Attitudes and perceptions of radiographers applying lead (Pb) protection in general radiography: an ethnographic study

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Lead Protection; Pb; general radiography; qualitative research; pregnant patient; protecting patients.

# Abstract

**Introduction:** Since the discovery of X-rays by Rontgen in 1895, lead (Pb) has been used to limit ionising radiation for both operators and patients due to its high density and high atomic number (Z = 82). This study explores the attitudes and perceptions of diagnostic radiographers applying Pb protection during general radiographic examinations, an area underexplored within a contemporary radiographic environment(s).

**Methods:** This paper presents findings from a wider ethnographic study undertaken in the United Kingdom (UK). The use of participant observation and semi-structured interviews were the methods of choice. Participant observation enabled the overt researcher to uncover whether Pb remained an essential tool for radiographers. Semi-structured interviews later supported or refuted the limited use of Pb protection by radiographers. These methods enabled the construction of original phenomena within the clinical environment.

**Results:** Two themes are discussed. Firstly, radiographers, underpinned by their own values and beliefs towards radiation risk, identify a dichotomy of applying Pb protection. The cessation of Pb may be linked to cultural myths, relying on ‘word of mouth’ of peers and not on the existing evidence-base. Secondly, radiographers acknowledge that protecting pregnant patients may be primarily a ‘personal choice’ in clinical environments, which can alter if a patient requests ‘are you going to cover me up?’

**Conclusion:** This paper concludes by affirming the complexities surrounding Pb protection in clinical environments. It is proposed that the use of Pb protection in general radiography may become increasingly fragmented in the future if radiographers continue rely on cultural norms.

# Introduction

Ever since the discovery of X-rays by Röntgen in 1895, lead (Pb) has been used to limit ionising radiation for both operators and patients due to its high density and high atomic number (Z = 82), offering significant photoelectric absorption.1 Pb protection devices are often available within the general X-ray room and include gonad shields, lead-rubber aprons and various square/rectangular lead-rubber shapes, accommodating the protection of radiosensitive organs in and outside of the primary X-ray beam. It is generally accepted that all X-ray exposures carry some stochastic risk and thus should be justified, optimised and limited wherever possible by radiographers.1, 2 This remains evident in current legislation in the United Kingdom (UK) whereby ionising radiation should be kept ‘as low as reasonably practicable’ (ALARP).3

Whilst studies have identified the usefulness of applying Pb during general radiographic examinations,4, 5, 6 others have recognised a lack of awareness, knowledge and low standards of Pb protection.7,8 Harbron9 affirms that some studies may facilitate misunderstandings of protecting radiosensitive organs in practice. He suggests that Pb protection measures may become based on no more than folklore and Chinese whispers and not on evidence-based research. Further, Snaith10 warns of a potential fragmentation of applying evidence-based research within radiography, challenging whether ‘evidence-based radiography’ is actually happening. These arguments are important to consider in contemporary practices and remain central in this paper.

Following the theory of Mead11 (p.99) it is claimed that there can be an infinite number of possible perspectives and each will give a different definition to the parts and reveal different relations between them. Whilst this may provide a rationale for limited practice of evidence-based radiography, it remains paramount to continually explore the views and attitudes of radiographers within clinical environments to identify areas for improvement and critical reflection. Publications by the Society of Radiographers (SoR)12, 13 offer guidance of applying Pb protection for dental and fluoroscopic examinations (for operators and patients), but offer little guidance for patients (and operators) in general radiography, an imaging modality that constitutes approximately 90% of all radiological examinations undertaken in the UK. It is acknowledged that the number of X-ray procedures and projections within general radiography is vast, thus advice for each examination and individual projection remains problematic. This study aims to bridge the gap between conjectures offered by Harbron and Snaith exploring whether Pb protection is based on evidence-based radiography, or whether radiographers are beginning to rely on ‘folklore’ and/or ‘word of mouth’, to protect radiosensitive organs. Few papers have explored the application of Pb protective devices amongst radiographers within general radiography thus adding to the existing evidence-base.

# Methodology

The methodology utilised within this paper was part of a larger study undertaken by the author, which has previously offered originality surrounding dose creep, person-centred care and the utilisation of direct digital radiography (DDR) equipment.14, 15, 16 This article reports additional findings surrounding the use of Pb protection by radiographers from the same study. The methodological approach utilised was ethnography. Ethnography can be used to explore cultural groups and is primarily aligned with the qualitative paradigm. Ethnography is often termed ‘practitioner ethnography’ following its use in education and other professional disciplines.17 The nature of ethnography enables researchers to ‘get close’ to social reality with the overall aim of uncovering phenomena pertinent to a social group.

## Selection of sites and participants

Research sites (A and B) were acute trauma centres, each undertaking an array of general imaging examinations. Ethical applications were submitted to two National Health Service (NHS) Trusts in the south east of England (approval numbers - site A - ref: 2012/RADIO/02 and site B - ref: R&D449). Participants were required to meet three inclusion criteria; be registered as a diagnostic radiographer with the Health Care Professions Council (HCPC), willing to participate in the study and have worked within the general imaging department undertaking X-ray examinations.

## Participant Observation

Participant observations remained vital in exploring the application of Pb protection amongst radiographers because if/when Pb was used may depend on an individuals’ knowledge and understanding of dose limitation. After seeking written informed consent from the radiographers, participant observation began by one observer. The author decided to be an overt researcher, requiring complete openness with his research participants in the X-ray room. As an overt observer it was less likely for the researcher to ‘go native’. This enabled the researcher to maintain an element of objectivity when recording the actions of practitioners.17 Observations started at 09:00 and ended at 12:00; the next set of observations began at 12:30 and ended at 17:00. Participant observation provided immersion as a ‘participant observer’. Barley18 recognises that to map emergent patterns of action and interpretation requires some reliance on the observation of practitioners to record interactions. Participant observation enabled the use of inductive reasoning to uncover original data. This meant that the researcher was able to record the actions and behaviours of radiographers in the clinical environment and use it to develop open-ended questions for semi-structured interviews. This remained grounded by the authors’ philosophical position, interpretivism and social constructivism. This assumed that reality of clinical practice was constructed, multidimensional and ever-changing. It does not suggest that a single, immutable reality is waiting to be observed and measured. During the observations, 36 radiographers were observed over 19 days. Observation of participants varied depending on the clinical rotation of radiographers within the department(s). For example, whilst some radiographers undertook general radiographic examinations throughout the day, some would often undertake portable and/or theatre examinations, thus demonstrating varied time with some participants in comparison with others. Information regarding radiographer experience and professional rank during observations at each site is depicted in table 1.

**Table 1: Radiographers observed, professional rank and experience**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Site | No. participants with experience ≤ 5 years | No. participants with experience ≥ 5 years | Professional Rank | | |
| Band 5 | Band 6 | Band 7 |
| A | 7 | 12 | 10 | 5 | 3 |
| B | 10 | 7 | 7 | 8 | 3 |
| Total | 17 | 19 | 17 | 13 | 6 |

Observations identified whether radiographers used Pb protective devices to limit ionising radiation to patients. Observations were detailed in nine dimensions and are depicted in table 2. Data from sites A and B were analysed, later informing the development of the semi-structured interview schedule.

**Table 2: Features observed within the DDR environment**

|  |  |
| --- | --- |
| Features Identified | Features of X-ray Environment |
| 1. Space | Identification of the surrounding layout of imaging department and equipment to the other clinical rooms and areas. |
| 2. Actors | The radiographers involved in the situation and their gender specific pseudonym. |
| 3. Activities | The opportunities to protect patients using Pb protection for a variety of X-ray examinations. |
| 4. Objects | The physical elements present e.g. lead-rubber devices located within the X-ray room. |
| 5. Acts | The actions of radiographers producing images of diagnostic quality with or without the use of Pb. |
| 6. Events | Activities of radiographers, such placing Pb on a patient. |
| 7. Time | The time sequence of starting a general X-ray examination and finishing it. |
| 8. Goals | The activities people are trying to accomplish in particular situations. |
| 9.Feelings | Emotions in particular contexts. |

## Semi-structured interviews

Twenty-two semi-structured interviews were undertaken at sites A and B. The radiographers observed were invited to attend the interview. This was important because it allowed the researcher to discuss ‘what had been seen and discussed’ with participants. Differences in radiographic experience was important in this study because it provided alternate points of view, producing rich and varied data.19, 20 Interviews explored if and/or when radiographers used Pb protective devices during general radiographic examinations. The open-ended question posed to radiographers exploring the application of Pb in general radiography is detailed below:

1. *During my observations I noticed that Pb was rarely used when irradiating patients – can you tell me why you think this may be?*

A digital audio device recorded participants’ voices verbatim and is represented by quotations. Participants are represented by a gender specific pseudonym, maintaining anonymity. Table 3 below demonstrates the number of participants, professional rank and experience interviewed as part of the wider study.

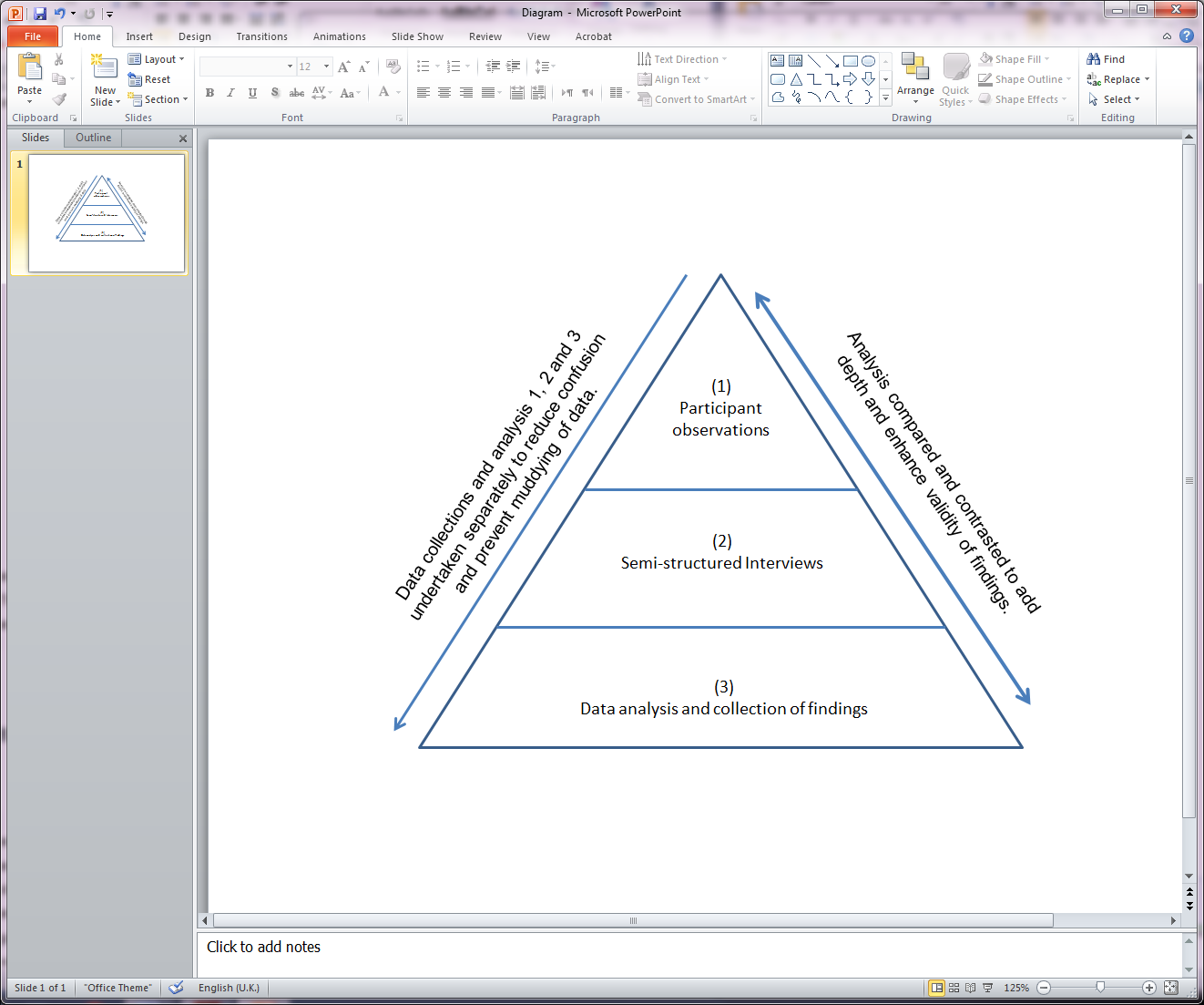
**Table 3: Radiographers interviewed, professional rank and experience**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Site | No. participants with experience ≤ 5 years | No. participants with experience ≥ 5 years | Professional Rank | | |
| Band 5 | Band 6 | Band 7 |
| A | 3 | 6 | 2 | 6 | 1 |
| B | 9 | 4 | 7 | 4 | 2 |
| Total | 12 | 10 | 9 | 10 | 3 |

## Data analysis

Data collection and analysis throughout the observations adhered to a grounded theory approach, identifying phenomena that remained ‘grounded’ on the X-ray practices observed.21 This method of analysis is depicted in figure 1 demonstrating the procedural steps, supported with the use of a comparative analysis enhancing trustworthiness of the qualitative findings.

Figure 1: Data collection and analysis process



Observations and interviews were undertaken sequentially. This allowed for a comparative analysis between the research sites. As depicted in figure 1 the researcher moved back and forth between the methods and emerging data, providing an on-going reflexive analysis.15 Glaser and Strauss21 support this method of analysis suggesting that general relations are discovered in the field through participant observation, whereby the researcher continually uncovers and analyses data. Data was transcribed by the author into Microsoft Word, dated and indexed with spelling and grammatical errors corrected. Observation and interview data were analysed using thematic analysis. Open coding began by reading the data and organising statements relating to the research questions. Statements were assigned a relevant code. Using these codes the researcher reread the qualitative data whereby additional codes developed during the analysis, this is termed axial coding. Lastly, selective coding involved the researcher reading through the raw data, searching for data that was contradictory, as well as confirmatory. This is important to consider because data analysis was undertaken by a sole researcher. It remained imperative that the researcher was not selective in choosing data, thus avoiding what is referred to as confirmation bias, which can impact on the trustworthiness of the findings. Categories were later assigned to overarching themes and later printed on A4 paper, ‘cut out’ and placed on A1 pieces of card, whereby theory could be linked across the themes. Colour pencils were used to cross reference data, which provided the foundation of theory development.

## Trustworthiness of qualitative data

In order to test the trustworthiness of this research, credibility, transferability, dependability and confirmability were considered as part of the larger study. These remain the most useful criterion within the radiography qualitative framework ensuring trustworthiness of data and can be seen in table 4.20, 23 (p.65)

**Table 4: Trustworthiness of qualitative data**

|  |  |
| --- | --- |
| **Criterion** | **Strategy employed** |
| Credibility | Prolonged engagement with participants; member checking; multi-sited ethnography |
| Transferability | Purposive sampling; providing thick description; providing demographics of participants and research site |
| Dependability | Create audit trail; researcher positionality |
| Confirmability | Engaging in reflexivity; triangulation of research methods |

# Results and discussion

## Is Pb utilised by diagnostic radiographers?

Radiographic positioning literature depicts patients wearing lead-rubber for chest and extremity examinations,24 (p.6), 25 (pp.74-75) limiting ionising radiation to a patients gonads. Similarly, the observation of radiographic practice highlighted the placement Pb protection on patients by some radiographers, which was supported by during semi-structured interviews:

Geoff: *The law of radiation protection applies to every radiation protection environment… For example, [someone] who has had previous abdomens and all that, I’d deem it necessary to protect their gonads or whatever. I’m going to use a gonad shield. It doesn’t matter whether it’s DR or CR. It’s an individual thing. You have to use protection. You’re using X-rays - protection is for the X-rays. It’s radiation, isn’t it? It has to be used in every sense. We’ve got Pb coats, we’ve got Pb gonad shields…You have to use them when necessary.*

*(Band 6 radiographer – transcript 7, page 13, lines 8-16)*

Sebastian: *We have an obligation to protect the patient. And we have to do it every time we’re X-raying, apart from peripheral. Anything that’s axial radiography, we have to protect the patient and think about some form of protection.*

*(Band 5 radiographer – transcript 17, page 8, lines 28-31)*

Alex: *But as far as I know, if it’s between the knee and the diaphragm then it’s an issue, but generally speaking with extremity work, you don’t really think about putting Pb or anything.*

*(Band 5 radiographer – transcript 5, page 10, lines 4-6)*

The radiographers above offer scenarios where the use of Pb would be utilised. On the other hand, radiographers from the same study were observed not using Pb protection on patients for similar examinations, immediately suggesting a dichotomy of clinical practices within the same radiology environment. This led the researcher to question whether Pb remained an essential tool for some radiographers when undertaking general radiography examinations? During the interviews some radiographers assert their lack of Pb protection in general radiography. Sharon advocated it is ‘not horrific’; additionally, Michael suggests it may ‘foster more paranoia’ for patients when compared to doses experienced in computed tomography (CT) for example:

Sharon: *Let’s face it, it’s not horrific if we don’t use it [Pb], is it?*

*(Band 6 radiographer – transcript 19, page 13, lines 10-11)*

Margaret: *You’re speaking to somebody who didn’t use a lot of Pb in the first place.*

*(Band 7 radiographer – transcript 20, page 11, lines 9-10)*

Michael: *I don’t tend to use it [Pb] a lot for a lot of things… Plus you’re fostering more paranoia in the people you’re X-raying, and making them uncomfortable. I think the doses that we’re using for things like extremities and stuff are quite minimal in reality [compared] to what people get in CT.*

*(Band 5 radiographer – transcript 16, page 14, lines 23-25)*

The narratives above suggest why radiographers’ may decide not to use Pb protection within the general radiography environment. The SoR26 (p.1) remind us that ‘autonomous professional practice entails the exercise of judgment and decision making through a complex process of assessment and actions that involves the interaction of knowledge, experience, values and practical skills’. The idea that Pb could do ‘more harm than good’ suggests that radiographers may be applying their own values and beliefs, without considering existing evidence-based knowledge. Further, it highlights that radiographers may be beginning to construct their own ideologies towards the application of Pb justifying its limited use. In support of these ideological constructs, radiographers at sites A and B emphasised ‘new research’ that can ‘trap/tunnel’ ionising radiation when using Pb, leading to a removal of Pb as a dose limiting device for patients:

Eric: *‘Named Radiologist’ told me there’s new research which says that it’s better not to use Pb protection, because it reflects it back and stuff like that.*

*(Band 6 radiographer – transcript 21, page 8, lines 25-27)*

Rosemary: *But now we’re told that it doesn’t help, it traps the radiation. That’s the last thing I heard, anyway. And so we stopped using it.*

*(Band 6 radiographer – transcript 18, page 9, lines 42-44)*

Annabelle: *I was told by a senior radiographer that there’s no need to use Pb on an adult patient, because research showed (whether this research is true or whether it’s word of mouth, I don’t know; I haven’t seen the research) that if you put the Pb on, then the scatter that goes into the patient can’t come out of the patient. You’re actually trapping it.*

*(Band 7 radiographer – transcript 9, page 13, lines 4-10)*

These comments offer insight suggesting why radiographers may be using fewer Pb protection measures within the clinical environment. Harbron9 first warned of the possibility that Pb protection may begin to be based on no more than folklore and Chinese whispers in clinical environments if radiographers fail to consult the evidence-base. The findings presented in this study support this assertion whereby the use of Pb protection may be eradicated by ‘cultural myths’ leading to inconsistencies of protection measures amongst staff. Some radiographers appeared to be acting ‘on instinct’ and/or ‘word of mouth’ of senior radiographers and radiologists without consulting the evidence-base literature. It is generally accepted that no single study offers findings that would support the complete removal of Pb within the general radiography. Further, the author(s) accept that it is neither possible nor practical to drape every patient in Pb, but such views and opinions should be explored, managed and critically reflected upon in both contemporary and future clinical practices.

## Protecting pregnant patients in general radiography

The practice of protecting pregnant patients in the general radiography environment remains an important area for discussion. A joint publication titled ‘Protection of Pregnant Patients during Diagnostic Medical Exposures to Ionising Radiation’ by the Health Protection Agency (HPA), Royal College of Radiologists (RCR) and Society of Radiographers (SoR)27 offers some quantifiable risk and approach to protecting pregnant patients in general radiography. It recognises that whilst radiation dose to an embryo or fetus (from any diagnostic imaging procedure) is likely to present no risk of causing fetal death, malformation, growth retardation or impairment of mental development, the guidance recognises that ‘fetal doses should be kept to a minimum consistent with the diagnostic purpose’.27 (p.13) This suggests that although levels of absorbed dose may offer negligible risks to a fetus [inside or outside] of the primary X-ray beam (less than 1 in 1,000,000 of an associated risk of childhood cancer), Pb can be used to limit ionising radiation to ensure doses are kept to a minimum. Radiographic techniques such as exposure factors, field size and source to image distance remain central parameters for dose optimisation. Further, the use of Pb rubber (0.35 mm) remains a generally accepted tool to limit dose to patients and/or a fetus when undergoing X-ray examinations.26, 27 Jumah26 (p.1) affirms that whilst examinations remote from the fetus such as chest and extremities may be conducted during pregnancy, offering Pb rubber to protect a fetus from ionising radiation remains useful. Other studies have identified a lack of awareness, knowledge and low standards of protection measures in both Pakistan27 and Nigeria.28 It therefore remains paramount to reflect on attitudes and perceptions of Pb use to protect a fetus outside of the primary X-ray beam. Rosemary above asserted that she had stopped using Pb on patients because she heard it ‘trapped’ the radiation, yet for pregnant patients she claims to use Pb following ‘requests’ of expecting mothers ‘are you going to cover me up?’.

Rosemary: *If it’s a pregnant lady and you’re doing something like an ankle, then I’ll try and protect. Especially in the first trimester. I think any protection. I’m not just going to leave her unprotected. Because the patient often says “Are you going to cover me up?” You can’t just say “Naah, it’s fine!”.*

*(Band 6 radiographer – transcript 18, page 10, lines 24-29)*

Whilst Jumah26 supports the use of Pb during extremity radiography on a pregnant patient, this narrative demonstrates that radiographers may adapt Pb protective practices in response to requests from patients. The SoR13 offers guidance for female patients undergoing dental radiography, yet there is little guidance associated with general radiography. Because current guidance does not suggest the complete removal of Pb protective measures for pregnant patients during general radiography examinations,25 this may continue to be debated. Interestingly, a publication by the American College of Radiology29 (p.29) recommend that in some instances providing lead shielding [during a pelvic CT examination] may help the ‘emotional well-being of a patient because dose is not materially altered by the shielding’. On the one hand, this suggests that radiographers may decide to utilise Pb protective devices to a patient’s unborn child in order to ensure ‘emotional satisfaction’ in fear of negligible risks associated with ionising radiation. On the other hand, this may present further challenges in contemporary practices because if Rosemary decides to use Pb protection for a pregnant patient during an ankle examination based on a patients ‘emotional well-being’, a colleague may disagree on this subjective position because it may ‘foster more paranoia’ in the patient. In short, this juxtaposition of clinical practices (within diagnostic radiography as a whole) may encourage patients to question ‘what is actually best for my unborn child?’ Burchell30 (p.35) identifies that ‘what is best may not be known, or there may be several solutions of nearly equal value. In some cases, medical experts may disagree because of predispositions due to training and experience’. This resonates with findings presented in this study whereby radiographers may be acting ‘on instinct’ and individual values and beliefs. The alternate subjective perspectives not only present a dichotomy of practice, but also affirm that radiographers within the same hospital or NHS Trust may be applying alternate protective measures. The author(s) acknowledges that practitioners should be autonomous in clinical decision making, yet there is the potential for patients to question: ‘can I have Pb during my X-ray? I had it last time!’ If alternate perspectives exist then practitioners should seek advice from the radiation protection advisor, with supporting evidence-based research. Terry, a senior radiographer enlightens this issue by identifying that Pb protection remains ‘a personal choice’, but recognised the need for guidance and support, linking to evidence-based research:

Terry: *And also the issue with pregnancy, about the suggestion that in some way, Pb may increase the dose, has been put forward. And I think that it’s a bit… there seems to be a lack of consensus about which way to go forward. And I think it’s just been left hanging. It’s become more or less a sort of personal choice of radiographers, rather than clear policy guidelines. I think that when you’re working at this level, what you want is clear guidance from the experts in dosimetry. And that’s not available, or hasn’t been available to us. And I think everybody is very confused. I think that confusion is leading to it not being used.*

*(Band 6 radiographer – transcript 6, page 6, lines 31-38)*

The author(s) acknowledges that it is neither possible nor practical to drape every patient in Pb, but there is a danger of overlooking the primary focus of dosimetry and keeping doses ALARP in the clinical environment. If practitioners begin to replace evidence based-research with radiological myths or hearsay, then knowledge, understanding and clinical practices will continue to become fragmented. Whilst these findings cannot be generalised they do offer an opportunity for debate and reflection of contemporary Pb use in diagnostic radiography.

# Conclusion

This paper provides insight into the use of Pb protective devices within the general radiography environment. Two issues stand out. First, radiographers may be beginning to apply their own values and beliefs of radiation risk, limiting the application of Pb in practice. For example, radiographers were captured dismissing the use of Pb protection because radiation doses appeared insignificant when compared to CT examinations. Further, the removal of Pb protection by radiographers was reported to be due to ‘new research’, which trapped/tunnelled ionising radiation, leading to increases in doses to patients. Such ‘phantom research’ supported the cessation of Pb protective measures by some radiographers, reinforcing the conjecture that current protection measures may be based on ‘hearsay’ and ‘word and mouth’ of peers and not evidence-based research. Second, one participant identified a dichotomy within her own clinical practices whereby although she would not principally use Pb protection, she would use Pb for pregnant patients querying ‘are you going to cover me up?’ This illustrates the possibility that radiographers may adopt an ad hoc approach to applying Pb protection, which supports a disparity of decision making by practitioners. In short, the arguments affirm that without adherence to Pb protection to radiosensitive organs, practice may become increasingly fragmented if radiographers continue to rely on cultural norms.

# Recommendations

* Radiographers should challenge ‘cultural norms’ concerning the application of Pb protection in clinical practice and begin to critically engage with evidence-based research.
* Regular audit and quality assurance could explore the application of Pb protective measures amongst radiographers supported with critical reflections linking to evidence-based research.
* On-going discussions with radiation protection supervisors and radiation protection advisors may help overcome confusion of applying Pb protection in practice.
* Experimental phantom studies to be performed to appreciate absorbed dose of scattered radiation, enabling a better informed profession.

# Conflict of interest

None.

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