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Individual patient radiation dose tracking: Perceptions of radiographers in South Africa

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ABSTRACT

Introduction: Medical imaging examinations that make use of ionising radiation provide valuable information towards patient management. Literature suggests that there is a significant rise in the number of patient referrals for such examinations. The concept "*individual patient radiation dose tracking*" (IPRDT) is introduced to optimise radiation monitoring. Many countries across the globe explored and implemented methods to enhance and promote the justification and optimisation principles essential for patient radiation safety. In South Africa (SA), however, attention to IPRDT is limited.
Methods: A qualitative research design was employed. Radiographers in the Western Cape Province of SA were purposefully sampled for participation in one-on-one, semi-structured interviews. Thematic analysis was applied to the transcribed interview data.
Results: This paper presents a theme developed from the radiographer cohort of ten (10) participants. The theme: the need for creating awareness and implementing legislative support structures, was developed from the data, with the following supporting subthemes: 1) stakeholder awareness and 'buy-in' 2) continuous professional development and 3) mandated practice.
Conclusion: This study provides findings that are of value for patient radiation safety in SA by giving a voice to local stakeholders. Other countries that are conducting similar research investigations toward the integration of an IPRDT model, method, or framework, may also benefit from these findings.
Implications for practice: The effective integration of IPRDT into the clinical environment requires unison amongst the relevant stakeholders and clarity on the various professionals' roles and responsibilities. The findings of this study furthermore suggest the involvement of regulatory organisations for the provision of a mandated form of practice at national and international levels.

Introduction

Soon after the discovery of X-rays in 1895,[1] the significant value of its application in medical imaging was recognised and expanded globally.[2] Not long after, however, reports started to surface detailing the harmful effects of medical radiation.[3] This meant that radiation safety during medical imaging examinations that make use of ionising radiation has become an area of considerable interest worldwide.[4]

Meyer et al.[5] reveal what seems to be a growing, and significant increase in the number of patients referred for medical imaging examinations over recent years. It is understood that the accompanied increase in patient radiation dose is due to the advancement of technology in the field,[6] the fear of litigation amongst referring practitioners causing them to practice what is known as "*defensive medicine*"[7] and self-referral for monetary gain.[8] Various measures were identified and implemented to support patient radiation safety in the medical imaging domain, all supporting the principles of justification and optimisation.

Patient radiation safety campaigns such as "*Image Gently*"[9] and "*Image Wisely*"[10] were established, focussing on specific patient groups as support mechanisms for their safety. Following these actions, an international debate was sparked, highlighting the need for innovative patient radiation safety measures, led by the "*Bonn Call for Action*".[11] Diagnostic reference levels were also recognised as a tool to aid in patient radiation safety[5] but these proved to have a limitation when focussed on the individual patient.[12]

The notion of individual patient radiation dose tracking (IPRDT) was initiated through the works of a medical physicist, Professor Madan Rehani, during his time at the International Atomic Energy

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Agency (IAEA).[13] The aim of IPRDT draws from the need to further protect the individual patient referred for a medical imaging examination that make use of ionising radiation. This can be done by keeping a detailed record of each imaging examination that an individual has received and by maintaining a cumulative record to continuously monitor the patient's total radiation dose. Similar records may be useful by providing sufficient clinical information to avoid performing another medical imaging examination on the same patient that will add to their cumulative radiation dose.[13]

Internationally many countries have embarked on IPRDT research, clinical practice trials, and implementations. Examples of IPRDT methods explored and reported on include, but are not limited to, the "*Smart Card/Smart RadTrack*" conceptualised by the IAEA,[14] the "*Radiation Passport*" which is an iPhone/iPod Touch application to track individual patient's radiation dose and to estimate their associated cancer risks,[15] the paper-based patient card known as the "*Röntgenpass*"[16] and web-based databases that utilise patient information systems such as the picture archiving and communication system (PACS) to monitor the patient radiation dose data received during medical imaging examinations.[17] A paper published by Seuri et al.[18] revealed the experiences of Finland after having embarked on IPRDT using several of their area-based PACS systems. In the same paper, four (4) clinical cases were presented indicating the value of having had access to an individual patient's previous radiation dose records.

In South Africa (SA), one (1) reference to IPRDT was found in a report published by the IAEA in 2012. In this report, it was indicated that the Society of Radiographers of South Africa (SORSA) agreed that IPRDT would be beneficial.[19] To date, however, and to the best of the authors' knowledge, there is paucity in local literature as no study has yet explored, described, or piloted a potential method on how IPRDT could be incorporated, that is responsive to the needs of the SA citizen and healthcare system. This study, therefore, sought to explore the perceptions of a cohort of SA radiographers about how IPRDT could be achieved locally. Additionally, it aimed to answer the overarching question: what could be done within the SA healthcare system to track the individual patient's radiation dose?

Methodology

Research design

A qualitative, exploratory, contextual, and descriptive research design was employed. This approach was deemed suitable to build understanding given the scarcity of literature on IPRDT from the SA context. In addition, these selections were made to generate new information in the field of medical imaging and radiation safety. The contextual element allowed the participants to share their professional experiences and opinions, based on their personal understanding of IPRDT and to make recommendations for its implementation. The descriptive component was utilised to describe and develop an understanding of the participants' input on how IPRDT could be integrated within the SA healthcare system.

Research setting, target population, and sampling

The study was conducted by purposefully targeting actively registered, independent practice (qualified) radiographers within the Western Cape Province of SA regardless of where they are employed (public or private facility). Qualitative research studies often employ similar sampling strategies to recruit potential participants who can provide in-depth information about a phenomenon under investigation.[20] Radiographers, in the context of this study were deemed knowledgeable on radiation safety during medical imaging examinations.

Data collection

Participants were invited in their personal capacity by means of social media (for example, via Facebook & LinkedIn) and word of mouth. No additional site permission was necessary as the researchers were interested in the participants' individual and professional, overall experience and perceptions, and not that from their respective place of employment. Semi-structured, one-on-one interviews were conducted with those participants who met the inclusion criteria and who signed the informed consent documents. An interview questionnaire was developed by the principal investigator based on the findings from internationally published papers on the subject matter.[14,15,17,21,22] Examples of questions ranged from the radiographers' understanding of IPRDT, how IPRDT could be implemented locally, who should be involved, as well as any potential barriers and recommendations/suggestions that they might foresee. Participants were also provided with an information letter before participating in the study and were allowed to ask any questions that they might have had before the interview.

The semi-structured interviews permitted the principal researcher some flexibility to further explore the ideas shared by the participants. A friendly, relaxed environment was maintained which enabled a more natural conversation. During the interviews, the principal investigator kept field notes of his reflections on the shared data and how it was shared, for example, the participant's body language and tone of voice. The duration of the interviews ranged between eleven (11) and eighty-one (81) minutes with the average duration being forty (40) minutes. The interviews were audio recorded and transcribed verbatim by an independent transcriber who signed an agreement of confidentiality. Data saturation was applied to cease the data collection process. Data saturation can be described as a technique whereby data is collected until no new ideas are generated and the data is considered sufficient to conclude.[23] It was determined that data saturation was reached by interview number eight (8); and, to add to the rigor of the study, an additional two (2) interviews were conducted to confirm this.

Data analysis

Braun and Clarke's reflexive thematic analysis was used to organise and describe the data.[24] This approach consists of six (6) phases as depicted in Fig. 1. The principal researcher made use of manual coding by using different colours to represent the different patterns noted within the study data. As an attempt to minimise bias throughout the data analysis process, the principal researcher engaged in debriefing sessions with the co-investigators by presenting the development process of the subthemes and overall theme. This approach added to the tenets of a reflexive thematic analysis approach whereby a conscious effort was made by the principal researcher to bracket his ideas and positionality in the study. This was considered important so that the influence of the researcher's prior assumptions and experience on shaping the findings were limited. In doing so, the authors were thus able to reliably convey the stories shared by the participants. Fig. 2 depicts a visual representation of the findings.

Trustworthiness

The trustworthiness of the study was led by four (4) criteria, namely: 1) confirmability, 2) transferability, 3) credibility, and 4) dependability.[25] *Confirmability* was achieved by exercising

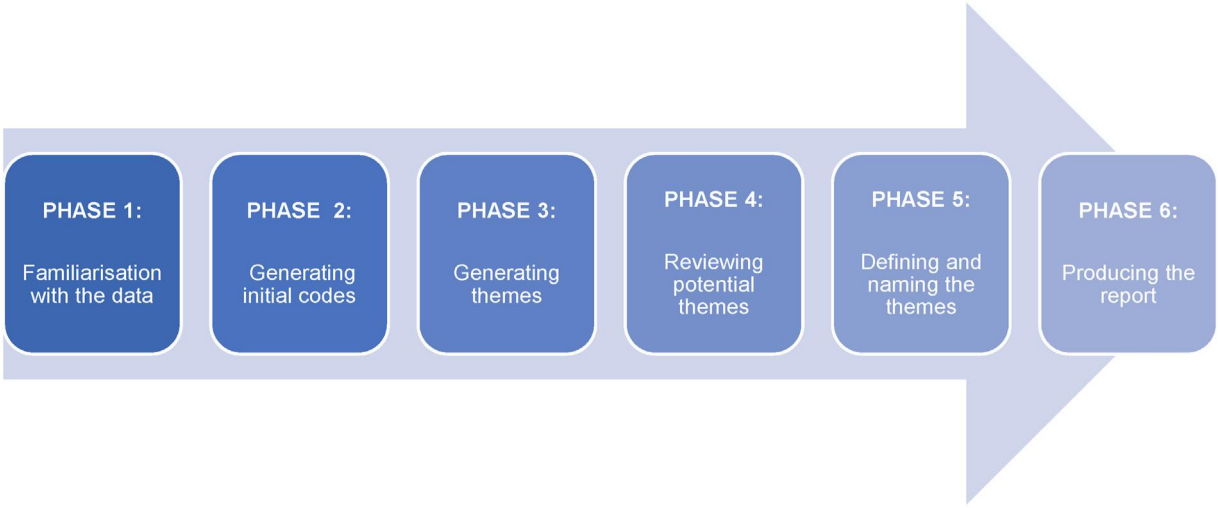

Figure 1. Steps in the reflexive thematic analysis.

member checking. *Transferability* was catered for by providing a detailed account of the research process that was followed. *Credibility* was ensured through a prolonged engagement with the study data, the keeping of reflective and reflexive notes, and conducting in-depth interviews with the study participants. *Dependability* was ensured by determining that the results presented were in keeping with the data collected and that it was consistent and accurate.

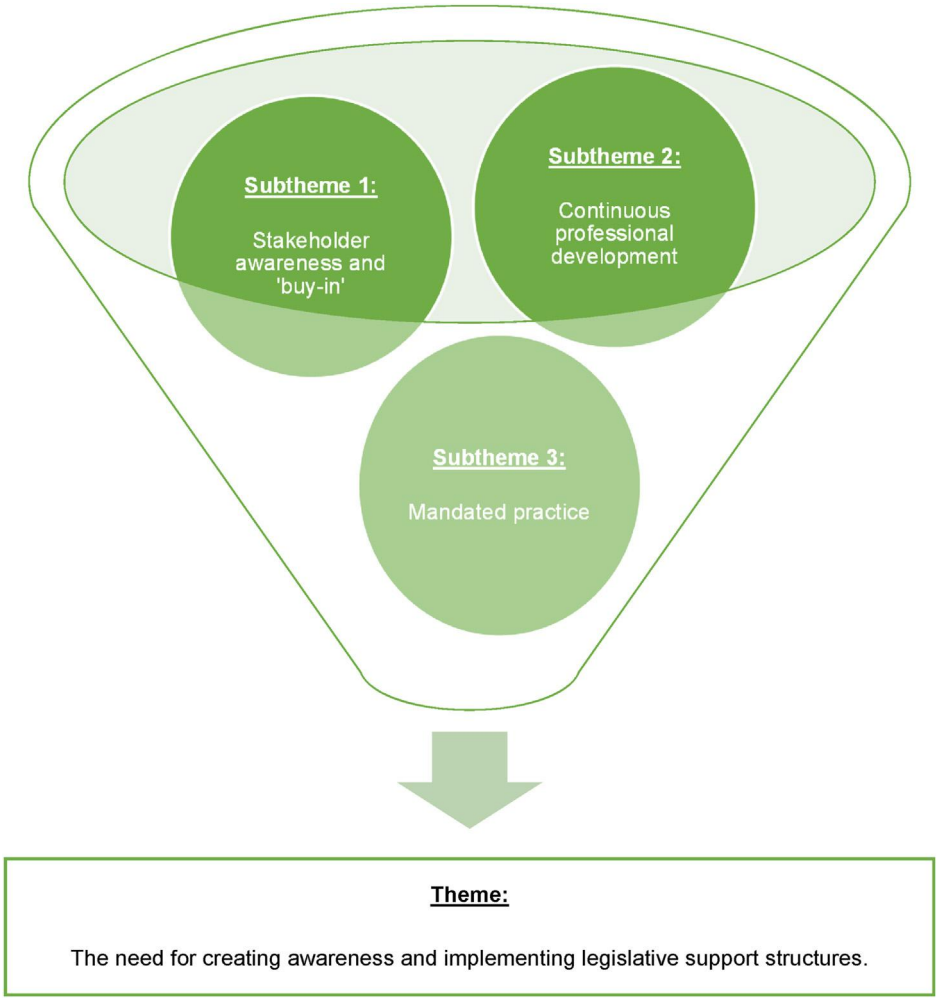

Figure 2. A visual representation of the findings.

Ethical considerations

Ethical clearance was obtained to conduct this study. Participants were furnished with a research information letter and were requested to sign two (2) separate informed consent letters: 1) for their participation in the study and 2) for their interviews to be audio recorded. Participation was voluntary with no financial benefits. None of the participants were subject to any known potential risks/harms, whether it be physical or psychological, due to the nature of the study and the researched topic.

No personal identifiers or information regarding the participants' place of employment were collected; this was deemed appropriate as the participants' professional experiences and opinions were considered more important when exploring IPRDT in the local context. The raw data was stored on a password-protected computer owned by the principal researcher and shared only with the transcriber. A data management plan was in place for all data of the study.

Results

Ten (n = 10) radiographers participated in this part of the study. The theme: the need for creating awareness and implementing legislative support structures, developed from the study data, is the focus of this paper (Fig. 2). Verbatim quotations are presented to support each of the subthemes followed by a literature control and critical analysis (discussion) of the findings. The abbreviation "*P*" refers to "*participant*" and a unique participant number was added after each verbatim quotation.

Subtheme 1: Stakeholder awareness and 'buy-in'

In the environment of the participants, IPRDT is still a fairly new and emerging area of clinical practice. Most of the participants reflected on the growing concern of patients exposed to high doses of ionising radiation, especially now in recent years, with the interest in and implementation of hybrid imaging. Given this, participants commented on the importance and potential benefits of IPRDT. This is because, currently, in SA, a standardised method for IPRDT is yet to be explored, developed, and implemented. Furthermore, participants commented that for IPRDT to be integrated effectively into clinical practice, a need exists for creating awareness and for the initial 'buy-in' of the relevant stakeholders.

> *"I think the biggest challenge is going to be to get all the different role players to play along and buy-in. But, maybe awareness, making them aware of the benefits, that would be a good way of overcoming it."* ***P5***

> *"So, I think at the end of the day it's the responsibility of the entire radiology practice, so it's an absolute teamwork that should come together to have this work."* ***P6***

> *"If everyone doesn't play their role or help to do this, your results won't be true results."* ***P8***

> *"If you do have a system in place, the only thing is the people don't like change – especially here. They are very full of nonsense. They don't want extra admin; they don't want change."* ***P8***

The participants of this study are of the opinion that in order to get overall approval and 'buy-in' from the relevant stakeholder groups, the potential benefits of IPRDT should be communicated and general awareness raised. Important to note is that the concept of IPRDT may be new for some individuals within these SA stakeholder groups. In addition, and as previously mentioned, the only evidence to date of a SA stakeholder group in favor of IPRDT was that from the SORSA in 2012.[19] An organisational and/or societal position statement, or any other form of a formal indication from the stakeholders' groups as a token of support, is thus deemed a critical step towards the recognition and implementation of IPRDT.

Rehani[13] indicates that IPRDT poses several benefits to patients, referring practitioners, policymakers/regulators, researchers, and the industry. Patients may directly benefit from IPRDT in the following ways: tailored amounts of ionising radiation exposure necessary for optimal care, knowledge of the fact there is some form of accountability for the delivery of ionising radiation, improved communication practices with their healthcare providers, and improved confidence in the care that they receive. These benefits, from the authors' point of view, fit well with the concept of person-centred care[26–28] through the delivery of a personalised, radiation conscious service to the individual patient. In saying this, IPRDT thus has the potential to be included in similar person-centred, theoretical, and clinical patient radiation protection models.

Additional benefits as identified by Rehani[13] for referring practitioners, amongst others, include enhanced decision-making support when requesting examinations that make use of ionising radiation and minimised patient radiation-induced effects by tracking the individual patient's dose records. One of the benefits that stood out for policymakers/regulators is the development of improved public health and safety protocols. Researchers in the field can provide robust patient radiation dose data sets to address research questions for the development of best practices and can then feed this information back to policymakers/regulators. A notable benefit for the industry is the fostering of partnerships with other stakeholders to establish effective IPRDT methods.

From the authors' personal observations and informal conversations in the field there seems to be some concerns due to a scarcity of available resources in the country to implement IPRDT. This is understandable, seeing that SA is a developing country facing many socio-economic challenges[29] and may prove to be a potential implementation barrier.[17] It is evident, however, that an urgent need exists for innovative patient radiation protection strategies to be implemented. This need was expressed in a paper that investigated multinational data on recurrent medical imaging examinations and the increased cumulative radiation exposure of the same patients.[30] The findings from this study, in essence, are no different.

Subtheme 2: Continuous professional development

Once the stakeholders' groups are made aware of the benefits of IPRDT and after they had expressed their interest and support in pursuing the same, a need was identified amongst the participants for incorporating continuous professional development (CPD) activities on the same topic at operational/ground level. This is because, through CPD, the relevant stakeholders may be better prepared and informed to comprehend their unique professional roles/responsibilities/contributions when implementing IPRDT. The proposed CPD activities are a more detailed and focused step towards the implementation of IPRDT when compared to creating that initial awareness and getting that initial 'buy-in'. In this way, through CPD, radiographers will be knowledgeable of their specific role within the chain of events in the provision of an effective IPRDT service. In saying this, the same notion applies to all stakeholder groups, for example the referring practitioners and their professional duties/services. Examples of similar activities may be offered as both formal and informal educational initiatives. In return, a better understanding of IPRDT was also believed to result in an improved adherence to the IPRDT method being practiced.

"I think ongoing information sessions and reminders for people, I think that would go a long way. They need to be made aware of the consequences of them forgetting to document or not documenting as they should, how that affects the entire process at the end and makes the entire dose tracking process ineffective." ***P1***

"The important thing to mention is that they also need to understand what the information means, because if they just see the numbers, they're not going to know what it means, they're not going to know when to start being concerned for the possible radiation effects." ***P1***

"So, radiographers would maybe repeat an X-ray to get it perfect according to the standard, but I think so many times we repeat unnecessary." ***P6***

"You can't send the patient the next day for another chest X-ray with the same history – the radiographer is going to ask you why you want this, and at a tertiary hospital where radiologists are readily available and available 24 hours, we would flag that to the radiologist. So, that's part of the training where radiographers are clued up, your radiologists are clued up, and the new doctors that join the hospital are orientated with the protocol of the department. This is how you go about ordering X-rays and specialised procedures. These are the boxes that need to be ticked." ***P10***

Multiple papers were found indicating limited knowledge and understanding of patient radiation dose data amongst a variety of healthcare professional groups, including radiographers.[31–34] Similar findings were noted through a web-based survey developed by the IAEA and deployed to referring physicians across the globe.[35] From the IAEA results, 70.9% of respondents were uncomfortable when questioned by their patients about the risks associated with medical radiation. A similar study conducted in India investigated the attitudes and knowledge of medical specialists on medical radiation.[4] The same study revealed that a mere 10.5% of the respondents made use of existing referral guidelines and that most of them (>55%) also possessed insufficient knowledge about the associated risks and concerns from medical radiation.

The current study findings, from the perspective of the SA radiographer cohort, compare favorably with the previously mentioned publications in the view of the need to upskill the relevant healthcare professionals' knowledge and understanding of patient radiation dose, especially so when it comes to the implementation of IPRDT. Similar upskilling sessions, as per the study findings, should not be done as a once-off exposure only, but continuously to build on/scaffold their understanding, confidence, and competence in carrying out IPRDT. In addition, the need for focused CPD activities as highlighted by the study participants are well aligned with the dynamic nature of the field where change is inevitable. Thus, by engaging in CPD activities those stakeholders involved in patient radiation safety can stay up to date with the still emerging and growing area of interest, known as IPRDT.

Subtheme 3: Mandated practice

Participants shared that they are not doing enough when it comes to keeping patient radiation dose records. They expressed that this lack of action may have a detrimental effect on themselves, from a legal perspective, and the individual patient due to the potentially harmful effects of ionising radiation. Departmental protocols, that speak specifically to IPRDT, were suggested for implementation to create a checkpoint for radiation safety and a standard form of clinical practice. There was a common understanding amongst the participants that IPRDT should be declared as a mandated form of clinical practice by the local regulatory bodies for those individuals/departments that own x-ray equipment. Similarly, this mandated form of practice should be applied to both the public and private healthcare sectors in SA. Some participants believed for IPRDT to be effective, a standard form of practice should be considered and implemented on an international scale.

"I think we are sitting ducks because we do not keep records." ***P4***

"It would be nice if it became something that was mandatory by our Department of Health because then there's no way around it, then government and private have to abide by it." ***P5***

"So, I think national and then ultimately international would be preferred. If this was international, then you would have a record that would follow the patient around. Then, if a patient decides to go international or travel internationally, then there will be no loss of data because the data will follow or move with the patient." ***P5***

"There should be documents or policies in place and guidelines which we can then follow to guide the doctors as well." ***P8***

Radiographers in SA are governed by a statutory body established by the Health Professions Act of 1974, known as the Health Professions Council of SA (HPCSA). The HPCSA is focussed on protecting the public and for providing guidance to those healthcare professionals actively registered within the country.[36] Similarly, the South African Health Products Regulatory Authority (SAHPRA), an entity of the National Department of Health, aims to preserve human health and well-being, including radiation protection, by having inherited the role of the Directorate of Radiation Control.[37] The SAHPRA published guidelines on the safe use of ionising radiation for those healthcare practitioners working with ionising radiation.[38] These guidelines, however, do not include any mention of the notion of IPRDT and thus leave room for further input from the relevant stakeholders. Important to keep in mind is that patient radiation safety during medical imaging examinations is the individual patient's right and, the ethical duty of the radiographer.

From an international perspective, the IAEA in collaboration with the World Health Organisation (WHO) and the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR), recently published a report under their "*Safety Reports Series*" to respond to a lack of definitive guidelines on IPRDT and to provide a holistic overview on the subject matter. Their publication includes information on elements such as the recording, collection, and analysis of individual patient radiation dose data by either manual or automatic methods. Furthermore, the same report aims to encourage those involved in patient radiation safety across the globe, to develop IPRDT methods.[39]

Although local guidelines are available for the safe use of ionising radiation (HPCSA & SAHPRA) and international recommendations are provided for those wanting to adopt IPRDT methods (IAEA, WHO & UNSCEAR), it is clear from the findings of this study that these are not enough. The participants from this study suggested the need for a mandated form of practice by implementing legislative support structures towards the compulsory implementation of IPRDT, first at a national level and then at an international level for standardisation. This was deemed important due to the possibility of patients relocating or traveling to different parts of the world, whether for work or pleasure. Their individual records should thus be accessible from around the globe, using a standardised database for the relevant stakeholders to track and monitor their cumulative radiation dose most accurately and effectively.

Limitation

This paper reported on the perceptions of one (1) cohort of participants: radiographers employed in the Western Cape Province of SA. The authors, however, reason, that there are contextual similarities across the healthcare systems in all nine provinces of SA and that the results can thus be transferred, with caution, to other settings within the country and will be of value in these similar contexts.

Conclusion

The literature reviewed and the findings of this study show that the notion of IPRDT is gaining momentum globally. Internationally, several methods have been identified to track the individual patient's radiation dose. What stands out is the need for stakeholders to fully comprehend their unique roles and responsibilities in the delivery of a person-centred radiation-conscious service. Stakeholder awareness and "buy-in", CPD and a mandated form of practice are considered the essential building blocks to lay the foundation for the implementation of IPRDT.

Although this study was conducted in a singular province in SA, the results are argued to be transferrable to other provinces and more widely to other countries that are at a stage of conducting similar research investigations toward the integration of an IPRDT model, method or framework that is unique and responsive to their needs. This study, therefore, contributes to the body of knowledge in the radiation safety field by giving a voice to the radiographers of SA. To the best of the authors' knowledge, such a study has not previously been done.

Recommendations

The need for further research to be conducted surrounding IPRDT is deemed critical, especially so, to obtain input from all the relevant stakeholder groups including patients and the public. It is the opinion of the authors that the concepts IPRDT and person-centred care be incorporated into the undergraduate curricula of radiography training. Furthermore, a shift from population dose studies to a more focused approach, directed specifically at the radiation safety of the individual patient is considered imperative. To achieve this, the organisational change management theory could be used to guide the effective integration of IPRDT.

Conflict of interest statement

Nil.

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