



การประเมินปฏิกิริยาภูมิไวเกินที่สัมพันธ์กับความแตกต่าง ของสารทึบรังสีชนิดไม่ใช่อิโอดีนในโรงพยาบาลตติยภูมิ: การศึกษาตามรุ่นย้อนหลัง

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Evaluation of Hypersensitivity Reactions Associated with Different Non-Iodinated Contrast Media (NICM) at a Tertiary Care Hospital: A Retrospective Cohort Study

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บทคัดย่อ

ภูมิหลังและวัตถุประสงค์: สารทึบรังสีที่ไม่มีส่วนประกอบของไอโอดีนถูกใช้อย่างแพร่หลายในเครื่องเอกซเรย์คอมพิวเตอร์ เพื่อเพิ่มความชัดเจนในการถ่ายภาพโครงสร้างภายในร่างกาย แม้ว่าสารทึบรังสีที่ไม่มีส่วนประกอบของไอโอดีนจะช่วยลดการเกิดปฏิกิริยาภูมิไวเกิน เมื่อเปรียบเทียบกับชนิดที่มีประจุแบบเดิม แต่เหตุการณ์ไม่พึงประสงค์ เช่น ผื่น ลมพิษ และในกรณีพบได้ไม่บ่อยอย่างภาวะช็อกจากการแพ้ นั้น ยังคงมีความสำคัญทางคลินิก การศึกษานี้มีวัตถุประสงค์ เพื่อประเมินอุบัติการณ์ ลักษณะทางคลินิก และความรุนแรงของการเกิดปฏิกิริยาภูมิไวเกินที่เกี่ยวข้องกับความแตกต่างของสารทึบรังสีที่ไม่มีส่วนประกอบของไอโอดีน

วิธีการศึกษา: เป็นการศึกษาแบบย้อนหลังในกลุ่มตัวอย่างที่เข้ารับการตรวจวินิจฉัยโดยใช้เอกซเรย์คอมพิวเตอร์ที่ใช้สารทึบรังสี ช่วงวันที่ 1 มกราคม พ.ศ. 2564 ถึง 31 ธันวาคม พ.ศ. 2566 ทั้งนี้ทำการประเมินการเกิดปฏิกิริยาภูมิไวเกินแบบเฉียบพลันตามเกณฑ์ Naranjo algorithm ใช้สถิติเชิงพรรณนาเพื่อบรรยายลักษณะผู้ป่วยและการเกิดปฏิกิริยาภูมิไวเกิน และ Fisher's exact test เพื่อเปรียบเทียบความแตกต่างของความรุนแรงระหว่างสารทึบรังสีชนิดต่าง ๆ

ผลการศึกษา: ผู้ป่วยจำนวน 412 ราย (เพศชาย ร้อยละ 42.50; อายุมัธยฐาน 60 ปี, พิสัยระหว่างควอไทล์ 52–67) ส่วนใหญ่มีการทำงานของไตปกติหรือบกพร่องเล็กน้อย มีการใช้สารทึบรังสีที่ไม่มีส่วนประกอบของไอโอดีน 7 ชนิด โดยการเกิดปฏิกิริยาภูมิไวเกิน ส่วนใหญ่เป็นผื่นผิวหนังระดับเล็กน้อยถึงปานกลาง เช่น ผื่นคันและลมพิษ อาการระดับรุนแรง เช่น anaphylaxis และ angioedema พบเพียง 8 ราย โดยอุบัติการณ์การเกิดปฏิกิริยาภูมิไวเกิน สูงสุดพบใน iomeprol (ร้อยละ 100.00), iohexol (ร้อยละ 88.60), และ iobitridol (ร้อยละ 88.00) ซึ่งไม่พบความแตกต่างของระดับความรุนแรงอย่างมีนัยสำคัญทางสถิติระหว่าง

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สารทึบรังสีแต่ละชนิด ($p > 0.05$) นอกจากนี้ผลการประเมินด้วย Naranjo algorithm พบว่าส่วนใหญ่ถูกจัดอยู่ในระดับ “น่าจะใช่” หรือ “อาจจะใช่”

สรุป: การเกิดปฏิกิริยาภูมิไวเกินต่อสารทึบรังสีที่ไม่มีส่วนประกอบของไอโอดีน ส่วนใหญ่มีความรุนแรงในระดับเล็กน้อย และมักแสดงออกในลักษณะอาการทางผิวหนังเป็นหลัก ขณะที่อาการระดับปานกลางและรุนแรงพบได้น้อย แต่มีความสำคัญทางคลินิก แม้ว่าจะพบความแตกต่างของการเกิดปฏิกิริยาภูมิไวเกินระหว่างสารทึบรังสีที่ไม่มีส่วนประกอบของไอโอดีนแต่ละชนิด แต่ก็ไม่พบความสัมพันธ์อย่างมีนัยสำคัญทางสถิติระหว่างชนิดของสารทึบรังสีกับความรุนแรงของอาการแพ้

คำสำคัญ: สารทึบรังสีที่ไม่มีส่วนประกอบของไอโอดีน, ปฏิกิริยาภูมิไวเกิน, อาการไม่พึงประสงค์จากยา, Naranjo algorithm, เอกซเรย์คอมพิวเตอร์

Abstract

Background and objective: Non-ionic iodinated contrast media (NICM) are widely used in computed tomography (CT) to enhance imaging of internal structures. Although NICMs reduce hypersensitivity reactions (HSRs) compared with conventional ionic formulations, adverse events including rash, urticaria, and rarely anaphylaxis remain clinically important. This study aimed to evaluate the incidence, clinical characteristics, and severity of HSRs associated with various NICMs.

Methods: A retrospective cohort study included patients undergoing contrast-enhanced CT between January 1, 2021, and December 31, 2023. Immediate HSRs were assessed using the Naranjo algorithm. Descriptive statistics summarized demographics and HSR features, and Fisher’s exact test evaluated differences in severity between contrast agents.

Results: Among 412 patients (42.5% male; median age 60 years, IQR 52–67), most had normal or mildly impaired renal function. Seven NICMs were used. HSRs were predominantly mild-to-moderate cutaneous reactions, mainly rash with itching and urticaria. While anaphylaxis and angioedema were observed in only eight patients. Highest HSR incidences were observed with iomeprol (100.00%), iohexol (88.60%), and iobitridol (88.00%) which severity distribution did not differ significantly among NICMs ($p > 0.05$). In addition, most reactions were classified as “probable” or “possible” by the Naranjo algorithm.

Conclusion: HSR to NICMs were predominantly mild and largely limited to cutaneous manifestations, while moderate and severe reactions are rare but clinically significant. Although numerical differences in reaction rates were observed among individual contrast agents, no statistically significant association was identified between type of contrast media and severity.

Keywords: non-ionic iodinated contrast media, hypersensitivity reactions, adverse drug reaction, Naranjo algorithm, computed tomography

Introduction

At the present, iodinated contrast media (ICM) are widely used in diagnostic imaging, particularly in techniques like X-rays-based modalities such as computed tomography (CT) scans, to enhance the visibility of internal organs. Iodine attenuates X-rays, thereby increasing image contrast and improving the detection of pathological conditions, including tumors, vascular occlusions, and structural abnormalities [1]. Despite their clinical utility, the administration of ICM is associated with adverse drug reactions (ADRs), which remain an important safety concern in radiological practice.

The incidence and severity of hypersensitivity reactions (HSRs) vary according to the physicochemical properties of contrast media (CM), particularly their chemical structure (ionic versus non-ionic) and osmolality (high-, low-, or iso-osmolar). Historically, ionic high-osmolar contrast media (HOCM) were associated with a higher frequency of adverse effects, including warmth sensation, nausea, vomiting, hemodynamic instability, and severe HSRs. These agents exert significant osmotic effects by shifting water from intracellular and interstitial compartments into the intravascular space, leading to transient plasma volume expansion, increased cardiac workload, elevated blood pressure, and potential renal injury. In contrast, low-osmolar contrast media (LOCM) and iso-osmolar contrast media (IOCM), which lack ionic dissociation and more closely approximate plasma osmolality, demonstrate a more favorable safety profile and a lower overall incidence of ADRs. Previous studies have reported that patients receiving ionic CM had a higher incidence of HSRs (4.17–12.66%) compared with those receiving non-ionic CM (NICM) (0.69–3.13%) [2-4]. Although the introduction of NICM has substantially reduced the incidence of immediate reactions, measurable rates of HSRs still occur. Immediate cutaneous reactions—such as urticaria, rash, and pruritus—have been reported in approximately 0.12% to 1.15% of exposures, depending on patient population and contrast agent used.

In the evaluation of suspected contrast-related ADRs, structured causality assessment tools are frequently applied to determine the likelihood of an association between contrast exposure and clinical manifestations. One widely used method is the Naranjo algorithm, a standardized questionnaire consisting of ten criteria that assess temporal relationship, alternative causes, drug levels, dose–response relationships, and previous patient experience with the agent. The total score categorizes the reaction as definite, probable, possible, or doubtful. Although rechallenge is rarely feasible in CM reactions due to ethical and safety concerns, the Naranjo algorithm remains a practical and reproducible method to support causality assessment. According to the American College of Radiology (ACR) manual on CM [5], ADRs are classified into three severity grades: mild, moderate, and severe. Mild reactions are self-limited and include limited urticaria, pruritus, and localized cutaneous edema. Moderate reactions are more pronounced and typically require medical intervention, such as diffuse urticaria, facial edema without dyspnea, bronchospasm, wheezing, or mild hypoxia. Severe reactions are life-threatening and may result in permanent morbidity or mortality if not promptly managed. These include severe bronchospasm, significant hypoxia, hypotension, hypertensive crisis, and anaphylactic shock [6-7]. Most contrast-related ADRs are immediate reactions, occurring within one hour—commonly within the first 30 minutes—after intravenous administration [8]. Approximately 70% develop within the first five minutes. In contrast, non-immediate (delayed) cutaneous reactions typically present from several hours up to one week after exposure [2,5,9].

Despite the widespread use of NICM, comparative data regarding differences among individual NICM agents and their associated clinical manifestations remain limited [3-4,7-8]. Furthermore, evidence describing variations in reaction severity among specific non-ionic agents is inconsistent. Therefore, this study aimed to evaluate the incidence, clinical characteristics, and severity of pharmacy associated

with different NICM in patients undergoing CT. Additionally, this study sought to determine whether significant differences exist in clinical presentation and severity profiles among individual agents.

Methods

A retrospective cohort study was conducted using the electronic database of patients who underwent contrast-enhanced CT procedures between January 1, 2021, and December 31, 2023 at the Department of Radiology, Srinagarind Hospital after screening for potentially eligible participants using the International Statistical Classification of Disease and Related Health Problems, 10th revision (ICD-10). Participants were screened according to predefined inclusion and exclusion criteria. Eligible participants were adults (≥ 18 years, male or female) who received NICM, either as a single agent or in combination with other NICM agents, for the first time at the study hospital.

Participants were categorized into four groups during screening based on HSR classification using the Naranjo algorithm. Patients without evidence of acute kidney injury or significant laboratory abnormalities—

including impaired creatinine clearance, elevated aspartate aminotransferase (AST), alanine aminotransferase (ALT), or reduced estimated glomerular filtration rate (eGFR)—were included. Exclusion criteria comprised any condition that, in the investigator's judgment, would render the participant unsuitable for study enrollment, including poor prognosis or terminal illness with an expected survival of less than three months. Patients receiving renal replacement therapy or undergoing hemodialysis were also excluded.

Patients who experienced immediate or delayed HSRs following administration of NICM were defined severity symptoms by the Naranjo algorithm (ADR Probability Scale was assessed relationship between an identified untoward clinical event and CM using a simple questionnaire to assign probability scores) and pharmacist completed a category severity on their symptoms with adverse reaction or pharmacy. Descriptive statistics were used to summarize patient demographics (gender, age, body mass index (BMI), systolic blood pressure (BP), diastolic BP, creatinine, and eGFR stage), and types of CM as presented in Table 1.

Table 1 Physicochemical characteristics of NICM classified by chemical structure

Chemical structure	Type of CM	Iodine content (mg/mL)	Osmolality (mOsm/kg)
Nonionic monomers	Iobitridol (Xenetix®)	350	915
	Iomeprol (Iomeron®)	400	726
	Ioversol (Optiray®)	320	702
	Iohexol (Omnipaque®)	300	640
	Iopamidol (Iopamiro®)	300	616
	Iopromide (Ultravist®)	300	590
Nonionic dimers	Iodixanol (Visipaque®)	320	290

Statistical analysis, the sample size was calculated using Cochran's formula for estimating proportions at a 95% confidence level ($z = 1.96$), with a margin of error of 5% ($\alpha = 0.05$). Categorical variables are

presented as frequencies and percentages. Continuous variables are reported as mean $\pm$ standard deviation (SD) for normally distributed data and as median with interquartile range (IQR) for non-normally distributed data. The association between types of CM and the

severity of HSRs was analyzed using Fisher's exact test due to the presence of at least one contingency table cell with an expected count of less than five. All statistical analyses were performed using Stata software, version 18.5 (StataCorp LLC, College Station, TX, USA). All statistical tests were two-sided, and p -value < 0.05 was considered statistically significant. Ethical approval for this study was obtained from the Ethics Committee of the Faculty of Medicine, Khon Kaen University (HE681161). All procedures were conducted in accordance with the ethical standards of the institutional research committee, Helsinki Declaration and its later amendments.

Results

Demographic data and clinical characteristics

Total of the 412 participants, 175 (42.5%) were male and 237 (57.5%) were female. The median age was 60 years [IQR, 52–67 years]. The mean body weight was 61.08 ± 12.03 kg, while the median height was 160 cm (IQR, 154–166 cm). The median BMI was 23.39 kg/m^2 (IQR, 20.93 – 26.33 kg/m^2). The median systolic and diastolic BP were 129 mmHg (IQR, 116–141 mmHg) and 75 mmHg (IQR, 67–82 mmHg), respectively. The mean serum creatinine level was $0.92 \pm 0.27 \text{ mL/dL}$. According to CKD staging, most participants were classified as stage 1 (44.7%) or stage 2 (37.4%), with smaller proportions in stage 3a (7.3%), stage 3b (7.3%), stage 4 (2.2%), and stage 5 (1.1%). The mean eGFR was $26.00 \pm 14.94 \text{ mL/min/1.73 m}^2$ among those with eGFR $< 60 \text{ mL/min/1.73 m}^2$, and $148.00 \pm 85.06 \text{ mL/min/1.73 m}^2$ among those with eGFR $> 61 \text{ mL/min/1.73 m}^2$ as presented in Table 2.

Table 2 Demographic and clinical characteristics of the study population (n = 412)

Variables	Values
Gender, n (%)	
Male	175 (42.5)
Female	237 (57.5)
Age, years old	60 (52–67)
Weight, kg	61.08 ± 12.03
Height, cm	160 (154–166)
BMI, kg/m^2	$23.39 (20.93\text{--}26.33)$
Systolic BP, mmHg	129 (116–141)
Diastolic BP, mmHg	75 (67–82)
Creatinine, mL/dL	0.92 ± 0.27
eGFR stage, n (%)	
Stage 1	80 (44.7)
Stage 2	67 (37.4)
Stage 3a	13 (7.3)
Stage 3b	13 (7.3)
Stage 4	4 (2.2)
Stage 5	2 (1.1)
eGFR $< 60 \text{ mL/min/1.73 m}^2$	26.00 ± 14.94
eGFR $> 61 \text{ mL/min/1.73 m}^2$	148.00 ± 85.06

Note: Values are presented as number (percentage), mean $\pm$ standard deviation (SD), or median (interquartile range [IQR]), as appropriate. BMI = body mass index; BP = blood pressure; GFR = glomerular filtration rate (based on patients with available eGFR data, $n=179$). GFR staging was classified according to estimated glomerular filtration rate (eGFR) criteria. stage 1: $\geq 90 \text{ mL/min/1.73 m}^2$; stage 2: $60\text{--}89 \text{ mL/min/1.73 m}^2$; stage 3a: $45\text{--}59 \text{ mL/min/1.73 m}^2$; stage 3b: $30\text{--}44 \text{ mL/min/1.73 m}^2$; stage 4: $15\text{--}29 \text{ mL/min/1.73 m}^2$; and stage 5: $< 15 \text{ mL/min/1.73 m}^2$.

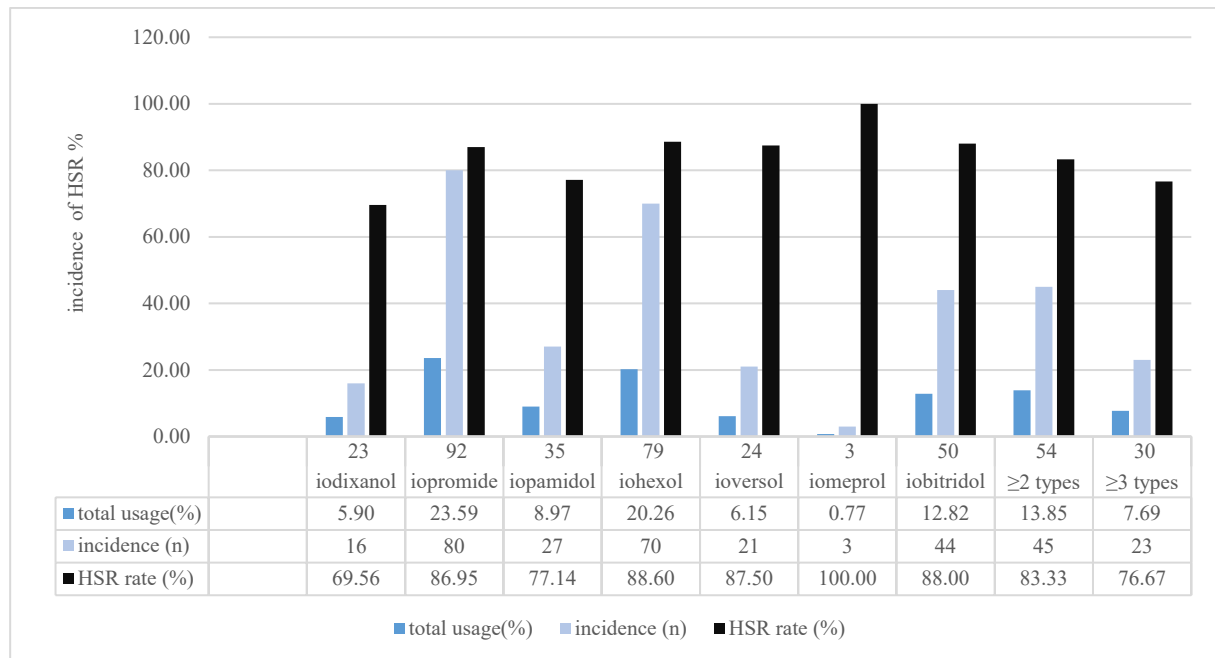


Figure 1 The overall incidence of HSR rate associated with various NICM.

Note: HSR = hypersensitivity reaction; NICM = non-ionic iodinated contrast media; n = number of administrations. Incidence was calculated as the number of HSR events divided by the total number of administrations for each agent. HSR refers to immediate hypersensitivity reactions occurring within 1 hour after contrast administration. HSR rate (%) is calculated among all exposures or per contrast agent. Provide the formula (e.g., HSR rate = number of HSR cases / total exposures to that agent] × 100)

HSRs according to type of CM

A total of seven types of NICM were used during the study period, with usage frequencies ranging from 0.77% (iomeprol) to 23.59% (iopromide). The highest HSR incidence rate was observed with iomeprol (100.00%), iohexol (88.60%), iobitridol (88.00%), ioversol (87.50%), iopromide (86.95%), ≥2 agents (83.33%), iopamidol (77.14%), followed by use of ≥3 agents (76.67%) and, iodixanol (69.56%), respectively as presented in Figure 1.

The distribution of HSRs according to the generic profile of NICM interpreted that mild reaction predominated across all CMs. Specially, iopromide accounted for the highest number of mild reactions (23.99%), followed by iohexol (20.23%) and iobitridol (12.72%), whereas iomeprol exhibited the lowest frequency (0.87%). These findings suggest that, although mild HSRs remain the most common presentation regardless of contrast type, the absolute frequency varies among individual agents. Moderate

reactions were uncommon and occurred only sporadically, with one case reported for iopromide, iopamidol, iohexol, and ioversol.

In contrast, no HSR were observed with iodixanol, iomeprol, or iobitridol. Severe reactions were rare overall. Iopromide showed the highest proportion of four cases (36.36% of severe reactions), followed by iodixanol and iobitridol (each 18.18%). In contrast, no severe reactions were observed with iopamidol or iomeprol. Despite these numerical differences, statistical analysis demonstrated no significant association between the type of NICM and HSR severity (all $p > 0.05$). This suggests that the observed variations in severity distribution may be attributable to sample size differences or exposure frequency rather than intrinsic differences in allergenic potential among the agents. Overall, the findings reinforce that most HSRs to NICM are mild and that severe reactions remain infrequent across all CMs as presented in Figure 2.

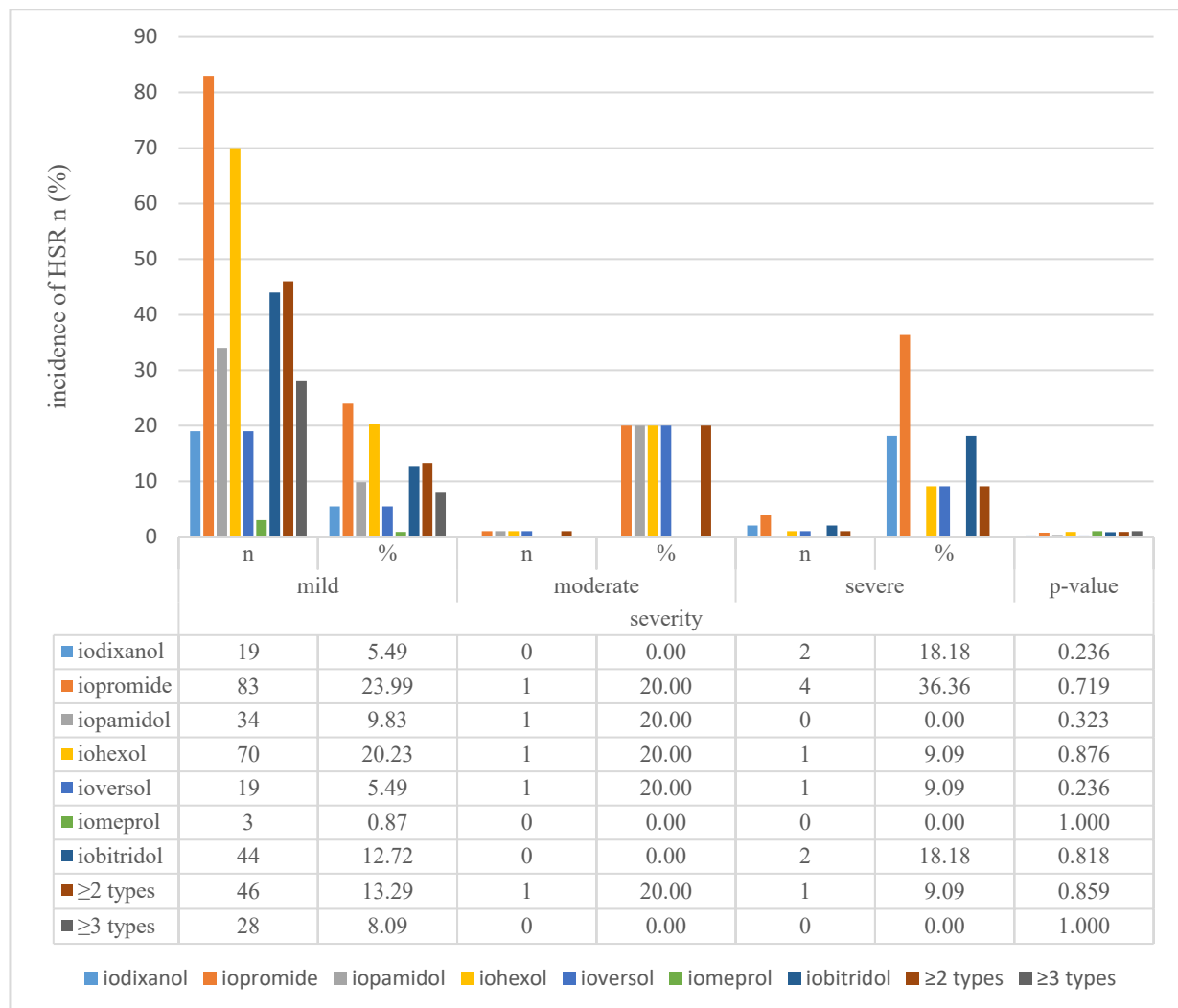


Figure 2 The overall incidence and severity of HSR according to the generic profile of NICM

Note: The p-value ($p = 0.648$) represents the overall association between the type of non-ionic iodinated contrast media (NICM) and the severity distribution of hypersensitivity reactions (HSRs), as assessed using Fisher's exact test. No statistically significant difference in severity distribution was observed among the different NICM agents. The p-value (Fisher's Exact Test) is correctly used for categorical data, but indicates the significance threshold (e.g., $p < 0.05$)

Clinical characteristics, and symptom of HSRs

Among patients who experienced HSRs, the most frequently reported symptoms were rash with itching and urticaria, observed across nearly all contrast agents. Rash and itching were most frequently reported in patients receiving iopromide and iohexol (45 cases each, 23.81%), followed by ≥ 2 contrast types (28 cases, 14.81%), and iobitridol (24 cases, 12.70%). Urticaria was most frequently associated with iopromide (31 cases, 23.48%) and iohexol (19 cases, 14.39%). Less common symptoms included isolated itching, dyspnea, edema, angioedema, anaphylaxis,

skin eruption, chills, and tachycardia. Eight reactions such as anaphylaxis occurred most often with iopromide (4 cases, 36.36%), iodixanol (2 cases, 18.18%), iobitridol (2 cases, 18.18%), and while angioedema was most frequently observed with iopamidol and iohexol (2 cases each, 25.00%). Dyspnea and edema were reported mainly with iopromide, iohexol, and iopamidol. Rare manifestations included chills (only in one patient with iopromide) and tachycardia (one patient with ≥ 2 contrast types). Overall, the distribution of symptom types varied across contrast agents, with milder cutaneous symptoms predominating as presented in Table 3.

Table 3 Clinical characteristics, and symptom of HSRs from contrast agents

	Symptoms of hypersensitivity, n (%)									
	Rash and Itching	Urticaria	Itching	Dyspnea	Edema	Angioedema	Anaphylaxis	Skin eruption	Chills	Tachycardia
Iodixanol	12(6.35)	6(4.55)	0(0.00)	0(0.00)	0(0.00)	1(12.50)	2(18.18)	0(0.00)	0(0.00)	0(0.00)
Iopromide	45(23.81)	31(23.48)	1(20.00)	1(33.33)	2(25.00)	1(12.50)	4(36.36)	2(50.00)	1(100.00)	0(0.00)
Iopamidol	15(7.94)	15(11.36)	1(20.00)	1(33.33)	0(0.00)	2(25.00)	0(0.00)	1(25.00)	0(0.00)	0(0.00)
Iohexol	45(23.81)	19(14.39)	2(40.00)	1(33.33)	2(25.00)	2(25.00)	1(9.09)	0(0.00)	0(0.00)	0(0.00)
Ioversol	8(4.23)	12(9.09)	0(0.00)	0(0.00)	0(0.00)	0(0.00)	1(9.09)	0(0.00)	0(0.00)	0(0.00)
Iomeprol	2(1.06)	1(0.76)	0(0.00)	0(0.00)	0(0.00)	0(0.00)	0(0.00)	0(0.00)	0(0.00)	0(0.00)
Iobitridol	24(12.70)	19(14.39)	0(0.00)	0(0.00)	0(0.00)	1(12.50)	2(18.18)	0(0.00)	0(0.00)	0(0.00)
≥ 2 types	28(14.81)	17(12.88)	0(0.00)	0(0.00)	0(0.00)	1(12.50)	1(9.09)	0(0.00)	0(0.00)	1(100.00)
≥ 3 types	10(5.29)	12(9.09)	1(20.00)	0(0.00)	4(50.00)	0(0.00)	0(0.00)	1(25.00)	0(0.00)	0(0.00)

Note: Data are presented as number of cases (n) and percentage within each symptom category. Percentages were calculated based on the total number of cases for each individual symptom (column percentage). Because patients may have experienced more than one symptom, categories are not mutually exclusive and percentages do not sum to 100% across rows. “≥2 types” and “≥3 types” refer to reactions occurring in patients exposed to two or three different iodinated contrast agents during the study period.

Discussion

In this study, HSRs to NICM were predominantly mild and primarily limited to cutaneous manifestations, whereas moderate and severe reactions were infrequent but clinically relevant. The incidence and severity observed in the present study are consistent with previous reports, demonstrating that modern non-ionic, low-osmolar CM are associated with fewer adverse reactions compared with conventional ionic formulations [2-3]. The incidence of HSRs with non-ionic agents typically ranges from 0.5% to 3% while as mild to moderate reactions usually occur in 0.7% to 3.0% of administrations, while severe reactions are exceedingly rare, often below 0.04% [6,10]. Although numerical differences in reaction rates were observed among individual contrast agents, no statistically significant association was identified between the type of CM and reaction severity. These findings suggest that, within contemporary non-ionic formulations, overall safety profiles are comparable in routine clinical practice.

Beyond agent-specific comparisons, structural and physicochemical characteristics of ICM warrant consideration. CM are structurally classified as monomeric or dimeric compounds, with dimeric agents containing two tri-iodinated benzene rings within a single molecule. These structural differences influence osmolality, viscosity, and molecular weight, which may in turn affect biological interactions at the cellular level. Dimeric iso-osmolar agents generally exhibit lower osmolality but higher viscosity compared with monomeric low-osmolar agents. Such physicochemical variations may theoretically modulate mechanisms implicated in HSRs, including direct mast cell activation, complement activation, and non-IgE-mediated pathways. Although our data did not demonstrate statistically significant differences in reaction severity across individual agents, structural properties remain biologically plausible contributors and may exert subtle effects that require larger, adequately powered studies to elucidate.

The potential influence of patient-specific factors must also be interpreted cautiously. While previous literature suggests that a history of prior contrast reactions, atopy, asthma, or other allergic conditions may increase susceptibility to HSRs [4,11], our study did not include multivariable modeling to assess the independent contribution of these variables within our cohort. Therefore, the suggestion that individual susceptibility plays a role is supported primarily by external evidence rather than direct statistical confirmation from our dataset. Future prospective studies incorporating comprehensive risk-factor analysis would be essential to refine individualized risk stratification and preventive strategies.

From a clinical perspective, the predominance of mild reactions reinforces the overall safety of NICM in contemporary practice. However, the occurrence of moderate and severe reactions, although rare, underscores the importance of preparedness, standardized monitoring protocols, and rapid management strategies in radiology departments.

Several limitations should be acknowledged. The retrospective design introduces potential selection and information bias, as data were derived from existing medical records that may contain incomplete documentation or misclassification of reaction severity. Missing data and inconsistent reporting could have influenced outcome assessment. Additionally, the single-center nature of the study may limit generalizability to other institutions with different patient demographics, contrast utilization patterns, or clinical protocols. Finally, the relatively low incidence of moderate-to-severe reactions may have limited statistical power to detect small but clinically meaningful differences between contrast agents. These limitations highlight the need for multicenter, prospective investigations with standardized reporting systems to validate and extend the present findings.

Conclusion

HSRs to INCM are usually mild, most often presenting as rash, itching, or urticaria. Eight events, though uncommon, remain clinically significant. Susceptibility depends more on patient-specific factors than on type of CM. Rigorous risk assessment and adherence to emergency protocols are essential to ensure safety during contrast-enhanced imaging.

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Conflict of Interest

The authors declare that they have no conflict of interest related to this study.

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