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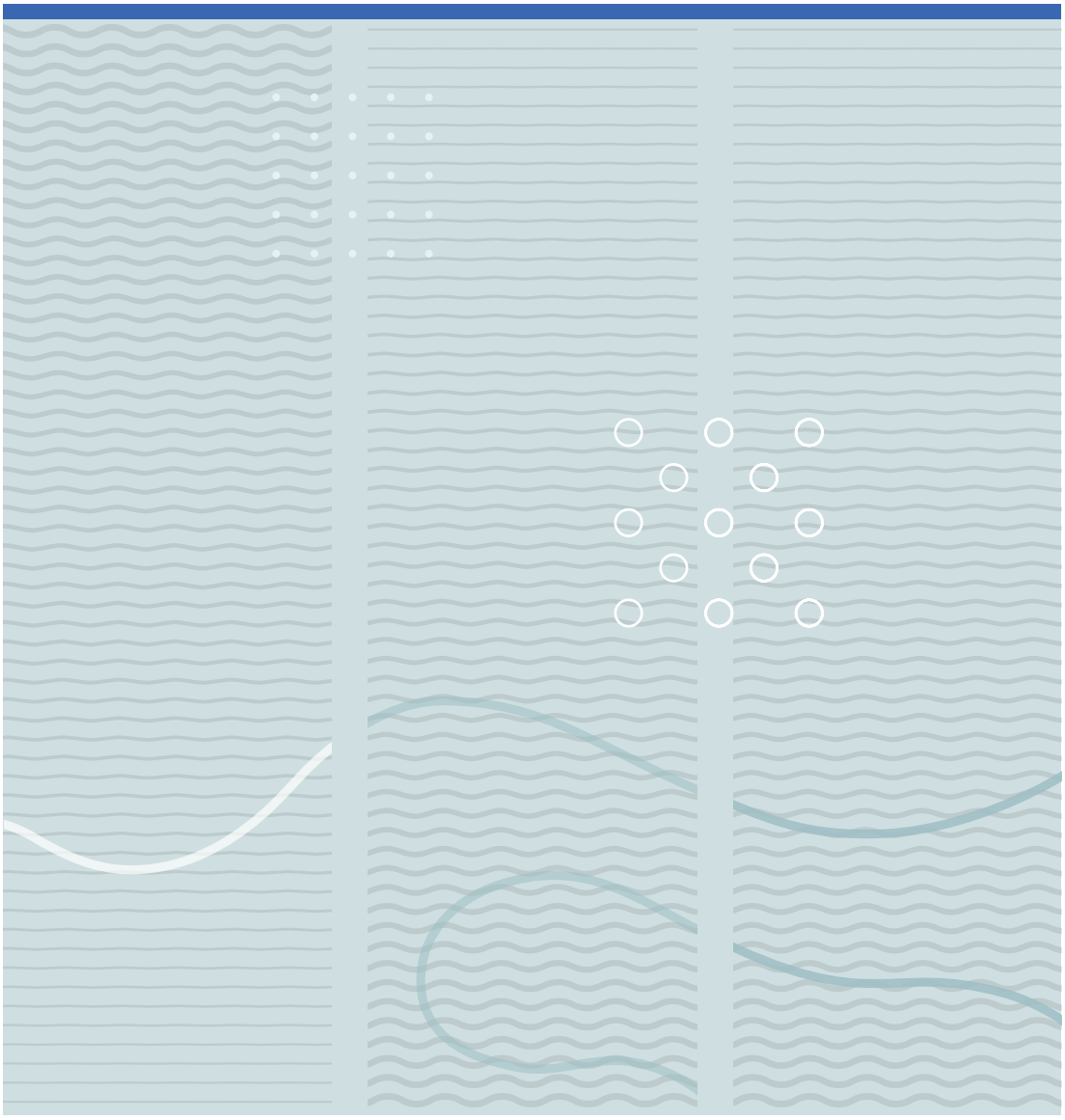
Catherine Chilute Chilanga

Appropriate medical imaging

Exploring radiographers' assessment of referrals



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To Tongase Mable Chilanga

'Nothing can dim the light which shines from within.'

Maya Angelou

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I could not have done this without my family; their support and encouragement carried me through this process. Furthermore, I believe we are all guided by divine faith, and I give thanks to the Almighty for helping me to make this remarkable journey.

Drammen 2022

Catherine Chilute Chilanga

Abstract

Introduction: A substantial number of radiological examinations are reported to be inappropriate. This is largely due to the fact that a huge number of referral forms received in radiology departments have inadequate patient clinical information to allow effective assessment for appropriate imaging. Inappropriate imaging is a huge global concern for patient safety, radiation protection, effective use of professional labour, and quality health services. Radiographers are identified as a potential professional group that can improve gatekeeping and ensure appropriate imaging through quality checks and assessing referrals due their pivotal position between referring clinicians and radiologists in the radiology referral process. The benefits of using radiographers to assess referrals and their role in ensuring appropriate imaging is, however, not clearly understood.

Aim: The aim of this research is to increase understanding of the radiology referral process, particularly the radiographers' role in referral assessment, and to discuss how the findings can be understood within the wider theoretical frameworks of people-centred health care (PCHC) and professional theory. To achieve this aim, four scientific papers are presented as part of this study.

Design, materials and methods: A multiple-method research design was employed comprising an ethical review of empirical studies analysed using Beauchamp and Childress' biomedical ethical framework (*Paper I*) and two descriptive cross-sectional surveys conducted sequentially, survey one (*Paper II*) and survey two (*Papers III and IV*). The target population in the cross-sectional studies consisted of qualified diagnostic radiographers working or with experience in various areas of medical imaging and actively involved in the profession through participation at the European Congress of Radiology (ECR) 2019 and following the activities of the International Society of Radiographers and Radiological Technologists (ISRRT). The data analysis for the ethical review (*Paper I*) was conducted by means of narrative discussions of literature on the issues of suboptimal referrals with respect to impact on ethical principles, *non-*

maleficence, beneficence, autonomy, and *justice* and challenges for the radiology professionals' work. In the cross-sectional studies, descriptive analysis was used to show frequencies in percentages and inferential statistical analysis, linear regression for *Paper II* and Pearson chi square tests for *Papers III and IV*.

Results: In *Paper I*, the empirical findings analysed within the ethical framework showed that patients can be harmed (violating the principle of *non-maleficence*) due to suboptimal referrals from exposure to unjustified ionising radiation procedures, contrast media used during unwarranted procedures, false findings in imaging, and failure in communication. Suboptimal referrals hinder benefits (*Beneficence*) from correct choice of imaging modality and protocol, an optimally performed examination, and an accurate radiology report, thus negatively affecting patients' healthcare management. Patient autonomy is compromised through infringement of their right to choose medical care and to give informed consent. Professional autonomy is also compromised as radiology professionals are deprived of the opportunity to practise according to ethical and professional standards. Suboptimal referrals challenge justice based on lack of reasonable patient prioritising *(violating procedural justice)* and unfairness caused by unnecessary examinations *(violating distributive justice)*.

Paper II analysed a sample of 91 radiographers. The study showed radiographers' competencies and knowledge of assessing referrals for advanced imaging. The majority (58% for CT and 57% for MRI) of the radiographers were able to identify anomalies and appropriately assess the designed referrals in compliance with guidelines and recommended practice. Possession of a master's qualification was an important influential factor for higher consistency with guidelines (p value =0.02) in assessing referrals for CT. Moreover, a radiography position as a lead professional and/or educator was a significant factor of influence for higher consistency with guidelines (p value =0.01) in assessing referrals for MRI.

Paper III analysed 279 radiographers. The majority (75%) of the participants working in clinical practice (N = 233) reported that they were involved in the task of screening

referrals, and 55% reported that the radiographer was the final referral assessor in general X-ray radiography. The most reported 'often/always' actions to supplement missing referral information were asking the patient or relative (73%) and examining the anatomical region of concern (70%). The actions taken when confronted with unjustified referrals were reported equally as consulting the radiologist, referring clinician and radiographer (69–68% often/always responses). The hindering factors to radiographers' assessment of referrals (ranked as agreed/strongly agreed responses) were: inadequate information in referral forms (83%), ineffective communication channels among healthcare professionals (79%), lack of training (70%) and allocated time (61%).

Paper IV analysed 279 radiographers. This study showed that radiographers perceived referral information as useful for many purposes in clinical practice, all vital for ensuring patient safety and quality radiology services. In general, the responses in both cohorts of radiographers not current working in clinical settings and those currently working in clinical settings were mostly in agreement. The radiographers in clinical practice gave the use of referral information for patient identification purposes the highest score (97%), followed by ensuring imaging of the correct body region (79%) where 'very frequently' response was chosen. The highest ranked benefits of radiographers' assessing referrals were: promotes radiographers' professional responsibility and improves collaboration with radiologists and referring clinicians, with 72 and 67% 'strongly agree' responses, respectively.

Conclusion: This research showed that suboptimal referrals are a concern for appropriate imaging and challenge radiology professionals' adherence to ethical principles of non- maleficence, beneficence, autonomy, and justice, thus impacting on provision of quality care and services in radiology departments. Radiographers' involvement in assessing referrals improves the justification process and appropriate imaging, supporting the effective principle of PCHC practices to promote patient safety and care. Radiographers' awareness and use of referral guidelines ensures evidence-based and empathic healthcare. Interprofessional collaboration and communication further promotes teamwork, which is essential for timely treatment, continuity, and

coordination of healthcare for patients, and adheres to the PCHC efficiency principle. To enable the radiography profession work force to carry out referral assessment tasks, mapping out essential skills and training is recommended. Radiographers who have gained the necessary training to assess referrals are contributing to the blurring of professional roles and a mixed division of labour, with radiologists thus reshaping the radiographers' role in referral assessment.

Keywords: Medical imaging. Referral. People-centred care. Radiology. Radiographers. Healthcare. Ethical aspects. Quality of care.

List of papers

Paper I

Chilanga CC, Lysdahl KB (2021). Ethical impact of suboptimal referrals on delivery of care in radiology department. BMJ Journal of Medical Ethics. DOI:https://doi.org/10.1136/medethics-2021-107335

Paper II

Chilanga CC, Lysdahl KB, Olerud HM, Toomey RJ, Cradock A, Rainford L (2020). Radiographers' assessment of referrals for CT and MR imaging using a web-based data collection tool. Radiography. DOI:https://doi.org/10.1016/j.radi.2020.04.001

Paper III

Chilanga CC, Olerud HM, Lysdahl KB (2022). Radiographers' actions and challenges when confronted with inappropriate radiology referrals. European Radiology. DOI:https://doi.org/10.1007/s00330-021-08470-z.

Paper IV

Chilanga CC, Olerud HM, Lysdahl KB (2022) The value of referral information and assessment – a cross sectional study of radiographers' perceptions. BMC health services research. DOI:https://doi.org/10.1186/s12913-022-08291-w.

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Abbreviations

ACR: American College of Radiology

AI: Artificial Intelligence

ALARA: As Low As Reasonably Achievable

BSS: Basic Safety Standards

CDS: Clinical Decision Support

CPD: Continuous Professional Development

CT: Computed Tomography

ECR: European Congress of Radiology

EEA: European Economic Area

EFRS: European Federation of Radiographer Societies

ESR: European Society of Radiology

EU: European Union

GDPR: General Data Protection Regulation

HERCA: Heads of the European Radiation Protection Competent Authorities

HREC: Human Research Ethics Committee

IAEA: International Atomic Energy Agency

ICRP: International Commission on Radiological Protection

ISRRT: International Society of Radiographers and Radiological Technologists

LNT: Linear No-Threshold

MRI: Magnetic Resonance Imaging

NSD: Norwegian Centre for Research Data (Norsk Senter for forskningsData)

PCHC: People-Centred Health Care

RCR: Royal College of Radiologists

SPSS: Statistical Package for the Social Sciences

UCD: University College Dublin

USN: University of South-Eastern Norway

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1 Introduction

In a study on appropriate imaging using a fictional case, Mendelson and Montgomery [1] address '*appropriate medical imaging*' and offer recommendations on good practice for healthcare professionals. Gaining an understanding of what defines appropriate medical imaging is, therefore, a suitable starting point for the introduction.

In healthcare, medical procedures are deemed appropriate when the expected health benefits significantly exceed the expected negative consequences [2]. In medical imaging, the ability to establish a diagnosis or provide positive treatment outcomes for the patient is suggested to determine imaging appropriateness [1, 3]. The International Commission on Radiological Protection (ICRP) publication 121 [4] states that medical imaging should guarantee that benefits outweigh radiation risks and other potential risks to patients. This implies that a balance between the risks and benefits of a diagnostic test determines appropriateness, where greater benefits indicate the level of appropriateness [5]. Sistrom [6] analyses the concept of appropriateness in relation to expected net health outcome in a clinical scenario of the difference between not performing and performing the imaging test, expressed in quality-adjusted life years. Sistrom [6] links cost-effectiveness to appropriate imaging and highlights a paradox that highly appropriate imaging tests could be attained at low costs, conversely expensive procedures could be completely inappropriate in certain situations. This indicates the importance of value or worth of a procedure and is supported by Mendelson and Bairstow [3] who state that inappropriate imaging leads to risks and costs without benefits. In addition, the World Health Organisation (WHO) [7] points out that availability of the imaging procedure, professional expertise as well as patients' needs, and values should be considered in ensuring appropriate imaging. The above definitions identify three aspects that contribute to appropriate medical imaging: the patient, procedure, and healthcare professionals. We could therefore state that 'appropriate medical imaging' considers the individual patient, efficacy, risks and cost-benefit of the imaging procedure and the healthcare professionals' expertise [4-7].

Delivering appropriate medical imaging in radiology departments involves a complex process of multidisciplinary healthcare professionals and continuous adherence to radiation protection principles[1] [8-10]. To grasp the complexities of this process, it is vital to understand two main concepts of radiation protection, namely the justification and optimisation principles. The following sections first describe the radiation protection principles and how they are applied in clinical practice within the radiology referral process. The various healthcare professionals involved and the challenges they face to ensure appropriate imaging are then highlighted. Thereafter the aim of this research is introduced.

1.1 The principles of radiation protection

1.1.1 Justification principle

Justification is defined by the International Atomic Energy Agency (IAEA) Safety Standards [9] as:

'the process of determining whether the use of the given radiological procedure is expected to yield benefits to the individuals who undergo the procedure and to society that outweigh the harm (including radiation detriment) resulting from the procedure' [p.8].

The justification principle involves a three-level approach [8]. Level one pertains to proper use of radiation in medicine – that it should provide more good than harm [11]. Level two pertains to the need for generic justification and applies to whether an imaging procedure will improve diagnosis or provide better health management information for individuals and patients [9]. Level three pertains to individualising the

[1] The three principles of radiation protection are Justification, Optimisation and Dose limitation. Only Justification and Optimisation apply here. Dose limitation is generally not applied to exposure of patients in clinical practice because it potentially reduces the effectiveness of patient diagnosis or treatment, thereby causing more harm than good [8]. Using ionising radiation at appropriate dose levels for a particular medical purpose is more valuable.

radiological procedure to a given patient [12]. The third level is the focus of this research and relates to whether a requested radiological procedure will provide accurate diagnosis or medical information that benefits a patient at minimum risk [8]. Justification at level three considers the benefits and risks of alternative procedures that might be available including imaging procedures that do not use ionising radiation[2] [9]. For instance, an alternative low dose or non-ionising modality such as ultrasound or a magnetic resonance imaging (MRI) procedure that provides comparable diagnostic benefits should be selected instead of a superior diagnostic-sensitive but high radiation dose procedure if there is a higher risk of adverse effects for the patient [4]. However, justification does not only apply in situations of radiation protection but is also based on selecting imaging procedures that provide diagnostic efficacy [9]. In practice, the justification process is applied through assessment of patients' clinical information to determine whether imaging is beneficial [9]. In this regard, the reasons for conducting the procedure and the patient's condition are assessed using radiology evidence-based referral guidelines[3] developed by recognised professional bodies and health authorities [12].

Justification is the principle mainly associated with appropriate imaging [13] and is described in terms such as 'justified/unjustified', 'necessary/unnecessary' and 'warranted/unwarranted' imaging, synonymously used for appropriateness and inappropriateness, respectively. Other newer terms such as 'value-based imaging' are also used [14, 15]. Various terms are used for the process of assessing clinical information during the justification process such as 'reviewing' 'assessing' or 'vetting[4] [16]. These terms will be used accordingly in this thesis.

[2] Exposure to Ionising radiation causes biological effects to the human body that cause harm. Examples of Ionising radiation imaging modalities or procedures would include X rays, CT, and nuclear medicine studies and non-ionising radiation would include MRI and Ultrasound procedures.

[3] Radiology referral guidelines are explained in section 2.2.

[4] Vetting and justification, though sometimes used synonymously, are separate activities occurring at different stages. Vetting usually refers to procedures that require a patient appointment and is linked to the scheduling of an examination [16].

1.1.2 Optimisation principle

The principle of optimisation occurs after imaging is accepted as justified [8], thus proceeding to conduct the procedure in the most optimal way [4]. Optimisation is the operational stage where radiation protection measures are applied, and equipment parameters adjusted to obtain quality imaging for diagnostic interpretation [4]. When high ionising radiation procedures are used, doses should be kept As Low As Reasonably Achievable (ALARA) [9], to mitigate radiation effects to patients. However, the diagnostic value of imaging is of higher benefit for patients. Based on this premise, radiation doses should not be reduced to levels that may compromise diagnosis benefit [9]. For non-ionising radiation procedures, optimisation for imaging of diagnostic value is the main consideration as there is no risk of radiation doses [17, 18]. The ICRP publication 121 [4] states that optimisation involves three main aspects: the radiological equipment, the equipment capabilities, and the suitability of technical parameters to the patient. The essence of optimisation is to balance acquiring imaging of diagnostic value while maximising benefits and safety to patients [9]. Achieving this balance in clinical practice could, however, be complicated by factors such as the differences of available imaging systems, human errors in procedural operations and the patients' natural variability [19].

1.1.3 Linking the justification and optimisation principles

In clinical practice, the two radiation protection principles can simply be described as conducting the right procedure (justification) and conducting it in the right way (optimisation) [7]. The principles are closely linked regarding appropriate imaging, both relying on information provided in the referral. An example is that during justification, the patients' clinical information should be of sufficient quality with a clearly stated diagnostic question to be answered [20]. This allows the most appropriate imaging procedure to be selected. An appropriate imaging choice is that which can answer the

requested diagnostic question, taking into account patient safety, lower radiation dose where required, cost, and use of local professional expertise [21].

Providing adequate clinical information assists the radiology professionals to optimally perform procedures and obtain images of diagnostic value, leading to accurate interpretation or reporting of imaging findings [7]. The benefit of the imaging procedure should be achieved in accordance with the initially justified intention and expected outcomes with appropriate optimisation. Optimisation therefore takes into account the associated risks of radiation exposure and likelihood of not delivering the very purpose of imaging (clinical risk) [19]. The diagnostic benefit of imaging depends on image quality. Images of low quality provide lower diagnostic confidence, which is associated with reduced likelihood of accurate image interpretation leading to misdiagnosis [19]. Notably, clinical risk from low-quality images is not always caused by failure in the justification process. For example, an imaging procedure could be effectively justified with all the relevant patient clinical information provided, but lack of optimisation can produce images of sub-standard diagnostic value, thus failing to provide the intended benefits.

1.2 The radiology referral process

To understand the activities that ensure appropriate medical imaging, it is important to have knowledge of the healthcare professionals involved and their stipulated roles. This is explained through the radiology referral process (Figure 1)[5] as described by Olerud et al. [22]. The radiology referral process is a complex multidisciplinary process that involves referring medical clinicians, radiological medical practitioners, medical

[5] Figure 1 provides a general illustration of the radiology referral process. Variation in consultations and performing of the procedure do occur in clinical practice. For example, radiologists could be involved in performing the procedure, while radiographers trained in image reporting could conduct the interpreting of imaging. The radiologists might inform the patient of the diagnosis. Consultation between the radiology department and medical clinicians could also occur before the patient is referred.

radiation technologists [22] [6] and sometimes medical physicists and nurses. The referring medical clinician is the physician or healthcare professional who refers a patient for a radiological procedure [9]. Depending on applicable legislation, radiological medical practitioners could be radiologists, nuclear medicine physicians, radiation oncologists, dentists and some specialist physicians or healthcare professionals with competence in radiation protection and safety within their sub-specialty [9, 23]. In this thesis, the term 'radiological medical practitioner' will refer to radiologists. The medical radiation technologists are usually responsible for performing the imaging procedures and are termed 'operators' [9]. In certain countries, the technologists could also take on the role of radiological medical practitioner [16, 23]. The practitioner role is further explained in section 2.3 of this thesis on professional policies for radiographers. In this thesis, the radiographers are referred to as technologists.

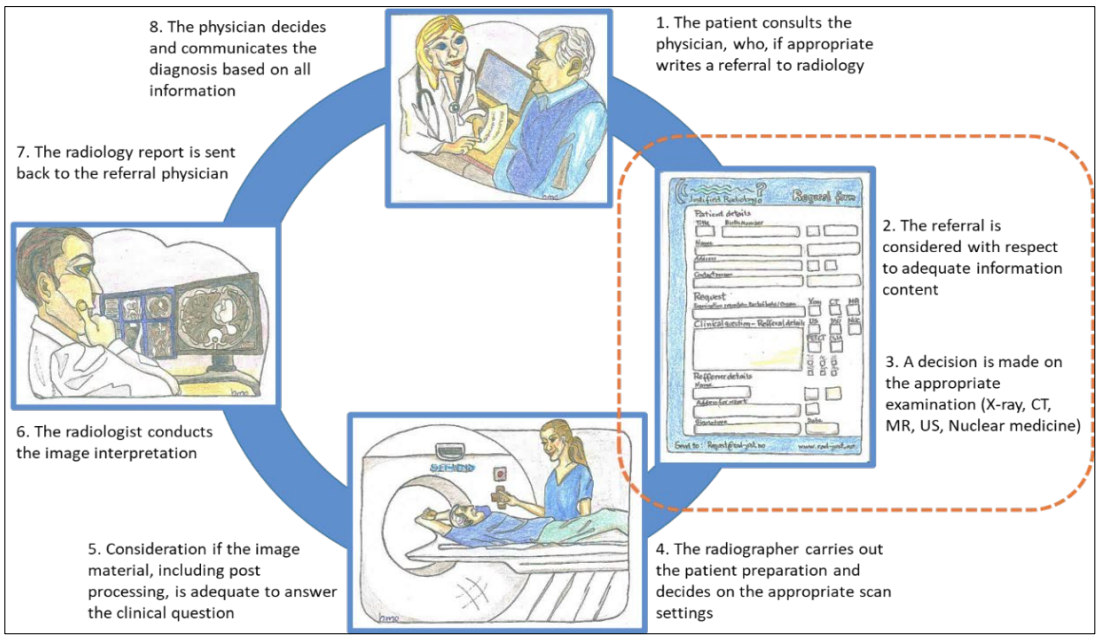

Figure 1 The radiology referral process [Olerud et al. 22]

[6] The three main professionals involved in the process are simplified for easier understanding i.e. referring clinicians, the radiologists, and radiographers. However, the referrers may include any registered healthcare professional entitled to refer individuals for medical exposures. The radiological medical practitioner could also refer to different medical professionals and include radiographers in some countries [16].

The justification process begins with the patient seeking medical consultation. This will include several activities to gather sufficient clinical information and will end when approval for imaging is granted [24]. During consultation with the patient, the referring clinician will select the best radiological examination to determine or confirm a suspected diagnosis. At this stage it, is recommended that the referring clinician uses radiology referral guidelines in selecting the appropriate imaging procedure. When a preferable procedure is selected, the clinician refers the patient to the radiology department using a referral (request) form to consult whether imaging is warranted [9, 22]. The referral form should contain comprehensive patient clinical information to enable the radiologists and radiographers to assess and determine whether imaging is beneficial in view of the possible risks [20, 25]. Justifying a radiological procedure should occur before imaging is conducted, and referral guidelines should be used to guide the radiologists and radiographers in decision-making. This process for assessment of imaging would include checking the urgency of the procedure, any previously conducted imaging, whether the appropriate imaging modality has been selected, and patients' tolerability to undergo the procedure [8]. It is recommended that the justification process be conducted in consultation between the referring clinicians and radiologists, including radiographers [9, 12, 26]. In the radiology departments, radiographers are generally the professionals that receive and inform patients about pre-procedural preparations and instructions [22]. Radiographers are in a vital position within the referral process and operate as the interface healthcare professionals between referring clinicians, radiologists, and patients [9, 22]. For conventional or plain X-ray procedures, assessing for appropriate imaging is usually performed by radiographers, and radiologists are generally consulted in cases of uncertainty [9]. For justification of advanced medical imaging as in non-ionising radiation, MRI, and relatively high dose imaging such as CT, the responsibility resides with radiologists in radiology departments [9, 24, 27]. However, radiographers could be delegated or assume the role [16, 26]. When justifying imaging for non-ionising modalities, radiation risks are not a concern, but other potential risks of imaging should be considered [28]. Before a radiological procedure is conducted, the justification process will involve identifying and verifying

that the procedure is selected for the correct patient and relevant information to ensure safe imaging has been obtained. Depending on the required procedure, assessing for appropriate imaging can be conducted while the patient waits in the radiology department, or an appointment is made for the imaging procedure. After completion of the justification process, the radiological procedure is scheduled to be performed by radiographers independently, or together with departmental radiologists depending on its complexity. During the procedure, the optimisation of parameters and safety measures is performed to deliver acceptable radiation doses and obtain images of diagnostic value [4]. Radiographers are routinely the operators of imaging procedures although in some instances radiologists or other radiological medical practitioners could assume the role [9]. In performing the procedures, the basic work of radiographers involves patient positioning and selection of projections, required radiation exposure parameters and imaging settings to produce quality images for diagnostic interpretation. When the procedure is completed, the radiologist or trained reporting radiographer interprets the findings in a radiology report which is sent back to the referring clinician. At the end of the procedure, radiographers will generally provide post-procedure instructions and any further required information to patients [29].

1.2.1 Responsibilities of the healthcare professionals

All healthcare professionals are responsibility for patient safety and appropriate health management when requesting and performing radiological procedures in the radiology referral process. A collaborative approach with shared decision-making is recommended [12, 26]. The referring clinicians bring knowledge of the medical context and patient history to the decision process, while radiologists and radiographers are experts in radiological procedures [9, 12]. However, there are variations in level of responsibility dependent on applicable national legislation for the healthcare professionals in the referral process. The IAEA safety standards [9, 12] state that referring clinicians are responsible for the patient's overall health management, and radiological medical practitioners or radiologists overseeing the procedure have responsibility for the overall

safety of patients in line with the justification and optimisation of radiological procedures performed in collaboration with medical physicists and radiographers. In accordance with the IAEA safety standards [9, 12], radiographers generally perform their tasks in liaison with and delegated by radiologists in radiology departments. The European Union (EU) Basic Safety Standards (BSS) directive [26] states that any medical exposure takes place under the clinical responsibility of a practitioner, affirming that clinical responsibility for medical exposure rests with the practitioner. The EU BSS directive further allows for a range of healthcare professionals to take on the role of practitioner, including radiographers [23, 26]. In situations where radiographers are responsible for or are delegated the task of justifying imaging, it is recommended that adequate training is provided, tasks be restricted to specific trained individuals and delegation of responsibilities clearly documented [9, 16, 23, 24].

1.2.2 Challenges for healthcare professionals in the referral process

The healthcare professionals do face various challenges during the referral process. Referring clinicians are the professionals who initially meet patients for medical consultation and decide on the most suitable imaging and healthcare management. Several challenges ranging from patient and organisational factors could occur at this point and influence the selection of appropriate imaging [30]. The referring clinician's decision-making process may be challenged by the unavailability of adequate patients' clinical history and delays in laboratory results preventing timely gathering of complete clinical information [30]. Patient demand for healthcare services and defensive medicine to avoid litigation are other factors reported to compel referring clinicians to request unjustified imaging [31, 32].

In radiology departments in many countries, radiologists are the professionals with the legal responsibility for determining and justifying the most appropriate imaging procedure [1, 9, 24]. Radiographers with appropriate training are the professionals best equipped to assess referrals for imaging in liaison with or in the absences of radiologists

[9, 25, 33]. Radiographers' training and competencies are, however, reported to vary between countries and regions [34, 35], and influence the allowed levels of responsibility and capabilities regarding assessing of referrals in clinical practice. The diversity in radiography education is addressed in section 2.4 of this thesis. More importantly, to adequately assess the risks and benefits of imaging for an individual patient, comprehensive and relevant clinical information is required [20]. Hence the need for referring clinicians to supply adequate clinical information to radiology departments.

Challenges referring clinicians encounter are exacerbated by advancements in imaging. Medical imaging has advanced from use of general X-rays to specialised technology and modalities such as CT, MRI, ultrasound, and nuclear medicine [36]. The imaging modalities are selected based on differences in superiorities in diagnosis and treatment of a pathology and their benefits assessed versus risks of radiation exposure and other risks to patients [36]. The referring clinicians possess more knowledge of patients' medical history but lack knowledge of radiation doses and benefits of imaging modalities [37]. Borgen et al. [38] report of clinicians under-estimating radiation doses and risks in most relatively high dose imaging procedures. Studies also report of clinicians not being aware that imaging procedures such as ultrasound and MRI do not use ionising radiation [37, 39, 40]. Although knowledge of radiation doses and risk estimates is also reported to be lacking among radiologists and radiographers [41-43], it is stated to be higher in these professional groups [44]. Khan et al. [45] reports of significantly lower knowledge of radiation protection and doses for common imaging procedures among junior medical doctors compared to radiology registrars and radiographers. The lack of knowledge regarding radiation doses and the benefits of various imaging modalities presents challenges for referring clinicians when requesting imaging procedures.

Use of radiology referral guidelines can assist when assessing for appropriate imaging. The available variants and importance of radiology referral guidelines are explained in section 2.2 of the thesis. However, studies show a lack of awareness and use of referral guidelines among healthcare professionals when ordering and assessing for imaging

procedures [38, 46-48]. Radiologists and radiographers are reported to be more familiar with referral guidelines [44], giving the radiology professionals an advantage in accurately assessing for appropriate imaging. Although both radiologists and radiographers have better knowledge of radiation doses and risks and are familiar with referral guidelines, patient clinical information provided by referring clinicians hugely influences decision-making regarding justification for appropriate imaging.

Communicating the benefits and risks of procedures to patients can be affected by knowledge difference among the healthcare professionals. The benefits, risks, and purposes of conducting a radiological procedure should be effectively communicated to patients to enable informed consent [11]. Communicating the risks to individual patients should, therefore, address their concerns within the framework of informed decision-making [49]. The appropriate time for referring clinicians to discuss benefits and risks of imaging with patients is when ordering the radiological examination [50]. Re-enforcing the discussions in radiology departments is encouraged [50]. Where the referring clinician is unaware of imaging modality benefits, radiation doses and other related risks, the patient is deprived of adequate information to make an informed decision in accepting to undergo the procedure. Collaboration among the healthcare professionals to provide the required information to patients is recommended [7].

1.3 Relevance of study and contribution to field

Quality referral information is vital to accurately assess referrals for appropriate imaging in radiology departments [20]. However, the current system in the radiology referral process presents challenges [44, 51, 52]. Radiology departments still encounter a substantial number of referrals with inadequate patient clinical information which hinders an effective justification of imaging [53-56]. Inappropriate imaging not only has adverse effects for patients' healthcare management, but also increases waste and workload for radiology departments and overall health services [57, 58]. Reducing the waste of resources through promotion of practices that are effective and efficient

improves healthcare outcomes [59]. International collaborative initiatives, such as the WHO and IAEA 'Bonn call for action 2012', recognise the need to enhance implementation of justification and optimisation processes and call on all involved to develop national action plans and regional campaigns [60]. Several countries have adopted the recommended IAEA Safety Standards [12] and in Europe, the EU BSS Directive [26] emphasises healthcare professionals' responsibilities in reinforcing implementation of justification of imaging. Initiatives to educate healthcare professionals and the public such as 'choose wisely' and 'image wisely' have also been implemented in efforts to combat inappropriate imaging [61, 62]. Several governing bodies at national and international level promote radiographers' active involvement as gatekeepers to assess radiology referrals in order to guarantee appropriate imaging in radiology departments [9, 16, 23, 63, 64].

In clinical practice, the assessment of radiology referrals to justify imaging is a multidisciplinary task between clinicians from diverse disciplines and radiology professionals. Advancement in imaging technology and legislation developed to adapt to current practice have led to radiographers taking up more responsibilities in assessing radiology referrals. Nevertheless, it is largely unclear how radiographers perform the role of assessing referrals for appropriate imaging in clinical practice. To promote quality care and services, health institutions are also adapting practices of person- and people-centred care. The goal of people-centred health care (PCHC) is to prioritise and harmonise health care to patients' needs as well as giving support to healthcare professionals in providing quality care and services. Furthermore, delivery of care in the radiology referral process will require interactions between various health professional groups. In this thesis, two theoretical frameworks – the PCHC framework and Abbott's theory of systems of professionals – are used to understand the radiographers' role in referral assessment. The PCHC framework and Abbott's theory are fully defined in sections 3.1 and 3.2 respectively. The PCHC framework was selected in order to comprehend how the radiographers' role could be understood using the defined principles within the framework. Abbot's theory of systems of professions analyses the status and interactions of professions in an interdependent system. This was selected as

a supporting theory to understand how professional interactions within the radiology referral process support and benefit radiographers in the task of assessing referrals. Motivation for selecting these two theories is discussed further in the theoretical framework chapter, section 3.3 of this thesis. Effectively assessing referrals help justify radiological procedures. This guarantees that patients' medical conditions are accurately and timely diagnosed, leading to quality management of patients' healthcare. To provide quality services, healthcare professionals in the radiology referral process, including radiographers, should be supported in their roles. This thesis aligns with PCHC practices in understanding that the radiographers' role of ensuring appropriate imaging promotes the provision of quality services in radiology departments.

This research shows radiographers' contribution to appropriate imaging in radiology departments, thus filling a knowledge gap. The research contributes to existing knowledge in two ways. First, the research identifies the importance of high-quality referral information and how radiology professionals use it to provide patient safety and care. Second, the research shows the referral assessment tasks radiographers perform to ensure appropriate imaging, thus providing quality radiological services. The research further reveals the factors that currently support radiographers in the role of assessing referrals. The knowledge obtained through this research can provide a foundation for radiographers' educational needs, such as strengthening skills in assessing of referrals, identifying areas within the radiology referral process where greater support is currently required for radiographers, as well as preparing the radiography profession for expected future roles in referral assessment.

1.4 Aim of the research

The aim of this research is twofold: To increase understanding of the radiology referral process, particularly radiographers' role in referral assessment, and to discuss how the findings can be understood within wider theoretical frameworks that include the WHO PCHC and Abbott's professions theory. This understanding may be valuable for the

implementation of initiatives to improve the appropriateness of radiology services. To achieve this aim, four scientific papers are used, focusing on the value of referral information for quality of radiological services, radiographers' capability to assess referrals, and how radiographers make use of referral information and act in situations of suboptimal referrals. The following objectives and research questions *(RQ*) were explored:

- To illuminate and reveal the ethical impact of suboptimal referrals on delivery of care in the radiology *department (Paper I)*

  RQ 1: Why and in what way does suboptimal referral information challenge the work of radiology professionals (radiologists/radiographers) and delivery of radiology services?

  RQ 2: How does the impact of suboptimal referral information present ethical challenges according to the principles of non-maleficence, beneficence, autonomy, and justice?

- To examine the capabilities of radiographers internationally in respect of compliance with radiology referral guidelines when assessing designed referrals for advanced imaging CT and MRI examinations, and identify factors that enhance their performance *(Paper II)*

  RQ 3: To what extent do radiographers' capabilities to assess referrals for CT and MRI examinations comply with referral guidelines?

  RQ 4: What factors contribute to their performance?

- To assess radiographers' contribution internationally in ensuring appropriate examinations are conducted in clinical practice (*Paper III*)

  RQ 5: How do radiographers act when confronted with missing referral information and inappropriate referrals?

  RQ 6: What factors hinder or facilitate radiographers' contribution in assessing and justifying referrals?

RQ7: How do these actions and factors depend on modality, educational level and having a delegated task to assess radiology referrals?

- To determine the use/usefulness of quality referral information and benefits of radiographers assessing referrals (*Paper IV*)
  RQ 8: How do radiographers make use of the information provided in the referral?
  RQ 9: What are the benefits of radiographers' assessment radiology referrals

- To discuss the impact of radiographers' contribution in the referral process, addressed in two main questions
  RQ 10: How do radiographers' efforts in the referral process support a PCHC approach?
  RQ 11: How can the radiographers' role be understood within Abbott's theory of systems of professions?

The first chapter introduced the topic the next chapter gives the relevant background to the study.

2 Background of study

Studies show that a high rate of unjustified imaging procedures are conducted in radiology departments, with variations in rates reported [5, 53, 65-69]. For instance, Rawle and Pighills [53] report 75% referrals for general X- ray examinations that were considered unjustified, with 32% of the cases attributable to insufficient clinical detail. Oikarinen et al. [67] report 30% unjustified referrals for CT imaging in young patients where in some instances MRI, ultrasound or no imaging procedure could have been beneficial. Sheehan et al. [69] report as high as 45% referrals for MRI ordered as first-line imaging where lower cost imaging such as general X rays or ultrasound might have been suitable for accurate diagnosis. The main reported cause of unjustified imaging procedures are the high numbers of suboptimal referrals that affect quality of assessing for appropriate imaging [53-56, 70]. A referral is considered suboptimal if information is lacking, conflicting, or wrong. In this implies that the clinical information might be insufficient to effectively assess for the benefits and risks of a procedure, the requested examination might not best answer the clinical question [20], re-referral to conduct the same procedure without a clear rationale [71], or improper timing of the procedure [72]. Patient safety or contra-indications to a procedure can also make a referral suboptimal [73].

2.1 The impact of inappropriate imaging

Inappropriate medical imaging has become a global concern as unwarranted imaging exposes patients to risks of harm from unnecessary exposure to radiation doses as well as the imaging procedure itself [74, 75]. Unnecessary imaging is also reported to have economic consequences for patients and represent increased waste of resources for healthcare institutions, thus challenging healthcare systems [57]. In order to understand the gravity of this global issue, this section explains the effects of inappropriate imaging by highlighting some risks of performing unjustified imaging procedures, including the

risk of unnecessary radiation exposure, harm from contrast agents, risks of unwarranted diagnostic outcomes and the challenge for health systems in terms of costs and labour.

2.1.1 Radiation risks

All radiation exposure in medical imaging carries certain risks of harm to the individuals exposed [9]. The risk becomes of greater concern when imaging procedures are conducted unnecessarily or without rationale. Ionising radiation imaging procedures pose risks of body tissue harm (deterministic effects) and an increased likelihood of developing radiation-induced cancers or genetic disorders (stochastic effects) [4, 11]. The risks of stochastic effects from ionising radiation are of particular concern [11]. Based on the linear no-threshold (LNT) model it is assumed that there is no threshold dose for radiation-induced cancer, as all absorbed radiation doses, no matter how minimal, have an infinite probability of causing cancer [8]. The risks of stochastic effects, although low, depend on age and gender with paediatric and female patients at higher risk [4]. Studies report on the probability of stochastic effects when ionising radiation procedures are used [76-79]. Linet et al. [78] report future projected cancer risks in currently used imaging procedures and advocate for measures to improve justification and optimisation processes to minimise effects. Pearce et al. [79] report that use of CT scans in children with delivered cumulative doses of about 50 to 60mGy triples the risk of leukaemia and brain cancer, although these are considered rare cancers and the cumulative absolute risks could be small. The radiation dose to the population is also of concern, necessitating the need for appropriate imaging. A higher confidence level on radiation effects has been estimated at effective radiation doses of over 100 millisievert (mSv) [80]. The effective dose is defined as the ionising radiation exposure to the entire body that would result in equivalent detriment as exposure over the nonuniform, partial-body irradiation in question [81], and establishes the relationship between the probability of radiation-induced cancer and equivalent dose [4]. Evidence shows that patients can receive cumulative effective doses of up to 100 mSv from undergoing multiple CT procedures within a period of 1 to 5 years [82, 83]. Nuclear medicine hybrid

imaging such as positron emission tomography (PET)/CT or single photon emission computed tomography (SPECT)/CT are other imaging procedures of concern as relatively higher radiation doses are used [84]. However, Hendee and O'Connor [85] state that for CT and nuclear medicine procedures generally, delivered doses to patients are below 100mSv when properly conducted. To ensure patient safety regarding radiation exposures, current radiation protection standards and risk assessments hinge on the LNT assumption [8] which provides rationale for justification and optimisation of all radiological procedures.

2.1.2 Risks from using contrast media

Harm from interventions that are used when conducting the imaging procedure, such as contrast media and other drugs, are another cause for concern in unwarranted imaging. Use of contrast media is of particular concern. Nearly half of all radiological procedures use contrast media, which is vital for accurate visualisation of anatomy and pathology [86]. Although rare, incidences of patients reacting to contrast media are reported. Contrast media exposes patients to risks of anaphylaxis, a severe potentially life-threatening allergic reaction, reported occurrence 1 in 100 000 patients [87]. The risk of anaphylaxis increases with repeated exposure to contrast media and history of severe previous reactions [88]. Using contrast media also carries the risk of patients developing contrast-induced nephropathy and complications of thyrotoxicosis, mainly reported in patients with pre-existing medical conditions such as diabetes and thyroid disease [89, 90]. Luca et al. [90] report that the risk of contrast-induced nephropathy is negligible in patients with normal renal function but there is an estimated risk of up to 25% in patients with pre- existing medical conditions and advanced age. Although the incidence of contrast induced nephropathy is considered low [91], it is associated with high mortality and also significantly extends patient hospitalisations and adds to healthcare costs [92]. Data from a study in France report of suspected contrast induced acute kidney injury in 3.1 % (n = 32,308) of patients hospitalised for an image-guided cardiovascular procedure using iodinated contrast media [92]. Some hospitalisations

necessitated renal replacement therapy and were associated with an extra length of stay of up to 32.4 days and additional costs of up to 200 million euros per year [92].

2.1.3 Risk of unwarranted diagnostic outcomes

False positive or negative results and unexpected diagnostic findings [93] (incidentalomas) [7] are another factor in unnecessary imaging. Inappropriate imaging has the potential for increased risk of reporting false positive and negative diagnostic results. Any diagnostic test is based on probabilities and associated with a proportion of false-positive and false-negative results [21]. A false positive is an error incorrectly indicating presence of disease while a false negative is the opposite error, indicating absence of a disease when it is present [94]. False positive results are of particular concern as they potentially lead to further medical investigations and treatment that instigates over-investigation, over-diagnosis, and over-treatment [95]. Incidental findings defined as undiagnosed medical conditions accidentally discovered during an imaging procedure are predominantly reported in unnecessary imaging [96]. Although detection of certain incidental findings may need further evaluation and instigates earlier intervention for potentially serious and treatable conditions [97], the findings are often not of clinical significance [98]. An institution study by Nijhuis et al. [99] on annual CT or PET/CT surveillance in asymptomatic patients with resected stage 3 melanoma showed 88% findings to be benign after further investigation of false-positive and incidental findings, and 15 patients with a benign finding underwent an unnecessary invasive procedure. Advanced imaging with its improved resolution has further increased the probability of discovering incidental findings. O'Sullivan et al. [98] report that because of improved image resolution, a significant number of incidental findings or low-grade malignancy that do not require medical follow up or treatment are

[7] An unexpected finding referring to incidental finding or incidentalomas could be valuable for early diagnosis and management if found to be malignant or urgent treatment is required. Studies show that the majority are generally not of concern, reporting and follow up of those that are highly suspicious is however recommended [93].

frequently observed in contrast enhanced advanced imaging such as CT and MRI examinations. Lumbreras et al. [52], however, report a higher frequency of additional imaging for incidental findings discovered in patient undergoing general X-ray imaging. In their study, Lumbreras et al. [52] report that follow-up was comparatively higher for general X-ray patients than those who had advanced imaging, and suggest that this could be due to low sensitivity of general X-rays leading to the need for further evaluations to characterise findings. This further highlights the importance of adequate clinical information to enable the selection of the most appropriate imaging procedure for a given condition. As indicated, incidental findings instigate unnecessary medical interventions that subject patients to unnecessary and longer medical care or hospital admissions.

2.1.4 Challenge to healthcare systems

Inappropriate medical imaging challenges the health system through increased cost and burden on both human and healthcare resources. The use of medical imaging has increased globally to cope with the demand due to the growing ageing population [100] and burden of chronic diseases [101]. Inappropriate imaging expands these healthcare costs and negatively affects the economy and sustainability of healthcare systems [3, 32, 102]. A study by Flaherty et al. [103] in the United States reports that the current estimated average 30% level of inappropriate advanced imaging expenditures could be reduced by more than 1 billion US dollars annually through elimination of inappropriate imaging procedures. In Australia, Morgan et al. [104] report of a national intervention to reduce inappropriate referrals for lower back imaging which was associated with a statistically significant 10.85% relative reduction in the volume of CT scans of the lumbosacral region, equal to a cost reduction of approximately 11.6 million Australian dollars. In a study in two Spanish public hospitals, Vilar-Palop et al. [56] report that 31.4% of imaging studies excluding MRI and ultrasound were inappropriate according to the referral guidelines, and incurring associated relatively high costs. In Norway, Hofmann et al. [105] report a tripled increased in MRI for surveillance and management of

prostate cancer from 2013 to 2021 with related increased cost and extra burden on imaging departments, raising the need for documentation of the benefits. Studies in other developed and developing countries also report increased use of advanced imaging with associated costs and all advocate for appropriate use of radiological services [75, 106-108].

A known problem with inappropriate or unjustified imaging is the higher probability for incorrect findings (false positives and incidental findings) as discussed in above section 2.1.3. Incorrect findings can lead to more futile tests and treatments which put a strain on healthcare systems [95]. Such futile testing causes delays in patients' management and leads to increased economic costs from waste of resources and possible litigation for healthcare institutions [96]. The issues of over-diagnosis and over-treatment result in over-utilisation of imaging [65, 109]. Over-utilisation of imaging implies any usage or circumstances where imaging is unlikely to improve patient outcome [96]. Over-utilisation is well documented as a major concern of inappropriate imaging, especially in advanced medical imaging, due to the cost related with these procedures [104, 107, 108, 110]. Several factors drive over-utilisation of imaging, ranging from defensive medicine, self-referral, patient demand, inappropriate and financially-motivated factors, health system factors, industry, media, and lack of awareness, all leading to inflated costs for healthcare organisations [32, 111]. Over-utilisation further creates disparities and unfairness in the distribution of medical imaging resources [112, 113]. Overuse of imaging also escalates shortages of human resources. The increased use of imaging services widens the gap between demand in the health services and the supply of healthcare professionals [101, 114, 115]. In a study from one large teaching hospital in the Netherlands assessing the increase of emergency radiology examinations performed during on-call hours, Bruls and Kwee [114] analysed data within a period of 15 years and reported workload consequences for both radiologists and radiographers with potential for staff burn-out and reduced safety of radiological care. Increased use of medical imaging and shortages of staff can further lead to constrained flow of patients' care processes within a health system.

2.2 Referral guidelines and clinical decision support systems

Tools are available to assist healthcare professionals with justification of imaging. Evidence-based radiology referral guidelines have been developed to assist referring clinicians in making decisions on selecting an appropriate imaging procedure [48]. The goal of imaging referral guidelines is to provide healthcare professionals with information regarding which procedure is most likely to yield the most effective needed outcome, and whether another modality is equally or more effective and appropriate [116]. Referral guidelines are reported to reduce unnecessary imaging. In a single university hospital study in Finland, Tahvonen et al. [117] report a significant reduction of unnecessary examinations for conventional radiography of the spine through active referral guideline implementation. In a trauma centre in the United States, Goldberg et al. [118] report implementation of guidelines for children with mild traumatic brain injuries resulting in reductions in the performance of unnecessary head CT imaging. In radiology departments referral guidelines assist radiologists and radiographers to ensure an accurate and rapid justification process [116]. The commonly available and internationally used guidelines include among others the American College of Radiology (ACR) Appropriateness Criteria [119], Royal College of Radiologists (RCR) iRefer [120], Western Australia Diagnostic Imaging Pathways [121], and European Society of Radiology (ESR) iGuide [122]. Other international and national variants are also available [51]. However, development of referral guidelines has failed to effectively reduce inappropriate imaging because they are not consistently used in clinical practice. An ESR EuroSafe Imaging survey of radiologists in 52 countries within the EU, European Economic Area (EEA) and non-EU EEA countries [48] report that imaging referral guidelines are not routinely used in many countries in Europe. A similar trend is reported worldwide in countries outside Europe [47]. Accessibility difficulties, outdated content, or non-existence of guidelines for certain medical conditions and the health professionals' attitudes towards referral guidelines are some reported reasons as to why guidelines are not consistently used [24, 31]. Furthermore, referral guidelines can be difficult to implement and are dependent on the availability of radiological technology as well as requiring constant updating [47, 71, 123]. The WHO suggest development of

a global set of guidelines that could be used internationally, including in regions with limited technology [124]. Electronically integrating the referral guidelines with clinical decision support (CDS) systems into daily healthcare workflows seems to improve the process and is recommended [116, 125]. Use of referral guidelines is currently considered the most effective method of ensuring that radiological examinations are justified, and appropriate imaging performed [24, 126]. Integrating referral guidelines in CDS support is reported to promote safer and more efficient health service delivery [116].

2.3 Professional policies for radiographers

Radiographers, as with all other professions, should adhere to professional policies. The code of ethics of the International Society of Radiographers and Radiological Technologists (ISRRT) [127] states that radiographers should maintain current knowledge of safety standards pertaining to clinical practice, and conduct all procedures and examinations in compliance with recommended standards. Radiographers are usually the professionals who perform radiological procedures. Radiographers as operators play a central role in optimising procedural doses to ensure image quality [9]. Both the IAEA Safety Standards [9] and EU BSS directive [26] recognise the importance of radiographers' involvement and responsibility in justification of imaging. The IAEA Safety Standards [9] recognise the referring clinician and radiologists as the overall jointly responsible professionals while the radiographers undertake a delegated responsibility. In Europe, several countries have adopted the regulatory requirements relating to radiation protection set out by the EU BSS directive [23, 26]. This directive [23] is more comprehensive compared to the IAEA safety standards as regards radiographers' role in the justification process. The EU BSS directive [23] classifies radiographers within professional groups that can take on the role of radiological practitioners. The BSS directive [23] further states that radiographers' responsibilities should include verifying the provided patient medical data to ensure that the procedure prescribed in the referral is justified, obtaining previous diagnostic information or

records where applicable to avoid repeated unnecessary exposure, and ensuring that patients are provided with adequate information relating to the benefits and risks associated with the procedures. The radiographers' challenges regarding benefit- risk communication is briefly addressed below in section 2.5 of the thesis.

The tasks of radiographers in assessing referrals to justify imaging vary, and are reported to occur at various levels or roles, depending on the adapted legislation. Critical assessment or review of referral information before conducting a procedure is considered radiographers' routine clinical practice and a measure of quality checks in most countries [23, 25, 29, 63]. The recognition of radiography as a profession and emphasis on professional accountability have to some degree instigated the need for radiographers to be fully involved in quality checks regarding appropriate imaging. In their code of conduct, several radiography governing bodies state that radiographers as professionals should be held accountable for their clinical practice [63, 64, 128]. The radiographers' increased clinical practice responsibility and adherence to professional conduct has necessitated training and more rigorous policies to ensure appropriate medical imaging.

2.4 Diversity of radiography education

Education and training of healthcare professionals in the radiology referral process provides the knowledge and competences required to conduct justification and optimisation activities in relation to imaging. International bodies such as the IAEA and ISRRT emphasise radiographers' education and training to enhance clinical competencies and performance of tasks with adherence to radiation protection principles [9, 127]. However, the education and training of radiographers is reported to vary [35, 129]. The duration and quality of training programmes differ between countries and regions worldwide [34]. A study analysing radiography training in four regions of the ISSRT (Europe, Africa, Americas and Asia/Australasia) report the duration of radiographers' education and training programmes ranging from one and half to five

years, as well as significant variations in scope of practice [35]. In Europe, Couto et al. [129] report education duration varying between two to four years with variations in subjects covered in the education programmes. England et al. [130] further report variations in clinical practice training in radiography educational instititions across Europe. An IAEA coordinated study analysing education programmes from 31 countries within Europe and Central Asia showed a significant variation in radiation protection topics within the curricula [34]. Radiographers' clinical involvement in justification and optimisation tasks were low in many countries [34]. Clinical practice is a core component of radiography education. The level of radiographers' clinical skills and competencies will depend on the health instititions providing the clinical training [131]. Radiography education has evolved over the years, allowing radiographers in some countries to acquire skills and responsibilities as specialists and consultants in areas of medical imaging [132-136]. Radiographers are obtaining advanced education and specialistions within various imaging modalities and clinical practice [132], including image interpretation and reporting [133]. These developments and variations in radiography education have a great impact on the level of radiographers' competencies, knowledge, responsibility and autonomy in clinic practice [34, 137].

2.5 Ethics and appropriate imaging

Ethics analyse right and wrong actions, and consider how basic moral standards are justified [138]. All professions are guided by ethical rules and standards [139] and have moral obligations towards the people receiving the professional services, colleagues, and work institution [140]. A framework that is widely used in medicine to govern healthcare professionals' adherence to ethical standards is Beauchamp and Childress' principles of biomedical ethics [141]. Beauchamp and Childress [138] define the ethical principles as *autonomy*: respect for autonomous choices of persons; *non-maleficence*: reflecting the maxim, *primum non-nocere*, first, do no harm; *beneficence*: promoting good for the person's wellbeing; and *justice*: fairness in provision of healthcare and services. The ethical standards in radiation protection relating to appropriate behaviours

regarding exposure of ionising radiation to people and the environment are founded on Beauchamp and Childress' principles [11]. The principles of justification and optimisation use similar ethical principles and guide the required professional duties and standards of care in the radiology referral process [11]. The radiation protection core ethical principles include non-maleficence, beneficence, prudence, dignity, and justice [11]. Dignity relates to autonomy as defined by Beauchamp and Childress [138]. Although used similarly with autonomy within the ethics of radiation protection, dignity is however more comprehensive, covering human rights [142]. In radiation protection, prudence or the *precautionary principle* is added, which allows for actions taken without exact knowledge of the risks involved [143]. The ICRP [11] publication 138 defines the precautionary principle as, '*a principle in risk management whereby measures are put in place to prevent or reduce risks when science and technical knowledge are not able to provide certainty*' [p.15]. The precautionary principle takes into consideration risk reduction when the cause–effect relationships of an action cannot be firmly established [11, 144]. Three procedural values to aid with practical implementation in radiation protection are further added [11]: accountability, transparency, and inclusiveness in decision-making processes [145].

In appropriate imaging, respect for autonomy is reflected in informed consent obtained from patients in agreeing to undergo a procedure based on sufficient information and their understanding of the purpose, benefits, and risks [11]. In this regard, the healthcare professionals' duty to provide benefit and risk information about a procedure is essential as it helps fulfil patients' right to information and allows patients to be involved in shared decision-making of their own care process [146]. Communicating the purpose, benefits, and risks of imaging procedures to patients is considered a vital role for radiographers as they are the professionals who interact with patients most in radiology department [22, 23]. However, studies indicate that lack of knowledge of the benefits and risks of imaging procedures among radiographers is a limiting factor for effective benefit-risk communication with patient [147-149]. The radiographers' role may also be ambiguous as they may not always be capable or qualified to discuss the

benefits of imaging as this requires a good understanding of patients' medical conditions [149]. This is reported to reduce radiographers' confidence when providing the needed information to patients [148]. In this instance, radiographers are reported to view communicating benefits and risks as a secondary or supportive role to the referring clinicians' discussions with patients, thus reinforcing and answering further queries patients might have about the procedure [148, 149].

Non maleficence is the obligation of healthcare professional to refrain from causing harm to patients and is one of the central features of the Hippocratic Oath [11, 138]. In appropriate imaging, this principle pertains to preventing or reducing harm from imaging procedures and minimising radiation exposure whenever possible. The obligation in appropriate medical imaging would therefore be to ensure low risks, with benefits outweighing the risks, by considering that appropriate procedures are selected and optimally performed (justification and optimisation) [4, 9]. The precautionary principle can be seen as an extension of non-maleficence, with an emphasis on lack of knowledge about the exact risks [145]. The precautionary principle implies assessing potential for serious harm before it happens [150]. Beneficence, doing good, follows the ethical measure to act in the best interests of the patient [138]. In medical imaging, this principle implies that no procedure should be conducted unless it is deemed necessary [9]. To achieve this, effective assessing of imaging referrals becomes paramount for all the healthcare professionals in the radiology referral process to ensure that only imaging that will benefit patient management is performed.

Justice regarding appropriate imaging may refer to equitable access to health resources (Distributive justice) and adherence to priority setting criteria in healthcare services (Procedural justice) [96, 151]. Distributive justice holds that healthcare resources should be distributed as equitably as possible [96]. Procedural justice may be reflected in healthcare priority- setting criteria based on disease severity or patients' medical needs [151]. Inappropriate imaging results in misuse of radiology resources that could be more effectively applied to other patients or decrease the cost of resources used for other

medical purposes [96]. Evaluation and clarification of requested examinations is a central part of radiographers' quality checks before performing an imaging procedure [25]. This ensures radiographers' adherence to justification and optimisation principles. Providing appropriate imaging at the right time and in an optimal way for individual patients can have significant value for patients in the knowledge that the procedure performed on them will bring about the needed diagnostic outcomes [96].

Various ethical dilemmas and conflicts[8] can occur in the radiology referral process. A few challenges are mentioned here to give examples of what could occur in clinical practice. For example, the initial step in the justification process involves selecting the most appropriate procedure and discussing the benefits and risks with the patient to obtain informed consent [152]. This encompasses the ethical procedural value of transparency, which is the requirement that healthcare professionals are honest during discussions with patients [142]. This applies equally to referring clinicians, radiologists and radiographers, and the duty to inform becomes paramount for all the professionals in this regard. However, in some cases when an ionising radiation modality is selected, the duty to inform about possible stochastic effects could cause a dilemma [152]. There is debate within the radiology community about the duty to inform and obtain patient consent on possible stochastic effects due to the uncertainty of the risk, especially at the level of a single medical imaging procedure [146, 153]. Although there is consensus on the fact that ionising radiation from imaging procedures has risks for radiation-induced stochastic effects [4, 11], the nature of the risk is difficult to assess [154]. Current epidemiological evidence supporting increased cancer incidence from radiation doses below 100 mSv is inconclusive, and diagnostic imaging doses are typically much lower than 100 mSv, when used appropriately [80]. Furthermore Picano [153] reports that cancer risks from various radiological examinations can vary widely, ranging from low to negligible or zero risk. This creates a dilemma for the healthcare professionals as

[8] The variations in conflicts and dilemmas will depend on the different situations that arise, and the course of action will vary and depend on several factors such as policy. Possible scenarios are given here only to provide an understanding of possible conflicts and dilemmas that might arise.

informing the patient could cause unnecessary distress, while withholding information breaches the concept of obtaining informed consent as an ethical duty of all healthcare professionals [146]. Moreover, it is vital that the operating radiographer responsible for the procedure is aware of the decision made regarding informing the patient about the stochastic effects. This assists the radiographer with patient communication and dialogue [155], and ensures uniformity in information given.

Another scenario involves experiences with unjustified referrals received in the radiology department, and the actions radiologists and radiographers could be forced to take when dealing with such referrals. The radiology professionals could change the referral as determined by the clinical information provided, and decide, for example, to use an alternative, more suitable imaging modality than that requested by the referring clinician. This could possibly reduce patient treatment delays but may also cause conflicts if not discussed with the referring clinician, or lead to errors where vital referral information is lacking. In their study, Bosmans et al. [156] report that most referring clinicians agree that the radiologists change imaging protocols where the requested examination is unsuitable for answering the desired clinical question. Nevertheless, dialogue among the professionals is emphasised. Constantly contacting the referring clinicians can be time consuming for the radiology professionals, and creates a burden on workload [157]. Dialogue among the professionals in the referral process when changes are needed is essential, reduces professional conflicts [158], increases patient safety and improves proper use of medical imaging [157]. The radiographers on the other hand are reported not to question unjustified referrals or are sometimes coerced to perform the unjustified requested examination [159]. Medical dominance is reported as one major reasons for radiographers' lack of participation in decision-making and engagement with the medical professions[9] [160-164]. Knowing the ethically correct thing to do but feeling unable to act leads to moral stress [165]. Moral stress is reported to decrease quality of patient safety and effective care and has a negative effect on

[9] Medical dominance is reported as an ongoing problem for radiographers and is related to several factors such as organisational and individual country cultural practices [160 -162].

healthcare professionals' well-being [165]. Effective and collaborative communication among healthcare professionals could be a solution to avoid and alleviate the potential conflicts and dilemmas [113, 158].

3 Theoretical framework

Two theoretical frameworks are used to support the research findings.

1. The WHO PCHC framework. The PCHC framework is used to discuss how the radiographers' task of referral assessment promotes quality care systems and processes that facilitate multidisciplinary teams and services. These include, effective, efficient, evidence based and empathic care, and empowerment of all stakeholders to enable delivery of quality health services.
2. Abbott's system of professions. Abbott's theory is used to discuss how the healthcare professionals' interactions support radiographers within the radiology referral process. The radiographers' role of assessing referrals for appropriate imaging is explained as defined by their professional jurisdiction. The discussed interactions are mainly between the radiologists and radiographers who work in adjacent roles and are seen from the radiographers' perspective. The referring clinicians' role and involvement are discussed accordingly.

This chapter begins by explaining the concepts of the two theories and ends with the motivation for using the theories.

3.1 People-centred health care

The terms 'patient centred' and 'person-centred care' are commonly used in healthcare services globally [166, 167]. Person-centred approaches focus on humanising health services and ensure that the person using the services is at the centre of care [168]. The concept of person-centredness originates from human rights, [169] including the right to be treated with dignity and receive healthcare services that are coordinated and personalised to patients or persons' needs [170]. Person-centredness in clinical practice is linked to the delivery of high-quality healthcare [171].

McCormack, et al. [172] describes person-centred care as an approach to clinical practice that is established through therapeutic relationships occurring between healthcare professionals, patients, and their relatives. However, people-centred care is much broader than patient or person-centred care. PCHC encompasses the patients, clinical encounters, the healthcare professionals, and healthcare systems where the care is provided [173]. Healthcare organisations are expected to adapt to the changes within the complex health systems to continuously provide person-centred and quality care [174]. The WHO [175] defines PCHC as,

'An approach to care that consciously adopts the perspectives of individuals, carers, families, and communities as participants in and beneficiaries of trusted health systems that are organised around the comprehensive needs of people rather than individual diseases, and that respect social preferences' [p.8]

PCHC therefore recognises healthcare professionals as people that collaborate and form healthcare organisations and systems to provide quality care [173]. The vision of PCHC is that all people have equal access to high quality healthcare services [176]. Healthcare organisations and system should therefore be designed to deliver care that is equitable, ethical, safe, effective, efficient, timely and compassionate [174, 176, 177]. The United States Institute of Medicine [178] states that PCHC systems should aim to deliver cost-efficient or non-wasteful and effective services to remain sustainable. Developing PCHC practices requires continuous commitment in facilitating positive changes within clinical healthcare teams and organisations and is thus not a one-time event [172, 173]. McCormack et al. [172] further emphasis that developing person- or people-centred care will require committing to changing processes and cultures in ways care is delivered within teams in clinical settings and organisations. The WHO [173] suggests that transforming the current health care system by adopting a people-centred orientation requires changes within specific healthcare domains that correspond to key areas that will continue to drive and sustain transformation. The WHO [173] further identifies values and principles that govern PCHC. The next section discusses the domains where the WHO [173] suggests change should be realised and PCHC principles adopted.

3.1.1 The four domains of people-centred health care

The WHO [173] identifies four main domains (Figure 2) where changes could be implemented in order to transform health care system towards PCHC. According to the WHO [173] change in these domains creates an informed and empowered population, competent and responsive healthcare professionals, and efficient healthcare organisations and systems. The WHO [173] suggests that transforming and achieving the goals of PCHC requires a shift in how health care is perceived in both clinical and public settings. The clinical or micro level is where PCHC values are brought into practice in practitioner/health professional–service user relationships [179]. The patient–professional interactions in the radiology referral process occur in clinical settings. In this thesis, the focus of discussion is within clinical settings.

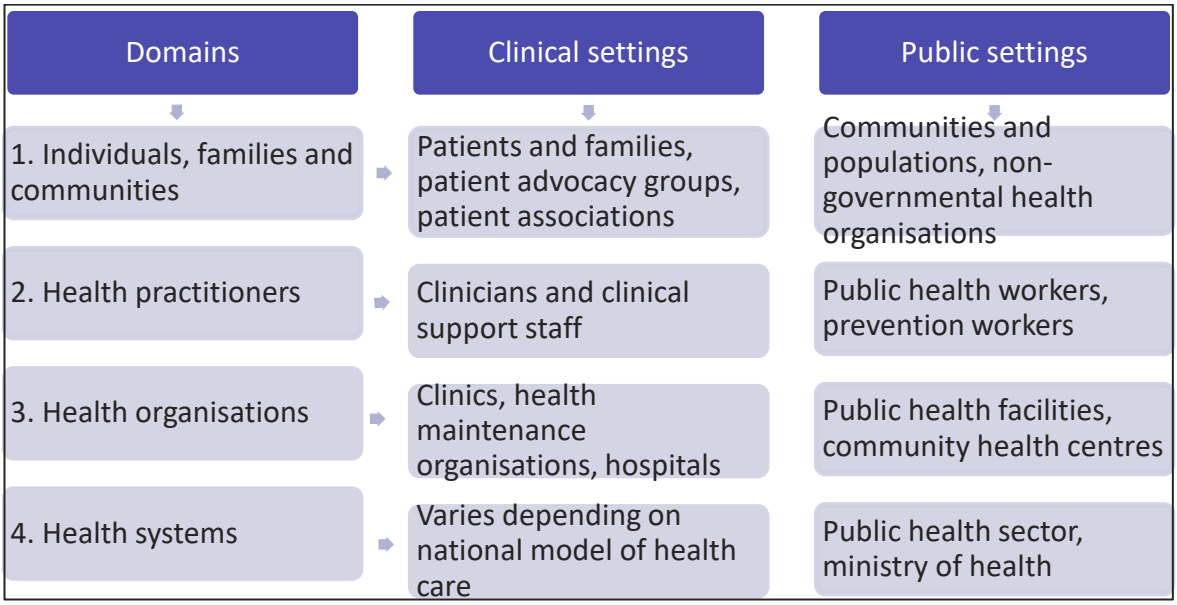

Figure 2 Players in the four domains of PCHC [WHO 173]

3.1.1.1 Individuals, families, and communities' domain

The individuals, families, and communities' domain represent the point where health care is experienced [173] and involves empowering patients or the people receiving the healthcare services in clinical settings. The WHO [180] advocates for people being

empowered to make effective decisions about their own health and healthcare professionals enabled to facilitate this process. In addition, strategies should be in place within the healthcare systems to ensure that people have the means to obtain the necessary information and are helped to access the needed care [173].

3.1.1.2 The health practitioners' domain

The health practitioners' domain is where health care is delivered and entails empowering healthcare professionals [173]. The workforce is an integral aspect of health systems as improving patients' experiences and health outcomes is dependent on professionals' availability, accessibility, acceptability, and quality of care [181]. The health professionals, as the people tasked with providing quality care and services, have an enormous responsibility to both the patients and healthcare organisations. The health workforce should therefore be encouraged to obtain the skills to work in the rapidly-changing healthcare organisations of today [173] in order to provide responsive and evidenced-based care that matches the needs and perspectives of individuals and communities [176]. Equipping the healthcare professionals with the needed skills reinforces the provision of quality health services [173].

3.1.1.3 The healthcare organisations' domain

The healthcare organisations' domain is where health care is facilitated, creating an enabling environment for health professionals to deliver quality care [173]. The delivery of quality care is an ongoing challenge for all healthcare organisations as health systems are complex and constantly need to adapt to continuously changing healthcare demands [177]. The WHO [173] states that PCHC requires a strong focus on safety and quality of care and healthcare organisations and professionals should be transparent about identifying and addressing unacceptable practices. Health care should also be coordinated for continuity of care and promote effective and efficient systems that serve patients' needs [176]. Continuity and coordination of care requires harmonious relationships and interactions among the multiple healthcare professionals within

interdisciplinary teams in the health systems [175]. This assists in ensuring a smooth patient transition between healthcare providers [173]. Promoting multidisciplinary healthcare enhances professional skill mix, communication, and knowledge-sharing across healthcare disciplines [182]. Multidisciplinary teams create greater efficiency of healthcare processes and more responsive health services [181].

3.1.1.4 The health systems domain

The health systems' domain is where the provision of health care is governed, and in clinical settings entails establishing standards of quality care and services [173]. Providing safe, effective, and timely care that responds to people's needs is the highest expected standard in PCHC systems [180]. In providing quality care, the healthcare professionals' standards of competence and accountability should be established and adhered to [173]. This implies that standards of professional education, expected level of clinical practice and well-functioning health systems should be in place. Health professionals are expected to adhere to the code of ethics, keep abreast of current knowledge to maintain skills, and participate in continuing professional development [173].

3.1.2 Principles of people-centred health care

The WHO [173] identifies seven essential principles that guide PCHC which include *equitable*, *effective*, *efficient, ethical*, *evidence based and empathic* care that *engages* and *empowers* all stakeholders. In clinical care settings, empowerment pertains to both patients and healthcare professionals. The seven principles which are summarised below (Figure 3) are based on the core values of PCHC. To bring about the required change and transform health care systems, these principles should be applied accordingly within the four key healthcare domains [173].

PRINCIPLES OF PEOPLE-CENTRED CARE	DEFINITIONS
1. People-centred care is equitable	•In the current global community, there should be no boundaries denying people the opportunity to improve their health
2. People-centred care engages all stakeholders	•The needs, perspectives and wishes of all stakeholders must receive thoughtful consideration. The decision-making process for health care reform should be shared across domains of healthcare
3. People-centred care is about empowerment	•Stakeholders should direct the process of change, and be helped to make appropriate choices. Health practitioners must be assisted to acquire the knowledge and skills to provide good quality and humane care
4. People-centred care is effective care	• Interventions should lead to better health outcomes in both clinical and public health settings which include addressing key issues of access, safety, quality, affordability and satisfaction
5. People-centred care is evidence-based and empathic	•Evidence and technology must be used within the context of compassionate and caring relationships that value people and their health experience
6. People-centred care is efficient	•Health care should occur in a coordinated and timely manner. Waste should be minimised.
7. People-centred care is ethical	•Respect for human rights, and recognition of the integral role of health for human development and happiness. A people-centred approach invokes transparency and accountability

Figure 3 The seven essential principles of PCHC [WHO 173]

The values and concepts of what person-centred care and PCHC encompass are vast and can refer to different activities [170]. The concepts presented are those mainly related to the findings in this thesis. Of the highlighted seven principles, *effectiveness, efficiency, empowerment,* and *evidence-based and compassionate care* are mainly referred to in the discussion in Chapter six.

3.2 Theory of system of professions

Abbott's theory of the system of professions [183] states that professions interact in an interdependent system where each profession performs its activities or work based on various kinds of jurisdictions. A profession's work consists of human problems needing expert services [184]. Abbott [183] claims that professional practice consists mainly of three components: diagnosis, inference, and treatment. The system of professions suggests that a jurisdiction links work and a specific profession [183]. A jurisdiction is maintained by identifying a problem for which the profession must provide a *diagnosis*, reduce the problem to its component parts through *inference,* and provide a solution achieved via *treatment* [183, 185]. The mechanisms of diagnosis, inference and treatment are based on *academic knowledge*, which provides a profession with the status and superiority to sustain a claim to a particular type of work [186].

Abbott [183] theorises that the chain of events starts with external forces such as technological advances and changes in the social structure of professional work that disturb the system (Figure 4 adapted and modified from Kroezen et al. [187]). In the process, professional work could be created, abolished, or reshaped, causing readjustments within the system. The changes within the system create areas of work where professions can contest for jurisdiction control or entry. The entry of a jurisdiction produces new roles and a temporary balance of work among professions [188]. Abbott [183] suggests that circumstances within professions, such as acquired new knowledge and skills, could strengthen jurisdictions.

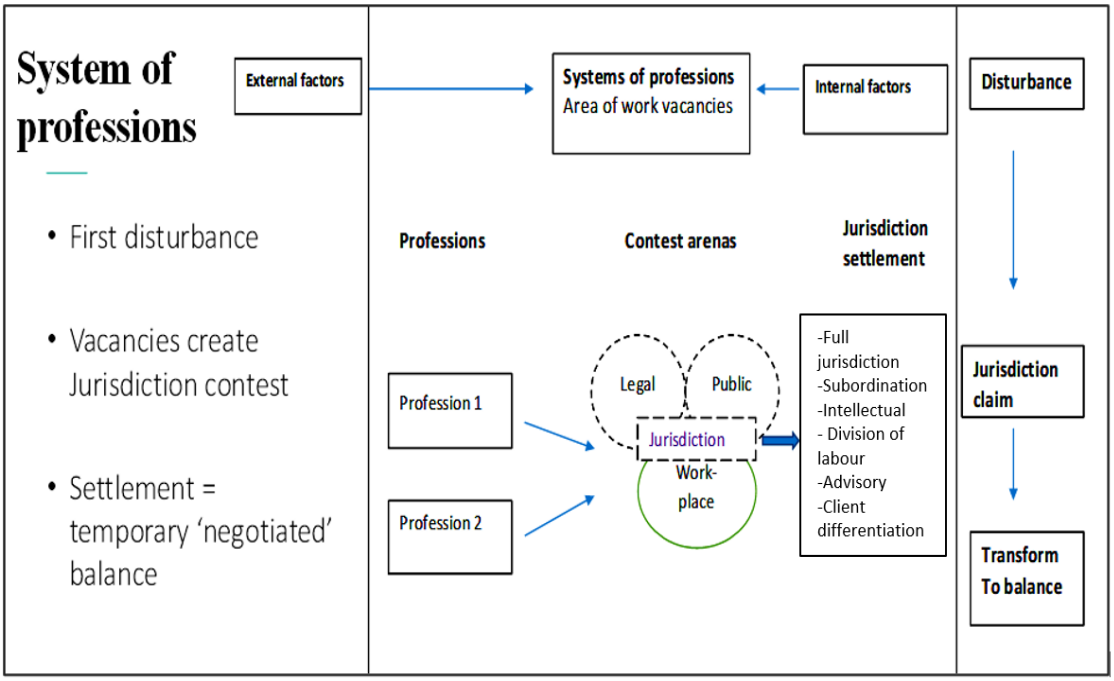

Figure 4 Theory of system of professions [Abbott's theory modified from Kroezen et al. 187]

3.2.1 Jurisdiction contested – arenas and settlements

Jurisdictional contest occurs in the public, legal, or workplace sphere (Figure 4). A contest in the public arena is generally a claim for legitimate control of a particular type of work. The public arena is where the profession could build a public image to pressurise the legal system in order to achieve control [183]. The legal arena grants formal work control, and the absence of legitimacy creates opportunities for competitors' attacks [183]. In the workplace, jurisdiction is a simple claim to control certain kinds of work and is usually blurred, distorting the official line of legality and publicity [184]. Subordination jurisdictions fall within this claim. Full jurisdiction is what most professions strive to achieve. Abbott [183] suggests that within an organisational structure, workplace arena claims represent a division of labour where expert knowledge is transferred from the legitimate profession to an equal or subordinate profession that then gains the needed knowledge to perform the required tasks. Other jurisdictional settlements according to Abbott [183] include division of labour, intellectual, advisory and client differentiation.

3.2.2 Subordination jurisdiction settlement

Subordination jurisdiction settlement will be the focus in this thesis as it relates to the work settlement as currently seen for the radiography profession. Radiography is one of the professions stated to be subordinate or lower ranked than medical doctors within the orthodox division of labour [189] although it has legal recognition and legitimation [190]. Abbott [183] states that subordination jurisdiction is generally a legal and public settlement, often resulting from failed attempts to obtain full jurisdiction. Abbott [184] suggests that subordination jurisdiction is common with professions working in adjacent roles, and such professions will generally need to know and learn about the work of others either through formal education or their job experience, termed 'workplace assimilation'. Workplace assimilation is defined as the transfer of knowledge where subordinate professionals obtain a set of skills on the job, though this does not necessarily lead to a jurisdiction control change [183]. The greater the acquisition of workplace assimilated knowledge, the greater the chances of a profession gaining increased jurisdiction [184]. In radiography departments, radiologists and radiographers work in adjacent roles with the radiographers taking on a subordinate or delegated role [190]. Over the past years, the radiography education and profession have advanced, enabling radiographers to take up tasks that were previously restricted to radiologists [135, 191, 192]. Furthermore, education in specialised areas of medical imaging is available, enabling increased responsibility and autonomy for radiographers [193].

3.3 Motivation for the theoretical framework

The motivation to use the PCHC framework and Abbott's system of professions was to understand the radiographers' provision of quality care and services in terms of referral assessment and appropriate imaging while operating within a subordinate or delegated professional role in relation to radiologists and referring clinicians. Rules and policies govern professional life [194]. In radiology, adherence to radiation protection principles and ethical standards form the basis of professional work, standards of quality care and

services provided [11]. The argument for using the PCHC framework is that for the healthcare professionals in the referral process to provide patient safety and quality care and services, imaging should be justified and appropriately conducted. Moreover, this complies with radiation protection principles and reflects the goals of PCHC on delivery of safe, effective, timely, and efficient health services [176]. Person-centred care further ensures that the patient or person receives the best healthcare services [178]. The WHO [173] recognises that to achieve and maintain quality health systems, the competencies of healthcare professionals are vital. Furthermore, new organisational and professional processes need to be created to improve people's care experiences and outcomes [195]. In order to improve delivery of health services, radiology departments are adapting person-centred approaches [196-198], although the studies referred to did not specifically focus on the referral process. The WHO [180] further recommends that health workers should be organised around teams and supported by processes that create an enabling environment.

To understand the current position of radiographers in the referral process, Abbott's theory of professions is applied. Radiologists and radiographers' adjacent or overlapping roles create points of collaboration and knowledge sharing, which is beneficial for the development of the radiography profession as well as provision of quality care. As stated by Abbott [183], legally established jurisdictions are enduring and difficult to change. The intention in this thesis is not to attempt to argue against the subordinate role and its disadvantages, but rather understand and highlight the benefits of the radiographers' role in referral assessment for appropriate imaging despite working in a subordinate role. An important aspect of professional growth is possession of academic knowledge [199]. The increase in theoretical and practical knowledge of radiographers influences the division of labour between radiologists and radiographers within radiology departments [200]. New knowledge obtained by a profession could threatens the power and status of the dominant profession as it could be strategically used to advance a claim for full jurisdiction [201]. Conversely, it could represent an area of cooperation between professions where knowledge is gained and shared [202]. Currently, a legal subordination professional jurisdiction is established between radiologists (and medical

physicians) and radiographers. However, points of jurisdiction blur occur as radiographers take on the tasks of radiologists within referral assessment and justification of imaging. This creates interprofessional collaborations that facilitate the informal sharing of professional knowledge. This interprofessional collaboration creates an environment in which the radiography professionals effectively perform their work in referral assessment.

4 Research design, materials and methods

A multiple-method design was used for this research. Multiple-method research attempts to combine two or more methods to address a particular research problem [203]. When using multiple methods, researchers can draw on data from more than one source and employ more than one type of analysis [204]. Multiple method is different from mixed method in that it is not restricted to combining qualitative and quantitative methods [205]. The research design in this thesis comprised of an ethical review of empirical studies (*Paper I*) analysed using the biomedical ethical framework as defined by Beauchamp and Childress [138], and two descriptive cross-sectional surveys conducted sequentially. An overview of the research design is shown in Table 1.

Table 1: Overview of research design, sample group and analysis

	Paper I	**Paper II**	**Paper III**	**Paper IV**
Study design	Ethical review	Cross-sectional	Cross-sectional	Cross-sectional
Sample	Radiology/Radiography journals	91 radiographers	279 radiographers	279 radiographers
Analysis	Narrative summary on review of empirical studies	Quantitative Descriptive Linear regression analysis	Quantitative Descriptive Pearson chi square test	Quantitative Descriptive Pearson chi square test

The target population in the cross-sectional studies consisted of qualified diagnostic radiographers working or with experience in various areas of medical imaging, and actively involved in the profession through participation at the European Congress of Radiology (ECR 2019) *(Paper II)* and following activities of the ISRRT *(Papers III and IV*). This chosen target group constituted a population of radiographers who are familiar or well oriented in practice regulations in their respective countries. The assumption for sample selection was that this group could provide the necessary information regarding radiographers' involvement in radiology referral assessment within their respective countries of practice.

4.1 Ethical review study

Beauchamp and Childress [138] define ethics as ways of understanding and examining moral aspects of life. In health care, ethics are generally applied to examining moral problems that arise, and act as guidance in decision-making about acceptable medical or clinical practice [206]. In the ethical review (*Paper I*), we illuminate and discuss the challenges and consequences presented when radiology referrals are of sub-standard quality. This includes challenges and consequences for patients, healthcare professionals and institutions providing the healthcare services. The ethical framework described by Beauchamp and Childress is typically used to discuss ethical issues in health care [141], and was chosen as the optimal framework. Using principlism as outlined by Beauchamp and Childress' framework, in the ethical review we were able to highlight the ethical dimension of the problem of suboptimal radiology referrals. The intended audience for the review (*Paper I*) are healthcare professionals other than radiologists and radiographers, in particular referring clinicians who may be unaware of issues related to suboptimal radiology referrals.

4.1.1 Materials and methods *Paper I*

In the ethical review, scientific literature was identified, and a narrative approach used to discuss issues relating to the consequences of suboptimal referrals with respect to ethical challenges as defined by Beauchamp and Childress' four bioethical principles. Narrative reviews can take many forms [207] and can involve selective inclusion of literature [208]. Narrative reviews therefore tend to be significantly affected by the reviewer's subjectivity [209]. Evidence suggests that systematic reviews improve the reliability and accuracy of research findings compared to narrative reviews [208, 210]. Greenhalgh et al. [207] state that the key contribution of narrative reviews is to provide a deeper understanding of a topic. A systematic review was not selected in this study because it was determined to have limited scope to cover relevant ethical issues related to the topic. The issue of high numbers of suboptimal referrals encountered in radiology departments [5, 53, 65-68] and the implications [57, 74, 75] are widely researched. The

intention of the ethical review was not to conduct a search for a complete sample, but rather to identify papers addressing the associated challenging consequences of suboptimal referrals. To our knowledge, few studies address the implications of suboptimal referrals for radiologists and radiographers' work and the provision of quality care as an ethical concern.

The point of departure was a review of literature pertaining to referral quality and its implications, largely sourced from radiology/radiography research journals. The principles outlined in Beauchamp and Childress' framework (*non- maleficence, beneficence, autonomy,* and *justice*) [138] guided selection of the relevant literature. The journals selected for discussion were mainly based on literature on the subject which has been used to develop a radiographers' master's degree course, justification and skills mix at the University of South-Eastern Norway (USN). This course includes topics related to the ethical foundation of appropriate imaging and the responsibilities of healthcare professionals. The ethical review (*Paper I*) was written by two authors, and to reduce bias, both authors were involved in selecting the relevant literature for inclusion in the analysis. Scientific literature was used and colleagues within the radiography department at USN were consulted about identification of what could be considered suboptimal referrals.

4.1.2 Data analysis *Paper I*

The data was analysed by review and discussion of literature on the issue of suboptimal referrals seriatim with respect to challenges to the four ethical principles (Figure 5). The concept of suboptimal referrals in the analysis was defined as a referral with missing, insufficient, inconsistent, misleading, hard to interpret or wrong clinical information. After selection of literature, several follow-up discussions were conducted with the radiography department's research group at USN on observed and possible practical clinical encounters in radiology departments in light of the four ethical principles. Following the research group meetings, the two authors further discussed each clinical encounter in order to decide whether it could be described as a direct or indirect

consequence in terms of the ethical principle, and categorised the encounters accordingly. For example, in the case of the principle of *non- maleficence*, a suboptimal referral can lead to conducting unjustified radiological examinations, thus further exposing patients to ionising radiation. This entails indirect harm or consequence whereas if a patient sustains injuries during a procedure due to a lack of adequate information on the referral, this entails direct harm or consequence. The discussions facilitated the categorisation of literature pertaining to ethical challenges in radiology departments using Beauchamp and Childress' ethical framework. A narrative summary was used to provide an overview and address the ethical challenges of suboptimal referral in radiology departments. The mechanism of what occurs on receipt of suboptimal referrals and possible consequences was analysed. A narrative summary involves discussions on a theoretical point of view with informal approaches [211]. Using a narrative summary, each category was discussed supported with the obtained relevant literature from radiology and radiography journals.

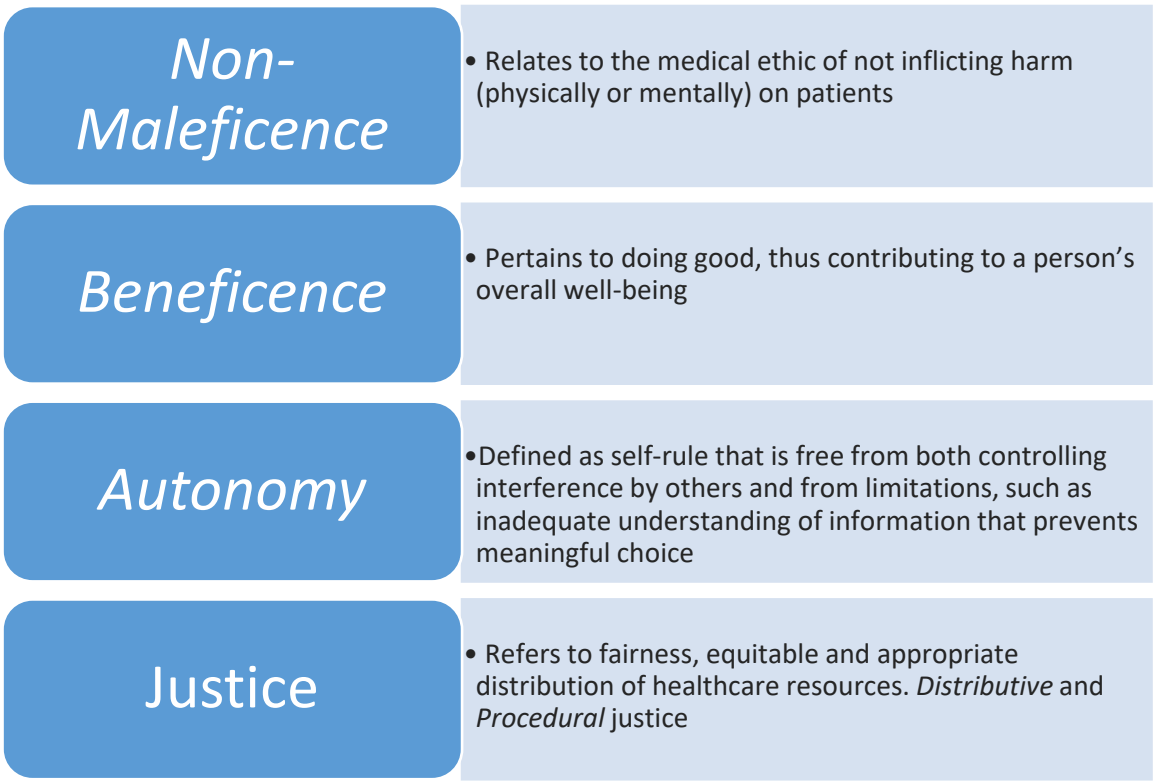

Figure 5 The principles of biomedical ethics [Beauchamp and Childress 138]

4.2 Cross sectional studies

Two descriptive cross-sectional studies, surveys one and two, were conducted sequentially. Descriptive cross-sectional studies are observational research studies conducted at one point in time with the aim of describing a population or a subgroup within the population with respect to an outcome or a set of risk factors [212]. Cross-sectional studies can be used to examine current attitudes, beliefs, opinions, or practices of a selected population [213]. Non-probability convenience sampling was used to select the sample group in both surveys. Convenience sampling methods entail that participants are selected due to their availability and willingness to participate in the study [213]. The drawback of convenience sampling as stated by Creswell, [213] is that the researcher cannot be confident as to whether the selected sample is representative of the population. Useful information for answering the research questions and hypotheses can however be obtained by using convenience sampling methods [213].

4.2.1 Survey 1 Materials and methods

The cross-sectional studies began with survey one which was conducted to explore and understand the capabilities of radiographers in assessment of radiology referrals in compliance with referral guidelines (*Paper II*). A questionnaire was designed to distribute five radiology referral scenario cases for conventional skeletal radiography (plain X-rays), CT and MRI procedures. Survey one and the referral cases were designed in collaboration between the radiography department at USN Drammen, Norway and the Radiography and Diagnostic Imaging Group at University College Dublin (UCD) in Ireland. The collaboration with UCD is related to the master's degree course in justification and skills mix in which master students are generally provided with cases similar to those designed in survey one. The objective of the master course is to assess and discuss the various cases, and receive feedback from expert radiographers as part of the dissemination of knowledge. This strengthens students' skills and enables them

to understand and perform tasks related to the assessment of referrals in clinical practice.

In total, 15 radiology referral cases were designed and distributed to the participants depending on their area or modality of specialisation. The referrals designed for assessment and distributed to the participants were of cases that are commonly seen in radiology departments. Each case was determined as realistic by an expert MRI radiographer employed as an academic lecturer, with extensive experience and knowledge in medical imaging. The case content was further supported by recognised international guidelines and literature. The questions in survey one included the participants' general demographics and background information on whether they routinely used referral guidelines (local or international) and assessed referrals as part of their clinical work. The participants were further expected to assess the appropriateness of each designed referral, highlight any concerns, and recommend suitable or alternative investigations if applicable. In designing the cases and questions, written text in the questionnaire was kept to a minimum. Furthermore, explanation of acronyms, medical words or terminologies used was provided to assist non-native English participants. The content of the final questionnaire was validated and approved during group meetings between the USN and UCD staff involved in the research. Face validity was used to validate the questionnaire before distribution. Validity refers to the extent to which a concept is accurately measured, and content validity considers whether a data collection instrument adequately covers all the intended content concerning variables in a quantitative study [214]. Face validity is a subset of content validity and involves subjectively assessing the content of a questionnaire to determine whether it measures the desired concept [214].

The data set for conventional skeletal radiography was not included in this thesis. The data on skeletal radiography is currently (to date) being analysed, and a scientific article on radiographers' compliance with guidelines for conventional X rays is planned for submission to a journal for publication. The reason for inclusion of only CT and MRI referrals in *Paper II* is because the two are advanced imaging modalities compared to

general X rays. CT imaging uses relatively higher ionising radiation doses and is widely accepted as a mainstream imaging modality for routine diagnosis [75, 215]. The IAEA Safety Standards [9] and EU BSS directive [23] state that justification tasks can be delegated to radiographers. However, a survey conducted in 19 EU member states by EuroSafe Imaging through the Heads of the European Radiation Protection Competent Authorities (HERCA) reported that in many instances, this did not apply to justification of CT imaging [24]. MRI is a non -ionising radiation modality, and radiographers' clinical practice usually requires some specialisation which can be done either as in-house training or through further education [216]. On this premise, it was vital to assess the radiographers' involvement in ensuring appropriate imaging for both MRI and CT examinations. The practicalities of shared ownership of the collected data between UCD and USN also played a part in the selection of only CT and MRI data in *Paper II*. The skeletal radiography referrals also had additional questions on radiographic techniques that are to be used in a study planned by UCD. The questionnaires for CT and MRI cases are attached as appendices (A1.1 and A1.2 respectively).

4.2.1.1 Recruitment of participants Survey 1

The recruitment of participants for survey one was conducted at the ECR 2019 in Vienna Austria. The ECR is one of the largest annual scientific congresses organised by the ESR, and attracts attendance from radiologists and other specialist physicians, radiographers, and medical physicists globally. An invitation (Appendix A1.3) and information about the opportunity to participate in a variety of radiography research conducted at ECR 2019 was advertised on the ECR and European Federation of Radiographer Societies (EFRS) websites before the start of the congress. The data collection site was 'a research hub' that was facilitated by EFRS. The EFRS research hub was considered an appropriate location for collecting the data since it targeted an international sample of radiographers. The EFRS research hub is a platform where radiographers and other medical professionals from various disciplines meet to share knowledge and are given the opportunity to conduct, participate and collaborate in research projects [217]. The

participants who visited the research hub received an information leaflet (Appendix A1.4) about the study and volunteered to participate. The questionnaire was distributed using a web-based data collection tool (Ziltron Ltd., Dublin, Ireland). Upon completing the survey, each participant was given an EFRS certificate of participation for continuous professional development (CPD) points. The data was collected over a period of five days (28 February to 2 March 2019).

4.2.2 Data analysis *Paper II*

On completion of the data collection, the raw data was transferred from the web-based tool to a USN secure data server. Sorting, coding, and quality checking of the data was then conducted, after which the data was analysed using Statistical Package for the Social Sciences (SPSS) software. The data was analysed using SPSS Version 25 (IBM, Armonk, NY, USA). Descriptive analysis showed the frequency in percentages of overall performance of the participants' assessment of the referral cases. Multivariable linear regression analysis was used to identify the factors that contributed to the radiographers' performance as regards consistency with guidelines. A preliminary analysis was conducted to make sure that there was no violation of assumptions of normality, linearity, and multicollinearity, and to analyse the relationship between the variables of interest. Sample size is an important factor in assumptions of multiple linear regression analysis. A multiple linear regression may therefore not be a recommended statistical technique to use with small sample size as this could obtain results that do not generalise with other samples [218]. To avoid sample violation in the multivariable linear regression analysis for *Paper II*, variables in the categories of graduate diploma and certificate and radiographer chief/leads, teachers, radiographer managers, other were grouped within each category as one variable. This was conducted to reduce the independent variables for analysis of sample size N = 91 using the recommended formula in linear regression analysis $N \geq 50 + 8$ (k) where k is the required number of independent variables [218, 219]. Possession of postgraduate qualification, grade/role of the radiographer and use of referral guidelines in each modality were analysed in

correlation with the overall performance score in assessing the referral cases in compliance with guidelines. The overall performance score was a calculated summation of an individual participant's scores in line with recommended guidelines. A two tailed *p value* ≤ 0.05 was considered significant.

4.2.3 Survey 2 Materials and methods

Survey two was conducted sequentially and explored the actions of radiographers when confronted with unjustified referrals and the value of referral information for the radiographers' clinical practice (*Paper III and IV*). In survey two a questionnaire (Appendix A2) was developed based on the data obtained from survey one and the review of literature on the topic. The designed questionnaire was evaluated and discussed at departmental research forums by the radiographers within the USN radiography research group and re-structured accordingly by the authors after the discussions. A pilot online survey was thereafter conducted in January 2020 through sending the questionnaire to radiographers working in six different countries (Norway, United Kingdom (UK), Canada, Uganda, Ireland, and South Africa) using an online web portal *Nettskjema* [220]. The pilot survey was sent twice, 10 days apart, to allow for test, re-test reliability. Test-retest reliability measures the consistency of results when the same test is repeated on the same sample at a different point in time [221]. The defined accepted interval between the two tests is depended on the type of test [222]. Marx et al. [222] suggest that intervals ranging from two days to two weeks are generally accepted time frames that would not influence the respondents' first set of responses. Streiner et al. [221] state that the appropriate interval could vary from an hour to a year depending on the task, however intervals of two days up to 14 days are usual. Intervals of up to one to two weeks have been used for questionnaire instruments [223, 224]. A 10-day interval was deemed reasonable and selected for this study. Initially, 20 radiographers from the different countries expressed interest in participating in the pilot. A total of 15 responded to the pilot questionnaire the first time it was sent. A total of eight participants completed the full pilot testing and were included for reliability

testing. The participants in the pilot were further asked to comment on their experience with the survey and suggest recommendations for improvement or changes, if any. A Cohen's weighted kappa (κ) analysis was used to determine agreement for categorical data between the repeated measures. McHugh [225] states that kappa values below 0.6 indicate inadequate agreement among the raters, thus reduced reliability. A kappa value of κ ≥0.6 was accepted in the values of a moderate agreement (0.60– 0.79) to almost perfect agreement (0.81– 1.00) as defined by McHugh [225]. All questions below 0.6 Kappa value were removed or adjusted according to the participants' comments for the final survey.

The final questionnaire in survey two consisted of two main parts in addition to the background information. In the first part the following two questions were asked. Six actions were listed, and a five-point Likert scale was used (Always, Often, Sometimes, Rarely, Never):

- Assuming you receive referrals with missing or unclear information, how often do you supplement the information by the following actions?
- Assuming you receive referrals with all relevant information included, but the requested examination is clearly not appropriate/justified. How often do you carry out the following actions?

The participants were also asked to rate their agreement (Scale: Strongly agree, Agree, Undecided, Disagree, Strongly disagree) with reasons that hindered them from taking part in referral assessment. A set of 10 possible reasons were listed. At the end of each question, the participants were asked to specify in free text if there were any other methods they used to supplement missing information, the actions they took when encountering inappropriate/unjustified referrals, and the reasons for them not taking part in assessing referrals.

In the second part of the questionnaire, radiographers working in clinical practice and those not currently in clinical practice were asked the following questions. Twelve items were listed using a five-point Likert scale. The radiographers working in clinical practice were asked to rate how often they made use of the referral information for 12 listed

purposes, while radiographers not currently working in clinical practice (i.e. administrators, researchers, educators) were asked to rate their agreement on the usefulness of the same 12 purposes. The questions were as follows:

- Information in the referral can be useful for a number of reasons. How often do you use the referral information for the following purposes?
  Scale: Very frequently, Frequently, Occasionally, Rarely, Never. Answered by clinical radiographers.
- Information on a referral can be useful for many reasons. Please rate the extent to which you agree with the statements below.
  Scale: Strongly agree, Agree, Undecided, Disagree, Strongly disagree**.** Answered by radiographers not currently working in clinical practice.

All the participants were also asked to rate the level of their agreement (Scale: Strongly agree, Agree, Undecided, Disagree, Strongly disagree) on the possible benefits of involving radiographers in assessing referrals. A set of eight possible responses were listed. At the end of each of the questions, the participants were also asked to specify in free text, if relevant, the usefulness of referral information and possible benefits of involving radiographers in assessing referrals.

The background section included demographics and the professional characteristics of the participants. The participants were asked to state their main area (modality) of diagnostic radiography experience with options including conventional radiography, advanced imaging (CT, MRI, Ultrasound, Mammography or Nuclear medicine), or multiple areas. Moreover, the participants were asked to indicate the final referral assessor before a patient's radiology examination was scheduled to be performed for each imaging modality in their workplace. The participants also stated whether referrals were critically reviewed and were available in electronic format, and whether they were delegated responsibility for screening imaging referrals. Furthermore, they were asked if referral guidelines were available in their clinical practice. At the end of the survey the participants were asked to comment on any additional information regarding radiographers' assessment of imaging referrals in free text. To allow for easier

comprehension for non-native English-speaking participants, simple English language written text was used throughout the questionnaire. Face validity was conducted by the three authors in *Papers III* and *IV* to validate the content in the final questionnaire before distributing survey two.

4.2.3.1 Recruitment of participants Survey 2

In survey two, the participants were recruited using *Nettskjema*, an on-line portal [220] where information about the research was given and participants could consent to participate in the study. The target population were radiographers who followed activities organised by the ISRRT. The ISRRT was selected as it is the organisation that represents radiographers globally, encourages exchange of information and provides guidance on radiography practice standards to improve the delivery of medical imaging and radiation therapy [226]. The survey was distributed to radiographers through the ISRRT networks, which included registered participants for the ISRRT 2020 world congress, which was cancelled due to the Covid-19 pandemic, active radiographers on ISRRT's Facebook page and within ISRRT member states' national societies. Eight ISRRT national societies agreed to distribute the survey. The data was collected over a five-month period starting in April 2020 before the implementation of Covid-19 restrictions. The initial data collection started by sending the survey to participants registered for the ISRRT world conference in Dublin, Ireland 2020. However, because this conference was cancelled due to the Covid-19 pandemic and registration for the congress discontinued, other strategies had to be implemented to collect the data. The data collection was restarted and conducted between September and December 2020, using the ISRRT Facebook page and national society contacts and websites. A link to the survey was advertised and posted on the ISRRT Facebook page and sent to the various national societies where participants could give their consent and participate in the study. The membership numbers for each ISRRT national society that participated in distributing the survey were registered to get an idea of how many radiographers the survey invitation could possibly reach. However, the response rate for survey two was quite

low considering the population of radiographers worldwide. This is further discussed in the limitations and strengths of the study – section 6.3.

4.2.4 Data analysis *Papers III* and *IV*

On completion of the data collection, an automatic generated Excel sheet was obtained from the *Nettskjema* online portal. The data were exported to a USN secure data server, where it was sorted, coded and quality checks were conducted. The data was then transferred to SPSS statistical software (IBM, Armonk, NY, USA) for analysis. The data consisted of quantitative and qualitative data obtained from the free-text questions. In *Papers III* and *IV*, only the quantitative data was analysed as very few or no responses in several items were given in the first and second part of questions requiring free text. The collected data in these sections was therefore not sufficiently satisfactory to warrant analysis. However, 30% of the participants responded to the last section of survey two, giving additional comments on radiographers' assessment of imaging referrals in free text. This data is planned to be used for a qualitative analysis and submission for journal publication of data on radiographers' opinions regarding assessment of referrals in radiology departments.

4.2.4.1 Paper III

The data was analysed using SPSS statistical software (IBM, Armonk, NY, USA), version 26. Descriptive analysis was used to show frequency in percentages. In the analysis, the five-point Likert scales were re-coded into a three-point scale, by merging the two responses at each end of the scales in order to ease interpretation and presentation of distribution of responses. A Chi-square test of independence was used to determine associations between the radiographers' actions when confronted with clearly unjustified referrals and hindrances to assessing referrals and the independent variables: dichotomised *education level* (Bachelor degree/equivalent versus master's/PhD degree), *delegated responsibility to screen imaging referrals* (Not sure/No

versus Yes), and three-split *modality of practice* (Conventional radiography versus One advanced modality (CT, MRI, Ultrasound, Mammography or Nuclear) versus Multiple modalities). A *p value* ≤0.05 was considered statistically significant.

4.2.4.2 Paper IV

The data was analysed using SPSS statistical software (IBM, Armonk, NY, USA), version 26. In order to compare variations in responses between the two groups, the data was split into two cohorts: radiographers working in clinical practice and others not currently working in clinical practice (non-current clinical radiographers). Descriptive analysis was used to show frequency in percentages of the radiographers' usefulness of referral information and benefits of assessing referrals. A chi-square test of independence was used to determine association between the clinical radiographers' perceived use of referral information and the independent variables: *dichotomised education level* (Bachelor's degree/ equivalent versus master's/PhD degree), and three-split *modality of practice* (Conventional radiography versus One advanced modality which included CT, MRI, Ultrasound, Mammography or Nuclear medicine, versus Multiple modalities).
A *p value* ≤0.05 was considered statistically significant.

4.3 Ethical considerations

Informed consent was obtained from all participants in the surveys. In survey one at the EFRS research Hub at ECR 2019, the participants consented by first registering to participate in ongoing research studies. Registration to obtain a CPD certificate was carried out on a separate computer platform and researchers collecting the data did not have access to this platform to ensure the anonymity of participants. After registration, the participants would select the studies in which they were interested to participate. For those who selected our study in survey one, an information sheet (A1.4) was given to each participant to read before proceeding to participate. The participants were informed that they could withdraw from the study at any point and were provided with

the contact information of the researchers involved with the study. In survey two, the research information and consent were given and obtained electronically on the online portal. The participants were given information about the study by means of an electronic consent form. They were informed about why they had been selected to participate, the researchers' contact details and whom to contact for further information. The participants were further informed that participation was voluntary, and they could withdraw their consent at any time. All the research processes and collected data from the surveys complied with Norwegian legislation under the guidance of the Norwegian Centre for Research Data (NSD). The data was stored in the USN data storage server with access restricted to persons directly involved with the research. The collected information was treated as confidential and stored in accordance with the privacy policy set out in the European General Data Protection Regulation (GDRP). Ethical approval was not required for the ethical review analysis as the data was collected from published scientific journals. Ethical approval was obtained for survey one from the UCD institutional Human Research Ethics Committee (HREC) in Ireland and from NSD, reference number 776616 (Appendix A3) in Norway. Ethical approval for survey two was obtained from the NSD, reference number 472337 (Appendix A4) in Norway.

5 Research results

The findings are reported and summarised. The details of the findings are documented in the published *Papers I – IV* attached.

5.1 Paper I

Using a review of published empirical studies, this examines how the impact of suboptimal referrals challenges adherence to the ethical principles of non-maleficence, beneficence, autonomy, and justice and the work of radiology professionals in delivering quality radiology services.

Non-maleficence challenges

Suboptimal referral can cause harm to patients due to unjustified ionising radiation, medical interventions during unwarranted procedures, false findings in imaging and failure in communication. Radiology professionals are hindered from properly justifying imaging, thereby exposing patients to risk of harm from radiation exposure. Risk of harm from the procedure itself, particularly from the side effects of contrast media, is a concern. Unnecessary imaging also has the potential for increased risk of false positive results, which instigates a chain of further investigations and treatments causing both physical and psychological harm to patients. Referrals lacking vital information about the patient's condition, such as mobility performance, increase the risk of physical injuries to patients where disabilities are not stated.

Beneficence challenges

Suboptimal referrals hinder benefits from the correct choice of imaging modality and protocol, an optimally performed examination, and an accurate radiology report, thus negatively affecting patients' healthcare management. Selecting the wrong examination (modality) may alter the balance of benefits and risks. Suboptimal clinical information also contributes to the reporting of incidental findings. The prevalence of incidental

findings further adds to the provision of non-valuable patient radiology reports, as the findings are unrelated to any clinical information. The radiology professionals' decisions on justification and optimisation are influenced by the available clinical information. Suboptimal referrals deprive radiology professionals of the ability to provide high quality professional work, thus affecting patient care and services.

Autonomy challenges

Suboptimal referrals negatively affect both patient and professional autonomy. Vital dialogue on benefit-risk communication to patients can be hindered. Consequently, patients' informed consent and right of choice of medical care are disregarded. The autonomy of the radiology professionals is also compromised due to suboptimal referrals. Constantly encountering suboptimal referrals deprives radiology professionals of the opportunity to practise according to ethical and professional standards.

Justice challenges

Suboptimal referrals challenge justice based on the lack of reasonable patient prioritisation *(violating procedural justice)* and the unfairness caused by unnecessary examinations *(violating distributive justice)*. Suboptimal referrals have the potential to create errors in prioritising patients' care as radiology professionals are hindered from accurately assessing the urgency of procedures. Justice in the distribution of resources in radiology can be compromised due to suboptimal referral as higher benefits could be attained by efficient allocation of health resources.

Paper I showed that suboptimal referrals reduce the quality of services provided to patients and present ethical and professional challenges for radiology professionals. We suggest improving the quality and assessment of referrals through the effective use of radiographers, for example by promoting shared tasks. Furthermore, promoting inter-professional communication among all the healthcare professionals involved in the referral process is vital for patients' safe and coordinated care.

5.2 Paper II

Paper two uses descriptive frequencies and multilinear regression analysis of a cross-sectional study (survey one), to show the radiographer's capabilities in compliance with guidelines, and the supporting factors in assessing referrals for advanced imaging.

Our study showed the radiographers' compliance with referral guidelines in assessing referrals for CT and MRI. In both imaging modality groups, 55 and 65% of the participants assessing for CT and MRI respectively had postgraduate education. In this study, 58% of the radiographers in CT and 57% in MRI modalities were able to identify anomalies and appropriately assess the designed referrals in compliance with recommended practice. This shows awareness of international radiology referral guidelines which are recommended for use when assessing referrals, and further ensures appropriate imaging. In 80% (4/5) of the designed cases for both CT and MRI, the radiographers in this study were able to identify and recommend the appropriate imaging modality. The results in this study further showed a tendency for the participants to seek clarity on the information given in the designed cases when required, showing the need for quality clinical information when assessing referrals. The supporting factors for better performance in assessing referrals were shown using a linear regression analysis. This indicated that possession of a master's degree was a statistically significant influencing factor for radiographers' higher performance in CT imaging, *p* value =0.02. Radiographers possessing a lead professional role and/or educator role performed better in MRI, with a statistically significant influencing factor for higher performance at *p* value =0.01.

Paper II showed that an average 58% of the radiographers adequately assess the referrals in compliance with recommended guidelines. The study concluded that postgraduate education and possessing a lead professional radiography position contributed to radiographers' improved performance in assessment of referrals for advanced imaging. The study indicates the need for clinical experience and higher education for radiographers who are delegated the task of justifying referrals for advanced medical imaging.

5.3 Paper III

This paper reports the actions radiographers take when confronted with inappropriate referrals and the facilitating factors in assessing referrals using descriptive frequencies and chi square test analysis of a cross-sectional study (survey two).

The majority (75%) of the participants working in clinical practice (N = 233) reported involvement in the task of screening referrals in clinical practice. The participants in this study reported that they performed referral screening tasks mostly together with the radiologists (See table 2 of published attached *Paper III*). In conventional radiography, 55% of the participants reported 'radiographer' as the final referral assessor in their respective clinical practice. 'Radiologist' was reported as the final assessor for conventional radiography referrals by only 5% of the participants, indicating that radiologists are rarely involved in conventional or general X ray referral assessment tasks. In advanced imaging, both 'radiographer and radiologist' were reported as the final referral assessors by 50%, 48% and 40% of the participants for CT, MRI, and ultrasound, respectively. A slightly higher percentage of participants reported 'radiographer only' as the final assessor for mammography (25%), ultrasound (20%), and CT (18%) compared to MRI (13%). This may be due to that ultrasound and mammography are areas of established advanced practice and specialised training for radiographers and CT a mainstream imaging in most radiology departments.

To ensure appropriate imaging in routine clinical practice, the radiographers in this study reported that they supplemented information and consulted colleagues about suspected unjustified referrals. The most reported 'often/always' actions of supplementing missing referral information were to ask the patient or relative (73%), examine the anatomical region of concern (70%) and check medical records (67%). The actions when confronted with unjustified referrals were reported equally as consulting the radiologist, referring clinician and radiographer (69–68% often/always responses). Most of the respondents (61%) reported that they never/rarely conduct an examination where the referral is clearly unjustified. Only 25% of the respondents reported that they

'often/always' conduct an unjustified referral. In this study, a few respondents reported that they 'often/always' return the referral along with a reason (36%) and change the referral to an appropriate examination (32%). A chi square test showed a higher level of responsibility for radiographers tasked with the role of assessing referrals. Radiographers with the delegated responsibility to screen imaging referrals reported that they returned an unjustified referral to the referring clinician, with giving a reason, more often than those without the delegated responsibility, chi square values: (39% vs. 28% often/always answers, $\chi 2=14,450$, df (2), $p = 0.001$).

The main reported hindrances to radiographers' referral assessment were factors related to communication and organisation, and professional role and ability. The communication factors highly ranked agree/strongly agree, were inadequate information in referral forms (83%) and ineffective communication among healthcare professionals (79%). Cultures of medical dominance were also rated quite high (68% agree/strongly agree responses) as hindrances to radiographers' referral assessment. However, this might reflect the radiographers' feeling of being in a subordinate position due to their lower medical and clinical knowledge in relation to performing the task. Nevertheless, this could not be substantiated by the collected data. Variation in educational and training may also influence the result on the issue of medical dominance relating to expected level of autonomy of radiographers in the various clinical practices. The organisational factors ranked high were lack of training in systematic assessment of referrals and lack of time allocation for assessing referrals with 'agreed/strongly agreed' responses totaling 70% and 61% respectively.

Paper III concluded that radiographers participate in referral assessment in several ways and across all imaging modalities, which is important for delivery of quality care in radiology departments. In clinical practice, radiographers consult radiologists, referring clinicians and fellow radiographers about suspected unjustified referrals. In *Paper III* we recommend that effective interprofessional communication, training, and time allocation to improve radiographers' skills to assess referrals would enhance appropriate imaging and delivery of quality patient care and services.

5.4 Paper IV

Findings for radiographers' need for quality referral information and the value of radiographers assessing referrals were reported using descriptive frequencies and chi square test analysis of a cross-sectional study (survey two).

This study showed that radiographers perceive referral information as useful for many purposes in clinical practice, all vital for patient safety and quality radiology services. In general, the responses of radiographers not working in clinical settings were mostly in agreement with radiographers currently working in clinical practice. The participants ranked all the listed purposes for use of referral information as 'high'. The clinical radiographers rated as 'very frequently' use score, the use of referral information to identify the patient (83%) and ensure imaging of the correct anatomical region (79%). These items further showed an even higher rating in combined analysed scores (very frequently/frequently use), showing the importance of using referral information for patient identification and imaging of the correct anatomical region for radiographers in clinical practice. The scores on the category 'using referral information for patient positioning' were reported for clinical radiographers ('very frequently' scores) as: for correct patient position 66% and selection of appropriate projections 63%. Using the referral information 'to ensure the patients' comfort during the procedure' and 'assessing if the patient can tolerate to undergo the procedure' were, however, ranked low by radiographers in both cohorts. These items were rated as 'use very frequently' by 36% and 35% respectively of clinical radiographers, and the 'strongly agreed' response was given by 26% and 30% respectively of radiographers not currently in clinical practice. In the category 'using the referral information for procedure decisions', the highest number of 'very frequently' used responses were reported by clinical radiographers for selecting the appropriate exposure parameters (50%) and selecting the appropriate imaging modality (48%).

A chi-square test showed no significant associations between the variables on the purposes of radiographers' frequent use of referral information and dependent variable

education level, indicating that radiographers at all levels of clinical practice need the referral information.

In analysing the benefits of radiographers assessing referrals, the items ranked high with 'strongly agree' scores, were 'promotes radiographers' professional responsibility' (72%), 'improves the radiographer-patient communication' (56%)', and 'sharing of tasks among radiology staff' (53%). 'Enables efficient use of radiology services' and 'reduces incidences and errors' were also ranked high with combined scores 'agreed/strongly agreed' 97% and 87% respectively. These factors are related to both benefits for professionals working within the referral process and delivering quality care and services.

Paper IV concluded that radiographers in various imaging modalities frequently use referral information for several activities across the imaging care continuum to manage patients in radiology departments. The referral information is needed for justifying and optimising radiological procedures thus facilitating appropriate imaging. This ensures not only patient safety and high-quality care and services but also enhances the sustainability of radiology services.

6 Discussion

This research aimed to increase understanding of the referral process for medical imaging, particularly the radiographers' role in assessing referrals for appropriate imaging. How radiographers assess referrals to ensure appropriate imaging and contribute to quality care and services in radiology are discussed with reference to the WHO PCHC framework. The radiographers' interactions with radiologists and referring clinicians in performing work to facilitate appropriate imaging are viewed from the perspective of Abbott's system of professions. The role of radiographers is discussed with emphasis on the value of assessing referrals and underpinned by the research findings and theoretical perspectives. The discussion ends by highlighting the strengths and limitations of the research.

Inappropriate imaging is reported globally [53-56] and is a major concern for patient safety, quality care and services in radiology departments [1, 73, 112]. The challenge for radiology departments is the huge number of referrals with suboptimal clinical information that hinder effectively assessing for appropriate imaging [53-56]. Several reasons are reported for this, ranging from patient to organisational factors that can prevent the gathering of clinical information and compel clinicians to refer patients to radiology departments with insufficient information [30-32]. In spite of the availability of patients' clinical information, referring clinicians still face challenges when selecting suitable imaging procedures [30]. The availability of referral guidelines and technological integrated CDS can assist [116]. However, implementation of referral guidelines and CDS is proving to be challenging [47, 71, 123]. To ensure appropriate imaging, gatekeeping processes should be enhanced in radiology departments. Radiology professionals acting as consultants for the referring clinicians could ease the process for referring clinicians, and benefit patients [21, 24]. In particular, radiographers routinely taking up more responsibility for thoroughly quality-checking referrals, would be beneficial to enhance gatekeeping processes [22, 33]. The two main questions addressed in this research are: how do the efforts of the healthcare professionals in the referral process, particularly

radiographers, to ensure appropriate imaging support PCHC practices and how can the radiographers' role be understood within Abbott's theory of professions?

6.1 How do the efforts of professionals in the referral process support PCHC?

The discussion will focus mainly on the radiographers' efforts of supporting PCHC, although in some areas efforts of the radiologists and referring clinicians are mentioned. The radiographers' involvement in assessing radiology referrals to ensure appropriate imaging accords with several of the principles of PCHC as identified by the WHO [173]. The PCHC principles discussed in the question of how healthcare professionals' efforts to ensure appropriate imaging contribute to PCHC practices, include the provision of *effective*, *evidence-based and empathic care* and *empowerment* of patients in their care. The discussion further demonstrates the importance of radiographers acquiring competencies and adapting practices that ensure *efficient* health services that are coordinated and timely through promoting teamwork among all healthcare professionals. The healthcare domains in which the highlighted PCHC principles apply are discussed accordingly with respect to clinical settings. The aspects discussed align with the WHO PCHC frame [173, 175] and focus on: the individuals, families, and communities' domain, to include patients receiving the healthcare services in decisions about their own health and the health professionals enabling the process; the health practitioners' domain, to enable a skilled and competent healthcare workforce; the healthcare organisations' domain to provide quality, safe, and coordinated care as well as continuity of care and services for patients; and the health systems domain to regulate and establish standards of care and services.

6.1.1 Effective healthcare

'Effectiveness' looks at the concept of whether an intervention works, and assesses whether it does more good than harm when provided under the normal circumstances of healthcare practice [227]. The WHO [173] PCHC framework defines effective healthcare as care that is accessible, safe, quality, affordable, and satisfactory thus ensuring that healthcare interventions lead to better health outcomes. The WHO [173] states that people want to receive effective treatments, administered by competent health professionals. Therefore, in clinical settings, effective care could pertain to both the individuals, families, and communities and health practitioners' domains.

The high numbers of suboptimal referrals encountered in radiology departments pose a threat to patient safety as indicated in our results (*Paper I*) as they increase the likelihood of radiology professionals to conduct unnecessary radiological examinations. Our results are supported by Wallin et al. [73] who also report risks for patient safety due to insufficient information in radiology referrals. Quality clinical information assists radiologists and radiographers to choose the right protocol and carry out an optimal imaging examination (*Paper I*), thus supplying quality radiology services. Strategies to combat the high numbers of suboptimal referrals and facilitate appropriate imaging need to be implemented for patient safety and to provide quality services in radiology departments. One prominent strategy identified in our research is enriching clinical information. In our study (*Paper III*), radiographers reported supplementing missing referral information before conducting imaging procedures. The supplementary information gathered by radiographers is reported to improve justification of imaging as rich and valuable patients' clinical history is obtained [228]. Our study shows that this process occurs mainly in three ways: during patient-radiographer interactions, through radiographers physically assessing the patient and checking medical records where additional medical information is collected. Lundvall et al. [29] report that the radiographer-patient point of contact is valuable, allowing radiographers to obtain vital information through observations and discussions with patients. This is vital for patient safety as the patient and referral information are validated before the imaging procedure is performed [229]. Radiographers' use of the referral to validate the given

clinical information against the requirements of an imaging procedure is further shown in our study (*Paper IV*). In *Paper IV*, the radiographers reported using the referral information for verifications about the patient and procedure, including confirming patient identification, imaging parameters, modality, and use of contrast media. Delivering the correct radiological examination to the right patient is the starting point of patient safety [230], and accurate selecting and conducting of an imaging procedure optimally adheres to the principles of 'justification' and 'optimisation' [9]. Patient safety forms the basis for high-quality care [231] and follows processes designed to prevent adverse outcomes or injuries in health care [232]. In radiology departments, radiologists and radiographers have a fundamental duty to provide patient safety at all times [233], which is consistent with the non-maleficence principle of 'first do no harm' [138]. Morally, healthcare professions are obliged to avoid causing harm to patients and move a step further towards doing good in order to contribute to patients' welfare [138]. The principle of beneficence is based on this concept, providing benefits and balancing benefits and drawbacks to produce the best overall results [138].

6.1.2 Evidence-based and empathic care

The evidence-based and empathic care principle relates to the use of evidence and technology within a holistic and compassionate system of care that values people and their health experience [173]. Studies show the value of using radiology referral guidelines in assessing referrals for appropriate imaging [116-118]. Our study *(Paper II)* showed that radiographers' use of current referral guidelines and their ability to adequately assess referrals for advanced imaging was in compliance with guidelines. Our study further identified possession of higher radiography education and clinical experience as facilitating factors for better performance in assessing referrals. Provision of quality health care requires conforming to evidence-based guidelines and recommended clinical practice [173]. In the PCHC framework health practitioners' domain, the WHO [173] advocates for practitioners' adherence to evidence-based guidelines and protocols. In radiology departments, awareness and adherence to

referral guidelines is vital for improving appropriate imaging. Use of referral guidelines guarantees that an appropriate imaging procedure is selected for an individual patient [116]. However, radiology referral guidelines vary and will depend on the availability of imaging technology [47, 123]. The results in *Paper II* could therefore have been influenced by variations in the referral guidelines used and available imaging technology in the radiographers' clinical practice. Despite some disadvantages, using referral guidelines is considered the most effective method of selecting an appropriate imaging procedure [24, 126]. To enhance gatekeeping processes in radiology departments, consistent and effective use of referral guidelines is required. Nevertheless, studies indicate that there is a lack of awareness and use of referral guidelines among all healthcare professionals in the radiology referral process [43, 46-48]. The ESR EuroSafe imaging survey [48] report that radiographers are among the professionals who find referral guidelines most useful for justification of imaging. Mork-Knudsen at al [234] also report that radiographers express that guidelines support them in tasks of assessing referrals in routine clinical practice. Various reasons as to why guidelines are not used are reported [24, 31, 47, 71, 123]. Strategies to promote acceptance and use of guidelines among healthcare professions are however, needed. Integrating referral guidelines with CDS is an option as this provides instant feedback on whether a selected imaging procedure demonstrates high or low appropriateness, with suggested alternatives [47]. Jeong et al. [71] further suggest that integrating referral guidelines and CDS within clinical workflows and electronic health records can improve knowledge of use for referring clinicians, radiologists, and radiographers. The ESR EuroSafe imaging study [48], states that health professionals using referral guidelines can reassure patients that an appropriate plan is implemented in their health management, thus providing empathic care. Therefore, use of referral guidelines not only promotes evidence-based practice and quality services but also provides a sense of personal value for the patient in reassuring them that the best healthcare services are being provided. This is the essence of person-centred care – to provide healthcare that is compassionate and personalised to the needs of patients 170].

However, regarding compassionate and personalised care, the radiographers in our study (*Paper IV*) reported a fairly low ranking for using referral information for patients' comfort and assessing if patients can tolerate the imaging procedure. These were low ranked for both cohorts of radiographers, both those not currently in clinical practice and those currently working in clinical practice. Taking account of the characteristics and clinical circumstances of an individual patient is an important part of the justification process [8, 12]. Considering the patient's comfort and tolerance of a procedure further assists in optimisation of imaging as it reduces the risk of obtaining imaging of low diagnostic value. The WHO [7] emphasises the needs and values of patients as vital aspects when selecting an appropriate imaging procedure. Providing physical comfort during radiological procedures to prevent unnecessary pain and offering emotional support to alleviate fear and anxiety foster higher value and more compassionate care for patients [196].

6.1.3 Stakeholders' empowerment

The WHO [173] emphasises that patients as stakeholders in the domains of health care should be supported in decisions about their health, and health professionals assisted to acquire the knowledge and skills to provide good-quality and humane care. The following sections focus on how radiographers' work in assessing referrals assists patients in their healthcare, and how they can be supported to acquire the necessary work competencies and skills in their tasks.

6.1.3.1 Patient empowerment

The empowerment principle of PCHC relates to practices of including patients in decision-making about their health, and enabling healthcare professionals to facilitate this process [180]. Promoting empowerment of patients is experienced within the individuals, families, and communities' domain [173]. Communication of the value of

imaging to patients is vital in appropriate imaging and should include communicating the benefits and risks of imaging. Our study (*Paper IV*) shows the importance of quality referral information for radiographers. In our findings (*Paper IV*), radiographers further stated that their involvement in referral assessment improves radiographer–patient communication. Our findings in *Paper I* indicate that the quality of information radiographers received in the referral form influences the quality of communication and dialogue between patients and radiographers. Quality information is therefore vital as it enables patients obtain accurate and consistent information about the procedure from all healthcare professionals throughout the referral process, thus promoting continuity of healthcare processes. The IAEA [9] recommends that benefit-risk communication of imaging procedures be undertaken as a joint task among health professionals involved in the referral process. The EU BSS directive [23] highlights benefit-risk communication as a vital role for radiographers. Providing information about the benefits and risks of an imaging procedure enables patients to make an autonomous decision to undergo the procedure, [196] which respects their needs and values [138]. However, studies show that radiographers face challenges in discussing the benefits and risks of imaging procedures with patients, due to limited knowledge in this area. Consequently, they tend to choose to undertake the task in a supportive role to referring clinicians [147-149]. Taking consideration of the reported lack of knowledge of benefits of imaging procedure and radiation risks among referring clinicians [37-40], radiographers actively engaging in benefit and risks communication with patient is vital and should be supported.

6.1.3.2 Enabling radiographers with skills and competencies

In PCHC health systems, a competent workforce is vital to deliver quality care and services [173]. However, the workforce should be empowered and supported for quality healthcare services to be realised in the health practitioners' domain, which is the domain where care is delivered [173]. In routine clinical practice, radiographers have the responsibility to assess referrals before conducting a procedure [25]. To enhance the

justification process, it is vital that radiographers are trained to assess referrals in a systematic manner. This could include systematic gathering and documentation of supplementary information [235, 236]. In our findings (*Paper III*), most radiographers stated that they are delegated responsibility for screen imaging referrals in general X ray and advanced imaging procedures. To some extent, this indicates the radiologists' confidence and trust in radiographers to carry out the tasks in their respective clinical practice. This is one of the central goals of PCHC – building trust across healthcare disciplines and transforming working relationships [173] to enhance quality of services. Our study showed that radiographers are involved in and able to adequately assess referrals for advanced imaging (*Papers II* and *III*), further showing the radiographers' knowledge on radiation dose risks and appropriately suggested radiation protection measures. Our study (*Paper IV)* further shows that participation in tasks of referral assessment promotes a sense of professional responsibility among radiographers. Professional responsibility in healthcare relates to how individuals perform their work based on ethical values and expected professional standards, which is linked to ethical care and quality services [237]. However, our study (*Paper III*) shows a lack of training and allocation of time as hindrances to radiographers' participating in tasks of assessing referrals. Our results further indicate that knowledge, particularly in the justification of advanced medical imaging, is limited to a specifically trained and experienced group of radiographers *(Paper II)*. Another important factor in our findings in *Paper II* is that despite this target group consisting of radiographers who are considered competent and experienced in the profession, on average only 58% were able to assess the referrals for advanced imaging effectively. Our findings indicate that radiographers' competencies and skills need to be enhanced. Medical dominance cultures were reported as one of the main hindrances to radiographers' assessing referrals (*Paper III*). Although medical dominance is reported as a challenge for radiographers' clinical practice [162-164], this was difficult to identify in our study. In situations where a clinical task is delegated, it is expected that adequate training is provided to allow for some level of autonomy in performing the task. Country and regional variations in radiographers' level of training, curriculum content and clinical practice are reported [34, 137], and may have influenced

the results in our study. Variation in radiography curricula implies that the level of competencies, knowledge, responsibility and autonomy in clinic practice among radiographers with similar qualification levels will vary. Identifying the education content and clinical training of radiographers with higher competencies in assessing referrals would be a starting point in mapping out the needed skills. Our analysis did not determine variations related to the radiographers' country or regions of practice though it did indicate that there was a variation of radiographers' knowledge regarding referral assessment. To provide quality services, PCHC practices advocate that professional standards of competence and accountability should be established to enable changes within the health systems domain [173]. The WHO PCHC framework [173] indicates that in order to provide quality services, agreed standards of professional education and required levels of clinical practice and health systems operations should be in place. Healthcare professionals' adherence to standards of excellence and duties should also be encouraged [238]. The standards of health care systems influence radiographers' level of clinical practice as they are the institutions providing clinical training. Considering that healthcare systems and environments are continuously changing, PCHC practices advocate for introducing new ways of training and collaborative education [175] such that healthcare professionals are able to adapt to both current and future health systems [181].

6.1.4 Efficient healthcare services

Efficiency in PCHC relates to reducing waste, while maximising quality of services [173]. Haynes, [227] states that '*efficiency measures the effect of an intervention in relation to the resources it consumes*' [p. 652]. The WHO [181] states that greater efficiency and more responsive health services can be achieved through optimising a skill mix where health professionals work in multidisciplinary teams. The WHO PCHC framework efficiency principle implies that health care occurs in a coordinated and timely manner and waste is minimised [173]. The radiology referral process involves the patient moving across various levels of care and services, combined with diverse healthcare

professionals' interactions [10, 22]. Continuity and coordination of care occurs in the healthcare organisations' domain and is where care is facilitated [173]. As indicated by our study in *Paper I,* all healthcare professionals in the radiology referral process strive to achieve the common goal of ensuring availability of high-quality referral information in order to facilitate appropriate imaging. Our study (*Paper III)* shows that radiographers collaborate with all healthcare professionals when dealing with referrals that are doubtful in appropriateness. Our results indicate that radiographers in clinical practice often work in a collaborative team within the profession, and work together with radiologists and referring clinicians to ensure appropriate imaging. The radiographers in our study (*Paper IV*) further reported that their involvement in referral assessment improves collaboration with radiologists and referring clinicians. This indicates the importance of interprofessional communication in enabling radiographers to effectively assess referrals for appropriate imaging. Our results are supported by Squibb et al. [163] who report that strong interprofessional relationships enabled direct communication pathways which improve the quality of health care for patients. Interprofessional collaboration and communication improves the transfer and quality of patients' clinical information and is useful in informing all healthcare professionals about the patients' healthcare pathway and management [229, 239]. To provide PCHC within integrated processes, teamwork and collaboration across diverse healthcare settings is required [173]. The WHO [175] states that coordination and continuity of care enhances the healthcare experience of people receiving the health services and providers of services. Strudwick [239] further suggests that meaningful relationships are created which assist in forming professional cultures. Conversely, the high numbers of suboptimal referrals received in radiology departments could depict a lack of collaboration on the part of the referring clinicians. However, challenges encountered by referring clinicians that could hinder provision of quality referral information are reported [31, 32] and could explain their encountered dilemmas.

As observed in our study (*Paper III)*, radiographers are taking on gatekeeping responsibilities such as documenting reasons as to why a referral is returned if it is unjustified. This signifies that the radiographers transfer patient information between

the professionals in question and document the decisions taken. Burns et al. [240] suggest that such transitions facilitate the communication of patient information and transfer of decision-making responsibility, thus maintaining continuity of care across health care teams. However, the radiographers in our study (*Paper III*) reported ineffective communication among healthcare professionals as a major hindrance to assessing referrals, implying that professional communication in the referral process presents challenges for radiographers. Makanjee et al. [159] report that radiographers' gatekeeping efforts in referral assessment can be prevented due to coercion from referring clinicians to perform unjustified examinations. Fatahi et al. [241] report situations where radiology professionals have been pressurised to alter prioritisation of patients' imaging procedure through referring clinicians exaggerating symptoms on referral forms so that the referral gains a higher priority. Such encounters negatively affect teamwork among healthcare professionals and the overall goal of appropriate imaging. The WHO [176] emphasises that to deliver high-quality PCHC, good communication, teamwork, and transparency are required. Continuity and coordination of care improves health outcomes for patients [175]. Where there are challenges in interprofessional communication and collaboration, processes should be re-evaluated and hinderances addressed in radiology departments.

High quality referral information assists radiology professionals to accurately prioritise and schedule urgent imaging procedures correctly and in a timely manner, as stated in our study (*Paper I*). Prioritisation of procedures improves patients' timely and equal access to healthcare services, and thus provides an efficient flow of patients' imaging pathways [242]. In our findings (*Paper IV*), the radiographers stated that their involvement in assessing referrals facilitates efficient use of radiology services. Our results are in line with Sheth et al. [235] who find that when radiographers assess referrals, this not only ensures patients' safety and better health experience, but also provides efficient workflow and services in radiology departments. One factor of concern is over-utilisation of imaging procedure. Over-utilisation is reported to affect healthcare costs, the operations of the healthcare system, information infrastructure and patient safety [243], and creates resource allocation disparities in radiology

departments [111]. Overuse of imaging further increases the workload of the radiology professionals [111, 114, 115]. In our study (*Paper III*), only a few radiographers reported performing a referral that they perceived as unjustified. Our results indicate that most radiographers take measures to prevent unnecessary imaging. This is crucial for guaranteeing that only imaging that will add value is conducted. Reducing low value imaging contributes to reduced waste and costs, and adds to the sustainability of radiology departments [14, 15].

In summarising the findings on the question of whether professionals in the referral process support PCHC, our research shows that radiographers' tasks of assessing referrals for appropriate imaging support PCHC practices that facilitate care and services that are safe, of high quality and coordinated for continuity of care. Better performance could be achieved through increasing radiographers' participation in joint gatekeeping and shared tasks with the radiologists where applicable. Training and education are vital for radiographers to obtain and sustain competencies that enable them to effectively perform the task of assessing referrals for appropriate imaging within the radiology referral process.

6.2 How can Abbott's theory explains professional roles?

In analysing the question of how the professions' interactions could be understood within Abbott's systems of professions theory, the discussion follows concepts related to the radiographer's role in supporting appropriate imaging within a subordination jurisdiction and reshaping the system. In the medical professionals' orthodox division of labour, radiography could be categorised within subordinate healthcare professions who perform work under delegation from medical doctors [189]. Justification of medical imaging is considered the responsibility of the radiologists in many countries, with radiographers mainly taking on the role as a delegated task [9]. Radiography education has advanced, allowing radiographers to adopt specialised clinical practices and roles within radiology departments [191, 193]. Advanced clinical practices are broadening the role of radiographers in many areas including in the justification of imaging [191, 193,

244, 245]. As the clinical responsibility of radiographers widens, more accountability is expected [246], with skilled radiographers taking on more responsibilities [193, 234]. Depending on the quality of skills gained and the applicable legislation, some countries will require and expect higher professional responsibility in performing certain medical imaging tasks.

6.2.1 The radiography profession supports appropriate imaging

Radiographers are the professionals who usually conduct imaging procedures, therefore involvement in assessing and gatekeeping of referral to ensure appropriate imaging is fundamental to radiographers' clinical practice [22, 25]. Our findings indicate that radiographers have some autonomous control in work regarding the justification of imaging. In *Paper III*, a significant percentage of respondents reported the radiographer as the final assessor of referrals in different imaging modalities. In general X rays imaging, more than half (55%) of the respondents reported that radiographers independently perform the task of final referral assessor. The task of radiographers in justifying imaging in certain general X ray procedures is already recognised and documented by IAEA Safety Standards [9], as stated in paragraph 3.145:

'For some radiological procedures, primarily 'well established' procedures and low dose procedures, the practical implementation of justification in many states is carried out by the medical radiation technologist, who is effectively representing the radiological medical practitioner with the formal understanding that, if there is uncertainty, the radiological medical practitioner is contacted' [p.91]

Our findings (*Paper III*) further showed that the final assessment for advanced imaging is mostly conducted jointly by radiographers and radiologists. The respondents in our study reported higher scores for 'radiographer and radiologist' jointly as final assessors in MRI and CT imaging, compared to ultrasound, mammography, and nuclear medicine Our findings are supported by Foley et al. [27] who analysed 30 European countries and reported that radiologists mainly make the final decision on justification of CT

examinations, although the decision-making is generally a shared effort that includes radiographers and referring clinicians in many countries. Our findings indicate patterns where professional roles are blurred between radiographers and radiologists in certain tasks of justification of imaging. Exactly how the referral assessment tasks are shared between the two professions in clinical practices was not determined in our study. Blurring of professional roles in radiology departments promotes a skill mix which is reported to benefit patients and reduce cost for healthcare systems [191], as the professionals' skills are used in a more effective way. A significant percentage of radiographers in our study (*Paper IV*) also reported that involvement in referral assessment promotes the sharing of tasks among radiology professionals. Interprofessional relationships are built as a result of sharing referral assessment tasks. Mork-Knudsen et al. [234] report that supporting environments with beneficial relationships are created when radiographers work together with radiologists in tasks related to assessment referrals. Liu [202] suggests that although boundaries between two professionals may be blurred and conflictual, relations are generally cooperative. Evans and Scarbrough [247] state that during processes and interactions of professional shared responsibilities, knowledge is transferred continuously and incrementally within daily routine practices. Larson [248] describes the transfer of professional knowledge as 'modern professionalisation', which is the basis for professionals gaining social recognition for a level of superiority. In this case, recognition is achieved through the radiographers' active participation in tasks of assessing referrals. The subordinate profession is also expected to gain more control of work within these blurred roles through participation and experience [249]. A drawback resulting from the blurring of professional roles is that lack of standardisation of work and non-description of roles can lead to loss of professional identity [191]. As stated by Abbott [182], jurisdiction boundaries in workplace settings may be vague as professionals share roles and responsibilities. Formal documentation and specific role description on the tasks radiographers perform in referral assessment would increase recognition and autonomous decision-making. Mork-Knudsen et al. [234] state that recognition by naming and documenting the radiographer referral-assessor role can enhance

understanding that the role requires an advanced set of skills and training. Recognition of skills can further improve effective use of the radiography profession [191, 250].

6.2.2 Professional roles reshaping the system

Abbott [183] suggests that as a profession claims jurisdiction of work in an area, new roles and settlement of work are created among the involved professions. For radiographers to effectively assess imaging referrals, adequate training is recommended and required [24]. Training is particularly recommended for radiographers assigned tasks as practitioners in justifying and authorising imaging [16, 26] as taking clinical responsibility for an individual medical exposure requires a higher level of medical knowledge [24]. Our study (*Paper III)* shows that some radiographers, though few, reported changing an unjustified referral to an appropriate examination. Furthermore, a higher percentage of radiographers with the delegated responsibility to screen imaging referrals reported documenting a reason when they returned an unjustified referral to the referring clinician compared to those without the delegated task. This might be because the radiographers with the delegated responsibility have greater involvement in tasks of referral assessment and have a higher accountability. Our data did not determine whether the reported changes made to imaging referrals were conducted in liaison or consultation with the radiologists, which would usually be the case in delegated tasks. Changing or returning unjustified radiology referrals are aspects of the vetting of referrals process and protocolling during scheduling of radiological examinations. These are reported as radiologists' duties as extensive medical knowledge may be required to perform the task [126]. However, with adequate training and clearly established vetting and protocolling guidelines, radiographers are reported to effectively undertake this role [251].

Adaptation of legislation regarding standards of practice [9, 26] plays a part in reshaping radiographers' roles. Several radiography national bodies state that assessment of referral information before conducting imaging is radiographers' routine clinical

practice, and should be adhered to [23, 25, 63, 128]. Countries that have adapted the IAEA safety standards, EU BSS directive or other recognised legislations [9, 16, 24, 26] will need to ensure that the stipulated standards are adhered to. The fact that training in certain countries has been adjusted to align with legislation or recommended practice could also explain the variation in competence to assess referrals for advanced imaging in our study (*Paper II)*, although other factors such as familiarity with international guidelines and expert or advanced educational practice may also have played a part. In any case, a higher level of radiography education and training will be required in fulfilling roles in referral assessment and performing expected tasks of justification, particularly for advanced imaging. If radiographers gain more knowledge and take on roles independently or jointly with the radiologists, this could also pave the way to increased and more formalised division of labour. This would further enable radiographers to gain more work in referral assessment and justification of imaging, thus contributing to the professions' development.

In summary, our findings on the question of how the radiographers' role could be understood within Abbott's theory of professions show that professional work interactions particularly between radiographers and radiologists results to a blurring of professional roles, and create a skill mix where valuable knowledge is exchanged and obtained regarding assessing referrals in radiology departments.

6.3 Limitations and strengths of the research

In this research the study design comprised multiple methods consisting of an ethical review and two cross-sectional studies conducted sequentially. The limitations and strengths of the research design and some methodological considerations are discussed in this section.

6.3.1 Study design

The ethical review was conducted to illuminate the challenges the radiologists and radiographers encounter from suboptimal referrals in radiology departments. A narrative review approach was used for analysis in the ethical review. A search in accordance with demands for systematic review search was not conducted. Instead, a purposive sampling of specific literature was used so as to illuminate how suboptimal referrals challenge the work of the radiology professionals and subsequent clinical impact. Snyder [252] states that non-systematic literature reviews often lack thoroughness, which can weaken the quality and trustworthiness of the research. Another limitation of the ethical review was that only empirical studies obtained in published radiography and radiology journals were analysed. A broader inclusion of studies from other healthcare sectors could have gathered knowledge on the subject from other professionals' perspectives. To focus or strengthen a perspective, narrative reviews may, however, be beneficial [207]. Beauchamp and Childress' ethical framework [138] guided selection of the literature to highlight the challenges encountered by radiologists and radiographers because there is rarely focus on their perspective. Furthermore, the impact on delivery of quality services was clearly illustrated using this method.

The cross-sectional studies were designed and conducted exploratively in order to acquire an impression of the competencies, roles, and attitudes of radiographers' participation in referral assessment tasks, broadly and across settings and countries. The design of the research questionnaires had some limitations. In survey one, the designed referral cases were limited to only five cases in each modality to allow sufficient time for participants to adequately assess the cases within a feasible time frame. However, this represents a small sample of clinical conditions routinely seen in practice and could have an impact on the study findings in *Paper II*. Furthermore, although the research showed that higher education is vital for radiographers assigned with tasks to justify and authorise medical imaging, the data failed to identify the specific education requirements. Inclusion of demographic data on more detailed radiography

specialisation other than modality of practice could have produced detailed results on this issue. Nor did the surveys and analysis consider variations in radiographers' education, organisational settings and national legislation pertaining to the individual participants. Moreover, the competencies and level of responsibility in referral assessment will differ among radiographers at similar education levels internationally and influence results. The radiographers' level of responsibilities is also influenced by national legislation and adaption of recommended policies. However, the professional standards of practice which all radiographers are expected to adhere to are outlined by international bodies as in the IAEA Safety Standards, EU BSS directive and ICRP recommendations.

6.3.2 Bias

Bias is defined as any systematic error that could result in an incorrect estimate of the true effect of a study result [253]. The ethical review is subject to reviewer selection bias. Reviewer selection bias occurs when the searched empirical data used for a study is not sufficient to encompass the entire evidence base [254]. This is a main problem with non-systematic reviews as conducted in this study's ethical review. The literature used in the ethical review was mostly selected on the basis of journal articles collected in connection with the two authors' involvement in a master's degree course for radiographers. This method may have increased the relevance of the articles included in the ethical review but added to bias due to focusing on the radiology perspective.

The cross-sectional studies are subject to sampling bias. Sampling bias is introduced when some individuals within a target population are more likely to be selected for inclusion than others, affecting the representativeness of the sample [253]. This is one of the drawbacks of non-probabilistic, convenience sampling methods as was used in this research. Furthermore, there was a population difference in the sample between the two surveys. In survey one, the participants' recruitment process was conducted at ECR, an annual conference that is quite costly and attended by only a few privileged

radiographers. In survey two, only participants who had access to and information from ISRRT organisation networks were able to view and respond to the survey. Therefore, caution is warranted in generalising the findings across all sectors of the population. The population for the sample in survey one was more clearly defined compared to survey two where there was little control and knowledge of the recruited participants.

The responses rate for both surveys, particularly survey two, were low. It was not possible to calculate exact response rates, thus estimated rates are presented. In survey one, a total of 144 radiographers participated in the survey. The survey included the data collected for conventional skeletal radiography, CT, and MRI. The estimated response rate was 8% (144/ 1767) calculated from the total number of radiographers who attended ECR 2019. However, a total of 437 participants visited the ECR 2019 research hub, giving a rate of 33% (144/ 437). Only data for CT and MRI (N=91) is reported in this research. Survey two was distributed to radiographers internationally, where a response rate range (0.1% to 6.8%) was calculated. This range was calculated by first categorising each participant within the country of practice, then obtaining response rates from lowest to highest based on the number of society members from each country as indicated by the respective radiography national societies. To comply with the European GDRP, survey two was not distributed directly to individual participants, but through the ISRRT networks in order to avoid collection of personal emails or other possible personal data. Recruitment of potential participants was therefore only conducted via announcements by the radiography national societies in their respective countries. The data collection in survey two also started at the time the global Covid-19 pandemic had reached Europe with anticipated spread to other countries. This may have further contributed to the lower responses. A longer time frame to collect the data could have possibly been beneficial. Language also contributed to low response rates as the surveys were only in English. However, simplifying the language and content for non-native English-speaking participants was considered when designing the questionnaires in both surveys.

Despite the highlighted limitations, the main strength of the research is that a wider perception of the roles and practices of radiographers in assessing radiology referrals was obtained. The sample in both surveys consisted mainly of radiographers actively involved in the profession as observed through attendance of international congresses (ECR 2019) and participation in ISRRT events. They could therefore be assumed to be knowledgeable and experienced in relation to current and expected clinical practices in their various departments and respective countries. The results obtained could be a useful platform for further research on how the radiography profession can contribute to justification of imaging processes more effectively. Applying the findings to the two theories, the PCHC framework and theory of professions further highlights areas of radiographers' clinical practice that enhance and promote quality care and services.

6.3.3 Validity and reliability

Face validity was used to validate the content in both questionnaires in the surveys. Face validity is a subjective judgment in measurement and may lead to higher inaccuracy in terms of validity, although it is commonly used because it is simple and quick to conduct [255]. In survey two, a test-retest analysis was used to assess the reliability of the questionnaire. However, there are variations in what is considered an accepted time between repeated measures when piloting a survey, and this generally depends on the type of study being conducted. We used recommendations by Streiner et al. [221] who suggest intervals of two to 14 days as a reasonable time frame. The test sample for reliability testing was also small only eight participants completed the full pilot testing. The obtained results from the pilot testing were however useful to modifying the final distributed questionnaire.

7 Conclusion

This research used an ethical review of empirical literature and two cross-sectional studies to understand the radiographers' role in assessing referrals in radiology departments. Taking account of the explorative approach and research limitations, three key areas were identified:

1) the importance of high-quality radiology referral information for both radiologists and radiographers
2) the significant role radiographers play within the multidisciplinary referral process
3) the supporting factors for radiographers to ensure appropriate imaging.

Suboptimal referrals are a concern for appropriate imaging and challenge radiology professionals' adherence to ethical principles of non- maleficence, beneficence, autonomy, and justice. This research showed that high quality referral information is vital for appropriate justification and optimisation processes and influences the quality of work provided by radiologists and radiographers in radiology departments. However, radiology departments still encounter high numbers of suboptimal referrals despite availability of referral guidelines. Strategies to address suboptimal referrals are suggested in this research and include continued gatekeeping within radiology departments, shared decision-making and inter-professional communication among the healthcare professionals involved.

This study further shows that radiographers' involvement in referral assessment plays a significant role in appropriate imaging. Radiographers improve the quality of referral information and the justification process through obtaining valuable information during routine patient-radiographer communication in clinical practice. This supports the effectiveness principle of PCHC practices to promote patient safety. Radiographers' awareness and use of referral guidelines further ensures evidence-based and empathic healthcare. Blurring of tasks and sharing of knowledge between radiologists and radiographers appear to be vital strategies to assist radiographers in gaining competencies in assessing referrals in order to combat issues of inappropriate imaging.

This further creates enabling environments of interprofessional relationships and collaboration among healthcare professionals in the referral process. Interprofessional collaboration and communication promotes teamwork, which is essential for timely, coordinated healthcare for patients and ensures continuity of care. The involvement of radiographers in referral assessment in radiology department therefore supports PCHC practices of delivering care that is compassionate, safe, efficient and effective, and sustains health services.

However adequate training is needed to support and empower the radiographers' role in referral assessment, particularly in advanced medical imaging. This will facilitate the organised distribution of labour within radiology departments. The specific training needed to enable radiographers to perform tasks that ensure appropriate imaging must be identified. The results in this thesis emphasise the importance of high-quality patient clinical information in radiology referrals, and promote awareness in healthcare professionals and the public of the value of appropriate medical imaging.

8 Future roles for radiographers in referral assessment

In the theory of professions, Abbott [183] suggests that jurisdiction settlements are ever changing as professions will continuously compete to gain control of work, creating temporary stability until further vacant areas of control become available. The development of the radiography profession has always been influenced by advances in imaging technology, which inevitably determines changes in clinical practice and legislation of work [256]. The data collected in this research did not analyse or determine future changes. Nevertheless, in light of anticipated technological developments in referral assessment and justification of imaging processes, it was important to highlight some expected changes to the roles of radiographers.

Abbott [183] states that a jurisdiction settlement entered into by a profession is 'temporal', and professions will continuously contest for control of a particular work, '*as every move in one profession's jurisdiction affects those of others*' [p.34].

This implies that changes in professional work are inevitable and continuous. New technology and changes in organisational structure are the two major factors that create new areas of work and changes in the system of professions, according to Abbott [184]. Based on the findings in this study, we attempt to describe the anticipated changes in the current roles.

Artificial Intelligence (AI) is one major technology advancement that is expected to alter the clinical workflow in radiology departments [257] and could have a significant effect on the work of all healthcare professionals in the radiology referral process in future. In our study (*Papers I* and *IV*), the use of and need for high quality referral information is shown for both the radiologists and radiographers' work to ensure appropriate imaging, patient safety and accurate diagnosis. The findings in *Paper IV* in particular show the radiographers using the referral information throughout the imaging continuum to justify and optimise imaging. Our study further shows that radiographers need referral information to limit errors and enable effective use of resources in radiology. Challenges faced by the referring clinicians in adhering to use of referral guidelines at the initial

stage of the justification process are reported [30, 31]. AI is expected, however, to ease the assessment or vetting of imaging referrals and the challenges of selecting appropriate imaging procedures. AI technology for automated assessing of referrals to provide guidance on the most appropriate imaging modality and techniques could soon be part of routine practice [257, 258]. An AI enhanced CDS tool could allow for rapid synthesis of all patient information for better risk-benefit assessment and communication [259]. AI-supported predictive modelling could assist with scheduling and prioritisation of procedures, thus increasing accuracy and facilitating better distribution of services [257]. Numerous AI applications are being developed that could potentially benefit the whole medical imaging chain from the ordering of imaging to diagnostic reporting [260]. The implications for radiographers' professional work are largely unknown, although higher quality and efficient workflows are expected [261]. Most reports lean towards the application of AI technology as a supplementary tool that will promote efficiency rather than being a replacement for healthcare professionals and services [257, 262, 263]. Quality checking of consistency of AI technology and its output is predicted to be a potential growth area for the role of radiographers [262, 264].

As with all healthcare systems, radiology departments are adapting person- and people-centred care practices to provide better and higher quality patient care and services [197]. In radiology departments, radiographers currently directly interact more with patients [22] compared to radiologists who mainly interact with other medical professionals regarding patients' management [196]. Developments in imaging informatics technology has the potential to allow for more interactions between radiologists and patients through digital platforms promoting the provision of person-centred care in radiology department [196, 265]. However, AI is unlikely to change the radiographers' role as 'imaging procedure operators' in interacting with patients [264], and imaging informatics could possibly provide even better integrated communication between patients, radiographers, and radiologists. Based on Abbott's theory on systems of professions, we could sum up by saying that currently radiographers play a significant role in ensuring appropriate imaging. However, future technology could create areas of more work or development for radiographers within referral assessment and

justification of imaging. Future technologies are expected to change the workflow within the referral process and the roles of the healthcare professionals. Preparedness to adapt to expected changes is required for all healthcare professionals within the radiology referral process.

The next chapter gives an outline of potential future research.

9 Further research

This study revealed need for future research in some areas which are outlined below:

1. There is a need to investigate how the sharing of tasks in justification of advanced imaging is conducted between radiologists and radiographers in radiology departments locally and nationally. This will identify areas where sharing of roles is most required.
2. The importance of understanding the opinions of radiographers regarding referral assessment in radiology departments and how radiographers view their role, in order to determine willingness and readiness for enhanced responsibilities.
3. Identifying how skilled radiographers perform or are trained to perform the task of justification of imaging is vital. This will provide information about the skills and education needed. This knowledge can further be used as a foundation for decisions on the introduction of advanced clinical practice within referral assessment and justification of imaging.
4. This study showed radiographers supplementing referral information and how vital the information is for routine clinical practice throughout the imaging continuum. However very few studies have investigated strategies for how radiographers can systematically obtain, assess, and supplement referral information such that useful clinical information is well organised for easy interpretation. Ways in which radiographers can systematically obtain useful information need to be developed as patients' clinical history improves the justification process.
5. There is a need to identify specific areas of where and how AI is expected to affect the radiology workflow and patient pathways in the referral and justification processes. This will identify areas of preparation for radiology departments and training required for both radiologists and radiographers.

6. Person-centred care is being introduced in many aspects of the healthcare sector. It is important to further investigate how person-/people-centred processes could be effectively adapted in radiology departments in view of the anticipated adoption of AI technology.

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11 Appendices

Papers *I* – *IV*

A1.1: Survey 1 Questionnaire CT referral cases

A1.2: Survey 1 Questionnaire MRI referral cases

A1.3: ECR research hub leaflet

A1.4: Participants' information sheet ECR 2019

A2: Survey 2 Questionnaire and participants consent letter

A3: NSD ethical approval survey 1

A4: NSD ethical approval survey 2

Paper I

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Ethical impact of suboptimal referrals on delivery of care in radiology department

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ABSTRACT

The referral is the key source of information that enables radiologists and radiographers to provide quality services. However, the frequency of suboptimal referrals is widely reported. This research reviews the literature to illuminate the challenges suboptimal referrals present to the delivery of care in radiology departments. The concept of suboptimal referral includes information, that is; missing, insufficient, inconsistent, misleading, hard to interpret or wrong. The research uses the four ethical principles of *non-maleficence, beneficence, Autonomy* and *Justice* as an analytic framework.

Suboptimal referrals can cause *harm* by hindering safe contrast-media administration, proper radiation protection by justification of procedures, and compassionate patient care. Suboptimal referrals also hinder promoting patient *benefits* from the correct choice of imaging modality and protocol, an optimal performed examination, and an accurate radiology report. Additionally, patient *autonomy* is compromised from the lack of information needed to facilitate benefit–risk communication. Finally, suboptimal referrals challenge *justice* based on lack of reasonable patient prioritising and the unfairness caused by unnecessary examinations. These findings illuminate how suboptimal referrals can inhibit good health and well-being for patients in relation to safety, missed opportunities, patient anxiety and dissatisfaction. The ethical challenges identified calls for solutions. Referral-decision support tools and artificial intelligence may improve referral quality, when implemented. Strategies addressing efforts of radiology professionals are inevitable, including gatekeeping, shared decision-making and inter-professional communication; thereby raising awareness of the importance of good referral quality and promoting commitment to ethical professional conduct.

INTRODUCTION

The radiology referral process involves clinicians referring a patient to radiology professionals (radiologists and radiographers) for medical imaging.[1 2] Transmission of information in the referral is core in this process. Pitman[3] emphasises that for appropriate medical imaging, a referral should be properly completed, legible and comprise adequate clinical information. Appropriate imaging adheres to radiation protection principles of justification where the benefits of imaging are balanced against the risks.[1] The benefits to individuals and society should outweigh the radiation risks, and other potential risks.[4 5] This is crucial for management of patients and reduces overuse of resources in radiology departments.[6 7] The importance of adherence and responsibilities of healthcare professionals to radiation safety in medical exposures is incorporation in national legislations following the European Council Basic Safety Standards Directive.[8] Initiatives like Image Wisely[9 10] are also available to raise awareness and educate healthcare professionals, patients and the public on appropriate imaging.

The issue of suboptimal referrals has long been a concern for quality and safety in radiology, reported across modalities and countries (table 1). In Australia, Rawle and Pighills[11] report of 75% of referrals for general X-ray examinations considered unjustified with 32% of the cases attributable to insufficient clinical detail. A similar trend is evident in several European countries. For example, in Poland, a review by Sobiecka *et al*[12] indicates insufficient clinical details in the referral as the most common reason for the unjustified computed tomography (CT) and magnetic resonance imaging (MRI). In the UK, Rawoo[13] reports high rates of inadequately completed referrals for CT abdominal scans. Oswal *et al*[14] report of vital missing information in referrals that could affect the quality of care and result in medico-legal consequences. Similar trends are reported from Portugal, by Martins *et al*[15] and in Canada by Logan *et al*.[16] This concern is also shown in South Africa and Nigeria where up to 98% of referrals for CT and X-ray examinations are reported as inadequately completed resulting in unnecessary imaging.[17 18]

The causes of suboptimal referrals are not fully established.[11] However, the task of ordering imaging investigations is challenging for clinicians and influenced by several factors. Martins *et al*[15] suggest that factors such as patient uncooperativeness, limited clinical history and delays in laboratory results hinder an expedient gathering of complete clinical information, compelling the clinicians to refer the patient without sufficient information. The tendency of replacing history-taking and clinical diagnosis by imaging tests are also reported.[19] The referring ' clinicians' lack of knowledge regarding radiation doses, non-use of referral guidelines and electronic decision support systems, patient demands and defensive medicine are also suggested as contributing factors.[7 15 19]

Decisions concerning the risk of harm of radiation exposure to patients can be challenging for radiology professionals,[4 20] as unnecessary radiation exposure to the patient is one consequence of suboptimal referrals. However, other potential challenges and factors that affect the quality of radiology services also need to be broadly addressed and scrutinised. This study aims to illuminate and reveal the impact of suboptimal referrals on the delivery of care in the radiology department within an ethical framework. The concept of *suboptimal*

Table 1 Studies of the scope and impact of suboptimal referrals

Authors	Area	Modality	Study size	Results
Akintomide *et al*[17]	Nigeria, Lagos: single teaching hospital	X-rays	580 referrals for X-rays	All with incomplete information. 28% non-use of standard radiology referral form. 7.37% illegible
Ihuhua and Pitcher[18]	South Africa: single public hospital	CT	100 electronic CT referrals	98% incomplete. 88% had a definitive diagnosis
Logan *et al*[16]	Canada, Newfoundland: single region	CT	3609 lumbar spine CT referrals	Only 6.5% appropriate. Most lacked sufficient information for adequate assessment
Martins *et al*[15]	Portugal: single centre	CT/ultrasound	1427 referrals CT/ultrasound	Assessed by clinical information, 23.8% inappropriate
Oswal *et al*[14]	UK: two hospitals	All imaging	400 referrals	Information incomplete in most referrals. Susceptible to medico-legal implications
Rawle and Pighills[11]	Australia, Queensland: single hospital	X-ray	186 X-ray referrals	75.3% of referrals unjustified. 31.7% lacked vital patient clinical details
Rawoo[13]	UK, Manchester: single hospital	CT	60 CT referrals	Inadequately filled referrals, CT abdomen highest rate
Sobiecka *et al*[12]	Poland, Warsaw: two centres	CT/MRI	1116 CT/MRI referrals	6.54% examinations unjustified. Main reason lacking clinical details
Vilar-Palop *et al*[47]	Spain: two public hospitals	All imaging (except MRI/ultrasound)	2022 referrals	1/3 of examinations inappropriate, 8.4% of referrals with insufficient clinical information to enable evaluation

referrals is to be understood broadly, including when information is missing, insufficient, inconsistent, misleading, hard to interpret or wrong.

METHODS

The point of departure is a review of the literature pertaining to referral quality and its implications, largely sourced from radiology/radiography research journals. The chosen ethical framework is principlism as outlined by Beauchamp and Childress.[21] The issue of suboptimal referrals will be discussed in seriatim with respect to challenges to: (a) *non-maleficence*, which relates to the medical ethics of not to inflict harm (physically or mentally) to patients; (b) *beneficence*, which pertains to doing good, thus contributing to a person's overall well-being; (c) *autonomy*, which is defined as self-rule, that is free from both controlling interference by others and from limitations, such as inadequate understanding of information that prevents meaningful choice and (d) *justice*, which refers to fairness, equitable and appropriate distribution of healthcare resources. The core ethical values of radiation protection are also based on these principles.[4 22] Prudence, for consideration of the uncertainty of radiation risks can for instance be regarded as a specification of non-maleficence,[22] and both dignity and honesty (including transparency and accountability) are closely linked to autonomy.[4] However, this study required a broader medical-ethics approach, as facilitated by the Beauchamp and Childress' framework.[21]

Suboptimal referrals from the perspective of the four principles of ethics

The following will explain why and in what way suboptimal information can challenge radiology professionals and the delivery of imaging services in accordance with each of the four ethical principles. This includes both the mechanism of what occurs on receipt of suboptimal referrals in radiology departments and the possible consequences.

Non-maleficence challenges

Radiological examinations do expose patients to certain risks, which calls for the obligation of avoiding the causation of harm, associated with the maxim *primum non nocere* (first, do no harm). The harms and risks of harm that can be inflicted on the patients may not be well known outside the radiology environment, but are mainly reported to originate from *contrast-media* and *the use of radiation* and occurrences of *incorrect findings*. Other causes of harm originate from *failure to communicate patients' conditions* and *time spent* in the radiology department on clarification of the suboptimal referrals.

Approximately half of all radiological procedures will involve the use of *contrast-media*[23] for the accurate visualisation of anatomy and pathology. However, contrast-media represents a direct risk of harm, a rare occurrence, but of vital concern, such as the risk of anaphylactic reactions, contrast-induced nephropathy and complications of thyrotoxicosis in patients with pre-existing thyroid disease.[24–26] The reported severe anaphylactic reactions are uncommon occurring in less than 1 in 100 000 patients and include hypovolemic shock, respiratory arrest, cardiac arrest and convulsions.[27] It is therefore vital that the referral contains detailed information of the patients' pre-existing conditions such as diabetes, asthma, thyroid disease and a history of allergies to determine the safety of administering contrast-media.[24] Particularly, information regarding kidney function tests is needed to avoid the risks of contrast-induced nephropathy. Although this is reported to be low and limited to patients with pre-existing conditions.[28] In high-risk patients, precautions can be undertaken, such as maintaining adequate hydration,[25] or advising the referring clinician to suspended potential nephrotoxic medications 48 hours pre-examination and post-examination, where feasible.[26] Similarly, the severe condition of nephrogenic systemic fibrosis caused by Gadolinium-based contrast agents in MRI procedures occurs almost exclusively in patients with chronic kidney disease,[24] further highlighting the importance of kidney function information. Many factors determine the benefits of using intravenous contrast-media, including the necessity of an accurate diagnosis or expected kidney function recovery.[26] Conversely suboptimal clinical details could also lead to unnecessarily withholding contrast-media for a procedure where the benefits of its use would have outweighed the risks.[26] Sufficient information in the referral is of value for accurate decision-making.

Some medical imaging *uses ionising radiation*. Indirect harm because of suboptimal referrals is that it leads to unwarranted or unjustified radiological examinations.[15 16] The consequence

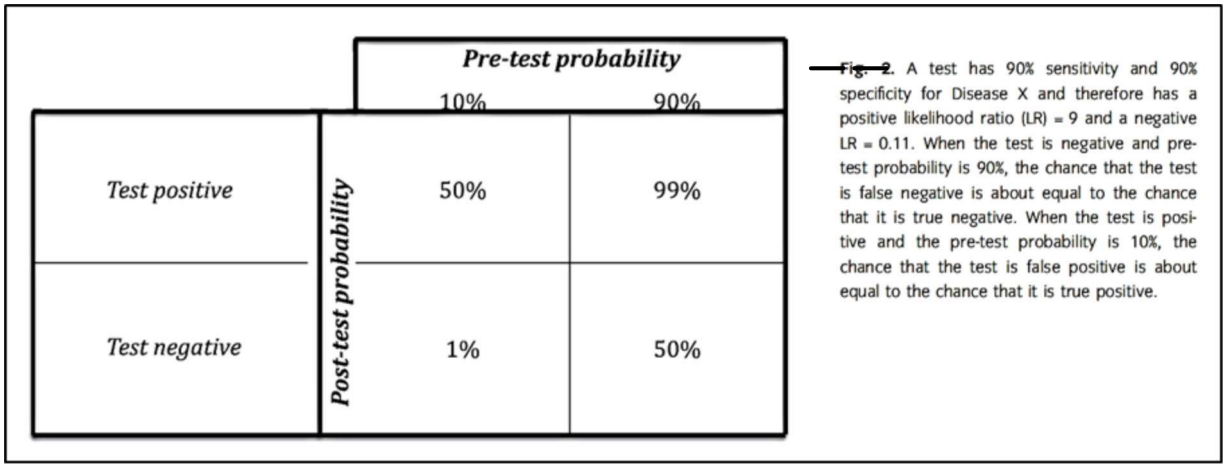

Figure 1 Caption. The clinical paradigms impact on the significance of test results. (Used with permission and derived from fig. 2 Mendelson, R. M. (2020). Diagnostic imaging: Doing the right thing. J Med Imaging Radiat Oncol.

of unjustified imaging is that the patients are deprived the benefits, but left with the risks of harm from ionising radiation. Radiological examinations that use ionising radiation have the potential to expose the patient to the risk of body tissue harm (deterministic effects) and the development of radiation-induced cancers (stochastic effects).[1 5] The risk of stochastic effects are reported to be rare and the cumulative absolute risk is small.[29] Nevertheless the goal is that the possibilities of deterministic and stochastic effects are avoided or reduced.[4] This can be achieved through appropriate referral patterns for patients' imaging and applying dose restrictions where applicable.[1] Seeking to protect patients against the harmful effects of radiation contributes to serving the best interest of patients and quality of social life.[4] When unnecessary examinations represent a moral challenge for radiology professionals,[30] the risk of harming patients by ionising radiation is one major factor in motivating for the prevention of unwarranted imaging.

Unwarranted imaging also has the potential for increased risk of false positive and negative results. This can be seen in light of the probability theory, and the fact that no examination is 100% accurate. A low probability of a certain disease before testing (eg, as in 'just in case' examination) will increase the chances of a false test result. If the test sensitivity and specificity is 90%, the positive likelihood ratio (LR)=9 and negative LR=0.11. In cases of a low 10% pretest probability, the 10% chance of true positive disease equals the 10% chance of false positive results, that is, the odds are 1:1 (see figure 1).

False positive results can lead to further medical investigations and treatment that usually instigate over-investigation, over-diagnosis and over-treatment. This is reported to cause 'cascade effects' that harm patients,[19] as they become victims of modern imaging technology.[31]

Missing information can instigate *failure to communicate patients' conditions*, to radiology professionals, causing risks of harm to the patient. Examples include risks of falls because the patient's mobility is unspecified or injuries from non-indicated metal objects that must be removed from the body before MRI.[32] A more indirect consequence that causes harm pertains to the increased *time spent* in seeking information or clarity in suboptimal referrals.[6] This results in an added workload to already busy radiology departments, which could further affect patient safety, increase delays and costs.[6] Hayre *et al*[33] report that increasingly pressed time schedules for radiology professionals create the danger of imaging departments resembling a production line, which de-humanise the patient. This morally violates the person's right to a sense of meaning, strength and belonging.[21]

Beneficence challenges

Beneficence goes beyond non-maleficence by seeking the best solution for each patient.[21] The two aspects of the beneficence principle; to provide benefits (positive beneficence) and to balance the benefits against the drawbacks to produce the best overall results (utility),[21] are both relevant with respect to referral quality. First, sufficient high-quality referral information is necessary in order to assess the patient's need for the examination and balance this against the possible harms and risks. This encapsulates the radiation principle of justification.[1] Selecting the wrong examination (modality) may alter the balance of benefit and risks, for instance, by leading to unnecessary imaging that could also cause delays in diagnosis and complications during the examination.[19 34]

Second, it can be implied that high-quality clinical information assists radiology professionals in choosing the right protocol[35] and carrying out an optimal examination; thereby acting in accordance with the principle of beneficence.[5] Dang *et al*[35] report that a comprehensive clinical history reduces the number of protocols identified as potentially appropriate by the radiologist thus improving accuracy when choosing imaging procedures. A radiology report is also dependent on the clinical information in understanding and interpreting the concerns of the referring clinician.[3] Castillo *et al*[36] report that quality referral information positively affects the radiology reporting process, improves interpretation accuracy, clinical relevance and reporting confidence. Suboptimal clinical information also potentially contributes to the reporting of incidental findings that may be observed during a review of diagnostic images but unrelated to the initial objective of a medical investigation.[19] Incidental findings, in some instances, is of benefit to the patient because of early detection of disease in urgent need of treatment. However, in many cases, the findings are insignificant and may lead to unnecessary medical intervention.[34 37] O'Sullivan *et al*[34] report that because of improved image resolution, higher numbers of incidental findings with a low malignancy rate are observed in contrast enhanced CT and MRI examinations. The frequency of incidental findings is reported to be higher in patients with unspecific initial diagnoses[37] as witnessed in suboptimal referrals. In this way, the increased prevalence of

incidental findings adds to the problem of providing unbeneficial patient radiology reports, as the findings are unrelated to any clinical information.

In particular, for radiographers, clinical information assists with overall work quality,[38] influencing decisions of patient positioning, selection of projections, exposure parameters and dose-optimisation. In the absence of adequate referral information, patient call-backs could occur due to protocol error, inadequate anatomic coverage or incomplete examinations.[39]

Autonomy challenges

Autonomy, defined as *self-rule and determination*, is the individual's ability to think and decide freely and independently.[21] To violate a person's autonomy is to treat that person merely as a means, in accordance with others' goals, rather than the person's own goal.[21] Beauchamp and Childress[21] define respect for autonomy as a positive or negative obligation; a positive obligation requires respectful treatment in disclosing information, and ensuring understanding and voluntariness, as well as fostering autonomous decision-making. As a negative obligation, autonomous actions should not be subjected to controlling constraints by others.

Regarding the positive obligation of respecting autonomy, the communication of correct information is vital to enable the patient's decision-making. The radiology referral is the main tool for communication among healthcare professionals and is in many instances used to communicate information to the patient. Radiology professionals convey information to the patient regarding the imaging procedure as well as the referring clinician's requests, based on the information extracted from the referral. Suboptimal information such as the lack of a specific area of pathology or urgency of the investigation could prevent the radiology professionals from obtaining the required information the patient should receive for a given procedure.[6] This results in failure to inform the patient adequately about the expected process and possible side effects and affects consent to the examination. The ICRP[4] publication 138 defines informed consent as the voluntary agreement to an activity based on sufficient information and understanding of the purpose, benefits and risks. A patient has the right to make an independent decision regarding potential risks of harm from a medical intervention that will ultimately benefit their health.[40] Discussions with the healthcare professional about benefits and risks of radiological examinations is vital in enabling patients to make this decision. Although it is recommended that discussions of benefits and risks of imaging occur at the time of ordering a radiological examination, usually with the referring clinician, reinforcing the discussions within the radiology department is required. Furthermore, most referring clinicians may have limited knowledge of the risks associated with radiological procedures and radiation doses.[19] Risk–benefit communication errors could occur either when the risks and benefits of an examination are assessed wrongly or are unidentifiable. This implies that vital information is not given to enable autonomous decision-making thus disregarding the patient's value.[21]

Autonomy as a negative obligation is about the rights of choice. Patients have become more aware of their rights and perceive access to healthcare services as their human right.[40] A patient's autonomous rights can involve drawbacks, particularly if this leads to a demand for medical procedures. Despite the importance of respect for patient's rights to medical care, caution should be taken in respect of patient demand for radiological procedures. These demands are reported as one of the reasons that referring clinicians are pressured to request unnecessary examinations, in some cases, altering clinical information in the referral to accommodate this.[6] This subsequently increases the pressure on radiology professionals to conduct procedures of questionable benefit to the patient.

Insufficient or altered referral information could compromise professional autonomy, which further affects patient care. Professional autonomy relates to competence and expected professional standards of the health professionals.[41] The constant encounter of suboptimal referrals for radiology professionals could lead to the compromise of, and disregard for, their professional autonomy, as they are deprived the opportunity to practice according to the professional standards.

Justice challenges

The principle of justice holds that benefits, risks and costs should be distributed equitably and fairly among people.[21] At least two aspects of justice are relevant with respect to referral quality. *Distributive justice* refers to fairness in the distribution of advantages and disadvantages among members of communities, which in healthcare implies equal and universal access to services.[42] *Procedural justice* is defined as fairness in the rules and procedures in the process of decision-making, which in healthcare is reflected in priority-setting criteria such as disease severity (medical need) and effects of the treatment.[43]

One problem with suboptimal referrals is the creation of errors in prioritising patients,[6] in that they hinder the radiographer in making the correct decision about which examination to perform next, and for radiologists to decide which study to interpret next. This problem of *procedural justice* can occur for three reasons. First, if the clinical information is insufficient and radiology professionals are not able to make any reasonable prioritisation of patients—simply because they may not be aware of the severity of the patient's condition or the urgency of the requested examination.[44] Second, the wording use to describe urgency can lead to 'competing or ambiguous priorities (eg, stat, ASAP, now, and critical) that are open to interpretation by the referrer, radiographer, and radiologist regarding which priority category is more urgent'.[45] Finally, the referral information may be incorrect or misleading as reported by Fatahi *et al*[6] when exaggerated patient symptoms are added to prioritise an examination. These issues can force the radiology professionals to act on loyalties to the referrer or patient at the expense of fairness.[44]

In regard to *distributive justice*, problems occur indirectly by inappropriate diagnostic imaging caused by suboptimal referrals. Inappropriate use of radiology resources creates the problem of over-utilisation of imaging,[34] that is incompatible with fairness from different perspectives. To draw on an egalitarian perspective, injustice originates from the arbitrary distribution of benefits and risk between people with equal medical needs, and those not exposed to unnecessary imaging have an advantage. Justice in this regard relates to fairness in decisions related to radiation protection[4] and others exposed including the patient's relatives and carers, healthcare professionals and the public.[1] Drawing on a utilitarian perspective, unnecessary examinations violate the justice in the distribution of resources,[7] as higher utility could have been achieved by a different allocation of resources. Fairness would be improved, for instance by quicker access to radiology service for patients in 'real' medical need.[6 7]

DISCUSSION

Healthcare services require reliable transmission of patient information.[46] Our study reveals that suboptimal radiology referrals disrupt the transmission of valuable information in

the health system. This imposes ethical and professional challenges for radiology professionals[20] and, of utmost importance, is the reduced possibility of providing reliably good services to patients. Several studies show how suboptimal referrals impact inappropriate imaging,[11–18 47] but few address the ethical implications and delivery of quality patient care.[30 44] Our findings can be shortened into some broader categories of reduced quality of services to patients.

First, the safety of patients is compromised mainly from unnecessary examinations that expose the patient to ionising radiation,[5 20] the adverse effects of contrast-media[24–26 28] and follow-up of incidental findings.[34] This increases the risk of further investigations for the patient, prolonged medical care and hospitalisations, causing anxiety and additional risks.[34] Second, conducting an inappropriate examination has the potential to elicit a missed positive result, causing delays and missed opportunities for a timely diagnosis.[19 34] The overall outcome is the increased likelihood of mismanagement of the patient's medical care. Finally, the mismanagement of care results in patients' dissatisfaction in healthcare services[46] and the loss of trust in healthcare professionals.[30]

These findings clearly demonstrate that measures to combat the problem of suboptimal referrals are required. Better dialogue is required among all healthcare professionals about referral patterns and guidelines, to ensure appropriate radiology services. The quality of discussion between patients and medical professionals in improving shared decision-making concerning useful imaging is vital. Public health literacy and education is imperative in avoiding unnecessary interventions.[9 10]

Strategies requiring healthcare professionals' efforts are called for and can be assisted by technological systems. Electronic referrals with decision support can decrease inappropriate utilisation of imaging procedures.[48] These systems can be helpful when widely available and implemented. In the future, artificial intelligence may assist further by automated vetting and checking of the correspondence between clinical indications and the imaging modality and techniques to be employed.[49] In the current situation, it seems reasonable to strengthen the professionals' efforts. It is argued that radiologists should be allowed more discretionary power to manage the entire imaging-value chain.[50] Radiographers could also assist in a more systematic manner. As suggested by Olerud *et al*[2] education and the effective use of radiographers in shared tasks could assist in ensuring effective referral assessment. Radiographers can evaluate the amount and quality of information in the referrals and provide supplementary information where needed. Communication strategies are also needed, for instance by providing an easy access platform for discussion among healthcare professionals within the radiology referral process. Finally, the radiology community should promote awareness of why the quality of the referral information is crucial for providing good quality radiological services to patients.

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Paper II

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Radiographers' assessment of referrals for CT and MR imaging using a web-based data collection tool

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ABSTRACT

Introduction: There is limited research related to the radiographers' role in assessing of radiology referrals to justify imaging. This study investigated radiographers' compliance with guidelines in the assessment of CT and MRI referrals and factors that influenced their performance.
Methods: This research was facilitated by the EFRS Research Hub at ECR 2019. Five radiology referral scenarios for CT and/or MRI were distributed to radiographers, as determined by their scope of practice, who volunteered at the Research Hub. A web-based data collection tool was used. The radiographers were required to determine the appropriateness of each referral, highlight any concerns and recommend suitable investigations if applicable. Linear regression analysis was used to determine whether postgraduate qualification, grade/role of the radiographer and use of guidelines influenced the radiographers' performance in assessing the referrals.
Results: Participants originated from 24 countries (n = 51 CT, n = 40 MRI), the majority originating from the UK, Ireland, Italy, Spain, Norway and Austria. Responses consistent with guidelines were 58% and 57% for CT and MRI, respectively. Possession of an MSc qualification in CT was a significant factor of influence for a higher consistency with guidelines ($p = 0.02$) in CT. Employment as a radiographer in a lead professional role and/or educator was a significant factor of influence for a higher consistency with guidelines in MRI ($p = 0.01$).
Conclusion: A total of 58% for CT and 57% for MRI of the radiographers' responses complied with guidelines. Factors such as postgraduate education and leading professional roles are associated with better performance.
Implications for practice: Considering qualifications, experience and managerial role is vital before radiographers are delegated task of justifying CT and MR Imaging.

Introduction

The International Atomic Energy Agency (IAEA)[1] recommends that all radiology examinations conducted, including non-ionising modalities such as ultrasound (US) and magnetic resonance imaging (MRI) should be justified to maximise the benefit-to-risk ratio. The European Council Basic Safety Standards (BSS) Directive[2] advocates for a team approach among clinicians, radiologists and radiographers when it applies to justification of imaging. Justifying of computed tomography (CT) and MRI examinations is legislatively the responsibility of the radiologist in many countries, though in practice radiographers could be delegated the task in consultation with the radiologist.[1] Radiographers are identified as a potential group to act as gatekeepers to ensure appropriate imaging.[3] For radiographers, this entails reviewing a referral to ensure the imaging procedure is appropriately justified, identifying and discussing with the radiologists on doubtful or inappropriate referrals and seeking further information from the referring clinician when needed.[4,5] However, the contribution of the radiographer in the justification process is unclear and under explored.

Abbreviations: IAMs, Internal Auditory Meatus; MGUS, Monoclonal Gammopathy of Undetermined Significance; MRCP, Magnetic Resonance Cholangiopancreatography; MS, Multiple Sclerosis; OPS, Overall Performance Score; TL, Temporal Lobe; WB, Whole Body.

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International radiology referral guidelines to assist selection of appropriate imaging are widely used in most countries[6–9] with national evidenced based variants of the guidelines available in some countries.[10] The positive impact of applying referral guidelines has also proved to be significant.[11]

Where confronted with inadequately filled referrals Matthews and Brennan[5] report of radiographers seeking further information from the patient or referring physician before conducting the examination. Triantopoulou et al.[12] reports of the usefulness of detailed clinical information to enable adequate justification of CT imaging. Koutalonis and Horrocks[13] have studied how both radiologists and radiographers assessed risks and benefits when justifying imaging and reported the most important criteria being the patient's medical condition, age, sex, and alternative techniques using less or non-ionising radiation. Others have reported on radiographers' knowledge of radiation protection and doses for various modalities.[14,15] This study aimed to examine the radiographers' compliance with radiology referral guidelines in assessing of designed referrals for CT and MRI examinations and to identify factors that potentially enhanced their performance. A web based data collection tool was used because it allows for real time and high quality data collection and analyses.[16]

Methods

Ethical approvals were obtained from University College Dublin (UCD) Institutional HREC in Ireland and from the Norwegian Centre for research data (NSD) reference number 776616 in Norway.

Development of the web-based data collection tool

Five referral clinical cases for both CT and MRI indicating only the diagnostic condition were prepared for participants to review in a short period of approximately 20 min within a "pop-up research hub" scenario.[17] Each case was determined as realistic by an expert MRI radiographer employed as an academic lecturer, with extensive experience and knowledge in medical imaging. The case content was supported by recognised international guidelines and literature (Table 1).

The designed clinical cases are commonly seen referrals for CT and MRI and were chosen to assess the radiographers' knowledge of benefits of an imaging modality for a given case, taking into account factors such as, clinical appropriateness to provide accurate diagnosis, urgency of the referral and radiation exposure. Participants were asked to assess and determine if the referral was *appropriate*, or *not appropriate*, or *possibly appropriate*, and whether further discussion with the referring clinician or with the radiologist was required. Space for free text was provided to enable the participants to explain any concerns they had about the referral or whether they would recommend an alternative examination, and if so to specify the recommended examination.

The participants were also asked to indicate which, if any, referral guidelines they used routinely; options included the American College of Radiology (ACR) Appropriateness Criteria, Royal College of Radiologists (RCR) iRefer, European Society of Radiology (ESR) iGuide and Western Australia Diagnostic Imaging Pathways, or participants could specify any others. Participants for either the CT and/or MRI referral cases had to state whether they assessed these imaging speciality referrals as part of their clinical work and how often they undertook this role. Finally, they were asked if they were permitted to modify referrals as part of clinical practice. In designing the cases and questions, written text was kept to a minimum, and clinical abbreviations limited with typed explanation of a limited number of medical words was provided to assist non-native English participants.

Demographic data was collected pertaining to the participants: country of training and practice; years of practice in radiography; radiography grade/role (clinical/academic); postgraduate education or training within a specific imaging modality; experience (years) working in CT and/or MRI.

Recruitment of participants

The sample population were radiographers who attended the European Congress of Radiology (ECR) 2019 in Vienna, Austria. A "pop-up research hub" was organised by the European Federation of Radiographer Societies (EFRS) in collaboration with the European Society of Radiology (ESR). The Research Hub initiative was based in a meeting room located adjacent to the Radiographers' Lounge area at ECR, and conference attendees could volunteer to take part in this and several other research activities. Advertisement of the research hub was approved by the EFRS and ESR, a flyer was sent through mailshots by the EFRS prior to ECR 2019, and the research activity was promoted at the conference venue. A total of 1767 fully qualified radiographers attended the congress originating from 84 countries.[30] Volunteers were allowed to select which study(ies) they wished to participate in provided they met the study inclusion criteria, with those reporting that they worked in CT and/or MRI invited to take part in the current study.

Data collection

The data for obtaining the demographics and for the designed cases was inserted into a password-protected, web-based user interface (Ziltron Ltd., Dublin, Ireland). The data collection tool was accessed via ten 4th generation (Apple) iPad tablet computers running IOS10.3.3 (Cupertino, CA, USA). Multiple tablets enabled several volunteers to take part simultaneously, although they were instructed to complete the task without conferring. The resultant data were saved in real time in secure cloud-based storage.

Participants were not provided with access to any referral guidelines or other aids while completing the task; however, to accommodate the wide array of nationalities and backgrounds of participants, the researchers provided clarification on terminology where necessary. A summary of the background to the study was also provided to explain the study aim and origin. Participants could also opt to provide email contact for a certificate of participation upon completion of the research activity; this was recorded at the Research Hub reception desk and was not associated with the study data, which was collected with no identifying details and identified participants only by code (e.g. "CT1" was the first participant in the CT study).

Data analysis

A score of consistency with recommended practice and participants' responses on each of the CT and MRI cases was recorded, from *cannot answer* (0) to *fully consistent response* (3), as outlined in Table 2 for each individual case for each participant response. Further to expert statistical advice the scores were then grouped as a inconsistent (score 0 and 1) or consistent score (2 and 3). This consistency score was based on responses for questions (q) for the decision of appropriateness (q1) followed by any concerned stated (q2) and a review of participants' responses to alternative appropriate examination(s) (q3) in line with referral guidelines and recommendations as stated in Table 1.

To enable accurate analysis for linear regression an overall performance score (OPS) was then determined for the participant across all five cases in the CT or MRI data set reviewed. The OPS was a summation of an individual participant's scores (1 = consistent, 0 = inconsistent, as indicated in Table 2) with a maximum score of 5

Table 1
Case description and preferred examination according to guidelines and other references.

Modality: CT		Preferred Examination	Appropriate guidelines/references
Case 1	CT Brain: Patient presents to emergency department with seizures. Query temporal lobe (TL) epilepsy	MRI	ACR Appropriateness Criteria,[18] Western Australia Diagnostic Imaging Pathways[19]
Case 2	CT abdomen: Pregnant patient. Severe abdominal pain. Query appendicitis	US	ACR Appropriateness Criteria[20]
Case 3	CT Brain: Patient has tingling and numbness in face. Query multiple sclerosis (MS)	MRI	RCR iRefer[21]
Case 4	CT Abdomen: Acute low abdominal pain. Query stone in urinary tract	CT low dose	ACR Appropriateness Criteria[22]
Case 5	CT Whole Body (WB): Patient with a history of monoclonal gammopathy of undetermined significance (MGUS) now has bone pain and loss of appetite. Query multiple myeloma	MRI WB	Chantry et al.[23] on behalf of the British Society for Haematology Guidelines
Modality: MRI		**Preferred Examination**	**Appropriate guidelines/references**
Case 1	MR cholangiopancreatography (MRCP) Patient presents with severe abdominal pain and jaundice. Query gallstones	US	ACR Appropriateness Criteria[24]
Case 2	MRI Knee: Chronic knee pain. Query Osteoarthritis (OA)	X-Rays	ACR Appropriateness Criteria,[25] RCR iRefer,[21] Australia diagnostic imaging pathway[26]
Case 3	MRI Lumbar Spine: Patient involved in heavy lifting as part of work. Low back pain with saddle paraesthesia	MRI, Urgent within 6 h	ACR Appropriateness Criteria[27]
Case 4	MRI Internal Auditory Meatus (IAMs): Severe facial pain. Family history of cancer. Query tumour	MRI whole Brain	ACR Appropriateness Criteria: Expert Panel on Neurologic Imaging[28]
Case 5	MRI Brain: History of lung cancer. Query brain metastases.	MRI	ACR Appropriateness Criteria: Expert Panel on Radiation Oncology–Brain Metastases[29]

if a participant was consistent across all five cases and a score of 0 if a participant was inconsistent across all five cases for CT or MRI.

Linear regression analysis was performed to identify whether the factors: possession of postgraduate qualification in that modality, grade/role of the radiographer and use of referral guidelines correlated with the OPS. A two tailed p value < 0.05 was considered significant. A preliminary analysis was performed to ensure no violation of assumptions of normality, linearity and multicollinearity and to analyse the relationship between the variables of interest. Furthermore, variables namely in categories of postgraduate education (i.e. graduate diploma and certificate) and radiographer position (i.e. radiographer chief/leads, teachers, radiographer managers, other) were grouped within each category as one variable. This was conducted to reduce the independent variables for analysis of the sample size $N = 91$ using the formula $N \geq 50 + 8\ (k)$ where k is the required number of independent variables in linear regression analysis as outlined by Green.[31] The results are presented as beta coefficients with accompanying 95%

Table 2
Grading and scores of assessed referral cases, based on the combination of participants' responses to referral appropriateness decision (q1), concern stated (q2) and alterative examination suggested (q3).

OPS	Score	Grading		Referral Appropriateness (q1)	Concern (q2)	Alternative examination (q3)
Inconsistent = 0	0	Cannot answer		Answered as "not sure"	None given	None given
	1	Not consistent	a)	Answered incorrectly as justified or not justified	None given or not reasonable	None given or inappropriate alternative examination(s) given
			b)	Answered possibly "appropriate (discuss with radiologist or clinician)" where correct answer in not appropriate	Unreasonable answers given	Inappropriate alternative examination(s) given or none given
			c)	Answered as "not sure"	Unreasonable answers given	Inappropriate alternative examination(s) given or none given
Consistent = 1	2	Acceptable	a)	Answered incorrectly as justified or not justified	Reasonable answers are given	Appropriate alternative examination(s) given
			b)	Answered "possibly appropriate (to discuss with radiologist or clinician)" where correct answer is not appropriate	Reasonable answers are given	Appropriate alternative examination(s) given
			c)	Answered "not sure"	Reasonable answers are given	Appropriate alternative examination(s) given
	3	Fully consistent	a)	Correctly answered that justified or not justified	Reasonable answers are given or none given	Appropriate alternative examination(s) given/not contradict the correct answer or none given
			b)	Answered "possibly appropriate (want to discuss with radiologist or clinician)" where correct answer is appropriate	Reasonable concerns are given or none given	Appropriate alternative examination(s) or none given

Table 3
Demographics for the participants' responses for CT and MRI cases.

Characteristics	CT responses	MRI responses	Total Responses
	n (%)	*n* (%)	*n* (%)
	51 (100.0)	40 (100.0)	91 (100.0)
Radiography position			
Radiography lead professional role/educator	14 (27.5)	22 (55)	36 (39.6)
Senior radiographer	16 (31.4)	4 (10.0)	20 (21.9)
Radiographer	21 (41.2)	14 (35.0)	35 (38.5)
Post-graduate training level studied			
MSc 120ECTs	9 (17.6)	12 (30.0)	21 (23.1)
Diploma/Certificate 60 to 30 ECTs	19 (37.2)	14 (35)	33 (36.3)
Hospital (in house) Training	23 (45.1)	14 (35.0)	37 (40.6)
Work full time in CT/MRI			
Yes	19 (37.3)	19 (47.5)	38 (41.8)
No	32 (62.7)	21 (52.5)	53 (58.2)
Years working in CT/MRI			
<5	18 (36.0)	12 (30.0)	30 (33.3)
5–9	11 (22.0)	9 (22.5)	20 (22.2)
10–14	14 (28.0)	8 (20.0)	22 (24.4)
15+	7 (14.0)	11 (27.5)	18 (20.0)
Missing	1	1	1

confidence intervals (CI) and p values. The data was analysed using SPSS Version 25 (IBM, Armonk, NY, USA).

Results

Demographics

A total 91 responses of radiographers from 24 countries were obtained in the study. The majority of the responses ($n = 81$) were from radiographers working in Europe; mainly in the United Kingdom (UK), Ireland, Italy, Spain, Norway and Austria. Within each imaging modality cohort, 55% and 65% of participants had attained CT and MRI postgraduate education, respectively ranging from certificate (30 ECTs) to Master's Degree (MSc 120 ECT) level. The remaining participants reported receiving in-house training in the indicated modality (Table 3).

Participants' responses

The overall findings for participant responses to the cases within the CT and MRI data sets regarding appropriateness with recommended practice, referral concerns and suggested examination, when analysed against referral guidelines are shown in Fig. 1 (for CT) and 2 (for MRI).

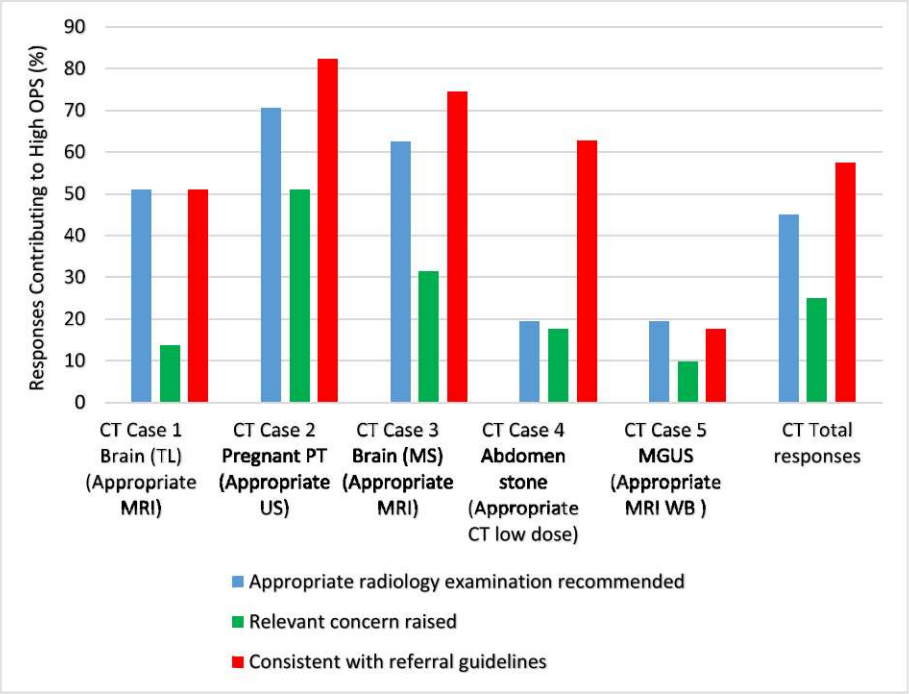

Figure 1. The proportion of participants' CT cases responses that were consistent with referral guidelines (red bars), that raised relevant concerns (green bars), and that recommended an appropriate radiology examinations (blue bars). The recommended appropriate modality for each case is indicated in parentheses. Note that for case 4 the CT referral was appropriate and appropriate recommendation responses here is therefore equal to a further specification of the examination.

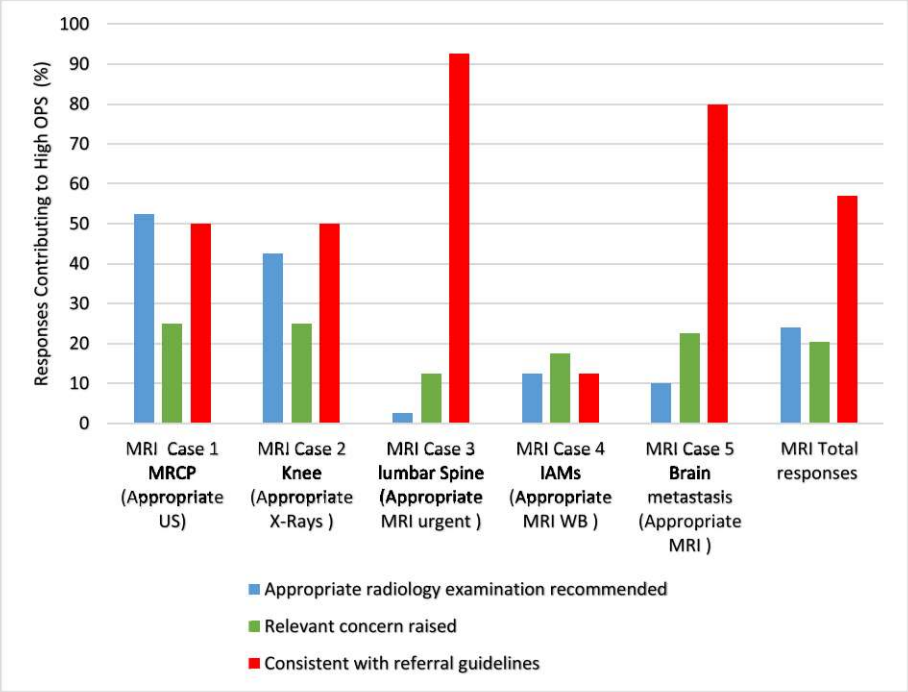

Figure 2. The proportion of participants' MRI cases responses that were consistent with referral guidelines (red bars), that raised relevant concerns (green bars), and that recommended an appropriate radiology examinations (blue bars). The recommended appropriate modality for each case is indicated in parentheses. Note that for case 3 and 5 the MRI referral was appropriate, and appropriate recommendation responses here is therefore equal to a further specification of the examination.

CT case findings

The overall performance score for the CT cases showed that a total of 58% of the participants accurately identified the appropriateness of the referrals (Fig. 1). High scores were obtained in Case 2 CT abdomen, pregnant patient (82%), Case 3 CT brain, MS patient (75%) and Case 4 CT abdomen urinary tract stone (63%). Case 5, CT WB, patient with MGUS, received the lowest score (18%).

Across the five CT cases, 25% of the responses raised concerns such as high radiation doses and sensitivity of the modality for accurate diagnosis for the referral. A common concern recorded was the need for more information within the referral, which was sought in 13% of the responses. Examples of further information requested included; age, status of the patient and gestation stage of pregnancy (Case 2). Most concerns for radiation dose were raised in CT Case 2, the pregnant patient. In Case 4 - CT abdomen urinary tract stone scenario, 20% of the radiographers further suggested the use of low dose CT imaging.

MRI cases findings

The overall performance score for the MRI cases showed that a total of 57% of the participants identified the appropriateness of the referral accurately (Fig. 2). High scores were obtained in MRI Case 3 lumbar spine urgent, saddle paraesthesia (93%) and MRI Case 5 brain metastases (80%). Case 4 MRI - IAMs, proved most challenging with a score of 13%.

Across the five MRI cases, concerns were stated with 21% of the responses to include; urgency of the referral, sensitive of the modality to provide accurate diagnosis, the need of wider exploratory scan and use of contrast media for better anatomy and pathology visualisation. Although MRI Case 3 lumbar spine saddle paraesthesia, was identified as an appropriate referral by a high number of the radiographers, only 13% of the respondents stated urgency, whilst 3 participants inappropriately recommended observational physiotherapy as other suggested investigation.

Table 4
Variables associated with overall performance score of the radiographers ($n = 91$).

Variables	CT			MRI		
	Beta	95% CI	p-value	Beta	95% CI	p-value
Radiography position						
Radiographer	Ref.			Ref.		
Radiography lead professional role/educator	0.28	−0.03 to 1.43	0.06	0.45	0.25 to 1.42	**0.01**
Senior radiographer	0.24	−0.15 to 1.28	0.12	−0.10	−1.27 to 0.66	0.53
Post-graduate training level studied						
Hospital (in house) Training	Ref.			Ref.		
MSc	0.35	0.19 to 1.88	**0.02**	0.07	−0.55 to 0.84	0.67
Diploma/Certificate	−0.03	−0.72 to 0.60	0.86	−0.27	−1.17 to 0.10	0.10
Use of referral guidelines						
No	Ref.			Ref.		
Yes	0.04	−0.66 to 0.89	0.77	−0.10	−0.90 to 0.43	0.48

CI: Confidence interval.
Statistically significant p-values in bold.

Linear regression analysis: factors influencing performance

Multivariable linear regression analysis was used to assess whether postgraduate education, the radiographers' position and usage of guidelines was associated to the overall performance score (OPS) of $n = 91$ radiographers' responses (CT $n = 51$, MRI $n = 40$) as indicated in Table 4. Possession of an MSc degree was a statistically significant influencing factor for a higher OPS in the CT participants at $p = 0.02$, but was not significant for those in MRI. Radiography lead professional role and/or educator in the MRI participants was also a statistically significant influencing factor for a higher OPS at $p = 0.01$, but failed to reach significant for CT imaging ($p = 0.06$). The use of referral guidelines were not a statistically significant influencing factor on OPS in neither CT nor MRI participants.

Discussion

In clinical practice, radiographers are required to review referrals to ensure imaging is justified for each examination.[3] Therefore radiographers should be able to identify anomalies of a referral and contribute to decision making together with radiologists and referring physicians accordingly. This study showed that 58% of participants for CT and 57% for MRI were able to identify anomalies and assess the designed referrals in compliance with recommended practice. It is important to note that availability of alternative imaging modalities plays a significant role in justification of imaging therefore the recommended practices outlined in this study may not be the routine pathways in every radiology department. The radiographers, however, were able to identify referral appropriateness for 4 out of 5 cases in each modality taking into account that no referral guidelines or other supporting tools were available when they assessed the referrals.

Imaging modality selection and knowledge of radiation doses

The IAEA[1] stipulates that the benefits and risks of an exposure including alternative investigations should be considered to ensure that the diagnostic benefits outweigh the harm. The selection of appropriate imaging should adhere to this regulation. In 80% (4/5) of the designed cases for both CT and MRI, the radiographers identified the appropriate imaging modality. The radiographers further demonstrated knowledge of the benefits of each modality through highlighting the sensitivity of a modality for specific pathologies. Furthermore the radiographers were able to apply radiation protection showing knowledge of radiation doses through suggesting non ionising modality or techniques that would ensure use of low doses in specific cases appropriately.

Information seeking

Obtaining optimal clinical information aides decisions that lead to appropriate imaging.[4,5,12] Our study showed a tendency of the radiographers to seek further or clearer information on a referral when required. The evaluation of a referral is based on clinical notes and patient information.[3] A similar trend as reported by Koutalonis and Horrocks[13] of the main information sought and criteria used when assessing referrals was also shown.

Factors influencing performance

The factors that influenced the radiographers' OPS was attributed to occupying a radiography lead professional role and/or educator for MRI and possession of an MSc degree for CT imaging as shown in Table 4, indicating the positive impact of postgraduate education and clinical experience on the radiographers' ability to identify appropriate referrals.[13,32] McNulty et al.[32] however reports insufficient postgraduate programs in Europe for radiographers. If we aim to effectively involve radiographers to ensure appropriate imaging, adhere to international guidelines in justification of imaging as stated by the IAEA,[1] and enhance radiography practice, the availability of higher education courses for radiographers in imaging specialities and justification of imaging is evidenced by this study's finding as a priority.

Limitations and strengths of study

The participants were radiographers, professionally active through their ECR 2019 attendance and predominantly working in Europe therefore caution to translate the outcomes outside this cohort is warranted. It should be noted that participants volunteered between conference activities, which may have caused participants to spend reduced time on questions. This may account for the limited responses in open-ended comment boxes. Additionally, the referral cases were designed with minimal text to enable easy comprehension for non-native English participants however greater referral text content was requested by some participants. The cases were limited to only five cases in each modality to allow sufficient time for the participants to adequately assess the cases as recommended of pop up research hubs. However, this represents a small sample of clinical conditions routinely seen in practice and could have an impact on study findings. A strength of the study was access to radiographers from a wide variety of clinical practices in different countries internationally.

Conclusion

Understanding the contribution of radiographers in assessing referrals is vital to ensure appropriate imaging is conducted in radiology departments. Furthermore, identifying the factors supporting radiographers that act as gatekeepers is vital. Our study identifies postgraduate education as particularly important and that those occupying lead radiography positions in both clinical and academic settings performed most optimally. Further research is warranted to investigate this subject across larger cohorts of radiographers and across the spectrum of medical imaging subspecialities.

Conflict of interest statement

None.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.radi.2020.04.001.

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Paper III

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RADIOLOGICAL EDUCATION

Radiographers' actions and challenges when confronted with inappropriate radiology referrals

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Abstract

Objectives To explore radiographers' actions toward inappropriate referrals and hindrances to assessing referrals.

Methods An online survey was distributed to radiographers via the International Society of Radiographers and Radiological Technologists (ISRRT) networks. The questionnaire consisted of 5-point Likert scale questions on radiographers' actions to supplement referral information, actions for unjustified referrals and hindrances to referral assessment. The questionnaire was validated using a test–retest reliability analysis. Kappa values ≥ 0.6 were accepted. SPSS software was used for data analysis and chi-square tests to compare subgroups.

Results Total responses received were 279. The most reported actions to supplement missing referral information were to ask the patient or relative, examine the body region of concern and check medical records (73%, 70%, 67%, responded often/always, respectively). The actions when confronted with unjustified referrals were reported equally to consult the radiologist, referring clinician and radiographer (69–68% often/always responses). The hindering factors ranked high (agreed/strongly agreed responses) pertained to inadequate information in referral forms (83%), ineffective communication among healthcare professionals (79%), lack of training (70%) and allocated time (61%). Statistically significant associations were observed for a few actions and hindrances with education level, modality of practice and responsibility to screen imaging referrals.

Conclusion Radiographers consult colleagues about suspected unjustified referrals. Effective communication pathways, training and time allocation to improve radiographers' skills to assess referrals may enhance appropriate imaging and delivery of quality patient care.

Key Points

- *Radiographers' actions of supplementing missing information in radiology referrals facilitate provision of high-quality health services.*
- *Radiographers' strategy when confronted with inappropriate referrals is to consult radiologists and referring clinicians.*
- *Better inter-professional communication and organisation of tasks can facilitate radiographers' participation in referral assessment to ensure appropriate imaging.*

Keywords Referral and consultation · Radiology department hospital · Delivery of health care

Abbreviations

ISRRT International Society of Radiographers and Radiological Technologists

Introduction

In referring a patient for a radiological procedure, a medical clinician (or physician) sends a referral form to consult the radiology department for possible imaging [1, 2]. The referral is evaluated against the clinical data supplied by the referrer [3] with adherence to referral guidelines [2]. The referrer must provide sufficient patient clinical information to enable the radiologist to determine whether there is a sufficient net benefit in performing the procedure [4]. This adheres to the radiation protection principle of justification, to determine that the use of a given radiological procedure yields benefits to the individuals undergoing the procedure.

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Justification of imaging aligns with basic patient safety and accepted ethics in medicine [5], and ensures better use of radiology resources from a health economic perspective [6].

Radiographers possessing advanced education and specialised training in justifying imaging may have an agreed scope of entitlement to perform justification tasks depending on state legislations [7]. Authorisation or using pre-justification guidelines as determined by the radiologists is also available for radiographers to assess referrals for imaging [8]. As part of routine clinical practice, radiographers also review the referral information before performing the radiological procedure [9]. If discrepancies are observed, the radiologist or referring clinician should be consulted. In this study, justification, authorisation and general pre-procedural review of referral information are termed 'referral assessment'.

Radiographers are vital in the justification process as they are centrally positioned to act as an interface between the referring clinician, radiologist and patient [1, 4]. The role of radiographers in the radiology referral process is poorly mapped and needs careful evaluation to ensure quality radiology services. This study aims to explore the radiographers' participation in assessing referrals concerning justified imaging in clinical practice. The actions that radiographers do to supplement missing information and when confronted with unjustified referrals, and the hindrances faced during the referral assessment tasks are analysed. Furthermore, the study analyses associations between the actions of radiographers when confronted with clearly unjustified referrals and the hindrances to referral assessment participation with their education level, delegated responsibility for screening imaging referrals and modality of practice.

Methodology

Ethical approval was obtained from the Norwegian Centre for Research Data (NSD) reference number 472337 in Norway.

Development of online questionnaire

A questionnaire (Supplementary Appendix 1) was developed informed by literature review on the topic including a survey on radiographers' competencies in referral assessment [10]. A pilot online survey was conducted in January 2020 through sending the questionnaire using 'Nettskjema' [11] to radiographers working in 6 different countries (Norway, United Kingdom (UK), Canada, Uganda, Ireland and South Africa). The survey was sent twice 10 days apart to allow for test–retest reliability. A final of 8 responses were received. A weighted kappa analysis was used to determine agreement for categorical data between the repeated measures. McHugh [12] states that kappa values below 0.6 indicate inadequate agreement among the raters, thus reduced reliability. All questions that were below 0.6 kappa value were removed or adjusted according to the participants' comments for the final survey.

The final questionnaire consisted of two main parts in addition to the background information. This study reports on the first part covering the questions on actions of radiographers when confronted with inappropriate referrals. The following two questions were asked with six actions listed and using a 5-point Likert scale (always, often, sometimes, rarely, never):

- Assuming you receive referrals with missing or unclear information, how often do you supplement the information by the following actions?
- Assuming you receive referrals with all relevant information included, but the requested examination is clearly not appropriate/justified, how often do you carry out the following actions?

The participants were also asked to rate their agreement (scale: strongly agree, agree, undecided, disagree, strongly disagree) on reasons that hindered them from taking part in referral assessment. A set of 10 possible reasons were listed.

The background section included demographics and professional characteristics of the participants. The participants were asked to state their main area (modality) of diagnostic radiography experience with options including conventional radiography, one advanced imaging (computed tomography (CT), magnetic resonance imaging (MRI), ultrasound, mammography or nuclear medicine) or multiple areas. The participants were further asked to indicate the final referral assessor before a patient's radiology examination is scheduled to be performed for each imaging modality in their work place. The participants also stated if they were delegated a responsibility for screening imaging referrals in their clinical practice.

Recruitment of participants and data collection

The final survey was distributed using 'Nettskjema' [11]. The target population were radiographers who follow activities organised by the International Society of Radiographers and Radiological Technologists (ISRRT). This target group was chosen because it mainly constitutes radiographers who are active in the profession and familiar or well orientated with practice regulations in their country. The survey was distributed to radiographers through the ISRRT networks, which included registered participants of the cancelled ISRRT 2020 World Congress due to the coronavirus (COVID-19) and active radiographers on ISRRT Facebook page or within ISRRT member state national societies. The

acknowledgements to distribute the survey were received from eight ISRRT national societies. The data was collected in 5 months, initially in April 2020 before the COVID-19 measures were implemented and between September and December 2020. The number of national society's members was registered to get an idea of how many radiographers the survey invitation could have possibly reached.

Data analysis

The data was analysed using IBM SPSS statistical software version 26. Descriptive analysis was used to show frequency in percentages. In the analysis, the 5-point Likert scales were re-coded into a 3-point scale, by merging the two responses at each end of the scales, to ease the interpretation and presentation of distribution of responses. The chi-square test of independence was used to determine association for the radiographers' actions when confronted with clearly unjustified referrals and hindrances to assessing referrals, with the independent variables: dichotomised *education level* (bachelor degree/equivalent versus master/PhD degree), *delegated responsibility to screen imaging referrals* (not sure/no versus yes) and 3 split *modality of practice* (conventional radiography versus one advanced modality versus multiple modalities). A p value ≤ 0.05 was considered statistically significant.

Results

Respondents and setting characteristics

The total number of respondents was 279. This represents a ranged from 0.1 to 6.8% of total member numbers as listed by the national radiography society. The respondents' demographics are displayed in Table 1. The majority of the respondents where from Asia (Indonesia/Taiwan) ($n=77$), the UK ($n=64$), Scandinavia (Norway/Denmark) ($n=33$) and Australia ($n=31$). The mean age was 38 years. The majority (74%) of the participants' education level was at bachelor's degree or equivalent. A total of 84% of the respondents reported currently working in clinical practice. The respondents worked or had experience from a broad range of modalities: conventional radiography (35%), one advanced modality (32%) and multiple areas (33%) which were inclusive of all imaging modalities and interventional radiography.

Radiographers' responsibility in referral assessment

A total of 75% of respondents who reported currently working in clinical practice ($N=233$) stated they are delegated the responsibility to screen imaging referrals. The radiographer was stated as final assessor before a patient's radiology examination is scheduled for conventional radiography by 55% of the respondents. The overall commonly reported practice, across the imaging modalities, is that radiographers mainly perform the referral assessing tasks together with the radiologists particularly for advanced modalities (Table 2).

Table 1 Demographic and professional characteristics of respondents ($N=279$)

Demographic and characteristics		*n* (%)
Continent/country	Asia (Indonesia/Taiwan)	77 (28)
	UK	64 (23)
	Scandinavia (Norway/Denmark)	33 (12)
	Australia	31 (11)
	Canada	12 (4)
	African countries[1]	21 (7)
	Other countries[2]	41 (15)
Gender	Male	131 (47)
	Female	148 (53)
Age (years)	< 30	71 (26)
	30–44	127 (46)
	45 +	80 (29)
Education level	PhD	16 (6)
	Master	56 (20)
	Bachelor or equivalent	207(74)
Currently in clinical practice	Yes full/part time clinical	233 (83)
	No	46 (17)
Modality of main experience	Conventional X-ray	98 (35)
	One advanced imaging modality[3]	90 (32)
	Multiple imaging modalities	91 (33)

[1]African countries; majority of respondents from Rwanda

[2]Other countries included Bangladesh, Cambodia, China, Estonia, Germany, Greece, Guyana, Ireland, Italy, Myanmar, Nepal, Netherlands, New Zealand, Palestine, Philippines, Singapore, Sultanate of Oman, the USA and Vietnam

[3]Advanced modality included CT, MRI, ultrasound, mammography or nuclear medicine

Radiographers' actions to supplement information

The respondents' main actions to supplement missing information were reported as often/always, to ask for information from the patient or accompanying relative (73%) and examining the body region of concern 70% (Fig. 1). These were followed by checking patients' medical records (67%). The respondents further reported slightly more often/always to discuss with the referring clinician (59%) than with the radiologist (55%) when seeking to supplement information.

Fewer respondents (34%) reported often/always to discuss with the patients' care provider.

Actions to justify imaging

The respondents reported to equally often/always consult the radiologist (69%), referring clinicians (69%) and a fellow radiographer (68%), when confronted with clearly unjustified referrals (Fig. 2). Fewer respondents reported to often/always return the referral along with a reason (36%) or change the referral to an appropriate examination (32%). The least frequent reported action was to conduct examinations as requested; however, 25% of the respondents reported the action as conducted often/always.

Table 2 Reported final assessors before a patient's radiology examination is scheduled for various modalities (percentages), $N=233$

Modality	Not applicable	Other	Radiologists only	Radiographers/ Radiologists	Radiographers only
Conventional radiography	5	4	5	32	55
CT	13	1	18	50	18
MRI	20	0.4	19	48	13
Ultrasound	11	6	24	40	20
Mammography	37	2	10	26	25
Nuclear medicine	54	3	14	23	7

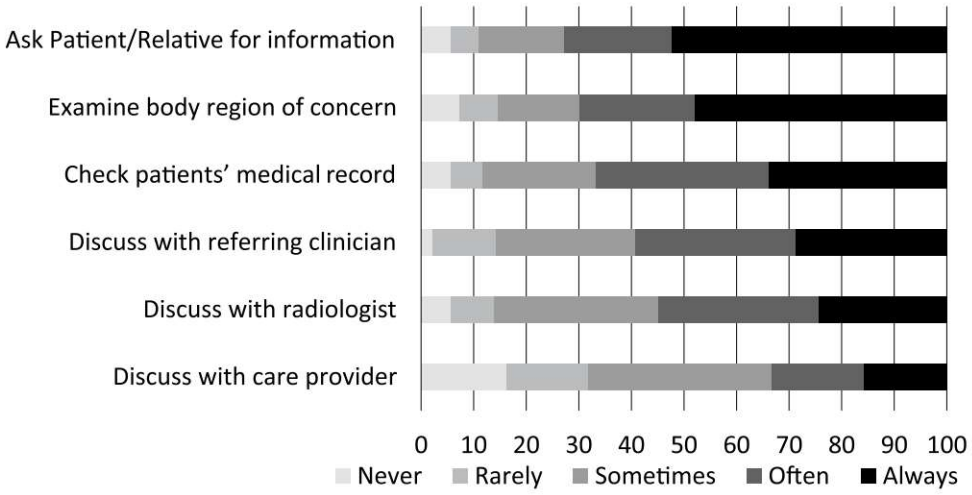

Fig. 1 Radiographers' reported actions to supplement missing referral information, percentages ($N=233$); only participants currently working in clinical practices responded

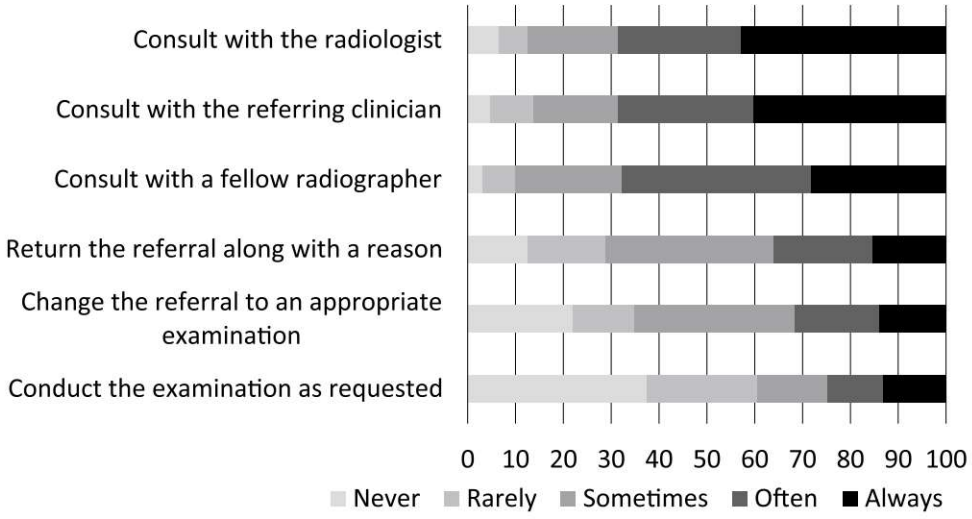

Fig. 2 Radiographers' reported actions when confronted with unjustified referrals, percentages ($N=233$); only participants currently working in clinical practices responded

A chi-square test showed statistically significant association as follows: Radiographers with bachelor's degree or equivalent more often reported to consult the radiologist compared to radiographers at masters or PhD level (70% vs. 63% often/always answers, $\chi^2 = 7.697$ (df)2, $p = 0.021$) and a fellow radiographer (73% vs. 51.0% often/always answers, $\chi^2 = 9.125$ (df)2, $p = 0.010$). Furthermore, the radiographers working in advanced or multiple modalities reported to consult the radiologist more frequency than those in conventional radiography only (77% and 73% vs. 56.3% often/always answers $\chi^2 = 11{,}210$, $df(4)$, $p = 0.024$). Finally, radiographers with the delegated responsibility to screen imaging referrals reported to more often return an unjustified referral to the referring clinician with giving a reason than those without the delegated responsibility (39% vs. 28% often/always answers, $\chi^2 = 14{,}450$, $df(2)$, $p = 0.001$). There were no observed statistically significant associations for other analysed actions.

Hindrances for radiographers' referral assessment

The main reported hindrances to radiographers' referral assessment are related to communicational and organisational factors in the referral process (Fig. 3). The communication factors ranked high agree/strongly agree, as hinders for assessing referrals were inadequate information in referral forms (83%) and ineffective communication among healthcare professionals (79%). The least reported hindrance in the communication category was lack of response from radiologists when ask about referral appropriateness (54%).

For the organisational factors, 70% of the respondents agreed/strongly agreed that lack of training in systematic assessment of referrals and 61% agreed/strongly agreed that lack of time allocation for assessing referrals were a hindrance. The least hindrance in the organisational category was patients showing up in the department before the referral is assessed, reported agree/strongly agree by 56% of the respondents.

The other factors relate to the radiographers' professional role and ability. A total 68% of respondents agreed/strongly agreed that cultures of medical profession dominance was a hindrance. The three suggested hindrances receiving the lowest scores for radiographers ability were lack of knowledge of clinical benefits of different imaging modalities, assessing of referrals perceived as not radiographers' responsibility and lack of knowledge of radiation dose rated 57%, 46% and 37% agree/strongly agree responses respectively.

A chi-square test showed few significant associations between hindrances and the three background variables (level of education, modality of practice and delegated the task to screen referrals). Only two significant associations were observed in the professional role and ability category. Radiographers delegated the task to screen referrals tend to consider perceiving referral assessment not a radiographers' responsibility as a hindering factor (43% vs. 26% strongly agree/agree answers, $\chi^2 = 5.915$ (df)2, $p = 0.05$).

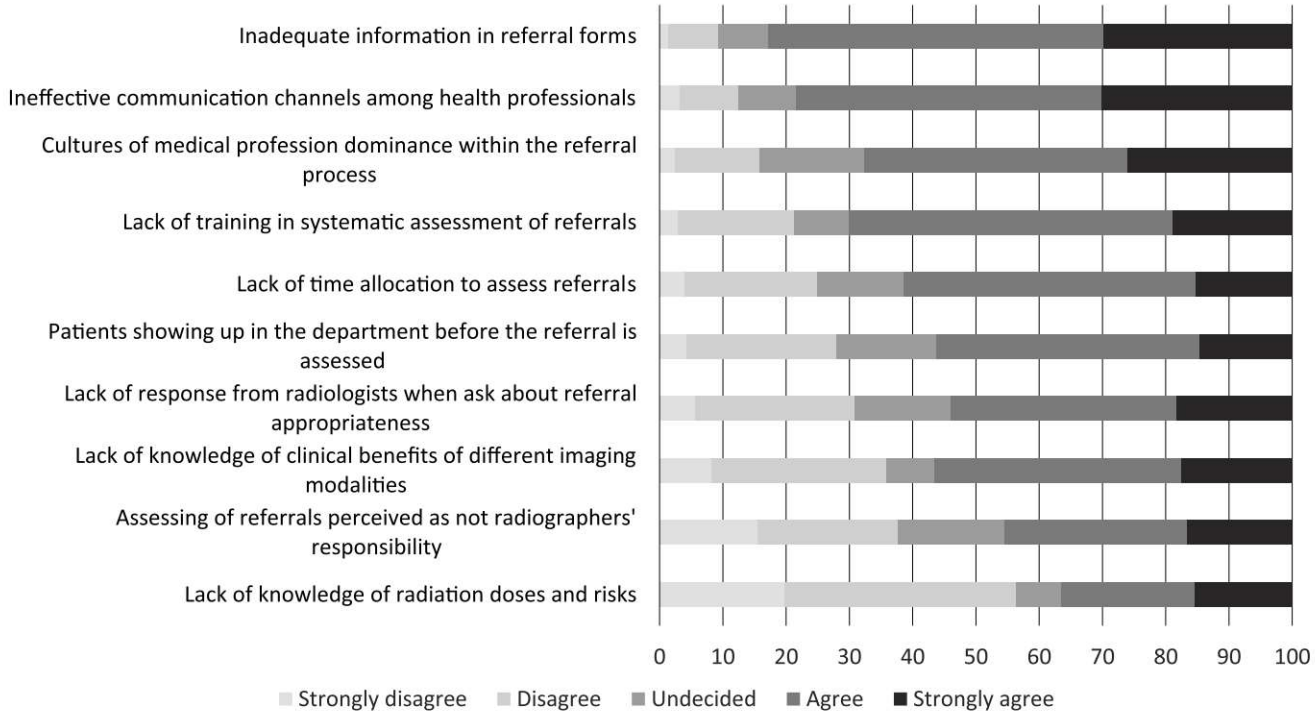

Fig. 3 Radiographers' reported hindrances to assessing referral percentages ($N = 279$)

Radiographers with a bachelor's degree or equivalent reported lack of knowledge of clinical benefits of different imaging modalities as a hindrance to participation compared to those with masters or PhD degree (33% vs. 43% strongly disagree/disagree answers, $\chi^2 = 6.286$ (df)2, $p = 0.04$).

Discussion

This study shows radiographers' participation in referral assessment in several ways and across all imaging modalities, which is important for delivery of quality care in radiology departments [1, 9], and potentially enable solutions for organised task-sharing between radiologists and radiographers [1].

Radiographers' actions to improve the referral assessment process

Our study shows radiographers supplementing missing information mainly through patient interactions. The radiographer-patient interactions are reported to assist radiographers to validate the referral information before conducting the radiological examination [13]. During such interactions, radiographers can recognise discrepancies in the referral form and obtain more information about the patient's medical condition, thus improving the quality of clinical information [9]. This assists to improve the justification process [14]. Furthermore, high-quality patient clinical information positively affects the radiologists' selection of imaging protocols [15], image interpretation accuracy and the radiology reports [16]. The clinical information also assist radiographers with decisions of patient positioning, imaging projections, exposure parameters and dose-optimisation, adding to patient safety [17].

When confronted with clearly unjustified referrals, our respondents tend to seek advice from the radiologist, referring clinician or a fellow radiographer. Particularly for advanced imaging, radiographers in our study report mostly to consult the radiologist. Consultation among healthcare professionals is advocated to enable effective justification of medical exposures [2]. Particularly imaging for non-standard protocols requires consultation and approval by the radiologist [3, 18]. Consultations among healthcare professionals are also important to clarify the best path for the patient and to ensure that all involved are looking out for the patient's needs [13]. Therefore, actions of consulting and discussing with both the referring clinicians and radiologist when confronted with unjustified referrals add to the patients' healthcare management.

In our study, few radiographers (36%) reported to often/always return an inappropriate referral to the referrer with a reason. Encouragingly the radiographers assigned the task to screen referrals showed to more likely return a referral with giving a reason. Returning a referral could be due to factors such as the requested examination not the best to answer the clinical question [19], repeated referrals without clear rationale [20] or improper timing of the procedure [21]. Patient's safety or contraindications are other factors, such as imaging for pregnant patients or in MRI referrals where the patient has metal implants in the body [22]. Where a referral is returned, it is advisable to document the reasons and inform the referring clinician. This further improves the patients' clinical information and adds to the quality of patient care [23].

Challenges to radiographers' participation and effects on patient care

Our study identifies two main categories of local circumstances that hinder radiographers to effectively participate in referral assessment: communicational and organisational factors. Inadequate information in referral forms and ineffective communication among healthcare professionals were identified as the main communication factors. Inadequately filled clinical information hinders an effective justification process [4]. Promoting the importance of sufficient clinical information, accompanied by use of referral guidelines and decision support tools, could be of benefit [24–26]. The quality of inter-professional communication is vital to reduce adverse effects that could affect the patients' referral management [22, 27]. Fatahi et al. [28] recommend joint discussions on indications, imaging methodology and routines, including imaging prioritisation ethics. Fatahi et al. [27] specifically report that quality radiologist-radiographer communication enhances the radiographers' skills in clinical practice, thus adding to the patients' safety and care. To promote smooth workflow and reduced interruptive verbal communication among the healthcare professionals, informatics tools with instant messaging systems could be of value in busy departments [29]. Strong inter-professional relationships further allow for direct communication among healthcare professionals, promoting better exchange of patient information [30].

In this study, lack of training and of time allocated to referral assessment tasks were reported as organisational hindrances for radiographers' participation. Training and time allocated for referral assessment tasks improve radiographers' skills and competencies within the justification process [31, 32].

The other reported hindrances relate to radiographers' professional role and ability. Cultures of medical dominance were rated quite high as hindrances in our study. This could be an indication of the reported prevalent cultures of medical dominance in radiology departments [33–35]. However, it could also reflect the radiographers' feeling of being in a subordinate position due to their lower medical and clinical knowledge to perform the task. Our study indicates that participation in tasks of referral assessment promotes a sense

of professional responsibility for the radiographers. This can create a platform for positive accountability where one critically assesses their way of clinical practice [36]. This further adds to the radiographers' vigilant practices to ensure presence of the justification process [9].

Potential bias, limitations and strengths of the study

The number of responses in the study is certainly very low compared to the high number of radiographers worldwide. In adherence with the European General Data Protection Regulation, the survey was not distributed directly to individual participants, but through the ISRRT networks to avoid collection of personal emails. Therefore, the study is potential to selection bias as only participants who had access to and information from ISRRT organisation networks were able to view and respond to the survey. This further reduces the amount of potential participants reached. Language also contributed to non-responses as the survey was only in English. The sample analysis for the hindrances to referral assessment included a proportion of radiographers (17%), not currently working in clinical practice. This could further affect the representative nature of respondents. However, this group was included to gain knowledge of the issue from both clinical and administrative or academic perspectives. Various other organisational settings and country legislations pertaining to the individual radiographers' work environment are not considered. The radiography education level and content vastly vary among countries and institutions of learning. The competencies and level of responsibility in referral assessment will therefore differ among radiographers at similar degree level internationally. Only the radiographers' perceptions are investigated; thus, the reported challenges could be bias in support of the profession. The study was however explorative to get an impression on the role and attitudes of radiographers' participation in referral assessment, broadly across settings and countries. The sample group was mainly radiographers well versed in the profession. Despite the low response rate, the results create a platform for further research on how the radiography profession can contribute efficiently to justification of imaging referrals.

Conclusion

The radiographers' actions of supplementing clinical information and consulting colleagues about inappropriate referrals improve the workflow and the quality of patient services. Promoting inter-professional relationships, providing training and allocating time for referral assessment will improve participation and competencies of radiographers. Policies on the required training for radiographers assessing referral at the stages of justification, authorisation and general referral review are vital. Future research should focus on clearly identifying education requirements including theoretical and practical aspects for radiographers performing justification and authorisation tasks.

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Statistics and biometry No complex statistical methods were necessary for this paper.

Informed consent Written informed consent was obtained from all subjects in this study.

Ethical approval Institutional Review Board approval was obtained from the Norwegian Centre for Research Data (NSD), approval reference number 472337.

Methodology
- prospective
- observational
- multicenter study

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Paper IV

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BMC Health Services Research

RESEARCH

Open Access

The value of referral information and assessment – a cross sectional study of radiographers' perceptions

Catherine Chilute Chilanga*, Hilde Merete Olerud and Kristin Bakke Lysdahl

Abstract

Background: Radiology professionals are frequently confronted with referrals containing insufficient clinical information, which hinders delivery of safe and quality medical imaging services. There is however lack of knowledge on why and how referral information is important for radiographers in clinical practice. This study explores what purposes referral information is used/ useful for the radiographers, and the benefits of involving them in assessing referrals.

Methods: A cross sectional study was conducted of radiographers recruited through the International Society of Radiographers and Radiological Technologists (ISRRT) networks. A questionnaire was developed and distributed consisting of 5-point Likert scale questions on a) use/usefulness of referral information for 12 listed purposes and b) the benefits of radiographers assessing referrals for 8 possible reasons. The questionnaire was validated using a test–retest reliability analysis. Kappa values ≥0.6 were accepted. SPSS software was used for data analysis and chi-square tests to determine associations between using referral information and background variables.

Results: Total respondents were 279 ($n=233$ currently in clinical practice and $n=46$ in other positions). The participants in clinical practice ranked high all 12 listed purposes for use of referral information, and all except one received ≥60% 'frequent'/'very frequent' responses. Use for patient identification purposes received the highest score (97% 'frequently'/'very frequently' responses), followed by ensuring imaging of the correct body region (79% 'very frequently' responses). Radiographers not currently working in clinical practice ranked the 'usefulness' of listed items similarly. Significant associations between frequent use of referral information and education level were not observed, and only three items were significantly associated with modality of practice. All items on benefits of radiographers assessing referrals received ≥75% 'agree'/'strongly agree' scores. The items ranked highest were promotes radiographers' professional responsibility and improves collaboration with radiologists and referring clinicians, with 72 and 67% strongly agreed responses, respectively.

Conclusion: Radiographers use referral information frequently for several purposes. The referral information is needed for justifying and optimising radiological procedures, hence crucial for ensuring patient safety and high-quality services. This further emphasis why radiographers perceive several benefits of being involved in assessing the referral information.

Keywords: Referral and consultation, Radiology department hospital, Patient safety, Health services research

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Background

When requesting a radiological procedure, the referring clinician sends a referral (request) form containing the patients' relevant clinical information to the radiology

department [1]. This information is vital for patients' quality care and utilisation of services in radiology departments [2, 3]. The radiologists and radiographers assess the referral information to determine whether the requested radiological examination is warranted and appropriate to confirm or rule out diagnosis of a given condition or disease [4]. Selecting the most appropriate examination prevents patients' exposure to unnecessary radiation doses in instances where ionising radiation is used [5]. The patients' safety when conducting radiological examinations is also dependent on the information in the referral. The radiologists and radiographers will need information about the patients' identity [2], general physical condition and pre-existing illnesses to ensure safety during the procedure [6]. This could be particularly critical when the procedure requires using contrast-media to better visualise anatomy, [7] as contrast media is known to cause adverse effects in patients with certain pre-existing medical conditions [8–11].

The referral information determines patient and procedure information such as radiographic patient positioning, procedure projections and exposure parameters [6, 12]. High quality referral information also enables better radiologist – radiographer communication on visualisation of pathology and suitable radiographic technique to employ to obtain imaging of diagnostic value [13]. The radiographers could further liaise with the radiologists on acceptable images, taking account of the patients' condition. The radiology report sent to the referring clinician of the outcome of the procedure is also influenced by the referral information. Studies show that referrals of high information quality improve image interpretation accuracy, clinical relevance, and reporting confidence for the radiologists [14]. The referral information is therefore useful for verifications about a patient and procedures [15], and procedure decision-making [6, 16] along the medical-imaging care continuum.

Referral information accordingly influences the quality of the outcome of the services provided in radiology departments. Inadequate referral information is reported as a cause of false positive diagnosis and incidental findings in medical imaging [17, 18], which instigates futile patient follow-up investigation and treatment, and consequently leading to unnecessary overuse of health resources and services [18]. Scheduling of the radiology examination according to priority or urgency is effectively conducted using the information on the referral [16]. The referral quality therefore potentially affects practicing according to healthcare priority setting criteria.

Despite the many indications outlined above on the value of referral information there is little evidence of why and how this is important in clinical practice for radiographers. This study aimed to map the value of referral information and assessment from the perceptive of radiographers working in clinical and non-clinical settings. The objectives were two-fold; to explore a) for what purpose the radiographers make use of referral information or consider it useful and b) the possible benefits of involving radiographers in assessing referrals.

Methods

This research is the second part of a larger study on radiographers' involvement in the process of assessing imaging referrals. The first part of the study analysed the radiographers' actions and challenges when confronted with unjustified radiology referrals and the paper [19] provides more detail on methods.

Study settings

A cross sectional study was conducted of radiographers internationally who follow activities organised by the International Society of Radiographers and Radiological Technologists (ISRRT). The ISRRT is the professional organisation representing radiographers globally and its mission is to improve the standards of delivery and practice of diagnostic imaging and radiation therapy worldwide [20]. The target group were radiographers currently working in clinical practice in various imaging modalities (clinical radiographers) and those not in clinical practice but have clinical experience in diagnostic radiography (non- current clinical radiographers i.e. radiography administrators, researchers and educators).

Participant recruitment and data collection

An online survey was distributed using a web form ('Nettskjema') [21] for 5 months, initially in April 2020 and between September and December 2020. The recruitment of participants and data collection was conducted using ISRRT networks (see [19]). Non-probabilistic, convenience sampling methods were employed to collect the data. The targeted sample population was selected because it constitutes of radiographers who are assumed to be active in the profession and familiar or well orientated with practice regulations in their respective countries.

Questionnaire

A questionnaire was piloted and validated using a test–retest reliability analysis. In the first part of this section of the study, questions about perceived usefulness of referral information were asked. The questions were phrased slightly different for radiographers working in clinical and non-clinical settings. After the statement 'Information in the referral can be useful for a number of reasons. The radiographers working in clinical setting were asked to rate how often they make use of the referral information

for 12 listed number of purposes, while radiographers not currently working in a clinical setting were asked to rate their agreement on the usefulness of the same 12 purposes. A five-point Likert response scale was used in both cases 'Very frequently, Frequently, Occasionally, Rarely, Never' and 'Strongly agree, Agree, Undecided, Disagree, Strongly disagree', for clinical radiographers and non- current clinical radiographers respectively.

For the second main question, all the participants were asked to rate their agreement (scale: strongly agree, agree, undecided, disagree, strongly disagree), on possible benefits of involving radiographers in assessing radiology referrals. A set of 8 possible benefits were listed. The background section included demographics and professional characteristics of the participants.

Data analysis

The data was analysed using IBM SPSS statistical software version 26. Descriptive analysis was used to show frequency in percentages. The data was split in to 2 cohorts: radiographers in clinical and non-clinical settings to compare variations in responses between the two groups. To analyse difference in how subgroup of clinical radiographers reported their use of referral information, the scales were dichotomised into frequently to never (1) and very frequently (2), based on the response pattern. A chi-square test of independence was used to determine association between the clinical radiographers perceived use of referral information, with the independent variables: dichotomised education level (Bachelor's degree/equivalent versus master/PhD degree), and 3 split modality of practice (Conventional radiography versus One advanced modality which included CT, MRI, Ultrasound, Mammography or Nuclear medicine, versus Multiple modalities). A p value ≤ 0.05 was considered statistically significant.

Ethics statement

Ethical approvals were obtained from the Norwegian centre for research data (NSD) reference number 472337 in Norway. All the participants consented to the study through the online portal.

Results

Respondents and settings characteristics

The total number of respondents were 279 ($n=233$ clinical radiographers, $n=46$ non-current clinical radiographers), as in Table 1. Most of the respondents where from Asia (Indonesia/Taiwan) (28%), United Kingdom (UK) (23%), Scandinavia (Norway/Denmark) (12%), and Australia (11%). The mean age was 38 years. A total 74% of the participants had education level at bachelor's degree or equivalent. Modality of practice of the participants was reported as follows; 35% conventional radiography, 32% one advanced modality and 33% multiple modalities.

Use/usefulness of referral information

The radiographers in clinical practice reported to very frequently use information in the referral for a variety of reasons (Fig. 1). The radiographers not-currently in clinical settings were also mostly in agreement to the usefulness of the referral information as reported by those in clinical practice (Fig. 2). Details on both groups' responses follows subsequently.

Clinical radiographers

Some of the reasons for use of the referral information concerns verification of the patient, which all received high scores. The clinical radiographers rated using the referral information for patient identification highest with combined score of 'frequently'/'very frequently' responses of 97%. Using the referral information to ensure imaging of the correct body region was rated quite high at 79% 'very frequently' used responses. This was followed by scores 'very frequently' using the information for obtaining previous imaging information (59%).

Other reasons for using the referral information for processes are related to patient positioning, where a rank of 'very frequently' responses was obtained for ensuring correct patient position (66%) and selection of appropriate projections (63%). The lowest rank related to patient positioning aspects was 'very frequently' to use the information for ensuring the patients' comfort during the procedure (36%) and assessing if the patient can tolerate to undergo the procedure (35%).

A third group of items concerned use the referral information for procedure decisions, were the highest number of 'very frequently' used responses was given for selecting the appropriate exposure parameters, selecting the appropriate imaging modality, and administration of pharmaceuticals (such contrast media, radioisotopes) as 50, 48 and 47% respectively. The lowest rank in this category was 'very frequently' using the information in accessing lab results, rated by 32% of respondents.

The overall lowest score was obtained for using the referral to inform the patient of possible diagnosis stated, with 63% 'never/rarely/occasionally' responses.

A chi square test performed (Table 2) showed significant association between a few of the variables (items) on the purposes of radiographers' frequent use of referral information and modality of practice. No significant associations were observed between the use of referral

Table 1 Demographic and professional characteristics of respondents ($N = 279$)

Sample characteristics		Non-current clinical radiographers[a]	Clinical radiographers	Total responses
		n (%)	*n* (%)	*n* (%)
Participants		46 (100)	233 (100)	279 (100)
Continent/ country	Asia (Indonesia/Taiwan)	17 (37)	60 (25.8)	77 (27.5)
	United Kingdom (UK)	10 (21.7)	54 (23.2)	64 (22.9)
	Scandinavia (Norway/Denmark)	3 (6.5)	30 (12.9)	33 (11.8)
	Australia	3 (6.5)	28 (12.0)	31 (11.1)
	Canada	2 (4.3)	10 (4.3)	12 (4.3)
	African countries[b]	3 (6.5)	19 (8.2)	22 (7.9)
	Other countries[c]	8 (17.2)	32 (13.7)	40 (14.3)
Gender	Male	26 (56.5)	105 (45.1)	131 (46.9)
	Female	20 (43.5)	128 (54.9)	148 (53.1)
Age (years)	< 30	8 (17.4)	63 (27.2)	71 (25.5)
	30–44	19 (41.3)	108 (46.6)	127 (45.5)
	45+	19 (41.3)	61 (26.3)	80 (28.7)
Education level	PhD	8 (17.4)	8 (3,4)	16 (5.7)
	Master	13 (28.3)	43 (18.5)	56 (20.1)
	Bachelor+ equivalent	25 (54.3)	182 (78.1)	207 (74.2)
Modality of practice	Conventional radiography	18 (39.1)	80 (34.3)	98 (35.1)
	One advanced imaging modality[d]	15 (32.6)	75 (32.2)	90 (32.3)
	Multiple modalities	13 (28.3)	78 (33.5)	91 (32.6)

[a] Radiographers not currently working in clinical practice included those in administration, research, education or other

[b] African countries; majority of respondents from Rwanda

[c] Other countries included Bangladesh, Cambodia, China, Estonia, Germany, Greece, Guyana, Ireland, Italy, Myanmar, Nepal, Netherlands, New Zealand, Palestine, Philippines, Singapore, Sultanate of Oman, USA, Vietnam

[d] Advanced modality included CT, MRI, Ultrasound, Mammography or Nuclear medicine

information in the listed items and the dependent variable education level.

Non-current clinical practice radiographers

A similar rating in agreement on usefulness of referral information by the non-current clinical radiographers was observed (Fig. 2). The radiographers not currently working in clinical practice ranked high the usefulness of referral information for patient verification as follows; combined 'agree'/'strongly agree' on patient identification (100%) and 'strongly agreed' on ensuring imaging of the correct body region responses (63%). However, agreement as useful to obtain previous imaging information was ranked lower by the non-current clinical radiographers, 46% 'strongly agreed' compared to 'very frequent' used score stated by 59% clinical radiographers.

Using the referral information for processes of patient position was rated 'strongly agreed' for ensuring correct patient position 52% and selecting the appropriate projections 50%. Using the referral information for assessing if the patient can tolerate to undergo the procedure and ensuring the patients' comfort during the procedure were ranked low in this category as 30 and 26% respectively.

In procedure decisions, the non-current clinical practice radiographers rated use for administration of pharmaceuticals and selecting the appropriate imaging modality as 48 and 46% 'strongly agreed' responses respectively. In this category using the information for 'selecting the appropriate exposure parameters', and 'accessing lab results', was ranked lowest as 33 and 22%, 'strongly agreed' responses. Use of the referral information in 'informing the patient of possible diagnosis' was however rated higher compared to the clinical radiographers, with combined ranked as useful 'strongly agreed'/'agreed scores' 57% (non- current clinical radiographers) versus 37% 'very frequent'/'frequent' used scores' (clinical radiographers).

Benefits of involving radiographers in referral assessment

In general, the clinical and non-current clinical radiographers provided similar responses on the benefit of involving radiographers in referral assessment. All the listed items (Fig. 3) contained benefits to the patients in shape of quality of care and services, some directly and others more indirect originating from benefits of the healthcare professionals providing the care and services. In total

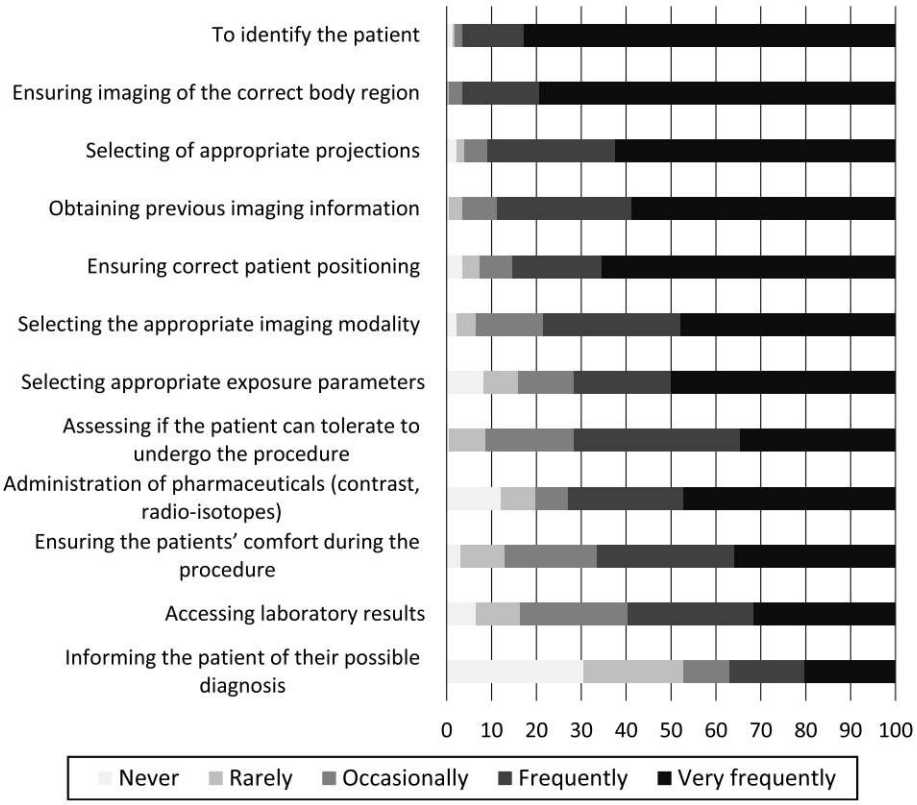

Fig. 1 Clinical radiographers frequent use of referral information for tasks in clinical practice. Items are arranged by mean values

these categories are ranked similarly. Among the items related to direct benefits for quality of care and services, the high ranked were 'promotes radiographers' professional responsibility', 'enables efficient use of radiology services', 'improves the radiographer-patient communication', and 'reduces incidences and errors', receiving 72, 57, 56 and 52% 'strongly agreed' responses respectively. Improves the patients' radiology report was low ranked ('strongly agreed' responses by 38% radiographers).

In the category of benefits to the healthcare professionals, the items that ranked high were 'improves radiographers' collaboration with radiologists and referring clinicians' and 'promotes sharing of tasks among radiology staff', with 67 and 53% 'strongly agree' responses respectively. The lowest score in this category was 'reduces the burden of the radiologists' workload' (37% 'strongly agree' responses).

Discussion

Our study shows radiographers in various imaging modalities frequently making use of referral information for several activities across the imaging care continuum to manage the patient. The crucial value of referral information may not be well known outside the radiology environment. This lack of awareness may be one of the reasons why referrals lacking vital clinical information seems to be a persistent problem [22–25]. Our study shows that radiographers need proper referral information to ensure patient safety, high quality care and services in radiology departments.

Use of referral information for radiographers' clinical practice

Our study shows radiographers using the referral information to identify the patient, verify information about the patient and the procedure. Almost all the respondents in our study stated the referral information to be very useful to identify the patient. Ensuring that the radiological procedure is delivered to the correct patient is the starting point of patient safety [15]. The participants further ranked high using the referral information for correct patient position and selection of appropriate radiographic projections which ensures that imaging of diagnostic value is obtained and enable an accurate diagnosis. Patient identification and ensuring the appropriate imaging procedure are selected and conducted optimally further adhere to the two core principles of radiation protection in medicine termed 'justification'

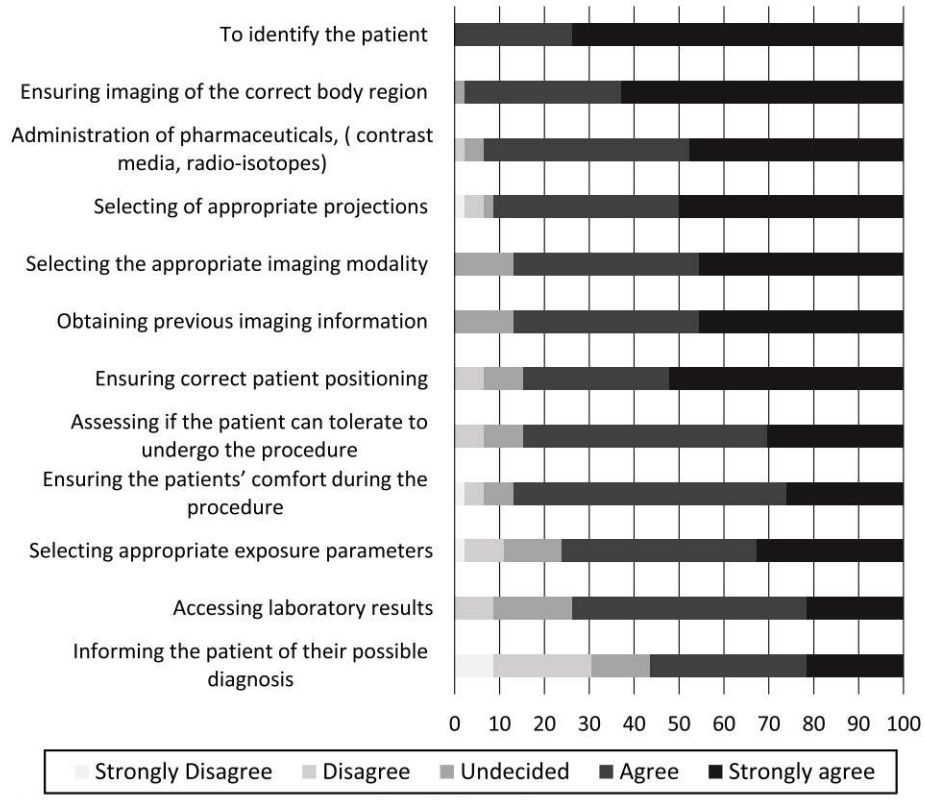

Fig. 2 Not-current clinical practice radiographers' agreement of use of referral information. Items are arranged by mean values

Table 2 Radiographers' reported use of referral information[a] for different purposes[b] associated with modality of practice

Purpose of use of referral information	Modality			Chi square values	*p* values
	Conventional	Advanced	Multiple		
Access laboratory results	16%	41%	43%	15.808 (df)2	< 0.001
Administration of pharmaceuticals i.e. contrast agents or isotopes	25%	35%	41%	9.614 (df)2	0.01
Selecting of the appropriate imaging modality	31%	27%	42%	7.195 (df)2	0.01

[a] Percentages of 'very frequent' use scores are displayed

[b] Only the purposes of use items (from the list of 12) with statically significant association are displayed

and 'optimisation'. The justification principle affirms that the benefits of medical imaging for patients should outweigh the radiation risks and other possible risks [5]. This entails that the radiographers evaluate the referral information against the requested radiological procedure and ensure that the correct imaging modality is selected before performing the procedure. This further ensures that the patient is not exposed to unnecessary risks due to the procedure. Optimisation ensures that radiation doses when used are kept as low as reasonably achievable (ALARA), and imaging of diagnostic value is obtained [5]. During optimisation the imaging procedure, doses, parameters, use of contrast media, and other drugs must be adapted to the individuals' specific clinical question [7]. Optimisation of procedures will therefore require that the radiographers select the most appropriate radiographic projects and exposure parameters to ensure that the procedure is optimally conducted with the minimum possible radiation exposures to the patient.

Using the referral information for assessing laboratory results and administration of pharmaceuticals is observed in our study mainly in clinical radiographers working in advanced imaging modalities. This was anticipated as most advanced imaging procedures use contrast

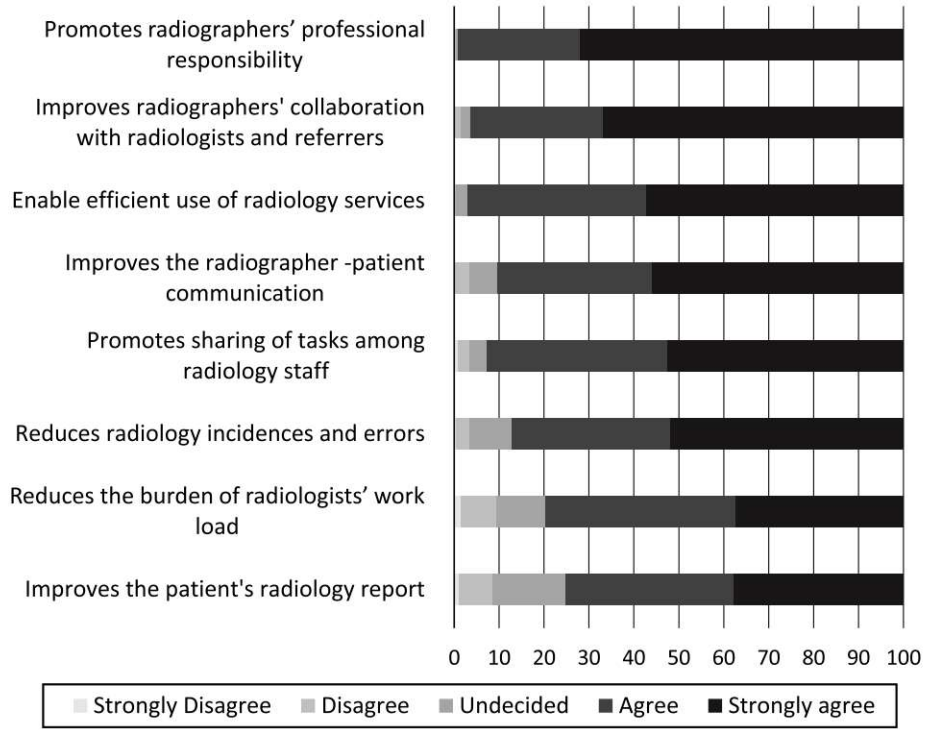

Fig. 3 Radiographers' perceived agreement of benefits of their involvement in assessing referrals. Items are arranged by mean values

medium which causes some adverse reactions in certain patients [26]. For example, checking of laboratory results such as blood tests that show estimated glomerular filtration rate can determine kidney function status in patients receiving contrast enhanced imaging [11], and ensures safety use of contrast media during imaging procedures.

In the chi square test analysis in our study, no significant associations were observed between the items on radiographer's use of clinical information and the dependent variable education level. This indicates that referral information is frequently used by all radiographers' and at all levels in clinical practice. Our results support those by Lundvall, et al. [27] that states that the radiographers' professional work and responsibilities in image production involves a process of planning, producing the images, and evaluation, where one of the main features of their professional work is patient safety.

Benefits of radiographers' assessing referrals

Our study show that the radiographer's assessing referrals directly or indirectly facilitates provision of quality care and services in radiology departments. First, the respondents in our study ranked highly that radiographers' assessing referrals improves professional collaboration with radiologists and referring clinicians and promotes sharing of professional tasks. This indicates that radiographers assessing referrals has benefits for the professionals working within the patients' referral pathway, which indirectly enhances quality of care and health services. Interprofessional collaborative practice occurs when professionals with different backgrounds work together to deliver the highest quality of healthcare [28]. This provides platforms for better professional communication and teamwork which further support quality patient management across the care pathway [29]. Professional task sharing does not only assist with efficient distribution and organises of work tasks, but also facilitates transfer of knowledge and skills among professions. Knowledge sharing among the radiology professionals is reported to assist with professional development and creates a supporting environment for the radiographers [30]. Supporting environments are further reported to increase job satisfaction of healthcare professionals [31], in turn facilitating provision of quality care.

Second the respondents in our study ranked highly that radiographers assessing referrals promotes professional responsibility. Professional responsibility in healthcare relates to how one performs their work based on ethical values and expected professional standards [32]. Professional responsibility therefore promotes commitment to ensuring quality care. The third factor the respondents ranked high for benefits of radiographers assessing

referrals in our study was that it enables efficient use of radiology services. Our findings are supported by Sheth et al. [33], that report that not only does radiographers' involvement in assessing referrals improve patients' safety and experience, but also provides an efficient workflow in radiology department. The other benefits to radiographers assessing referral ranked high in our study included, improves the radiographer-patient communication, and reduces incidences and errors. Studies show that through patient communication, radiographers gather vital information about the patient which adds to the patient's clinical history and is valuable for overall health management [27]. This further reduces incidences and errors [6] and improves the justification and optimisation processes [34]. Ensuring occurrence of justification and optimisation in radiology departments further prevents over-utilisation of radiology resources as unwarranted and repeated imaging is avoided and high-quality imaging of diagnostic value is provided.

Strength and limitations of study

This study had some limitations. The number of participants were quite low as expected of online survey and the recruitment process. In addition, language contributed to non-responses as the survey was only in English. The difference in organisational processes in radiography departments and country practice legislations could have influenced the radiographers' responses on how they make use of referral information within their respective institutions. A focused study of individual centres in selected countries could provide better detail on ways and differences radiographers use the referral information. The analysis of responses in the study were however based on expected or required standard practice. The responses on the benefits to assessing referral could be biased towards the radiography profession as the included sample group were only radiographers. The recruitment process indicates that the sample group are not representative for radiographers world-wide, which is an obvious limitation. On the other hand, this sample of radiographers are assumed to be well versed in the profession and assumed to be quite knowledgeable and experienced about the current and expected practices in their various clinical practices and respective countries. This could have strengthened our findings.

Conclusion

Information in the referral is vital for radiographers' clinical practice and is used frequently for several purposes. The referral information is needed for justifying and optimising radiological procedures, hence crucial for ensuring patient safety and high-quality care and services. It is therefore vital that radiographers are trained to systematically evaluate and supplement referral information in clinical practice. Radiographers' involvement in assessing referrals further promotes provision of quality professional work based on ethical values and standards.

Abbreviations

ALARA: As Low As Reasonably Achievable; CT: Computed Tomography; ISRRT : The International Society of Radiographers and Radiological Technologists; MRI: Magnetic Resonance Imaging.

Acknowledgements

We wish to thank the International Society of Radiographers and Radiological Technologists (ISRRT) and their respective affiliated national societies that facilitated the research and assisted in the distribution of the research questionnaire.

Authors' contributions

In the planning of the research all authors HO, KL and CC were involved. The design of the questionnaire and validation analysis were mainly done by CC and KL. HO contributed to the edit, revision, and validation analysis of the questionnaire. KL and HO facilitated the distribution of the questionnaire. The distribution of the questionnaire and follow up of data collection was conducted by CC. The sorting of data was conducted by CC. All the authors CC, HO and KL discussed and reviewed all the processed data and the final data analysis. The manuscript was written by CC. HO and KL edited and reviewed all parts of the manuscript. All the authors approved submission of the final manuscript. CC submitted the final manuscript.

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Availability of data and materials

The datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

The Norwegian centre for research data (Norsk senter for forskningsdata) NSD review board in Norway granted the ethical approval for this study, reference number 472337. Written information about the study was given to all the participants and informed consent obtained using an online portal. All methods used for data collection and processing were performed in accordance with the NSD standard ethical guidelines and regulations.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no conflict of interests.

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Publisher's Note

Requisition Vetting Project
CT Examinations

University of
South-Eastern Norway

Sign In

- **Ziltron to add text box for study code**

General Demographics

- Years qualified as a radiographer: Free Text
- Radiographer position: Chief/lead MRI radiographer, senior radiographer, radiographer, Radiographer manager, Radiography teacher
- Nationality: Free text

- Do you routinely vet CT patient requisitions:
  - all the time
  - often
  - occasionally
  - never.
- Comment box

Requisition 1
CT Brain

Patient presents to Emergency Department with seizures. ? temporal lobe epilepsy.

1. As part of clinical justification, would you consider this request:
    - To be appropriate
    - Possibly appropriate but discussion with radiologist required
    - Possibly appropriate but discussion with referring clinician required
    - Not appropriate
    - Not sure

Requisition 1
CT Brain

Patient presents to Emergency Department with seizures. ? temporal lobe epilepsy.

2. If you have a concern what is it?
    - Free text

3. Would you recommend an alternative examination?
    - Free text

Requisition 2
CT abdomen

Pregnant patient. Severe abdominal pain. ? appendicitis

1. As part of clinical justification, would you consider this request:
    - To be appropriate
    - Possibly appropriate but discussion with radiologist required
    - Possibly appropriate but discussion with referring clinician required
    - Not appropriate
    - Not sure

Requisition 2
CT abdomen

Pregnant patient. Severe abdominal pain. ? appendicitis

2. If you have a concern what is it?
    - Free text

3. Would you recommend an alternative examination?
    - Free text

Requisition 3
CT Brain

Patient has tingling and numbness in face. ? multiple sclerosis.

1. As part of clinical justification, would you consider this request:
    - To be appropriate
    - Possibly appropriate but discussion with radiologist required
    - Possibly appropriate but discussion with referring clinician required
    - Not appropriate
    - Not sure

Requisition 3
CT Brain

Patient has tingling and numbness in face. ? multiple sclerosis.

2. If you have a concern what is it?
    - Free text

3. Would you recommend an alternative examination?
    - Free text

Requisition 4
CT Abdomen

Acute low abdominal pain. ? stone in urinary tract.

1. As part of clinical justification, would you consider this request:
    - To be appropriate
    - Possibly appropriate but discussion with radiologist required
    - Possibly appropriate but discussion with referring clinician required
    - Not appropriate
    - Not sure

Requisition 4
CT Abdomen

Acute low abdominal pain. ? stone in urinary tract.

2. If you have a concern what is it?
    - Free text

3. Would you recommend an alternative examination?
    - Free text

Requisition 5
Whole Body CT

Patient with a history MGUS now has bone pain and loss of appetite.
? multiple myeloma

1. As part of clinical justification, would you consider this request:
    - To be appropriate
    - Possibly appropriate but discussion with radiologist required
    - Possibly appropriate but discussion with referring clinician required
    - Not appropriate
    - Not sure

Requisition 5
Whole Body CT

Patient with a history MGUS now has bone pain and loss of appetite. ? multiple myeloma

2. If you have a concern what is it?
    - Free text

3. Would you recommend an alternative examination?
    - Free text

Thank you

just 2 more slides

Do you use national, international or local guidelines when vetting referrals?”

- Yes
- No

If ‘Yes’, please select which guidelines you would use?

- American College of Radiology (ACR)
- Royal College of Radiology (RCR)
- National Institute of Health and Care Excellence, United Kingdom (NICE)
- Western Australia Diagnostic Imaging Pathways
- European Society of Radiology (ESR)
- Local / departmental
- National
  - Please specify
- Other
  - Please specify

? A drop down menu here.

Number of years working in CT

- free text

Do you work full time or part time in CT

- free text

Do you have a professional qualification in CT:

- MSc (90-120ECTS)
- Graduate Diploma (60ECTS)
- Graduate Certificate (30ECTS)
- Hospital training in CT only

In what country did you do postgraduate CT training

- free text

THANK YOU

University of
South-Eastern Norway

Requisition Vetting Project

MRI Examinations

Sign In

- **Ziltron to add text box for study code**

- Years qualified as a radiographer: Free Text
- Radiographer position: Chief/lead MRI radiographer, senior radiographer, radiographer, Radiographer manager, Radiography teacher
- Nationality: Free text

- Do you routinely vet MRI patient requisitions: all the time; often, occasionally, never.

- Comment box

Requisition 1
MR MRCP

Patient presents with severe abdominal pain and jaundice. ? gallstones.

1. As part of clinical justification, would you consider this request:
    - To be appropriate
    - Possibly appropriate but discussion with radiologist required
    - Possibly appropriate but discussion with referring clinician required
    - Not appropriate
    - Not sure

Requisition 1
MR MRCP

Patient presents with severe abdominal pain and jaundice. ? gallstones.

2. If you have a concern what is it?
    - Free text

3. Would you recommend an alternative examination?
    - Free text

Requisition 2
MRI Knee

Chronic knee pain. ? Osteoarthritis (OA)

1. As part of clinical justification, would you consider this request:
    - To be appropriate
    - Possibly appropriate but discussion with radiologist required
    - Possibly appropriate but discussion with referring clinician required
    - Not appropriate
    - Not sure

Requisition 2
MRI Knee

Chronic knee pain. ? Osteoarthritis (OA)

2. If you have a concern what is it?
    - Free text

3. Would you recommend an alternative examination?
    - Free text

Requisition 3
MRI Lumbar Spine

Patient involved in heavy lifting as part of work. Low back pain with saddle paraesthesia

1. As part of clinical justification, would you consider this request:
    - To be appropriate
    - Possibly appropriate but discussion with radiologist required
    - Possibly appropriate but discussion with referring clinician required
    - Not appropriate
    - Not sure

Requisition 3
MRI Lumbar Spine

Patient involved in heavy lifting as part of work. Low back pain with saddle paraesthesia

2. How urgent do you think this request is?
    - Very urgent- to be completed in 6 hours
    - Urgent- to be completed in 24 hours
    - Slightly urgent – to be completely within a week
    - Routine- to be completed within 6 weeks

Requisition 3
MRI Lumbar Spine

Patient involved in heavy lifting as part of work. Low back pain with saddle paraesthesia

3. If you have a concern what is it?
    - Free text

4. Would you recommend an alternative examination?
    - Free text

Requisition 4
MRI Internal Auditory Meatus (IAM's)

Severe facial pain. Family history of cancer. ? tumour

1. As part of clinical justification, would you consider this request:
    - To be appropriate
    - Possibly appropriate but discussion with radiologist required
    - Possibly appropriate but discussion with referring clinician required
    - Not appropriate
    - Not sure

Requisition 4
MRI Internal Auditory Meatus (IAM's)

Severe facial pain. Family history of cancer. ? tumour

2. If you have a concern what is it?
    - Free text

3. Would you recommend an alternative examination?
    - Free text

Requisition 5
MRI Brain

History of lung cancer. ? brain metastases.

1. As part of clinical justification, would you consider this request:
    - To be appropriate
    - Possibly appropriate but discussion with radiologist required
    - Possibly appropriate but discussion with referring clinician required
    - Not appropriate
    - Not sure

Requisition 5
MRI Brain

History of lung cancer. ? brain metastases.

2. If you have a concern what is it?
    - Free text

3. Would you recommend an alternative examination?
    - Free text

Thank you

just 2 more slides

Do you use national, international or local guidelines when vetting referrals?”

- Yes
- No

If ‘Yes’, please select which guidelines you would use?

- American College of Radiology (ACR)
- Royal College of Radiology (RCR)
- National Institute of Health and Care Excellence, United Kingdom (NICE)
- Western Australia Diagnostic Imaging Pathways
- European Society of Radiology (ESR)
- Local / departmental
- National
  - Please specify
- Other
  - Please specify

? A drop down menu here.

Number of years working in MRI

- free text

Do you work full time or part time in MRI

- Free text

Do you have a professional qualification in MRI

- MSc (90-120ECTS)
- Graduate Diploma (60ECTS)
- Graduate Certificate (30ECTS)
- Hospital training in MRI only

In what country did you do postgraduate MRI training

- free text

THANK YOU

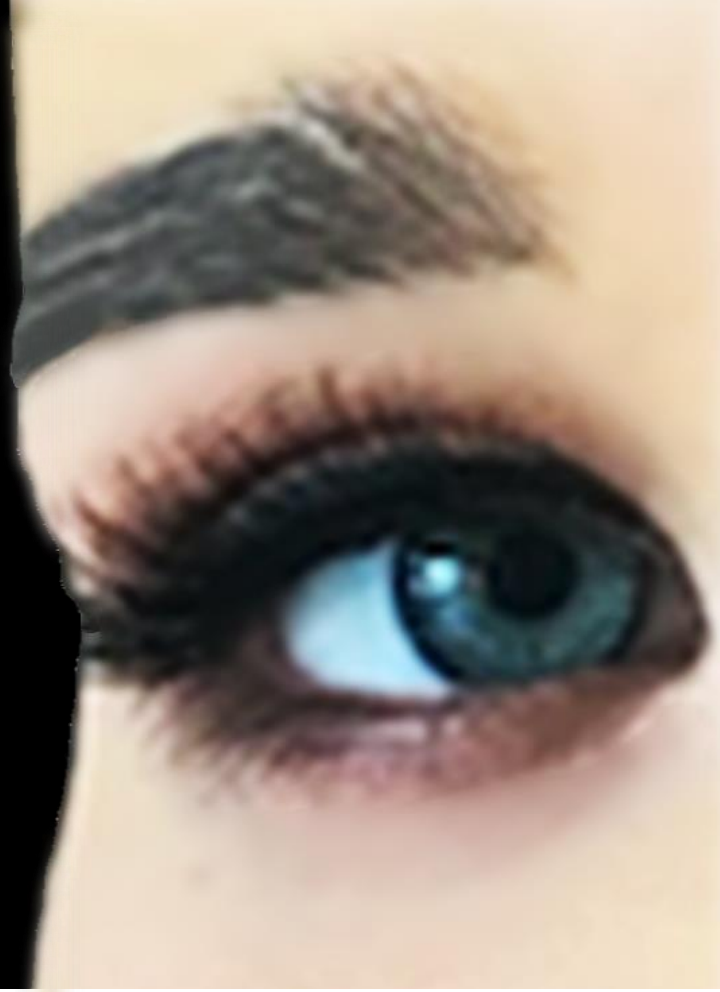
University of
South-Eastern Norway

A1.3: ECR research hub leaflet

EFRS Radiographers' Research Hub

Are you a radiographer or radiography student?

- **Volunteer 20 minutes at the EFRS Research Hub**
- **Participate in any of five studies and receive a certificate of participation**



Perception Studies:

- Radiographer evaluation of image quality & diagnostic efficacy
- Image quality judgements by radiographers – a "gist" study
- Review of technical factors during image quality decision making

Survey Studies:

- Scheduling and appropriateness of skeletal, MR and CT examinations
- Postgraduate training opportunities for radiographers in Europe

EFRS | EUROPEAN FEDERATION OF RADIOGRAPHER SOCIETIES

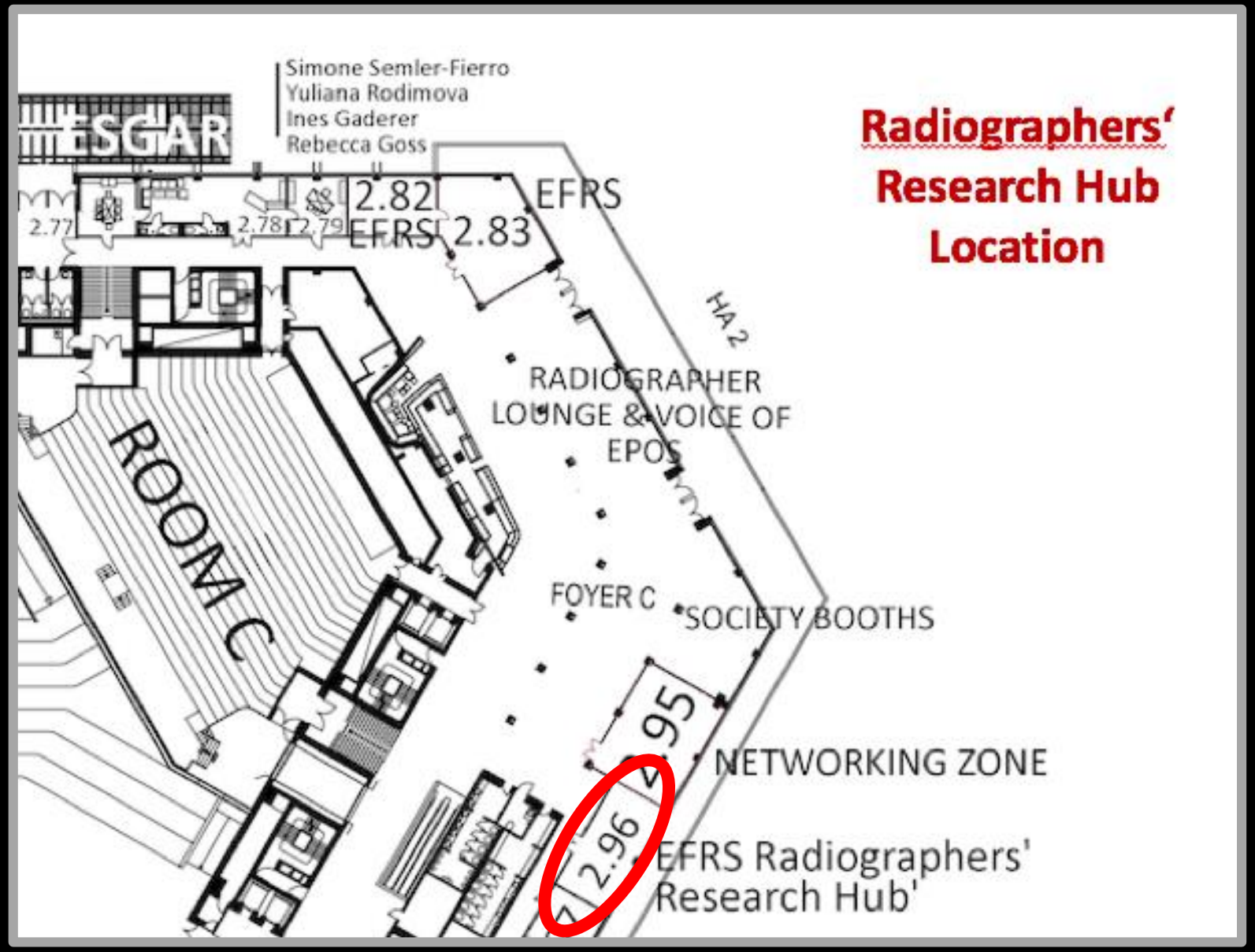
UCD DUBLIN

UNIVERSITY COLLEGE

University of South-Eastern Norway

Location: Level 2, Radiographers' Lounge, Room 2.96

9.00 – 17.30 Wed 27th Feb to Sat 2nd March
9.00 – 13.00 Sun 3rd March



The EFRS Radiographers' Research Hub receives in-kind support from Ziltron Ltd. and Barco

Are you a **radiographer**? Participate in our Survey

Scheduling and appropriateness of Skeletal, MR and CT examinations

The information obtained from this study will give insight into how radiographers assess adult patient referrals for three imaging modalities: skeletal radiography, MRI and CT. The extent to which radiographers may be responsible for assessing referrals in daily practice will vary across countries and we will be able to understand these differences. The study is part of a PhD research aimed to assess appropriateness of diagnostic imaging, and the perceptions, roles and responsibilities of radiographers in the process of justification. This study has ethical approval and all the data collected will be kept confidential and stored according to ethical guidelines. We aim to publish the research findings.

Be advised that you are free to withdraw your participation. For further information about the study, please contact Catherine Chilute Chilanga Email Catherine.Chilanga@usn.no or Kristin Bakke Lysdahl Email Kristin.Bakke.Lysdahl@usn.no.

Thank you for your participation.

……

Radiographers' assessment of imaging referrals

Are you a Diagnostic Radiographer i.e. medical imaging technologist in conventional radiography, mammography, CT, MRI, ultrasound or nuclear medicine? We invite you to take part in this study.

- Yes, I have experience in diagnostic imaging and work full/part time in clinical practice
- Yes, I have experience in diagnostic imaging but currently do not work in clinical practice
- No, I have no experience in diagnostic imaging

Consent
I have received and understood the information about the project radiographers' assessment of imaging referrals and have been given the opportunity to ask questions. I give consent (please tick to give consent to the study and personal data processing):To participate in the above explained survey I give consent for my personal data to be processed until the end date of the project, approx. [October 2022]

- Consent given

The management of referrals may vary between and within radiology institutions.
Please indicate the situation in your institution by answering the following questions.

1. In my work place, the majority of radiology referrals are from:
   - General practitioners
   - Hospital physicians
   - Radiologists
   - Other

If other specify----------

2. In my work place the final assessment of a referral, before a patient's radiology examination is scheduled, is done by:
Options (Radiographers Only, Radiographers and Radiologists, Radiologists only, Other, Not applicable)
a. For Conventional Radiography *
b. For CT *
c. For MRI *
d. For Ultrasound *
e. For Mammography
f. For Nuclear Medicine *
If other assessor, please specify:----------

3. In my work place,
Option (Yes , No ,Unsure)
a. the majority of referrals are in an electronic format *
b. radiology referral guidelines are available *
c. the referrals are perceived as "requests", subjected to critical review *
d. the referrals are perceived as "doctors order", not to be questioned *

4. I myself am delegated a responsibility for screening imaging referrals.
   - Yes
   - No
   - Not sure

5. Assuming you receive referrals with missing or unclear information, how often do you supplement the information by the following actions?
Scale options (Always, Often, Sometimes. Rarely, Never)

a. I ask the patient/patient's relatives for information *
b. I examine the body region of concern *
c. I discuss with referring clinician *
d. I discuss with radiologist *
e. I discuss with the accompanying healthcare provider *
f. I check patients' medical record
g. Other ways you use to supplement missing information please specify:----------

6. Assuming you receive referrals with all relevant information included, but the requested examination is clearly not appropriate / justified. How often do you carry out the following actions?
Scale options (Always, Often, Sometimes, Rarely, Never)

a. I consult with the referring clinician *
b. I consult with the radiologist *
c. I consult with a fellow radiographer
d. I change the referral to an appropriate examination *
e. I return the referral along with a reason *
f. I conduct the examination as requested *
g. Other actions carried out please specify:----------

7. Listed below are reasons that could hinder you, as a radiographer, from taking part in assessing referrals. Please state your agreement to these reasons.
Scale options (Strongly agree, Agree,Undecided, Disagree, Strongly disagree)

a. Lack of training in systematic assessment of referrals *
b. Lack of knowledge of clinical benefits of different imaging modalities *
c. Lack of knowledge of radiation doses and risks *
d. Lack of time allocation to assess referrals *
e. Inadequate information in referral forms *
f. Patients showing up in the department before the referral is assessed *
g. Ineffective communication channels among health professionals *
h. Lack of response from radiologists when radiographers ask about referral appropriateness *
i. Assessing of referrals perceived as not radiographers' responsibility *
j. Cultures of medical profession dominance within the referral process *
k. If you think of other reasons, please specify:----------

8.A. Information in the referral can be useful for a number of reasons. How often do you use the referral information for the following purposes? Scale (Very frequently, Frequently, Occasionally, Rarely, Never)
a. To identify the patient *
b. Obtaining previous imaging information *
c. Accessing laboratory results, e.g. blood tests *
d. Assessing if the patient can tolerate to undergo the procedure *
e. Administration of pharmaceuticals, e.g. contrast media, radio-isotopes *
f. Ensuring the patients' comfort during the procedure *
g. Selecting the appropriate imaging modality *
h. Ensuring imaging of the correct body region *
i. Ensuring correct patient positioning *
j. Selecting of appropriate projections *
k. Selecting appropriate exposure parameters *
l. Informing the patient of their possible diagnosis *
m. Other purposes, please specify:----------

8.B. Information on a referral can be useful for many reasons. Please rate your agreement on the usefulness with regards to the below statements. Scale (Strongly agree, Agree ,Undecided, Disagree, Strongly disagree)

a. For identifying the patient *
b. For obtaining previous imaging information *
c. For accessing laboratory results, e.g. blood tests *
d. For assessing if the patient can tolerate to undergo the procedure *
e. For decision of administration of pharmaceuticals, e.g. contrast media, radio-isotopes *
f. For ensuring the patients' comfort during the procedure
g. For selecting the appropriate imaging modality *
h. For ensuring imaging of the correct body region *
i. For ensuring correct patient positioning *
j. For selecting of appropriate projections *
k. For selecting appropriate exposure parameters *
l. For informing the patient of their possible diagnosis *
m. Other purposes, please specify:----------

9. Listed below are possible benefits of involving radiographers in assessing referrals. Please rate your agreement to the suggested benefits.

Scale (Strongly agree, Agree, Undecided, Disagree, Strongly disagree).

a. Improves radiographers' collaboration with radiologists and referrers *
b. Promotes sharing of tasks among radiology staff *
c. Promotes radiographers' professional responsibility *
d. Reduces the burden of radiologists' work load *
e. Reduces radiology incidences and errors *
f. Improves the radiographer -patient communication *
g. improves the patient's radiology report *
h. enable efficient use of radiology services *
i. If you think of other benefits, please specify:----------

Background information

10. Gender *
    - Male
    - Female

11. Age *
12. Country of practice:
13. Education level in Radiography
    - PhD Degree
    - Masters Degree
    - Bachelors Degree
    - Other

    If other education level, please specify:----------
14. How recent is your clinical practice *
    - Currently in clinical practice full time
    - Currently in clinical practice part time
    - During last year
    - 1 to 5 years ago
    - More than 5 years ago
15. In which diagnostic radiography area(s) is your main experience?
    - Conventional radiography including floroscopy
    - CT
    - MRI
    - Ultrasound
    - Mammography
    - Nuclear Medicine
    - Multiple/ Other areas

      If you selected multiple/other areas, please specify:----------
16. In what kind of clinical practice do you have your main experience *
    - Public practice
    - Private practice
    - Other

      if other clinical practice type specify----------
17. How available are radiologists for consultation at your site of practice *
    - Always
    - Often
    - Sometimes
    - Rarely
    - Never
    - Not in clinical practice/ not applicable
18. Please add any comments you may have to this study about "radiographers' assessment of imaging referrals" in free text below

A3: NSD ethical approval survey 1

NSD Personvern
25.03.2019 22:28

Det innsendte meldeskjemaet med referansekode 776616 er nå vurdert av NSD.

Følgende vurdering er gitt:

Det er vår vurdering at behandlingen av personopplysninger i prosjektet vil være i samsvar med personvernlovgivningen så fremt den gjennomføres i tråd med det som er dokumentert i meldeskjemaet med vedlegg den 25.03.2019, samt i meldingsdialogen mellom innmelder og NSD. Behandlingen kan starte.

MELD ENDRINGER
Dersom behandlingen av personopplysninger endrer seg, kan det være nødvendig å melde dette til NSD ved å oppdatere meldeskjemaet. På våre nettsider informerer vi om hvilke endringer som må meldes. Vent på svar før endringer gjennomføres.

TYPE OPPLYSNINGER OG VARIGHET
Prosjektet vil behandle alminnelige kategorier av personopplysninger frem til 27.02.2020.

LOVLIG GRUNNLAG
Prosjektet vil behandle personopplysninger med grunnlag i en oppgave av allmenn interesse.

Vår vurdering er at behandlingen oppfyller vilkåret om vitenskapelig forskning, jf. personopplysningsloven § 8, og dermed utfører en oppgave i allmenhetens interesse.
Lovlig grunnlag for behandlingen vil dermed være utførelse av en oppgave i allmenhetens interesse, jf. personvernforordningen art. 6 nr. 1 bokstav e, jf. art. 6 nr. 3 bokstav b), jf. personopplysningsloven § 8.
PERSONVERNPRINSIPPER
NSD vurderer at den planlagte behandlingen av personopplysninger vil følge prinsippene i personvernforordningen:

- om lovlighet, rettferdighet og åpenhet (art. 5.1 a)
- formålsbegrensning (art. 5.1 b), ved at personopplysninger samles inn for spesifikke, uttrykkelig angitte og berettigede formål, og ikke viderebehandles til nye uforenlige formål
- dataminimering (art. 5.1 c), ved at det kun behandles opplysninger som er adekvate, relevante og nødvendige for formålet med prosjektet
- lagringsbegrensning (art. 5.1 e), ved at personopplysningene ikke lagres lengre enn nødvendig for å oppfylle formålet

DE REGISTRERTES RETTIGHETER
Så lenge de registrerte kan identifiseres i datamaterialet vil de ha følgende rettigheter: åpenhet (art. 12), informasjon (art. 13), innsyn (art. 15), retting (art. 16), sletting (art. 17), begrensning (art. 18), underretning (art. 19), dataportabilitet (art. 20).

NSD vurderer at informasjonen om behandlingen som de registrerte vil motta oppfyller lovens krav til form og innhold, jf. art. 12.1 og art. 13.

Vi minner om at hvis en registrert tar kontakt om sine rettigheter, har behandlingsansvarlig institusjon plikt til å svare innen en måned.

FØLG DIN INSTITUSJONS RETNINGSLINJER
NSD legger til grunn at behandlingen oppfyller kravene i personvernforordningen om riktighet (art. 5.1 d), integritet og konfidensialitet (art. 5.1. f) og sikkerhet (art. 32).

or å forsikre dere om at kravene oppfylles, må dere følge interne retningslinjer og/eller rådføre dere med behandlingsansvarlig institusjon.

OPPFØLGING AV PROSJEKTET
NSD vil følge opp underveis (hvert annet år) og ved planlagt avslutning for å avklare om behandlingen av personopplysningene er avsluttet/pågår i tråd med den behandlingen som er dokumentert.

Lykke til med prosjektet!

Kontaktperson hos NSD: Anne-Mette Somby
Tlf. Personverntjenester: 55 58 21 17 (tast 1)

NSD NORSK SENTER FOR FORSKNINGSDATA

NSD sin vurdering

Prosjekttittel

Radiographers' assessment of imaging referrals

Referansenummer

472337

Registrert

19.02.2020 av Catherine Chilanga - Catherine.Chilanga@usn.no

Behandlingsansvarlig institusjon

Universitetet i Sørøst-Norge / Fakultet for helse- og sosialvitenskap / Institutt for optometri, radiografi og lysdesign

Prosjektansvarlig (vitenskapelig ansatt/veileder eller stipendiat)

Catherine Chilute Chilanga, Catherine.Chilanga@usn.no, tlf: 31009083

Type prosjekt

Forskerprosjekt

Prosjektperiode

30.03.2020 - 31.10.2022

Status

24.02.2020 - Vurdert

Vurdering (1)

24.02.2020 - Vurdert

Det er vår vurdering at behandlingen av personopplysninger i prosjektet vil være i samsvar med personvernlovgivningen så fremt den gjennomføres i tråd med det som er dokumentert i meldeskjemaet 24.02.2020 med vedlegg, samt i meldingsdialogen mellom innmelder og NSD. Behandlingen kan starte. MELD VESENTLIGE ENDRINGER Dersom det skjer vesentlige endringer i behandlingen av personopplysninger, kan det være nødvendig å melde dette til NSD ved å oppdatere meldeskjemaet. Før du melder inn en endring, oppfordrer vi deg til å lese om hvilke type endringer det er nødvendig å melde: https://nsd.no/personvernombud/meld_prosjekt/meld_endringer.html Du må vente på

svar fra NSD før endringen gjennomføres. TYPE OPPLYSNINGER OG VARIGHET Prosjektet vil behandle alminnelige kategorier av personopplysninger frem til 31.10.2022. LOVLIG GRUNNLAG Prosjektet vil innhente samtykke fra de registrerte til behandlingen av personopplysninger. Vår vurdering er at prosjektet legger opp til et samtykke i samsvar med kravene i art. 4 og 7, ved at det er en frivillig, spesifikk, informert og utvetydig bekreftelse som kan dokumenteres, og som den registrerte kan trekke tilbake. Lovlig grunnlag for behandlingen vil dermed være den registrertes samtykke, jf. personvernforordningen art. 6 nr. 1 bokstav a. PERSONVERNPRINSIPPER NSD vurderer at den planlagte behandlingen av personopplysninger vil følge prinsippene i personvernforordningen om:
- lovlighet, rettferdighet og åpenhet (art. 5.1 a), ved at de registrerte får tilfredsstillende informasjon om og samtykker til behandlingen
- formålsbegrensning (art. 5.1 b), ved at personopplysninger samles inn for spesifikke, uttrykkelig angitte og berettigede formål, og ikke viderebehandles til nye uforenlige formål - dataminimering (art. 5.1 c), ved at det kun behandles opplysninger som er adekvate, relevante og nødvendige for formålet med prosjektet - lagringsbegrensning (art. 5.1 e), ved at personopplysningene ikke lagres lengre enn nødvendig for å oppfylle formålet DE REGISTRERTES RETTIGHETER Så lenge de registrerte kan identifiseres i datamaterialet vil de ha følgende rettigheter: åpenhet (art. 12), informasjon (art. 13), innsyn (art. 15), retting (art. 16), sletting (art. 17), begrensning (art. 18), underretning (art. 19), dataportabilitet (art. 20). NSD vurderer at informasjonen som de registrerte vil motta oppfyller lovens krav til form og innhold, jf. art. 12.1 og art. 13. Vi minner om at hvis en registrert tar kontakt om sine rettigheter, har behandlingsansvarlig institusjon plikt til å svare innen en måned. FØLG DIN INSTITUSJONS RETNINGSLINJER NSD legger til grunn at behandlingen oppfyller kravene i personvernforordningen om riktighet (art. 5.1 d), integritet og konfidensialitet (art. 5.1. f) og sikkerhet (art. 32). Nettskjema er databehandler i prosjektet. NSD legger til grunn at behandlingen oppfyller kravene til bruk av databehandler, jf. art 28 og 29. For å forsikre dere om at kravene oppfylles, må dere følge interne retningslinjer og eventuelt rådføre dere med behandlingsansvarlig institusjon. OPPFØLGING AV PROSJEKTET NSD vil følge opp ved planlagt avslutning for å avklare om behandlingen av personopplysningene er avsluttet. Lykke til med prosjektet! Tlf. Personverntjenester: 55 58 21 17 (tast 1)

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2023

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Appropriate medical imaging:
Exploring radiographers' assessment of referrals

Dissertation for the degree of PhD

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Catherine Chilute Chilanga

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