



Evaluation of MRI Units' Compliance to International Safety Guidelines in Southern Nigeria

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Abstract

The study presents the result of MRI safety practices of 23 (twenty three) MRI units in the south-west, south-east and south-south geopolitical zones of Nigeria. It was carried out between September 2022 to December 2023 in both public and private hospitals with a total number of 50 (fifty) Questionnaires given out with 45 (forty-five) responded to and returned with at least one from all the facilities (hospitals) giving a response rate of 90% with only 5 (five) unresponded to representing 10%. Generally, out of all the 23 (twenty three) MRI facilities identified, there was response from all of them giving a response rate of 100%. The study showed that almost all respondents from about 20 (twenty) facilities (n=20) representing 87% indicated that they have safety document and about half of the respondents representing 48% review and update the MRI safety policy document on regular basis. From the study, it was discovered that the use of patients screening questionnaire and visual observation of equipment and patients was common representing about 100% from respondents. with regards to the use of ferromagnetic detection system and hand held magnet, only respondents from 5 (five) facilities (n=5) representing 22% and 15 (fifteen) facilities(n=15) representing 65% confirmed the availability of ferromagnetic detection system and handheld magnets respectively. For accessories for emergency, a lot of respondents indicated they have fire tender (87%) and other sources of power (96%). It was noted in this study that about (46%) indicated that they lack drills for emergency response. Finally, from the study, contrast reaction occurred more representing 87%, others are projectile incidents and fire outbreaks all corresponding to 9%.

Keywords: MRI (Magnetic Resonance Imaging), Magnetic, Field, ACR, Evaluation, Safety, Guidelines

Introduction

Magnetic resonance imaging (MRI) is generally considered a safe imaging modality because it does not alter or change the structure, composition and properties of atoms as ionizing radiation – based modalities do (Shellock, 2007). Magnetic resonance imaging (MRI) has a superior soft-tissue contrast compared to other radiological imaging modalities and its anatomical, physiological and functional applications have led to a significant increase in MRI scans world-wide (Chakeres et al, 2017). The increasing clinical demand for magnetic resonance imaging (MRI) with its superior soft-tissue contrast and potential physiological and functional applications has contributed to the installation of almost 30,000 MRI scanners worldwide (Chakeres, 2017)

Notably, the MRI environment presents potential risks or bio-effects because of three major magnetic fields which are the strong static magnetic fields (B_0), the gradient magnetic fields

and the pulsed radio-frequency (RF) fields employed to produce the three-dimensional images. The hazards associated with static magnetic fields are interaction with human tissue and interactions with equipment like projectiles, implant malfunction, implant movement, monitoring device malfunction and monitoring device movement (Hartwig et al, 2009). The radio-frequency (RF) associated risk or bio-effects include specific absorption rate (SAR) issues, tissue heating, burns, implant heating and implant interference effects. The main concerns with time-varying gradients are peripheral nerve stimulation and acoustic noise, including potential implant or monitoring device interference (Wilde et al, 2012).

Most MRI incidents can be attributed to the presence of ferromagnetic devices and equipments including implants in the MRI environment. Aside magnetic field emergencies, others include patient emergency, quenching and fire outbreaks. Reports of MRI adverse incidents have been published extensively in the medical literature and media. In Ghana for example, the MRI suit of the Korle-bu teaching hospital have recorded incidents of fire outbreak in 2007, a projectile incident in 2010 and wrong switching “off” of the MRI safety button (Opoku et al, 2013). These incidents and others in other countries clearly demonstrate the risk associated with the MRI environment and the need to evaluate compliance to safety guidelines in the south-west, south-east and south-south geopolitical zones of Nigeria. To reduce the risk, in 2013, the American College of Radiology (ACR) guidance document on MRI safe practices was published as a reviewed, modified and updated versions of the 2002, 2004 and 2007 document. The rationale for providing this document is in view of the potential risks associated with the MRI environment and reports of adverse incidents involving patients, personnel and equipment.

Therefore, this study is being undertaken to assess the level of awareness and compliance to international safety guidelines in MRI in south-west, south-east and south-south geopolitical zones of Nigeria.

Research Method

The study adopted a quantitative designed format. A well-designed and less ambiguous questionnaire was used for the study. The target population for this study involves the entire population of radiographers in the identified MRI suits in South – South, South – East and South – West Nigeria from September 2022 to December 2022.

The research studied the response of radiographers on compliance to international safety guidelines in Southern Nigeria. Convenient sampling method was used in the course of the study based on the purpose of the study.

A total number of 23 facilities with MRI suites were identified in the South – West, South – East and South – South geopolitical zones of Nigeria during the period of the study.

A self – administered open and closed ended survey questionnaire was used to obtain data from the participants. The data collected was tallied and analyzed in line with the objectives of the study using appropriate descriptive statistical tools such as percentages, frequencies and presented in tabular and graphical forms in the study.

Results

Table 1. Summary of MRI facilities: type of facility, magnetic field strength and number of MRI scanners in Southern Nigeria (September 2022 – December 2023).

S/No.	TYPE OF FACILITY	FIELD STRENGTH (TESLA)	NUMBER OF MRI SCANNERS	YEAR OF COMMENCEMENT OF OPERATION								
				2005	2022							
1	PUBLIC HOSPITAL(S)	1.5 ≤ 0.5	7 -	2	07-08	09-10	11-12	13-14	15-16	17-18	19-20	21-22
					1	2	-	-	1	-	-	1
2	DIAGNOSTIC CENTER	1.5 ≤ 0.5	4 4	05-06	2	1	1	2	-	1	1	-
					-	1	1	2	2	-	1	-
3	PRIVATE HOSPITAL(S)	1.5 ≤ 0.5	8 -	-	1	1	2	2	-	1	-	1

Table 1 above shows the ownership of MRI facility whether public hospital, private hospital and diagnostic center with the field strength of the MRI scanners (≤ 0.5 and 1.5 Tesla), the number of MRI scanners (23) and their year of commencement of operation ranging from 2005 – 2022.

TABLE 2: The Summary of Respondent's Responses on Availability of MRI Safety Policy, Review and Update of Safety Policy and Patient Screening Tools.

S/No.	Type of Facility	MRI Safety Policy (yes or no)	Review and update of safety policy (yes or no)	Hand held magnet (yes or no)	Ferromagnetic detection system (yes or no)	Patient Screening questionnaire (yes or no)	Visual observation (yes or no)
1	PUBLIC HOSPITAL	4 (Yes)	3 (Yes)	5 (Yes)	2 (Yes)	7 (Yes)	7 (Yes)
		3 (No)	4 (No)	2 (No)	5 (No)	- (No)	- (No)
2	DIAGNOSTIC CENTER	8 (Yes)	4 (Yes)	5 (Yes)	2 (Yes)	8 (Yes)	8 (Yes)
		- (No)	4 (No)	3 (No)	6 (No)	- (No)	- (No)
3	PRIVATE HOSPITAL	8 (Yes)	4 (Yes)	5 (Yes)	1 (Yes)	8 (Yes)	8 (Yes)
		- (No)	4 (No)	3 (No)	7 (No)	- (No)	- (No)

Table 2 shows the summary of respondent's responses on the availability of MRI safety policy, review and update of safety policy and patient screening tools. The table shows that all the MRI facilities use patient screening questionnaire and carry out general visual observation before patients are attended to with all the respondents/facilities responding "YES". From the above table also, 20 (twenty) out of the 23(twenty-three) facilities indicated that they have MRI safety policies with the respondents from all the 20 (twenty) facilities ($n = 20$) responding "Yes" while all the respondents from 3 (three) facilities ($n = 3$) in public hospitals indicated "No". It is however worrisome from the table that only 5 (five) responded that they have ferromagnetic detection system in their units with only respondents from the 5 (five) facilities ($n = 5$) indicating "YES"

TABLE 3: Summary of The Respondent's Responses on Availability of Accessories for Emergency Preparedness and Documentation on Drills.

S/N	Type of Facility	Crash carts (yes or no)	Emergency Resuscitation on Equipment (yes or no)	Fire tender (yes or no)	Alternative power source (yes or no)	Provision of drills on emergency response protocol (yes or no)	Document on emergency response protocol (yes or no)	Document to show evidence of drills (yes or no)	Document on emergency preparedness plan (yes or no)
1	Public Hospital	1 (Yes)	3 (Yes)	4 (Yes)	6 (Yes)	4 (Yes)	3 (Yes)	5 (Yes)	3 (Yes)
		6 (No)	4 (No)	3 (No)	1 (No)	3 (No)	4 (No)	2 (No)	4 (No)
2	Diagnostic Center	- (Yes)	2 (Yes)	8 (Yes)	8 (Yes)	4 (Yes)	2 (Yes)	2 (Yes)	2 (Yes)
		8 (No)	6 (No)	- (No)	- (No)	4 (No)	6 (No)	6 (No)	6 (No)
3	Private Hospital	1 (Yes)	3 (Yes)	8 (Yes)	8 (Yes)	4 (Yes)	3 (Yes)	3 (Yes)	3 (Yes)
		7 (No)	5 (No)	- (No)	- (No)	4 (No)	5 (No)	5 (No)	5 (No)

Table 3 shows the summary of respondents to availability of accessories for emergency preparedness and documentation on drills. From the table, respondents from 22 (twenty-two) facilities ($n = 22$) indicated that they have alternative power source on standby with all respondents from the 22 (twenty two) indicating "Yes". Only 1 from a public hospital ($n = 1$) had no alternative power source with all the respondents in that particular facility indicating "No".

The use of Crash Carts was generally discouraging with only respondents from 5 (Five) facilities ($n = 5$) indicating that they have crash carts in their facilities.

TABLE 4: Summary of Infection Control Practices in The MRI Units.

S/n	Type of Facility	Hand Washing sink (Yes or No)	Wall – Mounted Sanitizers (Yes or No)	Hand Sanitizers (Yes or No)
1	Public Hospital	6 (Yes)	3 (Yes)	5 (Yes)
		1 (No)	4 (No)	2 (No)
2	Diagnostic Center	8 (Yes)	2 (Yes)	6 (Yes)
		- (No)	6 (No)	2 (No)
3	Private Hospital	8 (Yes)	3 (Yes)	7 (Yes)
		- (No)	5 (No)	1 (No)

Table 4 shows the summary of infection control practice in the MRI units with respondents from 22 (Twenty-two) facilities ($n = 22$) indicating that they have hand washing sink with all of them responding "Yes" which is encouraging.

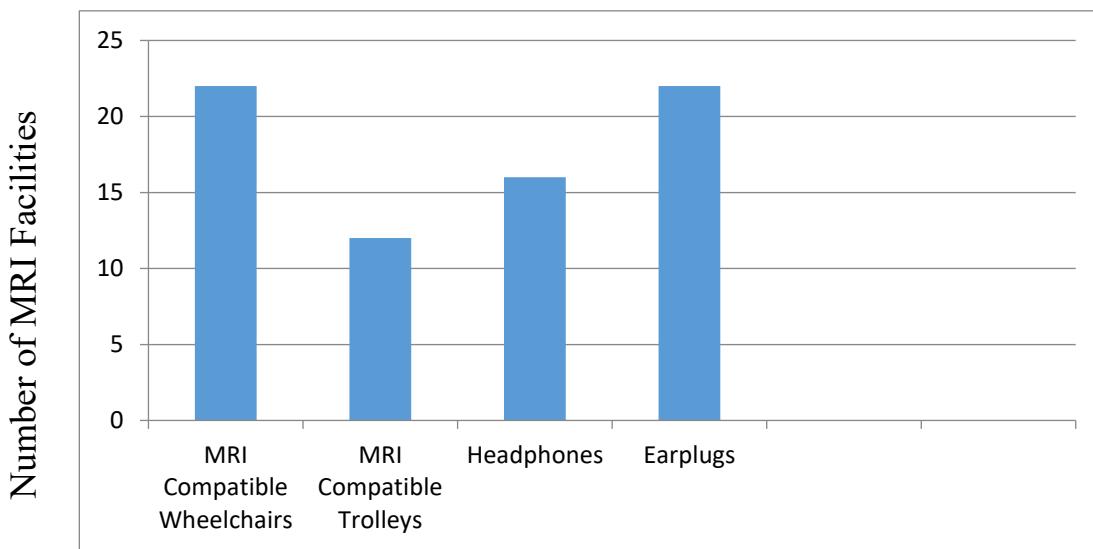


FIG 1. Summary of MRI Safety Accessories

Fig 1: shows the summary of MRI safety accessories which indicates that the use of MRI compatible wheelchairs and earplugs was encouraging with respondents from 22 (twenty two) facilities ($n=22$) responding that they use MRI compatible wheelchairs and earplugs. However, only respondents from 12 (twelve) MRI facilities ($n=12$) responded that they use MRI compatible trolleys which is not in line with ACR guidance document on MRI safe practice, (2002, 2004 and 2007 documents).

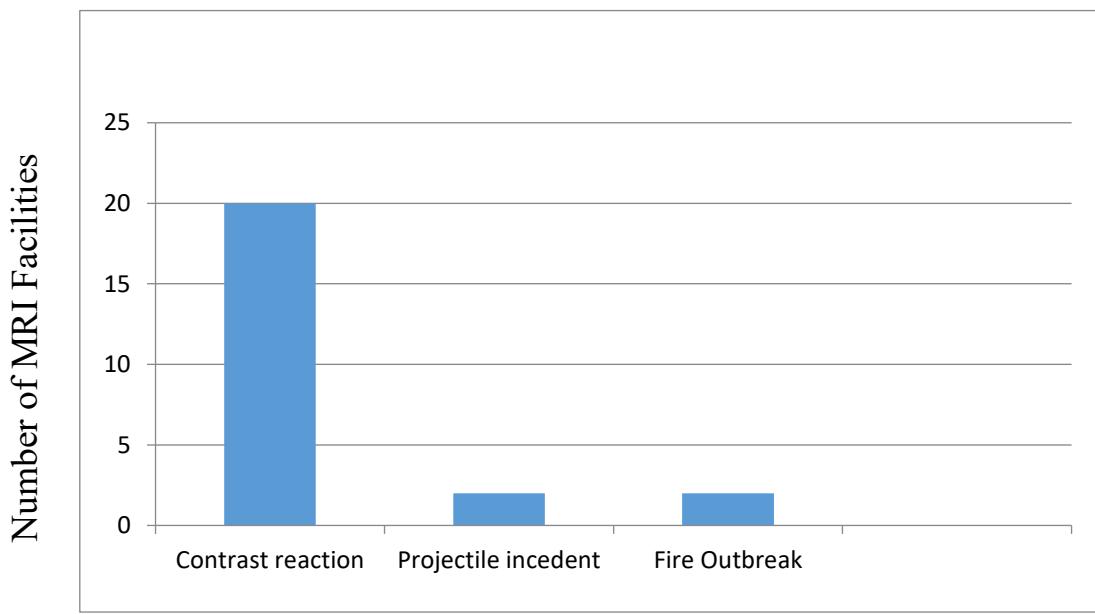


FIG 2: Summary of Report of Adverseincidents.

Fig 2 shows summary of reports of adverse incidents like contrast reaction, projectile incidents and fire outbreaks.

It is encouraging from figure 2 that only 2 (two) facilities ($n = 2$) reported incidents of projectile accidents and fire outbreaks, while contrast reaction was generally high with respondents from 20 facilities ($n = 20$) reporting incidents of contrast reaction.

Table 5. Summary of Response to Equipment Safety and Signage and Barriers.

	Questions	Responses to equipment safety		
		Yes	No	Total
1	Do you check the equipment brought into the MRI suite?	23 (100%)	0 (0%)	23 (100%)
2	Do you have emergency exit door?	19 (83%)	4 (17%)	23 (100%)
3	Are equipments used in the MRI suite colour coded?	0 (%)	23 (100%)	23 (100%)
	Response To Signage and Barriers			
		Yes	No	Total
4	Is zone 4 clearly marked with a red light and lighted sign stating the magnet is “on”?	18 (78%)	5 (22%)	23 (100%)
5	Is zone 3 demarcated and clearly marked as being potentially dangerous?	12 (52%)	11 (48%)	23 (100%)
6	Are all entrances marked to indicate the presence of a magnetic field hazard?	22 (96%)	1 (4%)	23 (100%)
7	Are there physical barriers to prevent unauthorized or accidental access to zone 3 and 4?	19 (83%)	4 (17%)	23 (100%)

Table 5 above shows the response to equipment safety and signage and barriers indicating that all the MRI facilities do check the equipment brought into the MRI unit. However, only 19 (Nineteen) facilities ($n = 19$) representing 83% have emergency exit doors while 4 (Four) representing 17% do not have emergency exit doors.

Table 5 also shows that the equipment used in all the MRI facilities are not colour coded which is not in line with ACR guidance document on MRI safe practice, (2002, 2004 and 2007 documents).

Table 6: Summary of Responses to Access and Communication.

	Questions	Responses to access and communication		
		Yes	No	Total
1	Do employees have direct visual observation of access corridors to zone 4 from their working positions in the MRI scanner room?	19 (83%)	4 (17%)	23 (100%)
2	Has the facility ever invited police/fire representatives for MRI safety presentations or facility tours?	0 (0%)	23 (100%)	23 (100%)

Table 6 above shows the response to access and communication indicating that 83% of MRI facilities have direct visual observation of access corridors to zone 4 (four) from their working

position, while 4 (Four) facilities (n=4) representing 17% do not. It also shows that none of the facilities have ever invited police or fire representatives for MRI safety presentation or facility tour.

Discussion

This study presents the findings (results) of the current magnetic resonance imaging (MRI) safety practices in the south-west, south-east and south-south geopolitical zones of Nigeria. The study provides information on safety issues in MRI using numerical and graphical illustrations of current safety practices. The ACR document (2002, 2004 and 2007 versions that were updated in 2013) was adopted as a standard template for the study.

From the study in Southern Nigeria, the findings suggest that almost all the respondents corresponding to about 20 (87%) or about 20 facilities (n=20) representing 87% responded that they have safety MRI policy documents which is in line with the ACR International Safety Guidelines and an indication that majority of the respondents comply with the recommendations of the ACR. When compared to related literatures, Karnal et al., (2008) reported a significant level of non compliance with MRI safety policy documents, Johnson et al., (2014) also reported a high level of non compliance to MRI safety documents in their work safety for healthcare personnel in MRI. However, about half of the respondents representing 48%, 11(48%) review and update the MRI safety policy document regularly. Indeed, in a correlative study, (Opoku et al, 2013) in their single site study of MRI safety practice in Ghana noted that there was lack of an effective and efficient policy and guidelines in most hospitals generally and the radiology department in particular which correlates with the issue of review and update of safety policy as was noticed in the current study in the 3 (three) zones in southern Nigeria.

From this current study, it was discovered that the use of patient screening questionnaire and visual observation of equipment and patients was common representing about 100% from the respondents which is very encouraging and it is in line with the objectives of the study. Indeed, in a correlative study by Opoku et al., (2013) there was generally a high compliance with patient screening questionnaire and visual observation of equipment and patients which is similar with the findings in the current study.

Also from the study, with regards to the use of ferromagnetic detection system and handheld magnet, only respondents from 5 (five) facilities (n=5) representing 5(22%) and 15(fifteen) facilities (n=15) representing 15(65%) confirmed the availability of ferromagnetic detection system and handheld magnet respectively in their facilities which is worrisome and not in line with the recommendations of the ACR guidelines on International Safety. When compared to related literatures, Johnson et al., (2010) in a similar work reported a significant level of compliance of about 96% which is far better when compared to the current study, Pinnac et al., (2007) in a correlative study also reported high level of compliance to the use of ferromagnetic detection system and handheld magnet which is also encouraging and much better than the level of compliance reported from the findings in the current study which is worrisome and far below the ACR guidelines.

With regards to the availability of accessories for emergency preparedness, most respondents indicated they have fire tender (87%) and other source of power in case of outage (96%). However, the low availability of MRI-compatible crash carts (9%) and emergency resuscitation equipment (36%) within the MRI suites is appalling and clearly not in agreement with the International safety recommendations. Opoku et al., (2013) in a correlative study also recorded a significantly low level of the availability of MRI compatible crash carts (9%) and emergency resuscitation equipment (36%) within the MRI suite which corresponds with the findings in the current study.

It was noted in the study that majority of the respondents indicated they lacked drills on emergency response protocols (46%) which is supported by their lack of documents to show for it and also not in agreement with the ACR guidelines. Indeed, Studies have shown that many health professionals are unprepared for a disaster or sometimes even common medical emergencies (Gould, 2008).

The study revealed that most facilities have earplugs; 22 (96%) and compatible wheelchairs; 22 (96%), however most lacked MRI compatible trolleys 10 (44%), and about 6 (26%) indicated they lacked headphones which is not encouraging and when compared to related literatures, Junk et al., (2007) reported high level of compliance to the use of ear plugs, MRI compatible wheelchairs, MRI compatible trolleys and headphones which is far better than the findings from the current study, Karnal et al., (2008) also reported high level of compliance to the use of MRI compatible trolleys and headphones in line with the ACR guidelines which is encouraging when compared with the findings from the current study.

Impressively from the current study, all respondents indicated that they check all equipments brought into the MRI suite 23 (100%). This is obviously an improvement compared to the study conducted by Opoku et al., (2013) in which they reported that 75% respondents indicated they check equipment used in the MRI environment. The study also revealed that most respondents 19 (83%) indicated they have emergency exit door. However, none of the respondents indicated the equipment used in the MRI suite are colour coded which is not in line with ACR document on safety guidelines. Johnson et al., (2105) in a correlative study reported a high level of compliance with colour coding in a similar study which does not correspond with the findings from the current study.

Finally, from the current study in southern Nigeria, for accessories for emergency, a lot of respondents indicated that they have fire tender (87%) and other sources of power (96%). Contrast reaction occurred more representing (87%), others are projectile incidents and fire outbreak incidents both representing nine percent (9%) which correlates with the findings from (Opoku et al, 2013) in a similar study in Ghana.

Conclusion

This study shows the current MRI safety practices in the south-west, south-east and south-south geopolitical zones of Nigeria. It was generally encouraging that most respondents

(radiographers) indicated and demonstrated high level of compliance in some areas of the study, there were still some critical areas that the response was very low and hence, there is need for improvement generally with compliance to the ACR guidelines.

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