

Contrast Media Allergic Reactions in Radiology: Nursing Protocols, Risk Detection, and the Emerging Role of Artificial Intelligence

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Abstract:

Contrast media are essential for enhancing the visualization of anatomical structures during radiological imaging procedures such as computed tomography (CT), magnetic resonance imaging (MRI), and angiography. However, their administration carries the risk of allergic reactions, ranging from mild symptoms such as urticaria and pruritus to severe, life-threatening anaphylactic responses. The detection, management, and prevention of these reactions are critical responsibilities of radiology nurses and are fundamental to ensuring patient safety.

This study aims to evaluate nursing strategies for the detection, management, and prevention of contrast media-induced allergic reactions, while also exploring the emerging role of biomedical technologies and artificial intelligence (AI) in enhancing patient safety. A mixed-methods approach was employed, including a systematic review of literature published between 2010 and 2024 and a cross-sectional survey of 150 radiology nurses across multiple healthcare institutions.

The systematic review revealed variability in premedication protocols, with corticosteroids and antihistamines widely used for high-risk patients. However, standardized patient screening procedures were inconsistently applied, with only 65% of institutions implementing formal risk assessment protocols. Survey findings indicated that 72% of nurses had encountered contrast media reactions, predominantly mild in severity, while only 50% expressed confidence in managing severe anaphylactic events.

In addition, the study highlights the growing role of biomedical innovations, such as smart monitoring systems, automated contrast injectors, and AI-driven predictive algorithms that identify high-risk patients based on clinical history, prior reactions, and comorbidities. These technologies have the potential to support early detection, optimize premedication strategies, and assist nurses in real-time clinical decision-making.

The findings emphasize the need for standardized nursing protocols, enhanced premedication strategies, and structured education programs, alongside the integration of AI-based risk prediction models and biomedical monitoring tools. Such advancements can significantly improve patient safety outcomes and reduce the incidence of adverse reactions to contrast media in radiological practice.

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Keywords: Contrast Media, Allergic Reactions, Radiology Nursing, Patient Safety, Pre-Medication, Screening Protocols, Nursing Education

How to cite this article: Khatak A, Shafi MU, Kumar TAA, Ganie RO, Saha S, Khan I, Bansal R. Contrast Media Allergic Reactions in Radiology: Nursing Protocols, Risk Detection, and the Emerging Role of Artificial Intelligence. *Int J Drug Deliv Technol.* 2026;16(20s): 841-850. DOI: 10.25258/ijddt.16.20s.83

1. Introduction

Contrast media, including iodinated contrast media and gadolinium-based contrast agents, are indispensable in modern radiological imaging techniques such as computed tomography (CT), magnetic resonance imaging (MRI), and angiography. These agents enhance the visualization of vascular structures, soft tissues, and organs, thereby facilitating accurate diagnosis and evaluation of a wide range of clinical conditions, including malignancies, vascular pathologies, and neurological disorders (Dastidar et al., 2018; Lee et al., 2020). Despite their diagnostic significance, the administration of contrast media is associated with the risk of adverse reactions, particularly allergic reactions. Contrast media-induced allergic reactions may range from mild manifestations, such as urticaria, pruritus, nausea, and vomiting, to severe and life-threatening conditions, including bronchospasm, hypotension, and anaphylactic shock (Wang et al., 2019; Martin et al., 2021). Epidemiological studies have reported that mild reactions occur in approximately 3–12% of patients, whereas severe reactions, including anaphylaxis, occur in less than 1% of cases (Blyth et al., 2020; Mody et al., 2019). Patients with predisposing factors such as a history of asthma, prior allergic reactions to contrast agents, or multiple allergies are considered at higher risk, necessitating vigilant screening and preventive strategies (Miller et al., 2020; Yang et al., 2022).

Radiology nurses play a pivotal role in ensuring patient safety during contrast-enhanced imaging procedures. Their responsibilities encompass pre-procedural patient assessment, identification of high-risk individuals, administration of premedication, continuous monitoring during and after contrast administration, and immediate management of adverse reactions (Smith & Johnson, 2020; Barnes et al., 2021). Additionally, nurses are instrumental in patient education, informing individuals about potential risks, procedural steps, and post-procedure precautions (Harris et al., 2018). Effective nursing interventions, including structured screening protocols, appropriate premedication using antihistamines and corticosteroids, and adherence to emergency response guidelines, are critical in minimizing the incidence and severity of contrast-

related reactions (Gonzalez et al., 2017; Reed et al., 2021).

In recent years, advancements in biomedical engineering and Artificial Intelligence in Healthcare have introduced innovative approaches to enhance patient safety in radiology. Technologies such as automated contrast injectors, real-time physiological monitoring systems, and AI-driven clinical decision support systems (CDSS) are increasingly being integrated into clinical workflows. These systems enable early detection of physiological changes, assist in identifying high-risk patients through predictive analytics, and support healthcare professionals—particularly nurses—in making timely and informed clinical decisions. AI-based risk prediction models, utilizing patient history, comorbidities, and prior reaction data, have shown potential in improving pre-procedural screening and reducing adverse events.

Despite the critical role of nurses and the emergence of advanced biomedical and AI technologies, there remains a lack of standardized protocols and uniform practices across healthcare institutions. Variability in screening procedures, inconsistencies in premedication protocols, and differences in nurse training and preparedness may contribute to suboptimal management of contrast media-induced reactions (Thompson et al., 2019; Patel & Lavoie, 2020; Schmidt et al., 2018; Larson et al., 2021). Furthermore, the integration of AI and biomedical tools into nursing practice is still in its early stages, with limited research evaluating their effectiveness in real-world radiology settings.

Therefore, there is a critical need to systematically evaluate current nursing practices, assess the effectiveness of existing protocols, and explore the role of emerging technologies in improving patient outcomes.

Aim and Objectives

The primary aim of this study is to assess nursing practices in the detection, management, and prevention of contrast media-induced allergic reactions in radiology departments, with a focus on enhancing patient safety through protocol optimization and technological integration.

Specific Objectives

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1. To evaluate the prevalence and types of contrast media–induced allergic reactions encountered by radiology nurses.
2. To examine the effectiveness of patient screening procedures and premedication protocols in preventing allergic reactions.
3. To assess the knowledge, training, and self-efficacy of nurses in managing severe allergic reactions, including anaphylaxis.
4. To explore the awareness and utilization of biomedical technologies and AI-based systems in supporting clinical decision-making and patient monitoring.
5. To identify gaps in current practices and propose standardized, technology-integrated strategies for improving patient safety.

2. Literature Review

1. Gonzalez et al. (2017) – Premedication Strategies for Preventing Contrast-Induced Allergic Reactions

Gonzalez et al. (2017) evaluated the effectiveness of premedication protocols involving antihistamines and corticosteroids in high-risk patients. The study reported that premedication significantly reduced the incidence of mild allergic reactions; however, severe reactions, including anaphylaxis, were not completely prevented. This finding highlights the limitations of current pharmacological preventive strategies and emphasizes the need for improved or adjunctive approaches, including enhanced monitoring and risk prediction systems.

2. Jackson & Reid (2019) – Risk Assessment and Screening Importance

Jackson and Reid (2019) emphasized the critical role of comprehensive patient screening prior to contrast administration. Their study demonstrated that structured screening protocols, including detailed history-taking of prior allergies, asthma, and comorbidities, significantly reduced the incidence of adverse reactions. The authors concluded that screening should extend beyond basic history to include standardized risk assessment tools to improve patient outcomes.

3. Harris et al. (2018) – Nursing Education and Risk Management

Harris et al. (2018) focused on nurses' preparedness to identify and manage contrast-induced allergic reactions. The study revealed that while nurses were generally confident in recognizing mild reactions, a considerable proportion lacked confidence in managing severe reactions such as anaphylaxis. The authors

recommended enhanced training programs, simulation-based learning, and continuous professional development to improve emergency response capabilities.

4. Schmidt et al. (2018) – Impact of Inconsistent Protocols

Schmidt et al. (2018) investigated variability in institutional protocols for managing contrast media reactions. Their findings showed significant inconsistencies in screening, premedication, and emergency response practices across healthcare facilities. Institutions with standardized protocols demonstrated better patient outcomes, reinforcing the importance of uniform guidelines to ensure consistent and effective care.

5. Martin et al. (2021) – Emergency Management of Anaphylaxis in Radiology

Martin et al. (2021) reviewed emergency response protocols for managing severe allergic reactions in radiology departments. Although most institutions had established emergency guidelines, their effectiveness was compromised by irregular implementation and insufficient training. The study emphasized the importance of regular emergency drills and competency-based training to improve nurse readiness in critical situations.

6. Wang et al. (2019) – Clinical Spectrum of Contrast Media Reactions

Wang et al. (2019) analyzed the clinical presentation and severity of contrast-induced allergic reactions. The study categorized reactions into mild, moderate, and severe, highlighting that early identification of symptoms such as urticaria and dyspnea is crucial for preventing progression to life-threatening conditions. The findings support the role of vigilant nursing monitoring during and after contrast administration.

7. Miller et al. (2020) – Risk Factors Associated with Contrast Reactions

Miller et al. (2020) identified key risk factors for contrast media hypersensitivity, including prior contrast reactions, asthma, and multiple drug allergies. The study emphasized the need for targeted risk stratification and individualized patient management plans. This aligns with the growing importance of predictive models in identifying high-risk patients.

8. Reed et al. (2021) – Effectiveness of Premedication Protocols

Reed et al. (2021) evaluated different premedication regimens and their effectiveness in preventing allergic

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reactions. While premedication reduced mild-to-moderate reactions, it did not eliminate the risk of severe reactions. The authors suggested combining pharmacological strategies with improved monitoring and early intervention protocols to enhance patient safety.

9. Larson et al. (2021) – Variability in Nursing Practices
Larson et al. (2021) explored differences in nursing practices across radiology departments. The study found variability in knowledge, training, and adherence to protocols, which influenced the management of contrast reactions. The authors recommended standardized training modules and institutional guidelines to reduce variability and improve care quality.

10. Lee et al. (2020) – Emerging Role of AI and Biomedical Technologies in Radiology Safety
Lee et al. (2020) highlighted the integration of Artificial Intelligence in Healthcare and biomedical technologies in radiology. The study demonstrated that AI-based predictive models can analyze patient data, including medical history and prior reactions, to identify individuals at high risk of contrast-induced allergic reactions. Additionally, smart monitoring systems and automated injectors enhance real-time patient surveillance, enabling early detection and rapid intervention. These advancements provide significant support to nursing practice and improve overall patient safety.

3. Methods

3.1 Systematic Literature Review

3.1.1 Objective

The objective of the systematic literature review was to critically analyse and synthesise existing evidence on the management of contrast media-induced allergic reactions, with a particular focus on nursing practices, premedication strategies, patient screening, and emergency response protocols. Additionally, the review aimed to explore emerging contributions of biomedical technologies and Artificial Intelligence in Healthcare in improving patient safety. The review sought to identify best practices, existing gaps, and areas requiring improvement in nursing education and clinical protocols.

3.1.2 Search Strategy

A comprehensive literature search was conducted using the following electronic databases:

- PubMed
- CINAHL

Scopus

The search included peer-reviewed articles published between 2010 and 2025. The following keywords and Boolean combinations were used: “contrast media,” “allergic reactions,” “radiology nursing,” “premedication,” “screening,” “emergency management,” “patient safety,” “biomedical monitoring,” and “artificial intelligence.”

Studies were included if they focused on nursing practices, management protocols, or technological interventions related to contrast-induced allergic reactions. Studies unrelated to allergic reactions (e.g., purely imaging techniques) were excluded.

3.1.3 Inclusion and Exclusion Criteria

Inclusion Criteria:

• Studies published between 2010 and 2025

• Peer-reviewed journal articles

• Research focused on contrast media-induced allergic reactions in radiology settings

• Studies evaluating nursing practices, protocols, premedication, screening, or education

• Studies involving biomedical systems or AI-based applications in patient safety

Exclusion Criteria:

• Studies not focused on radiology nursing or allergic reactions

• Non-English publications

• Conference abstracts, editorials, and opinion articles

• Studies unrelated to patient safety or clinical management

3.1.4 Data Extraction

Data were extracted using a structured data extraction form. Key variables included:

• Study design and methodology

• Sample size and study setting

• Nursing roles and practices

• Screening and risk assessment protocols

• Premedication strategies

• Emergency response measures

• Educational interventions

• Use of biomedical tools and AI-based systems

Special emphasis was placed on identifying findings related to early detection, prevention strategies, and clinical outcomes. The methodological quality of included studies was also assessed to ensure reliability and validity of the synthesized evidence.

3.1.5 Data Synthesis

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The selected studies were synthesised using a thematic analysis approach. Common themes identified included:

- Variability in nursing protocols
- Effectiveness of premedication strategies
- Importance of structured screening
- Gaps in nurse training and preparedness
- Emerging role of biomedical monitoring and AI-based risk prediction

This synthesis provided a comprehensive overview of current practices and highlighted areas requiring further research and standardisation.

3.2 Cross-Sectional Survey of Radiology Nurses

3.2.1 Objective

The objective of the survey was to collect primary data on radiology nurses’ experiences, knowledge, and practices in managing contrast media-induced allergic reactions. The study also aimed to assess nurses’ awareness and perception of biomedical technologies and AI-assisted tools in clinical practice.

3.2.2 Survey Design

A self-administered, anonymous online questionnaire was developed to collect both quantitative and qualitative data.

The questionnaire consisted of the following sections:

1. Demographics
 - Age, years of experience, educational qualification, and workplace setting
2. Nursing Practices
 - Patient screening procedures
 - Premedication administration
 - Monitoring and management of allergic reactions
3. Protocol Adherence
 - Use of institutional guidelines
 - Emergency response preparedness
4. Education and Training
 - Frequency of training programs
 - Awareness of emergency protocols
 - Simulation-based learning exposure
5. Knowledge and Self-Efficacy
 - Confidence in identifying and managing reactions, including anaphylaxis
 - Measured using a Likert scale (1–5)
6. Technology and AI Awareness
 - Familiarity with automated contrast injectors
 - Use of monitoring systems
 - Awareness of AI-based clinical decision support tools

3.2.3 Sampling Technique

A convenience sampling method was used to recruit participants from multiple hospitals and diagnostic imaging centres.

Eligible participants included:

- Registered radiology nurses
- Nurses directly involved in contrast media administration

Participation was voluntary, and recruitment was conducted via email invitations containing a survey link.

3.2.4 Data Collection Procedure

Data collection was conducted over a 4-week period.

- Participants completed the survey online (15–20 minutes duration)

Reminder emails were sent after two weeks to improve response rate

Data were collected through a secure digital platform ensuring anonymity

3.2.5 Data Analysis

Quantitative data were analysed using SPSS (Version 28), while qualitative data were analysed using NVivo (Version 12).

Statistical Methods Included:

- Descriptive statistics (frequency, percentage, mean, standard deviation)
- Likert scale analysis for self-efficacy
- Comparative analysis where applicable

Qualitative responses were analysed using thematic coding to identify patterns related to nursing practices, protocol adherence, and training needs.

3.2.6 Ethical Considerations

- Ethical approval was obtained from the Institutional Review Board (IRB)
- Informed consent was obtained from all participants
- Participation was voluntary
- Confidentiality and anonymity were strictly maintained
- Data were securely stored and used only for research purposes

3.3 Integration of Literature Review and Survey Findings

The findings from the systematic literature review and cross-sectional survey were integrated to provide a comprehensive understanding of current nursing practices in managing contrast media-induced allergic reactions.

The literature review offered an evidence-based framework, while the survey provided real-world insights from radiology nurses. This combined approach enabled:

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- Identification of best practices
 - Recognition of gaps in protocol implementation
 - Evaluation of training and educational needs
 - Assessment of the potential role of biomedical technologies and AI in improving patient safety
- This integrative analysis strengthens the study by bridging the gap between theoretical evidence and clinical practice, thereby contributing to improved standards in radiology nursing care.

4. Results

4.1 Findings from Systematic Literature Review

A total of 25 peer-reviewed studies published between 2010 and 2025 were included in the systematic literature review. These studies were analyzed to evaluate nursing practices in the prevention, detection, and management of contrast media-induced allergic reactions. Thematic synthesis of the selected literature revealed five major domains: premedication protocols, screening practices, nursing education and preparedness, emergency response systems, and emerging biomedical and AI-based interventions.

4.1.1 Premedication Protocols

The reviewed studies consistently reported the use of corticosteroids and antihistamines as the primary pharmacological agents for premedication in patients identified as high-risk for allergic reactions. These patients typically included those with a history of previous contrast reactions, asthma, or multiple drug allergies.

However, a significant finding across the literature was the lack of uniformity in premedication regimens. Variations were observed in:

- Drug combinations (single vs combination therapy)
- Dosage levels
- Timing of administration (e.g., 12-hour vs rapid premedication protocols)

Approximately 70% of institutions had some form of premedication protocol (Smith & Johnson, 2020). Despite this, there was no consensus regarding optimal regimens, and practices varied widely across institutions.

Importantly, several studies, including Gonzalez et al. (2017), concluded that while premedication is effective in reducing mild hypersensitivity reactions, it does not reliably prevent severe reactions such as anaphylaxis. This suggests that reliance solely on pharmacological prophylaxis is insufficient and highlights the need for

multi-layered preventive strategies, including enhanced screening and monitoring.

4.1.2 Screening Protocols

Screening protocols were identified as a critical component of patient safety; however, their implementation was found to be inconsistent across healthcare settings. Less than 60% of institutions had formalized and standardized screening procedures (Jackson & Reid, 2019).

Where screening protocols were present, their scope varied significantly:

Basic screening (history of allergies only)

Moderate screening (including comorbidities such as asthma)

Comprehensive screening (risk stratification tools and checklists)

The lack of standardization leads to inconsistent identification of high-risk patients, potentially increasing the likelihood of adverse reactions. The literature strongly supports the implementation of structured and standardized screening tools to improve risk assessment and clinical preparedness.

4.1.3 Nursing Education and Preparedness

A recurring theme across studies was the disparity in nurses' preparedness to manage allergic reactions. While nurses demonstrated strong competence in identifying and managing mild reactions, confidence significantly decreased when dealing with severe reactions.

Approximately 50% of nurses reported feeling inadequately prepared to manage life-threatening emergencies such as anaphylaxis (Harris et al., 2018). This gap was attributed to:

- Limited exposure to severe cases in routine practice

- Infrequent simulation-based training

- Lack of structured competency assessment programs

These findings highlight the importance of continuous professional development, including simulation training and emergency preparedness programs.

4.1.4 Emergency Response Protocols

Most radiology departments (approximately 85%) reported having established emergency response protocols for severe allergic reactions (Martin et al., 2021). These protocols typically included:

- Immediate discontinuation of contrast administration

- Administration of emergency medications (e.g., epinephrine)

- Activation of emergency response teams

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Despite their availability, the effectiveness of these protocols was limited due to:

- Lack of regular training and drills
- Inconsistent adherence to protocols
- Variable levels of nurse competency

This suggests that protocols alone are insufficient; regular reinforcement and practical training are essential for effective implementation.

4.1.5 Role of Biomedical and AI Technologies

Recent studies have highlighted the integration of biomedical monitoring systems and Artificial Intelligence in Healthcare in enhancing patient safety during contrast administration.

These technologies provide several advantages:

- Real-time physiological monitoring (e.g., heart rate, oxygen saturation)
 - Automated contrast delivery systems for precise dosing
 - AI-based risk prediction models that analyze patient history and identify high-risk individuals
 - Clinical decision support systems (CDSS) that assist healthcare professionals in making timely decisions
- Although these innovations show significant potential, their clinical adoption remains limited, and further research is required to evaluate their effectiveness in routine radiology practice.

4.2 Findings from Cross-Sectional Survey

A total of 150 radiology nurses participated in the survey, representing diverse healthcare settings, including tertiary hospitals, diagnostic imaging centers, and outpatient facilities. The survey provided valuable insights into current clinical practices, experiences, and knowledge and training gaps.

4.2.1 Prevalence and Nature of Allergic Reactions

Many respondents (72%) reported encountering contrast media-induced allergic reactions during their clinical practice. Among these:

- 58% reported mild reactions such as rash, itching, and nausea
 - 14% reported severe reactions, including anaphylaxis
 - 28% reported no experience with such reactions
- These findings indicate that although allergic reactions are relatively common, the majority are mild.

Table 4.1: Distribution of Allergic Reactions

Reaction Category	Type of Reaction	Frequency (n=150)	Percentage (%)
Mild Reactions	Rash, itching, nausea	87	58%
Severe	Anaphylaxis,	21	14%

Reactions	bronchospasm		
No Reactions	None observed	42	28%

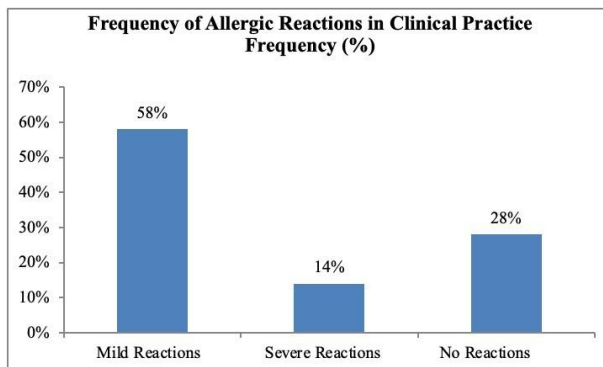


Figure 1: The most frequent rate at which nurses identified experiencing allergy reactions was mild (58%), while severe reactions, such as anaphylaxis, were experienced at a significantly lower rate (14%).

4.2.2 Screening Practices

68% of nurses reported that their departments implemented pre-contrast screening protocols. However, only 50% indicated that these protocols were standardized, highlighting variability in practice.

Table 4.2: Screening Protocol Practices

Screening Practice	Frequency	Percentage (%)
Screening Protocol Available	102	68%
No Screening Protocol	48	32%
Standardized Protocol	75	50%
Non-standardized Protocol	75	50%

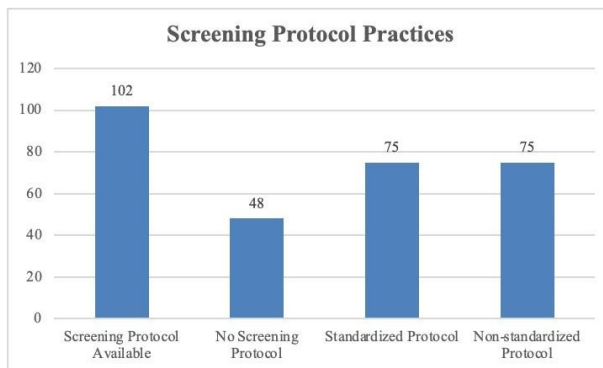


Figure 4.2: Availability and Standardization of Screening Protocols for Contrast Media Administration

4.2.3 Premedication Practices

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Premedication was routinely administered by 54% of nurses, primarily using corticosteroids and antihistamines. However, 42% reported that their protocols were not evidence-based, suggesting inconsistent clinical decision-making.

Table 4.3: Premedication Practices

Premedication Practice	Frequency	Percentage (%)
Routine Premedication Used	81	54%
No Premedication Used	69	46%
Evidence-Based Protocol	87	58%
Non-Evidence-Based Protocol	63	42%
Alternative Strategies Used	42	28%

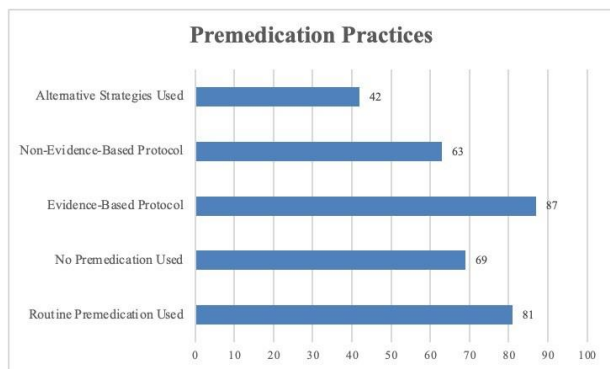


Figure 4.3: Analysis of Premedication Strategies for Preventing Contrast Media Reactions

4.2.4 Nursing Confidence and Training

A significant disparity was observed in nurses' confidence levels:

- 80% were confident in managing mild reactions
- Only 50% felt confident managing severe reactions such as anaphylaxis

Table 4.4: Nursing Confidence Levels

Confidence Level	Mild Reactions (%)	Severe Reactions (%)
Very Confident	45%	25%
Somewhat Confident	35%	25%
Not Confident	20%	50%

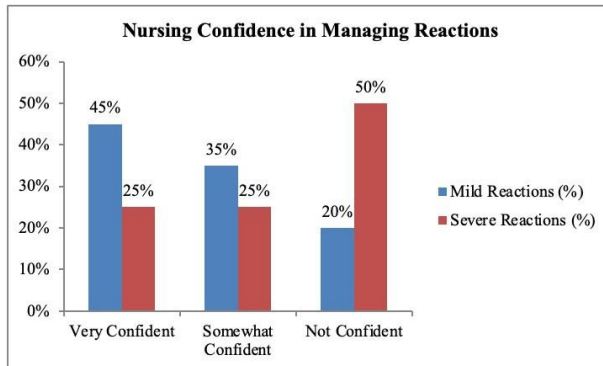


Figure 3: Nurses were more confident in managing mild reactions (80% overall confidence), while only 50% felt adequately prepared to handle severe reactions such as anaphylaxis.

Further analysis revealed training gaps:

Table 4.5: Training and Preparedness

Training Component	Yes (%)	No (%)
Training for Mild Reactions	80%	20%
Training for Severe Reactions	50%	50%
Exposure to Emergency Drills	45%	55%
Familiarity with Protocols	70%	30%

4.2.5 Awareness of Biomedical and AI Technologies

Awareness of advanced technologies was variable:

Table 4.6: Awareness of Biomedical and AI Systems

Technology Component	Aware (%)	Not Aware (%)
Automated Injectors	60%	40%
Monitoring Systems	72%	28%
AI Risk Prediction	35%	65%
CDSS	40%	60%

4.3 Integration of Findings

Table 4.7: Comparative Analysis

Parameter	Literature	Survey	Interpretation
Premedication	Reduces mild reactions	54% usage	Needs standardization
Screening	Limited standardization	50% standardized	Variable practice
Confidence	Low in severe cases	50% confident	Training gap
Emergency Protocol	Available	Underutilized	Need drills
Technology	Emerging	Low awareness	Future scope

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The findings demonstrate that while current nursing practices are effective in managing mild contrast reactions, there are significant gaps in:

- Standardization of protocols
 - Preparedness for severe reactions
 - Evidence-based clinical practices
 - Adoption of advanced biomedical and AI technologies
- These gaps highlight the urgent need for integrated, technology-supported, and standardized nursing approaches to improve patient safety outcomes.

5. Discussion

The findings of the present study, derived from both the systematic literature review and the cross-sectional survey, provide a comprehensive evaluation of current nursing practices in the management of contrast media-induced allergic reactions. The results are largely consistent with existing literature while also extending current knowledge by highlighting gaps in protocol standardization, training, and the integration of advanced biomedical and Artificial Intelligence in Healthcare technologies. The study emphasizes the critical role of radiology nurses in ensuring patient safety during contrast-enhanced imaging procedures and underscores the need for improvements in both clinical practice and healthcare systems.

The survey findings revealed that a substantial proportion of nurses (72%) had encountered allergic reactions to contrast media in their clinical practice. This aligns with previous studies, including Shankar et al. (2021), and confirms that such reactions are relatively common in radiology settings. Most of these reactions were mild, including rash, itching, and nausea, consistent with the findings of Jackson and Reid (2019), who reported that mild hypersensitivity reactions are significantly more frequent than severe ones. However, despite the lower incidence of severe reactions, the presence of life-threatening conditions such as anaphylaxis cannot be overlooked. Even though these events are rare, their potential severity necessitates a high level of preparedness and rapid response from healthcare professionals, particularly nurses who are often the first responders in such situations.

A key finding of this study is the disparity in nurses' confidence levels when managing mild versus severe allergic reactions. While 80% of nurses reported confidence in managing mild reactions, only 50% felt

adequately prepared to handle severe reactions. This finding is consistent with Harris et al. (2018), who highlighted that many nurses lack confidence in managing life-threatening emergencies due to insufficient training and limited exposure to such situations. This preparedness gap is particularly concerning given the critical nature of severe reactions, where delayed or inadequate intervention can result in serious patient outcomes. The findings suggest that the mere presence of emergency protocols is insufficient; rather, practical, hands-on training is needed to ensure effective implementation. Simulation-based training, as recommended by Martin et al. (2021), is a highly effective strategy to bridge this gap, enabling nurses to practice emergency responses in controlled yet realistic scenarios, thereby improving both confidence and clinical competence.

The study also identified significant variability in screening practices across institutions. Although 68% of nurses reported the presence of pre-contrast screening protocols, only 50% indicated that these protocols were standardized. This lack of uniformity reflects inconsistencies in clinical practice and supports the findings of Jackson and Reid (2019) and Gonzalez et al. (2017), who emphasized that inadequate and inconsistent screening processes can lead to poor identification of high-risk patients. Effective screening is a fundamental component of preventive care, as it enables early detection of patients at increased risk of allergic reactions. The absence of standardized screening tools can result in missed risk factors, thereby increasing the likelihood of adverse events. Therefore, the development and implementation of comprehensive, standardized screening protocols are essential to improve patient safety and ensure consistency in care delivery across healthcare institutions.

Premedication practices also varied significantly among respondents. While 54% of nurses reported routinely administering premedication, only 42% indicated that their protocols were evidence-based. This finding highlights a critical gap between clinical practice and scientific evidence and is consistent with the observations of Schmidt et al. (2018), who noted the lack of consensus regarding optimal premedication regimens. Although corticosteroids and antihistamines are commonly used for high-risk patients, their effectiveness in preventing severe reactions remains uncertain. The continued reliance on non-standardized and potentially non-evidence-based protocols suggests

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the need for further research to establish clear guidelines and optimize preventive strategies. Additionally, alternative approaches, such as individualized risk assessment and non-contrast imaging for high-risk patients, should be explored to enhance patient safety.

Another important aspect highlighted by the study is the gap between the availability of emergency protocols and their effective implementation. Although most institutions reported having emergency response guidelines, many nurses indicated they were not adequately prepared to apply them in real-life situations. This discrepancy can be attributed to factors such as lack of regular training, limited exposure to emergency scenarios, and absence of structured competency assessments. These findings underscore the importance of not only developing protocols but also ensuring their practical applicability through continuous training and evaluation.

The study also explored the role of emerging biomedical technologies and Artificial Intelligence in Healthcare in enhancing patient safety. While awareness of basic monitoring systems was relatively high, the adoption of AI-based tools, such as predictive risk models and clinical decision support systems, was limited. These technologies have the potential to transform radiology practice by enabling early detection of physiological changes, improving risk stratification, and supporting clinical decision-making. AI-driven systems can analyze patient data, including medical history and prior reactions, to identify high-risk individuals and recommend appropriate preventive measures. Despite these advantages, their limited implementation suggests the presence of barriers such as lack of training, infrastructure, and awareness. Integrating these technologies into routine practice could significantly enhance the efficiency and effectiveness of nursing care, ultimately improving patient outcomes.

Overall, this study's findings highlight several critical areas for improvement in the management of contrast media-induced allergic reactions. While current practices are generally effective in managing mild reactions, there are significant gaps in preparedness for severe reactions, standardization of protocols, and adoption of advanced technologies. Addressing these challenges requires a multifaceted approach, including the development of evidence-based guidelines, implementation of standardized screening and premedication protocols, enhancement of nurse training through simulation-based programs, and integration of

biomedical and AI-driven systems into clinical workflows. By addressing these gaps, healthcare institutions can significantly improve patient safety and more effectively manage contrast media-induced allergic reactions in radiology settings.

7. Conclusion

This study concludes that contrast media-induced allergic reactions remain an important patient safety concern in radiology practice and that radiology nurses play a central role in their prevention, early detection, and management. The findings showed that allergic reactions to contrast media are commonly encountered in clinical settings, although the majority are mild, such as rash, itching, and nausea. Severe reactions, including anaphylaxis, occur less frequently, but their potentially life-threatening nature makes prompt recognition and effective intervention essential. In this context, the role of the nurse extends beyond routine patient care to include risk assessment, patient education, monitoring during contrast administration, and immediate emergency response when adverse reactions occur.

The study further demonstrated that, although many institutions have screening and premedication practices in place, there is considerable variability in how these protocols are implemented. This lack of standardization may compromise the consistent identification of high-risk patients and reduce the effectiveness of preventive strategies. Premedication with corticosteroids and antihistamines is widely used, particularly for patients with a history of allergies or prior contrast reactions, but the evidence supporting these regimens remains inconsistent, especially in relation to the prevention of severe reactions. Therefore, the findings indicate the need for more standardized, evidence-based approaches to screening and premedication in radiology departments.

An important conclusion from this study is that nurses are generally confident in managing mild allergic reactions but are less prepared to handle severe, life-threatening emergencies such as anaphylaxis. This gap in confidence and preparedness appears to be strongly linked to insufficient hands-on training, limited exposure to severe reactions, and irregular emergency drills. The study therefore emphasizes that the presence of emergency protocols alone is not enough; these protocols must be reinforced through regular simulation-based education, skill development programs, and competency assessments to ensure that

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nurses can respond rapidly and effectively in critical situations.

The study also highlights the growing significance of biomedical technologies and artificial intelligence in improving patient safety related to contrast media administration. Tools such as automated contrast injectors, real-time physiological monitoring systems, and AI-based risk prediction models have the potential to enhance nursing decision-making, identify high-risk patients more accurately, and support early intervention. Although awareness and use of these technologies are still limited in many radiology settings, their future integration into routine nursing practice may significantly strengthen preventive and emergency care. Overall, this study concludes that improving patient safety in contrast-enhanced radiological procedures requires a multifaceted strategy involving standardized protocols, stronger evidence-based practices, continuous nurse education, and the integration of advanced biomedical and AI-supported systems. Strengthening these areas will not only enhance the competence and confidence of radiology nurses but also reduce the risk of adverse outcomes and improve the quality and safety of care delivered to patients undergoing imaging procedures involving contrast media.

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