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Preparation for Clinical Practice in Radiology: A Survey of Interns and Radiologists

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for the degree of

MRes (MASTER OF RESEARCH) in Health Professions Education

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ABBREVIATIONS:

ACR	American College of Radiologists
UCC	University College Cork
HSE	Health Service Executive
GMC	General Medical Council
UL	University of Limerick
RCSI	Royal College of Surgeons in Ireland
TCD	Trinity College Dublin
IMC	Irish Medical Council
ESR	European society of radiolology
EU	European Union
CT	Computed Tomography
US	Ultrasound
MRI	Magnetic Resonance Imaging
PET	Positron Emission Tomography
ALARA	As Low As Reasonable Achievable
eGFR	Estimated Glomerular Filtration Rate
CIN	Contrast-Induced Nephropathy
NSF	Nephrogenic Systemic Fibrosis
PRHO	Pre Registration House Officer
GPs	General Practitioners
NCHD	Non Consultant Hospital Doctor
SPR	Specialist Registrar

NG Tube	Nasogastric Tube
GCM	Group Concept Mapping
PHPQ	Preparation for Practice Questionnaire
EPA	Environmental ProtectionAgency
HIQA	Health Information and Quality Authority
MERU	Medical Exposure Radiation Unit

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DECLARATION:

"*This is to certify that the work I am submitting is my own and has not been submitted for another degree, either at University College Cork or elsewhere. All external references and sources are clearly acknowledged and identified within the contents. I have read and understood the regulations of University College Cork concerning plagiarism."*

Dr Thabisile Simelane.

Signature---------- Date----------

Abstract:

Title:

Preparation for Clinical Practice in Radiology: A Survey of Interns and Radiologists

Objective:

The purpose of this study was to evaluate interns' preparedness to deal with radiology departments, and to identify knowledge gaps which will facilitate the design of simplified evidence-based radiology orientation course for students or newly qualified doctors, to ease the transition from theory to practice.

Methods:

A cross-sectional, mixed-methods approach was employed.

A sample of Irish interns and practicing radiologists were asked to complete a quantitative survey regarding perceptions of intern readiness to interact with the radiology department. A mixed quantitative/qualitative analysis using group concept mapping was also conducted involving perspectives of doctors in various categories, including NCHDs, and consultants, to evaluate what topics should be covered in a related preparatory course. Pearson's Chi Square analysis was employed to examine the association between socio-demographic and educational variables and selected categorical item responses. Kruskal-Wallis analysis of variance (ANOVA) and/or Mann–Whitney U tests were employed to carry out univariate comparisons.

Results:

The majority of interns 66%9 n=66) and radiologists 52%(N=26) felt that undergraduate medical training did not prepare the interns to interact with radiology department. More than half of the intern respondents 52%(N=52) were frequently uncertain about radiology exam indication when completing a request form. Most interns identified challenges in choosing appropriate examinations and communicating with the radiology department. A significant number also regarded the radiology department as unapproachable. Most radiologists 92%(N=92) felt that intern understanding of indications for imaging modalities is inadequate, reflecting intern uncertainty regarding exam indications. Most radiologists 86%(N=43) perceived that interns' understanding of contrast medium was inadequate, and 78%(N=39) perceived that interns were lacking in the knowledge of (N=39) radiation protection.

Results of the group concept analysis suggested the following topics to be included in the intern radiology preparatory module: ordering investigations; clinical decision support; radiology department IT and communication; adverse reactions and risks; urgent imaging; interpretation of radiology results.

Conclusion:

This study has highlighted vital topics to be included if one were to design a preparatory module in radiology which would promote smooth transition from theory to practice. Future research would be to design, implement, and evaluate an appropriate preparatory module.

Introduction

Are interns sufficiently prepared to interact with the radiology department? This study represents a comprehensive assessment of junior doctors' interactions with the radiology department, with a view to identifying competencies that are required during the first year of practice as a medical doctor, and to gauge how students can be best prepared to develop these during undergraduate medical school training.

An internship year is the first year of postgraduate medical training, and is an important and necessary step in every doctor's career in Ireland. (1) It is compulsory for newly trained doctors to complete an internship year where they are supervised and assisted to commence their new role in the medical profession. This is an exciting phase, but it is not without challenges. It has been reported that the transition from study to work is stressful, and challenging (2), and the first postgraduate year is associated with high levels of distress and burnout. (2,3) Burnout is reported to be more prevalent in younger doctors compared to more experienced, older doctors (4, 5); psychological distress is also reported to be ten times more prevalent in doctors younger than thirty years of age, compared with those of same age in other professions. (4)

There are additional challenges during the internship year such as graduates' perception of large gaps in their knowledge and skills during this transition from medical school to professional practice. These challenges include the following: workload increases, longer working hours, on-call duties, changes in lifestyle, assuming responsibilities for patient care (4); uncertainty about the various parts of their role, including daily duties (3); unfamiliarity with the preferences of individual consultants and registrars (2); adequate filling of imaging request forms and knowing which examinations to request. (6) In a more general clinical

context, they are exposed to scenarios which they may feel ill prepared for, e.g. handling emergency situations in the wards, like NG tube positions, and responding to questions from other professionals such as nursing and radiography colleagues. This thesis uses scientific methods to identify the challenges which new doctors experience when working with radiology department, and aims to explain why these occur and learn what can be done to make this transition from student to health professional smooth, manageable, and empowering.

1.1 Background

In the current century, imaging plays an important role in patient evaluation, management, and monitoring of therapeutic responses; in some interventional procedures, imaging can have a therapeutic role. Radiology is a unique multidisciplinary speciality that interacts with all other specialities. A wide range of specialities depend on the input from imaging data in order to make informed decisions to facilitate optimal patient management, and to provide guidance regarding follow up; in these scenarios, radiological imaging often provides answers to important clinical questions. (7)

Imaging plays an important role in patient management (8), regulating patient flow in the emergency department by identifying the patients that require immediate or urgent attention, even admission. Imaging can also assist in minimising unnecessary admissions, and facilitate discharge of those patients that do not have immediate risk by characterising the nature of the disease processes. Since the advent of advanced cross-sectional imaging and interventional radiology, patient management has significantly changed, with improved outcomes including shorter hospital stays. (7, 9), 10, 11) Medical imaging has resulted in a reduction in surgery-related cost and morbidity, with subsequent reduction in the number of patients that undergo

invasive procedures like exploratory laparotomy, thus enabling minimally invasive alternatives to surgery. (7, 12, 13) Radiology also assists in visualisation of the internal anatomy, physiology, and pathology, thereby assisting the clinicians to establish diagnoses. (12)

The demand for radiological imaging has increased, with a rapid annual increase in the volume of the imaging examinations. Bhogal et al. reported a 12-fold increase in the number of investigations performed in the last two decades in Europe, a 20-fold increase in the USA, with an estimated 62 million imaging examinations performed annually. (8) Shyu & Sodickson (14) reported an estimated 81 million CT examinations in the USA in 2014.(14) In Ireland, approximately 2.4 million examinations are performed annually, with an estimated cost of 350 million euros; an increase of 8-10% is observed per year. (15) There is a recognition of an increased need for radiology competency for doctors in all sub-specialties since there is continuous rise in the utilisation of diagnostic imaging (16), as well as the fact that radiology is a rapidly advancing specialty, with fast technological development. (8) At an undergraduate level, the use of radiology by anatomical educators has increased as it has been integrated with anatomy . (17), (18)

Thoroughly preparing medical students for clinical practice is one of the objectives of the undergraduate medical curriculum. (19) Preparing them regarding radiology-related matters such as appropriateness of an imaging modality, documentation, and communication, would help them to understand how the radiology department functions, including the examinations performed, resulting in well informed clinicians who will develop into mature specialists. Hendee et al. (13) assert that educating physicians, and other individuals who request imaging on behalf of physicians, on the use and limitations of imaging should commence at the

undergraduate level and should be a continuous process, initiated and supported by the radiological team. (13)

There is a requirement for a proportionate increase in radiology teaching during the undergraduate curriculum. In a survey-based study of medical students, which involved an evaluation of radiology exposure and training at the undergraduate level, Nyhsen et al. (20) asserted that most students felt that radiology teaching received in the preclinical undergraduate years was inadequate and concluded that early exposure to radiology and interventional procedures should be encouraged. They stated that radiology should be taught in all undergraduate years, and that the preferred method is interactive teaching, but should also include eLearning options. (20) Radiology can be taught as part of other clinical disciplines, or as a standalone area; in some studies the latter is preferred, the reason being to encourage the students to concentrate specifically on radiology. (20,21) In another survey of medical students, Dmytriw et al. (22) asserted that radiology teaching in their institution had declined over the years; this was supported by the results of a survey in which the majority of the medical students, 63%, felt that radiology teaching was inadequate, and 19% indicated it was very inadequate. (22)

Undergraduate radiology teaching should be designed to educate trainee doctors on how to appropriately undertake radiology department-related matters, which are pivotal to patient management and safety. There is concern about the adequacy of mentoring that newly qualified doctors receive, and the impact on their own and patients' wellbeing. Specifically, there have been concerns that the doctors in their first year of training after graduation from medical school are being asked to act above their level of competency, for example, being required to obtain patient consent for procedures which the intern is unfamiliar with. (23) The Irish

Medical Council intern survey indicated that interns can be subjected to bullying and inadequate supervision. (24) Medical interns should be supported, guided, and nurtured so that they are able to deal with the challenges of their new profession. (25) These challenges are compounded by the current condition of the healthcare system.

There have been numerous challenges facing the Irish healthcare system. Complex issues are involved, including the shortage of staff (including consultants, hospital doctors, and nurses), increased disease burden, over-crowded acute emergency departments, and the migration of the junior doctors to more supportive countries. A negative or unsupportive training environment in Ireland has been highlighted as one of the reasons why junior doctors consider their options abroad. (26) The Irish Medical Council report has asserted that continuous improvement in the trainee experiences of medical education and training in Ireland would positively impact on retention of doctors within the Irish system. (24) These factors have an impact within the health sector, hence measures should be taken to support young doctors, assist them to settle, build morale, so that they are well equipped to deal with the challenges during their first year of practice. Identifying the knowledge gaps in areas of service delivery, including radiology, and taking measures to address these would increase the confidence of the newly qualified doctors, and will improve patient safety.

The introduction of the European Working Time Directive (EWTD,2003/88/EC) has produced important differences with respect to shift work conditions for doctors in training; this was enshrined in Irish law in July 2004 (S.I.No.494 of 2004), and was aimed at creating balance, and reducing stress for the junior doctors. It has been a positive development; however it is not

uncommon that interns find themselves assuming more responsibility for patient care, in a restricted time, and sometimes with inadequate interaction or supervision by senior members of the team. (27) In this scenario, the intern might be the only doctor available to manage acutely ill patients, request and discuss the radiology examination, sometimes without support, e.g. the surgical rotation, where the team might be in theatre or during the on call duties. (2) (28)

There is a demand for innovative approaches towards the development of evidence-based preparatory teaching to enable a smooth transition from undergraduate medical training to practising as an intern, thereby encouraging younger doctors to stay in the country and also improving patient safety. This research aims to identify the knowledge gaps, and competencies required to help develop an undergraduate radiology teaching curriculum which prepares graduates for internship year.

1.1.1 Place of radiology in the undergraduate medical curriculum

Various studies have highlighted the need for inclusion of radiology in undergraduate training. (9, 20-21, 29, 78) Gunderman et al. (7) assert that if radiology is not taught or inadequately taught, most students will not think of pursuing radiology as career, whereas if radiology is well taught at the undergraduate level, even those who will pursue other specialities will have a better understanding of radiology, and communicate better with radiology department. Jimmy et al. (29) asserted that a good foundation in, and understanding of, radiology is essential in all practice areas of clinical medicine. It is essential that referrers requesting radiologic investigations must clearly understand various modalities, their contraindications, limitations, and which modality is most suitable for a given clinical scenario. (29) A strong undergraduate

training in radiology will result in efficient, and improved patient care, thus reducing unnecessary imaging examinations, minimising the potential harm to patients and reduce costs. (29)

Sadler et al. (30) conducted an electronic survey that was distributed to the organisers of anatomy teaching at 35 UK medical schools. A high response rate (29/35, 83%) was obtained for participating medical schools, and the study demonstrated that there had been an increase in the involvement of radiology in anatomy teaching. The majority of anatomy departments in the United Kingdom expressed the requirement for more direct radiologist involvement in the undergraduate medical training. They highlighted the importance of collaboration between anatomy and radiology departments. This group also asserted that radiological images were utilised as part of anatomy education by all medical schools who participated in their study. (30).

Oris and colleagues (31) distributed a web-based questionnaire to radiology teaching staff from 93 European teaching institutions. The results of the study showed that radiology teaching was an integral part of both conventional and modern curricula, with almost the same number of hours spent in undergraduate radiology teaching across both types of curricula. In the modern curriculum, radiology teaching commences early in preclinical years, in the first year of the medical training, and is taught mainly by the radiologists and radiology trainees (50%), radiographers (20%), or clinicians (17%). (31) Radiology is an intrinsic part of the medical curriculum in every medical training year in institutions that adopt a modern curriculum approach. In the conventional curriculum, radiology teaching commences only in the last three years. Both conventional and modern curricula focus on radiology imaging

examinations, radiology teaching files, attendance at radiology conferences, and radiology multidisciplinary meetings. (31)

Branstetter et al. (32) asserted that early exposure to radiology resulted in improved impression of radiology as a speciality and resulted in increased interest in radiology as a career. In study by Dmytriw et al. (22), a multi-institutional survey-based study conducted in three medical schools, all medical students were asked to provide their impression of radiology education in their undergraduate medical school curriculum. The majority of the medical students (over 91%), reported that they felt that more radiology teaching was required in the undergraduate medical training. This group asserted that radiology education is essential as every medical practitioner should be able to understand, identify, and interpret the basic radiology imaging. The majority of the students felt that basic understanding of general radiology, and appropriateness criteria were vital for their future clinical practice; that is, being able to select the relevant imaging examinations, and provide adequate clinical information when requesting the studies. Students reported that they preferred different methods of teaching of radiology content, such as lectures, group learning, and web-based modules. (22)

Despite radiology being central to patient management, undergraduate trainees are overall less exposed to radiology, relative to other mainstream specialities like surgery, and medicine. (32) While most studies have concluded that radiology must be integrated in the undergraduate curriculum (12, 29, 31), these studies have also identified the constraints of radiology teaching such as insufficient time in the curriculum. (12, 29) Educator-related matters have also been raised, as academic radiology involvement is poorly remunerated when compared with those

with a high clinical workload, which is better paid (7, 32), and a lack of protected time for teaching in the radiologist's busy daily work schedule. (32)

There are different opinions regarding the categories of undergraduate radiology teachers, with some literature stating that it is important that radiology is taught by radiologists. (12, 18, 33) This view posits that radiology is introduced to students by radiologists at the early stages of training to allow integration, and enhance the level of understanding among the medical trainees. (30) Others assert that radiology can be taught by senior radiographers, hospital radiologists at any grade, clinical consultants, and university radiology lecturers. (29) In this respect, the involvement of radiology specialist registrars has increased in the modern medical curriculum. (29) Undergraduate trainees must acquire certain radiology competencies; these include how to correctly interpret basic imaging adequately and safely, especially in the emergency situations, e.g. misplaced NG tube, chest x-ray, CT brain with haemorrhage, and common fractures. (21, 34) They must be able to request appropriate examinations, provide relevant information, and should be able to understand the implications of radiology results. (34)

Mode of delivery of radiology education

There have been various approaches to teaching radiology including traditional didactic lectures, and interactive learning, which at times may include flipped learning (35), and small group tutorials. (36) Alternative technology-enhanced methods of teaching undergraduate radiology have been described, e.g. online e- learning (37); the latter category includes virtual lectures (38) and video tutorials for specific areas like interventional procedures, and some

have suggested blending online teaching which includes traditional face-to-face teaching methods. (19) (39)

Understanding, and discussing the radiology exams can be also be taught by simulation of the clinical scenario, and giving the students an opportunity to practice these interactions between the radiologist and the interns, using the clinical cases. (34) There has been no consensus on the optimal method of radiology content delivery, and more studies are required to ascertain the most effective method of teaching radiology as part of undergraduate medical training. (40)

Radiology competencies required at the undergraduate level

Apart from being competent in interpretation of basic radiological examinations such as chest x-ray, abdominal x-rays (41), and understanding the role of radiology in disease management in various body systems (21), there are other radiology-related competencies that are important for the junior doctors to comprehend in order to safeguard patient safety. (42) In radiology, the major part of communication between the radiologist and the clinicians is through the request form, which details the patient's clinical information. This should be taught at the undergraduate level so that the doctors will know how to give clear, concise, and relevant clinical information that will assist in patient management. (43) It should be emphasised that the need for imaging is justified based on the clinical history, physical examination, and relevant tests, e.g. blood results where applicable. (8) For example, it is not adequate to request the imaging test based on a clinical history of abdominal pain alone. While there are various causes of abdominal pain, it is important to include relevant information that would assist the

radiologist not only in interpreting the examination, but also to make an informed decision regarding the most appropriate test, the specific protocol for performing the study, and also to advise on the choice of further imaging. An informed decision might require consideration of the onset of pain, the duration, the character, location, distribution, of pain, relevant clinical investigation performed, and the clinical question. The prior relevant medical history, and the existing known comorbidities also form an important aspect of the clinical history.

The clinical request is the most important document which medical undergraduates should clearly understand. Demographic data is an important aspect of patient safety; the use of the personal IT log details should be emphasised as this also has potential legal implications (43), which would be taken into consideration at any stage should a situation arise that requires the case to be reviewed.

With respect to image modalities, and appropriate examinations, undergraduate trainees need to know which modalities are most suitable for given clinical scenarios. They should also understand the contraindications, and the limitations of the various tests. (29) They should be taught about the guidelines; for example, the HSE has adopted the *irefer* guidelines for radiology, and interns must be directed to these, and they should be readily accessible. (21)

Radiation protection is an important aspect in radiology, and should be clearly taught, in simple terms, so that the doctors learn early in their career, about the uses, and adverse effects of radiation. Faggioni et al. (44) conducted a survey study at their academic institution, where respondents were 60 radiology residents, 56 medical students, and 43 student radiographers, and they discovered a significant knowledge gap regarding radiation protection among the

participants; more than half of respondents demonstrated limited knowledge. (44) In another survey-based study by Rickets et al. (45), which aimed to assess their understanding of radiation effects, the participants were patients (N=127), medical students (N=30), and referring physicians (N=32). Almost all the patients, 92%, who were scheduled for the examinations utilising ionising radiation did not have knowledge of radiation, and were not informed of the radiation risks. Some knowledge gaps were also identified among the physicians, and medical students, but these gaps were only observed in less than 50% of the sample. (45) There are specific considerations in children, women of childbearing age, and in pregnancy, as the rapidly dividing cells are more sensitive to radiation (46), and where the long lifespan for children allows for the manifestation of the adverse effects of ionising radiation. (46) Some studies have reported radiation-induced malignancies, such as leukaemia and brain tumours (47), 48), hence the suggestions that paediatric physicians should consider imaging without utilising ionising radiation. (46) There has been a worldwide increase in the number of CT examinations, and this comes with an increased risk for cancer in patients with repeated exposure. (14, 46) Despite the fact that CT is such a problem solving tool, it also has potential harmful effects in the future should the patient be repeatedly exposed, especially in a paediatric population, and physicians should therefore first consider alternative imaging to protect the children. (46, 47, 49)

The three basic radiological protection principles are justification, optimisation and dose limitation. Critical judgement is therefore important as to whether radiation exposure will do more good than harm. (50) Medical trainees should be taught to clearly understand that there should be no examination requested which involves exposure to radiation, unless it adds value to patient management. The students must be familiar with the justification process for the examinations, and the process of optimisation involved in the ALARA principle, which states

that where ionising radiation examination is a necessity, the dose should be as low as reasonably practicable. (49)

The effects of radiation are classified as somatic or genetic, stochastic or nonstochastic. Somatic effects refer to the radiation received directly by an individual or individuals. Genetic effects are those that manifests in the offspring of the individual that has been exposed to ionising radiation. In stochastic effects the probability is proportional to the ionising radiation dose. Nonstochastic (deterministic) effects occur after the high radiation dose where the threshold has been exceeded. Deterministic radiation exposure effects during pregnancy depend not only on the radiation dose received but also on the gestational age at which it occurred. The U.S. Department of Health and Human Services has classified ionizing radiation as a human carcinogen. (48) Unfortunately, doses which have been shown to result in this increased relative malignancy risk are similar to levels which can also be imparted by repetitive radiology studies such as CT scans, interventional radiology, and barium enema procedures. It is also important to emphasise that the advantages obtained by an accurate diagnosis usually outweigh this slightly increased malignancy risk. (50) It is therefore important that referrers adhere to the justification process for the radiology examinations. The Medical Council states that "clinical responsibility*"* means "responsibility regarding individual medical exposures attributed to a practitioner, notably: justification; optimisation; clinical evaluation of the outcome; cooperation with other specialists and the staff, as appropriate, regarding practical aspects; obtaining information, if appropriate, of previous examinations; providing existing radiological information and/or records to other practitioners and/or prescribers, as required; giving information on the risk of ionising radiation to patients and other individuals involved, as appropriate". (51)

It is important that students become aware of the Irish Medical Ionising Radiation Protection laws, for example Ionising Radiation Regulations 2019 (S.I. No 30 of 2019) for the protection of workers and members of the public from the harmful effects of ionising radiation were signed into law on the 5th of February 2019. These new regulations, referred to as the Ionising Radiation Regulations of 2019 (IRR19), replace S.I. No 125 of 2000. The new Regulations introduce a number of important key changes to the way in which the use of ionising radiation is regulated in Ireland. The public and staff protection is still the responsibility of the Environmental Protection Agency (EPA), but patient protection is now regulated by the Health Information and Quality Authority (HIQA) , no longer the Medical Exposure Radiation Unit (MERU) in the HSE (https://epa.ie/radiation/regulation/irr2019/).

The use of contrast medium in imaging is also important; doctors must know which examinations require contrast, as well as non-contrast studies. The role of intravenous contrast medium is to increase sensitivity in identifying structures, enhance the difference between the soft tissue densities, hence improving diagnostic accuracy, of various disease processes. (52) Nonionic iodinated contrast medium is commonly used in CT imaging, it is reported that there is an increase in the use of IV contrast, more than 30 million doses are administered annually. (53) Gadolinium-based contrast is used in magnetic resonance imaging (MRI). Although both the nonionic iodinated, and gadolinium-based contrast materials are generally regarded as safe, there are still reported cases where the adverse reactions have occurred. (54)

The risk factors for using intravenous contrast are uncontrolled asthma, previous reaction to contrast, and allergies that require therapy. Cross reactions between iodinated contrast, and gadolinium-based contrast have not been researched, but are not expected, as these compounds

have difference chemical composition. (54) The contraindications require a knowledge of the factors that minimise incidence of renal impairment like isotonic volume expansion. Serum creatinine levels within an individual are affected by diet, intrinsic physiology, fluid related causes, age related muscle loss, hence the use of estimated glomerular filtration rate (eGFR) is sometimes preferred mainly in the elderly, and inpatients. (53, 55) Acute reactions are the same for the iodinated and MR contrast agents, but in the latter, reactions are very rare. It is reported that gadolinium-based contrast agents used in MRI are more nephrotoxic than iodine-based contrast media. (52) Delayed reactions occurring later, even months after contrast, are thyrotoxicosis for iodinated contrast agents. For gadolinium-based contrast agents, nephrogenic systemic fibrosis (NSF) is a late manifestation of reaction to contrast. (52, 55) It is reported that the risk of CIN (contrast-induced nephropathy) in most patients is very low or negligibly small, therefore individual. (55) There is a paucity of the literature specifically addressing junior doctors' knowledge of contrast medium, and this is a platform for future research.

1.1.2 Medical education: transition from theory to practice

There are numerous transitions that take place throughout the medical education. These include the transition from preclinical to clinical years, from final year medical student to practice as an intern, and from residency or registrar to independent practitioner, as well as transitions during the periods of training. It has been reported that the period when the trainees change over, and newly qualified doctors commence clinical practice, known as the 'July effect' in the USA, or the August change over in the UK, is associated with reduced quality of patient care. (56-58) Although this is multifactorial, there is no doubt that the adverse outcomes are minimized or eliminated by measures taken in handling the transition period. (57) Preparation for practice and/or work orientation modules should be designed to enhance knowledge, and assist junior

doctors to be well-prepared for various aspects of their responsibilities during the transition, thereby increasing patient safety and quality of care. (58)

The transition from undergraduate medicine to practice as a junior doctor is a significant stage. It is very exciting as one becomes a doctor for the first time, a long-awaited experience. However, it is also challenging moving from the protected medical school environment to a full-time role in the hospital environment during internship. (59) It is described as a most stressful, and difficult experience (60), as the students assume new roles as newly qualified physicians, taking responsibilities of patient care. (61) This can lead to stress and burnout, mental problems, thereby compromising patient safety. (62) Therefore the newly qualified doctors need a lot of support, as poor support is associated with difficult transition experience. (61)

Throughout the life of the medical professional, change is inevitable and requires adjustment and proper orientation to alleviate the stress levels that accompanies any change. Transition from preclinical to clinical years has also been described as a stressful period; in most studies, the reasons for this include the increase in the working hours, increased workload, and, at times, a perceived knowledge deficit , and at times the roles are not clearly defined, therefore not aware of what is expected from them. (63) Some students have described it as being thrown in the deep end. (64)

Numerous studies have indicated that despite vast knowledge of the various subjects learned at the medical school, newly qualified doctors still find themselves not adequately prepared. (41,

63, 65) The collaboration of medical schools and hospital groups is important to make the transition from undergraduate training to internship a well manageable process, with the end results that interns will fully adapt to their new role. The transition from medical graduate to internship should be standardised. Various attempts should be made to make this an easy, structured process, and the hospital environment must be conducive for continued learning, personal and professional development.

Shaffer et al. (66) asserted that there are still concerns regarding transition from mentored trainee to junior doctor, and also to independent practitioner. They identified the skills that were lacking and designed workshops for medical residents to close the gaps, targeting practice management skills. Workshop topics included job searching strategies, requirements, methods of reimbursement, the role and relevance of malpractice insurance, contract negotiations, and other practice-related matters. The transition to practice curriculum was implemented as a pilot programme to integrate practice management into postgraduate medical education. Post-workshop evaluations revealed that senior trainee participants demonstrated an improvement in the understanding of the managerial tasks. The responses highlighted the requirement for structured education in practice management. Fisher et al. (67) designed an elective integrated clinical experience course, which was implemented at the end of the final undergraduate year, aiming to prepare the medical students for the challenges that they would encounter during internship. Various topics were covered, namely: management of acutely ill patients including radiology basics; communication within the teams, patients, and families; teaching; and coping with stressors like managing finances, medicolegal issues, and other concerns related to internship duties. Survey questionnaires were distributed to the students one week prior to commencement of the course, evaluating how they perceive their level of preparedness for

internship. After the course, respondents reported that their level of preparedness for internship was much improved.

Transition has also been described in the context of various medical specialities, for example in the surgical discipline. Minter et al. (68) asserted that medical educators and academic medical departments have been addressing the curriculum reform specifically to prepare the students for transition to internship. They conducted a multi-institutional survey, where surgical interns that commenced residency reported that they felt unprepared to fulfil the common clinical and professional responsibilities. They reported feeling unprepared with regard to performance of technical skills, and procedures, managing multiple demands at the same time, being first responders for critically ill patients, and identified communication issues. (68)

Transition is also difficult for the doctors who, after obtaining their qualifications, decide to work abroad; this has added stress because of the cultural differences, different ethical work practices, and integration with the local hospital staff. Orientation programmes to address the transition phase for international graduates are encouraged. (69)

Another body of literature describes the transition from medical school to internship as an electric mixture of emotions, excitement, anxiety, uncertainty, pride, and disorientation. (70) It is also reported that it is difficult to shift from a protected, supervised environment as a student to being an intern, the first line doctor dealing with sick patients. They occupy a new role where there is an expectation that new doctors are well trained, and have basic knowledge, and so are not expected to keep asking for continued assistance. (70) Stuurman et al. (71)

conducted 15 semi-structured interviews about the transition from medical student to work as an intern. Intern participants described it as physically, emotionally, and mentally draining. Although the interns had somehow adjusted to the job demands like clinical administrative, handling conflicts, etc, they reported reduction of their self-confidence, reduced ability to adequately take care of themselves, and an inability to maintain healthy relationships outside work due to time pressure, and work demands.

To ease the transition from medical school to internship, the use of student assistantship roles have been introduced in the United Kingdom. This is a programme designed to gradually introduce the final year medical students to the practical aspects of practising medicine. The students are shadowing the junior doctors, under strict supervision, and are allowed to perform certain procedures like IV cannulation, and prescribing drugs, in preparation for their first year of practice as doctors. The issues of patient safety are taken into consideration, such that students are not expected to take responsibility for patient care. (72)

Scicluna et al. (73) asserted that preparation of medical graduates for facing the challenges as the newly qualified doctors is the responsibility of the medical schools. However, some medical schools mainly teach clinical radiology, image recognition, and interpretation. While this is appropriate, it does not fully prepare the interns for the practical aspects of interacting with radiology. Hence, curriculum reform to supplement clinical radiology knowledge would add value to the medical students, and limit the anxiety associated with non-readiness to deal with radiology in clinical practice. Morris et al. (1) identified that the skills taught at the medical school were not concordant with the skills required in clinical practice. They suggested an intermediate training programme, bridging the gap between medical school, and

commencement of internship. Teo et al. (61) asserted that transition courses should be considered to prepare the medical graduates for practice, but these authors also recognised that the students may be reluctant to forfeit their well-deserved holiday after many years of hard work as medical students to attend the transition course. There is no consensus that preparatory courses, like radiology preparatory modules, be part of the undergraduate medical curriculum, a standalone transition course post-graduation but prior to internship, or during the internship period.

Yardley et al. (74) also asserted that in the current healthcare system it is important to recognise that transition is not just confined to a short specific period, but a gradual dynamic process involving continuous learning on the job, with supported personal and professional development. This posits that some skills can be learnt during the transition or internship to complement the basic knowledge obtained from the medical school. Some interns find the application of their knowledge to practice rather challenging. It is generally expected that the newly qualified doctors should progress smoothly from being students to become responsible practitioners, as they leave the protected medical school environment to serve the public in the healthcare system. (65)

1.1.3 Radiology and preparation for clinical practice

There have been numerous studies, and organisations providing opinions and raising concerns about preparation for practice over the decades (1, 19, 75-77), mostly concentrating on the clinical procedural skills, some including non-procedural skills like communication and escalation (75), but little emphasis is placed on radiology. To ease the transition in the UK, the General Medical Council (GMC) has introduced shadowing, and in the 2018 edition of

Tomorrow's Doctors (78) states that "students must be properly prepared for their first day as a PRHO (pre graduate house officer). They should have opportunities to shadow the PRHO in the post that they will take up when they graduate; this allows them to become familiar with the facilities, the working environment and to get to know their colleagues, and develop working relationships with the clinical and educational supervisors they will work with in the future. This offers opportunities for students to refresh the practical and clinical skills that they will be expected to carry out on their first day as a PRHO. These include prescribing drugs under the supervision of a qualified doctor and to carry out venous cannulations." This is a period of training where final year students take on duties of a foundation doctor under supervision. On reviewing the effectiveness of the student assistantship, Fullbrook et al. (72) listed the competences that the students are expected to master; the list included requesting and reviewing investigations in general terminology. Radiology is not specifically mentioned, and yet it is central to the patient management in clinical disciplines, raising the question why there is not a specific chapter or module addressing new doctors about radiology-related matters.

Nyhsen et al. (20) concluded that the existing radiology teaching did not meet the learning needs in preparation for clinical practice. In the general comments section of the questionnaire, the interns reported that they frequently felt lost in the radiology department. They had no direction and did not know how to handle radiology-related matters. Ferris et al. (79) also reaffirmed non-readiness of interns to deal with radiology related matters. They found that approximately 80% of the junior doctors who were included in the study were not aware of the American College of Radiologists Appropriateness Criteria. The Faculty of Radiologists in Ireland has adopted the iRefer guidelines" Making the best use of clinical radiology" from the United Kingdom, prepared by the Royal College of Radiologists, UK. These guidelines assist doctors in Ireland to order appropriate radiologic examinations to promote patient safety and

avoid unnecessary radiation exposure acquired by doing inappropriate examination. In the public hospitals the guidelines are available via http://guidelines.irefer.org.uk. The GPs can access this through healthlink. The private hospitals can access via the independent Hospitals Association. https://www.hse.ie/eng/about/who/cspd/ncps/radiology/resources. Newly qualified doctors should be taught, and be encouraged to familiarise themselves with the guidelines. The imaging referral guidelines project workshop was a European commission-led initiative, during which the ideas regarding appropriateness, and the use of imaging guidelines in Europe and worldwide were presented; this group recommended that the guidelines should be made available and used in all EU member states, and should be included in the curriculum for undergraduate trainees. (80)

Moloney et al. (81) distributed a questionnaire to evaluate participants' understanding of the appropriateness criteria when ordering radiological examinations. The first participant group (N=72) comprised of medical students at the beginning the final year (group A). The second group (N=53) were medical students at the end of the final year, who had completed the radiology module (group B). The third group (N=35) included residents at the end of their first year of clinical practice. In four questions, less than 60% of respondents selected the correct responses, although overall the third group performed better than group A and B. 96% of medical students reported that they had no prior knowledge of ACR guidelines, and only 1.5% of physicians reported using ACR guidelines as the initial source when selecting best imaging technique. The authors asserted that educating medical trainees, and junior doctors about appropriateness criteria might result in the improvement in the way radiology services are utilised. (81)

Hurst & Oswal (82), in a descriptive study of the induction process in radiology department, suggested that there should be a link to the national guidelines so that they should be easily accessible. It is envisaged that the radiology preparatory module will provide the links to the important guidelines, and appropriate criteria, radiation protection, EU directives, and other important documents including, but not limited to, the national pregnancy protocol. Hurst & Oswal (82) describe various fundamental aspects of the induction process in the radiology department, also emphasising the importance of structured methods to educate newly qualified doctors about radiology referral process. However, this can be included as a short module in the final medical student curriculum, to avoid bombarding the interns with a vast amount of new information. Many studies have addressed the necessity of teaching radiology in the undergraduate curriculum; some have asserted that small group tutorials are more effective, while some support the online material, with guidance. (65) Murphy et al. (18) asserted that self-directed learning was not the preferred method among the group of medical students in radiology and anatomy teaching. Surveys were conducted pre- and post- a radiological anatomy module which was delivered by senior radiologists to first year medical students. The results demonstrated an increased understanding of the imaging modalities that involve radiation, and those which do not. There was also an improvement in the understanding of radiation protection.

Kassim et al. (83) asserted that medical school career guidance, and early exposure to postgraduate career preparation would ensure that the interns are ready for their destination. Currently the internship year is spread over different disciplines, and radiology is in the centre, so all interns should be able to deal with radiology related matters, as most are common to almost all disciplines. The undergraduate radiology curriculum should address this aspect, in a brief, and concise manner.

The Medical Council states that “an Intern may also be employed for not less than two months, not more than four months”, in other specialities, including radiology. (84) This means that once the final year medical students are well educated about various aspects of radiology, more might be interested in rotating in radiology. This would be a major change, which would require involvement of the radiologists, in the recognised training hospitals. It is envisaged that this will increase interest in radiology, promote radiology as the speciality, and help to deal with the shortages of radiologists.

1.2 Problem statement

The interns are the most junior members of the medical teams, responsible for various tasks including requesting radiology examinations, and at times discussing the necessity of the scans with the radiologist. Are the interns aware of the various aspects involved in radiology? Are they in a position to justify the radiology examinations they are requesting? Are the interns empowered to understand the various modalities, indications, and contraindications of the imaging tests ordered?

1.2 Research aim and objectives

The aim of the research is to evaluate intern’s preparedness to deal with radiology departments, and to identify knowledge gaps which will facilitate the design of a simplified evidence-based radiology orientation course for students or the newly qualified doctors to ease the transition from theory to practice.

Overview of Thesis chapters:

The first chapter outlines the background of the research, the problem statement, and objectives of the study. The contemporary literature is reviewed identifying the role of radiology in the undergraduate curriculum, transition from theory to practise in the medical education, and preparation for radiology in clinical practice.

The second chapter explains the research methodology applied in the study. The first part of the methodology involves the description involving a quantitative survey of interns and radiologists. The second part is the group concept mapping methodology in which opinions of qualified doctors across different levels of seniority about important things to include when designing an appropriate preparatory module for interacting with the radiology department.

The third chapter outlines the results of the intern and radiologist survey on the perceptions of intern preparedness for clinical practice in radiology, as well as the group concept mapping results detailing cluster and map generation of the items that are deemed necessary to be included in a radiology preparatory module. In chapter four, the results are discussed. Chapter five outlines conclusions and recommendations based on this research.

Chapter 2. Material and Methods

2.1 Introduction

A mixed methods approach was employed, where both quantitative and qualitative methods were used, respectively, in the following manner:

I. A sample of medical interns and practicing radiologists were asked to complete a quantitative survey on perceptions of interns' readiness to interact with the radiology department.

II. A mixed quantitative/qualitative analysis was conducted involving perspectives of NCHDs and consultants to evaluate what topics should be covered in preparatory course, using the group concept mapping (GCM) approach.

2.2 Research design

Part I: Quantitative survey of interns and radiologists

A questionnaire was designed to evaluate the interns', and radiologists' perceptions on the interns' readiness to interact with the radiology department.

Study population

The study population was (a) all interns in the following Irish intern training networks: West / Northwest (NUIGalway); Dublin / Northeast (RCSI); Dublin / Mid-Leinster (UCD);(no approval from UCD, therefore interns who were in UCD affiliated hospitals did not participate in this study) Dublin / Southeast (TCD); South (UCC); Mid-West (UL); (b) all consultant radiologists, and radiology registrars registered in the Republic of Ireland in 2017.

Ethical approval

Ethical approval was obtained from the relevant ethics committees affiliated with each of the Irish intern training networks: UCC, TCD, UL, NUI Galway, and RCSI (Appendices A-D).

Survey design

A novel questionnaire was designed to cover the following three domains:

1. Demographic characteristics and educational/career background for intern and radiologist participants

2. Perceived adequacy of undergraduate radiology teaching, and perception of how this prepares interns for clinical practice.

3. Radiology and working as an intern, based on the competencies as outlined in the radiology undergraduate curriculum. (34) It included the following core competencies: understanding various imaging modalities, their appropriateness, indication, and limitations; radiation protection as it applies to radiological examinations; use of contrast media in radiology; communication in radiology; checking and acting on radiology results, and handover.

There were short multiple choice questions, and a free text option which allowed additional comments for selected items. The questions were not confrontational, not sensitive, and did not involve individual unpleasant experiences, but aimed to evaluate the interns' understanding of the operational, and practical aspects of radiology, considering the anticipated competencies. The questions were graded, using a six-point Likert scale, with ranging from 'strongly agree' to 'strongly disagree', and the respondents were asked to select what they felt was appropriate for them. The six-point scale was selected based on its use in Preparation for Practice Questionnaire (PHPQ), an instrument that has been previously used by medical schools to assess their graduate's clinical capabilities. (83,85)

The wording of items administered to both interns and radiologists were matched as far as possible in order to evaluate the radiologists' opinions regarding the interns' readiness to interact with radiology department, and to facilitate comparisons.

Questionnaire validity

The validity of the questionnaire was checked prior to distribution. The questionnaire was reviewed by eight consultant radiologists to assess whether the questions were appropriate, clearly designed, and suitable for answering the research question. A validity study begins with gathering evidence-based items for potential inclusion in the instrument or tool, in this case, the evaluation of the questionnaire. Once the items to be evaluated have been collected, the content evaluation panel is formed. The content evaluation panel should be composed of people who are experts about the domain being studied (86); in our study the experts were radiologists. The panel was composed of consultant-level radiologists working in Irish teaching hospitals. Responses from all panellists were identified, and feedback was provided regarding the

suitability of the content and response format. We were confident to proceed with the questionnaire, after the amendments, and when the experts agreed that the questions were appropriate, to yield the appropriate information to answer the research question.

Questionnaire piloting

The questions were also piloted, and verbal feedback was obtained from several interns at University Hospital Kerry.

They were asked to comment on the content of the questions, clarity of presentation, the length of the questionnaire and time to completion (5-10 minutes). They were also asked to comment if they perceived any potential for bias. The finalised version of the questionnaire was generated based on pilot participant feedback.

Questionnaire distribution

The invitation to complete the intern questionnaire was distributed by the intern training network coordinators across the training networks where ethical approval had been granted. The radiologist questionnaire was distributed by the faculty of radiologists in Ireland. This is the body responsible for keeping the records of all radiologists who practice in Ireland, and works closely with the Irish Medical Council to maintain high national professional standards, and promotes quality matters.

The questionnaire was hosted electronically via SurveyMonkey in April 2018. The link was sent to the interns, and radiologists, via the email contact described in the previous paragraph,

and accompanied by an information sheet which outlines the purpose of the study, and stated that participation was voluntary, and there was no risk of victimisation for the participants. The intern survey question link was distributed towards the end of the internship in April, and was open over a two-week period. The responses were anonymised, so that the participants could not be traced. 100 interns and 50 radiologists responded.

Statistical analysis

Summary statistics (means (M) and standard error of the mean (SEM)) were used to summarise Likert-scale responses and ratio scale measurements for all respondents. Frequency analysis was used to describe and summarise questionnaire items, which required a categorical response. Pearson's Chi Square analysis was employed to examine the association between socio-demographic and educational variables and selected categorical item responses. Kruskal-Wallis analysis of variance (ANOVA) and/or Mann–Whitney U tests were employed to carry out univariate comparisons (e.g. intern vs radiologist responses) where the outcome variable(s) consisted of Likert-scale question responses. Statistical analyses were carried out using IBM SPSS 20 (IBM, New York, NY, USA).

2.3. GCM analysis

Part I1: Mixed methods examination :

Mixed methods examination of topics to be addressed as part of an intern preparatory course for radiology: a group concept mapping (GCM) study

2.3.1. Rationale for GCM study

GCM is an integrated mixed-method technique which involves a combination of qualitative and quantitative methodologies in order to identify an expert group's understanding about a topic. The GCM is not based on a prearranged categorization system in comparison with other research methodologies such as the Delphi method and focus groups. Its classification and organisation of data is determined by the participants themselves. Congruity arises naturally from the data and does not rely on inter-coder discussion to arise with a consensus as participants work independently of each other. In this way researchers find the group concept system to be very accessible and amenable to use. Furthermore, the GCM has proved to generate significant internal representational validity with substantial reliability estimates for sorting and rating. (87), (88) Therefore, GCM combines aspects of both quantitative and qualitative methods, and is deemed the most appropriate methodological approach to utilise in this study. Every opinion counts, and the system is able to generate the cluster map composed of the predominant ideas generated from the group involved.

Setting

The study was conducted at the School of Medicine, University College Cork (UCC), Ireland.

Participants

The participants were randomly selected, irrespective of the category, invited to participate in the brainstorming section. Employing a combination of convenience and snowball sampling techniques, interns, non-consultant hospital doctors (NCHDs), and consultants were invited to participate in the GCM process via email. The email contained a link that directed the participants to a questionnaire comprised of socio-demographic questions. Once completed, the participants were redirected to a link to the group concept system software. Participation in the GCM was considered to indicate consent had been gained. Incentives were not offered to encourage participation.

All steps were completed by participants on the Concept System software and involved the generation of ideas, sorting of ideas into categories and rating these ideas on values of *importance* and *ease of inclusion/implementation* in preparation for practice intervention programme. The participants then essentially coded the text themselves as they sort statements into categories based on perceived similarities, and then rate them across both criteria. The participants work individually and anonymously of one another without interdependent agreement or discussion.

2.3.2 The GCM process – stages

This mixed-method approach is comprised of five stages: (1) brainstorming (idea/strategy generation phase), (2) sorting of strategies to categories (3) rating strategies on values of ‘effectiveness’ and ‘importance of inclusion in preparation for practice module’ (4) data analysis (5) interpretation of results. Participants were assured their inputs on the concept

system software were anonymous during the first three stages of the process. They were provided with a username and password with a link to the site containing the brainstorming page on the software. They were free to visit the site as frequently as required at their own convenience. They were asked to generate ideas in response to the focus prompt: 'If I was asked to design an intern preparatory course for interacting with the radiology department, the following topics would be covered'. Two weeks were granted to complete the brainstorming stage. Once the deadline was reached, convenience sampling was applied to elicit a smaller focused group to participate in the sorting and rating stages. This subset group consisted of participants who had previously completed the brainstorming stage. The final list of student preparatory topic statements was sent to these participants for sorting and rating.

The focus group sorted the strategies into categories based on perceived thematic similarities, designating titles for these categories. They rated them on value of 'ease of inclusion in preparation for practice modules' and 'importance'. As allocated in the brainstorming stage, two weeks were set aside in the sorting and rating stages, participants were free to save, continue work and return to the site at their own convenience.

2.3.3 Outcome measures

The primary outcome measure in this study was the list of topics derived from the GCM with which interns and other respondents would include when asked to design an intern preparatory course for interacting with the radiology department. The secondary outcome measures were

the rating of these strategies in terms of effectiveness and importance of inclusion in a preparation for practice module.

2.4 Data analysis

Data analysis employed The Concept System © software which utilises multidimensional scaling (MDS) to create a series of interrelated maps organising the data and hierarchical cluster analysis (HCA) of the MDS coordinates. This two-dimensional composition illustrates the preparatory topic statements and their relationship to each other through points on the map. The closer the points are together in terms of distance on the map, the closer their relationship to each other.

CHAPTER 3: RESULTS

3.1 Introduction

The study involved administration of a quantitative survey to current Irish medical interns and radiologists to investigate their perceptions regarding the intern's readiness to interact with radiology department. This analysis was supplemented by the consensus-building Group Concept Mapping study, where the participants were asked to identify the important points to be considered when designing a radiology module in the undergraduate medical curriculum.

3.2 Results of the intern survey

Seven hundred and thirty-three interns working in Irish teaching hospitals in 2017 were invited to participate in this study, and a total of 100 responses were received. This corresponds to a response rate of 14%.

3.2.1 Demographics and educational background of the interns

The majority of intern respondents were female 52% (N=52) The age range of most of the respondents was between 20 -25 years 65% (N=65), and the remaining percentage split was as follows: 26-30 years 22% (N=22), 31-35 years 11% (N=11), and 36-40 years 2% (N=2). All the interns graduated in Ireland. The majority graduated in 2017 94% (N=94) and the remaining 6% (N=6) graduated in 2016.

Most interns, 69% (N=69) had completed the undergraduate-entry (i.e. school leavers) medical programme. The remaining 31%(N=31) had completed a graduate-entry programme, which is open to students who have already completed an undergraduate degree prior to studying medicine. Most graduate-entry programme graduates, 21%, (N=21), had studied science or health care-related degrees; the breakdown was as follows: biochemistry 3% (N=3); biology, 4% (N=4); biomedical science 3% (N=3); nursing 3% (N=3); general science 2% (N=2); pharmacy 1% (N=1); physiotherapy 2% (N=2); neuroscience 1% (N=1); genetics 1% (N=1); electrical engineering 1% (N=1); science and anatomy 1%(N=1); physiology 1% (N=1).

A small number of graduate-entry based interns, 7% (N=7), had originally completed non-scientific degree programme, as detailed here: music 1% (N=1); law 1% (N=1); philosophy and

psychology 1% (N=1); commerce 1% (N=1); Italian literature 1% (N=1); education 1% (N=1); and economics 1% (N=1).

The majority of interns, 94% (N=94), had no prior exposure to radiology before commencing their medical training. Only 6% (N=6) reported prior exposure to radiology.

At the time of the survey, most of the respondents were based in the Departments of Surgery 49% (N=49) and Medicine 45% (N=45). The minority were in other disciplines – Obstetrics & Gynaecology 3%,(N=3), Paediatrics 2%, (N=2), and Emergency Medicine 1%,(N=1).

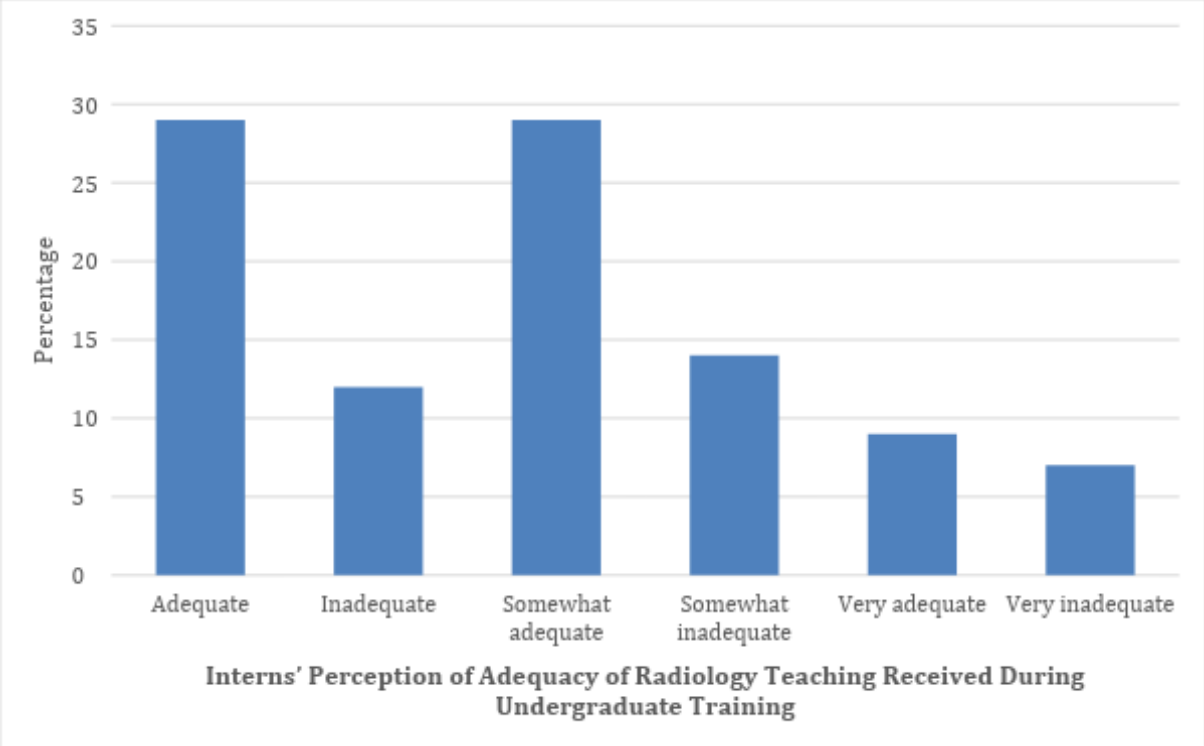
3.2.2 Intern exposure to radiology during undergraduate training in medicine

Radiology teaching received by the interns during undergraduate training

Most of the interns, 67% (N=67) felt that they were adequately taught radiology during their undergraduate training. Of these, 9% (N=9) perceived the training received as 'very adequate'. The same percentage of the respondents felt that the radiology teaching was 'adequate' and 'somewhat adequate', 29% (N=29) respectively.

33% (N=33) of intern respondents felt radiology teaching received during undergraduate training was 'inadequate'. Of these, 7% (N=7) of respondents felt that radiology teaching they received was 'very inadequate', 12 % (N=12) felt the teaching was 'inadequate', and 14% (N=14)perceived it as 'somewhat inadequate' (Figure 3.1).

Figure 3.1. **Intern perception of adequacy of radiology teaching received during undergraduate training**



Knowledge of radiology relative to other clinical subjects in the undergraduate curriculum

The majority of interns 55% (N=55), reported 'adequate' knowledge of radiology when compared to other subjects, but 45% (N=45) reported 'inadequate' knowledge of radiology compared with other subjects. Of the respondents that reported adequate knowledge, only 9% (N=9) felt it was 'very adequate', 20% (N=26) felt it was 'adequate', and 26% (N=26) felt it was 'somewhat adequate.'

Of the respondents that reported that their knowledge of radiology was 'inadequate 'when compared to other subjects, 6% (N=6) felt it was 'very inadequate', 21% (N=21) perceived

their knowledge as ‘inadequate’, and 18% (N=18) felt it was ‘somewhat inadequate’ (Table 3.1).

Table 3.1. **Knowledge of radiology compared with other clinical subjects in the undergraduate curriculum in the intern sample (N=100)**

Knowledge level	**Percent**
Adequate	20.0
Inadequate	21.0
Somewhat adequate	26.0
Somewhat inadequate	18.0
Very adequate	9.0
Very inadequate	6.0
Total	100.0

Adequacy of formal teaching in radiation protection during undergraduate training

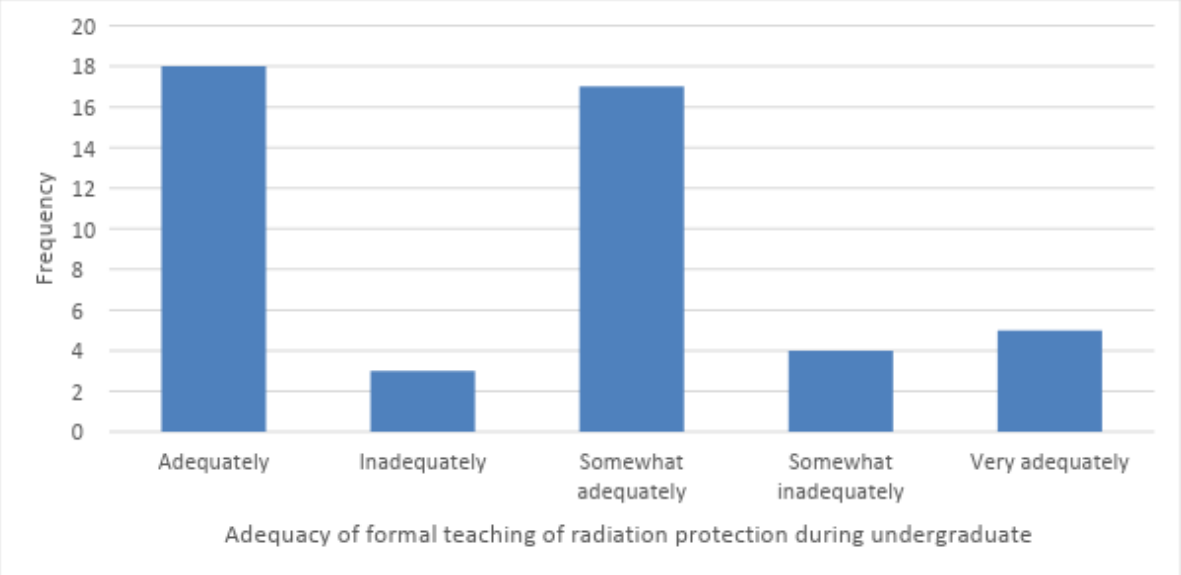
Forty-three percent (N=43) of interns reported that they received formal radiation protection teaching during their undergraduate training. Thirty-five percent (N=35) were informally taught, and 22% (N=22) had little or no exposure to radiation protection matters (Table 3.2).

Table 3.2 **Formal teaching in radiation protection during undergraduate training in the intern sample (N=100)**

Formal teaching of radiation protection	**Percent**
I had little or no exposure to radiation protection matters	22.0
I was informally taught about radiation protection	35.0
Yes I attended a formal course	43.0

The majority of the respondents that received formal teaching in radiation protection during their undergraduate degree felt that the course prepared them for clinical practice as an intern (N=40). Of this number, 42% (N=18) felt that the course 'adequately 'prepared them for practice, 40% (N=17) described it as 'somewhat adequate', and 2% (N=5) 'very adequately prepared'. Fifteen percent (N=7) felt the radiation protection course received did not prepare them for practice, 7% (N=3), felt 'inadequately' prepared, and 9% (N=4) felt it was 'somewhat inadequate' (Figure 3.2).

Figure 3.2 **Adequacy of formal teaching of radiation protection during undergraduate training in the intern sample (N=100)**



Familiarity with 10-day rule in imaging patients of childbearing age at the beginning of the intern training

The majority of interns 77% (N=77) were not familiar with the 10-day rule; of this number, 31% (N=31)were ‘very unfamiliar’; 37% (N=37) ‘unfamiliar’; 9% (N=9)‘somewhat unfamiliar’. 23%(N=23) reported that they were familiar with the rule; only 1% (N=1)indicated that they were ‘very familiar,’; 8% (N=8) were ‘familiar ‘; and 14% (N=14)‘somewhat familiar’ with the 10-day rule (Table 3.3).

Table 3.3 **Familiarity with 10-day rule in imaging patients of childbearing age at the beginning of the intern training in the intern sample (N=100)**

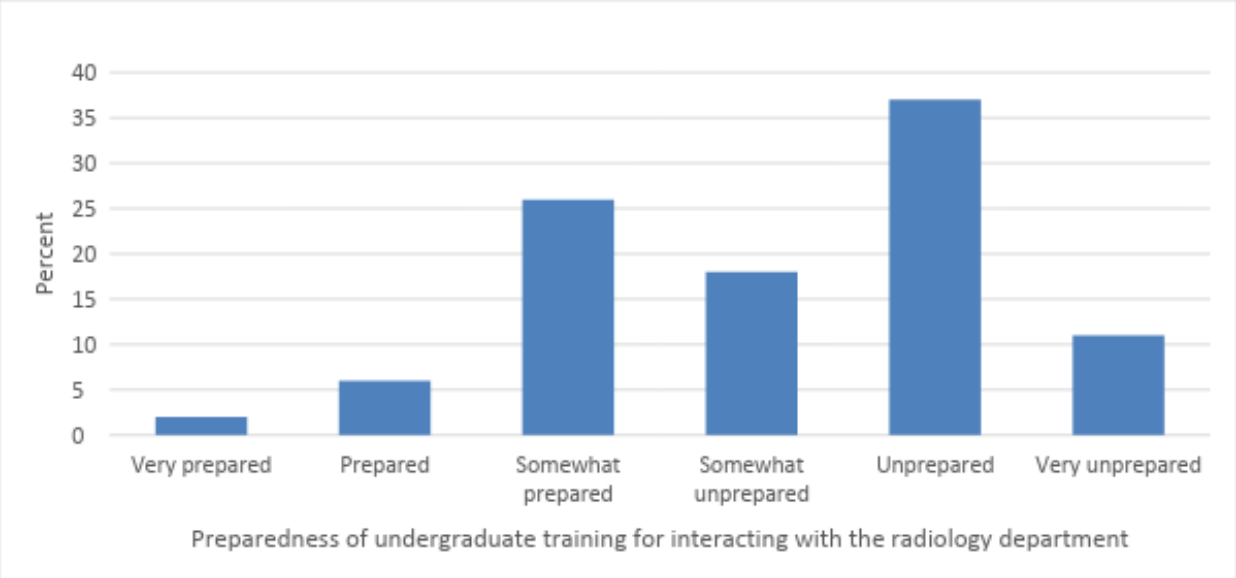
Familiarity with 10-day rule	**Percentage of total sample**
Familiar	8.0
Somewhat familiar	14.0
Somewhat unfamiliar	9.0
Unfamiliar	37.0
Very familiar	1.0
Very unfamiliar	31.0
Total	100.0

3.2.3 Radiology and working as an intern

Interns’ perceptions of undergraduate medical training and preparedness for interacting with the radiology department during intern year

The majority of the respondents, 66% (N=66), felt that the undergraduate medical training did not prepare them for interacting with radiology department. 11% (N=11) felt 'very unprepared', 37% (N=37) felt 'unprepared,' and 18% (N=18) felt 'somewhat unprepared'. 34 % (N=34) felt that the undergraduate training prepared them for interacting with radiology; of these, 2%(N=2) felt they were 'very prepared,' 6% (N=6) felt they were 'prepared', and 26% (N=26) felt that they were 'somewhat prepared'(Figure 4.3).

Fig 3.3 **Undergraduate medical training and preparedness for interacting with radiology during intern year in the intern sample**



Intern confidence regarding understanding of the different imaging modalities, and their indication in radiology

Sixty-six percent(N=66) of intern respondents indicated that they were confident that they had a clear understanding of the different imaging modalities, and their indication in radiology. 7% (N=7)indicated they were ‘very confident’; 22% (N=22), ‘confident’; 37% (N=37), ‘somewhat confident’. Thirty-four percent perceived that they did not have a clear understanding of the various imaging modalities, and their indication in radiology. Of these 2% (N=2) was ‘very unconfident’, 14% (N=14)‘not confident’, and 18% (N=18)were ‘somewhat unconfident’ (see Table 3.4).

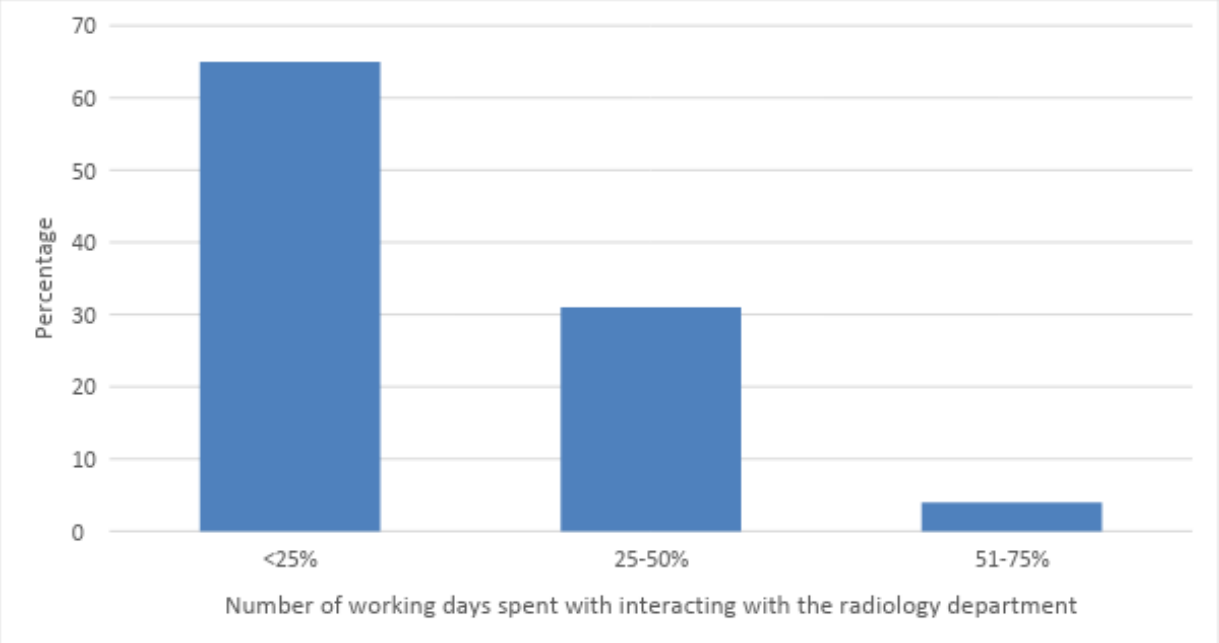
Table 3.4 **Confidence regarding understanding of the different imaging modalities, and their indication in radiology in the intern sample (N=100)**

Confidence regarding clear understanding of the different imaging modalities	**Percentage**
Very confident	7.0
Confident	22.0
Somewhat confident	37.0
Somewhat unconfident	18.0
Not confident	14.0
Very unconfident	2.0

Percentage of normal working day spent interacting with the radiology department

These interactions include requesting radiology tests, preparing patients for radiology examinations, and procedures, multidisciplinary meetings, radiology results follow up, and communicating the results. Most of the interns, 65% (N=65), reported spending less than 25% of their time during internship interacting with radiology. 31% (N=35) reported spending 25 to 50% of the day, and 4% (N=4) reported spending more than half a day (51-75%) interacting with radiology related matters (Figure 3.4).

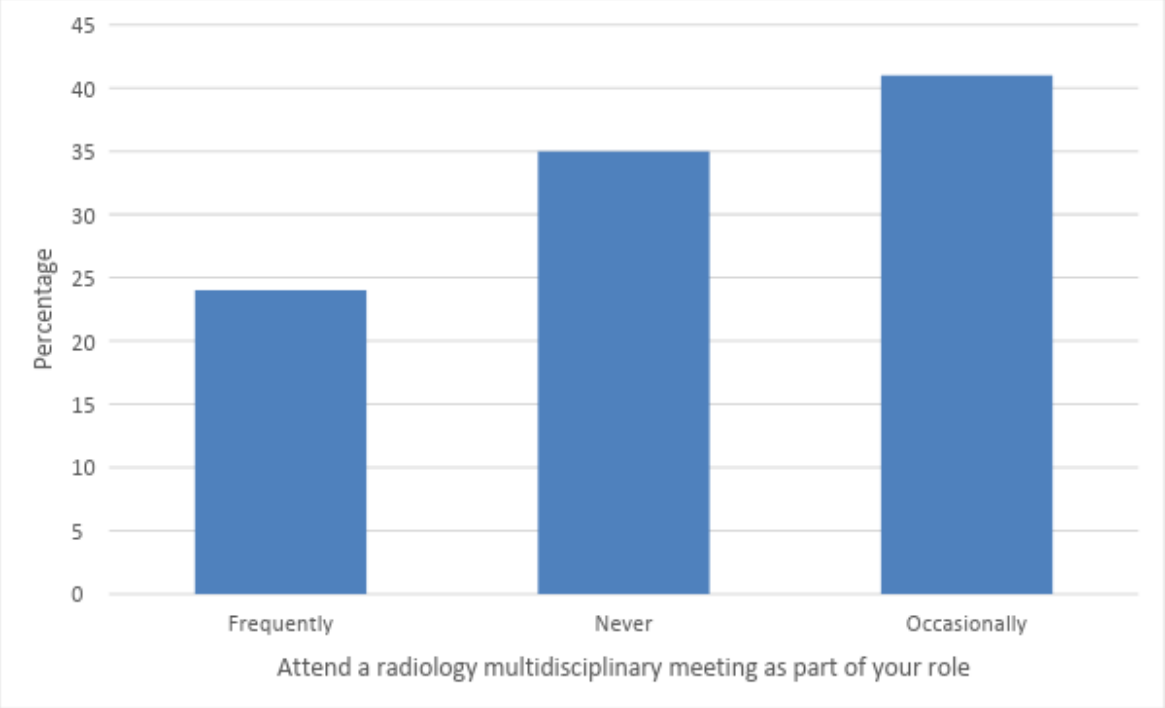
Figure 3.4 **Number of normal working day spent interacting with the radiology department including ordering tests, preparing patients, multidisciplinary meetings and following up or communicating results in the intern sample (N=100)**



Attending a radiology multidisciplinary meeting as part of the intern's role

Twenty four percent (N=24) of the interns reported that they frequently attend the radiology multidisciplinary meeting. 41% (N=41) reported that they attended occasionally, and 35% (N=35) had never attended the meeting (Figure 3.5).

Figure 3.5 **Intern attendance at a radiology multidisciplinary meeting**

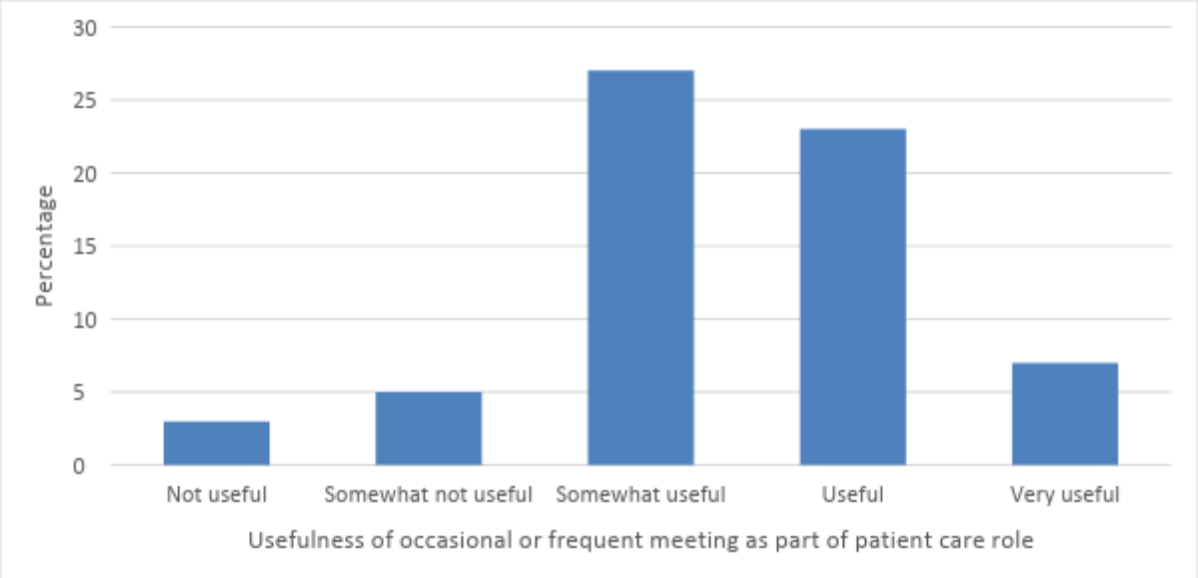


Usefulness of occasional or frequent multidisciplinary meeting as part of patient care role

Most respondents 65% (N=65) who attended the radiology multidisciplinary meeting frequently or occasionally reported that they found the meetings 'useful'; of these, 10% (N=7)

found the radiology meetings ‘very useful’, 35% (N=23) ‘useful’, and 42% (N=27) ‘somewhat useful’. 5% (N=3) reported that they found the radiology multidisciplinary meeting ‘not useful’, and 8% (N=5), ‘somewhat not useful’ (Figure 3.6).

Figure 3.6 **Usefulness of occasional or frequent multidisciplinary meeting as part of patient care role in the sample of interns who attended this meeting (N=65)**

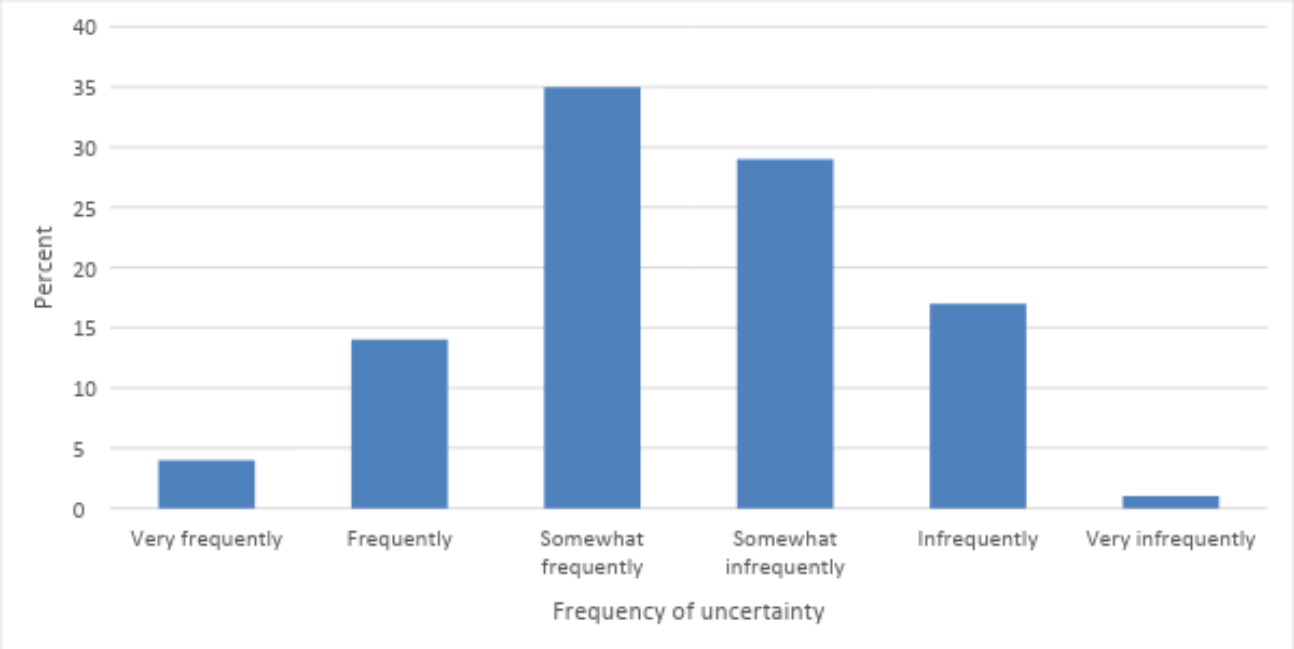


Frequency of uncertainty regarding radiology examination indication when filling the request form

Most interns, 53% (N=53), reported frequent uncertainty regarding the indication for the radiology examination; of this number, 4% (N=4) reported very ‘frequently uncertain’, 14% (N=14) ‘frequently’ uncertain, and the highest percentage of respondents, 35% (N=35), reported being ‘somewhat frequently’ uncertain of the indication. Forty-seven percent (N=47)

of the interns perceived that they were infrequently uncertain of the indications of the radiology exams; of these, 17% (N=17) were ‘infrequently uncertain’, 1% (N=1) ‘very infrequently’, and 29% (N=29) ‘somewhat infrequently’ (Figure 3.7).

Figure 3.7 **Frequency of uncertainty regarding radiology exam indication when filling the request form in the intern sample (N=100)**



Challenges in dealing with radiology department

When asked to rate on a 5-point difficulty scale the greatest challenges in dealing with their radiology department, the observed results are presented in Table 3.5.

Table 3.5 **Percentage of responses for each point on 5-point difficulty scale for each challenge in dealing with radiology department in the intern sample (N=100)**

Challenges	**1 (not difficult)**	**2**	**3**	**4**	**5 (most difficult)**
Getting a study done when needed	5.0	15.0	30.0	30.0	20.0
Communicating with the Whenradiographer or radiologist	8.0	11.0	22.0	28.0	31.0
The online ordering system	39.0	33.0	17.0	9.0	2.0
Deciding which study to choose	13.0	38.0	40.0	8.0	1.0
Receiving the results of the test	25.0	37.0	19.0	13.0	6.0
Acting on the results of the test	21.0	25.0	25.0	20.0	9.0
Preparing patients for a test or intervention	17.0	25.0	32.0	21.0	5.0

When asked to identify the challenges encountered when dealing with radiology, 50% (N=50) of the intern respondents indicated difficulty in getting the study done when required. Of these, 20 % (N=20) indicated it was ‘most difficult’, 30% (N=30) indicated it was ‘difficult’. 20 % (N=20) asserted that it was ‘not difficult’. Of these, 5% (N=5) specified ‘not difficult’, 15% (N=15) ‘less difficult’. 30% (N=30) were neutral.

Fifty nine percent (N=59) of the interns indicated difficulty in communicating with the radiographer or radiologist. Of these 31% (N=31) reported ‘most difficult’, 28% (N=28) reported ‘difficult’.19% of the interns indicated no difficulty in communicating; of these, 8% reported ‘not difficult’, 11%(N=11) ‘less difficult’, and 22%(N=22) were neutral.

Seventy two percent (N=72) reported no difficulty with the online ordering system. Of these, 39% (N=39) reported ‘not difficult’, and 33% (N=33) reported ‘less difficult’.

11% (N=11) reported difficulty with the online ordering system. Of these, 2% (N=2) reported ‘most difficult’, 9% (N=9) reported ‘difficult’.17% (N=17) were neutral.

Fifty-one percent (N=51) asserted that there was no difficulty in deciding which study to choose. Of these, 13 % (N=13) selected ‘not difficult’, 38% (N=38) ‘less difficult’. 9% (N=9) reported difficulty in deciding which study to choose; of these, 1%(N=1) reported ‘very difficult’, 8% (N=8) reported ‘difficult’, and 40% (N=40) were neutral.

62% (N=62) reported no difficulty in receiving results of the test requested. Of this number, 25% (N=25) selected ‘not difficult’, 37% (N=37) ‘less difficult’. 19% (N=19) reported difficulty in receiving the results of the test; of these, 6% (N=6) chose ‘most difficult’, 13% (N=13) ‘difficult’. 19 % (N=19) was neutral.

46% (N=46) reported no difficulty in acting on the results of the test; of these, 21 % (N=21) reported ‘not difficult’, 25% (N=25) ‘less difficult’. 29% (N=29) reported difficulty in acting on the results; of these, 9% (N=9) reported most difficult, 20% (N=20) reported difficulty. 25% (N=25) were neutral.

39% (N=39) of the intern respondents reported no difficulty in preparing the patients for a test or intervention; of these, 17% (N=17) reported ‘not difficult’, 25% (N=25) ‘less difficult’. 26% reported difficulty in preparing; of these, 5% reported ‘most difficult’, 21 % ‘difficult’. 32% were neutral.

Source of guidance regarding the choice of imaging modality

The majority of the interns, 74% (N=74), reported that if they need guidance, they ask the colleague from the team. 11% (N=11) look it up on the internet, and 5% (N=5) ask the consultant. 7% (N=7) reported other guidance, which included the combination of asking the colleague on the team, asking consultant, and looking it up on the internet (Table 3.6). The internet sources for guidance on choice imaging modality used by the respondents was a search engine like google, 46% (N=46), while 32% (N=32) reported using specific radiology site such as irefer, ACR or radiopedia, and 3% (N=3) reported using other sources (Table 3.7)

Table 3.6 **Source of guidance regarding the choice of imaging modality in the intern sample (N=100)**

Source of guidance on the choice of imaging modality	**Percentage**
Ask a colleague on your team	74.0
Ask a radiologist	3.0
Ask your consultant	5.0
Look it up on the internet	11.0
Other (please specify)	7.0
Total	100.0

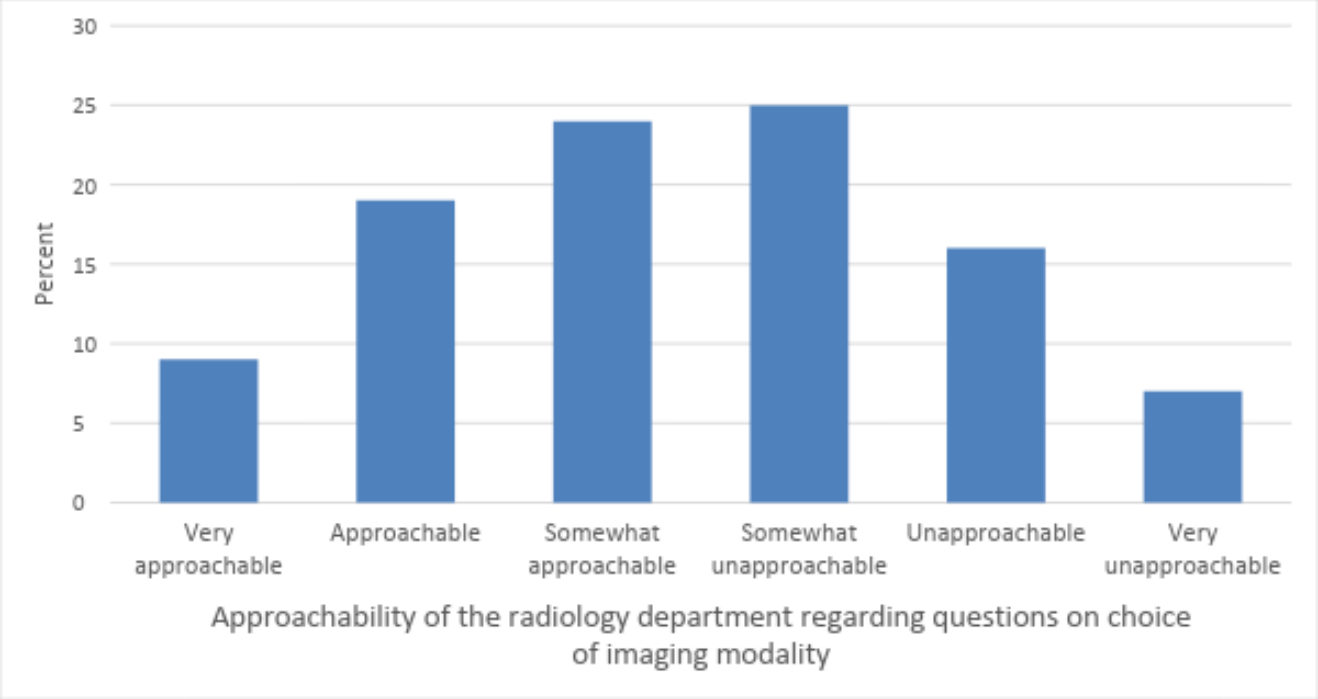
Table 3.7 **Internet sources for guidance on choice of imaging modality in the intern sample (N=100)**

Internet sources for guidance on choice of imaging modality	Percentage
A specific radiology site such as irefer, ACR, or radiopedia	32.0
Other (please specify)	3.0
Use a search engine such as google	46.0
Total	100.0

Approachability of the radiology department regarding questions on choice of imaging modality

Fifty two percent (N=52) of the respondents felt that the radiology department was approachable. 9% (N=9) reported 'very approachable', 19% (N=19) 'approachable', 24% (N=24) 'somewhat approachable'. Conversely, 48% (N=48) of the interns felt that the radiology department was 'not approachable'. Of these, 7% (N=7) reported 'very unapproachable', 16% (N=16) 'unapproachable', 25% (N=25) 'somewhat unapproachable' (Figure 3.8).

Figure 3.8 **Approachability of the radiology department regarding questions on choice of imaging modality in the intern sample (N=100)**



Use of radiology results

When asked what they would do if the shift ends, and they have ordered a radiology exam which is expect to be performed within 8 hours of their shift ending, 51% (N=51) reported that at the end of the shift they hand over the information to the team that is taking over. Thirty-six percent (N=36) reported that they check the following day, 7% (N=7) follow up the exam from home, and 6% (N=6) go home without checking at all (Figure 3.9).

When asked about checking radiology results, 87% (N=87) reported that they frequently check the radiology results; of these, 24% (N=24) check 'very frequently', 40% (N=40) 'frequently', and 23% (N=23) 'somewhat frequently'. In contrast, 13% (N=13) reported 'infrequently' checking the radiology results, 1% (N=1) 'very infrequently', 12% (N=12) 'somewhat infrequently'. When asked about the form of viewing the radiology results, 94% (N=94) of

interns reported that they view the results in the hospital computer. 3% (N=3) get the verbal report, and 3% (N=3) request the hard copy or printed report from radiology (Figure 3.10)

Most of the interns, 74% (N=74), reported that they are confident in discussing the results with the patient. 6% (N=6) were 'very confident', 37% (N=37) 'confident', and 31% (N=31) 'somewhat confident'. 26% (N=26) reported that they were not confident in communicating the results to the patient, with 4% (N=4) 'very unconfident', 3% (N=3) 'unconfident', and 19% (N=19) 'somewhat unconfident'.

The majority of the respondents, 74% (N=74) reported that they frequently view the images of the radiology test requested. 26% (N=26) reported infrequently viewing the images of the test ordered. The majority view the results in the hospital computer.

Figure 3.9 **Responses to "What do you do if the shift ends, and you have ordered a radiology exam which you expect will be performed within 8 hours of your shift ending?" in the intern sample (N=100)**

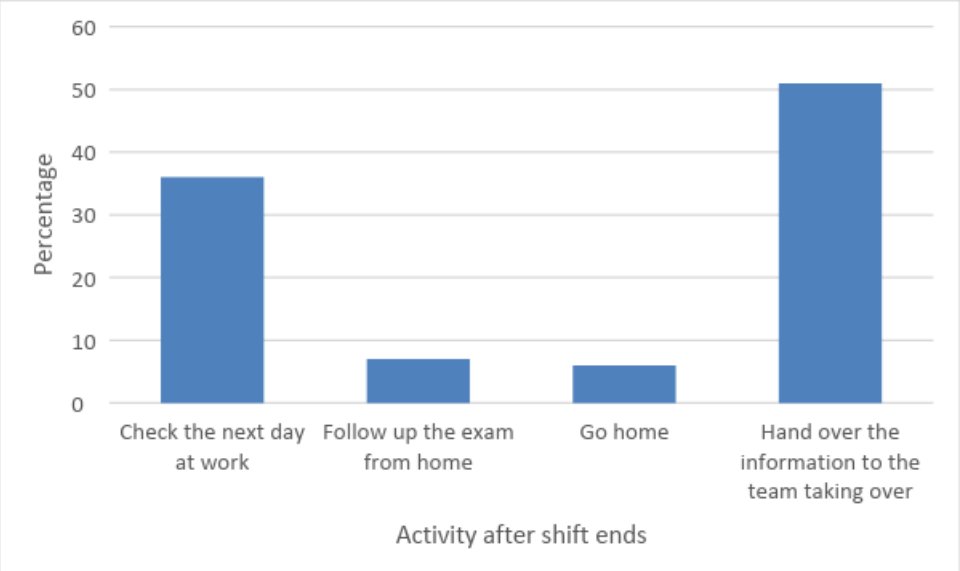
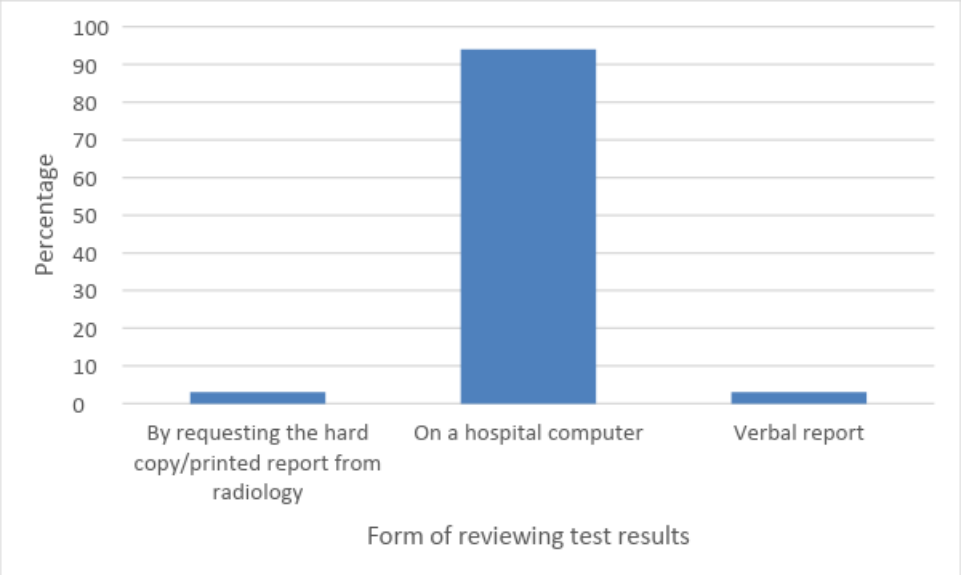


Figure 3.10 **Form of reviewing radiology test results based on responses from the intern sample (N=100)**



Level of confidence in understanding the indications of the radiology modality test ordered

When asked to rate on a 6-point confidence scale their confidence in understanding the indication across various imaging modalities, a summary of these results is presented in Table 3.8.

Table 3.8 **Percentage of responses across six confidence level grades in relation to tests where there was awareness of the indications, based on responses from the intern sample**

Indications	Very confident	Confident	Somewhat confident	Somewhat unconfident	Unconfident	Very unconfident
Plain film	25.0	49.0	19.0	3.0	2.0	2.0
Ultrasound	18.0	30.0	23.0	13.0	9.0	7.0
CT	13.0	24.0	41.0	12.0	7.0	3.0
MRI	6.0	14.0	42.0	23.0	10.0	5.0
PET CT	2.0	14.0	22.0	28.0	21.0	13.0
Nuclear medicine	1.0	2.0	17.0	31.0	27.0	22.0

Ninety three percent (N=93), of the intern respondents reported confidence in understanding the indications of the plain films; of these, 25% (N=25) were ‘very confident’, 49% (N=49) ‘confident’, 19% (N=19) ‘somewhat confident’. 5% (N=5) were ‘not confident’; of these, 2% (N=2) were ‘very unconfident’, 2% (N=2) ‘unconfident’, and 3% (N=3) ‘somewhat unconfident’.

78% (N=78) reported confidence in understanding indications for CT. Of these, 13% (N=13) responded ‘very confident’, 24%(N=24) ‘confident’, and 41 % (N=41) ‘somewhat confident’. 22% (N=22) were ‘not confident’ with CT indications; of these, 3% (N=3) were ‘very unconfident’, 7% (N=7) ‘unconfident’, and 12 % (N=12) ‘somewhat unconfident’.

71% (N=71) reported confidence in understanding indications for ultrasound. Of these, 18% (N=18) were ‘very confident’, 30 % (N=30) ‘confident’, and 23% (N=23) ‘somewhat confident’. 29 % (N=29) reported non-confidence with ultrasound indication; of this number, 7% (N=7) were ‘very unconfident’, 9% (N=9) ‘unconfident’, and 13% (N=13) ‘somewhat unconfident’.

62% (N=62) reported confidence in understanding MRI indications; of these, 6% (N=6) were 'very confident', 14% 'confident', and 42% (N=42) 'somewhat confident'. 38% (N=38) reported non-confidence with MRI indictions; of these, 5% (N=5) were 'very unconfident', 10% (N=10) 'unconfident', and 23% (N=23) 'somewhat unconfident'.

38% (N=38) reported confidence understanding indications of PET/CT. Of these, 2% (N=2) were 'very confident', 14% (N=14) 'confident', and 22% (N=22) 'somewhat confident'. 62% (N=62) reported non-confidence with understanding PET/CT indications; of these, 13% (N=13) were 'very unconfident', 21% (N=21) 'unconfident', and 28% (N=28) 'somewhat confident'.

20% (N=20) reported confidence understanding indications of Nuclear medicine. Of these, 1% (N=1) were 'very confident', 2% (N=2) 'confident', and 17% (N=7) 'somewhat confident'. 80% (N=80) reported that they were 'unconfident' in understanding indications of Nuclear Medicine, Of these, 22% (N=22) were 'very unconfident', 27% (N=27) 'unconfident', and 31% (N=31) were 'somewhat unconfident'.

Level of understanding of the use of contrast media for radiology investigations

Fifty-two percent (N=52) of interns felt that they had adequate understanding of the use of contrast medium in radiology investigations. Specifically, 2% (N=2) indicated 'very adequate'; 16% (N=16) 'adequate'; and 35% (N=35) felt it was 'somewhat adequate'. In contrast, 48% (N=48) felt their understanding of the use of contrast media was inadequate, where 3% (N=3) stated 'very inadequate,' 15% (N=15) 'inadequate', and 29% (N=29) indicated that it was 'somewhat inadequate.'(Table 3.9)

Table 3.9 **Level of interns' understanding of the use of contrast media for radiology investigations in the intern sample (N=100)**

Level of understanding of use of contrast	Percentage
Very Adequate	2.0
Adequate	16.0
Somewhat Adequate	35.0
Somewhat Inadequate	29.0
Inadequate	15.0
Very inadequate	3.0
Total	100.0

Interest of the interns in a career in radiology, and working as an intern in radiology

Thirty three percent (N=33) of the intern respondents demonstrated an interest in becoming a radiologist. 66% (N=66) reported that they were 'not interested' (Table 3.10). When asked if the interns have worked in radiology, they all reported that they have never worked in radiology as interns.

Table 3.10 **Level of the intern interest in becoming a radiologist based on intern responses (N=100)**

Interest	Percentage
Very interested	6.0
Interested	4.0
Somewhat interested	23.0
Somewhat uninterested	14.0
Uninterested	26.0
Very uninterested	27.0
Total	100.0

Designing an intern preparatory course: analysis of open comments

In an open-ended question, interns were asked to highlight any topics not covered in this survey which were important for inclusion in an intern preparatory course, the following themes emerged. Their responses were categorised by the lead investigator using seven overarching themes (A-G).

A. Communication with radiologists, and clinical information

Most of the interns felt communication with the radiologist should be included in the intern preparatory radiology course. The following statements are examples of this theme:

“A list of information that the radiologist is likely to require would be useful”

“How to make a case for a scan when discussing with the radiologist”

“How to present the patient relevant details that radiologists like to know”

“How to present clinical questions in a meaningful way to radiologists so that they would be able to help with the patient’s case.”

“Indications for scans and what the radiologist likes to see.”

“What the radiologist wants to know”

“An induction from the in-hospital radiologist”

“How to argue your case with the radiologists, they are extremely unhelpful, and try to avoid doing CT scans at all costs, will redirect you to every other modality of imaging”

“Feel radiology should have a course on how to deal with other healthcare professionals as they are notorious for their unwillingness to cooperate with other teams”

“How not to get berated by radiology, i.e. ensure you are well prepared with results and for the rudeness that you may be presented with”.

“Run through ISBAR type scenario for communicating with radiologists. Create a per hospital guide as to how to communicate with radiology, information on how to make contact with them, and how nighttime imaging requests work in each hospital, e.g. consultant to consultant or Registrar to consultant, etc”

“Structured approach to vetting scans, what information to present or have on hand”

B. Communication with radiographers

A sample of the comment is presented below:

“What the radiographer wants in the clinical information”

C. Patient preparation for radiology procedures

Examples of comments belonging to this theme are presented below:

“What is required to prepare a patient for e.g. CTPA , Renal biopsy”

“Why do patients need to fast for certain procedures”

“The main issue for interns is preparing the patients for scans”

D. Interventional radiology

Examples of comments belonging to this theme are presented below:

“Indications for interventional radiology”.

“how to prepare the patient for interventional procedures, including whether to fast or not”

E. Clinical radiology

Examples of comments belonging to this theme are presented below:

“Terminology of scans eg. hypoattenuation versus hypodensity, etc, what they mean”

“Give more one to one understanding radiology using clinical cases”.

“Tips and tricks for reading CTs, common findings to look for e.g. bowel obstruction, run through the case e.g. lung ca, positive CTPA, perforated diverticulitis, renal pathology, etc, point out the findings. Teaching needs to be applicable to a clinical situation, and case.”

“If we go through the process of writing a report, weekly tutorials for one hour where we go through some cases of the week”

F. Working with the national integrated medical imaging system

A sample of the comment is presented below:

“Dealing with NIMIS”

G. Use of contrast in radiology

Examples of comments belonging to this theme are presented below:

“Main issue for interns is when to use contrast”

“Making a formal request, further information on contrast versus non contrast”

“Discussing scans, contrast”

H. Radiation protection

A sample of the comments is presented below:

“understanding radiation protection”

I. Patient communication

A sample of the comments is presented below:

“Communicating Results to patients”

3.3 Results of the radiologist survey

The questionnaire was distributed to the radiologists and SPRs registered in 2017 total of 350, only 50 responded, response rate of 14%.

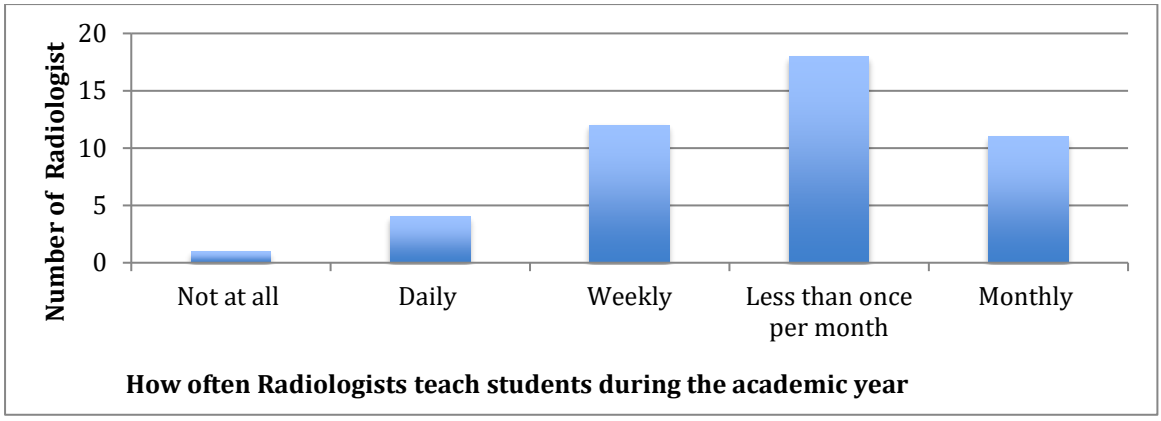
3.3.1 Demographic characteristics and educational background of radiologists

Most of the radiologist respondents were male, 64% (N=36). Most responders, 92% (N=46), worked in the teaching hospitals, and a minority, 5% (N=4), are based in the non-teaching 4hospitals. The majority of the respondents were consultant radiologists, 77% (N=37), and the remaining 23 % (N=13) were specialist trainees in radiology (SpR).

Teaching radiology to medical students

Thirty-six percent (N=18) of respondents reported that they teach medical students less than once a month. Twelve percent (N=6) reported teaching the students weekly; 11% (N=5) monthly; 4% (N=2) daily. Two percent (N=1) reported that they are not involved in medical student teaching (Figure 3.11).

Figure 3.11 **Student teaching undertaken by radiologist respondents (N=50) during the academic year**



Examining undergraduate students as part of medical school examinations

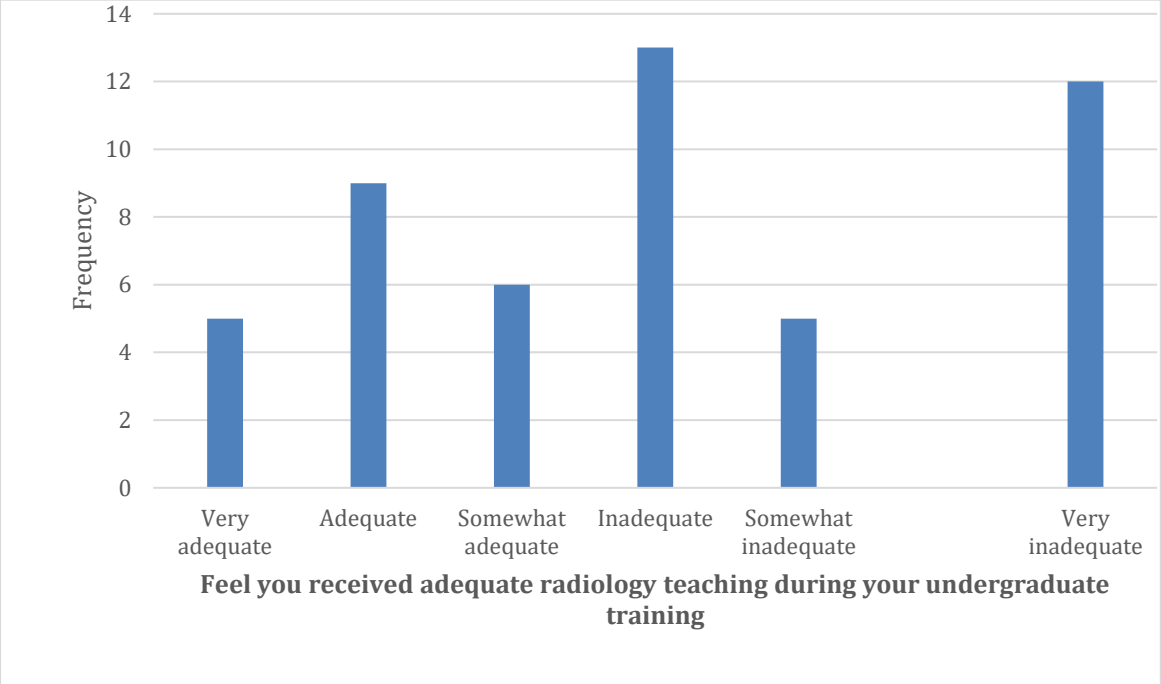
Among the respondents that are involved in teaching undergraduate medical students, 48% (N=24) reported that they were not involved in undergraduate medical examinations.

46% (N= 23) of the respondents involved in teaching medical students also participate in the undergraduate medical examination.

Perceived adequacy of radiology teaching received by the radiologists during their undergraduate training

When asked to indicate to what extent they feel they received adequate radiology teaching during their undergraduate training, the majority of respondents, 60% (N= 30), reported that they did not receive adequate radiology teaching during their undergraduate training. Of this number, 26% (N=13) reported 'inadequate training'; 10% (N=5), 'somewhat inadequate'; and 24% (N=12) 'very inadequate'. 40% (N=20) of respondents reported that their undergraduate radiology teaching was adequate. Of these, 18% (N=9) reported 'adequate' training, 12% (N=6) reported 'somewhat adequate', and 10% (N=5) 'very adequate' training. (Figure 3.12).

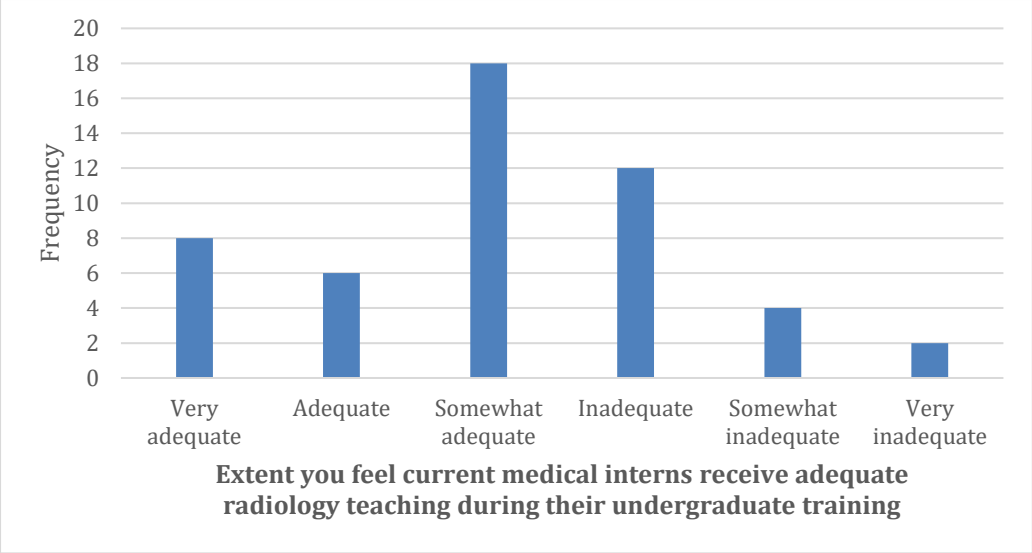
Figure 3.12 **Perceived adequacy of radiology teaching received by the radiologists (N=50) during their undergraduate training**



3.3.2 Radiologists' perception of intern exposure to radiology during undergraduate training in medicine

The majority of the radiologists, 64% (N=32), felt that the interns receive adequate radiology teaching during their undergraduate training. Specifically, 16 % (N=8) felt the teaching was 'very adequate'; 12% (N6), felt that it was 'adequate'; 36% (N=18) felt it was 'somewhat adequate'. In contrast, 36% (N=18) of radiologists felt that interns' exposure to radiology was not adequate. Of that number, 4 % (N=2) felt that it was 'very inadequate', 24% (N=12) felt it was' inadequate', and 8% (N=4) felt it was 'somewhat inadequate (Figure 3.13).

Figure 3.13 **Radiologists' (N=50) perception of the extent to which current medical interns receive adequate radiology teaching during their undergraduate training**



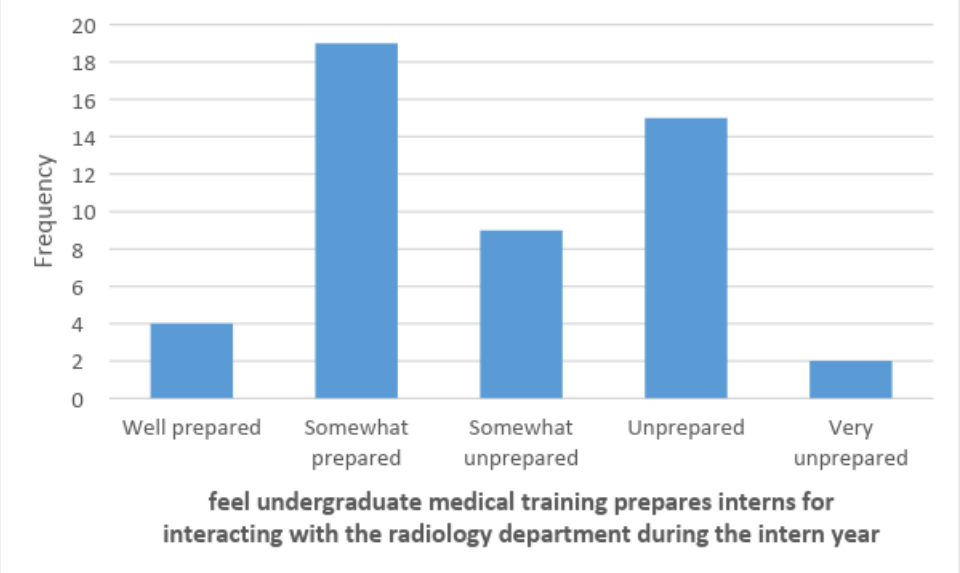
3.3.3 Radiologists' perceptions of intern interactions with the radiology department

Radiologists' perception on how the undergraduate medical training prepares interns for interacting with the radiology department during the intern year

Radiologists were asked for their views on how undergraduate medical training prepares interns for interacting with the radiology department during the intern year**.** The majority of the radiologists, 52% (N=26), indicated that the interns were not prepared for interacting with the radiology department. Of this number, 4% (N=2) felt that they were 'very unprepared'; 30% (N=15), 'unprepared'; 18% (N=9), 'somewhat unprepared'. 46% (N=23) of radiologists felt

that undergraduate training prepares the interns for interacting with radiology. Of this number, 8% (N=4) felt that the interns were 'well prepared', and 38% (N=19) felt that they were 'somewhat prepared' (Figure 3.14).

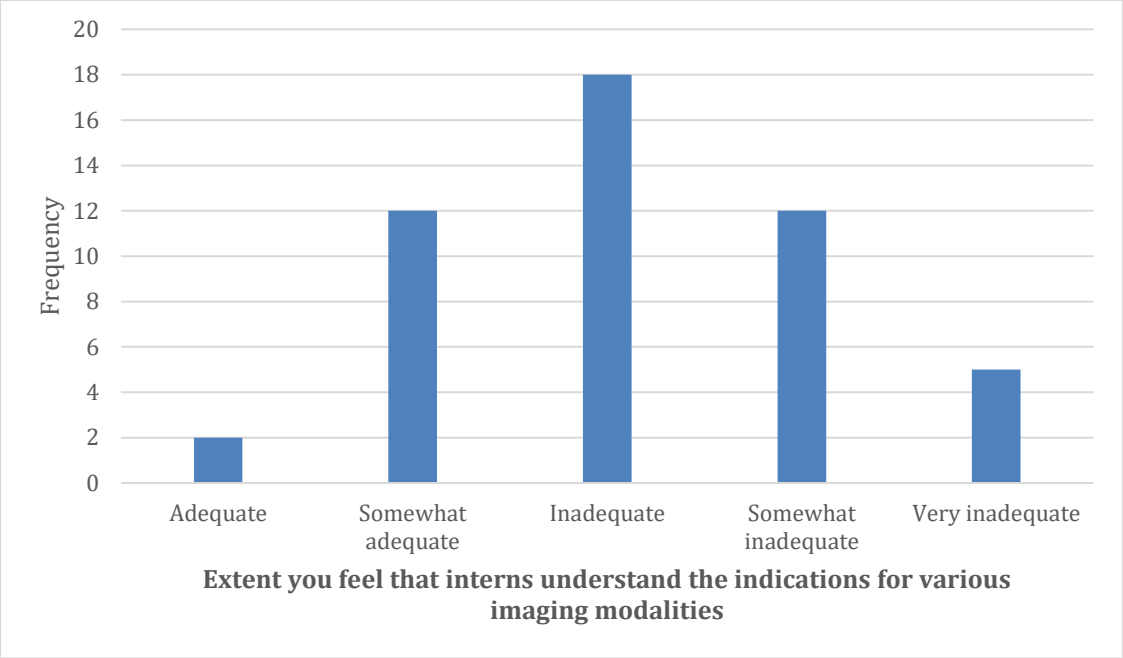
Figure 3.14 **Radiologists' (N=50) perception that undergraduate medical training prepares interns for interacting with the radiology department during the intern year**



Radiologists' perceptions regarding interns' understanding of the indications for various imaging modalities

Many of the radiologists, 70% (N=35), felt that interns' understanding for the various modalities was inadequate. Of these, 36% (N=18) reported that it was 'inadequate'; 24% (N=12), 'somewhat inadequate'; 10% (N=5), 'very inadequate'. Thirty percent (N=15) of the radiologists felt that interns' understanding of the various modalities is 'adequate'. Four percent (N=2) reported 'adequate', 2% (N=1) reported "very adequate", and 24% (N=12) reported 'somewhat adequate'.(Figure 3:15).

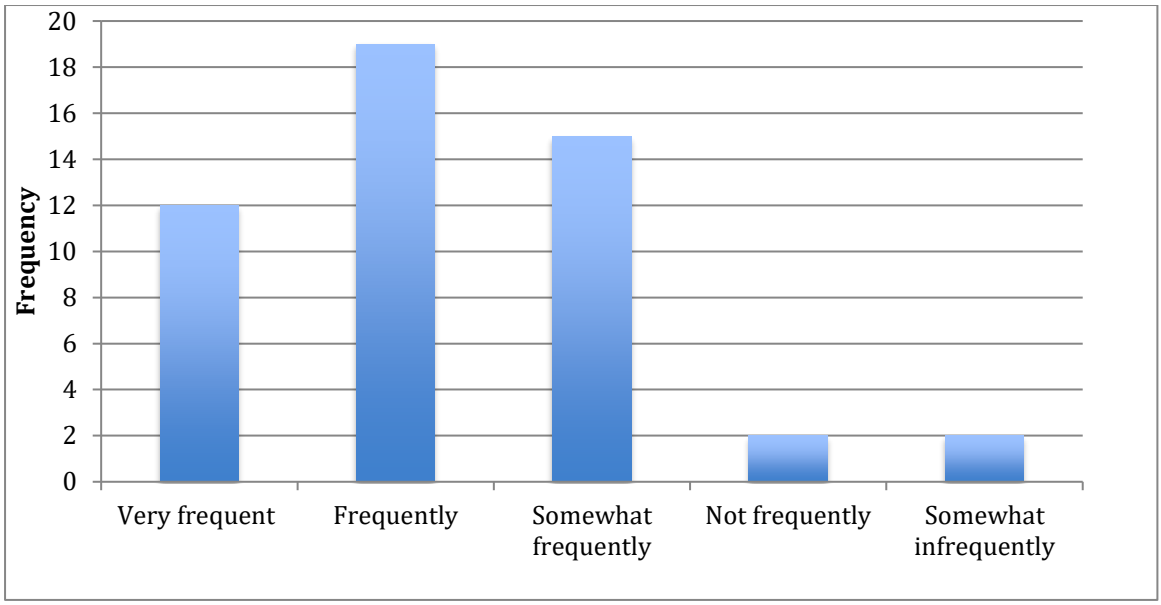
Figure 3.15 **Radiologists' (N=50) perceptions of interns' understanding of indications for various imaging modalities**



Radiologists' perceptions of interns' uncertainty regarding the indication of the radiology examination

The majority of the radiologists, 92% (N=46) reported that they felt that the interns were frequently uncertain regarding the indication of the radiology examination. Of this number, 38% (N=19) reported 'frequently', 24% (N=12) 'very frequently', and 30% (N=15) 'somewhat frequently.' Eight percent (N=4) of the radiologists felt that the interns were infrequently uncertain regarding the indication of the radiology examination. Four percent (N=2) reported 'not frequently', and 4% (N=2) reported 'somewhat infrequently' (Figure 3:16).

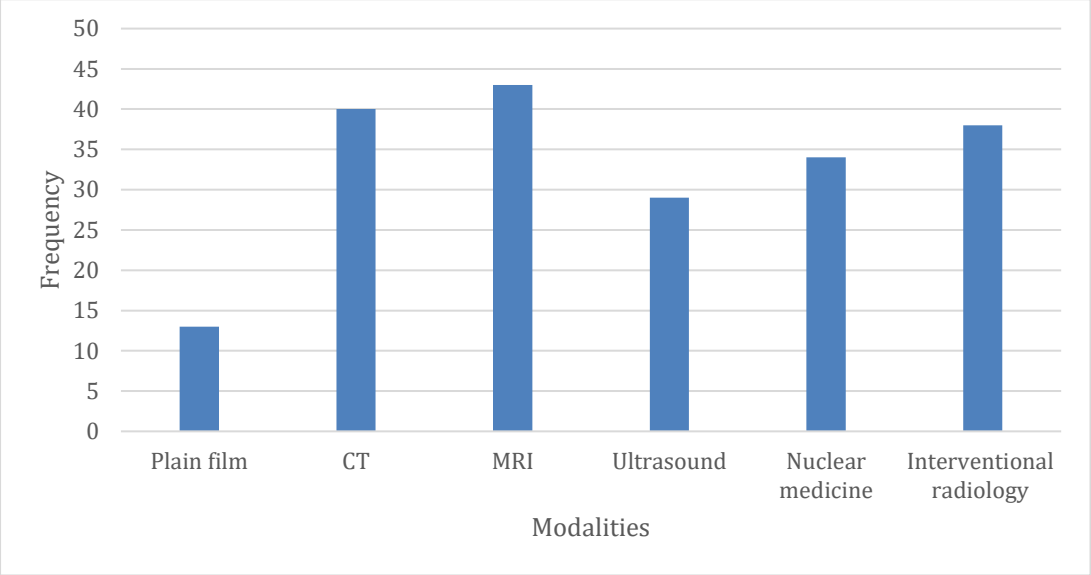
Figure 3.16 **Radiologists' (N=50) perceptions regarding how frequently they feel interns have uncertainty regarding the radiology exam indications**



Radiologists' perception regarding intern uncertainty based on imaging modality

Figure 3.17 summarises radiologists' perceptions of intern uncertainty regarding indications for the various imaging modalities, where they were asked to check which of the modalities were more likely to be areas of uncertainty for interns. Radiologists felt that the interns were unceetain about the indications of the following modalities in the decreasing order: MRI, CT, interventional radiology, nuclear medicine, and ultrasound.

Figure 3.17 **Radiologists' views (N= 50) regarding intern uncertainty with respect to indication for various imaging modalities.**



Radiologists' perceptions of interns' performance in interacting with radiology department

When the radiologists were asked to rate on a 5- point scale ranging from 1=poor to 5=excellent, interns' performance in terms of interaction with radiology department, a summary of the results is presented in Table 3.11

Table 3.11 **Radiologists' (N=50) ratings of interns' performance in terms of interaction with radiology department (1 = poor, to 5 = excellent)**

Variable	**1=poor**	**2**	**3**	**4**	**5=excellent**

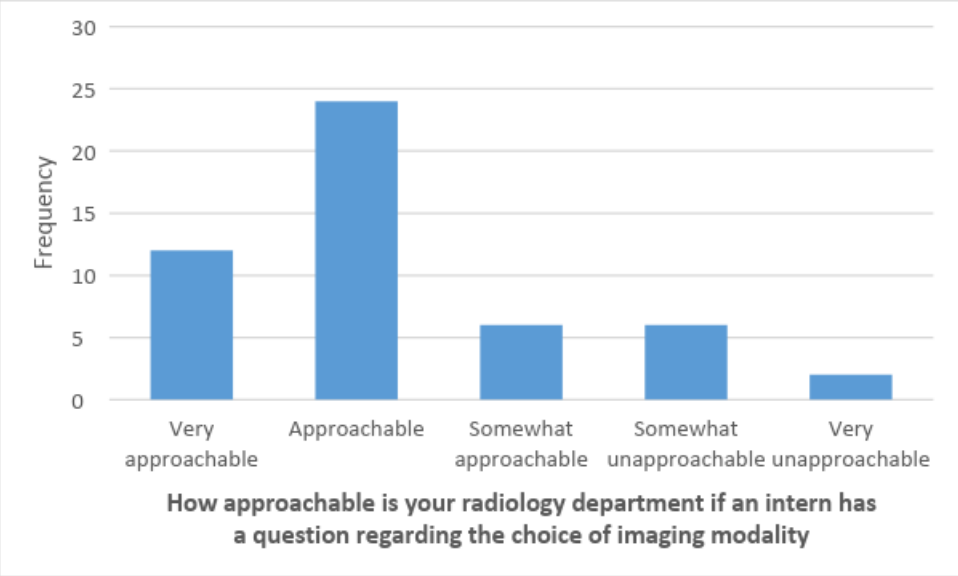
Providing relevant clinical information.	8	21	12	9	0
Understanding the indication for the studies they are requesting.	9	25	14	2	0
Deciding which modality is appropriate	8	25	15	2	0
Communicating with the radiographer or radiologist	3	19	19	9	0
Receiving the results of the test	1	14	16	17	2
Acting on the results of the test	2	15	17	15	0
Preparing patients for a test or intervention	6	17	19	6	0

As indicated in Table 3.11, radiologists rated the following performance domains as most inadequate: understanding study indication 68%(N=34); selecting the most appropriate imaging modality 66%(N= 33) providing relevant clinical information 58%(N=29); selecting the most appropriate imaging modality.

Approachability of the radiology department regarding questions on choice of imaging modality

When the radiologists were asked about the approachability of their department if an intern has a question regarding the choice of the imaging modality, 66% (N=33) felt that their departments were approachable; 48% (N=24) reported 'approachable', 12% (N=6), 'somewhat approachable', and 24% (N=12) 'very approachable'. 16% (N=8) of the radiologists reported that their departments were not approachable. Of these, 4% (N=2) felt their departments were 'very unapproachable', and 12% (N=6) felt their departments were 'somewhat unapproachable'. (Figure 3.18)

Figure 3.18 **Radiologists' (N=50) perceptions of approachability of the radiology department regarding questions on choice of imaging modality**



Perceptions of radiologists regarding interns' checking the radiology results

The majority of the radiologists, 74% (N= 37) perceive that the interns check the radiology results; of this number, 4% (N=2) reported 'very frequently, 34% (N=17) reported 'frequently', and 36% (N=18) reported 'somewhat frequently'.

Twenty-six percent (N=13) of the radiologist reported that they perceive that the interns do not frequently check the radiology results; of this number, 8% (N=4) reported 'infrequently', 16% (N=8) 'somewhat infrequently', and 2% (N=2) 'very infrequently' (Table 3.12).

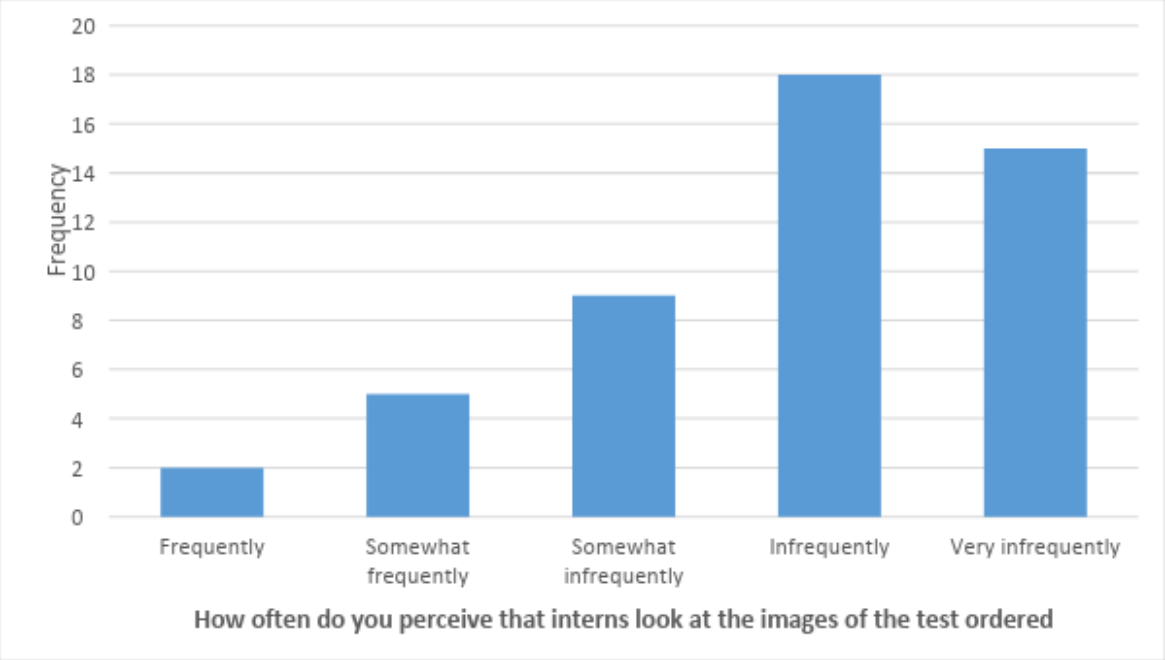
Table 3.12 **Radiologist perception of interns checking radiology results**

	Frequency	Percentage
Very infrequently	1	2.0
Frequently	17	34.0
Infrequently	4	8.0
Somewhat frequently	18	36.0
Somewhat infrequently	8	16.0
Very frequently	2	4.0
Total	50	100.0

Perceptions of radiologists regarding interns' viewing of the images of the test ordered

The majority of the radiologists, 84% (N=42) perceive that the interns infrequently looked at the images; of these, 36% N=18) reported 'infrequently', 18% (N=9) reported 'somewhat infrequently', and 30% (N=15) reported 'very infrequently'.14% (N=7) felt that the interns viewed the images of the radiology test they have ordered; 4% (N=2) reported 'frequently', and 10% (N=5) reported 'somewhat frequently' (Figure 3.19).

Figure 3.19 **Radiologists' perceptions regarding interns viewing the images of the test requested.**



3.3.3.1 Perceptions of radiologists regarding interns' understanding of the indications of various imaging modalities

When the radiologists were asked to rate on a 6-point scale the interns' understanding of the indications of various imaging modalities, a summary of the results is presented in Table 3.13.

Table 3.13 **Radiologists' perceptions (summarised as total frequency across response categories) regarding interns' understanding of the indications of various imaging modalities**

Modalities	Very unconfident	Not confident	Somewhat unconfident	Somewhat confident	Confident	Very confident
Plain film	2	5	5	21	14	3

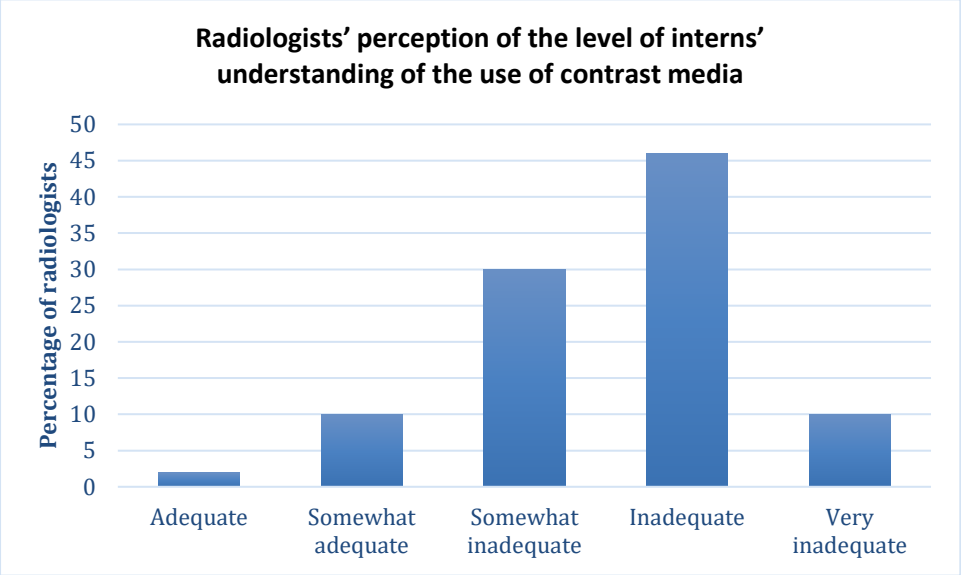
CT	3	7	19	18	2	1
MRI	3	8	18	14	7	0
Ultrasound	6	15	19	8	2	0
Nuclear medicine	10	22	11	5	2	0
Interventional radiology	12	22	11	3	1	0

Radiologists perceived that interns were not confident in understanding the use most imaging modalities , Interventional radiology 90%(N=45), Nuclear medicine 86%(N=43) Ultrasound 80% (N=40) CT 58% (N=29) most radiologists 70%(N=35) felt interns were confident in understanding plain films.

3.3.3.2 Perceptions of radiologists regarding interns' understanding of the use of contrast media

Most of the radiologists 86% (N=43) reported that they feel the interns have an inadequate understanding of the use of contrast media for radiology investigations. Of these 10% (n=5) reported 'very inadequate,' 46% (N=23) reported 'inadequate', and 30% (N=15) reported 'somewhat inadequate'. Twelve percent (N=6) reported that they feel the interns have an adequate understanding of the use contrast medium for radiology investigations. Of these, 2% (N=1) reported adequate understanding, and 10% (N=5) reported somewhat adequate (Figure 3.20).

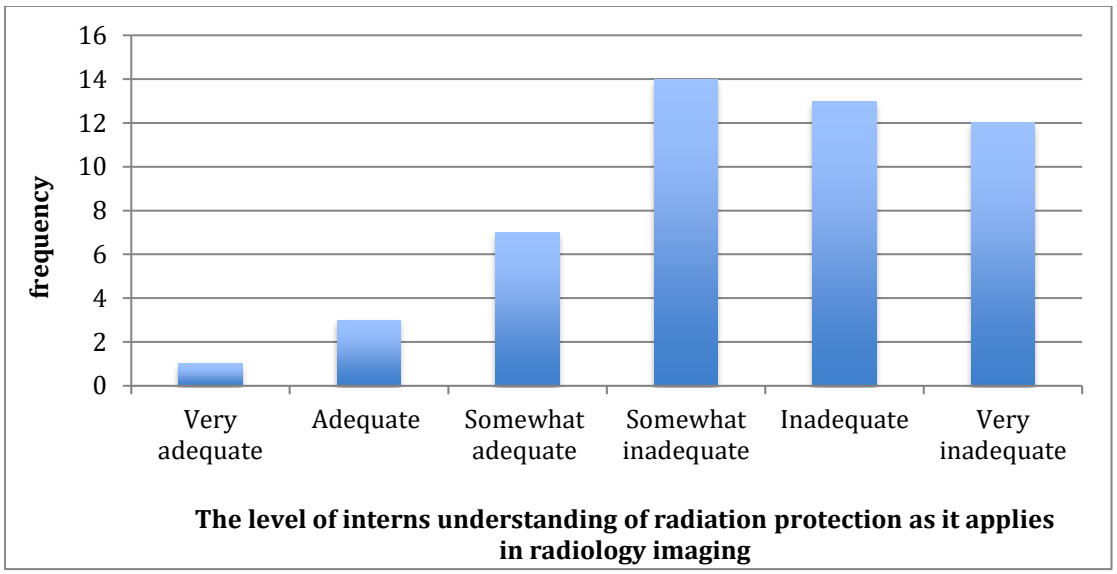
Figure 3.20 **Radiologists' perception of interns understanding of the use of contrast media**



3.3.3.3 Radiologists perceptions of the interns' understanding of radiation protection as it applies in radiology imaging

The majority of the radiologists, 78% (N=39), feel that the interns have inadequate understanding of radiation protection as it applies in radiology imaging. Of these, 24% (N=12) reported' very inadequate', 26% (N=13) reported 'inadequate', and 28% (N=14) reported 'somewhat inadequate.'22% (N=8) reported that they feel the interns have an adequate understanding of radiation protection. Of these 2% (N=1) reported 'very adequate', 6% (N=3) reported 'adequate', and 14% (N=7) reported 'somewhat adequate'.(Figure 3:21)

Figure 3.21 **Radiologists' perceptions regarding the level of interns' understanding of radiation protection as it applies in radiology imaging**



3.3.3.4 Open-ended comments

When questioned if they were asked to design an intern preparatory course for interacting with radiology department, and whether there were any topics not covered in this survey which they felt are important, the following five themes (A-E) emerged:

A. Communication and clinical information

Most radiologists expressed that communication, e.g. appropriate clinical information, and discussing the clinical cases with radiology, should be part of the undergraduate radiology

curriculum. Some radiologists preferred that the cases be discussed by senior members of the team, not the interns. Examples of comments belonging to this theme are presented below:

” Appropriate clinical information is essential.”

” How to put the information we need to know down” “

“Patients clinical information”

“How to ignore instructions from the team, and think for themselves,” being prepared to discuss the case as opposed to “oh I didn’t see the patient”.

“Why do I as a consultant have to repetitively interact with an intern at all? it doesn't happen as much in other jurisdictions.”

B. Imaging modalities and requesting examinations

The radiologists mentioned that interns should be taught various image modalities, and the use of radiology investigations. Examples of comments belonging to this theme are presented below:

“Choosing and using radiology investigations.”

“Every medical staff need to understand that newer techniques do not mean better, they are simple more specialised to answer specific questions, and basic radiological techniques like X Ray, and ultrasound should not be abandoned”

“Understanding why multiphase CT may sometimes be required.”

Understanding MRI indications

Awareness of waiting list, and prioritisation, to minimise unnecessary examinations.

C. Patient preparation for radiology examinations

Examples of comments belonging to this theme are presented below:

"Fasting patients pre ultrasound abdomen, filling bladder pre transabdominal pelvic ultrasound". "Explaining the procedure to the patient."

"Sufficient IV access, e.g. Exams which require green line".

D. Understanding contrast media

"Understanding contrast media"

E. Radiation safety

"Radiation safety"

Table 3.14 Summary of open ended resposes for interns and radiologists: what should be included in the undergraduate radiology module

Interns	Radiologists
Communication with radiologist and radiographers	Communication skills when discussing imaging requested

Radiation protection	Radiation safety
Use of contrast in radiology	Understanding of contrast
Patient preparation for radiology procedures	Patient preparation for radiology examinations.
How to provide relevant,appropriate clinical information for radiologist	Imaging modalites and requesting examinations
Clinical radiology terminology	
NIMIS how to fill the request	Appropriate clinical information

Table 3:15 Summary of the results of the interns' and radiologists' survey responses

	Interns	**Radiologists**
Undergraduate medical education preparedness for radiology interactions	66% (N=66) unprepared	52% (N=26) felt intens were unprepared

Understanding indication when filling request form	52% (N=52) lacked understanding	92% (N=46) felt interns frequently uncertain.
Radiology contrast media usage	52% (N=52) indicated inadequate understanding	86% (N=43), felt interns do not understand
Radiation protection & 10-day rule	43% (N=43) had formal teaching. 77% were unfamiliar with 10d ay rule.	78% (N=39) felt interns have inadequate knowledge
Checking results of test requested	87% (n=71) check results	74% (N=37) perceive that interns check results
Viewing inages of test ordered	71% (N=71) frequently viewed	84% (N=42) perceive interns do not view images
Undergraduate radiology teaching	67% (N=67) felt they received adequate radiology teaching	64% (N=32) perceive interns receive adequate teaching
Approachability of radiology department	48% (N=48) felt it was unapproachable	16% (N=8) felt the department was unapproachable

3.4 Univariate comparison of intern and radiologist questionnaire responses

Mann-Whitney U comparisons of intern and radiologist responses to selected items were completed. It was demonstrated that radiologists were significantly more likely to rate interns' undergraduate training in radiology as adequate when compared with interns themselves. (U=1792, z=-2.78, P = 0.004). Radiologists were significantly more likely to rate their

department as approachable relative to interns (U=1318, z=4.82, P < 0.001). No significant difference was observed between interns and radiologists with respect to how they rated intern preparedness to interact with the radiology department (P > 0.05). Radiologists were significantly less likely than interns themselves to express confidence in intern's awareness of the indications for the following modalities: plain film (U=1345, z=-4.10, P < 0.001), ultrasound (U=1392, z=-3.42, P = 0.001), CT (U=1412.5, z=-3.20, P = 0.001), and MRI (U=1164.5, z=-3.07, P = 0.002). Radiologists were also more likely to state that interns did not frequently look at the images ordered (U=394, z=-8.50, P < 0.001), and believed that interns checked the results of the tests ordered less frequently compared to the responses of interns themselves (U=1629, z=-3.47, P = 0.001). Radiologists also rated interns' understanding of the use of contrast media (U=339, z=-6.46, P < 0.001) and indications for imaging modality relative to interns (U=353, z=-6.67, P < 0.001).

3.5 Univariate comparisons of gender and programme differences across intern questionnaire responses

Female interns were significantly more likely to rate the radiology as unapproachable relative to males (U=918.5, z=-2.32, P = 0.02). No other gender differences across the item responses achieved statistical significance (all P > 0.05). Interns who graduated from a graduate-entry programme were less likely than their undergraduate-entry counterparts to rate the quality of their undergraduate radiology education as adequate (U=771, z=-2.28, P = 0.02). They were also more likely to report that they did not frequently look at the images ordered (U=733, z= 2.64, P = 0.008). No further programme-related differences were observed.

3.6. GROUP CONCEPT MAPPING RESULTS

Stage 1: Brain storming:

When the participants were asked if they were to design a preparatory course for radiology, a number of statements emerged. Sixty-nine participants submitted responses during the brainstorming stage. In total, 87 non-duplicate statements were submitted. 56.5% (N=39) of the respondents during this stage were male, and the remaining 43.5% (N=3) were female. Ninety percent (N=62) completed their medical training in Ireland, and the remaining 10% (N=7) completed their training in Europe (6%, N=4) or an unspecified location (4%, N=3). 24.6% (N=17) graduated between 1972-1990, 23.1% (N=16) between 1991-1999, 21.7% (N=15), and 27.5% (N=19) between 2000-2017. 15.9% (N=11) of respondents were consultant radiologists, 34.7% (N=24) were consultant grade doctors in other specialties, 15.9% (N=11) were specialist registrars (across a variety of specialties), 14.5% (N=10) were senior house officers, 4.3% (N=3) were registrars, and the remaining respondents (14.5%, N=10) included medical educators, interns, and unspecified.

Stage 2: Sorting and Rating

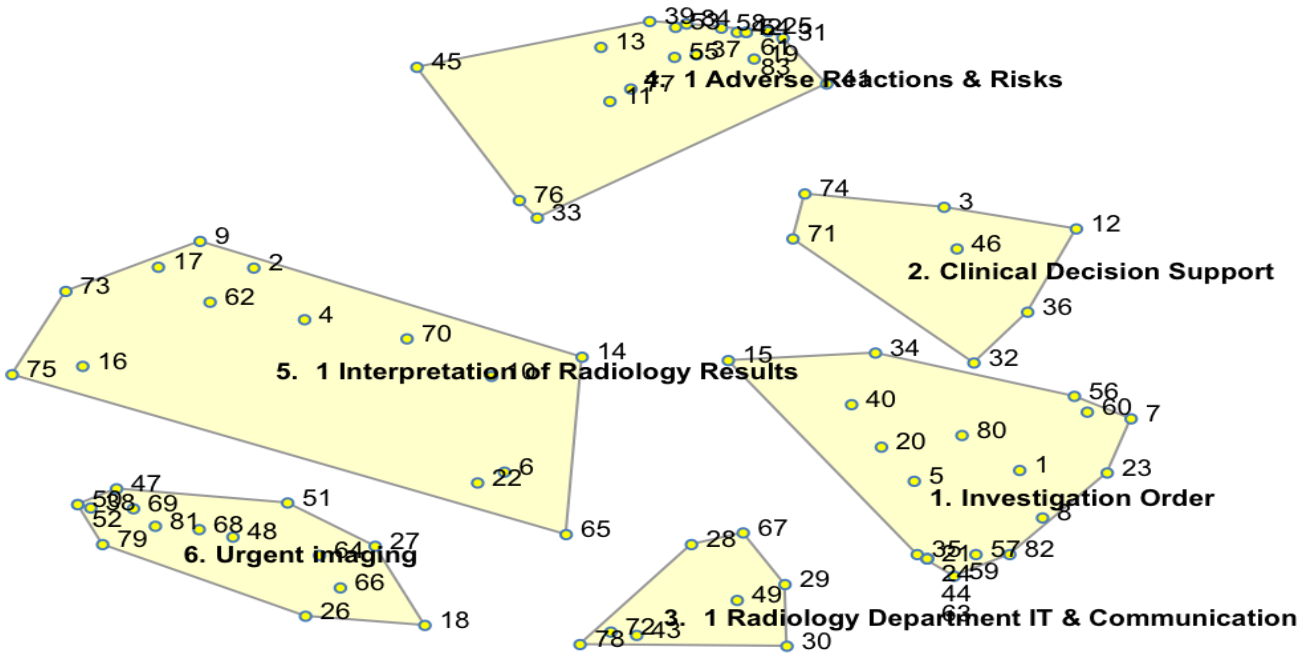
In Stage 2, the participants were asked to sort the statements based on thematic similarity. Additionally, they were asked to identify which statements are (a) most important, using a five-

point scale, and (b) difficult or easy to include as a topic in a preparedness for practice course. The following cluster maps were generated (Figure 3:22):

As indicated in the cluster map below, the following six clusters were generated:

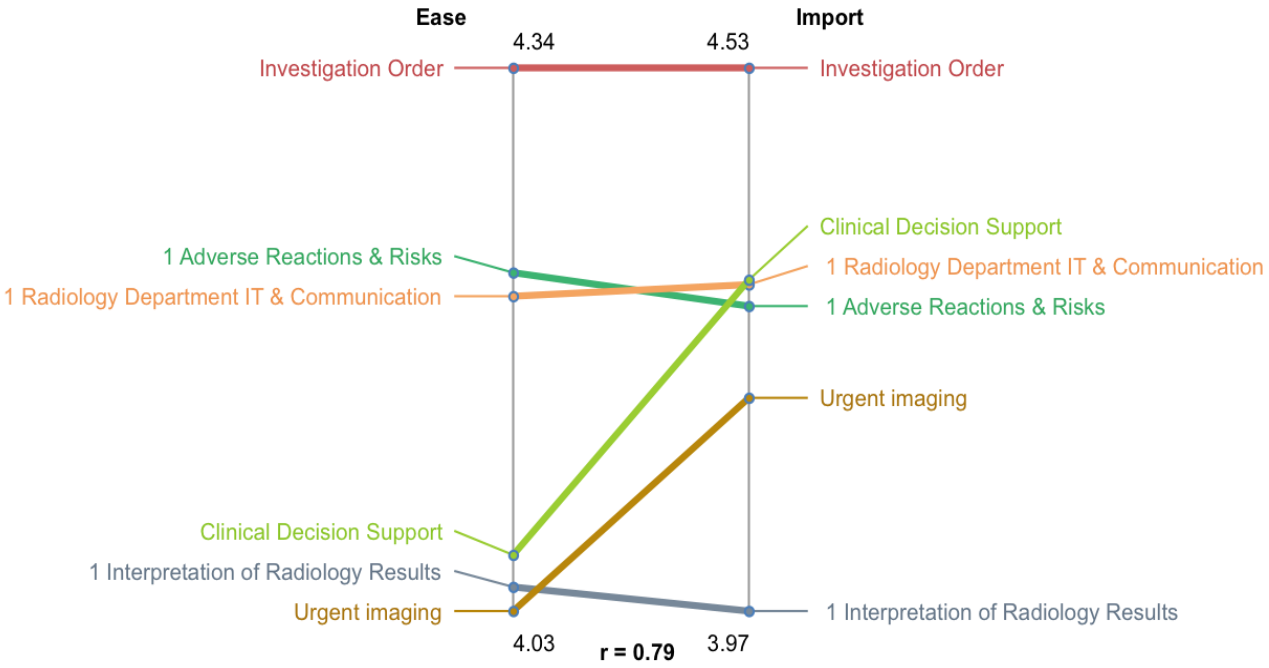
1. *Investigation Order*- relevant clinical details, and appropriate, necessary examinations.
2. *Clinical decision support*- hypothesis of the outcome, based on the clinical background
3. *Radiology department IT and communication*-communication with radiologists, radiographers, and other radiology departmental staff members.
4. *Adverse reactions and risks* - contrast media, radiation
5. *Urgent imaging*- triaging urgent versus non urgent to optimise and expedite imaging where appropriate.
6. *Interpretation of radiology results*

Figure 3.22 **The cluster map, where each point corresponds to a statement (N=87)**



The pattern match map (Figure 3.23) demonstrates participants' relative ratings of how important and easy or difficult it would be to implement these in the curriculum. In relation to the cluster category *Investigation order* (relevant clinical details, request form, appropriate exams, etc), a review of Figure 3.23 indicates that participants regarded this as both important, and easy to implement in the undergraduate radiology preparatory module. A similar profile was observed for *Communication with the radiology department and IT* and *Adverse reactions and risks*. In contrast, *Clinical decision support* and *Urgent imaging* were both rated as important, the former more than the latter, but both were perceived as difficult to implement in the curriculum. *Interpretation of radiology results* was ranked as the least important compared to the others, and not so easy to implement.

Figure 3.23 **Pattern match analysis of six thematic clusters using the rating criteria "Importance" and "Ease of Inclusion/Implementation" in the GCM study**



CHAPTER 4: RESULTS DISCUSSION

4.1 Introduction

The results of the intern and radiologist survey responses will be discussed. The similarities and differences in opinions will be explored. The results of the clusters generated in the GCM analysis will be discussed.

4.1.1 Summary of the results for discussion

4.1.1.1 Interns

Most interns, 66% (N=66), felt that undergraduate medical training did not prepare them to interact with radiology department, although only less than half reported that they received inadequate radiology teaching during undergraduate training. The understanding of radiation protection was suboptimal, and the majority of the interns 77% (N=77) were unfamiliar with the 10-day rule. More than half of the intern respondents 52% (N=52) were frequently uncertain about radiology exam indication when completing a request form. Most interns 59%(N=59) identified challenges in choosing appropriate examinations, communicating with the radiology department. Almost half of the interns 49% (N=49) also regarded the radiology department as unapproachable. Only 33% are considering radiology as a career.

4.1.1.2 Radiologists

More than half of the radiologist respondents, 52% (N=26), felt that the undergraduate medical training did not prepare interns to interact with radiology department. Most radiologists 92% (N=46) feel that intern understanding of indications for imaging modalities is inadequate. Most

of the radiologists also feel that interns have uncertainty regarding exam indications. Most radiologists, 78 % (N=39), felt that the interns' understanding of radiation protection is indequate, and 86% (N=43) perceived that interns understaning of contrast medium not adequate.

Analysis of the open-ended comments revealed that both interns and radiologists rated communication as an essential component if one were to design the radiology preparatory module, with some interns perceiving the radiology department as bullying.

4.1.1.3 Results of the Group Concept Mapping Study (GCM)

The GCM study generated clusters of what the participants deemed important when designing the radiology module.

Six clusters were generated and rated in the order of importance and ease of inclusion in a preparatory module.

- Investigation Order- relevant clinical details, and appropriate, necessary examinations.
- Clinical decision support- hypothesis of the outcome, based on the clinical background
- Radiology Department IT and communication-communication with radiologists and radiographers
- Adverse reactions and risks- contrast media, radiation, invasive interventional procedures.

- Urgent imaging- triaging urgent versus non urgent to optimise and expedite patient management where appropriate.
- Interpretation of radiology results- multimodality results.

The participants felt that investigation order, adverse reactions, and risks, and radiology communication and IT can be easily implemented, however, they perceived clinical decision support, interpreting radiology results, and urgent imaging, as less easy to implement in a radiology preparatory module.

4.2. Demographic characteristics of the Interns and Radiologist survey respondents

Most of the intern survey respondents were females 52%(N=52) Most intern participants 69% N=69)enrolled for medicine directly from secondary school. Less than half, 31%(N=31) had a primary degree prior to commencing medicine, with the majority having completed science degrees. In contrast to the interns, most of the radiologist respondents 64%(N=32) were males. The majority of radiologist respondents 92%(N=46)were based in the teaching hospitals; of these, fewer than half were involved in the final year medical students' examinations. The respondents were mainly consultant radiologists 74% (N=37) and the remainder were specialist trainees in radiology. Only 8% (N=4)of radiologists reported teaching medical students daily, with 36 %(N=18) teaching radiology less than once a month. This concurs with the prior studies that reported over the decades, that the radiologists have difficulty in getting protected time for teaching due to increase demand of the workload. (7, 8, 12, 89)

4.3. Exposure to radiology during undergraduate training in medicine

4.3.1 Interns' and radiologist perceptions of radiology teaching received during undergraduate training

Most of the interns, 67% (N=67), reported that they felt that the radiology teaching that they received during undergraduate training was adequate. This demonstrates improvement, compared to the results of previous studies. For example, in a University of British Columbia study, only 17% of student respondents reported adequate radiology teaching, and 54% rated the teaching as poor. (29) Our results also contrasted to those of Bell et al. (33), where more than half of junior doctors reported that undergraduate radiology teaching was not adequate, and felt that it should be increased in the curriculum.

More than half, 55%,(N=55) of the intern respondents perceived their knowledge of radiology was adequate when compared to other clinical specialities. This concurs with the narrative of the Irish study published by Kassim and colleagues (83), which reported that medical students acquire a lot of knowledge from the undergraduate training, which they are empowered with when they start working as newly qualified doctors, but the degree of converting this theoretical knowledge to practise is not well known.

Most of the radiologists 60% (N=30) felt that the radiology teaching that they received during their undergraduate medical training was not adequate, and most radiologists 64% (N=32) stated that the current interns received adequate radiology teaching during their undergraduate

training. Our study results contrast with those of Schiller et al. (90), where the program directors perceived that the interns were deficient in the imaging skills, and concluded that there should be an increase in teaching imaging at the undergraduate level.

Only 36% (N= 18) of radiologists perceived that current undergraduate radiology teaching is inadequate. Univariate comparisons revealed that indeed radiologists are more likely than interns to rate interns' current level of undergraduate radiology teaching as adequate. The reason may be that most of the radiologist respondents 92%(N=46) are in the academic hospitals. This may signify a perceived improvement in undergraduate radiology teaching over the decades, as evidenced by the fact that most radiologists 60% (N=30) perceived their own undergraduate radiology teaching to be inadequate, whereas they perceived the current interns' undergraduate radiology teaching to be adequate. However, it should be noted that there are still approximately a third of the interns and radiologists in this study who felt that current interns' undergraduate radiology teaching was not adequate. The aim is to bring this to zero, with every new graduate feeling adequately prepared to deal with radiology. However, it should be noted that in a UK study, Jacob et al. (41) reported that most junior doctors felt that undergraduate radiology teaching was unstructured and inadequate, and recommended radiology clinical placements. Only 11% of this UK sample were considering radiology as a career.

Some studies have investigated the perceptions of preparedness among interns in Ireland. Morris et al. (1) reported lack of preparedness in a survey of Irish interns. In another study, the interns stated that they felt that inadequate preparation had a negative effect on their clinical practice during internship. (3)

4.4 Radiology and working as an intern: interns and radiologists

4.4.1 Interns' and radiologists' perceptions on how the undergraduate medical training prepared interns for interacting with the radiology department during the internship year

The majority of interns, 66% (N=66) and radiologists 52% (N=26) perceived that the undergraduate medical training does not prepare the interns well for interacting with the radiology department during the internship year. This highlights the need for radiology preparatory module which would address the knowledge gap identified on this study.

Less than half of the interns, and the radiologists felt that the undergraduate medical training adequately prepares the interns to interact with radiology during the intern year. Although the interns, and the radiologists assert that the undergraduate radiology teaching received by the interns was adequate, both groups concur that the undergraduate radiology teaching did not prepare the interns for interacting with radiology during the internship year. Ferris et al. (79) also reported non-readiness of Irish interns to deal with radiology. Morris et al. (1) asserted that the skills that were taught in the undergraduate training were not concordant with what was required in practice.

4.4.2. Interns and radiologists' perceptions regarding interns' understanding of radiation protection as it applies in radiology imaging

Most of the radiologists, 78%,(N=39) felt that the interns have inadequate understanding of radiation protection as it applies in radiology imaging. Less than half of the intern respondents 43%(N=43) reported that they had received formal teaching on radiation protection during undergraduate training. This demonstrates an improvement when compared to the study conducted by McCuster et al. (91) where only 1% of Irish medical students and junior doctors reported to have had completed a formal radiation protection course. Knowledge of radiation protection is inadequate, as most of the interns, 77%,(N=77) were not familiar with the ten-day rule in imaging patients of childbearing age at the beginning of their internship year. Numerous studies have reported that the knowledge of radiation related matters among interns and non-consultant doctors was suboptimal. (44, 90, 92, 93) Radiation is an important component of radiology and should be included in the preparatory module to increase awareness of the associated risks. This should include awareness of the individual doctor's commitment to safe use of imaging, e.g. eurosafe imaging, image wisely and image gentle.org. (92)

4.4.3. Interns' and radiologists' perceptions of the intern's confidence regarding understanding of the imaging modalities

The majority of the interns 66%(N=66) perceived that they were confident that they had a clear understanding of the different imaging modalities, and their indications in radiology, whereas the majority of the radiologists 70% (N=35) reported that they felt that the interns' understanding of various modalities was inadequate. Only 28% of radiologists felt that the interns' understanding of the various imaging modalities was adequate, and the statistical

analysis confirmed that these discrepant responses were statistically significant. The radiologists' views concur with Schiller et al. (90) where the programme directors asserted that the intern's understanding of imaging was insufficient.

4.4.4. Interns' and radiologists' perceptions of intern uncertainty regarding the indication for the radiology examination, and various modalities

The majority of the radiologists, 92%,(N=46) reported that they perceived that the interns were frequently uncertain regarding the indication of the radiology examination, and more than half, 53%(N=53) , of the interns reported that they are frequently uncertain regarding the indication for the radiology examination when filling the request form. This difference was statistically significant. There is continuous call from various levels that emphasise the importance of the junior doctors or medical students' understanding of various imaging modalities, and their appropriate usage. (21, 34, 79, 81, 94) These studies and recommendations have stated unanimously that teaching the undergraduate students about the various imaging modalities will equip them for clinical radiology practice, and eliminate or reduce unnecessary examinations, reducing overall costs. Allen et al. (95) asserted that appropriate use, and ordering of the imaging examination is a vital skill that should be taught in the practical setting in the undergraduate medical education. It is important for the students to understand that radiology examinations are aligned with the clinical question, therefore critical to provide relevant, precise clinical details. (42)

This result concur with the study conducted by Saha et al (6), where interns reported that they have received inadequate training with regard to ordering studies. The interns' perceived confidence regarding the understanding of the indications of the image modalities, in decreasing order, is as follows: X Rays, computerised tomography, ultrasound, MRI, PET/CT,

and nuclear medicine, with the last two scoring the lowest scores. In contrast, and the level of disagreement achieved statistical significance, radiologists were more likely than interns to indicate that interns were not certain regarding the indications for plain film, MRI, and ultrasound.

4.4.5 Percentage of time the interns spend interacting with radiology

Most of the interns 65% (N=65) reported that they spend less than 25% of the time per day interacting with radiology. This includes requesting tests, preparing patients, attending multidisciplinary meetings, discussing the examinations they are requesting with the radiologists, follow up or communicating the results (to the patients, and the team). Only 24% (N=24) interns reported frequent multidisciplinary meeting attendance.All intern respondents had not worked in the radiology department at the time of the study.

This indicates there has not been much change in the time spent in radiology, concurs with the University of British Columbia study, more than a decade ago in which 65% of respondents felt the time devoted to radiology was inadequate, and most respondents supported an increase in radiology teaching with a mandatory two week rotation in third year, and for it to be an available option in fourth year. (29) The Medical Council has also recommended that the interns rotate in radiology for a period between two and four months. (84) On reviewing the undergraduate radiology curriculum in the UK, Jacob et al. (41) recommended radiology clinical placements and small group tutorials to improve radiology teaching. Hartman et al (42), explored the value of radiology field trips during clerkship, and found this useful in educating students about various aspects of radiology. It has also been documented that early

exposure to radiology is important, so that the students understand and develop an interest in radiology. (7, 29, 96)

4.4.6 Frequency of uncertainty regarding radiology examination when filling the request form.

Most of the interns 53% (N=53) reported that they are frequently uncertain regarding the indication for the radiology examination when filling the request form. 87% (N=87) of the interns felt they encountered some difficulty in deciding which study to choose. This means that most of the interns do not understand the appropriate use of the various imaging modalities. Moloney et al. (81) recommended extending radiology teaching to include appropriateness criteria, as they discovered that the participants were lacking in the understanding of appropriate imaging examinations.

The majority of radiologists 70% (N=35) perceived that the interns understanding for various modalities is inadequate. This point has been raised previously (7, 29), where it was emphasised that the importance of understanding radiology is that it provides a good foundation which assists clinicians in all disciplines. They asserted that all the referrers authorised to request imaging examinations should have a clear understanding of the clinical indications, contraindications, and limitations. This also means understanding which modalities are appropriate for the specific clinical scenarios. This study reveals that we are not yet there, there is still a scope for improvement in radiology education.

4.4.7 Interns' and radiologists' perceptions on intern performance, and challenges when dealing with the radiology department

Most interns 59%(N=59) perceived 'getting the study done', and 'communication with the radiologist or radiographer' as the most difficult challenges interns face when dealing with the radiology department. Most radiologists 92% (N=46)felt interns are not good in providing relevant clinical history, understanding the indications of the study they are requesting, and deciding on the appropriate imaging modality. Radiologists also highlighted the limitations of interns with respect to communication with the radiologist or radiographer, and preparing for the test, or intervention. This is an important finding, demonstrating that there is a mismatch, and highlighting areas where improvements should be made , so that there will be effective communication between the interns and radiology department.

Some intern respondents reported difficulty in preparing patients for a test, acting on the results of the test, and encountered difficulty with the online system. This emphasises the value of radiology induction which some literature recommends should be done by the radiologists, (82) to supplement undergraduate radiology training.

Most interns 87% (N=87) and radiologists 74% 9 N=37) perceived that the interns were good in reviewing the results of the test, and acting on the test they requested, but not in viewing the images. However, radiologists were significantly more likely to indicate that interns were not viewing the images, as 84%(N=42) of the radiologists perceived that the interns do not frequently look at the images, whereas the 71%(N=71) of the interns asserted that they do view the images.

4.4.8 Interns' and radiologists' perceptions of the approachability of the radiology department, and sources of guidance

Most of the radiologists 66% (N=33) reported that the radiology departments were approachable if the interns have questions regarding the choice of the imaging modality, but lower percentage of the interns 52%(N=52) perceived the radiology department to be approachable. This difference in opinion was statistically significant. It is important to note that only 1% of interns reported asking the radiologist if they needed information regarding the choice of the imaging modality, and only 5% ask the clinical consultant.

Crowe et al. (26) in their study of postgraduate doctors at an early and later stage of training asserted that, generally in Ireland, the hierarchy plays a vital role in professional interactions. The trainees reported that the culture is that there is an expectation that non consultant doctors (NCHDs) do not question the consultant's decision. This might explain the reason some interns and other NCHDs would request the examination for which they have no clue, and when asked for a reason, and to expand on the clinical information, and rationale for requesting the examination, they simply say " I don't know, my registrar or consultant has asked me to place an order" While this is a genuine answer, it is frustrating for the radiologists who are vetting the studies as it delays the diagnosis and greatly interferes with the patient care pathway. This is supported by the response in the open comment section of the radiologist survey, where one respondent mentioned that interns must be taught how to think critically and should be prepared to discuss the case, instead of them saying "Oh I did not see the patient". It is believed that a preparatory module should empower the newly qualified doctors, and also encourage the senior clinicians in the teams to assist the interns by making them understand why the imaging is done in the particular patient. In the same study (26), the respondents stated that sometimes they do not ask because they are scared to expose themselves as inadequate. Even if stuck, at

no stage would the intern call the consultants as they think the consultant would be angry at them and may not get a good reference when they proceed to the next job. (26)

On the other hand, the interns may not be asking radiologists because they do not have that platform readily available to them. Numerous studies have addressed interruptions in radiology as the root cause for the report errors, missed diagnosis, and reduced productivity. (97) Therefore it is vital that the healthcare providers ensure that radiologists get protected time for reporting, thus minimising distractions. (98) This leaves an intern in the middle between the authoritarian clinical team (26), and the unavailable radiologist. The aim of the prospective undergraduate radiology module should be to empower the medical students with compressed information that will ameliorate the transition process to clinical radiology practice.

4.4.9 Interns' and radiologists' perceptions of interns' level of understanding of the use of contrast media in radiology imaging

The majority of the radiologists 86%(N=43)reported that they feel the interns do not have adequate knowledge on the use of contrast media, whereas less than half of interns 48% (N=48) perceived their understanding of the use of contrast media to be inadequate. This difference was statistically significant. Most interns perceived that they had adequate understanding of the use of contrast medium in radiology investigations. In contrast with the study conducted by Saha et al. (6) in which the interns reported that they received inadequate training with regard to correctly ordering the imaging studies, they were uncertain as to which studies require contrast media, when to use premedication, as well as the contraindications of the examinations, and contrast media .There has been an increase in the use of contrast in radiological studies, with some literature reporting approximately 71 million

CT and 3 million MRI studies per year requiring intravenous contrast. (99) Although the contrast media that are currently used in imaging are generally regarded as safe, they are still associated with risk, so the referring doctors must be aware of these. It is reported that patients are more prone to experience the adverse effects of post-iodinated contrast, compared to togadolinium-based contrast. Therefore, it is important for the interns to understand the risk benefit assessment and that, in collaboration with the radiologist, alternative imaging can be performed for the same or improved patient outcomes. (99)

4.4.10 Interest of the interns in becoming radiologists

Thirty three percent(N=33)of the intern respondents reported interest in becoming radiologists, and the remaining interns had no intention of specialising in radiology. This percentage is higher than in the previous literature, e.g. only 11% were considering radiology as a career (41), but it still concurs with the results of Dymtriw et al. (22) who asserted that the majority of the medical students, in any class, had no interest in becoming radiologists. (22) Visscher et al. (96) asserted that although the undergraduate medical students appreciate that imaging, and interventional radiology, are important to many medical specialties, they felt radiologists are not visible (96), and this is worsened by inadequate exposure to radiology. (7)

In another study, Murphy et al. (18) distributed a survey pre- , and post- radiology module to first year medical students; the results demonstrated an increased understanding of the imaging modalities whether it involved radiation or not. There was improvement in the understanding of radiation protection, this was enhanced by the involvement of the senior radiologists in teaching anatomy. Therefore, teaching imaging is important to increase interest in radiology. (7), (22).

When the interns were asked what they you do if the shift ends, and they have requested a radiology exam which they expect will be performed within 8 hours of their shift ending? Almost half of the intern respondents 49% (N=49)reported that they do not hand over to the colleague taking over from them after the eight-hour shift. In this scenario when the radiology department requires clarification, or additional information, often the doctor will not know about the details of the studies requested by the colleague, this is time consuming, and compromises patient care. Doctors should be encouraged to hand over the radiology examinations that are outstanding, and the important radiology results that are pending. The interns must be educated about the importance of the handover related to radiology imaging, as the clinical information may be lost if not communicated promptly. (100)

4.4.11 Qualitative analysis of open-ended question responses

When the interns and radiologists were asked about other topics not covered that they felt were important to design an intern preparatory course for interacting with radiology department, most of the interns felt communication with the radiologist should be included in the curriculum, e.g. how to present the clinical question in a meaningful way or present patient's relevant clinical details, indications for the scans, etc. It is interesting to note that some intern respondents expressed their frustration in dealing with the radiologist, specifically mentioning that the radiologist avoid doing the CT scans at all costs. Some perceived the radiologists as bullying, and that was illustrated in the following comments: "*how not to be berated by the radiologist, i.e. ensure that you are well prepared for the rudeness that you may be presented with", "How to argue your case with the radiologist, they are extremely unhelpful, and try to avoid doing CT scans at all costs, will direct you to every other modality of imaging*"

It is noteworthy that interns rated themselves high in the knowledge of the indications of CT scan, 66%(N=66) whereas most radiologists 80%(N=40)perceive that the interns do not have adequate knowledge of the CT indications. This discrepancy in perceptions could possible partly account for the arguments referred to above as most of the interns 52% (N=52)also reported difficulty in deciding which imaging modality to choose.

Another important point is that the radiologists also criticised intern quality of communication, summarising it as inadequate, and stating that interns need to be taught how to communicate better with the radiology department. This is very important because the interns view radiologists as 'bullying', 'berating' them, 'not wanting to do scans'. A similar scenario was described by the interns in the Australian study by Ward et al. (25), where the interns felt undervalued, and viewed seniors as rude, lacking respect and kindness. Proper orientation to radiology will help to eliminate these perceptions, and will improve the wellbeing of junior doctors, and promote patient safety. Contrary to the interns' perceptions, the radiologists view interns as not able to discuss the patient's clinical details relevant to the imaging requested; this may partly be related to the fact that the interns are not aware of some radiology related criteria which the radiographers, and radiologists are using to prioritise the lists, implying that they might not be necessarily victims of bullying in some situations. (101) Harassment can be devastating for the individual leading to psychological stress, anxiety and depression (102), thus adversely affecting patient care and safety, therefore should be avoided at all times.

In the UK study by Bradley et al. (103), radiology was mentioned as one of the specialities in which rudeness, dismissive and aggressive behaviours were reported. In same study, the associations were multifactorial, but the professionals who were reported to be rude were also reported to be overworked with lack of support. These behaviours were also seen where culture of rudeness was tolerated, with no accountability. It is well documented that inadequate or misleading clinical information has a negative impact on the quality of the radiology report, adverse effect on patient management, and compromise patient care, and safety. (7, 43, 107) Therefore, part of what is perceived as bullying could also be related to both interns' and radiologist' frustrations related to knowledge deficit, rather than straightforward berating. Empowering the interns by addressing these issues at the undergraduate level would be a major step to solve some problems in radiology, and ensure patient safety.

Bullying is still reported by the NCHD s in the Irish hospitals (24)(Irish Examiner, August 16, 2018). The RCSI and IMC survey results concurred that bullying is reported in radiology profession. About one third of trainees and consultants reported that they have experienced bullying in the workplace. The RCSI reported that new behaviour training is to be introduced after a radiology SPR survey reported bullying. (www.mindoe.ie, Medical Independent, Issue 16, volume 10, 4 July 2019)

This study also highlights the intern's limited understanding that if the radiologist recommends a different modality, it is usually because it is the most appropriate. This emphasises that including communication in the undergraduate radiology curriculum would assist to alleviate stress encountered by both interns, and radiologists, and promote meaningful communication, which will result in patient safety, and efficient utilisation of the radiology department. The UK

GMC in their seminal ‘Tomorrow’s Doctors’ publication (78) assert that the graduates must be able to communicate in various clinical scenarios, with different departments. and must have opportunities to practice communication. This may require linking simulation and role play methods with the clinical radiology scenarios during content delivery, in the process of mentoring the junior doctors (104), to become effective communicators with the radiology department. Simulation has been applied with success in teaching radiology interventional procedures and non-interventional skills like ultrasound (105), interpretative and non-interpretative skills like communication, and management of adverse reactions to contrast media (106), and in teaching online radiology examination ordering. (107)

4.5 Results: Group Concept Mapping

Based on the brainstorming section, the system generated six clusters of what the participants felt should be included when designing preparatory course in radiology. There is agreement between the results of the GCM analysis and the survey results in the following to be included if one were to design an intern radiology preparatory module.

1. Ordering investigation - how to order imaging examinations with emphasis on relevant clinical information.

2. *Clinical decision support*, understanding appropriate imaging modalities, which are necessary, and add value in diagnosis, and in patient management.

2. *Communication* with radiologists, and radiographers, mainly pertaining to how to justify the imaging examinations they are ordering.

3. *Adverse reactions and risks of imaging*. Preparation for the radiology examinations, with examples of specific scenarios, like cannula sizes in CT pulmonary angiogram. Preparation for

interventional procedures like renal biopsy, and what can go wrong if preparation is not done properly.

Understanding which studies use contrast. Indications, contraindications, and adverse effects of contrast media used in radiology. Ionising radiation use, and risks.

4. Prioritising the examinations based on clinical grounds, *urgent versus non urgent*, as opposed to categorising all exams as urgent. Understanding how the radiology department prioritise the examinations.

5. *Clinical radiology*-interpretation of the emergency, and common examinations

6. *IT / NIMIS*

4.6 Strengths and limitations of the study

Limitations of the study include limited sample size, common in quantitative survey studies, there is difficulty in getting people to participate in the survey studies, particularly for web-based survey studies. (109) Additionally, these are self-reported perceptions of intern readiness for clinical practise in radiology, not based on direct objective assessments.

The intern respondents were more than halfway through their internship, perhaps distributing the survey shortly after they started would have yielded different results. As they had passed the first two weeks which are regarded as the most crucial for assessing how much the students have learned in preparation for their practical job situations. (109)

The strength of the study is that this is original research, as most studies have concentrated on the interns or junior doctors' perceptions of their preparedness for practice in medicine more generally. (109) To our knowledge there are few studies addressing preparedness specifically related to radiology, and this is the only study that explored the views of both interns and radiologists, thus able to compare and contrast the perceptions. The use of GCM has strengthened outcome of the study, according to our knowledge, this method has not been used in radiology research. The ability to examine in parallel the survey and GCM results gives a robust confirmation of the perceived knowledge gaps that need to be addressed in order to prepare the interns for radiology related interactions.

CHAPTER 5: CONCLUSIONS

5.1 Introduction

The conclusions, based on this study are discussed, and recommendations are outlined.

5.2 Conclusions

For decades preparation of the medical graduates for clinical practice and handling the transition period between the medical school and hospital practice have been the subject of concern. Firth-Cozens in 1987, as cited in Hill et al. (111), reported failure of most medical schools to adequately prepare the interns for clinical practice, even though many studies have reported that newly qualified doctors experience high levels of psychological stress.

The recent studies are still addressing the same issue, emphasising the requirement for adequate preparation of the medical students for clinical practice. (59)

The earlier studies conducted in Ireland in 2005 and 2009, demonstrated that the majority of the interns felt unprepared for the intern year, and deficiencies were identified. (19) (112)

Various studies have investigated different aspects of intern preparation, including clinical, and non-clinical skills. Few studies have addressed radiology related matters like knowledge of appropriateness criteria (81), undergraduate radiology curriculum, radiology teaching, etc. Radiology teaching has received special attention in the EU, with the European Society of Radiology (ESR) education committee identifying important aspects of undergraduate curriculum (21), and the EU community of radiologists placing emphasis on imaging guidelines. (80) This is the first study addressing the comprehensive approach to radiology and looking at the contents of a putative radiology preparatory module. Most interns and radiologists in Ireland concur that undergraduate radiology teaching received by the interns is adequate. However, the majority in both groups agree that medical school radiology education does not prepare the interns for radiology interactions. There are perceived knowledge gaps which were identified by the participants. Combined with the results of the GCM study, these knowledge gaps were accentuated, as most of the participants highlighted similar competencies that should be addressed when designing the preparation for practice in radiology module.

5.3. Recommendations based on this study:

Undergraduate radiology teaching should not only concentrate of the interpretative skills, but should include noninterpretative skills, such as communication, clinical indications, various imaging modalities, and their appropriateness, contrast media, radiation protection, ,understanding, and acting on radiology results, and handover. Designing the radiology module

that addresses these issues, will ease the transition, and assist interns in understanding, and dealing with imaging departments.

The medical school administrators, intern training networks, medical council, hospital administrators should work as a team to design policies that promote interns readiness for practice, these should involve radiology departments, to promote preparation of interns for interacting with radiology in clinical practice.

Radiologists must be visible, take the lead in undergraduate radiology education, and participate in the inductions so that the interns know how the radiology departments function, and what is expected of them. This will be facilitated by improving the remuneration structure to a salary as opposed to a stipend or doing it as per requirement in the post the radiologist occupies.

There is discrepancy in the radiology teaching across the medical colleges in Ireland, for example some interns never attended radiation protection formal lectures. Structured radiology preparatory module should be established to ensure uniform radiology teaching across the medical schools. The faculty of radiologists RCSI has introduced the common stem SHO, which is aimed at attracting the doctors who would like to specialise in radiology. This is a great step toward promoting radiology, but does not nullify the need for increasing radiology teaching in the undergraduate curriculum.(15)

The issue of undermining, berating, bullying behaviours is reported, and all aspects should be looked into, and the stakeholders must ensure that the junior doctors are well educated, empowered, and protected at all times, to promote the friendly learning environment, encourage retention of doctors locally and worldwide.

Happy well informed, well supported interns, makes good doctors, and excellent consultants, with better resource management, limiting unnecessary examinations which are often very costly in time, and money, but do not add value to patient management. More important, they add a high level of patient safety.

Future work:

More work should be done regarding the mode of radiology content delivery preference, online versus face to face small group tutorials, or the combination. Radiologists moving from the "darkroom" to "light" to be visible, advocates for more face-to-face teaching. Conversely, as online radiology teaching is becoming more prominent, more research needs to be done in this aspect. The role of artificial intelligence in radiology has emerged, and may have impact on radiology education in the near future. (111) More studies have explored the role of simulation in undergraduate radiology teaching, to develop the competencies required by the junior doctors when interacting with the radiology department.(59).

The coronavirus (COVID 19) pandemic has imposed challenges to education worldwide, radiology included. Radiology, and its ability to create various reconstructions to view gross, functional, and cross sectional anatomy, will play an important role in anatomy education, as COVID 19 has forcefully restricted cadaveric disscections. (115)Radiologists need to explore the new methods of teaching, and embrace change.The future is virtual learning development

statergies , embracing the synchronous(live)including videoconferencing and other interactive methods, and asychronous (pre recorded) statergies (115).The future studies will explore these stratergies, and further develop newer techniques that will enhance undergraduate medical education.

REFERENCES

1. Morris M, Charania S, Fitzpatrick J, Rosli S, Ridgway PF. Prepared for Practice? Interns' Experiences of Undergraduate Clinical Skills Training in Ireland. J Med Educ Curric Dev. 2016;85–90.

2. Tallentire VR, Smith SE, Facey AD, Rotstein L. Exploring newly qualified doctors' workplace stressors: An interview study from Australia. BMJ Open. 2017;7(8).

3. Hannan E, Breslin N, Doherty E, McGreal M, Moneley D, Offiah G. Burnout and stress amongst interns in Irish hospitals: contributing factors and potential solutions. Ir J Med Sci.

2018;187(2):301–7.

4. National Mental Health Survey of Doctors and Medical Students. 2013;(October):156. Available from: http://apo.org.au/node/35920

5. Shacklady J, Holmes E, Mason G, Davies I, Dornan T. Maturity and medical students' ease of transition into the clinical environment. Med Teach. 2009;31(7):621–6.

6. Saha A, Roland RA, Hartman MS, Daffner RH. Radiology Medical Student Education. An Outcome-based Survey of PGY-1 Residents. Acad Radiol [Internet]. 2013;20(3):284–9. Available from: http://dx.doi.org/10.1016/j.acra.2012.10.006

7. Gunderman RB, Siddiqui AR, Heitkamp DE, Kipfer HD. Opinion: The vital role of radiology in the medical school curriculum. Am J Roentgenol. 2003;180(5):1239–42.

8. Bhogal P, Booth TC, Phillips AJ, Golding SJ. Radiology in the undergraduate medical curriculum - Who, how, what, when, and where? Clin Radiol [Internet]. 2012;67(12):1146–52. Available from: http://dx.doi.org/10.1016/j.crad.2012.05.005

9. Cournane S, Conway R, Creagh D, Byrne DG, Sheehy N, Silke B. Radiology imaging delays as independent predictors of length of hospital stay for emergency medical admissions. Clin Radiol [Internet]. 2016;71(9):912–8. Available from: http://dx.doi.org/10.1016/j.crad.2016.03.023

10. Cope L. The role of interventional radiology in palliative care of malignant disease. 2009;(February).

11. Summary of the proceedings of the International Forum 2017 : B Position of interventional radiology within radiology ^. 2018;189–97.

12. Mirsadraee S, Mankad K, McCoubrie P, Roberts T, Kessel D. Radiology curriculum for undergraduate medical studies - A consensus survey. Clin Radiol. 2012;67(12):1155–61.

13. Hendee WR, Becker GJ, Borgstede JP, Bosma J, Erickson BA, Maynard CD, et al. Addressing Overutilization in. 2010;257(1).

14. Shyu JY, Sodickson AD. Communicating radiation risk to patients and referring physicians in the emergency department setting. Br J Radiol [Internet]. 2016 May 11 [cited 2019 Sep 29];89(1061):20150868. Available from: http://www.birpublications.org/doi/10.1259/bjr.20150868

15. National Doctors Training & Planning. Review of the Clinical Radiology Medical Workforce in Ireland. 2017; Available from: https://www.hse.ie/eng/staff/leadership-education-development/met/plan/specialty-specific-reviews/clinical-radiology-chapter-for-web-2017.pdf

16. Wilson JS, Alvarez J, Davis BC, Duerinckx AJ. Cost-Effective Teaching of Radiology with Preclinical Anatomy. 2018;206(April):196–206.

17. Keeffe SDGWO, Phelan NMN. A practical description and student perspective of the integration of radiology into lower limb musculoskeletal anatomy. Irish J Med Sci (1971 -). 2017;186(2):409–17.

18. Maher MM, O'Tuathaigh CMP, O'Malley E, Cryan JF, O'Connor OJ, Daly FE, et al. Medical student knowledge regarding radiology before and after a radiological anatomy module: implications for vertical integration and self-directed learning. Insights Imaging. 2014;5(5):629–34.

19. Gome JJ, Paltridge D, Inder WJ. Review of intern preparedness and education experiences in General Medicine. Intern Med J. 2008;

20. Nyhsen CM, Steinberg LJ, O'Connell JE. Undergraduate radiology teaching from the student's perspective. Insights Imaging. 2013;4(1):103–9.

21. Breatnach Eamann. Undergraduate education in radiology. Awhite paper by European Society of Radiology. Insights imaging. 2011;2:363–74.

22. Dmytriw AA, Mok PS, Gorelik N, Kavanaugh J, Brown P. Radiology in the Undergraduate Medical Curriculum: Too Little, Too Late? Med Sci Educ. 2015;

23. Heaney RM, Murray M, Heaney AM, Doherty EM. ‘All by myself’: interns’ reports of their experiences taking consent in Irish hospitals. Ir J Med Sci. 2018;1–5.

24. Stephen Bance CC and JO. Your training counts. An investigation of trainee well being and their experiences of clinical learning environments in Ireland 2017 [Internet]. [cited 2019 Oct 12]. Available from: https://www.medicalcouncil.ie/News-and-Publications/Reports/Your-Training-Counts-2017-Full-Report.pdf

25. Ward S, Outram S, Heslop B. Perceived utility and relevance of intern well-being sessions. Intern Med J. 2018;48(6):645–50.

26. Crowe S, Clarke N, Brugha R. ‘You do not cross them’: Hierarchy and emotion in doctors’ narratives of power relations in specialist training. Soc Sci Med [Internet]. 2017;186:70–7. Available from: http://dx.doi.org/10.1016/j.socscimed.2017.05.048

27. Datta ST, Davies SJ. Training for the future NHS: Training junior doctors in the United Kingdom within the 48-hour European working time directive. BMC Med Educ [Internet]. 2015;14(1):S12. Available from: http://www.biomedcentral.com/1472-6920/14/S1/S12

28. Tallentire VR. Preparing for practice: What really counts? Clin Teach. 2011;8(4):280–1.

29. Jimmy S, John E. Implementation of a New Undergraduate Radiology Curriculum : ... 2007;58.

30. Sadler TJ, Zhang T, Taylor HL, Brassett C. The role of radiology in anatomy teaching in UK medical schools: a national survey. Clin Radiol [Internet]. 2018;73(2):185–90. Available from: https://doi.org/10.1016/j.crad.2017.08.008

31. Oris E, Verstraete K, Valcke M. Results of a survey by the European society of radiology (ESR): Undergraduate radiology education in Europe-influences of a modern teaching approach. Insights Imaging. 2012;3(2):121–30.

32. Branstetter BF, Faix LE, Humphrey AL, Schumann JB. Preclinical medical student training in radiology: the effect of early exposure. AJR Am J Roentgenol. 2007;188(1).

33. Bell LTO, Dick O, Ali N, Little D. Undergraduate radiology education: foundation doctors' experiences and preferences. [cited 2019 Aug 3]; Available from: https://doi.org/10.1016/j.crad.2019.01.029

34. Royal College of Radiologists. Undergraduate Radiology Curriculum. 2012;(April). Available from: https://www.rcr.ac.uk/sites/default/files/docs/radiology/pdf/Undergraduate_Radiology_Curriculum_2012.pdf

35. O'Connor EE, Fried J, McNulty N, Shah P, Hogg JP, Lewis P, et al. Flipping Radiology Education Right Side Up. Acad Radiol [Internet]. 2016;23(7):810–22. Available from: http://dx.doi.org/10.1016/j.acra.2016.02.011

36. Zou L, King A, Soman S, Lischuk A, Schneider B, Walor D, et al. Medical Students' Preferences in Radiology Education: A Comparison Between the Socratic and Didactic Methods Utilizing PowerPoint Features in Radiology Education. Acad Radiol [Internet]. 2011 Feb 1 [cited 2019 Feb 3];18(2):253–6. Available from: https://www.sciencedirect.com/science/article/pii/S1076633210005143#

37. Zafar S, Safdar S, Zafar AN. Evaluation of use of e-Learning in undergraduate radiology education: A review. Eur J Radiol [Internet]. 2014;83(12):2277–87. Available from: http://dx.doi.org/10.1016/j.ejrad.2014.08.017

38. Sendra-Portero F, Torales-Chaparro OE, Ruiz-Gómez MJ, Martínez-Morillo M. A pilot study to evaluate the use of virtual lectures for undergraduate radiology teaching. Eur J Radiol [Internet]. 2013;82(5):888–93. Available from: http://dx.doi.org/10.1016/j.ejrad.2013.01.027

39. Howlett D, Vincent T, Watson G, Owens E, Webb R, Gainsborough N, et al. Blending online techniques with traditional face to face teaching methods to deliver final year undergraduate radiology learning content. Eur J Radiol. 2011;78(3):334–41.

40. Pascual TNB, Chhem R, Wang SC, Vujnovic S. Undergraduate radiology education in the era of

dynamism in medical curriculum: An educational perspective. Eur J Radiol. 2011;78(3):319–25.

41. Jacob J, Paul L, Hedges W, Hutchison P, Cameron E, Matthews D, et al. Undergraduate radiology teaching in a UK medical school: A systematic evaluation of current practice. Clin Radiol [Internet]. 2016;71(5):476–83. Available from: http://dx.doi.org/10.1016/j.crad.2015.11.021

42. Hartman M, Thomas S, Ayoob A. Radiology Field Trips—A List of "Must Sees" in the Radiology Department for Medical Students: How We Do It. Acad Radiol [Internet]. 2018;25(12):1646–52. Available from: https://doi.org/10.1016/j.acra.2018.05.028

43. Oswal D, Sapherson D, Rehman A. A study of adequacy of completion of radiology request forms. Radiography [Internet]. 2009;15(3):209–13. Available from: http://dx.doi.org/10.1016/j.radi.2008.05.003

44. Faggioni L, Paolicchi F, Bastiani L, Guido D, Caramella D. Awareness of radiation protection and dose levels of imaging procedures among medical students, radiography students, and radiology residents at an academic hospital: Results of a comprehensive survey. Eur J Radiol [Internet]. 2017 Jan 1 [cited 2018 Nov 10];86:135–42. Available from: https://www.sciencedirect.com/science/article/pii/S0720048X16303394

45. Ricketts ML, Baerlocher MO, Asch MR, Myers A. Perception of radiation exposure and risk among patients, medical students, and referring physicians at a tertiary care community Hospital. Can Assoc Radiol J [Internet]. 2013;64(3):208–12. Available from: http://dx.doi.org/10.1016/j.carj.2012.05.002

46. Rehani MM, Berry M. Radiation doses in computed tomography. The increasing doses of radiation need to be controlled. BMJ [Internet]. 2000;320(7235):593–4. Available from: http://www.ncbi.nlm.nih.gov/pubmed/10698858

47. Meulepas JM, Ronckers CM, Smets AMJB, Nievelstein RAJ, Jahnen A, Lee C, et al. Leukemia and brain tumors among children after radiation exposure from CT scans: Design and

methodological opportunities of the Dutch Pediatric CT Study. Eur J Epidemiol. 2014;29(4):293–301.

48. Davis F, Il'yasova D, Rankin K, McCarthy B, Bigner DD. Medical Diagnostic Radiation Exposures and Risk of Gliomas. Radiat Res [Internet]. 2011;175(6):790–6. Available from: http://www.bioone.org/doi/10.1667/RR2186.1

49. Lee EY, Saxena AK, Sinha A, Sodhi KS, Krishna S, Khandelwal N. Clinical application of 'Justification' and 'Optimization' principle of ALARA in pediatric CT imaging: "How many children can be protected from unnecessary radiation?" Eur J Radiol [Internet]. 2015;84(9):1752–7. Available from: http://dx.doi.org/10.1016/j.ejrad.2015.05.030

50. Mobbs SF, Muirhead CR, Harrison JD. Risks from ionising radiation: An HPA viewpoint paper for Safegrounds. J Radiol Prot. 2011;31(3):289–307.

51. Irish Medical Council. European Communities (Medical Ionising Radiation Protection) Regulations 2002 [Internet]. [cited 2019 Oct 12]. Available from: https://medicalcouncil.ie/About-Us/Legislation/Statutory-Instrument-No-478-of-2002.pdf

52. McDonald RJ, McDonald JS, Newhouse JH, Davenport MS. Controversies in Contrast Material–induced Acute Kidney Injury: Closing in on the Truth? Radiology. 2015;277(3):627–32.

53. ESUR guidelines on Contrast Media - A. General adverse reactions [Internet]. Available from: http://www.esur-cm.org/index.php/en/a-general-adverse-reactions-2

54. Sodagari F, Mozaffary A, Wood CG, Schmitz B, Miller FH, Yaghmai V. Reactions to Both Nonionic Iodinated and Gadolinium-Based Contrast Media: Incidence and Clinical Characteristics. Am J Roentgenol [Internet]. 2018 Apr 7 [cited 2019 Oct 13];210(4):715–9. Available from: https://www.ajronline.org/doi/10.2214/AJR.17.18655

55. Nyman U, Ahlkvist J, Aspelin P, Brismar T, Frid A, Hellström M, et al. Preventing contrast

medium-induced acute kidney injury: Side-by-side comparison of Swedish-ESUR guidelines. Eur Radiol. 2018;28(12):5384–95.

56. Vaughan L, McAlister G, Bell D. “August is always a nightmare”: Results of the Royal College of Physicians of Edinburgh and Society of Acute Medicine August transition survey. Clin Med J R Coll Physicians London. 2011;11(4):322–6.

57. Hussain S. The July Effect – An Intern ’ s Perspective. 2018;3(March):126–7.

58. Jen MH, Bottle A, Majeed A, Bell D, Aylin P. Early in-hospital mortality following trainee doctors’ first day at work. PLoS One. 2009;4(9).

59. Teagle AR, George M, Gainsborough N, Haq I, Okorie M. Preparing medical students for clinical practice: easing the transition. Perspect Med Educ [Internet]. 2017;6(4):277–80. Available from: http://link.springer.com/10.1007/s40037-017-0352-2

60. Brennan N, Corrigan O, Allard J, Archer J, Barnes R, Bleakley A, et al. The transition from medical student to junior doctor: Today’s experiences of Tomorrow’s Doctors. Med Educ. 2010;44(5):449–58.

61. Teo AR, Harleman E, O’Sullivan PS, Maa J. The key role of a transition course in preparing medical students for internship. Acad Med. 2011;86(7):860–5.

62. Ripp J, Fallar R, Babyatsky M, David R, Reich L, Korenstein D. Prevalence of resident burnout at the start of training. Vol. 22, Teaching and Learning in Medicine. 2010. p. 172–5.

63. Godefrooij MB, Diemers AD, Scherpbier AJJA. Students´perceptions about the transition to the clinical phase of a medical curriculum with preclinical patient contact; a focus group study. BMC Med Educ. 2010;10(28):1–9.

64. Cho KK, Marjadi B, Langendyk V, Hu W. Medical student changes in self-regulated learning during the transition to the clinical environment. BMC Med Educ. 2017;17(1):1–9.

65. Nyhsen CM, Lawson C, Higginson J. Radiology teaching for junior doctors: their expectations,

preferences and suggestions for improvement. Insights Imaging. 2011;

66. Shaffer R, Piro N, Katznelson L, Gephart MH. Practice transition in graduate medical education. Clin Teach. 2017;14(5):344–8.

67. Fisher JW, Thompson BM, Garcia AD. Integrative clinical experience: An innovative program to prepare for internship. Teach Learn Med. 2007;19(3):302–7.

68. Minter RM, Amos KD, Bentz ML, Blair PG, Brandt C, D'Cunha J, et al. Transition to Surgical Residency: A Multi-Institutional Study of Perceived Intern Preparedness and the Effect of a Formal Residency Preparatory Course in the Fourth Year of Medical School. Acad Med. 2015;90(8):1116–24.

69. Harris A, Delany C. International medical graduates in transition. Clin Teach [Internet]. 2013;10(5):328–32. Available from: http://doi.wiley.com/10.1111/tct.12021

70. Jill Thislewaite. The transition into working practice. Clin Teach. 2015;12(5):297–8.

71. Sturman N, Tan Z, Turner J. "a steep learning curve": Junior doctor perspectives on the transition from medical student to the health-care workplace. BMC Med Educ. 2017;17(1).

72. Fullbrook A, Ross M, Mellanby E, Wylde K, Jaap A, Cameron H. Initial experiences of a student assistantship. Clin Teach. 2015;12(5):310–4.

73. Scicluna HA, Grimm MC, Osullivan AJ, Harris P, Pilotto LS, Jones PD, et al. Clinical capabilities of graduates of an outcomes-based integrated medical program. BMC Med Educ. 2012;12(1).

74. Yardley S, Westerman M, Bartlett M, Walton JM, Smith J, Peile E. The do's, don't and don't knows of supporting transition to more independent practice. Perspect Med Educ [Internet]. 2018;7(1):8–22. Available from: http://link.springer.com/10.1007/s40037-018-0403-3

75. Kelly C, Noonan CLF, Monagle JP. Preparedness for internship: A survey of new interns in a large Victorian health service. Aust Heal Rev. 2011;

76. Matheson C, Matheson D. How well prepared are medical students for their first year as doctors? The views of consultants and specialist registrars in two teaching hospitals. Postgrad Med J. 2009;85(1009):582–9.

77. Matheson CB, Matheson DJ, Saunders JH, Howarth C. The views of doctors in their first year of medical practice on the lasting impact of a preparation for house officer course they undertook as final year medical students. BMC Med Educ. 2010;10(1).

78. House N, House R, Drive F. Tomorrow ' s. 44(0).

79. Ferris HA, Joyce MB, Hogan J. Small Group Tutorials in Radiology: a Pilot Study. MedEdPublish [Internet]. 2016 Jul 20 [cited 2019 Oct 13];5(2). Available from: http://www.mededpublish.org/manuscripts/439/v1

80. Remedios D, Hierath M, Ashford N, Bezzi M, Cavanagh P, Chateil J, et al. Imaging referral guidelines in Europe : now and in the future — EC Referral Guidelines Workshop Proceedings. 2014;9–13.

81. Moloney BM, McCarthy CE, Byrne D, McVeigh TP, Kerin MJ, McCarthy PA. Teaching Radiology to Medical Students—There Is a Need for Change to Better Prepare Students for Clinical Practice. Acad Radiol [Internet]. 2017;24(4):506–13. Available from: http://dx.doi.org/10.1016/j.acra.2016.10.009

82. Exhibit E, Hurst ER, Oswal D. Structured induction of junior doctors into making appropriate use of radiology services - a local experience. 2015;1–11.

83. Kassim SS, McGowan Y, McGee H, Whitford DL. Prepared to practice? Perception of career preparation and guidance of recent medical graduates at two campuses of a transnational medical school: A cross-sectional study Career choice, professional education and development. BMC Med Educ. 2016;16(1):1–3.

84. Irish Medical council. Improving-Intern-Training-in-Ireland. [cited 2019 Oct 13]; Available

from: https://www.medicalcouncil.ie/Education/Career-Stage-Intern/Quality-Assurance/Consultation-on-Intern-Year-/1_Improving-Intern-Training-in-Ireland.pdf

85. Goldacre MJ, Taylor K, Lambert TW. Views of junior doctors about whether their medical school prepared them well for work: Questionnaire surveys. BMC Med Educ. 2010;10(1).

86. Gilbert GE, Prion S. Making Sense of Methods and Measurement: Lawshe's Content Validity Index. Clin Simul Nurs. 2016;12(12):530–1.

87. Stoyanov S, Spoelstra H, Bennett D, Sweeney C, Van Huffel S, Shorten G, et al. Use of a group concept mapping approach to define learning outcomes for an interdisciplinary module in medicine. Perspect Med Educ. 2013;

88. Rosas SR, Kane M. Quality and rigor of the concept mapping methodology: A pooled study analysis. Eval Program Plann [Internet]. 2012 May [cited 2019 Oct 14];35(2):236–45. Available from: https://linkinghub.elsevier.com/retrieve/pii/S0149718911000784

89. Royal College of Radiologists. 2015 Clinical Radiology UK Workforce Census. R Coll Radiol [Internet]. 2016;(September). Available from: https://www.rcr.ac.uk/clinical-radiology/service-delivery/rcr-workforce-census

90. Schiller PT, Phillips AW, Straus CM. Radiology Education in Medical School and Residency: The Views and Needs of Program Directors. Acad Radiol [Internet]. 2018;25(10):1333–43. Available from: https://doi.org/10.1016/j.acra.2018.04.004

91. McCusker MW, de Blacam C, Keogan M, McDermott R, Beddy P. Survey of medical students and junior house doctors on the effects of medical radiation: is medical education deficient? Ir J Med Sci [Internet]. 2009 Dec 10 [cited 2019 Oct 14];178(4):479–83. Available from: http://link.springer.com/10.1007/s11845-009-0341-5

92. Aldossari HM, Aldosary A, Alrashed A, Mohammed H. Assessing the Level of Knowledge About Radiation Dose in Common. 2018;7(1):114–8.

93. M S, MD N. Radiation Awareness amongst Junior Doctors. J Adv Radiol Med Imaging. 2016;1(2):1–6.

94. Barkhausen J, Mahnken AH, Mentzel HJ, Uder M, Weidemann J, Stumpp P, et al. White Paper: Curriculum Radiologie für das Studium der Humanmedizin in Deutschland. Fortschr Röntgenstr. 2016;188:1017–23.

95. Allen B, Prabhakar Reddy K, Miller W, Casale Menier DR, Lubinus FG, Bansal OP, et al. Summary of the proceedings of the international forum 2016: "Imaging referral guidelines and clinical decision support - how can radiologists implement imaging referral guidelines in clinical routine?" Insights Imaging. 2017;8(1):1–9.

96. Visscher KL, Faden L, Nassrallah G, Speer S, Wiseman D. Radiology Exposure in the Undergraduate Curriculum : A Medical Student Perspective on Quality and Opportunities for Positive Change Radiology Exposure in the Undergraduate Curriculum : A Medical Student Perspective on Quality and Opportunities for Positiv. Can Assoc Radiol J [Internet]. 2017;68(3):249–56. Available from: http://dx.doi.org/10.1016/j.carj.2016.10.004

97. Williams LH, Drew T. Distraction in diagnostic radiology: How is search through volumetric medical images affected by interruptions? Cogn Res Princ Implic. 2017;2(1):1–11.

98. Degnan AJ, Ghobadi EH, Hardy P, Krupinski E, Scali EP, Stratchko L, et al. Perceptual and Interpretive Error in Diagnostic Radiology—Causes and Potential Solutions. Acad Radiol. 2019 Jun 1;26(6):833–45.

99. Beckett KR, Moriarity AK, Langer JM. Safe use of contrast media: What the radiologist needs to know. Vol. 35, Radiographics. Radiological Society of North America Inc.; 2015. p. 1738–50.

100. Teaching handover of care to medical students - Darbyshire - 2013 - The Clinical Teacher - Wiley Online Library.

101. Nyhsen CM, Patel P, O'Connell JE. Bullying and harassment – Are junior doctors always the

victims? Radiography. 2016;

102. Verdonk P, Räntzsch V, De Vries R, Houkes I. Show what you know and deal with stress yourself: A qualitative interview study of medical interns' perceptions of stress and gender. BMC Med Educ. 2014;14(1).

103. Bradley V, Liddle S, Shaw R, Savage E, Rabbitts R, Trim C, et al. Sticks and stones: Investigating rude, dismissive and aggressive communication between doctors. Clin Med J R Coll Physicians London. 2015;15(6):541–5.

104. Dalgaty F, Guthrie G, Walker H, Stirling K. The value of mentorship in medical education. Clin Teach. 2017;14(2):124–8.

105. Klein KA, Neal CH. Simulation in Radiology Education: Thinking Outside the Phantom. Acad Radiol [Internet]. 2016;23(7):908–10. Available from: http://dx.doi.org/10.1016/j.acra.2016.02.013

106. Chetlen AL, Mendiratta-Lala M, Probyn L, Auffermann WF, DeBenedectis CM, Marko J, et al. Conventional Medical Education and the History of Simulation in Radiology. Acad Radiol [Internet]. 2015;22(10):1252–67. Available from: http://dx.doi.org/10.1016/j.acra.2015.07.003

107. Marshall NL, Spooner M, Leo Galvin P, Ti JP, Gerald McElvaney N, Lee MJ. Informatics in radiology: Evaluation of an e-learning platform for teaching medical students competency in ordering radiologic examinations. Radiographics. 2011;31(5):1463–74.

108. Nulty DD. The adequacy of response rates to online and paper surveys: what can be done? Assess Eval High Educ [Internet]. 2008 Jun [cited 2019 Aug 3];33(3):301–14. Available from: http://www.tandfonline.com/doi/abs/10.1080/02602930701293231

109. Monrouxe L V., Grundy L, Mann M, John Z, Panagoulas E, Bullock A, et al. How prepared are UK medical graduates for practice? A rapid review of the literature 2009-2014. BMJ Open. 2017;7(1).

110. Hill J, Rolfe IE, Pearson SA, Heathcote A. Do junior doctors feel they are prepared for hospital practice? A study of graduates from traditional and non-traditional medical schools. Med Educ. 1998;

111. Finucane P, O'Dowd T. Working and training as an intern: A national survery of Irish interns. Med Teach. 2005;27(2):107–13.

112. Jones OM, Okeke C, Bullock A, Wells SE, Monrouxe L V. "He's going to be a doctor in August": A narrative interview study of medical students' and their educators' experiences of aligned and misaligned assistantships. BMJ Open. 2016;6(6).

113. Eamann B. Undergraduate education in radiology. Awhite paper by European Society of Radiology. Insights imaging. 2011;2:363–74.

114. Pakdemirli E. Artificial intelligence in radiology: friend or foe? Where are we now and where are we heading? Acta Radiol Open. 2019 Feb;8(2):205846011983022.

115. Darras KE, Spouge RJ, de Bruin ABH, Sedlic A, Hague C, Forster BB. Undergraduate Radiology Education During the COVID-19 Pandemic: A Review of Teaching and Learning Strategies. Canadian Association of Radiologists Journal. SAGE Publications Inc.; 2020.

APPENDICES

Appendix A: Ethical approval South/UCC

Appendix B: Ethical approval University of Limerick

Appendix C: Ethical Approval University of Galway.

Appendix D: Beamont Hospital Ethics(Medical research)

Appendix E: Intern Questionnaire

Appendix F: Radiologist Questionnaire

Appendix G: Intern Results

Appendix H: Radiologist Results.

Appendix I: GCM brainstorming statements

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Appendix A: Ethical approval South/UCC

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COISTE EITICE UM THAIGHDE CLINICIÚIL Clinical Research Ethics Committee

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Tel: +353-21-490 1901 Fax: + 353-21-490 1919
Lancaster Hall, 6 Little Hanover Street,
Cork, Ireland.
Coláiste na hOllscoile Co University College Cork, Ireland

ECM 4 (0) 15/08/17 & ECM 3 (hhh) 05/09/17

28th August 2017

Dr Colm O'Tuathaigh Lecturer Medical Education Unit
School of Medicine University College Cork

Re: Preparation for clinical practice: a survey of interns and radiologists.

Dear Dr O'Tuathaigh

The Chairman approved the following:

Revised Application Form Revised Questionnaire for Interns Revised Questionnaire for Radiologists.
>

Permission is now granted to begin this study.

The date of this letter is the date of authorization of the project.

Please keep a copy of this signed approval letter in your study master file for audit purposes.

Yours sincerely

*1. [ue.an Soeo*A/

Cao, Professor Michael G Molloy Chairman Clinical Research Ethics Committee of the Cork Teaching Hospitals

The Clinical Research Ethics Committee of the Cork Teaching Hospitals, UCC, is a recognised Ethics Committee under Regulation 7 of the European Communities (Clinical Trials on Medicinal Products for Human Use) Regulations 2004, and is authorised by the Department of Health and Children to carry out the ethical review of clinical trials of investigational medicinal products. The Committee is fully compliant with the Regulations as they relate to Ethics Committees and the conditions and principles of Good Clinical Practice.

Allonnil na hÉireann Forrainh . Natinnal (Iniversity of Ireland, Cork

Appendix B: Ethical approval University of Limerick

TEOspidéil OL EUL Hospitals
Ospidéal na hOllscoile, Luimneach
University Hospital Limerick

Quality & Safety Department, University Hospital Limerick
Dooradoyle
Limerick.

Tel: 061 482519

10th November, 2017.

Dr. Colm O'Tuathaigh, Lecturer, School of Medicine, Room 1.50, Brookfield Health Sciences Complex, University College Cork,
Cork.

Re:
Protocol Title: Preparation for clinical practice: a survey of interns and radiologists REC Ref: 139/*17*

Dear Dr. O'Tuathaigh,

I am in receipt of your proposal as above submitted for review by our Research Ethics Committee, I have **reviewed the contents of same.**

I wish to advise that I have given your study Chairperson ethical approval.

You should note that your study cannot commence until you also receive AON approval which will issue from the Quality and Safety Department shortly. You are obliged to inform us as soon as your study is completed or if it terminates early for any reason.

I wish you every success with your study.

Yours sincerely,

Pat Dillon, **Consultant Anaesthetist, Chairperson, Research Ethics Committee.**

HULH

Feidhmeannacht na Seirbhíse Sláinte Health Service Executive
Caring, Courteous and Professional

Appendix C: Ethical Approval University of Galway.

(圖盖国 UGG

COISTE EITICE UM THAIGHDE CLINICIÚIL Clinical Research Ethics Committee

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Tel: +353-21-490 1901 Fax: + 353-21-490 1919
Lancaster Hall, 6 Little Hanover Street,
Cork, Ireland.
Coláiste na hOllscoile Co University College Cork, Ireland

ECM 4 (0) 15/08/17 & ECM 3 (hhh) 05/09/17

28th August 2017

Dr Colm O'Tuathaigh Lecturer Medical Education Unit
School of Medicine University College Cork

Re: Preparation for clinical practice: a survey of interns and radiologists.

Dear Dr O'Tuathaigh

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Revised Application Form Revised Questionnaire for Interns Revised Questionnaire for Radiologists.
>

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Yours sincerely

*1. [ue.an Soeo*A/
Cao, Professor Michael G Molloy Chairman Clinical Research Ethics Committee of the Cork Teaching Hospitals

The Clinical Research Ethics Committee of the Cork Teaching Hospitals, UCC, is a recognised Ethics Committee under Regulation 7 of the European Communities (Clinical Trials on Medicinal Products for Human Use) Regulations 2004, and is authorised by the Department of Health and Children to carry out the ethical review of clinical trials of investigational medicinal products. The Committee is fully compliant with the Regulations as they relate to Ethics Committees and the conditions and principles of Good Clinical Practice.

Appendix D: Beamont Hospital Ethics(Medical research)

Beaumont Hospital Ethics (Medical Research) Committee

Chairperson: Professor Gerry McElvaney Administrator: Gillian Vale Convenor: Dr. Peter Branagan

24th November 2017 **Our Ref: 17/Oth/92**

Dr. Colm O Tuataigh Lecturer School of Medicine Room 1.50 Brrokfield Health Science Complex UCC Cork

To: c.otuataigh@ucc.ie

Dear Dr. O Tuataigh

Re: 17/Oth/92 – Dr. Colm O Tuataigh (UCC) / Dr. Thabiselene Simelane (HSE) – Preparation for clinical practice: a survey of interns and radiologists

I refer to your email dated 1st November 2017 outlining the proposed project.

I can advise that your proposal does not require Ethical approval and therefore will not need to be submitted to the Ethics Committee.

I trust this information is of assistance.

Kind regards

Yours sincerely

_____

Dr. Peter Branagan Ethics Convenor Beaumont Ethics (Medical Research) Committee

_____

Ethics (Medical Research) Committee, Beaumont Hospital. Dublin 9 Tel: 353-1-809 2680 Email: beaumontethics@rcsi.ie https://beaumo

Appendix E: Questionnaire: Interns

University College Cork, Ireland
Coláiste na hOllscoile Corcaigh

2nd Draft Preparation for Clinical Practice: A Survey of Interns and Radiologists

My name is Dr Thabisile Simelane and I am completing a Master of Research in Health Professions Education at UCC. I am completing a research project which will focus on the interaction between medical interns and the radiology department, and your participation will give us valuable first-hand information.

The online survey will take approximately 5-10 minutes.

Ethical approval for the project has been granted by the Clinical Research Ethics Committee of the Cork Teaching Hospitals.

If you have any questions or concerns about this survey, please do not hesitate to contact me, Thabisile Simelane at Thabisile.Simelane@hse.ie.

A. Demographics and Educational Background

1. Please indicate gender:

- ○ Male
- ○ Female

2. Please state age (years):

3. Where did you complete your undergraduate medical training?

- ○ Ireland
- ○ UK
- ○ European mainland
- ○ North America
- ○ Other (please specify)

4. What year did you complete your undergraduate medical degree?

5. Which route did you choose to pursue a medical degree?

- ◯ Undergraduate Entry (i.e. directly post secondary level education)
- ◯ Postgraduate Entry (i.e. having already completed an undergraduate degree)

6. If you already completed an undergraduate degree prior to studying medicine, please state the degree and subject:

7. Outside of your undergraduate medical training, have you completed any course or other training in radiology (e.g. postgraduate qualification, CPD, other courses)?

- ◯ Yes
- ◯ No

If you answered Yes, please provide details below:

B. Exposure to Radiology during Undergraduate Training in Medicine

8. Please indicate to what extent you feel you received adequate radiology teaching during your undergraduate training:

- ◯ Very inadequate
- ◯ Inadequate
- ◯ Somewhat inadequate
- ◯ Somewhat adequate
- ◯ Adequate
- ◯ Very adequate

9. How does your knowledge of radiology compare with other clinical subjects which were part of the undergraduate curriculum?

- ◯ Very inadequate
- ◯ Inadequate
- ◯ Somewhat inadequate
- ◯ Somewhat adequate
- ◯ Adequate
- ◯ Very adequate

10. Please indicate if you had formal teaching in radiation protection during your undergraduate training.

- ◯ Yes I attended a formal course
- ◯ I was informally taught about radiation protection
- ◯ I had little or no exposure to radiation protection matters

11. If you answered "Yes I attended a formal course" to the question above, how adequately do you feel the radiation protection course prepared you for practice as an intern?

- ◯ Very inadequately
- ◯ Inadequately
- ◯ Somewhat inadequately
- ◯ Somewhat adequately
- ◯ Adequately
- ◯ Very adequately

12. At the time you commenced your intern training, how familiar were you with the 10 day rule in imaging patients of childbearing age?

- ◯ Very unfamiliar
- ◯ Unfamiliar
- ◯ Somewhat unfamiliar
- ◯ Somewhat familiar
- ◯ Familiar
- ◯ Very familiar

C. Radiology and Working as an Intern

13. How well do you feel your undergraduate medical training prepared you for interacting with the radiology department during the intern year?

- ◯ Very unprepared
- ◯ Unprepared
- ◯ Somewhat unprepared
- ◯ Somewhat prepared
- ◯ Prepared
- ◯ Very prepared

14. Are you confident that you have a clear understanding of the different imaging modalities, and their indication in radiology?

- ◯ Very unconfident
- ◯ Not confident
- ◯ Somewhat unconfident
- ◯ Somewhat confident
- ◯ Confident
- ◯ Very confident

15. How much of your normal working day is spent interacting with the radiology department including ordering tests, preparing patients, multidisciplinary meetings and following up or communicating results?

- ◯ <25%
- ◯ 25-50%
- ◯ 51-75%
- ◯ >75%

16. Which of the following disciplines do you currently work for?

- ◯ A medical discipline
- ◯ A surgical discipline
- ◯ Paediatric discipline
- ◯ Obstetric & Gynaecology discipline
- ◯ A&E
- ◯ Mental health

17. Do you attend a radiology multidisciplinary meeting as part of your role?

- ◯ Never
- ◯ Occasionally
- ◯ Frequently

18. If you answered "Occasionally" or "Frequently" to the question above, do you find this useful as part of your patient care role?

- ◯ Very useful
- ◯ Useful
- ◯ Somewhat useful
- ◯ Somewhat not useful
- ◯ Not useful
- ◯ Very not useful

19. How frequently do you have uncertainty regarding the radiology exam indication when filling the request form?

- ◯ Very frequently
- ◯ Frequently
- ◯ Somewhat frequently
- ◯ Somewhat infrequently
- ◯ Infrequently
- ◯ Very infrequently

20. Please rate the following challenge on the basis of difficulty, from not difficult at all (=1) to most difficult (=5) when dealing with the radiology department is:

	1	2	3	4	5
Getting a study done when needed	○	○	○	○	○
Communicating with the radiographer or radiologist	○	○	○	○	○
The online ordering system	○	○	○	○	○
Deciding which study to choose	○	○	○	○	○
Receiving the results of the test	○	○	○	○	○
Acting on the results of the test	○	○	○	○	○
Preparing patients for a test or intervention	○	○	○	○	○

21. If you need guidance regarding the choice of imaging modality, do you: [please tick all that apply]

- ○ Look it up on the internet
- ○ Ask a colleague on your team
- ○ Ask your consultant
- ○ Ask a radiographer
- ○ Ask a radiologist
- ○ Other (please specify)

22. How approachable is the radiology department if you have a question regarding the choice of imaging modality?

- ○ Very approachable
- ○ Approachable
- ○ Somewhat approachable
- ○ Somewhat unapproachable
- ○ Unapproachable
- ○ Very unapproachable

23. If you use the internet to provide guidance regarding choice of imaging modality, do you: [please tick all that apply]

- ○ Use a search engine such as google
- ○ A specific radiology site such as insite, ACR, or radiopedia
- ○ Other (please specify)

24. What do you do if the shift ends, and you have ordered a radiology exam which you expect will be performed within 8 hours of your shift ending?

- ◯ Go home
- ◯ Hand over the information to the team taking over
- ◯ Follow up the exam from home
- ◯ Check the next day at work

25. How frequently do you check radiology results?

- ◯ Very frequently
- ◯ Frequently
- ◯ Somewhat frequently
- ◯ Somewhat infrequently
- ◯ Infrequently
- ◯ Very infrequently

26. Please grade the level of your understanding of the use of contrast media for radiology investigations

- ◯ Very inadequate
- ◯ Inadequate
- ◯ Somewhat inadequate
- ◯ Somewhat Adequate
- ◯ Adequate
- ◯ Very Adequate

27. In what form do you (most often) review test results?

- ◯ Verbal report
- ◯ On a hospital computer
- ◯ By requesting the hard copy/printed report from radiology

28. How often would you look at the images of the test you have ordered?

- ◯ Very frequently
- ◯ Frequently
- ◯ Somewhat frequently
- ◯ Somewhat infrequently
- ◯ Infrequently
- ◯ Very infrequently

29. Please indicate your level of confidence on the following point scale in relation to tests that you feel you are aware of the indications for?

	Very unconfident	Unconfident	Somewhat unconfident	Somewhat confident	Confident	Very confident
Plain film	○	○	○	○	○	○
Ultrasound	○	○	○	○	○	○
CT	○	○	○	○	○	○
MRI	○	○	○	○	○	○
PET CT	○	○	○	○	○	○
Nuclear medicine	○	○	○	○	○	○

30. How confident would you be communicating the radiology results, eg. a CT scan to a patient?

- ○ Very confident
- ○ Confident
- ○ Somewhat confident
- ○ Somewhat unconfident
- ○ Unconfident
- ○ Very unconfident

31. How much are you interested in becoming a radiologist?

- ○ Very interested
- ○ Interested
- ○ Somewhat interested
- ○ Somewhat uninterested
- ○ Uninterested
- ○ Very uninterested

32. If you were asked to design an intern preparatory course for interacting with the radiology department, are there any topics not covered in this survey which you feel are important?

33. Have you worked as a radiology intern?

- ○ Yes
- ○ No

Appendix F: Radiologist Questionnaire.

University College Cork, Ireland
Coláiste na hOllscoile Corcaigh

Preparation for Clinical Practice: A Survey of Interns and Radiologists [Radiologists]

My name is Dr Thabisile Simelane and I am completing a Master of Research in Health Professions Education at UCC. I am completing a research project which will focus on the interaction between medical interns and the radiology department, and your participation will give us valuable first-hand information.

The online survey will take approximately 5 minutes.

Ethical approval for the project has been granted by the Clinical Research Ethics Committee of the Cork Teaching Hospitals.

If you have any questions or concerns about this survey, please do not hesitate to contact me, Thabisile Simelane at Thabisile.Simelane@hse.ie.

A. Demographics and Educational Background

1. Please indicate gender:

- ◯ Male
- ◯ Female

2. Please indicate type of radiology practice:

- ◯ Teaching Hospital
- ◯ Non-Teaching Hospital

3. **If you answered "Teaching Hospital" to Question 2**, please indicate how often you teach students during the academic year

- ◯ Daily
- ◯ Weekly
- ◯ Monthly
- ◯ Less than once per month
- ◯ Not at all

4. **If you answered "Teaching Hospital" to Question 2**, do you examine undergraduate students as part of medical school examinations?

- ◯ Yes
- ◯ No

5. What is your Current Position?

- ◯ Radiologist
- ◯ SPR in Radiology

6. Please indicate to what extent you feel **you** received adequate radiology teaching during **your** undergraduate training.

- ◯ Very inadequate
- ◯ Inadequate
- ◯ Somewhat inadequate
- ◯ Somewhat adequate
- ◯ Adequate
- ◯ Very adequate

B. Exposure to Radiology during Undergraduate Training in Medicine

7. Please indicate to what extent you feel current medical interns receive adequate radiology teaching during their undergraduate training:

- ◯ Very inadequate
- ◯ Inadequate
- ◯ Somewhat inadequate
- ◯ Somewhat adequate
- ◯ Adequate
- ◯ Very adequate

C. Radiology and Working as an Intern

8. How well do you feel undergraduate medical training prepares interns for interacting with the radiology department during the intern year?

- ◯ Very unprepared
- ◯ Unprepared
- ◯ Somewhat unprepared
- ◯ Somewhat prepared
- ◯ Well prepared
- ◯ Very well prepared

9. Please indicate to what extent you feel that interns understand the indications for various imaging modalities

- ◯ Very inadequate
- ◯ Inadequate
- ◯ Somewhat inadequate
- ◯ Somewhat adequate
- ◯ Adequate
- ◯ Very adequate

10. How frequently do you feel interns have uncertainty regarding the radiology exam indications?

- ○ Very frequently
- ○ Frequently
- ○ Somewhat frequently
- ○ Somewhat infrequently
- ○ Not frequently
- ○ Very infrequently

11. With respect to intern uncertainty regarding radiology exam indications, to which modality does this apply (tick all that apply):

- ☐ Plain film
- ☐ CT
- ☐ MRI
- ☐ Ultrasound
- ☐ Nuclear Medicine
- ☐ Interventional Radiology

12. Please rate intern performance from poor (=1) to excellent (=5) with respect to interns' interactions with the radiology department:

	1	2	3	4	5
Providing relevant clinical information.	○	○	○	○	○
Understanding the indication for the studies they are requesting.	○	○	○	○	○
Deciding which modality is appropriate	○	○	○	○	○
Communicating with the radiographer or radiologist	○	○	○	○	○
Receiving the results of the test	○	○	○	○	○
Acting on the results of the test	○	○	○	○	○
Preparing patients for a test or intervention	○	○	○	○	○

13. How approachable is your radiology department if an intern has a question regarding the choice of imaging modality?

- Very unapproachable
- Unapproachable
- Somewhat unapproachable
- Somewhat approachable
- Approachable
- Very approachable

14. How frequently do you perceive that interns check radiology results?

- Very frequently
- Frequently
- Somewhat frequently
- Somewhat infrequently
- Infrequently
- Very infrequently

15. How often do you perceive that interns look at the images of the test ordered?

- Very frequently
- Frequently
- Somewhat frequently
- Somewhat infrequently
- Infrequently
- Very infrequently

16. Please indicate your level of confidence on the following point scale in relation to tests that you feel interns are aware of the indications for?

	Very unconfident	Not confident	Somewhat unconfident	Somewhat confident	Confident	Very confident
Plain film	○	○	○	○	○	○
Ultrasound	○	○	○	○	○	○
CT	○	○	○	○	○	○
MRI	○	○	○	○	○	○
PET CT	○	○	○	○	○	○
Nuclear medicine	○	○	○	○	○	○

17. Please grade the level of interns' understanding of the use of contrast media for radiology investigations

- ○ Very inadequate
- ○ Inadequate
- ○ Somewhat inadequate
- ○ Somewhat adequate
- ○ Adequate
- ○ Very adequate

18. Please grade the level of interns' understanding of radiation protection as it applies in radiology imaging

- ○ Very inadequate
- ○ Inadequate
- ○ Somewhat inadequate
- ○ Somewhat adequate
- ○ Adequate
- ○ Very adequate

19. If you were asked to design an intern preparatory course for interacting with the radiology department, are there any topics not covered in this survey which you feel are important?

[ ]