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NEPHROGENIC SYSTEMIC FIBROSIS (NSF): AN ASSESSMENT OF PERCEPTION AND PRACTICE OF NIGERIAN MRI RADIOGRAPHERS.

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ABSTRACT

Background: Nephrogenic Systemic Fibrosis (NSF) is a serious fibrotic disorder seen in patients with kidney impairment, triggered by gadolinium-based contrast agents (GBCAs) used in MRI. It manifests with skin thickening, joint contractures, and potential organ involvement, with no available cure. Linear GBCAs have higher associated risks, prompting global regulatory restrictions. As MRI utilization increases in Nigeria, the level of radiographers' awareness and adherence to NSF prevention guidelines remains unclear. Assessing their training and clinical practices is essential for improving patient safety and aligning with international standards.

Objective: To assess the perception, knowledge, and clinical practices of MRI radiographers regarding NSF and GBCA safety.

Method: A descriptive cross-sectional study was conducted to evaluate knowledge, awareness, perception, and practices regarding NSF and GBCA safety among Nigerian MRI radiographers. Participants involved in patient screening and GBCA administration across multiple centers were surveyed using a structured, pre-tested questionnaire adapted from validated instruments. Data analysis employed descriptive and inferential statistics to assess understanding and compliance with NSF prevention protocols. Ethical approval and participant confidentiality were strictly maintained.

Results: Among 42 surveyed Nigerian MRI radiographers, 78.4% were aware of NSF, but only 37.8% demonstrated comprehensive knowledge of prevention guidelines. Overall knowledge was adequate; however, notable gaps existed concerning gadolinium contrast risks and renal function markers. Weight-based gadolinium dosing was commonly practiced. Renal screening protocols varied, being more consistently applied in private healthcare facilities. Radiographers' experience and clinical role significantly influenced NSF knowledge, while the practice environment predicted adherence to safety measures.

Conclusion: MRI radiographers demonstrate general awareness of NSF, but gaps persist in guideline familiarity and standardized renal screening practices. Strengthening education, institutional protocols, and regulatory oversight may enhance patient safety and reduce NSF risk.

Keywords: Nephrogenic Systemic Fibrosis (NSF); Gadolinium-based Contrast Agents (GBCAs); MRI Safety; Nigerian MRI Radiographers; NSF Prevention Guidelines.

Introduction

Nephrogenic Systemic Fibrosis (NSF) represents a serious, ongoing, and advancing fibrotic condition that impacts individuals with kidney dysfunction, particularly those suffering from chronic kidney disease (CKD) [1, 2]. It arises chiefly from exposure to gadolinium-based contrast agents (GBCAs) administered during magnetic resonance imaging

(MRI) to improve image clarity and better visualise tissues.

In patients with compromised kidney function, NSF develops due to poor gadolinium clearance, leading to its buildup in body tissues. This triggers fibroblast stimulation and widespread fibrosis in the skin, joints, and internal organs [3]. Clinically, NSF presents with joint stiffness, indurated and rigid skin, and potential organ involvement, all of which severely diminish quality of life while elevating risks of morbidity and death. First identified in the early 2000s, NSF prompted extensive studies and the establishment of rigorous global guidelines to minimize its incidence, especially among high-risk patients.

Risk factors for NSF are clearly defined, with kidney dysfunction as the primary driver. This affects patients with severe CKD or those on dialysis for renal failure. The type of gadolinium-based contrast agent (GBCA) plays a crucial role in risk levels where newer macrocyclic agents (Group II GBCAs) show much lower risks, whereas linear non-ionic types like gadodiamide link to higher NSF rates [2,3]. International systematic reviews and meta-analyses provide robust evidence for these links.

This body of evidence has shaped safer practices for GBCA administration, including thorough renal function checks, thoughtful agent selection, and dialysis after imaging when needed [3,4]. Major groups such as the National Kidney Foundation and American College of Radiology have issued guidelines outlining NSF prevention strategies that maintain MRI's diagnostic value. Even so, NSF remains a notable clinical issue [5].

In the African context, surveys such as the one conducted in Ghana revealed variability in the awareness, perception, and practices related to gadolinium use and NSF risk mitigation among radiology professionals. [6,7] Patient safety may be impacted by this variability, which reflects variations in training, institutional protocols, regulations, and resource availability [6]. The use of MRI is growing quickly in Nigeria because of improvements in medical diagnostics and infrastructure. The Radiographers Registration Board of Nigeria (RRBN) and other regulatory and operational frameworks for MRI practice, are still developing, with continuous efforts to standardize professional conduct, certification, and licensure for MRI radiographers [7]. Ensuring patient safety, following set procedures, keeping correct records, and pursuing ongoing professional development to stay current with developments and safety precautions are all examples of legal and ethical obligations. Even as these frameworks serve as a basis for safe imaging procedures, patients with kidney impairment must be protected by paying particular attention to the nephrotoxicity risks associated with gadolinium use and NSF prevention [7,8]

Despite global advances in the understanding of NSF, there is a dearth of information on Nigerian MRI radiographers' attitudes and clinical practices regarding NSF prevention. In a healthcare setting where renal screening prior to gadolinium administration may be inconsistent and where MRI contrast agent selection and usage protocols differ among facilities, it is critical to comprehend the knowledge, attitudes, and adherence to guidelines.[9,10] With the intention to improve patient safety and radiologist-radiographer collaboration in risk assessment, it is possible to identify knowledge gaps, training needs, and practical challenges by evaluating the perception and practice of Nigerian MRI radiographers. This is significant, given the potential severity of NSF and its irreversible effects caused by improper gadolinium exposure.

Such research can help Nigerian regulatory bodies develop and implement strict guidelines on gadolinium use. In addition to improving clinical safety, it can also enforce renal function screening. Additionally, this will increase awareness of the worth of kidney health evaluation before contrast-agent-based MRI exams.

The present study, therefore, aim to assess Nigerian MRI radiographers' perception and practices related to NSF risk. It will also highlight awareness levels, adherence to safety recommendations, and challenges faced in the local context. This effort will help develop plans to bring Nigerian MRI procedures into compliance with international standards.

Methods

A descriptive cross-sectional study design was adopted in this study. Only MRI radiographers who were currently directly participating in patient screening and/or contrast injection in MRI centres were targeted. Radiographers who were not currently performing MRI scans were excluded. Since few radiographers in Nigeria practice MRI, a convenience sampling technique was used. The data collection method involved the use of a structured questionnaire, which was self-administered and modified from other

validated instruments concerning NSF awareness and GBCA use.

The questionnaire was divided into sections on awareness and knowledge of NSF, general characteristics, perceptions of the severity and risk factors associated with NSF, GBCA administration, renal risk stratification and mitigation strategies, and, finally, open-ended questions about contrast. Regarding the completion of the questionnaire, follow-ups were conducted via phone calls, emails, and social media. Anonymity was preserved throughout the study.

Quantitative survey data were analysed using the Statistical Package for Social Sciences (SPSS), version 26, while open-ended responses were analysed thematically.

Results

Whilst 42 radiographers answered the survey, only 88.1% (n=37) of respondents were practicing MRI Radiographers. The study's findings are based on the information provided by these 37 respondents.

Table I: Frequency Distributions of Renal Screening and Risk Mitigation

Variable	Category	Frequency (37)	Percentage (%)
Departmental Screening Practice Prior to GBCAs Administration	All patients for possible GBCAs administration undergo Renal function test	20	54.1
	Patients do not undergo Renal function test	8	21.6
	Only patients with history of renal impairment undergo Renal function test	4	10.8
	All patients above the age of 60years undergo Renal function test	3	8.1
	Patients with known history of diabetes and/or hypertension undergo Renal function test	2	5.4
Acceptable Renal Function Test	Estimated Glomerular Filtration Rate (eGFR)	11	29.7
	Serum Creatinine	24	64.9
	Others	2	5.4
eGFR Threshold Used in Department/Centre	eGFR less than 30 mL/min	13	35.1
	eGFR of 30-59mL/min	4	10.8
	eGFR greater than or equal to 60mL/min	3	8.1
	Do Not Know	7	18.9
	Not Applicable	10	27.0

Nearly three-quarters of the respondents [78.4% (n=29)] had an awareness that risk of NSF is tied to the use of GBCA in MRI examinations (Fig. I). However, only 37.8% (n=14) of respondents claimed a solid grasp of current prophylactic guidelines and measures to prevent the occurrence of NSF (Fig. I). Correspondingly, based on responses to Likert scale questions, most respondents had a general understanding of NSF as a complication of using GBCA. Even though the problem was acknowledged, there were uncertainties about how different GBCAs compare in terms of risk.

91.9% (n=34) of respondents attested to the daily use of GBCAs in MRI imaging. Among the gadolinium-based contrast agents used by MRI Radiographers, Omni scan (a high-risk linear GBCA) stands out. This frequency is followed by use of Magnevist and other agents with stronger side effects. On the flip side, there's a variable use of safer macrocyclic options such as Gadavist and Dotarem.

54.1% (n=20) of respondents attested to screening all patients before administering GBCAs, 10.8% only scr een patients with a history of renal impairment, and 21 .6% (n=8) reported no routine screening (Fig. II).

Additionally, an inclination to use serum creatinine tests to assess renal function was observed amongst respondents (Table I). Few respondents use the estimated glomerular filtration rates (eGFR), with nearly two-fifths of respondents [35.1% (n=13)] stating they do not administer GBCA if eGFR is below 30 mL/min. A smaller group [8.1% (n=3)] reported using contrast at eGFR of 60 mL/min or higher, whereas 10.8% (n=4) reported using contrast when eGFR ranged from 30 to 59 mL/min.

According to MRI guidelines, 81.1% (n=30) of respondents said they used weight-based dosing. This study found that the responsibility of contrast administration differs between facilities where radiologists, MRI radiographers, or both oversaw administration of GBCA.

Inferential analysis showed associations between MRI experience and awareness of NSF guidelines ($p = 0.044$). There was also an association between the settings of the facility and consistency of screening tests, as private centers were more likely to adhere to guidelines on screening tests ($p < 0.05$).

Discussion

Initially, the occurrence of NSF was not linked to the administration of GBCA, as early reports suggested that GBCAs lacked nephrotoxic potential [11, 12]. This perception changed after the increased occurrence of NSF was identified in patients with advanced renal disorders after their exposure to GBCAs. Later evidence backed by clinical trials has since then confirmed a clear relationship, which has led to the formulation of international recommendations and guidelines that serve as preventive measures [13].

The findings from this study suggest that within MRI practice in Nigeria, NSF is no longer a vague complication. However, an interesting disconnect was observed between awareness and informed practice following guidelines, as fewer than half of the respondents felt familiar with current NSF prevention recommendations, highlighting a key discrepancy between MRI radiographers' knowledge and their practice. A pattern that has been previously reported in a study that revealed perceptions of nephrologists on NSF not aligning with existing data and practices, even though they were acquainted with the risk factors and after-effects [14].

The identification of the lethality of NSF in this study among respondents, however, did not necessarily mean a significant knowledge of gadolinium-based contrast agents and MRI contrast media guidelines. This aligns with findings from other studies [14,15]. The preference for the choice of GBCA used amongst MRI radiographers is based on factors such as cost, availability, and perceived notion of safety (fewer adverse reactions or side effects) [16]. In our study, there was an observed uncertainty about the types of GBCAs, and the individual risks associated with brands of GBCAs. The reported continued use of high-risk linear GBCAs (group I gadolinium-based agents) such as Omniscan and Magnevist (gadodiamide and gadopentetate dimeglumine, respectively), which have been classified by the ACR as agents that are associated with the greatest number of NSF cases, reflects poor practice [17,18]. This report is congruent with a study amongst nephrologists, where there was a huge awareness of NSF but a poor awareness of its association with a specific GBCA brand [14]. On the contrary, a study in Istanbul had respondents who had better awareness of the classification of GBCAs and, as a result, switched to the use of macrocyclic group II, which are less associated with the occurrence of NSF. [19]

For a low-resource setting like Nigeria, macrocyclic agents are both expensive and not readily available. The continuous use of high-risk agents may reflect challenges with cost and availability considerations. Institutional policies on procurement of contrast may also increase the risks of NSF, as most institutions in low-resource environments mostly focus on making profits. It is recommended that the opinions of MRI radiographers be sought since they are more qualified to make the distinction between the safe and unsafe types of contrast to use for patients with abnormal renal clearance. Furthermore, the observed irregularity in brand recall and multiple utilization of different GBCA in a single facility underpins the necessity for a structured pharmacovigilance and education on GBCA selection for patients.

For MRI radiographers, increasing years of experience, continuous professional development, and pharmacological contrast training are hypothesized to be predisposing factors that may induce transition to macrocyclic agents; hence a lesser frequency of NSF cases because of MRI practice in Nigeria [20].

The nephrogenic screening of patients before MR imaging serves as a prophylactic measure to establish which patients have increased risks of NSF and reduce the risks of this condition [21]. In our analysis, we found inconsistencies in renal screening practices, where over half of respondents reported screening all patients routinely, selectively, or not at all before administration of GBCA. Furthermore, there appears to be an underestimation of the superiority of eGFR as a measure for the assessment of renal status since more respondents relied on serum creatinine rather than eGFR as specified by guidelines.

Despite international recommendations that prescribe that in patients with eGFR values below 30 mL/min, contrast should be withheld, our study shows there is a variation in reported thresholds, with radiographers admitting to administering contrast at different thresholds. This finding suggests inconsistencies in protocol implementations and is highly likely to expose

patients to the risk of NSF, especially when linear GBCA are used. Although in this study the exclusive use of specific types of GBCAs was not assessed, it can be hypothesized that a switch to the exclusive use of macrocyclic agents in patients with eGFR ≥ 30 and < 60 mL/min/1.73 m2 makes the use of screening tests and other precautions superfluous. This is congruent with recommendations from a prior study, that the exclusive use of class II GBCAs may reduce the dependence of screening tests.[22]

The study found that MRI radiographers' adoption of weight-based dosing represents a positive step toward adhering to recommendations. However, a step back due to the uneven screening and contrast selection procedures may result from an uneven transfer of responsibility for contrast administration between radiologists and/or radiographers. It has been demonstrated that professional experience has a major impact on awareness of NSF guidelines, suggesting that first-hand experience is crucial for learning about safety procedures. Similarly, private settings are strongly linked to increased awareness of and adherence to the use of eGFR for renal screening. The difference may be caused by the triumvirate elements of improved resource availability, more stringent regulations, and organization policies. The adoption of these factors in the public MRI sector would also greatly help reduce the iatrogenic risk and ultimate incidence of NSF.

Whilst this study offers information about MRI radiographers' perception and practice in relation to NSF, it has several limitations. First, the study design only recorded practice patterns at a particular moment in time with no follow-up of perception and practice changes over time. Another restriction to consider is social desirability bias since MRI radiographers' self-reporting may cause them to adjust their renal screening and contrast administration procedures. It is advised that longitudinal designs and objective evaluations be used in future studies to assess adherence to NSF prevention recommendations.

In conclusion, since NSF poses a serious iatrogenic risk associated with GBCA in patients with renal impairment, there is a need for greater awareness of NSF and the application of preventative measures against its occurrence. However, improving MRI radiographers' clinical skills and knowledge is essential to reducing patient risk of NSF in Nigeria, where resource limitations and lax regulations present difficulties. This study promotes increased pharmacovigilance in MRI practice and policy enforcement backed by ongoing training for radiographers to achieve our safety goal of improved MRI safety and improved patients' outcome.

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Conflict of Interest

The authors declare no conflict of interest.

Generative AI use

During the preparation of this work, the authors used generative AI to trim total wordings without losing original ideas. The authors take full responsibility for the content of this publication.

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