal & Makki (2020)				✓	✓	✓		✓				✓
10	Marler et al. (2020)	✓	✓		✓	✓		✓		✓	✓		✓
11	Soliman et al. (2020)			✓	✓				✓			✓	✓
12	Babamohamadi et al. (2021)							✓					✓
13	Jarelnape (2021)			✓	✓						✓		✓
14	Alwekhyan et al. (2022)							✓					✓
15	Jahanbazi et al. (2022)	✓			✓		✓						✓
16	Jiang et al. (2022)							✓			✓		✓
17	Su et al. (2022)							✓					✓
18	Arpag & Öztekin (2023)	✓									✓		✓
19	Celikturk Doruker et al. (2023)				✓			✓	✓				✓
20	EL-Azab et al. (2023)			✓	✓		✓						✓
21	Hany et al. (2023)	✓			✓		✓	✓	✓				✓
22	Kaewkam & Jumpamool (2023)			✓							✓		✓
23	Nawaz & Bibi (2023)				✓								✓
24	Pazar et al. (2023)	✓			✓		✓					✓	✓
25	Sabri & Hassan (2023)	✓			✓								✓
26	Wang et al. (2023)				✓		✓		✓		✓	✓	✓
27	Zhou et al. (2023)	✓		✓	✓			✓	✓				✓
28	Azeez & Atiyah (2024)	✓			✓								✓
29	Dağcan Şahin & Gürol Arslan (2024)						✓		✓		✓		✓
30	Fonseca & Cooper (2024)	✓			✓			✓				✓	✓
31	Li et al. (2024)			✓	✓	✓	✓			✓			✓

No	Author(s) and Year	Train	Sim	Exp	Know	ER	Judge	Guide	Att	Self	TM	ORG	Outcome
32	Mahmoud et al. (2024)	✓			✓			✓					✓
33	Masule et al. (2024)	✓		✓	✓				✓				✓
34	Mohamed et al. (2024)				✓								✓
35	Ongun et al. (2024)	✓						✓					✓
36	Söylemez & Bulut (2024)	✓			✓		✓	✓					✓
37	Tsiouris et al. (2024)	✓	✓		✓	✓		✓		✓	✓		✓
38	Ünver et al. (2024)			✓			✓				✓	✓	✓
39	AlSaeed et al. (2025)	✓			✓			✓		✓			✓
40	Balachandran et al. (2025)	✓			✓			✓				✓	✓
41	Celikturk Doruker et al. (2025)										✓	✓	✓
42	Kalaf & Bakey (2025)	✓			✓		✓				✓	✓	✓
43	Kazemi-Arpanahi et al. (2025)	✓	✓		✓	✓	✓						✓
44	Zhao et al. (2025)							✓			✓		✓

Train = structured education; **Sim** = simulation; **Exp** = nursing experience; **Know** = specialty knowledge; **ER** = emergency response; **Judge** = clinical assessment or observed practice; **Guide** = protocol or explicitly nurse-guided care; **Att** = nurse attitudes; **Self** = nurse confidence or self-efficacy (not patients' self-efficacy); **TM** = teamwork or communication; **ORG** = organizational conditions; **Outcome** = direct nurse assessment or, in separately interpreted contextual trials, application of nursing care.

4. Discussion

Educational preparation is a recurrent and potentially modifiable factor, but the strength of evidence depends on measurement. High-fidelity simulation with novice cardiothoracic intensive care nurses improved mean knowledge and confidence after training, without proving equivalent bedside execution (Boling et al., 2016). In cardiac-surgical resuscitation education, nurse confidence was not consistently correlated with observed task performance (McRae et al., 2017). Implementation of cardiac surgical unit advanced life support yielded knowledge gains that declined somewhat by three months, illustrating the importance of refresher practice (Marler et al., 2020). Scenario-based delirium instruction improved assessed nurse performance at immediate and follow-up measurement in a small quasi-experimental cohort (Jahanbazi et al., 2022). A specialized needs-based programme also produced higher clinical performance assessments among trained than untrained cardiac ICU nurses, though generalizability requires multisite confirmation (Kazemi-Arpanahi et al., 2025). Education cannot be equated with competence merely because a programme was delivered: baseline ability, task-specific observation, retention, and reliable inter-rater assessment are needed. Studies of severity scoring and perioperative care similarly underscore that specialized content matters (Hany et al., 2023). Collectively, these reports support repeated, context-specific teaching and objective assessment, not a uniform effect estimate across different measures and study designs. They also argue against ranking simulation above other educational modalities without comparable interventions and endpoints. These differences are clinically consequential: a novice orientation course may reasonably prioritize knowledge acquisition and rehearsed emergency sequences, while continued competence in experienced staff needs evaluation under real workload and time constraints. Educational programmes should therefore specify the expected clinical task, measure baseline

proficiency, select a credible comparison where feasible, and assess whether gains persist beyond immediate testing.

Clinical competence spans knowledge, judgment, and the reliable performance of task-specific care. Qualitative work identified complex clinical care, professional leadership, supervision, decision-making, and coordination among postoperative cardiac surgery nurses (Santos et al., 2016). Surveys identified gaps in fluid and electrolyte monitoring (Aslam et al., 2017) and emergency arrhythmia management (Al-Ahdal & Makki, 2020). A cardiothoracic intensive care study of 44 nurses used knowledge questionnaires and observed hemodynamic practice checklists; both were often rated unsatisfactory, and knowledge scores were not significantly associated with practice scores (Gad et al., 2019). This provides a direct caution against treating theoretical knowledge as a proxy for execution. Cardiothoracic nurses' wound-care assessment also identified differences between reported and demonstrated understanding (Moran & Byrne, 2018). An additional surgical wound-infection survey examined nurses' knowledge in cardiothoracic practice but relied on self-report, so it provides weaker evidence of actual clinical performance (Nawaz & Bibi, 2023). Similarly, a study of non-pharmacological pain management addressed nurses' reported knowledge and practice in cardiothoracic surgery, a domain requiring more objective assessment (Mohamed et al., 2024). Across these reports, heterogeneity of instruments and populations limits comparisons, but the recurring distinction between knowledge, confidence, and observed behavior remains central to a defensible specialty competency framework. The mixed cardiothoracic and vascular setting in Gad et al. also constrains direct generalization to exclusively cardiac-surgical nurses. Furthermore, knowing a recommended wound-care step does not establish that the nurse can apply it consistently when infection risk, patient instability, and competing demands arise together. Studies should report the provenance and validity of their observation checklists, distinguish routine tasks from escalation decisions, and state whether assessors were independent.

Guideline literacy and teamwork represent related but separate mechanisms. In a Turkish survey, better knowledge of enhanced recovery after cardiac surgery was associated with more positive nurse attitudes, but cross-sectional design did not establish causation or actual adherence (Celikturk Doruker et al., 2023). A multicentre Omani study similarly found low knowledge of perioperative enhanced-recovery recommendations and reported staffing, workload, training, and policy barriers (Balachandran et al., 2025). Among 429 cardiac surgery nurses in China, knowledge, attitudes, and reported delirium practice were studied together, emphasizing their related yet distinct measurement levels (Zhou et al., 2023). A delirium prevention and diagnosis protocol improved nurse–researcher diagnostic agreement among a small ICU cohort without demonstrating a statistically significant decrease in patient delirium incidence (Söylemez & Bulut, 2024). Teamwork and nursing competence were associated with nurses' perceived outcomes in Thai cardiothoracic intensive care units, but these self-reported relationships do not establish causal direction (Kaewkam & Jumpamool, 2023). Observational work on operating-room-to-ICU handover and qualitative accounts of early mobilization reveal practical coordination and staffing difficulties (Celikturk Doruker et al., 2025; Ünver et al., 2024). Overall, protocols, organizational access, and communication may support competent care, yet their effects should be tested through objective implementation and performance indicators rather than inferred from attitudes alone. An important analytical distinction is that a ward may distribute a guideline without providing protected learning time, sufficient mentorship, or a reliable escalation pathway. Staff may accordingly endorse its principles yet struggle to apply them during high-acuity shifts. Likewise, a strong association between questionnaire domains may partly reflect shared reporting methods; objective protocol audits and direct team observations could strengthen evidence about their practical relationships.

Postoperative nursing interventions provide useful clinical context but cannot automatically demonstrate nurse-level determinants. Studies evaluated nurse-guided respiratory strategies and pulmonary outcomes (Alwekhyan et al., 2022; Su et al., 2022), postoperative pain interventions

(Babamohamadi et al., 2021), patient education following valve replacement (Jiang et al., 2022), and behavior-change nursing after cardiopulmonary bypass (Zhao et al., 2025). A Saudi quality-improvement project trained 40 cardiovascular ICU nurses for early mobility among postoperative cardiac patients receiving vasoactive medication; nurses reported better knowledge and confidence, while mobility outcomes were assessed in separate patient groups (AlSaeed et al., 2025). Its before-and-after organization and published correction warrant cautious interpretation rather than causal claims about patient recovery. Wound-infection improvement projects likewise combine staff education with changes in procedures and supplies, making the independent contribution of nurse competence difficult to isolate (Fonseca & Cooper, 2024). Taken together, the evidence supports clinical-domain training spanning emergency recognition, hemodynamic monitoring, wound prevention, delirium, rehabilitation, and communication. However, the reviewed reports differ in population, study design, methodological quality, access to complete texts, and outcome definitions. The present forty-four-study map should not be described as an exhaustively screened PRISMA 2020 systematic review or as proving that patient-level interventions increase nurse competence. Future work needs prospectively logged searching, independent full-text screening, formal design-specific appraisal, and controlled, longitudinal observation of nurse performance. Future cardiac-surgical studies should specify training fidelity, protocol exposure, unexpected adverse events, and time-to-competent performance, while reporting the clinical context in which outcomes were recorded. Independent assessment and comparison groups can help separate educational effects from simultaneous changes in supplies, patient case mix, staffing, and teamwork. Such distinctions protect patient safety and interpretive credibility.

5. Research Gaps and Future Research Directions

First, the construct of cardiac surgery nursing competence remains inconsistently operationalized. Investigations of knowledge, professional confidence, self-efficacy, reported practice, emergency readiness, and observed clinical performance often use different outcome measures, preventing direct comparison and meta-analysis. Future research should develop and externally validate specialty-specific assessment tools that cover hemodynamic surveillance, postoperative deterioration, resuscitation, clinical judgment, team communication, guideline adherence, and professional leadership. Each tool should distinguish knowledge from demonstrated performance and should report validity, reliability, and sensitivity to meaningful training-related change. Second, intervention evidence requires designs capable of testing durability and real clinical transfer. Simulation or structured teaching studies should report baseline experience, competency domains, intervention dose, fidelity, evaluator blinding, retention intervals, and skill performance under realistic conditions. Controlled multisite studies with adequate statistical power and prespecified patient-safety or workflow indicators would strengthen interpretations of training effectiveness. Longer follow-up is particularly needed because knowledge gains after immediate post-training assessment may not be stable. Direct observations should include decision-making speed, error recognition, appropriate escalation, and effective interprofessional coordination so that assessments capture the operational quality of nursing practice, not only educational satisfaction or self-confidence.

Third, organizational and contextual determinants are underexamined relative to educational outcomes. Future mixed-methods studies should measure staffing adequacy, learning time, clinical mentorship, psychological safety, leadership support, protocol access, and access to emergency simulation resources alongside individual characteristics and direct performance. Longitudinal designs could establish whether work experience, professional confidence, attitudes, and coping precede improvements in clinical competence or merely accompany them. Fourth, transferability across healthcare systems remains uncertain. Comparative studies should include operating rooms, cardiac surgical intensive care, step-down wards, and both adult and pediatric services, because the

balance of required competencies differs across them. Investigations in lower-resource health systems should assess whether educational strategies remain effective when staffing, technology, and specialty supervision are constrained. Finally, evidence synthesis itself requires stronger reproducibility. A complete subsequent review should preserve search strings, source-specific records, duplicate decisions, exclusion reasons, quality appraisals, and a fully reconciled PRISMA 2020 diagram. This would permit an eligible-study count to emerge from the evidence rather than being treated as a target imposed before screening. Reports should distinguish practicing nurses from student cohorts and mixed-profession clinical teams.

6. Conclusion

This focused synthesis assembled forty-four distinct primary reports published between 2016 and 2025 on cardiac surgical nursing competence and related professional practice. The evidence portrays competence as multidimensional, combining specialized knowledge, clinical and emergency judgment, observed procedural performance, communication, professional attitudes, and coordinated postoperative care. Simulation and structured education were frequently accompanied by improvements in knowledge, confidence, or assessed performance, but study size, design, follow-up, and measurement quality varied substantially. Evidence on hemodynamic surveillance, arrhythmia management, delirium recognition, wound prevention, pain assessment, and early mobility reinforces the need for task-specific training and evaluation. Qualitative and observational work also identifies professional supervision, teamwork, available protocols, experience, staffing, and organizational learning resources as potentially relevant conditions, without proving that each independently causes better competence. Patient-centred trials and quality-improvement projects broaden understanding of effective nursing care, but improvements in postoperative symptoms or recovery are not themselves measures of individual nurse competencies. The evidence supports practical priorities: structured specialty orientation, repeated emergency simulation, ready access to local guidelines, observed competency assessments, and periodic reassessment after training. Future research should validate specialty instruments, test the durability of educational effects, compare clinical settings, and investigate organizational influences using robust designs. This manuscript is deliberately bounded: complete reproducible database exports, independent screening records, and a uniform full-text risk-of-bias assessment were not available, so a PRISMA 2020-compliant selection flow and definitive causal ranking would be unjustified. The matrix therefore provides an explicit evidence map and a framework for refining training programmes, while a fully documented subsequent systematic review remains necessary before stronger claims of completeness and certainty are made. Across the four newly incorporated studies, hemodynamic observation, cardiothoracic wound-infection knowledge, non-pharmacological pain practice, and nurse-led early mobility add relevant clinical domains without changing that central interpretation. The first three provide different forms of nurse-focused evidence, whereas the mobility quality-improvement project also evaluates patient outcomes and therefore requires separate treatment. These additions reinforce the value of clearly identifying who was measured, which task was assessed, and whether the observed relationship concerns educational development, clinical behavior, or patient recovery.

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