

Awareness of Interventional Radiology Among Medical Students in Saudi Arabia

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Abstract: Introduction: Interventional Radiology (IR) has become an important medical subspecialty, offering minimally invasive diagnostic and therapeutic procedures. However, awareness of IR among medical students remains limited, which may affect their understanding of the specialty and future career choices. **Aim:** This study aimed to assess awareness and perceptions of IR among medical students and interns studying or training in Saudi Arabia and to explore factors associated with their level of awareness. **Methods:** A cross-sectional questionnaire-based study was conducted from March to June 2024 among 110 medical students and interns using non-probability convenience sampling. Data were collected through a self-administered online questionnaire. Descriptive statistics, Mann-Whitney U and Kruskal-Wallis tests and ordinal logistic regression were used to analyze the data. **Results:** Forty-nine participants (44.5%) reported being familiar with IR, while the mean self-rated awareness score was 2.76 ± 1.16 out of 5 (95% CI, 2.54-2.98). Self-rated awareness did not differ significantly between pre-clinical and clinical participants ($p = 0.641$). However, awareness differed significantly according to the level of IR educational exposure ($p < 0.001$). Greater educational exposure to IR was independently associated with higher self-rated awareness (adjusted OR = 2.82, 95% CI 1.85-4.30, $p < 0.001$). Lack of resources or tools was the most frequently reported training challenge (42.7%), while simulation-based training was the most commonly suggested strategy for improving IR education (72.7%). **Conclusion:** Awareness of IR among the surveyed medical students and interns was limited. Greater educational exposure was strongly associated with higher awareness, whereas academic stage alone was not. These findings support the value of structured IR education, including simulation and practical exposure, within undergraduate medical training.

Key Words: Interventional Radiology, Medical Students, Awareness

INTRODUCTION

Interventional Radiology (IR) is a rapidly evolving medical specialty that uses minimally invasive, image-guided techniques to diagnose and treat a wide range of medical conditions in various body systems. Leveraging advanced imaging technologies, such as fluoroscopy, ultrasound, Computed Tomography (CT) and Magnetic Resonance Imaging (MRI), interventional radiology enables precise, targeted interventions with reduced operative risks compared to traditional open surgery [1-4]. These advantages have resulted in shorter hospital stays, lower complication rates, reduced healthcare costs and improved patient satisfaction, making interventional radiology a cornerstone of modern, value-based healthcare [5]. Interventional radiologists now play a pivotal role in the management of vascular diseases through angioplasty, stenting, thrombolysis and embolization, as well as in the

care of oncology patients through procedures such as transarterial chemoembolization, radiofrequency ablation and microwave ablation [3-6]. In addition, interventional radiology makes significant contributions to trauma care, hepatobiliary interventions, women's health procedures, underscoring its clinical versatility and growing importance [5,7].

Evidence consistently shows that interventional radiology remains underrepresented in undergraduate medical education worldwide [1,3]. Several international studies have reported limited awareness of IR among medical students, particularly regarding its procedural scope, clinical applications and career pathways. However, the reported level of awareness has varied between studies. While some studies found generally poor knowledge of IR, others reported better awareness among students with greater clinical exposure or

previous participation in IR-related teaching [1,6,8]. These differences may reflect variations in curriculum structure, access to clinical rotations and opportunities for direct exposure to the specialty.

Similar findings have been reported in Saudi Arabia, although awareness levels have not been consistent across institutions and student groups. Some studies have shown limited familiarity with IR and insufficient curricular exposure, whereas others found greater awareness among students who had attended lectures, workshops, electives or clinical training related to IR [7,13]. These differences suggest that students' awareness may be influenced by the level and type of educational exposure available at individual medical schools. This variation supports the need for further assessment across different institutions and stages of medical training.

Professional organizations, including the European Society of Cardiovascular and Interventional Radiology (CIRSE) and the Society of Interventional Radiology, have emphasized the urgent need for structured interventional radiology education at the undergraduate level [3,10,14]. Proposed strategies include integrating interventional radiology into the curriculum early, dedicated lectures, simulation-based training and supervised clinical training to familiarize students with the principles of interventional radiology and its clinical applications [14]. Evidence suggests that these interventions not only improve knowledge and confidence but also correct misconceptions and foster an understanding of the patient-centered nature of interventional radiology [10]. However, the implementation of standardized interventional radiology curricula remains inconsistent across medical schools, particularly in developing and transitional healthcare systems. Barriers such as the limited availability of trained faculty, resource constraints and rigid curriculum structures continue to hinder the effective integration of interventional radiology into university education [7]. These challenges highlight the need for institution-specific assessments to guide targeted educational reforms.

In the context of Saudi Arabia's Vision 2030, which prioritizes innovation in healthcare, the adoption of advanced medical technologies and the development of a highly skilled national workforce, enhancing interventional radiology education is both timely and strategically important. Improving medical students' knowledge of interventional radiology aligns with national objectives for capacity building, enhancing the quality of healthcare and ensuring the sustainability of minimally invasive services. Ensuring that future physicians possess sufficient knowledge in interventional radiology is crucial for improving patient care pathways and supporting the long-term growth of this specialty in the Kingdom.

Although previous studies in Saudi Arabia have explored medical students' awareness of interventional

radiology, there is still limited information about students from different universities in Saudi Arabia and how they view their exposure to IR, the challenges they face during training and the ways they believe IR education could be improved. Therefore, this study aimed to assess awareness of interventional radiology among medical students and interns studying or training in Saudi Arabia and to explore their perceptions of IR training, related challenges and educational needs. By including students from different universities and stages of medical training in Saudi Arabia, this study provides an updated local picture of IR awareness while also examining perceived training barriers and students' preferred approaches for improving IR education.

The study addressed the following research questions:

- What is the level of awareness of interventional radiology among medical students in Saudi Arabia?
- How do students perceive their exposure to IR education and training?
- What are the main challenges and concerns students associate with IR training and career choice?
- What educational approaches do students believe could improve undergraduate exposure to IR?

METHODS

A cross-sectional questionnaire-based study was conducted from March to June 2024 among medical students and interns studying or training in Saudi Arabia. A total of 110 medical students and interns were included in the study, representing different stages of medical education.

A non-probability convenience sample was used. Eligible participants were medical students from the second year through internship who were studying or undertaking internship training in Saudi Arabia. The survey link was distributed electronically through student and faculty communication channels. Because the exact number of eligible students who received or viewed the invitation could not be determined, a conventional response rate could not be calculated. Before answering the questionnaire, written informed consent was obtained, participation was voluntary and participants were informed about the purpose of the study. Participants who refused to participate were not included; only those who provided consent were included in the study.

The questionnaire was an online, self-administered questionnaire developed by the research team based on relevant literature and the study questions. It was reviewed by experts in radiology and medical education to assess content validity. Because the questionnaire consisted mainly of independent items assessing different domains rather than a single multi-item scale, internal consistency using Cronbach's alpha was not calculated for the questionnaire as a whole.

The questionnaire comprised 16 items across two sections. Section 1 captured demographic characteristics, including gender, study year (2nd-6th year/intern) and university affiliation. Section 2 assessed IR familiarity and educational exposure, perceived challenges during IR training, radiation-related perceptions, suggestions to improve training, career interest in IR and a single-item self-rated awareness score on a 5-point scale (1 = very low to 5 = very high). The complete questionnaire is provided in Supplementary Material 1.

Data were analyzed using IBM SPSS Statistics, version 26. Descriptive and inferential statistics were used. Categorical variables were summarized using frequencies and percentages, while the self-rated awareness score was summarized using the mean and standard deviation. Differences in awareness scores between two groups were assessed using the Mann-Whitney U test, while comparisons involving more than two groups were assessed using the Kruskal-Wallis test. Associations between categorical variables were examined using the chi-square test where appropriate. Ordinal logistic regression was performed to identify factors independently associated with higher self-rated IR awareness. Adjusted Odds Ratios (ORs) with 95% Confidence Intervals (CIs) were reported. A p-value <0.05 was considered statistically significant.

RESULTS

A total of 110 medical students and interns were included in the study. Of these, 69 (62.7%) were male and 41 (37.3%) were female. Participants represented different

stages of medical education, with third-year students forming the largest student group (27.3%), followed by fourth-year students (26.4%) and interns (22.7%). Participants were drawn from several institutions, with the largest proportions from the University of Jeddah (42.7%), King Abdulaziz University (22.7%) and King Saud bin Abdulaziz University for Health Sciences (13.6%) (Table 1).

Among the 110 participants, 49 (44.5%) reported being familiar with interventional radiology, 34 (30.9%) responded "maybe," and 27 (24.5%) reported that they were not familiar with IR. The mean self-rated awareness score was 2.76 ± 1.16 out of 5 (95% CI, 2.54-2.98). Twenty-five participants (22.7%) reported high awareness, corresponding to scores of 4 or 5 (Table 2).

Lack of resources or tools was the most frequently reported challenge during IR training, reported by 47 participants (42.7%). This was followed by lack of adequate supervision among 36 participants (32.7%) and work pressure among 19 participants (17.3%). Eight participants (7.3%) provided other responses, including not currently being in IR training or not having encountered specific training challenges (Table 3).

Fear of radiation exposure was reported as a reason for not pursuing interventional radiology by 43 participants (39.1%), while 35 (31.8%) indicated that it was partially a reason. Thirty-two participants (29.1%) reported that fear of radiation exposure was not a reason for avoiding IR (Table 4).

Forty-one participants (37.3%) reported that they would consider interventional radiology as a potential

Table 1: Demographic Characteristics of Participants (N = 110)

Variable	Category	Frequency (n)	Percentage (%)
Gender	Male	69	62.7
	Female	41	37.3
Study year	2nd year	7	6.4
	3rd year	30	27.3
	4th year	29	26.4
	5th year	13	11.8
	6th year	6	5.5
	Intern	25	22.7
University	University of Jeddah	47	42.7
	King Abdulaziz University	25	22.7
	King Saud bin Abdulaziz University for Health Sciences	15	13.6
	Ibn Sina Medical College	10	9.1
	Batterjee Medical College	6	5.5
	Al-Baha University	3	2.7
	Imam Abdulrahman Bin Faisal University	1	0.9
	Imam Mohammad Ibn Saud Islamic University	1	0.9
	Vision Colleges	1	0.9
	Middle Tennessee State University*	1	0.9

The Participant Affiliated with Middle Tennessee State University was Completing Internship Training in Saudi Arabia at the Time of Participation

Table 2: Awareness of Interventional Radiology

Measure	Response/Statistic	n (%) / Value
Familiar with IR	Yes	49 (44.5%)
	Maybe	34 (30.9%)
	No	27 (24.5%)
Self-rated awareness score	Mean $\pm$ SD	2.76 $\pm$ 1.16
	95% CI	2.54-2.98
High awareness (score 4-5)	Yes	25 (22.7%)

career choice. Thirty-seven (33.6%) reported that they would not consider IR because of concerns about radiation exposure, while 29 (26.4%) indicated that they were not interested in the specialty. Three participants (2.7%) were uncertain and responded "maybe" (Table 5).

Simulation-based training was the most frequently suggested approach for improving IR training, selected by 80 participants (72.7%). Increasing hands-on training hours was suggested by 55 participants (50.0%), while 47 (42.7%) recommended greater supervision by senior doctors (Table 6).

Self-rated IR awareness did not differ significantly between pre-clinical and clinical students (Mann-Whitney U = 1279.0, $p = 0.641$) or between male and female participants (U = 1477.5, $p = 0.689$). In contrast, awareness differed significantly according to the reported

level of IR educational exposure (Kruskal-Wallis H = 22.86, $p < 0.001$). Mean awareness increased from 2.13 ± 1.13 among participants who reported no familiarity with IR training to 3.82 ± 1.01 among those reporting a good understanding of IR (Table 7).

In ordinal logistic regression, greater IR educational exposure was independently associated with higher self-rated awareness (adjusted OR = 2.82, 95% CI 1.85-4.30, $p < 0.001$). Clinical stage and gender were not independently associated with awareness (Table 8).

Figure 1 shows that 44.5% of participants reported being familiar with interventional radiology, while 30.9% were uncertain and 24.5% reported that they were not familiar with IR.

Figure 2 illustrates the main challenges reported during IR training. Lack of resources or tools was the most

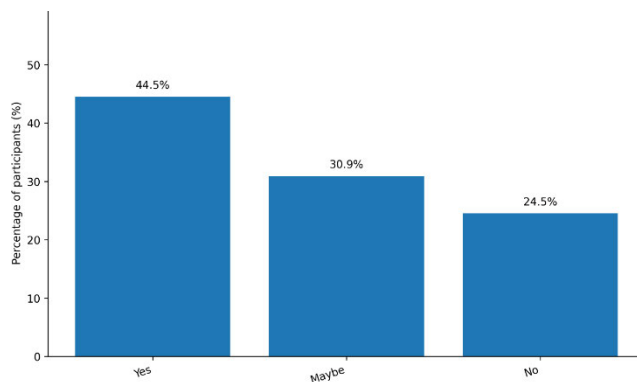


Figure 1: Familiarity with Interventional Radiology Among Medical Students and Interns (N = 110)

Table 3: Challenges Reported During Interventional Radiology Training (N = 110)

Challenge	Frequency (n)	Percentage
Lack of resources or tools	47	42.7
Lack of adequate supervision	36	32.7
Work pressure	19	17.3
Other responses*	8	7.3

*Other responses included participants who indicated that they were not currently trainees, had not yet encountered challenges or provided other individual comments

Table 4: Fear of Radiation Exposure as a Reason for Not Pursuing Interventional Radiology (N = 110)

Response	Frequency (n)	Percentage
Yes	43	39.1
Partially	35	31.8
No	32	29.1

Table 7: Factors Associated with Self-Rated Interventional Radiology Awareness

Factor	Comparison/Effect	Statistical result	p-value
Study stage	Pre-clinical vs clinical	Mann-Whitney U = 1279.0	0.641
Gender	Male vs female	Mann-Whitney U = 1477.5	0.689
Level of IR educational exposure	Four exposure levels	Kruskal-Wallis H = 22.86	<0.001

Table 8: Multivariable Ordinal Logistic Regression

Predictor	Adjusted OR	95% CI	p-value
Greater IR educational exposure	2.82	1.85-4.30	<0.001
Clinical stage	1.21	0.60-2.46	0.592
Male gender	0.97	0.48-1.99	0.944

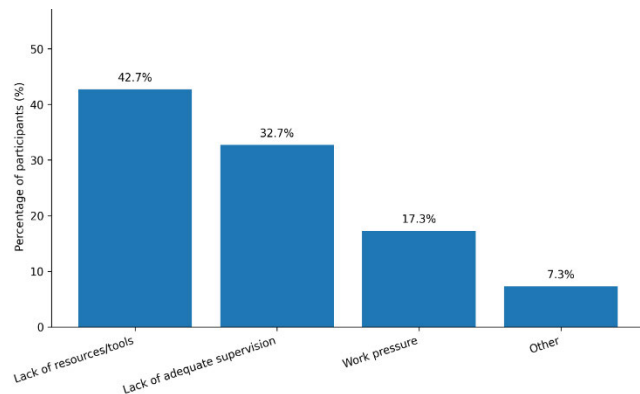


Figure 2: Main Challenges Reported During Interventional Radiology Training (N = 110)

Table 5: Interventional Radiology as a Potential Career Choice (N = 110)

Response	Frequency (n)	Percentage
Yes	41	37.3
No, because of high radiation exposure	37	33.6
No, because I am not interested	29	26.4
Maybe	3	2.7

Table 6: Suggested Approaches to Improve Interventional Radiology Training (N = 110)

Suggested approach	Frequency (n)	Percentage of participants
Simulation-based training courses	80	72.7
Increase hands-on training hours	55	50.0
Increase supervision by senior doctors	47	42.7

Multiple responses were permitted; therefore, percentages do not sum to 100%

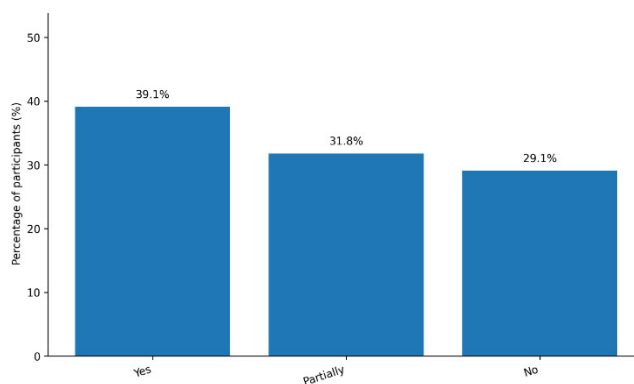


Figure 3: Fear of Radiation Exposure as a Reason for Not Pursuing Interventional Radiology (N = 110)

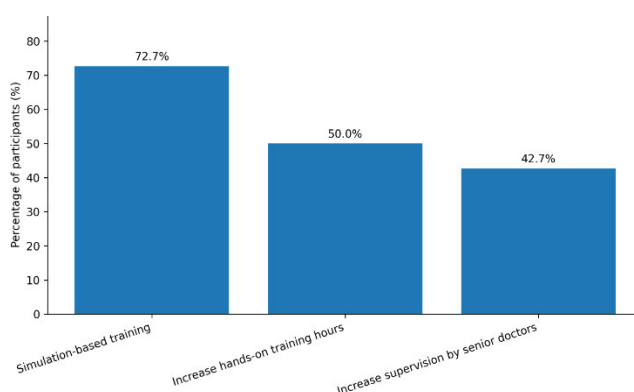


Figure 4: Suggested Approaches to Improve Interventional Radiology Training (N = 110)
Multiple responses were permitted

commonly reported challenge (42.7%), followed by inadequate supervision (32.7%) and work pressure (17.3%). Other responses accounted for 7.3%.

Figure 3 shows participants' responses regarding fear of radiation exposure as a reason for not pursuing IR. Overall, 39.1% reported that radiation exposure was a reason, 31.8% indicated that it was partially a reason and 29.1% reported that it was not a reason.

Figure 4 summarizes participants' preferred approaches for improving IR training. Simulation-based training was the most frequently suggested approach (72.7%), followed by increasing hands-on training hours (50.0%) and increasing supervision by senior doctors (42.7%). Multiple responses were permitted for this question.

DISCUSSION

This study assessed awareness and knowledge of interventional radiology among medical students and interns in Saudi Arabia. The findings showed that only 44.5% of participants reported being familiar with IR, indicating that awareness of the specialty remains limited

within the study sample. This finding highlights a significant educational gap regarding IR during undergraduate medical training.

This result aligns with prior reports indicating limited exposure to IR among medical students. In India, Agrawal *et al.* reported that 60% of medical students described their IR knowledge as very poor/poor, suggesting that insufficient curricular coverage may contribute to low perceived competence [15]. Similarly, recent research in Saudi Arabia reported that medical students' exposure to IR remains limited, highlighting the need for greater integration of IR education into medical curricula [7]. Taken together, these findings suggest that the observed knowledge gap may be influenced by limited curricular exposure to IR.

Students at different stages of medical education may have different opportunities for exposure to IR; however, in the present study, self-rated awareness did not differ significantly between pre-clinical and clinical students. This suggests that progression through medical school alone may not necessarily lead to greater awareness of IR. In contrast, students with greater educational exposure to IR reported significantly higher awareness levels. This finding is consistent with previous studies showing that lectures, electives, workshops and clinical exposure can improve medical students' knowledge and understanding of IR [8,16,17]. Structured educational exposure may therefore play a more important role in improving awareness than academic seniority alone.

The limited exposure to IR within medical curricula has emerged as a major factor behind its low awareness. Despite its well-established role in the diagnosis and treatment of conditions such as cancer, vascular diseases and spinal disorders, it remains underrepresented in university education. This finding is consistent with Alnajjar *et al.* [18], who reported that students who had undertaken or intended to undertake, an IR elective were more informed about the specialty than those without elective exposure, highlighting the potential value of structured IR electives in improving students' understanding and recognition of IR.

Fear of radiation exposure remained an important concern among participants. In this study, 39.1% reported that fear of radiation exposure was a reason for not pursuing IR, while a further 31.8% indicated that it was partially a reason. This may reflect ongoing uncertainty or misconceptions regarding occupational radiation risks and highlights the importance of strengthening radiation safety education during undergraduate training [18]. Targeted teaching on radiation protection and risk communication may help address these concerns.

Regarding preferred approaches to improve IR training, simulation-based training was the most frequently suggested strategy (72.7%), followed by

increased hands-on training hours (50.0%) and greater supervision by senior doctors (42.7%). These findings suggest that students place particular value on practical and structured learning opportunities. Previous studies have similarly highlighted the potential role of simulation and supervised clinical exposure in improving students' understanding and confidence in IR [11,22,23].

The findings also have implications for undergraduate medical education. Rather than relying mainly on incidental clinical exposure, medical schools could consider introducing structured IR teaching within relevant radiology and clinical modules. Short introductory lectures, supervised observation in IR units, simulation-based activities and focused teaching on radiation safety may help improve students' understanding of the specialty and address common concerns. These approaches could be incorporated without requiring a separate full course, making them more practical within existing medical curricula.

CONCLUSIONS

Awareness of interventional radiology among the surveyed medical students and interns was limited, with 44.5% reporting familiarity with the specialty and a mean self-rated awareness score of 2.76 ± 1.16 out of 5. Greater educational exposure to IR was significantly associated with higher awareness, whereas awareness did not differ significantly between pre-clinical and clinical participants. Lack of resources or tools and inadequate supervision were the most commonly reported training challenges, while simulation-based training and increased hands-on exposure were the most frequently suggested approaches for improving IR education. These findings support the value of structured educational exposure to IR within undergraduate medical training. Larger studies involving more diverse samples across Saudi Arabia are recommended to confirm these findings and further evaluate effective approaches to IR education.

Limitations

This study has several limitations. First, the cross-sectional design does not allow causal relationships to be established. Second, the use of convenience sampling may have introduced selection bias and limits the generalizability of the findings. Third, the relatively small sample size may limit the precision of some subgroup and multivariable estimates. In addition, awareness and perceptions were self-reported and may therefore be affected by response bias. The study also included participants from multiple institutions using an open electronic survey, which prevented calculation of a conventional response rate. Finally, no formal a priori sample-size calculation was performed.

Future research should include larger samples from multiple regions of Saudi Arabia to improve the generalizability of the findings. Studies using objective measures of IR knowledge may provide a more accurate assessment of students' understanding. In addition, educational intervention studies could evaluate the effect of structured lectures, simulation-based training, electives and supervised clinical exposure on students' knowledge and perceptions of IR.

Ethical Consideration

As the study involved an anonymous questionnaire with no collection of personally identifiable information, formal Institutional Review Board approval was not required under institutional policy.

Participation was voluntary, informed consent was obtained before completion of the questionnaire and the study was conducted in accordance with the ethical principles of the Declaration of Helsinki.

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Supplementary Material 1: Questionnaire Used to Assess Awareness and Perceptions of Interventional Radiology Among Medical Students

No.	Questionnaire item	Response options
1	Agreement to participate in this research	Agree/Disagree
2	What is your gender?	Male/Female
3	What is your study year?	2nd year/3rd year/4th year/5th year/6th year/Intern
4	What is your university?	University of Jeddah/King Abdulaziz University/King Saud bin Abdulaziz University for Health Sciences/Other
5	Are you familiar with interventional radiology?	Yes/Maybe/No
6	Have you received sufficient training and learning in interventional radiology during your studies?	Yes, I have a good understanding/Yes, but only basic knowledge/No, I have heard of it but do not know much/No, I am not familiar with it at all
7	According to your knowledge, is interventional radiology used for:	Diagnostic procedures/Therapeutic procedures/Both/Neither
8	According to your knowledge, is interventional radiology more invasive than traditional surgery?	Yes/No
9	According to your knowledge, can imaging modalities such as CT, MRI, ultrasound, and nuclear medicine be used to assist interventional radiology procedures?	Yes/No
10	What are the biggest challenges you face as a trainee in interventional radiology?	Lack of resources or tools/Lack of adequate supervision/Work pressure/Other
11	Is fear of radiation exposure a reason for not pursuing interventional radiology?	Yes/Partially/No
12	Do you think medical students receive sufficient information about interventional radiology during their studies?	Yes/Partially/No
13	In your opinion, is the limited spread of interventional radiology due to:	High cost of equipment and procedures/Concerns about radiation exposure/Shortage of trained radiologists/Other
14	What are your suggestions for improving the training program?	Increase hands-on training hours/Provide simulation-based training courses/Increase supervision by senior doctors
15	Would you consider interventional radiology as a potential career choice?	Yes/No because of high radiation exposure/No because I am not interested/Maybe
16	On a scale of 1 to 5, how would you rate your overall awareness of interventional radiology?	1 = Very low/2/3/4/5 = Very high