

ORIGINAL ARTICLE

Radiographic technique modification and evidence-based practice: A qualitative study

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Abstract

Introduction: Evidence-based practice in radiography is an emerging practice, due to a lack of evidence. Beyond the diagnostic requirements of the examination, imaging technique decisions are guided by the radiographer's tertiary education and clinical experience. Imaging technique decisions should include all aspects of evidence-based practice: research-based evidence, patient circumstances and clinical experience. Previous research suggests radiographers do to not fully engage with the latter, which may jeopardise progress in the field and lead to outdated practices and suboptimal outcomes for patients. This study aimed to examine the motivators and influences involved in radiographers' decision-making when modifying imaging acquisition techniques. **Methods:** An exploratory descriptive, inductive qualitative interview-based design was used with a convenience sample of radiographers from three public hospital sites in Queensland. Twelve one-on-one semi-structured interviews were performed via video conference, the data were analysed through thematic analysis. **Results:** Five themes emerged from the data: advancement of technology; experience rather than evidence; radiology's influence on radiographic practice; information sources; and image quality. The pursuit of image quality was the key motivator and criterion that influenced radiographers' choices in imaging technique modification. Interviewees did not engage routinely with research-based evidence, preferring to rely on empirical observations and professional experience. **Conclusion:** The exclusion of research-based evidence can lead to outdated and ineffective clinical decisions. Further work is needed to promote more research in the field of radiography and increase the willingness and capacity of radiographers to follow the principles of evidence-based practice.

Introduction

Evidence-based medicine has formed the basis of best clinical care since it was first described by Sackett and colleagues.¹ The literature supports its use by other healthcare professions and has resulted in adoption of the broader term evidence-based practice.² The term evidence-based practice denotes a decision-making process that integrates (1) research-based evidence, (2)

patient circumstances or needs and (3) clinical experience of the healthcare professional.³

Keeping up-to-date with ever-changing research-based evidence is a time-consuming and difficult task. Without research-based evidence, however, clinical decisions can become driven by outdated knowledge and practices, which may lead to suboptimal patient care.¹ Conversely, using research-based evidence alone, without consideration of patient circumstances or clinical

experience, can lead to inappropriate care decisions for individual patients.¹ Hence, evidence-based practice requires a conscious effort and ongoing commitment by clinicians in their day-to-day practice.^{2,4}

The uptake of evidence-based practice differs across the range of allied health professions.⁵ The main barriers to its use are a lack of time, the skills to implement evidence-based practice and insufficient published evidence.^{4,5} In an attempt to overcome these barriers, most health professions now include a research methods subject in their curricula.^{6,7} Nevertheless, there remains a disconnect between research-based evidence and clinical practice.⁸

Evidence-based practice in radiography or 'evidence-based radiography' is still emerging.³ There is a shortage of published research-based evidence, which may explain why evidence-based radiography is rarely adopted in practice.^{9,10} There is a paucity of published research about image technique modification, for example, adaptation of the upper limb X-ray views for severely injured patients, as well as a lack of evidence relating to general radiographic practices, such as source to image-receptor distance.^{11–17} Most of the published literature about evidence-based radiography focuses on editorial or opinion articles rather than primary research. The extent to which published literature is incorporated into Australian radiographic practice is also unclear.^{2,3}

In other countries, studies investigating the involvement of radiographers in research activities have reported varying levels of engagement, from reading journal articles to being lead researchers.^{6,18,19} These studies also reported a large variation in the level of radiographers' consumption of research and its effect on their clinical practice.^{6,18,19} Additionally, some radiographers were reported to prefer that research be conducted by academic researchers outside the profession.¹⁸

When choosing an imaging technique, radiographers are guided by their tertiary training and clinical experience, as opposed to research-based evidence.^{5,20,21} Technique choices include positioning of the patient, imaging equipment such as grids, collimation, filters and exposure parameters. These choices fall under the 'clinical experience' component of evidence-based practice; the extent to which these choices incorporate 'research-based evidence' is uncertain. The third aspect of evidence-based practice, 'patient circumstances' is generally addressed by modifying imaging techniques when a patient is unable to achieve the desired position.

Evidence-based practice is promoted in the literature as fostering best practice.² Radiographers are increasingly expected to demonstrate efficiency and effectiveness in service provision.³ Previous work suggests that radiographers rely heavily on clinician experience and patient condition for their clinical decisions, with little

apparent consideration of research-based evidence.^{6,18,22} The extent to which Australian radiographers are using research-based evidence in their decisions and best ways to further encourage this practice are unclear. This qualitative interview-based study aimed to explore the decision-making process of general radiographers when modifying image acquisition techniques and to examine the motivators and influencing factors driving these decisions.

Methods and Techniques

Design

This study was conducted using an exploratory descriptive, inductive qualitative design. This qualitative methodology was selected as it is most suited to investigating new concepts not previously studied, and there was no published qualitative research into the topic.²³ The project aimed to capture and understand the opinions, experiences and decision-making processes of general radiographers regarding image technique modification.

For the purpose of this project, the term 'modification' refers to substantial changes to the basic imaging technique or examination, such as the routine addition or removal of a projection in a single examination; the substitution of one projection with another or a significant modification to the existing imaging technique.

Ethical approval was obtained from the Human Research and Ethics Committees of Townsville Hospital and Health Service and James Cook University (HREC/17/QTHS/123 and H7090).

Study sites

Three public hospitals in Queensland were invited to participate. All sites provided research governance authorisation prior to the research commencing. One site (identified as site 'A') is located in a 'major city' (as per the Australian Institute of Health and Welfare classification)²⁴ and has a full-time equivalent (FTE) of 75.6 radiographers.²⁴ The other two sites (identified as sites 'B' and 'C') are classified as 'outer regional' and have 53.2 and 2 FTE radiographic staff, respectively. Due to the small number of sites involved, the small radiography community in Queensland and the need to maintain participant anonymity, the sites cannot be further identified.

Recruitment

Convenience sampling was used to recruit radiographers, who volunteered to be interviewed. Purposive sampling

was used to recruit sites, which were deliberately chosen to include locations with different characteristics.

Information about the project was emailed to all radiographic staff at the chosen sites, inviting them to participate. One-on-one interviews were conducted between 4th September and 16th October 2017. Participation was voluntary, with withdrawal possible at any time. Volunteers emailed the principal investigator (MR) to indicate their interest and suitable date, time and location for the interview was arranged. Participants were eligible if they had worked at least one general X-ray shift in the 2 weeks preceding the interview and were a qualified radiographer with at least 1 year of clinical experience (including their post-graduate professional development year). Signed consent forms were obtained via email prior to interviews being conducted.

Data collection tool

Participants were asked open-ended questions about their perspectives and experiences of using research-based evidence in their clinical decisions and their motivations when deciding to modify imaging techniques. Probing questions were asked when further clarification was required. Prior to the interview, participants were asked for demographic information, such as their age, gender and years of experience, to gain contextual information about their knowledge and professional experience.

The interview questions focused on the following topics: (1) what prompted them to consider using a different imaging technique; (2) what sources of information they used when modifying an imaging technique; (3) what factors they considered when making a change; and (4) how they analysed these factors during the decision-making process. The interview questions were guided by knowledge gaps identified in relevant literature examining evidence-based practices in radiography.

Data collection

Semi-structured interviews were conducted in the participants' workplace via video conference or telephone. All interviews were audio-recorded and conducted by the principal investigator (MR), an experienced female radiographer with developing research skills in qualitative interview techniques, under the guidance of co-investigators with qualitative research skills and radiographic experience. Following each interview, reflections were recorded by the interviewer as field notes, including possible themes identified. Interviews were conducted until data saturation was reached.

Data management

Each participant was given a unique alphanumeric identifier to anonymise the data during transcription and analysis. Audio recordings were transcribed verbatim by the interviewer within 3 days of each interview. Transcribed interviews were imported into NVivo Pro Edition (QSR International Pty Ltd. version 11, 2017) prior to analysis.

Data analysis

Interview data were initially coded following each interview to identify preliminary themes, which were then further explored during subsequent interviews. Thematic analysis was carried out using NVivo Pro Edition and conducted by the principal researcher (MR), with a subset of data reviewed by a second researcher (AP) to ensure agreement on thematic coding. Theme discrepancies were discussed by both researchers until consensus was reached. The themes identified were also discussed with other research team members who had research methodology expertise and extensive radiographic experience (DM and KD, respectively).

Trustworthiness

Guba's four concepts of trustworthiness (credibility, transferability, dependability and confirmability) were applied in the design and delivery of this research project.^{25,26}

Credibility of the research was maximised by using well-established research methods; the researcher being familiar with the culture of the participating sites; credibility of the researcher as an experienced radiographer; piloting questions to check that they would be easily understood by participants; giving people the option to refuse to participate, to ensure that participants were willing to freely offer data; prolonged engagement with participants, to establish trust and create a relaxed atmosphere in the interviews; using iterative questioning, by rephrasing and asking probing questions, to seek further clarification of meaning; using triangulation through participation of a wide range of informants from three organisations and completing reflective journals immediately after each interview for reference in the analysis; and frequent peer debriefing sessions with the research team to consider alternative perceptions and approaches.

Transferability was enhanced by providing a detailed description of the phenomenon under investigation, to enable readers to determine whether the results may be

relevant to their context. Dependability was achieved by providing a detailed description of the study methods, how the data were gathered and reflecting on the effectiveness of the data collection process. Confirmability was addressed via a second researcher independently reviewing a subset of data, to check for discrepancies in thematic coding, with the two researchers reaching consensus through discussion; iteratively examining and re-examining the data; and data triangulation to mitigate researcher bias. These measures were used to ensure that the analysis reflected the experiences and ideas of the participants rather than any researcher's preferences.

Results

Twelve interviews were conducted for this study. Seven participants worked at the site located in a major city area and five worked across the two outer regional sites.²⁴ Participants ranged in experience from new graduate to 42 years (median 5 years, interquartile range 13.5 years). Half of the interviewees had more than 5 years of clinical experience. Participants' age ranged from 22 to 60 years, with a median of 35 years (interquartile range of 15.5 years). Ten of the participants (83.3%) were female. Interviews took between 27 and 50 minutes, with an average of 40 minutes.

Data analysis yielded five themes, reflecting motivators and influencers affecting participants' choices in imaging technique modification: advancement of technology; experience rather than evidence; radiology's influence on radiographic practice; information sources; and image quality.

Advancement of technology

Technological advancement in radiography was a major driver of imaging technique modification. Nearly all the radiographers with more than 5 years' experience reported that advances in imaging equipment during their careers had influenced changes to their imaging technique choices. They referred to changes in image detector technology, with the evolution from film/screen radiography to phosphor plate computed radiography (CR) to direct digital radiography (DR). Specifically, interviewees reported having to modify their imaging techniques due to changes in the size of image detectors, the requirement of grids and the variances in exposure requirements.

The other thing is equipment changes. . . so I originally trained with film, so I've been through the film, CR, DR you know, lower exposures um, not using grids with some of your DR work. . .

(11C)

. . . traditionally we always used a grid. . . but now we find that some patients we can get away with not using a grid and it comes up with a better exposure anyway. You know better diagnostic quality . . .

(1A)

Experience rather than evidence

Experience rather than research-based evidence was relied upon when making decisions about modification of imaging techniques. Radiographers explained their reliance on experience, their own or that of a colleague, when making decisions to modify imaging techniques, rather than research-based evidence. Participants described a reluctance to adopt a change in practice, recommended in the literature or other sources of information, without trialling the new method.

. . . learning has to happen through your own experience and what you do in the department, you can only use what Uni has given you for so long, before you sort of have to go a little bit by your own experiences and just see what works for you.

(5A)

I'd use their ideas in my daily work. . . I might just try it their way and see if I like it, if it works better.

(2A)

Most participants assumed that research-based evidence had been used to select existing imaging techniques and the minimum number of standard projections in their department. Due to the technical nature of their role, they presumed evidence had already been used to demonstrate that the prescribed radiographic techniques produced the highest-quality images for the assessment of relevant pathology.

. . . historically there would have been a lot of research put into what distance is the best to use, what technical factors are the most ideal . . . a lot of research has been put into all of that I am sure.

(10B)

Radiology's influence on radiographic practice

Some participants reported a lack of autonomy over the choice of projections they were required to obtain. Most thought that approval from senior radiography or radiology staff was required before they could implement a new imaging projection. As radiologists are responsible for image interpretation, radiographers were accepting of their lack of autonomy in choice of X-ray projection.

We can only get approval to change [the projection], if our chief radiologist is happy. . .

(12C)

...I feel like we [radiographers] are stuck in that middle ground where we are not the ones interpreting what we are doing...

(5A)

However, interviewees reported they retained control over the selection of technical factors associated with image acquisition. This included modification or substitution of views when patients were unable to maintain or attain the desired projection position, for example, due to their injury.

...I would change it [the projection] to accommodate for them [patients], I guess if I think there might be another view that may help more I might include that as well...

(7C)

Information sources

Participants sought information about new imaging techniques from a variety of different sources which were perceived to have varying degrees of reliability. Most participants used online search engines, such as Google®, to access resources about new imaging techniques. Positioning textbooks and online peer-reviewed journal databases were also used, though less commonly than online search engines. Textbooks were seen as static sources of information, whereas online sources were considered more up-to-date. Participants felt time was a limiting factor to searching and appraising new techniques as this often took place during the actual examination.

...there are textbooks ... but if it's current things they are not always published in textbooks ... all the current things tend to be online...

(5A)

All participants reported other colleagues as a source of information about alternate imaging techniques. Recently recruited colleagues with clinical experience in other hospitals or radiology practices were perceived to bring new and different imaging methods.

That is the beauty of ... you know, cross pollination of ideas when you've got lots of different staff coming from lots of different places to work with you.

(2A)

Colleagues were considered a reliable source of information, whereas online sources were viewed with more circumspection. Others considered information more reliable if the technique was being used by multiple people or sites, or if it was presented online by more than

one person. Equipment manufacturer training and sales representatives, while still considered reliable, were viewed as providing information that promoted their own product.

That's the only way we would change our protocols, making sure that you know other hospitals are getting the same or doing similar things.

(12C)

You have to take it with a little bit of a grain of salt I suppose because it is not the full story they [sales representatives] are wanting to sell a product at the end of the day...

(8A)

Image quality

Image quality was a major driver of technique change and was also used in the evaluation of new techniques by the radiographers. All interviewees aspired to produce images of high diagnostic quality to improve patient outcomes. Participants reported modifying their imaging techniques for a variety of reasons that related to image quality: (1) observed a colleague using a better technique; (2) suboptimal image obtained; (3) delivered radiation dose higher than desired; (4) high patient discomfort; or (5) negative feedback about image quality. The success of a new technique was chiefly determined by appraisal of the image quality.

...I was frustrated not getting good views on people who couldn't straighten their arm up and not wanting to cause them any further pain...

(2A)

...is it a view that will be more diagnostic than what you were doing...then you've gotta think...is it just going to be just more radiation dose to the patient...

(12C)

...if I had exhausted my resource list of how to do a certain technique, so if I thought ok I try this, no that doesn't work, try this, doesn't work etc and I don't have anything else.

(7C)

Furthermore, one radiographer commented that seeking alternative techniques was not routine practice and was only triggered to meet a specific need:

I must admit I don't go sourcing out new techniques just for the sake of it, I suppose.

(10B)

Discussion

This study shows that technique modifications in general radiography are driven by a number of motivators and influencing factors. The majority of the factors relate to the production and appraisal of image quality, with the main objectives being a better image than by the existing methods and improving patient outcomes. Past clinical experiences, radiology profession characteristics, available sources of information (including professional development) and image quality all influenced the decision-making process of the radiographers interviewed.

Most of the experienced radiographers interviewed said that changes to the imaging equipment had a marked influence on the imaging techniques they used over time. The introduction of large, bulky DR image detectors changed their image acquisition techniques, through technique adaptation or use of smaller CR imaging plates. Such technique changes result in 'practice drift', which is the loss of knowledge through technological advancement and workflow pressures.²⁷ This can lead to staff modifying techniques without proper evaluation.²⁷

Radiography's continuous technological advances make it difficult to maintain up-to-date research-based evidence that endorses the use of new technologies.^{18,28,29} As such, new equipment may be introduced without researched evidence of its effectiveness. Many participants thought the change to digital radiography had reduced the need to use grids; however, no research-based evidence was identified to support their choices; most relied on image quality to justify the change.

Much of the published literature states that radiographers rely on traditional practices rather than research-based evidence for their clinical decisions.^{3,18,30} The interviewed radiographers also relied on clinical experience rather than research-based evidence when it came to technical choices. Regardless of the source of information, most participants also felt the need to personally evaluate a new imaging technique before adopting it. This might reflect how radiographers learn,³¹ or the lack of time they can dedicate to formalising continuing professional development.³² The need to trial new techniques may also be due to a lack of critical appraisal skills,³ a lack of evidence to use⁹ or a lack of trust in others' practices. A scant amount of literature on imaging techniques does exist; however, the little research that is available is not translated into routine clinical practice.^{12,16} This could be due to either a delay in translating research into clinical practice or radiographers' aversion to using research-based evidence.

The assumption that evidence already underpins current practice may be another reason radiographers do not seek further evidence to support their imaging

technique decisions. Evidence-based practice, however, requires that radiographers evaluate and integrate current and valid evidence into practice.^{2,33} With the reported rapid development of technology, scrutiny of the latest evidence may not be occurring. In the long term, this may result in a disconnect between research-based evidence and clinical practice.

Participants raised the issue of reliability of information sources; this highlights the need for radiographer competence in critically appraisal of evidence. Castle (2011) discusses the required skills of separating fact from opinion when making judgements on information.³⁴ Such evaluation of research-based evidence or information from other sources is an important part of evidence-based practice which ensures that clinical practice is based on the best available evidence and not just personal opinion. Mandatory continuing professional development and inclusion of research methods in the radiography tertiary curriculum support the profession to further develop and encourage use of evidence-based practice.^{3,6,10} These practices need to be accepted as routine elements of clinical radiography and performed as core components of clinical practice.

Radiographers interviewed felt a lack of autonomy over the selection of views required and the imaging techniques they were permitted to use. Sim and Radloff state that dominance by the medical profession has ensured radiographers remain subordinate to radiologists.¹⁰ Participants, however, did not report this feeling of subordination, but rather felt that both professions worked in collaboration toward a common goal. This may be due to an understanding that radiography contributes technically to a diagnosis by providing the images radiologists interpret. Furthermore, participants did not feel limited by the minimum standard projections required when patient circumstances required additional projections, or when they felt additional views would provide important information for the referrer or reporting radiologist.

Opinions varied on radiologists' level of participation in imaging technique decisions; younger participants consulted radiologists, whom they considered to be more knowledgeable about radiography, while more experienced radiographers felt that radiologists were not overly concerned about how images were acquired. Snaith identified that the development of advanced practice and reporting radiographer roles had removed senior radiographers from clinical areas, thus removing an important resource for younger staff.²⁹ The lack of availability of senior radiographers may explain why some participants reported a reliance on radiologists to provide imaging technique advice. Some participants also highlighted the isolation between the two professions and

the ensuing reduced interaction between staff. This situation is possibly compounded by the separation of work areas and the use of electronic image transfer.

Interviewed radiographers used image quality to gauge the success of an imaging technique. Empirical observations, however, do not constitute research-based evidence, but rather fall under the 'clinical experience' component of evidence-based practice.³⁵ Rycroft-Malone and colleagues proposed the definition of evidence as '*...knowledge derived from a variety of sources that has been subjected to testing and has found to be credible.*' (P83)³⁵ Image quality in the clinical setting relies on subjective judgement, thus, can be viewed differently by various staff members. Such inconsistency in opinion means image quality would not be considered evidence using the above definition. Research-based evidence should be used to guide selection of the imaging technique that will produce the best image, which may include the selection of projections, the size of collimation, positioning of the patient and the choice of exposure factors.⁹

Limitations and strengths

Due to researcher time constraints, a full second analysis of the transcripts was not conducted. Only a subset of transcripts was analysed by a second researcher, the effect this had on the study outcomes is unknown. Additionally, this study may not have captured the views and opinions of all public sector radiographers working in Queensland. The sample population, however, reflected the profile of Queensland radiographers' in terms of age and gender, according to the demographic data of registrants of the Medical Radiation Practitioner Board of Australia in June 2017.³⁶ Further research would be required to confirm whether these results reflect radiographer opinions at a state or national level and across the private and public sectors.

The order in which recruitment and interviews were conducted was dictated by when site-specific approval was granted. This resulted in all participants from site 'A' being interviewed before the participants from sites 'B' and 'C'. This order may have altered the depth of questioning and exploration of ideas during the interviews at each site. We did not take measures to prevent contamination of information within sites, because participants were given the questions in advance of the interviews and were asked to think about their use and opinion of evidence-based decision-making.

The fact that the principal researcher was a radiographer was a strength of the study. Professional knowledge and connections brought an in-depth understanding of the context of the research and facilitated data collection and analysis. This allowed for more relaxed interviews to be

conducted using professional jargon, which enhanced the richness of the data.

Conclusion

Many factors influence a radiographer's production of X-ray images. Evidence-based practice should guide radiographic decision-making processes and take into account the patient, clinician experience and evidence generated by primary research. Despite this, radiographers in this study preferred to use image quality and personal experience to support their decisions. It was outside the scope of this project to identify the reasons why radiographers do not include research-based evidence in their decision-making process, although understanding these reasons may enable the profession to further embrace evidence-based practices.

The lack of available evidence is a significant barrier to adopting evidence-based practice in radiography. Research needs to be conducted on current imaging techniques, and imaging equipment, to determine if they are the best methods to depict anatomy and detect pathology. By filling this evidence gap, radiographers are likely to become more research literate and, hence, analyse and incorporate research-based evidence into their daily practice.

Image quality was reported as the key factor influencing and motivating modification of imaging techniques. The reasons radiographers use such a subjective measure to support their choices remain unclear. Radiographers use image quality to determine whether an image needs to be repeated; however, it does not indicate whether the technique used was the best method. Changing this misperception in the future may have a significant impact on how radiographers think about and use evidence in the clinical environment.

Interviewees perceived a more balanced relationship between radiology and radiography than has previously been reported. While radiology continues to be the authority on which projections are required, radiographers perceive their role to be optimising image quality. Clinical decisions made within both these roles should include all three aspects of evidence-based practice (research-based evidence, patient circumstances and clinical experience) to ensure that current, appropriate and effective care is delivered to patients.

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