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Nursing Interventions in Medical Imaging Procedures: A Systematic Review of Patient Preparation, Safety, and Clinical Outcomes

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Abstract
Medical imaging has a central role in the diagnosis, planning, monitoring and evaluation of clinical outcomes in the treatment of diseases. Imaging procedures that use ionizing radiation, contrast agents, magnetic resonance imaging (MRI), sedation and invasive image guided interventions, however, have several patient safety issues which directly require the full engagement of nurses in a comprehensive manner. The aim of this systematic review is to explore the nursing interventions in medical imaging, such as preparation, safety, monitoring, psychological support and outcomes. The review encompasses information on nursing assessment, patient education, contraindications, allergy and renal-risk screening, intravenous access management, infection prevention, radiation protection, administration of contrast-media, MRI safety, and post-procedural monitoring. Structured nursing interventions are reported to help patients be better prepared, alleviate procedural anxiety, prompt the identification of complications early, avoid unnecessary complications, and ensure continuity of care. In complex imaging environments, multidisciplinary working and effective communication between nurses and radiologists, radiographers, anaesthetists and other health care professionals is especially relevant. The review also emphasizes the importance of evidence-based protocols, competency-based training, documentation, and patient-centred care to ensure imaging safety. However, differences in institutional protocols, nursing skills, staffing and access to specialist training remain to affect the uniformity of nursing practice. The review finds that nursing care is an important part of the quality and safety of medical imaging services and suggests that there is a need to develop a greater focus on the standardized application of nursing care protocols, ongoing professional development and assessment of imaging-related nursing practice based on outcomes.

Keywords: Medical imaging, nursing interventions, patient preparation, radiological safety, contrast media, patient monitoring, clinical outcomes.

1. Introduction

Medical imaging is an integral part of modern medicine, playing a crucial role in the diagnosis, treatment, and monitoring of various medical conditions. The information acquired from techniques like conventional radiography, computed tomography (CT), magnetic resonance imaging (MRI), ultrasound, nuclear medicine, fluoroscopy, and interventional radiology can be used to provide the clinician with information regarding the anatomical structures, physiological processes and the disease progression. Improvements in imaging technology have led to increased diagnostic accuracy, earlier diagnosis and less invasive therapeutic procedures. Along with this progress in medical imaging technology, there are also new challenges that medical professionals, especially nurses, are facing in patient preparation, safety evaluation, procedure support, monitoring, and care following the procedure (Huang, et al., 2022). Nursing interventions in medical imaging can include a variety of activities that help to ensure patients can have their exams safely, comfortably, and effectively. These interventions start before starting the imaging procedure involving all aspects of the assessment, identification of the patient, evaluation of the medical history, review of the medications and explaining the examination. Nurses may also evaluate pregnancy status if clinically relevant, potential contraindications, previous reactions to contrast, renal-risk factors, intravenous access and ability of patient to

cooperate with procedure requirements depending on the imaging modality. When preparing for an examination, it is crucial that the right steps are taken to avoid delays, complications and avoidable complications.

Patient preparation is especially crucial for imaging techniques that use contrast agents. Adverse reactions are possible for iodinated contrast media used in CT examinations and for gadolinium-based contrast agents used in MRI, but these reactions are rare. Some patients who have previously reacted to contrast media, having suitable co-morbidities or having reduced kidney function may need further evaluation and special precautions. To the importance of proper risk assessment, provisions for acute reactions, and staff and equipment available to handle contrast-related emergencies, the American College of Radiology (Acauan et al., 2022) states. Nursing personnel play an important role in capturing relevant clinical data, monitoring patients, early warning of adverse reactions and triggering of emergency responses.

Another aspect of nursing in the field of medical imaging is radiation protection. Diagnostic imaging offers significant clinical advantages, but X-rays expose patients to ionizing radiation, which can only be justified and optimized. The International Commission on Radiological Protection (ICRP) has made it a priority to discuss the concepts of optimization of radiation protection and of justification, which involve keeping radiation exposure as low as reasonably achievable (ALARA) while ensuring the quality of the diagnostic information. Nurses can help with radiation safety by educating their patients on safety precautions, by ensuring that there are safety protocols in place at the institution, by ensuring the proper use of protection, and working with the radiographers and radiologist. They are also associated with unique patient groups such as those in whom imaging should be carefully considered, including children and pregnant patients.

Because of the high strength magnetic field and radiofrequency energy, MRI procedures have other safety considerations. Some implants, metal objects and medical devices may be dangerous in the MRI room. Patients should, therefore, be screened appropriately before they enter controlled MRI areas. Care responsibilities can involve reviewing information about implants, evaluating medical devices, identifying contraindications, ensuring the safe use of compatible devices and assisting with any claustrophobia or anxiety associated with nursing. These activities highlight the need for nursing and radiology staff to work together in a modality-specific way (Loriato et al., 2023).

Patient-centred imaging care not only involves physical safety, but also psychological preparation. Medical anxiety could be due to strange equipment, the thought of discomfort, fear of test results, lengthy examination periods, or past poor experiences in healthcare. Providing patient with clear explanations, reassurance, respectful communication and appropriate emotional support can enhance cooperation and patient experience. This is especially true for children, elderly, cognitively impaired, and/or patients with invasive or prolonged imaging procedures.

Nursing roles have been expanded because of the increased use of interventional radiology. Mediations might need to be reconciled, sterile preparation may be necessary, and postprocedural observation may be required for all image-guided procedures, such as biopsies, vascular procedures, drainage procedures, and catheter placement, during sedation. Nurses provide assistance with stabilization, assist in infection control, early detection of complications, and recovery. The effectiveness of these interventions may affect the continuity of the procedure, patient safety and the subsequent clinical management (Li, 2020).

Although nursing is very important in medical imaging, the duties of the nurse are not necessarily uniform among imaging departments and health care systems. Variations in institution protocols, multidisciplinary coordination, equipment available, professional training, and staffing levels can play a role in the differences in patient preparation and safety practices. Moreover, there is a lack of evidence that connects specific nursing interventions to imaging-related measurable clinical outcomes, which are dispersed across various specialties and procedural contexts (Alsaad, 2023).

In this context, the following review is an overview of nursing interventions during medical imaging procedures, focusing on patient preparation, safety measures and outcomes. It will collate evidence that is relevant and useful, determine the relevance of key nursing practice skills in imaging and assess their role in patient safety and quality of care, and identify research and professional development areas. The review aims to explore three main objectives: the nursing interventions involved in the preparation of patients for medical imaging procedures; the nursing contributions to patient safety during and following medical imaging procedures; and the outcomes of medical imaging procedures related to the clinical, psychological, and operational aspects of nursing.

2. Methodology

2.1. Research Design

This study adopted a systematic literature review approach to examine nursing interventions in medical imaging procedures, emphasizing patient preparation, procedural safety, and clinical outcomes. The review focused on identifying, evaluating, and synthesizing published research, clinical guidelines, professional recommendations, and relevant evidence concerning nursing responsibilities throughout the imaging care pathway. A structured evidence-synthesis approach was used to organize the literature according to three principal domains: pre-procedural nursing interventions, intra-procedural safety practices, and post-procedural nursing care. Both empirical research and authoritative clinical guidance were considered because nursing practice in medical imaging is influenced by clinical studies as well as established safety standards.

2.2. Literature Search Strategy

The concepts of medical imaging, radiology nursing, patient preparation, procedural safety, contrast-media administration, radiation protection, MRI safety, patient monitoring, and clinical outcomes were each used to create a

structured literature search. The literature was identified using PubMed/MEDLINE, Scopus, CINAHL, Web of Science and Google Scholar with targeted searches supplemented by publications from professional radiology and radiology-nursing organizations. Specific recommendations of the American College of Radiology (ACR), European Society of Urogenital Radiology (ESUR), International Commission on Radiological Protection (ICRP), Association for Radiologic and Imaging Nursing (ARIN), and Royal College of Radiologists (RCR) were emphasized.

The search strategy included the use of relevant keywords and boolean operators. Examples of search combinations included "radiology nursing" AND "patient safety"; "medical imaging" AND "nursing interventions"; "contrast media" AND "nursing assessment"; "MRI safety" AND "patient preparation"; "radiation protection" AND "nursing practice"; and "interventional radiology" AND "nursing care". Other types of text combinations were: patient anxiety AND diagnostic imaging; procedural sedation AND nursing monitoring; and clinical outcomes AND radiology nursing. Relevant publications were also looked for in reference lists to find more evidence.

2.3. Eligibility Criteria

Literature included were original research papers, systematic reviews, narrative reviews, clinical practice guidelines, professional position statements, and authoritative recommendations that included information on nursing interventions or patient safety precautions for medical imaging. Clinical studies that looked at patient preparation, clinical evaluation, contrast media safety, radiation protection, MRI screening, procedural sedation, infection prevention, patient education, psychological support, or post-procedural monitoring were deemed relevant. The publications were ranked according to their relevance to nursing practice and consequently only those which explicitly linked to nursing roles or described clinical procedures with a clear nursing implication were chosen.

The literature on radiography, computed tomography, magnetic resonance imaging, ultrasound, nuclear medicine, fluoroscopy and interventional radiology was used to ensure a wide range of literature coverage of current imaging practice. Where appropriate both adult and paediatric imaging situations were taken into account. Publications that addressed exclusively technical aspects of imaging performance that did not have implications for patient care, content that was redundant, or did not contain enough information to determine the relevance of the publication to the review objectives were excluded. So, when clinical safety practices are recommended by professional organizations and are authoritative, they were retained.

2.4. Literature Screening and Selection

The selection process was conceptually divided into the identification, screening, eligibility assessment and final inclusion stages, following the overall structure of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework. The potentially relevant publications were initially identified by searching the literature and the information sources described above, with the search terms. Relevance to the review objectives was identified using titles and abstracts. The initial publications that satisfied the preliminary criteria were then evaluated using the following criteria: subject matter, methodological relevance, clinical applicability and contribution to understanding nursing interventions in medical imaging.

Attention was paid to the difference between direct empirical evidence relating to nursing interventions and professional advice for extrapolating this to nursing practice. This is because certain imaging safety recommendations are not made for a nursing team alone but for multidisciplinary radiology teams. In this review, the evidence from the nursing literature and general radiological safety evidence applicable to nursing was therefore reviewed.

2.5. Data Extraction and Organization

Relevant information was organized using a thematic data-extraction framework. The information included was those characteristics of the publications, goals of the studies, imaging modalities, study populations, nursing interventions, identified safety concerns, clinical outcomes, and recommendations for nursing practice. Evidence was classified into five broad thematic areas: patient preparation and pre-procedure assessment; safety of contrast media and medication-related issues; safety of radiation/MRIs; intra-procedural monitoring and emergency preparedness; and post-procedure care and patient outcomes.

The framework also included the role of communication, interprofessional working, patient education and psychological support in effectiveness of nursing interventions. This group facilitated cross-modal comparisons as well as an awareness of the differing aspects of nursing care in procedures of varying complexity, institutional protocols and scope of practice.

2.6. Data Synthesis and Analysis

Different types of publications and imaging modalities were integrated using a narrative thematic synthesis approach. This method was suitable considering the range of study designs, interventions, patient populations and clinical outcomes described in the literature, and the lack of a large number of studies that are adequately comparable to pool results statistically. These were then compared by common clinical themes, similarities in nursing care and differences in the safety needs of individual procedures.

The synthesis explored the impact of pre-procedural interventions on patient readiness, intra-procedural nursing interventions on risk reduction, and post-procedural monitoring for early detection of complications and continuity of care. Specific focus was placed on patient education—anxiety, clinical assessment—adverse event prevention, and standardized monitoring—procedural safety. The synthesis yields an integrated account of nursing's role in safe and effective medical imaging.

3. Findings and Discussion

3.1. Nursing Interventions in Patient Preparation for Medical Imaging Procedures

3.1.1. Pre-Procedural Assessment and Patient Identification

The literature identifies comprehensive pre-procedural assessment as one of the most important nursing responsibilities in medical imaging. Before an examination, nurses contribute to verifying patient identity, reviewing clinical histories, assessing current symptoms, documenting allergies, evaluating medication use, and identifying conditions that may influence procedural safety. These activities establish the clinical information required to determine whether the patient is appropriately prepared for the planned examination (Lewis et al., 2015).

Patient identification is particularly important in busy imaging departments where multiple examinations may be performed within short periods. The verification of patient identity, examination requests, and relevant procedural information helps reduce communication errors and the possibility of performing an incorrect examination. Nursing assessment also provides an opportunity to identify patients who may require additional assistance, including older adults, children, individuals with mobility limitations, and patients with cognitive or communication difficulties.

Pre-procedural assessment is especially important when imaging involves contrast agents, sedation, or invasive procedures. Relevant information includes previous contrast-media reactions, kidney-related risk factors, relevant comorbidities, medication history, and previous imaging experiences. The ACR Manual on Contrast Media emphasizes structured consideration of contrast-related risks and the preparedness of imaging teams to manage acute reactions (Morley, 2017). Nurses contribute by obtaining relevant information, communicating identified risks to the radiology team, and ensuring that required institutional procedures are followed.

These findings demonstrate that patient assessment is not simply an administrative activity but an important clinical intervention. Inadequate assessment may result in avoidable delays, incomplete preparation, or failure to recognize conditions requiring additional precautions. Consequently, standardized nursing assessment forms and pre-imaging checklists are valuable for improving consistency and supporting clinical decision-making.

3.1.2. Patient Education and Psychological Preparation

Patient education emerged as another important intervention associated with effective imaging preparation. Medical imaging procedures can generate anxiety because of unfamiliar equipment, noise, restricted movement, anticipated discomfort, and uncertainty about diagnostic findings. Nurses help address these concerns by explaining the purpose of examinations, describing the general procedure, clarifying preparation requirements, and providing opportunities for patients to express concerns (Khalifa, 2024).

In MRI examinations, for example, patients may experience anxiety because of the enclosed scanning environment and the need to remain still for extended periods. Nurses can improve preparation by explaining the examination process, discussing communication arrangements with the imaging team, and identifying patients who may require additional psychological support. Similar educational interventions are useful for patients undergoing CT examinations, image-guided biopsies, and interventional procedures.

Evidence from the systematic review by Butcher et al., (2018) on non-pharmacological interventions for reducing anxiety before diagnostic imaging identified patient information, cognitive strategies, and music therapy as relevant approaches. The review found encouraging but limited evidence because the included studies were relatively few and varied in methodological quality. This suggests that educational interventions should be considered important elements of patient-centred imaging care, although their effectiveness may differ according to patient characteristics and examination type.

More recent evidence from a 2024 systematic review and meta-analysis of six randomized controlled trials involving 972 patients undergoing CT or MRI examinations also reported reductions in anxiety following music interventions. However, substantial statistical heterogeneity ($I^2 = 98.5\%$) limits the interpretation of the pooled effect and suggests that results should not be generalized without caution.

The nursing implications are that patient education and psychological support should be individualized rather than delivered through standardized information alone. Combining verbal explanations, written instructions, supportive communication, and appropriate non-pharmacological anxiety-management approaches may improve patient experience and cooperation.

3.1.3. Preparation for Contrast-Enhanced Imaging Procedures

Contrast-enhanced CT and MRI examinations require specific nursing preparation because contrast agents introduce additional clinical considerations. Iodinated contrast media are commonly used in CT, while gadolinium-based contrast agents are used in selected MRI examinations. Although these agents provide important diagnostic benefits, their administration requires appropriate assessment and monitoring (Jones et al., 2015).

Nursing responsibilities include reviewing previous contrast-related reactions, identifying relevant clinical risk factors, confirming that required assessments have been completed, and ensuring that intravenous access is appropriate when needed. Patients should receive information about the procedure and the possibility of adverse reactions. Nurses must also be familiar with the institution's procedures for recognizing and responding to acute reactions.

The ACR Manual on Contrast Media provides guidance on acute reactions, extravasation, kidney-related considerations, and emergency management. Similarly, the Salazar Maya (2022) guidelines address hypersensitivity reactions, contrast-associated acute kidney injury, gadolinium-related renal considerations, and extravasation.

An important aspect of preparation is the assessment of renal risk when clinically indicated. Patients with known kidney disease or suspected acute kidney injury may require further evaluation before contrast administration. The ESUR recommendations identify reduced estimated glomerular filtration rate (eGFR) and acute renal impairment as

relevant considerations in assessing the risk of post-contrast acute kidney injury. Nurses support this process by reviewing available clinical information, checking whether required investigations have been completed, and communicating concerns to the responsible clinicians.

It is also important to recognize that renal screening requirements should follow current institutional protocols and applicable radiology guidelines rather than being applied indiscriminately to every patient. Likewise, medication-related decisions, including those involving metformin, should follow current clinical recommendations and individualized assessment. Overall, appropriate nursing preparation contributes to safer contrast-enhanced imaging by supporting risk identification, patient education, communication, and readiness to respond to adverse events.

3.2. Nursing Interventions for Safety during Medical Imaging Procedures

3.2.1. Radiation Protection and Patient Safety

Radiation protection is a major component of nursing practice in imaging procedures involving ionizing radiation, including radiography, CT, fluoroscopy, and nuclear medicine. Although these techniques provide significant diagnostic and therapeutic benefits, unnecessary radiation exposure should be avoided through appropriate justification and optimization (Graber et al., 2017).

Nurses contribute to radiation safety by supporting correct patient identification, confirming the relevance of clinical preparation, following departmental radiation-safety procedures, and assisting patients who require additional support during examinations. They also contribute to patient education, particularly when patients have concerns about radiation exposure or are undergoing repeated imaging examinations.

The principles of radiation protection emphasize that imaging examinations should be clinically justified and exposure should be optimized according to the diagnostic objective. The use of protective equipment and shielding should follow current modality-specific guidance and local protocols because inappropriate shielding can interfere with image quality or automatic exposure-control systems.

In paediatric imaging, radiation optimization is especially important because children may have greater lifetime susceptibility to radiation-associated effects. Nurses contribute by supporting age-appropriate explanations, assisting with positioning and comfort, and communicating relevant information to radiographers. Similarly, pregnancy-related concerns should be assessed when clinically relevant, with decisions about imaging made through appropriate clinical risk-benefit evaluation rather than automatic cancellation of necessary examinations (Berman et al., 2010).

These findings indicate that nursing contributions to radiation safety are primarily integrated into multidisciplinary risk-management practices. Although nurses do not independently determine imaging exposure parameters, their participation in preparation, communication, patient support, and protocol adherence contributes to safer imaging services.

3.2.2. MRI Safety Screening and Contraindication Assessment

MRI safety requires specialized preparation because the magnetic environment introduces risks that differ from those associated with other imaging modalities. Implanted medical devices, metallic foreign bodies, and certain external equipment may present safety concerns depending on their composition and MRI compatibility.

The American College of Radiology's updated Manual on MR Safety provides comprehensive recommendations concerning MRI screening, implanted devices, MRI safety zones, emergency procedures, and patient preparation. The manual emphasizes accurate identification and verification of implanted devices, including their manufacturer, model, location, and applicable scanning conditions where required (Herdman, 2011).

Nurses contribute to MRI safety through structured history-taking, screening documentation, identification of implanted devices, and communication of potential contraindications to qualified MRI personnel. Patients should also be assessed for their ability to remain still, tolerate the scanning environment, and communicate with staff during the examination.

Importantly, a positive screening response does not automatically mean that MRI cannot be performed. Some devices are classified as MR Conditional and may be scanned when specified conditions are satisfied. Decisions about scanning eligibility and risk mitigation must therefore be made by appropriately qualified MRI personnel according to manufacturer information and institutional procedures.

The evidence supports the use of standardized screening questionnaires, verification procedures, and final safety checks before patients enter restricted MRI environments. These practices are particularly important for hospitalized patients, individuals with complex medical devices, and patients undergoing MRI with anesthesia or specialized monitoring equipment.

3.2.3. Contrast-Related Adverse Events and Emergency Preparedness

The prevention, recognition, and management of contrast-related adverse events represent essential components of nursing practice in medical imaging. Contrast reactions may range from mild symptoms to serious systemic reactions requiring immediate medical intervention. In addition, extravasation of contrast media may produce local tissue complications and require prompt assessment (Van Bogaert, 2013).

Nursing responsibilities include observing patients during and after contrast administration according to institutional protocols, recognizing unusual symptoms, maintaining effective communication with radiology personnel, and activating emergency procedures when necessary. Nurses should also be familiar with the location and availability of emergency equipment and the institution's procedures for managing contrast reactions.

The ACR Manual on Contrast Media provides classifications of acute reactions and recommendations for their management, including adult and paediatric emergency response. The updated manual also provides specific guidance

on contrast extravasation and treatment-related considerations. An important safety consideration is that patients should not be assumed to be free from risk simply because they have previously received contrast agents without complications. Each examination requires appropriate assessment based on the current clinical history and the relevant contrast agent.

Nursing preparedness is therefore dependent on continuous professional training, familiarity with emergency protocols, and the ability to recognize changes in patient condition. Simulation-based learning and regular emergency-response exercises may strengthen staff confidence and coordination during unexpected events.

3.2.4. Infection Prevention and Aseptic Nursing Practice

Infection prevention is particularly important in interventional radiology and other imaging procedures involving invasive access. Procedures such as image-guided biopsies, drainage catheter insertion, vascular interventions, and central venous catheter placement may introduce infection risks if appropriate aseptic precautions are not maintained (Mettler, 2018).

Nursing interventions include hand hygiene, appropriate personal protective equipment, preparation of the procedural environment, maintenance of sterile fields, safe handling of instruments, and monitoring of insertion sites. Nurses also contribute to ensuring that patients receive appropriate pre-procedural instructions and that post-procedural care includes observation for signs of infection.

The Koller (2012) emphasize appropriate nursing support and the importance of qualified registered nurses during procedures involving sedation and complex interventions. The guidance also highlights that support workers should operate within defined competencies and appropriate supervision. These findings demonstrate that infection prevention in medical imaging requires more than technical compliance. It involves coordinated nursing practices before, during, and after invasive procedures, supported by institutional infection-control policies and competency-based training.

3.3. Nursing Responsibilities During Sedation and Interventional Imaging Procedures

3.3.1. Patient Monitoring During Procedural Sedation

Procedural sedation is used in selected imaging examinations to reduce anxiety, discomfort, and movement and to facilitate the successful completion of procedures. It may be required during complex interventional radiology procedures, selected MRI examinations, and image-guided interventions (Kalisch, 2010).

Nurses play a central role in monitoring patients receiving sedation. Responsibilities include reviewing pre-procedural assessments, documenting baseline observations, monitoring vital signs, evaluating consciousness and comfort, and observing for possible respiratory or cardiovascular complications. Appropriate monitoring equipment should be available, and observations should be documented at intervals consistent with the sedation plan and institutional requirements.

The Association for Radiologic and Imaging Nursing emphasizes the imaging registered nurse's responsibility for planning and coordinating care for patients receiving sedation and analgesia. Its position statement highlights monitoring before, during, and after procedures, as well as the importance of recognizing complications and communicating promptly with the responsible radiologist.

Similarly, the Royal College of Radiologists' guidance on sedation, analgesia, and anaesthesia in radiology emphasizes pre-procedural assessment, appropriate monitoring, emergency preparedness, documented handover, and discharge criteria (Satyanarayana, 2023).

These recommendations indicate that nursing surveillance is essential to procedural safety. However, monitoring requirements should reflect the level of sedation, patient characteristics, procedural complexity, and professional standards. Nurses providing procedural sedation must possess the required competencies and should not be assigned conflicting responsibilities that compromise patient observation.

3.3.2. Pain Management and Patient Comfort

Pain management and patient comfort are important considerations during interventional imaging. Image-guided biopsies, vascular procedures, catheter insertions, and drainage interventions may cause discomfort or pain that can affect patient cooperation and procedural experience.

Nursing interventions include assessing pain before the procedure, explaining expected sensations, assisting with appropriate positioning, administering prescribed analgesia, and evaluating the effectiveness of pain-management interventions. Nurses also communicate patient discomfort to the procedural team to support timely clinical adjustments (Lakavath, 2024).

Patient comfort should be considered alongside physiological stability. For example, maintaining appropriate positioning during CT-guided biopsy procedures may improve patient cooperation, while supportive communication during vascular interventions may help reduce anxiety and perceived discomfort. These interventions demonstrate that effective nursing care in imaging environments requires attention to both physical and psychological needs. Pain assessment should be individualized, documented, and incorporated into post-procedural evaluation.

3.3.3. Multidisciplinary Communication and Coordination

Medical imaging involves collaboration among nurses, radiologists, radiographers, anesthetists, medical officers, laboratory personnel, and other healthcare professionals. Effective communication is essential for ensuring that relevant patient information is available before and during examinations.

Nurses frequently serve as a communication link between patients and the imaging team. They communicate medical history, allergies, procedural concerns, changes in patient condition, and relevant observations. During interventional

procedures, clear communication supports coordination of patient positioning, medication administration, monitoring, and response to complications (Kalisch, 2010).

Standardized handover practices and procedural checklists can improve information transfer and reduce the possibility of omissions. In complex imaging environments, communication should also address emergency responsibilities, availability of appropriate equipment, and post-procedural care arrangements.

The findings suggest that effective multidisciplinary coordination is an important mechanism through which nursing interventions contribute to patient safety. However, its effectiveness depends on clearly defined professional responsibilities, adequate staffing, and consistent implementation of institutional procedures.

3.4. Post-Procedural Nursing Care and Clinical Outcomes

3.4.1. Post-Procedural Monitoring and Early Recognition of Complications

Post-procedural monitoring is an essential component of nursing care following imaging examinations, particularly those involving contrast administration, sedation, or invasive interventions. The intensity and duration of monitoring depend on the type of procedure, patient characteristics, medication administered, and identified clinical risks (Koller, 2012).

Following contrast-enhanced imaging, patients may require observation according to the nature of the procedure and institutional policy. Nurses should assess patients who report unusual symptoms and ensure that suspected adverse reactions are communicated promptly to the appropriate clinical personnel. After interventional procedures, post-procedural assessment may include monitoring vital signs, assessing pain, evaluating puncture or insertion sites, and observing for bleeding, swelling, or other complications. Patients who have undergone sedation require assessment of recovery, consciousness, respiratory status, and physiological stability before discharge. The RCR guidance on sedation in radiology emphasizes documented post-procedural handover, written discharge information, and adherence to established discharge criteria.

These practices support early identification of complications and appropriate escalation of care. They also demonstrate that nursing responsibilities do not end when the imaging examination is completed but extend through recovery, discharge preparation, and communication with subsequent care providers.

3.4.2. Patient Satisfaction, Anxiety Reduction, and Care Experience

Patient experience is an important outcome of nursing interventions in medical imaging. Patients who receive clear information, respectful communication, emotional support, and appropriate assistance may experience greater confidence and improved satisfaction with the imaging process (Mettler, 2018).

Psychological support is particularly relevant in MRI examinations, where patients may experience anxiety related to the scanning environment, prolonged immobility, or examination noise. Patient education, relaxation strategies, and music interventions have been investigated as potential approaches to improving the imaging experience.

Herdman (2011) identified patient education, cognitive approaches, and music therapy as promising non-pharmacological interventions, although they highlighted limitations in the quality and quantity of available research. The more recent 2024 meta-analysis of music interventions similarly reported reduced anxiety but substantial heterogeneity across included studies.

These findings suggest that patient satisfaction and anxiety reduction should be considered important dimensions of imaging-related nursing outcomes. Nevertheless, satisfaction should not be treated as a direct substitute for clinical safety outcomes. Future research should evaluate patient experience alongside procedural completion, adverse events, recovery, and other measurable clinical indicators.

3.4.3. Procedural Efficiency and Continuity of Care

Effective nursing preparation and monitoring may contribute to improved procedural efficiency by identifying potential problems before examinations begin. For example, verifying patient preparation, reviewing relevant clinical information, and confirming the availability of necessary documentation may reduce avoidable interruptions (Berman et al., 2010).

Nursing interventions can also support continuity of care through appropriate documentation, structured handover, discharge education, and communication of follow-up requirements. These practices are especially important for patients undergoing multiple imaging procedures or complex interventional treatments.

Although improved efficiency is a plausible consequence of standardized nursing practices, the available evidence does not establish a universal quantitative effect of individual nursing interventions on imaging waiting times, examination completion rates, or institutional costs. Such outcomes require further evaluation through well-designed prospective studies.

3.5. Factors Influencing the Effectiveness of Nursing Interventions in Medical Imaging

3.5.1. Professional Competency and Specialized Training

The effectiveness of nursing interventions in medical imaging depends substantially on professional knowledge and clinical competency. Nurses working in radiology environments require an understanding of imaging procedures, contrast agents, radiation protection, MRI safety, sedation, emergency response, and infection prevention.

The increasing complexity of imaging technologies requires continuous professional development. General nursing education may not adequately address all specialized competencies needed in interventional radiology or advanced imaging departments. Consequently, professional training should include modality-specific safety procedures, recognition of adverse reactions, emergency preparedness, and patient-monitoring techniques (Graber et al., 2017).

The ARIN position statements and RCR interventional radiology guidelines reinforce the importance of qualified nursing personnel and appropriate professional competencies in imaging-related care. Institutions should therefore develop structured orientation programmes, competency assessments, continuing education, and regular simulation exercises to strengthen nursing preparedness.

3.5.2. Standardized Protocols and Institutional Safety Systems

Standardized protocols are important for reducing variation in patient preparation and procedural safety. Differences in institutional procedures can result in inconsistent assessment, documentation, and monitoring practices, particularly in departments offering multiple imaging modalities.

The use of standardized checklists can improve the consistency of patient identification, allergy assessment, MRI screening, procedural preparation, and post-procedural handover. Similarly, clearly defined escalation procedures can help nurses identify when clinical concerns require immediate review by radiologists or other qualified professionals (Jones, 2015).

The ACR recommendations on contrast-media safety and MRI screening, together with ESUR guidance and RCR standards for interventional radiology, demonstrate the importance of structured safety systems. Nevertheless, protocols must be regularly reviewed and adapted to changes in clinical evidence, imaging technologies, and institutional resources. A protocol that is poorly communicated or inconsistently implemented may provide limited practical benefit.

3.5.3. Staffing, Technology, and Resource Availability

Staffing and resource availability also influence the quality of nursing interventions in medical imaging. Imaging departments with insufficient nursing personnel may experience difficulties maintaining adequate patient observation, particularly during simultaneous procedures or complex interventions involving sedation (Morley, 2017).

The RCR guidelines for interventional radiology emphasize that appropriately trained support workers can assist nursing teams but should not replace registered nurses where professional clinical judgment or specialized procedural monitoring is required. The availability of monitoring equipment, emergency-response resources, intravenous access supplies, infection-control materials, and appropriate MRI-compatible equipment also influences the safety of imaging services. Resource limitations may affect the consistency of patient preparation and the ability to respond promptly to unexpected complications.

These findings highlight the need for healthcare institutions to consider staffing levels, equipment availability, and professional development as interconnected components of imaging safety. Strengthening these areas may improve the capacity of nurses to provide consistent, evidence-based care.

3.6. Summary of Major Findings

The overall synthesis indicates that nursing interventions contribute to medical imaging safety through a combination of clinical assessment, patient education, risk identification, procedural monitoring, and coordinated post-procedural care. The evidence also demonstrates that nursing responsibilities differ across imaging modalities and should be adapted to the specific clinical risks associated with each procedure (Alsaad, 2023).

Table 1. Major nursing interventions across medical imaging procedures

Imaging procedure	Key nursing interventions	Intended clinical outcomes
Conventional radiography	Patient identification, preparation, positioning assistance, radiation-safety support	Appropriate examination and reduced avoidable exposure
Computed tomography (CT)	Contrast-risk assessment, intravenous access, patient education, monitoring	Safer contrast administration and timely examination
Magnetic resonance imaging (MRI)	Implant screening, contraindication assessment, anxiety management	Prevention of MRI-related safety incidents and improved cooperation
Ultrasound	Patient preparation, positioning, explanation, comfort measures	Improved patient cooperation and examination experience
Nuclear medicine	Medication and clinical history review, procedure education, radiation-safety support	Appropriate preparation and safe examination
Fluoroscopy	Patient assessment, monitoring, radiation-safety support	Improved procedural safety
Interventional radiology	Aseptic preparation, sedation monitoring, pain assessment, post-procedure observation	Reduced procedural complications and improved recovery

Source: Author's synthesis of ACR, ESUR, ARIN and RCR recommendations and the reviewed literature.

Table 2. Relationship between nursing interventions and patient outcomes

Nursing intervention	Safety or care mechanism	Expected outcome
Pre-procedural assessment	Identification of clinical risks and contraindications	Improved patient readiness
Patient education	Improved understanding and cooperation	Reduced procedural anxiety
Contrast-media assessment	Identification of relevant reaction and renal-risk factors	Improved contrast-related safety

MRI screening	Identification and verification of potentially incompatible devices	Reduced MRI-related risks
Radiation-safety practices	Support for justification and exposure optimization	Reduced unnecessary radiation exposure
Sedation monitoring	Early recognition of physiological deterioration	Improved procedural safety
Infection prevention	Maintenance of aseptic practices	Reduced infection risk
Post-procedural observation	Identification of complications during recovery	Improved continuity and safety of care
Documentation and handover	Accurate communication of clinical information	Improved coordination of care

Source: Author's synthesis.

3.7. Conceptual Framework of Nursing Interventions in Medical Imaging

The findings support a conceptual framework in which nursing interventions operate across three interconnected stages: pre-procedural preparation, intra-procedural care, and post-procedural management. These stages are supported by professional competency, evidence-based protocols, multidisciplinary communication, and adequate institutional resources.

Figure 1. Conceptual framework linking nursing interventions to patient safety and clinical outcomes in medical imaging

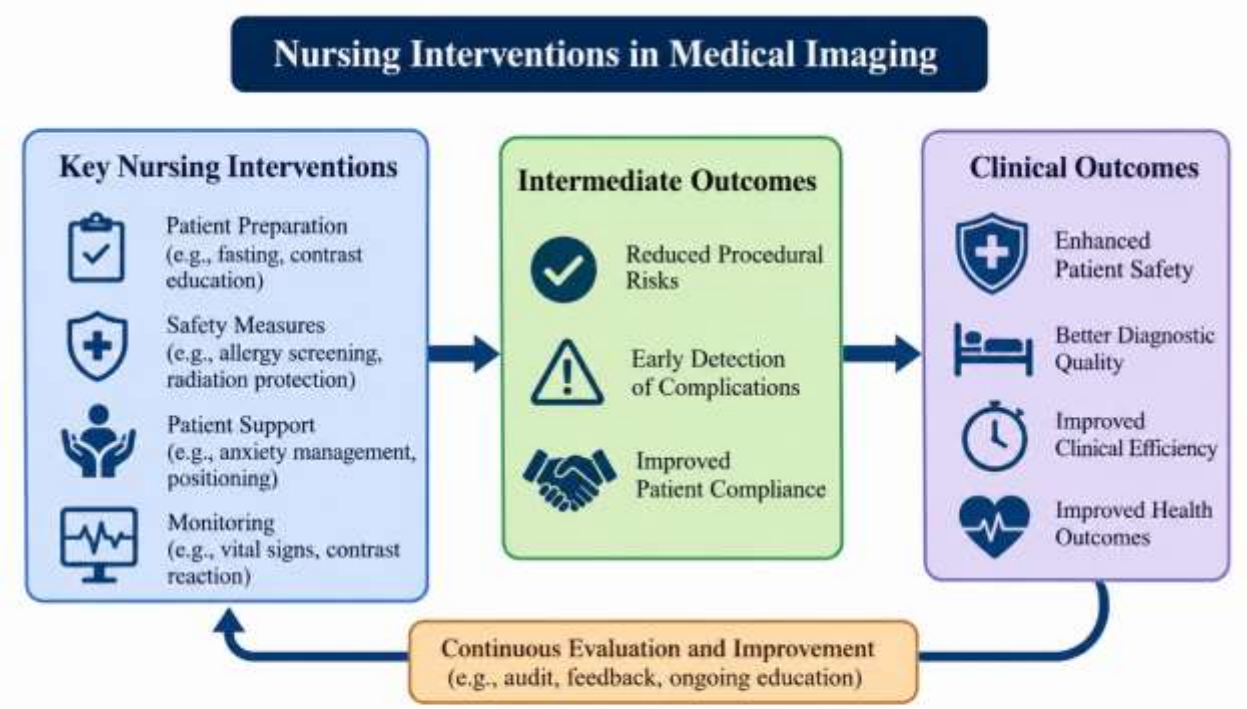

Figure 1. Conceptual framework linking nursing interventions to patient safety and clinical outcomes in medical imaging.

Source: Developed by the author from the thematic synthesis.

The framework illustrates that nursing interventions should not be understood as isolated activities but as interconnected processes that influence the quality of imaging services. Effective preparation establishes the foundation for safe procedures, while intra-procedural monitoring enables early identification of potential complications. Post-procedural care supports recovery and continuity of treatment. The effectiveness of these interventions is influenced by professional competence, institutional protocols, staffing, and multidisciplinary coordination.

3.8. Research Gaps and Future Directions

Despite the established importance of nursing interventions in medical imaging, several gaps remain in the available evidence. First, there is a shortage of nursing-specific empirical studies evaluating the direct relationship between individual nursing interventions and measurable clinical outcomes. Much of the available guidance originates from radiology organizations and multidisciplinary clinical recommendations. Although these sources provide valuable direction, they do not always establish the independent contribution of nursing interventions to observed outcomes (Loriato et al., 2023).

Second, there is a need for more comparative research examining the effectiveness of different patient-preparation approaches across imaging modalities. For example, additional studies could investigate whether structured

educational programmes, standardized preparation checklists, and individualized anxiety-management interventions improve patient cooperation and reduce examination interruptions.

Third, further research is required to evaluate nursing competencies in contrast-media safety, MRI screening, radiation protection, and procedural sedation. Competency-based training programmes should be assessed using measurable indicators, including knowledge acquisition, adherence to safety protocols, recognition of adverse events, and quality of documentation.

Fourth, limited evidence is available regarding the influence of staffing levels and institutional resources on imaging-related nursing outcomes, particularly in resource-constrained healthcare settings. This is important for healthcare systems where access to specialized radiology nurses, advanced monitoring equipment, and continuous professional development may be uneven.

Future research should therefore prioritize multicentre studies, prospective observational designs, controlled evaluations of nursing interventions, and standardized outcome measures. Particular attention should be given to patient safety incidents, procedural cancellations, patient anxiety, patient satisfaction, recovery outcomes, and the effectiveness of multidisciplinary communication.

4. Conclusion

Nursing interventions are fundamental to ensuring patient safety, effective preparation, and positive clinical outcomes in medical imaging procedures. This review demonstrates that nursing responsibilities extend across the entire imaging care pathway, encompassing pre-procedural assessment, patient identification, health education, psychological preparation, contrast-media risk assessment, MRI safety screening, radiation protection, infection prevention, procedural monitoring, and post-procedural recovery. The evidence indicates that structured nursing practices support patient preparedness, improve communication, facilitate early recognition of complications, and strengthen continuity of care. Particular importance is attached to specialized nursing competencies in contrast-enhanced imaging, interventional radiology, and procedures involving sedation, where effective monitoring and emergency preparedness are essential. Furthermore, patient-centred interventions, including clear communication, individualized education, and psychological support, contribute to improving the overall imaging experience. However, variations in institutional protocols, staffing, professional training, and resource availability continue to present challenges to consistent nursing practice. The review also identifies a need for additional nursing-specific empirical research to establish the effectiveness of individual interventions using standardized clinical and patient-reported outcomes. It is therefore recommended that healthcare institutions strengthen specialized radiology nursing education, implement standardized evidence-based protocols, improve multidisciplinary collaboration, and establish continuous quality-monitoring systems. Ultimately, integrating competent nursing interventions into medical imaging services is essential for promoting safer examinations, improving patient experiences, reducing preventable complications, and enhancing the overall quality of diagnostic and interventional healthcare.

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