

Implementing Evidence-Based Practice in Diagnostic Radiography: an Exploration of Education and Culture

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Thesis submitted in fulfilment of the requirements for the degree of

Doctor of Philosophy

Sydney School of Health Science

Faculty of Medicine and Health

The University of Sydney

Statement of originality

This is to certify that to the best of my knowledge, the content of this thesis is my own work. This thesis has not been submitted for any degree or other purposes.

I certify that the intellectual content of this thesis is the product of my own work and that all the assistance received in preparing this thesis and sources have been acknowledged.

Laura Di Michele

Abstract

Evidence-based practice is vital to providing healthcare that is effective, efficient, and patient-centred. Despite its importance, evidence-based practice is poorly implemented in diagnostic radiography, with evidence underutilised by clinicians. In this doctoral thesis I explore two major influences on the implementation of evidence-based practice within diagnostic radiography: education and culture. I advocate for an approach that sets up diagnostic radiography students for success when it comes to the application of evidence in practice, exploring current disciplinary culture, and the intersection of university education and disciplinary culture during clinical placements.

In this thesis, I present a literature review and three empirical studies. My narrative review explored the application of knowledge translation techniques in diagnostic radiography and disciplinary culture. In the first of the empirical studies, I conducted focus groups with student participants (N=20) to explore their experiences of evidence-based practice during clinical placement. For the second empirical study, I introduced an applied educational intervention, to enhance students' knowledge and skills, practices and attitudes and application of evidence-based practice. I evaluated this intervention using a convergent parallel mixed methods design. I employed focus groups (N=12), and pre- and -post intervention surveys (N=23, 18) to assess the effectiveness of the intervention. In the third empirical study, I undertook a national survey of diagnostic radiographers in Australia (N=131) to establish a baseline of their evidence-based practice capabilities.

Through my analysis I developed several key findings and a series of practical recommendations that are presented in my thesis. In relation to education, students' experiences of evidence-based practice during work integrated learning placements were fundamental to setting them up for future clinical practice. It is therefore essential that universities position students for success by ensuring these experiences are positive. This is easier said than done; organisational and professional cultures in clinical settings have a significant impact on both students' and practitioners' ability to implement evidence in practice. Therefore, educational efforts in the absence of cultural change are unlikely to be impactful on future clinical practice.

Culture is innately shaped by leaders; in my national survey of radiographers, I found that institutional leaders in Australia were no more likely to have positive attitudes towards evidence-based practice than other radiographers. To create the cultural change required, their attitudes must shift through a coordinated and strategic effort at both professional and organisational levels. This culture shift would include more diagnostic radiographers actively engaging with and contributing to

our profession's evidence base. Furthermore, radiographers must learn from other disciplines, like implementation science, to ensure the evidence is applied in practice.

This thesis argues that the educational foundation of diagnostic radiography students in relation to evidence-based practice is imperative to the application of the practice for graduate clinicians. Substantial thought, research and planning of radiography curricula are crucial to ensure that graduate practitioners are ready to address the challenges of tomorrow. Furthermore, we must prioritise a strategically led cultural shift towards an evidence-based paradigm as the norm for our profession. This will ensure that our clinical practices remain effective and efficient, and ultimately, enhance patient outcomes and professional standards.

Authorship statement

Chapter 3 is published as **Di Michele, L.**, Thomson, K., McEntee, M. F., Kenny, B., & Reed, W. (2020). Knowledge translation: Radiographers compared to other healthcare professionals. *Radiography* (London, England. 1995), 26, S27–S32. <https://doi.org/10.1016/j.radi.2020.06.007>. The contributions of Kate Thomson (KT), Mark McEntee (MME), Belinda Kenny (BK) and Warren Reed (WR) are outlined below. The candidate's role (LDM) in this publication was substantial. Therefore, this paper should be considered as part of the candidate's work as part of her PhD.

- Original conception by LDM and PhD supervisory team (MME, BK, WR)
- Development of search strategy, article searching and data analysis LDM with comments provided by PHD supervisory team (KT, MME, BK, WR)
- First and subsequent drafts of manuscript written by LDM with comments provided by full authorship team (KT, MME, BK, WR)
- Response to reviewer and revision written by LDM with comments from full authorship team (KT, MME, BK, WR)

Chapter 4 is published as **Di Michele, L.**, Bell, A., Thomson, K., McEntee, M., Kenny, B., Reed, W., (2023) Student radiographers' perceptions of evidence-based practice during clinical placements. *International Journal of Work Integrated Learning* 24(4), 553-566 <https://doi.org/10.21203/rs.3.rs-1767136/v1>. The contributions of Amani Bell (AB), Kate Thomson (KT), Mark McEntee (MME), Belinda Kenny (BK) and Warren Reed (WR) are outlined below. The candidate's role (LDM) in this publication was substantial. Therefore, this paper should be considered as part of the candidate's work as part of her PhD.

- Original conception by LDM and PhD supervisory team (MME, BK, WR)
- Research design, data collection and data analysis LDM with comments provided by PHD supervisory team (AB, KT, MME, BK, WR)
- First and subsequent drafts of manuscript written by LDM with comments provided by full authorship team (AB, KT, MME, BK, WR)
- Response to reviewer and revision written by LDM with comments from full authorship team (AB, KT, MME, BK, WR)

Chapter 5 has been submitted for publication to *Radiography* and as of 26.06.2024 is currently under review as of 19.09.24, with the title *Enhancing evidence-based practice in radiography education: evaluation of an applied curriculum intervention*. The contributions of Amani Bell (AB), Kate Thomson (KT), and Warren Reed (WR) are outlined below. The candidate's role (LDM) in this publication was

substantial. Therefore, this paper should be considered as part of the candidate's work as part of her PhD.

- Original conception by LDM and PhD supervisory team (AB, KT, WR)
- Research design, data collection and data analysis LDM with comments provided by PHD supervisory team (AB, KT, WR)
- First draft of manuscript written by LDM with comments provided by full authorship team (AB, KT, WR)

Chapter 6 is published as **Di Michele, L.**, Thomson, K., Bell, A., & Reed, W. (2024). Assessing evidence-based practice among Australian radiographers: A self-report survey. *Radiography*, 30(2), 696-701. <https://doi.org/10.1016/j.radi.2024.02.007>. The contributions of Amani Bell (AB), Kate Thomson (KT), and Warren Reed (WR) are outlined below. The candidate's role (LDM) in this publication was substantial. Therefore, this paper should be considered as part of the candidate's work as part of her PhD.

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- Response to reviewer and revision written by LDM with comments from full authorship team (AB, KT, WR)

Supervisor statement

As supervisor for the candidature upon which this thesis is based, I can confirm that the authorship attribution statements above are correct.

Kate Thomson

17.09.2024

Acknowledgements

It's been a big eight years and what a journey it's been! There were so many people who helped and hindered this thesis coming to fruition. Firstly, to my two best distractions – Tommy and Leo. In this world where everything and everyone are racing faster than Lightning McQueen, you've taught me the beauty of slowing down. You've brought kindness and patience beyond your years to this adventure. You're the future and the reason I'm driven to make a difference with my work. I may have done a PhD focused on education but the two of you teach me something new every day!

To Nick, without whom the two distractions might have been overwhelming! You're the reason I'm still sane (or am I?), to say you're the definition of support may be an understatement, thank you for all you have done and continue to do. I've loved growing with you every step of the way.

To my families, friends, and colleagues, (you know who you are), thanks for the babysitting, PhD brunch dates, proofreading and support – I wouldn't be here without you.

To all the supervisors I've had along the way, my sincere thanks go to you! Warren Reed, you're the only one who made it through the whole journey with me! Thank you for your guidance, support and for putting up with me along the way! To Mark McEntee and Belinda Kenny who got me started, I have such huge appreciation for your direction and advice. To Kate Thomson and Amani Bell who have kept me sane over the last few years of my candidature. You are mentors and friends, and I appreciate so much the advice and support over this journey.

I'm lucky to have had such an amazing team of colleagues, family and friends with me and supporting me. From the bottom of my heart thank you to each and every one of you.

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Di Michele, L., Thomson, K., McEntee, M. F., Kenny, B., & Reed, W. (2020). Knowledge translation: Radiographers compared to other healthcare professionals. *Radiography*, 26, S27–S32.

<https://doi.org/10.1016/j.radi.2020.06.007>

Di Michele, L., Bell, A., Thomson, K., McEntee, M., Kenny, B., Reed, W., (2023) Student radiographers' perceptions of evidence-based practice during clinical placements. *International Journal of Work Integrated Learning* 24(4), 553-566 <https://doi.org/10.21203/rs.3.rs-1767136/v1>

Di Michele, L., Thomson, K., Bell, A., & Reed, W. (2023). Educating for the future: Bookending evidence-based practice. *Radiography* 29(5), 958–960. <https://doi.org/10.1016/j.radi.2023.07.007>

Di Michele, L., Thomson, K., Bell, A., & Reed, W. (2024). Assessing evidence-based practice among Australian radiographers: A self-report survey. *Radiography*, 30(2), 696-701.

<https://doi.org/10.1016/j.radi.2024.02.007>

Di Michele, L., Bell, A., Thomson, K., & Reed, W. (2024). Evidence-based practice in radiography: A strategy for shifting our culture. *J Med Radiat Sci*. <https://doi.org/10.1002/jmrs.801>

Di Michele, L., Thomson, K., Bell, A., & Reed, W. (2024). Enhancing evidence-based practice in radiography education: Evaluation of an applied curriculum intervention. *Radiography*.

<https://doi.org/https://doi.org/10.1016/j.radi.2024.12.007>

Funding awarded

Di Michele, L., Reed, W., Kenny, B., McEntee, M. (2016). *The translation of research findings into evidence-based practice within diagnostic radiography in Australia*. (\$9, 972) Australian Society of Medical Imaging and Radiation Therapy Research Scholarship

Di Michele, L., Bell, A., Thomson, K., Reed, W. (2023). *Transforming students' evidence-based practice, knowledge, skills and attitudes through an applied educational intervention* (\$4,949) Australian New Zealand Association for Health Professional Educators

List of presentations

Di Michele, L., McEntee, M. F., Kenny, B., & Reed, W. (2017). The implementation of research findings into evidence-based practice within diagnostic radiography in Australia. Annual Scientific Meeting of Medical Imaging and Radiation Therapy, Perth.

Di Michele, L., Thomson, K., McEntee, M. F., Kenny, B., & Reed, W. (2021). Knowledge translation in diagnostic radiography: Where are we and what needs to be done? International Society of Radiographers and Radiological Technologists World Conference, Dublin.

Di Michele, L., Bell, A., McEntee, M. F., Kenny, B., & Reed, W. (2022). Student perspectives of evidence-based practice during work integrated learning experiences; an Australian perspective. European Congress of Radiology, Vienna. (E-poster)

Di Michele, L., Jimenez, J., (2023). Translating knowledge into evidence-based practice – a practical guide for clinicians. Australian Society of Medical Imaging and Radiation Therapy, Sydney. (Workshop)

Di Michele, L., Bell, A., Thomson, K., & Reed, W. (2023). The self-reported knowledge, skills and attitudes of Australian diagnostic radiographers towards evidence-based practice. Australian Society of Medical Imaging and Radiation Therapy, Sydney.

Di Michele, L., Bell, A., Thomson, K., & Reed, W. (2023). Student radiographers' observations of evidence-based practice during placements: implications for radiography education, culture and practice. Australian Society of Medical Imaging and Radiation Therapy, Sydney.

Di Michele, L., Bell, A., Thomson, K., & Reed, W. (2024). Evidence-based practice in medical imaging curriculum. Australian Society of Medical Imaging and Radiation Therapy, Darwin.

Di Michele, L., Bell, A., Thomson, K., & Reed, W. (2024). Transforming students' evidence-based practice knowledge, skills and attitudes through an applied educational intervention. Australian & New Zealand Association for Health Professional Educators, Adelaide.

Chapter 1: Introduction

1.1 Evidence-based practice: what it is and why we should implement it

Evidence-based practice is crucial; its effective application benefits patients, practitioners, organisations and healthcare systems (Connor et al., 2023; Emparanza et al., 2015; Melnyk, Fineout-Overholt, Giggelman, et al., 2010). Due to these wide-reaching benefits, it is considered a core competency for healthcare professionals internationally; from medical doctors to nurses and allied health professionals (Greiner & Knebel, 2003). The evidence-based movement is in fact so influential that it has transcended its origins in medicine, permeating through healthcare more broadly. Its reach now extends beyond healthcare to many other disciplines, including educational science, marketing, and management (Branthwaite, 2002; Hannes et al., 2020; Pfeffer & Sutton, 2006).

Evidence-based practice is also innately challenging to implement. Despite its name, evidence-based practice involves far more than simply putting current empirical evidence into action. Reducing evidence-based practice to merely the application of empirical evidence is a common strategy used by those who argue against the utility of the concept. As a result, evidence-based practice advocates have made efforts to achieve consensus on what evidence-based practice is, explicitly stating that evidence-based practice must incorporate the three pillars of empirical evidence, clinical expertise, and patient preferences (Sackett et al., 1996).

More recently, it has been argued that a fourth pillar is necessary: the consideration of the clinical context within which the practitioner operates (Hoffmann et al., 2017). For example, the best diagnostic test for a patient's condition may be an MRI, but if your facility lacks an MRI scanner, this option isn't feasible. Similarly, we may know that a particular test is the most evidence-based for a patient's condition, however if that test does not receive a government or health insurance rebate, it may not be accessible. To apply evidence-based practice, the practitioner must pivot. They must use their reasoning, navigating these pragmatic challenges by utilising clinical expertise, knowledge from empirical evidence, and patients' preferences to suggest the next best test or treatment. A visual representation of the elements of evidence-based practice is displayed in figure 1.

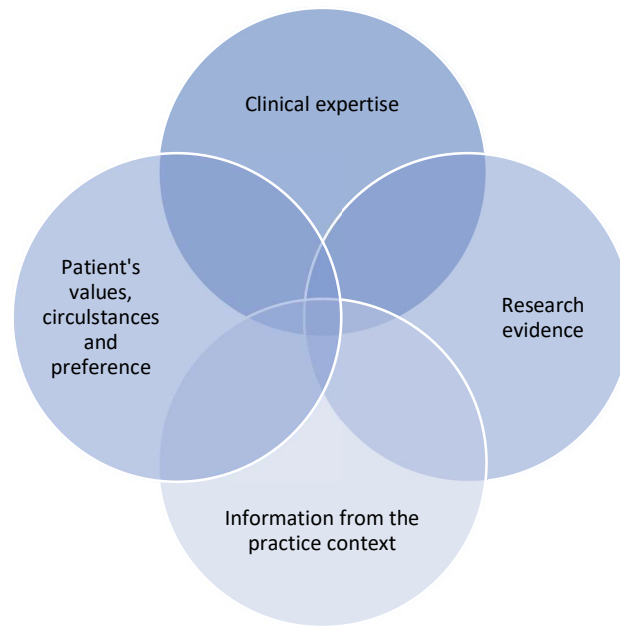


Figure 1. Visual representation of the 4 elements of evidence-based practice from (Hoffmann et al., 2024)

Therefore, when discussing evidence in the context of this thesis, the term is not confined to empirical research but rather encompasses patient preferences, pragmatics of context, clinical expertise, and empirical research. Evidence-based practice is the very essence of clinical reasoning, requiring practitioners to understand, value, and act in alignment with evidence of many forms, to provide the best care possible for their patients. It is a process through which clinical challenges are translated into questions, evidence is sought to answer these questions, and the findings are then translated into actionable outcomes.

1.2 The evidence-based practice cycle

Literature on evidence-based practice often helpfully simplifies the concept into a stepwise process. The Sicily Statement was developed at the second international conference of Evidence-Based Practice in 2003 by delegates from eighteen different countries and eighteen healthcare professions (Dawes et al., 2005). The consensus statement proposed a five-step cycle for evidence-based practice, which includes: 1) asking clinical questions, 2) searching for evidence, 3) critically appraising the evidence, 4) applying results in practice, and 5) evaluating the implementation attempt. While substantial literature in the area of evidence-based practice tends to focus on this model, this thesis will build on the more holistic model proposed by Melnyk, Fineout-Overholt, Stillwell, et al. (2010), which offers two additional steps, bookending those in the Sicily Statement. These steps are cultivate a spirit of enquiry (first step) and disseminate (final step), these concepts are explored in detail in

[Appendix 1](#). In addition, I propose that step 4 of the Sicily Statement and step 5 of the Melnyk, Fineout-Overholt, Stillwell, et al. (2010) model, should be renamed ‘implement’, in line with the language of implementation science. I intentionally use the term implement (Di Michele et al., 2023), rather than apply (Dawes et al., 2005) or integrate (Melnik, Fineout-Overholt, Stillwell, et al., 2010) to bring it more in line with the discipline of implementation science, a discipline which is concerned with the study of applying evidence-based findings in practice.

The proposed seven-step model for evidence-based practice is visually represented in Figure 1.



Figure 2. Visual representation of the seven steps of evidence-based practice adapted from the Sicily Statement (Dawes et al., 2005) and Melnyk, Fineout-Overholt, Stillwell, et al. (2010)'s model

Implementation science is a field of research concerned with how research findings are applied in practice (Eccles & Mittman, 2006). In a similar vein, knowledge translation is “the ‘exchange’, ‘synthesis’, and ethically sound ‘application’ of researcher findings with a complex system of relationships among researchers and knowledge users” (Khalil, 2016, p. 39). Namely, it is concerned with the empirical evidence pillar of evidence-based practice and enhancing its translation in clinical practice. The fields of implementation science and knowledge translation were developed as a response to the slow nature of practice change in healthcare, with estimates that changes to clinical practice take up to seventeen years to implement (Morris et al., 2011).

This slow translation of evidence is complex as there are factors that affect the uptake of change at systems, organisational, and individual levels. When it comes to implementing evidence-based practice, there are many barriers and enablers that may relate to the change itself, the context in which the change is being implemented, the individuals involved, and the implementation process (Damschroder et al., 2022). Concerningly, at a practitioner level, amongst allied health professionals, there is a documented decline in the application of evidence-based practices in under five years in the

profession (Klaic et al., 2019). In this study examining physiotherapy, occupational therapy, speech pathology, social work, dietetics/nutrition, radiation therapy, and others, (2019) postulate that this may be due the predominant focus on clinical work in the immediate years following graduation, noting that at lower levels, allied health staff do not have time inbuilt in their roles to engage in quality improvement and research. They note the importance of both immediate colleagues and supervisors in setting expectations in relation to evidence-based practice.

1.3 Evidence-based practice in diagnostic radiography

When it comes to empirical evidence, diagnostic radiography professionals have been found to rely heavily on their formal education and/or advice from a colleague with the application of evidence-based practice not the norm (Ahonen & Liikanen, 2010; Challen et al., 1996; Hafslund et al., 2008; Rawle et al., 2023). However, a problem arises when what was learned during formal education is no longer consistent with current evidence. Similarly, when considering the advice of colleagues, it can be challenging for practitioners to determine whether that advice itself is evidence-based and current.

The disciplinary culture within diagnostic radiography in Australia is explored in [Section 1.6](#) *The Australian diagnostic radiography context* and throughout the publications arising from this thesis. A number of studies address the barriers to applying evidence-based practice; radiographers often cite lack of time, lack of access to appropriate mentors, limited funding, limited access to literature, insufficient knowledge, poor working practices, and organisational structures as barriers to implementing evidence-based practice (Al Balushi et al., 2024; Alakhras et al., 2023; Oliveira et al., 2024; Upton & Upton, 2006). Understanding the barriers and enablers to evidence-based practice is complex and further influenced by disciplinary culture and organisational structures, which play significant roles in the application of evidence-based practice in diagnostic radiography.

In physiotherapy, it has been shown that practitioners who have positive attitudes towards evidence-based practice, along with the knowledge and skills required to practice it, are more likely to implement it in their daily practice (Bridges et al., 2007). Examining each of the seven steps of evidence-based practice as they relate to diagnostic radiography is important to enable a deeper understanding of how we can improve the attitudes, knowledge and skills towards it within our discipline.

When taking the first step of 'cultivate a spirit of enquiry', we should consider how it is inherently tied to enabling practitioners to value lifelong learning. To spark this spirit of enquiry, we must firstly turn to education (D'Alimonte, 2016; Di Michele et al., 2023; Higgins et al., 2015), ensuring learners' passion for enquiry is cultivated during their formative experiences. Disciplinary examples such as OPTIMAX, an international, collaborative, research intensive summer school, provide a perfect

example of how this may be achieved (Hogg et al., 2020). It is imperative that we foster this spirit in our students, as when these students become clinicians in a busy clinical environment with multiple competing priorities, finding the motivation to stay up to date with current research evidence is challenging. For clinicians to prioritise evidence-based practice, they need to value it and continuously seek improvement. Further to this spirit of enquiry, clinicians need to possess the skills required to undertake evidence-based practice and be supported by their organisation to do so.

Next, we consider asking, searching, and appraising (steps 2, 3 and 4). Internationally, there has been a recent proliferation in research establishing baselines of radiographers' evidence-based practice tendencies (Alakhras et al., 2023; Chukwuani et al., 2017; Kyei et al., 2015; Moran & Davis, 2020; Sauti & Yamin, 2020; Ugwu et al., 2009) however an Australian baseline was missing. The lack of an adequate baseline for Australian diagnostic radiographers will be explored in detail in [Chapter 6](#). A recent systematic review examining evidence-based practice in clinical radiography found that knowledge and skill gaps among radiographers affect the translation of evidence within the discipline (Al Balushi et al., 2024). The skills required for evidence-based practice are teachable, but careful consideration must be given to how they are incorporated into training programs for diagnostic radiography students. How to embed evidence-based practice in curriculum will be discussed in [Section 1.4](#) *Pedagogy for teaching evidence-based practice*.

When it comes to step 5, implementing, and step 6, evaluating, it is important to consider insights from implementation science. Defined by Eccles and Mittman (2006, p. 1), as “the scientific study of methods to promote the systematic uptake of research findings and other evidence-based practice into routine practice” implementation science is a complex and challenging discipline. Implementation attempts often deviate from established principles, leading to poor or failed uptake of changes. Consequently, empirical evidence tends to take a long time to be integrated into evidence-based practice (Morris et al., 2011). Diagnostic radiography is no exception: a special issue of the journal *Radiography* in 2020 highlighted many of the challenges that radiographers face when trying to implement evidence-based practice (Kelly, 2020; McEntee & Hogg, 2020; Munn, 2020). [Chapter 3](#) of this thesis is a literature review published in that special issue, that examines the current state of knowledge translation in diagnostic radiography and suggests a pathway forward.

Finally, in step 7, dissemination, it is essential to ensure that best practices are shared. Effective dissemination requires that the findings of both research and evidence-based initiatives can have greater impact and be of broad benefit to society (Marín-González et al., 2017). Without broad dissemination there is no evidence to enable others to engage in the search and appraise steps of the process. Given the current disciplinary culture within diagnostic radiography, the exploration of non-

traditional research dissemination such as podcasts, social media and or radiography specific EBP platforms could be considered and their effectiveness assessed. Additionally, dissemination affects culture; the more we normalise and talk about our implementation of evidence-based practice, the more it becomes the expected norm. Given radiographers' tendency to implement advice from colleagues (Rawle et al., 2023), once best practices are shared widely among colleagues, they are likely to be adopted.

1.4 Pedagogy for teaching evidence-based practice: what diagnostic radiography can learn from other health professions

As we delve into the discussion of pedagogy for teaching evidence-based practice, valuable insights can be extrapolated from the literature in medicine, nursing, and other allied health professions. The following review examines literature from these disciplines.

The Sicily Statement not only described the evidence-based practice cycle but was also the first consensus statement on the teaching of evidence-based practice in health professional education (Dawes et al., 2005). It highlighted the inconsistency and inadequacy in evidence-informed approaches to teaching evidence-based practice internationally. The statement called for evidence-informed health professional education to ensure that future healthcare professionals possess the necessary skills for evidence-based practice. The Sicily Statement provided five recommendations, each of which is summarised below.

Firstly, the authors of the statement recommended that knowledge, skills, and attitudes towards evidence-based practice be integrated into the education and registration requirements for healthcare professionals (Dawes et al., 2005). In Australia, the importance of evidence-based practice has been widely acknowledged by the organisations that governs diagnostic radiography. Indeed, Domain 4 of the Medical Radiation Practice Board of Australia's Professional Capabilities Statement is entirely dedicated to evidence-based practice (Medical Radiation Practice Board of Australia, 2020). However, it is noteworthy that the domain does not explicitly address all steps of evidence-based practice, omitting the steps of evaluation and dissemination. This omission may explain the paucity of literature on evidence-based initiatives within the discipline and may impact the professional culture as discussed in [Section 1.6](#) *The Australian diagnostic radiography context: culture and professionalisation*.

The second recommendation is that health professional education curricula should address all steps within the model to promote good evidence-based practice (Dawes et al., 2005). The Sicily Statement's five-step model is discussed in [Section 1.2](#) *The evidence-based practice cycle*, as is the argument that the seven-step model of Melnyk, Fineout-Overholt, Stillwell, et al. (2010) is a more

comprehensive description of the process of good evidence-based practice. The recommendation that each step should be incorporated into curricula remains valid, regardless of the model used. Multiple systematic reviews have emphasised the importance of integrating all the necessary steps for evidence-based practice within curricula for formal education of healthcare professionals (Horntvedt et al., 2018; Thomas et al., 2011; Young et al., 2014). Furthermore, evidence suggests that integrating these skills across both academic and clinical curricula helps solidify the skills required for evidence-based practice by teaching and assessing them in more authentic ways (Horntvedt et al., 2018; Khan & Coomarasamy, 2006; Larsen et al., 2019; Young et al., 2014).

There is strong evidence to suggest that students who are confident in the skills required for evidence-based practice are more likely to practice in an evidence-based manner once they become practitioners (Ajzen, 1991; Amit-Aharon et al., 2020). Therefore, it is crucial to integrate and scaffold the skills required for evidence-based practice throughout curricula, ensuring that graduates are equipped to meet the ongoing needs of the evolving healthcare environment. Additionally, creating and fostering a culture of evidence-based practice begins with staff (Kalb et al., 2015) and it could be argued that step one of Melnyk's process "cultivate a spirit of enquiry" is intrinsically linked to the cultivation of lifelong learning skills, a concept that I discuss further in [Appendix 1](#).

The third recommendation of the Sicily Statement is that we should empirically research the most effective ways to teach each step of the evidence-based practice cycle (Dawes et al., 2005). This call has been answered with individual studies and systematic reviews examining the effectiveness of teaching practices in relation to evidence-based practice. Khan and Coomarasamy (2006) proposed a hierarchy of teaching and learning strategies for evidence-based practice, displayed visually in Figure 2. They suggested that the most effective approach is through interactive and clinically integrated methods (Level 1). A level 1 curriculum level solution is discussed in detail in [Chapter 5](#).

Within this thesis, there will be a particular focus on understanding the intersection of education and clinical practice. Students' socialisation into the profession begins during their early experiences of clinical placements. Throughout the thesis, I utilise the phrases "clinical placement" and "work integrated learning" interchangeably, recognising that the former is more common amongst the international community, whilst work integrated learning is more common in the Australian context.

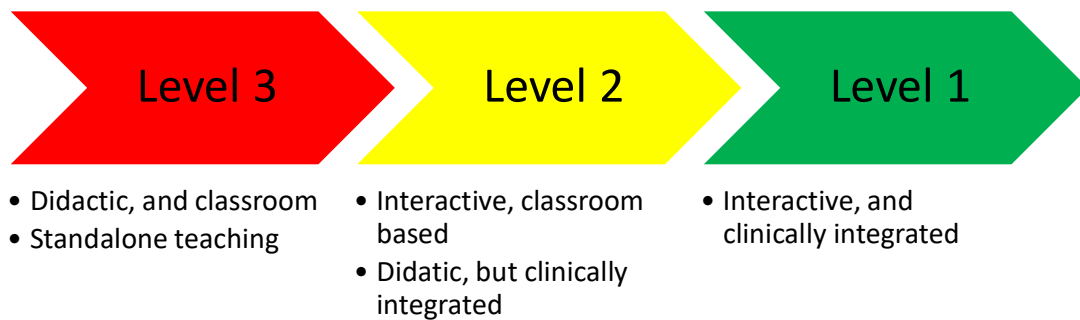


Figure 3. Visual representation of hierarchy of evidence-based medicine teaching and learning adapted from Khan and Coomarasamy (2006)

The finding that interactive strategies are more effective than didactic teaching methods for evidence-based practice is unsurprising and consistent with the literature on teaching in higher education (Qureshi et al., 2023; Vuopala et al., 2016). Successful strategies include collaborative e-learning, interactive workshops, collaboration with clinical practice, journal clubs, and the involvement of librarians as a resource within units (Khan & Coomarasamy, 2006; Larsen et al., 2019). Amit-Aharon et al. (2020) also highlight the importance of teaching strategies that elicit intrinsic motivation among students to both learn about and implement evidence-based practice.

The fourth recommendation states that validated and freely available assessment tools should be developed that address each aspect of the evidence-based practice cycle (Dawes et al., 2005). In response to this recommendation, Tilson et al. (2011) developed the Classification Rubric for Evidence-Based Practice Assessment Tools in Education (CREATE), providing a useful tool to classify assessment tools and provide a framework and guidance for identifying appropriate tools for the assessment of evidence-based practice. This framework provides a tool whereby the steps of the evidence-based practice cycle are mapped to assessment categories, the type of assessment and the steps of the evidence-based practice cycle, as described by (Dawes et al., 2005) and is useful at a programmatic level to map assessment effectively. To enhance the tool further I would suggest expanding the steps of the cycle in line with Melnyk and colleagues (2010) steps of evidence based practice.

The fifth and final recommendation emphasises that courses claiming to teach evidence-based practice should ensure that all components of evidence-based practice are taught and assessed effectively (Dawes et al., 2005). It is worth noting that there is minimal literature reporting on educational interventions that address all stages of the evidence-based practice process (Albarqouni et al., 2018; Khan & Coomarasamy, 2006). Most studies focus on educational interventions that involve asking clinical questions, searching for literature, and critical appraisal (Steps 2, 3 and 4).

1.5 Education in diagnostic radiography: teaching our students to be evidence-based

Evidence-based practice in radiography curricula has received growing attention in recent years (England & McNulty, 2020; McNulty et al., 2021). In 2015, the European Federation of Radiographers of Radiographer Societies released its statement on the implementation of evidence-based practice in undergraduate radiography curricula which outlines a number of methods and approaches to curriculum and teaching (EFRS, 2015). This document highlights helpful and practical strategies for university academics who are hoping to more effectively integrate evidence-based practice within their curricula and has been an impetus for broader conversations about the way in which we teach evidence-based practice within the discipline.

Unfortunately, in Australia we have no such equivalent document proposed by either our professional society, the Australian Society of Medical Imaging and Radiation Therapists or our accrediting body, the Medical Radiation Practice Board of Australia. The Medical Radiation Practice Board of Australia published the first set of *Professional Capabilities for Medical Radiation Practice* in 2013, which were subsequently revised in 2020. These capabilities provide an overarching framework for the core responsibilities of radiographers. They define the standard for threshold capability which informs accreditation standards for the level of education required for diagnostic radiographers (MRPBA, 2013, 2019, 2020). The professional capabilities highlight the importance of evidence-based practice by dedicating an entire domain, Domain 4, to the “evidence-informed practitioner”. However, Domain 4 is the has the fewest key components of the 5 domains of practice and is quite limited in its scope, recognising only the ask, search and appraise steps (2, 3 and 4) of the evidence-based practice cycle. Likewise, the current educational accreditation standards fail to address the importance of evidence-based practice beyond a requirement to address the professional capabilities in curriculum (MRPBA, 2019). This lack of priority mirrors the current culture towards evidence-based practice within the discipline.

In terms of how to implement evidence-based practice into radiography curriculum, Higgins et al. (2013a) argue that research and education should be intrinsically linked to create a “research-teaching nexus” and go on to do this using a research informed teaching approach to curriculum (Higgins et al.,

2013a, 2013b; Higgins et al., 2017; Higgins et al., 2014). These contributions make significant headway to providing important guidance for how the empirical evidence pillar of evidence-based practice can be integrated into curriculum within diagnostic radiography. In progressing evidence-based practice education in diagnostic radiography, it is important to consider how the empirical evidence pillar is integrated with the other pillars of evidence-based practice.

David Sackett, one of the pioneering authors on evidence-based practice wrote that “Without clinical expertise, practice risks becoming tyrannized by external evidence, for even excellent external evidence may become inapplicable to or inappropriate for an individual patient” (Sackett, 1997, p. 3). We must ensure that diagnostic radiography students are afforded the opportunity to develop this expertise in ways that are clinically integrated and pedagogically sound, including simulation and clinical placements. Additionally, students must have a good foundational understanding of clinical practice to enable them to use their clinical reasoning to adapt their practice when it is required due to patient preferences or the clinical context.

1.6 The Australian diagnostic radiography context: culture and professionalisation

The Australian Council of Professions defines a profession as “a disciplined group of individuals who adhere to ethical standards and who hold themselves out as, are accepted by the public as possessing special knowledge and skills in a widely recognised body of learning derived from research, education and training at a high level, and who are prepared to apply this knowledge and exercise these skills in the interest of others” (ACoP, 2003), acknowledging that professional autonomy is a key component of a profession. Over the years, there has been ongoing debate surrounding whether diagnostic radiography fits within this definition, raising questions about the professional status of the discipline. Lewis (2003) argued that diagnostic radiography should be classified as a semi-profession, as it possesses some but not all of the attributes required for professional status.

In the last twenty years, diagnostic radiography has undergone significant changes in relation to professionalisation. These changes are resulting from concerted efforts in various areas such as education, curriculum, research trends, and public expectations (Higgins et al., 2013a; Malamateniou, 2009). They have advanced diagnostic radiography towards professional status. Malamateniou (2009) described the transition within diagnostic radiography as a shift “from a knowledge-based discipline to an evidence-based practice” (p. 2) discipline. In Australia, consistent with many other international jurisdictions, diagnostic radiography has now moved to a university-based education model overseen by the national accreditation body, the Medical Radiation Practice Board of Australia. Despite this, a recent study of Australian medical radiation scientists found that radiographers lacked interest, experience, and confidence in research (Dennett et al., 2021).

Radiographers have historically displayed apathy, low self-esteem and low confidence in engaging in research (Yielder & Davis, 2009). Much of the literature pertaining to diagnostic radiography is produced by researchers outside the profession, such as medical doctors and radiation physicists (Higgins et al., 2015; Malamateniou, 2009). Furthermore, the confidence of radiographers in utilising research to provide evidence-based care has also been reported as low (Dennett et al., 2021; Upton & Upton, 2006), with diagnostic radiographers rating their research experience and confidence as limited. Estimates indicate that between 0.3 - 1% of Australian diagnostic radiographers hold PhD qualifications (Dennett et al., 2021; Ekpo et al., 2017).

Some of this lack of confidence may be attributed to a culture of medical dominance in diagnostic radiography. The subordination of radiographers by their medical colleagues, both historically and currently, has resulted in a lack of professional autonomy (Lewis et al., 2008). In Australia, this is exacerbated by the Medicare funding model, where the radiologist reporting the study is the beneficiary of the associated rebate (Francis Health, 2018). In this environment, radiologists face financial loss as a direct consequence of role advancement of the radiographers and have loudly advocated against advanced radiography practice (RANZCR, 2018), perpetuating the cycle of dominance.

Issues of hierarchy and inconsistent reporting lines within diagnostic radiography also contribute to medical dominance. In Australia, there is no clear or consistent definition of where diagnostic radiographers fit within the broader healthcare environment. The lack of consistency between states and territories means that radiographers are often classified differently in different health districts. In some districts, radiographers fall under medical classifications, governed by the dominating medical fraternity, while in others, they are classified within allied health (Francis Health, 2018). The lack of consistency in classification can result in radiographers being overlooked or included only as an afterthought in many important decisions. This extends to efforts that are aimed at improving evidence-based practice among healthcare professionals more broadly. A lack of consistent advocacy from within the healthcare system perpetuates the difficulties faced by diagnostic radiographers in Australia.

This lack of consistency between geographic contexts further extends to education, with different states and territories having extremely different approaches and attitudes to clinical education, both in student and ongoing professional development contexts. Much of this stems from differences in state-based awards that classify, and therefore remunerate, clinical education differently. This means that while clinical education may be seen as a viable career path in some states, in others, it is not attractive in terms of career progression (IRCoNSW, 2023; VAHPA, 2021). These challenges of

professional subordination that are entrenched in both funding models (Medicare) and models of care in Australia must be addressed in order to change attitudes of radiographers towards evidence-based practice.

Many radiographers may feel that their professional worth is measured in terms of productivity and the number of services they provide (Lewis et al., 2008). This challenge is likely reinforced by activity-based management models of funding, whereby healthcare providers are remunerated based on instances of service (Francis Health, 2018). This focus on immediate productivity has created a culture where tasks not perceived as directly productive are undervalued. Consuming and producing research often fall into the category of not directly productive, and as a result, these tasks are not prioritised in the same way as direct clinical tasks, such as imaging patients.

Rawle and colleagues (2023) note that within the field, technological advancements often drive practice change. This is problematic as Munn and colleagues (2020) point out that technological advances do not always translate into advances in patient care. In a field where substantial investments are made in generating and improving technologies, the crucial translational aspect is often missing. Teaching diagnostic radiographers the skills required for evidence-based practice and increasing their confidence levels, could lead to greater adoption of evidence-based practices within the field of diagnostic radiography. This concept will be discussed in further detail in [Chapter 5](#).

1.7 Structure of the thesis

This thesis explores evidence-based practice in diagnostic radiography, from both educational and cultural perspectives. It is divided into seven chapters. This introductory chapter provides the thesis background and context, the current literature, and the focus areas for each of the following chapters. Chapter 2 details the methods of the thesis; it provides the opportunity for a more in-depth explanation of the methodological choices made for each study and establishes rigour. Chapters three through six are based on papers that have been published in international peer-reviewed journals during my candidature. These chapters each consist of an introductory section, the paper as published/submitted, and the key practical recommendations arising from the chapter. The practical recommendations are derived from the key findings of each paper and evidence-based strategies that have proven effective in other disciplines. Each chapter is summarised below.

1.7.1 Chapter 2: Methods

[Chapter 2](#) presents the methods of the thesis. In this chapter, I outline my epistemological stance and explain how this shaped the research presented throughout the thesis. I describe how my lens of social

constructivism is aligned to the thesis topic of evidence-based practice and discuss its relevance. Then, I detail the specific methods utilised in each chapter, explaining the methodological choices and arguing their rigour. Finally, I outline the quality measures taken throughout the research process, with a particular focus on reflexivity, a concept highly valued in social constructivism.

1.7.2 Chapter 3: Knowledge translation: Radiographers compared to other healthcare professionals

[Chapter 3](#) contains a narrative review that examined evidence-based practice and knowledge translation, comparing diagnostic radiographers with other healthcare professionals. The narrative review methodology was utilised to synthesise current literature from various healthcare professions and provide a contextualised understanding for diagnostic radiographers. This chapter establishes the importance of evidence-based practice and investigates the current state of the implementation phase as the oft-forgotten link within the cycle. It argues that knowledge translation strategies used in other healthcare disciplines and the learnings from the field of implementation science should be applied to diagnostic radiography. It proposes a pathway for the advancement of evidence-based practice in diagnostic radiography.

1.7.3 Chapter 4: Student radiographers' perceptions of evidence-based practice during clinical placements: Implications for health professional education

[Chapter 4](#) presents a focus group study that explored diagnostic radiography students' experiences of evidence-based practice during their clinical placements. This study focussed on the relationship between education and evidence-based practice. It highlighted the foundational role of education in students and future professionals acquiring the skills required for evidence-based practice: as aptly stated by one participant, "education is the genesis". This chapter argues that social and cultural influences significantly impact the implementation of evidence-based practice. Additionally, it discusses how the formative experiences of university education and clinical placements shape the ability and inclination of individuals to implement evidence-based practice.

1.7.4 Chapter 5: Enhancing evidence-based practice in health professions education: evaluation of an applied curriculum intervention

[Chapter 5](#) reports on the outcomes of an evidence-based practice – applied education intervention (EBP-AEI). The intervention aimed to enhance students' knowledge and skills, practices, and attitudes regarding evidence-based practice. It was developed by collating materials that aligned with the pedagogical principles discussed in [Section 1.4](#) *Pedagogy for teaching evidence-based practice* and [Section 1.5](#) *Education in diagnostic radiography – teaching our students to be evidence-based*. To evaluate the effectiveness of this intervention, a mixed-methods approach was utilised. A validated

survey tool measuring practices, knowledge and skills, practices, and attitudes was administered both before and after students completed the intervention to assess its impact. Focus group studies were conducted to gain insights into students' experiences with the intervention and to guide iterative improvements of the EBP-AEI.

1.7.5 Chapter 6: Assessing evidence-based practice among Australian radiographers: A self-report survey

[Chapter 6](#) establishes a baseline for evidence-based practices, knowledge and skills, practices and attitudes among Australian diagnostic radiographers. By establishing a baseline for Australian radiographers, this study creates an opportunity for future efforts to enhance these areas of evidence-based practice to demonstrate their impact. Additionally, it facilitates direct comparisons between the Australian context and others. The chapter identifies specific steps of the evidence-based practice cycle in which Australian radiographers encounter challenges and advocates for targeted improvements in education within these.

1.7.6 Chapter 7: Discussion

[Chapters 7](#) synthesises findings across these individual studies and offers recommendations. It discusses the importance of education in enhancing evidence-based practice, to pave the way forward for change and facilitate improved translation of knowledge into practice within diagnostic radiography. This chapter provides a comprehensive overview of the research conducted for this thesis, highlights key insights and implications, and proposes practical recommendations for advancing evidence-based practice.

1.8 Research questions

This thesis sets out to explore the implementation of evidence-based practice in diagnostic radiography in Australia. My aim in doing so was to better understand the factors affecting this implementation in order to provide practical recommendations for enhancing evidence-based practice within diagnostic radiography. Each chapter was designed to uncover a particular element affecting the uptake of evidence-based practice in diagnostic radiography in Australia. The specific research questions for each chapter are detailed below:

- **Chapter 3:** How can we enhance the translation of evidence-based practices within diagnostic radiography in Australia?
- **Chapter 4:** How do students' placement experiences affect their ability to implement evidence-base practice, both on placement and into the future?

- **Chapter 5:** How can we improve the education of diagnostic radiographers to enhance the translation of evidence-based practices?
- **Chapter 6:** What are the current knowledge and skills, practices and attitudes towards evidence-based practice of diagnostic radiographers in Australia?

Following the references for Chapter 1 will be the next chapter, *Methods*. It will provide an understanding of my epistemological stance and describe the methods and quality measures used in the research studies presented in Chapters 3 – 6.

1.9 Chapter 1 References

- ACoP. (2003). *What is a Profession?* Retrieved April 4 from <https://www.professions.org.au/what-is-a-professional/>
- Ahonen, S.-M., & Liikanen, E. (2010). Radiographers' preconditions for evidence-based radiography. *Radiography*, 16(3), 217-222. <https://doi.org/10.1016/j.radi.2010.01.005>
- Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes*, 50(2), 179-211. [https://doi.org/https://doi.org/10.1016/0749-5978\(91\)90020-T](https://doi.org/https://doi.org/10.1016/0749-5978(91)90020-T)
- Al Balushi, H., Watts, H., & Akudjedu, T. N. (2024). Research and evidence-based practice in clinical radiography: A systematic review of barriers and recommendations for a new direction. *Radiography*, 30(2), 538-559. <https://doi.org/https://doi.org/10.1016/j.radi.2024.01.012>
- Alakhras, M., Al-Mousa, D. S., Al Mohammad, B., & Spuur, K. M. (2023). Knowledge, attitude, understanding and implementation of evidence-based practice among Jordanian radiographers. *Radiography*, 29(4), 760-766. <https://doi.org/https://doi.org/10.1016/j.radi.2023.05.007>
- Albarqouni, L., Hoffmann, T., & Glasziou, P. (2018). Evidence-based practice educational intervention studies: a systematic review of what is taught and how it is measured. *BMC Medical Education*, 18(1), 177. <https://doi.org/10.1186/s12909-018-1284-1>
- Amit-Aharon, A., Melnikov, S., & Warshawski, S. (2020). The effect of evidence-based practice perception, information literacy self-efficacy, and academic motivation on nursing students' future implementation of evidence-based practice. *Journal of professional nursing*, 36(6), 497-502. <https://doi.org/10.1016/j.profnurs.2020.04.001>
- Branthwaite, A. (2002). Investigating the power of imagery in marketing communication: evidence - based techniques. *Qualitative Market Research: An International Journal*, 5(3), 164-171.
- Bridges, P. H., Bierema, L. L., & Valentine, T. (2007). The propensity to adopt evidence-based practice among physical therapists. *BMC health services research*, 7(1), 103-103. <https://doi.org/10.1186/1472-6963-7-103>
- Challen, V., Kaminski, S., & Harris, P. (1996). Research-mindedness in the radiography profession. *Radiography*, 2(2), 139-151. [https://doi.org/10.1016/S1078-8174\(96\)90005-X](https://doi.org/10.1016/S1078-8174(96)90005-X)
- Chukwuani, A. E., Osanaie, A., & Obinna, F. E. (2017). Attitude towards research evidence utilization in radiography practice. *Biomedical Statistics and Informatics*, 2(4), 162e165.
- Connor, L., Dean, J., McNett, M., Tydings, D. M., Shrout, A., Gorsuch, P. F., Hole, A., Moore, L., Brown, R., Melnyk, B. M., & Gallagher-Ford, L. (2023). Evidence-based practice improves patient outcomes and healthcare system return on investment: Findings from a scoping review. *Worldviews Evid Based Nurs*, 20(1), 6-15. <https://doi.org/10.1111/wvn.12621>
- D'Alimonte, L. (2016). Why Student Research Sparks Passion! Perspectives from a Clinician Scientist. *J Med Imaging Radiat Sci*, 47(3s), S8-s9. <https://doi.org/10.1016/j.jmir.2016.07.007>
- Damschroder, L. J., Reardon, C. M., Widerquist, M. A. O., & Lowery, J. (2022). The updated Consolidated Framework for Implementation Research based on user feedback. *Implementation Science*, 17(1), 75. <https://doi.org/10.1186/s13012-022-01245-0>
- Dawes, M., Summerskill, W., Glasziou, P., Cartabellotta, A., Martin, J., Hopayian, K., Porzsolt, F., Burls, A., & Osborne, J. (2005). Sicily statement on evidence-based practice. *BMC Medical Education*, 5(1), 1. <https://doi.org/10.1186/1472-6920-5-1>
- Dennett, A. M., Cauchi, T., Harding, K. E., Kelly, P., Ashby, G., & Taylor, N. F. (2021). Research interest, experience and confidence of allied health professionals working in medical imaging: a cross - sectional survey. *Journal of medical radiation sciences*, 68(2), 121-130. <https://doi.org/10.1002/jmrs.432>
- Di Michele, L., Thomson, K., Bell, A., & Reed, W. (2023). Educating for the future: Bookending evidence-based practice. *Radiography*, 29(5), 958-960. <https://doi.org/https://doi.org/10.1016/j.radi.2023.07.007>
- Eccles, M. P., & Mittman, B. S. (2006). Welcome to Implementation Science. *Implementation Science*, 1(1), 1. <https://doi.org/10.1186/1748-5908-1-1>

- EFRS. (2015). EFRS Statement on the Implementation of Evidence-Based Practice in Undergraduate Radiography Curricula. In.
- Ekpo, E. U., Snaith, B., Harris, M. A., & McEntee, M. F. (2017). Doctoral profile of the medical radiation sciences: a baseline for Australia and New Zealand. *Journal of medical radiation sciences*, 64(3), 195-202. <https://doi.org/https://doi.org/10.1002/jmrs.231>
- Empananza, J. I., Cabello, J. B., & Burls, A. J. (2015). Does evidence - based practice improve patient outcomes? An analysis of a natural experiment in a Spanish hospital. *Journal of evaluation in clinical practice*, 21(6), 1059-1065.
- England, A., & McNulty, J. P. (2020). Inclusion of evidence and research in European radiography curricula. *Radiography* (London, England. 1995), 26, S45-S48. <https://doi.org/10.1016/j.radi.2020.04.018>
- Francis Health. (2018). *Medical Radiation Science - Horizons Scanning and Scenario Generation Report*. <https://www.health.nsw.gov.au/workforce/alliedhealth/Documents/medical-radiation-sciences-horizons-scanning-report.PDF>
- Greiner, A., & Knebel, E. (2003). *Health professions education : a bridge to quality*. National Academies Press.
- Hafslund, B., Clare, J., Graverholt, B., & Wammen Nortvedt, M. (2008). Evidence-based radiography. *Radiography*, 14(4), 343-348. <https://doi.org/10.1016/j.radi.2008.01.003>
- Hannes, K., Atkinson, P., Delamont, S., Cernat, A., Sakshaug, J. W., & Williams, R. A. (2020). *Evidence-based practice*. SAGE Publications Ltd.
- Higgins, R., Hogg, P., & Robinson, L. (2013a). Integrating research-informed teaching within an undergraduate level 4 (year 1) diagnostic radiography curriculum: a pilot study. *Journal of Vocational Education & Training*, 65(3), 351-368. <https://doi.org/10.1080/13636820.2013.819562>
- Higgins, R., Hogg, P., & Robinson, L. (2013b). Towards a research informed teaching experience within a diagnostic radiography curriculum: The level 4 (year 1) student holistic experience. *Radiography*, 19(1), 62-66. <https://doi.org/https://doi.org/10.1016/j.radi.2012.08.006>
- Higgins, R., Hogg, P., & Robinson, L. (2017). Constructive alignment of a research-informed teaching activity within an undergraduate diagnostic radiography curriculum: A reflection. *Radiography*, 23, S30-S36. <https://doi.org/https://doi.org/10.1016/j.radi.2016.11.004>
- Higgins, R., Robinson, L., & Hogg, P. (2014). Integrating research-informed teaching within an undergraduate diagnostic radiography curriculum: Results from a level 4 (year 1) student cohort. *Radiography*, 20(2), 100-106. <https://doi.org/https://doi.org/10.1016/j.radi.2014.02.002>
- Higgins, R., Robinson, L., & Hogg, P. (2015). Unlocking Student Research Potential: Toward a Research Culture in Radiography Undergraduate Learning Curricular. *Journal of Medical Imaging and Radiation Sciences*, 46(3), S6-S9. <https://doi.org/10.1016/j.jmir.2015.06.009>
- Hoffmann, T., Bennett, S., & Del Mar, C. (2017). *Evidence-based practice across the health professions* (3E [3rd edition]. ed.). Elsevier Australia a division of Reed International Books Australia Pty Ltd.
- Hoffmann, T., Bennett, S., & Del Mar, C. (2024). *Evidence-based practice across the health professions* (4th edition. ed.). Elsevier.
- Hogg, P., Alrehily, F., Dos Reis, C. S., Buissink, C., Erenstein, H., & Voet, M. (2020). Inspiring radiographers to engage in research. *Radiography*, 26, S69-S70.
- Horntvedt, M.-E. T., Nordsteien, A., Fermann, T., & Severinsson, E. (2018). Strategies for teaching evidence-based practice in nursing education: a thematic literature review. *BMC Medical Education*, 18(1), 172. <https://doi.org/10.1186/s12909-018-1278-z>
- IRCoNSW, I. R. C. o. N. S. W.-. (2023). Health Employees' Medical Radiation Scientists (State) Award 2023. In.

- Kalb, K. A., O'Conner-Von, S. K., Brockway, C., Rierson, C. L., & Sendelbach, S. (2015). Evidence-Based Teaching Practice in Nursing Education: Faculty Perspectives and Practices. *Nursing education perspectives*, 36(4), 212-219. <https://doi.org/10.5480/14-1472>
- Kelly, J. (2020). Translating research evidence into clinical practice within a single breast imaging unit—a personal reflection. *Radiography*, 26, S33-S36.
- Khalil, H. (2016). Knowledge translation and implementation science: what is the difference? *JBI Evidence Implementation*, 14(2). https://journals.lww.com/ijebh/Fulltext/2016/06000/Knowledge_translation_and_implementation_science_1.aspx
- Khan, K. S., & Coomarasamy, A. (2006). A hierarchy of effective teaching and learning to acquire competence in evidenced-based medicine. *BMC Medical Education*, 6(1), 59. <https://doi.org/10.1186/1472-6920-6-59>
- Klaic, M., McDermott, F., & Haines, T. (2019). How soon do allied health professionals lose confidence to perform EBP activities? A cross-sectional study. *Journal of evaluation in clinical practice*, 25(4), 603-612. <https://doi.org/10.1111/jep.13001>
- Kyei, K., Antwi, W., & Suapim, J. (2015). Evidence-based practice in radiography: attitudes, beliefs, knowledge and practices of radiographers in Ghana. *Omics J Radiol*, 4(176), 2.
- Larsen, C. M., Terkelsen, A. S., Carlsen, A.-M. F., & Kristensen, H. K. (2019). Methods for teaching evidence-based practice: a scoping review. *BMC Medical Education*, 19(1), 259. <https://doi.org/10.1186/s12909-019-1681-0>
- Lewis, S., Heard, R., Robinson, J., White, K., & Poulos, A. (2008). The ethical commitment of Australian radiographers: Does medical dominance create an influence? *Radiography*, 14(2), 90-97. <https://doi.org/https://doi.org/10.1016/j.radi.2007.01.004>
- Lewis, S. J. (2003). *Ethics and the professional status of radiography in Australia a qualitative comparison of Australian and United Kingdom radiographers* University of Sydney].
- Malamateniou, C. (2009). Radiography and research: A United Kingdom perspective. *European Journal of Radiography*, 1(1), 2-6. <https://doi.org/https://doi.org/10.1016/j.ejradi.2008.12.003>
- Marín-González, E., Malmusi, D., Camprubí, L., & Borrell, C. (2017). The Role of Dissemination as a Fundamental Part of a Research Project. *Int J Health Serv*, 47(2), 258-276. <https://doi.org/10.1177/0020731416676227>
- McEntee, M. F., & Hogg, P. (2020). Translating radiography research into practice. *Radiography*, 26, S1-S2.
- McNulty, J. P., England, A., & Shanahan, M. C. (2021). International perspectives on radiography practice education. *Radiography (Lond)*, 27(4), 1044-1051. <https://doi.org/10.1016/j.radi.2021.04.004>
- Medical Radiation Practice Board of Australia. (2020). *Professional capabilities for medical radiation practice* <https://www.medicalradiationpracticeboard.gov.au/Registration-Standards/Professional-Capabilities.aspx>
- Melnyk, B. M., Fineout-Overholt, E., Giggelman, M., & Cruz, R. (2010). Correlates among cognitive beliefs, EBP implementation, organizational culture, cohesion and job satisfaction in evidence-based practice mentors from a community hospital system. *Nursing outlook*, 58(6), 301-308. <https://doi.org/10.1016/j.outlook.2010.06.002>
- Melnyk, B. M., Fineout-Overholt, E., Stillwell, S. B., & Williamson, K. M. (2010). Evidence-based practice: step by step: the seven steps of evidence-based practice. *Am J Nurs*, 110(1), 51-53. <https://doi.org/10.1097/01.NAJ.0000366056.06605.d2>
- Moran, K., & Davis, C.-A. (2020). Pan-Canadian survey of medical radiation technologist's views toward evidence-based practice, research, barriers, and Enablers. *Journal of Medical Imaging and Radiation Sciences*, 51(1), 29-39.
- Morris, Z. S., Wooding, S., & Grant, J. (2011). The answer is 17 years, what is the question: understanding time lags in translational research. *J R Soc Med*, 104(12), 510-520. <https://doi.org/10.1258/jrsm.2011.110180>

- MRPBA. (2013). Professional capabilities for medical radiation practice. In.
- MRPBA. (2019). Medical radiation practice accreditation standards. In.
- MRPBA. (2020). Professional capabilities for medical radiation practice. In.
- Munn, Z. (2020). Why isn't there an evidence-based radiography? Reflections and a call to action. *Radiography*, 26, S14-S16. <https://doi.org/https://doi.org/10.1016/j.radi.2020.05.005>
- Munn, Z., McArthur, A., Mander, G. T. W., Steffensen, C. J., & Jordan, Z. (2020). The only constant in radiography is change: A discussion and primer on change in medical imaging to achieve evidence-based practice. *Radiography (London, England. 1995)*, 26, S3-S7. <https://doi.org/10.1016/j.radi.2020.07.001>
- Oliveira, M., Hogg, P., Di Prospero, L., Lacey, S., El-Farra, S., & Johansen, S. (2024). Research activity among diagnostic and therapeutic radiographers: An international survey. *Journal of Medical Imaging and Radiation Sciences*, 55(2), 232-243. <https://doi.org/https://doi.org/10.1016/j.jmir.2024.02.005>
- Pfeffer, J., & Sutton, R. I. (2006). Evidence-based management. *Harvard business review*, 84(1), 62.
- Qureshi, M. A., Khaskheli, A., Qureshi, J. A., Raza, S. A., & Yousufi, S. Q. (2023). Factors affecting students' learning performance through collaborative learning and engagement. *Interactive Learning Environments*, 31(4), 2371-2391. <https://doi.org/10.1080/10494820.2021.1884886>
- RANZCR. (2018). Image Interpretation by Radiographers - Not the Right Solution. In *Position Statement*. Sydney, Australia.
- Rawle, M., Pighills, A., Mendez, D., & Dobeli, K. (2023). Radiographic technique modification and evidence - based practice: A qualitative study. *Journal of medical radiation sciences*, 70(1), 56-63. <https://doi.org/10.1002/jmrs.616>
- Sackett, D. L. (1997). Evidence-based medicine. *Seminars in Perinatology*, 21(1), 3-5. [https://doi.org/https://doi.org/10.1016/S0146-0005\(97\)80013-4](https://doi.org/https://doi.org/10.1016/S0146-0005(97)80013-4)
- Sackett, D. L., Rosenberg, W. M. C., Gray, J. A. M., Haynes, R. B., & Richardson, W. S. (1996). Evidence based medicine: what it is and what it isn't. *BMJ*, 312(7023), 71. <https://doi.org/10.1136/bmj.312.7023.71>
- Sauti, N. E. A. M., & Yamin, L. S. M. (2020). Evaluation on the knowledge, attitude, and practices toward evidence-based practice in computed tomography among radiographers. *Healthscope: The Official Research Book of Faculty of Health Sciences, UiTM*, 3(3), 87-91.
- Thomas, A., Saroyan, A., & Dauphinee, W. D. (2011). Evidence-based practice: a review of theoretical assumptions and effectiveness of teaching and assessment interventions in health professions. *Advances in health sciences education : theory and practice*, 16(2), 253-276. <https://doi.org/10.1007/s10459-010-9251-6>
- Tilson, J. K., Kaplan, S. L., Harris, J. L., Hutchinson, A., Ilic, D., Niederman, R., Potomkova, J., & Zwolsman, S. E. (2011). Sicily statement on classification and development of evidence-based practice learning assessment tools. *BMC Medical Education*, 11(1), 78. <https://doi.org/10.1186/1472-6920-11-78>
- Ugwu, A. C., Benjamin, E. U., Jennifer, M. I., & Felix, E. O. (2009). Evidence based medical imaging practice in Nigeria: A paradigm or a placebo? *European Journal of Radiography*, 1(4), 169-172.
- Upton, D., & Upton, P. (2006). Knowledge and use of evidence-based practice by allied health and health science professionals in the United Kingdom. *Journal of allied health*, 35(3), 127-133.
- VAHPA, V. A. H. P. A. (2021). Allied Health Professional (Victorian Public Sector) (Single interest employers) Enterprise Agreement 2021 - 2026. In.
- Vuopala, E., Hyvönen, P., & Järvelä, S. (2016). Interaction forms in successful collaborative learning in virtual learning environments. *Active Learning in Higher Education*, 17(1), 25-38.
- Yielder, J., & Davis, M. (2009). Where radiographers fear to tread: Resistance and apathy in radiography practice. *Radiography*, 15(4), 345-350. <https://doi.org/https://doi.org/10.1016/j.radi.2009.07.002>

Young, T., Rohwer, A., Volmink, J., & Clarke, M. (2014). What are the effects of teaching evidence-based health care (EBHC)? Overview of systematic reviews. *PLoS One*, 9(1), e86706-e86706. <https://doi.org/10.1371/journal.pone.0086706>

Chapter 2: Methods

In [Chapter 1](#), I provided an introduction to the relevant literature and outlined the structure of this thesis. In this chapter I will reflexively describe my background as a researcher and explain how this led me to undertake this study. I will outline my epistemological stance and locate this in terms of my subject matter, evidence-based practice, and the research that I am undertaking. I will then go on to detail the methods I utilised in the studies presented in chapters 3 – 6. I conclude by reporting on the quality measures undertaken throughout the research process, linking these to my epistemological stance and methodological choices to highlight the rigour of the research conducted during this thesis.

2.1 Context and researcher stance

As a diagnostic radiographer with firsthand experience in the field, I was motivated to undertake this research because I had observed the dire need for change within the discipline. Time and time again, I found myself asking questions about why we do things the way that we do. Upon deeper investigation, I discovered certain practices were based in tradition rather than evidence.

I vividly recall a specific incident during my clinical work at a tertiary public hospital. I was contacted in the early hours of the morning by the emergency registrar, who requested an abdominal x-ray for a 3-year-old patient with suspected constipation. Despite knowing that it was not an appropriate test for the patient and having department protocol on my side, I was pressured into performing the examination by the registrar, who emphasised the importance of satisfying the parents' wishes and claimed medico-legal responsibility. When I sought guidance from a mentor in my department the next day, I was disheartened to hear that this was the way things had always been and always would be.

This is an experience consistent with that reported in Rawle and colleagues (2023). Transitioning into academia gave me hope that I could make a difference to diagnostic radiography practice, and now I aim to do so through this research. My goal is to empower the future generation of radiographers with the knowledge, skills, and confidence required to become evidence-based practitioners and through this, advance the culture of diagnostic radiography in Australia.

My approach is grounded in social constructivist principles (Vygotskiĭ & Cole, 1978). I believe that knowledge is inherently shaped by context, an approach that resonates well with the application of evidence-based practice. Implementing evidence requires the integration of context and preferences, which fundamentally shape the clinical pathway. Without understanding the social context of knowledge within the clinical setting, achieving evidence-based practice is not possible.

I believe that the issues surrounding the implementation of evidence-based practice in diagnostic radiography are intrinsically linked to the culture of the discipline as described in [Section 1.6 The Australian diagnostic radiography context: culture and professionalisation](#) and explored by Dennett and colleagues (2021), Lewis (2003) and Nightingale (2016). Left unchecked, this culture reinforces a pattern of bad habits. Important efforts to improve this culture within our discipline are ongoing (Nightingale, 2016). While disciplinary cultural change is innately slow, there is always the potential to make progress with enough effort. By intervening and developing the building blocks required for evidence-based practice, we can help to construct a new reality for the discipline.

Given my transition to an academic career pathway, learning how to conduct research effectively holds great importance to me. I view my PhD study as a step towards completing more research and mentoring students in the future rather than the culmination of my journey. Therefore, gaining proficiency in various research approaches, including qualitative and quantitative methods, was imperative. With this in mind, I selected research questions that are conducive to both approaches and allowed me to gain a greater insight into the disciplinary culture and evidence-based educational practices. My aim is to enhance our understanding of how evidence-based practice can be advanced in diagnostic radiography through a mixed-methods approach.

2.2 Thesis methods

In this section I outline the specific methodological choices that were made in the design of the research projects outlined in Chapters 3 – 6.

2.2.1 Chapter 3: Knowledge translation: Radiographers compared to other healthcare professionals

In [Chapter 3](#), I examine the current state of knowledge translation in diagnostic radiography and compare this to other healthcare disciplines. Originally, I had set out to examine diagnostic radiography only, however when I started examining the literature more closely, it became apparent that there was limited research that specifically looked at knowledge translation in diagnostic radiography. I therefore decided to include other comparable healthcare disciplines with the hope that summarising that literature would provide potential avenues for the growth of knowledge translation within diagnostic radiography.

I utilised a narrative approach in my literature review which helped to provide a broad overview of the existing literature that was presented in a readable manner (Green et al., 2006). In keeping with the Scale for the Assessment of Narrative Review Articles (Baethge et al., 2019), I ensured that 1) the article's importance was explicitly justified, 2) the aims were concrete and stated, 3) the search

strategy was clearly presented, 4) key statements were backed up by sufficient evidence, 5) appropriate evidence was presented, and 6) the evidence was appropriately presented.

To supplement the methods section of the published article, here I provide additional information on the methods utilised to undertake the review. Medline and CINAHL were identified by the authorship team in conjunction with an academic librarian as being the most appropriate databases for the search, with further databases identified as likely only producing more duplicates and unlikely to yield additional papers. After an initial search was undertaken utilising radiographers as the target population, it became apparent that this search would not yield enough papers to complete a comprehensive review, hence search terms were expanded to include other healthcare professionals. The revised search strategy is displayed in Table 1. Figure 4 details the articles retrieved and screened for inclusion in the review. To be included in the review, articles were required to be in English, and pertinent to either the application of evidence-based practice in radiography or offer transferable knowledge from other disciplinary contexts.

Cohort (or)	(or)	(or)
Health science*	Implement* ADJ3 research	Model*
Medical science*		Framework*
Nurs, nursing, nursing staff, hospital	Research ADJ3 translation	Theor*
Patient care		Guideline
Clinic*	Knowledge translation	Models, theoretical
Health personnel	Translational Medical Research	Practice guideline

Table 1. Revised search strategy

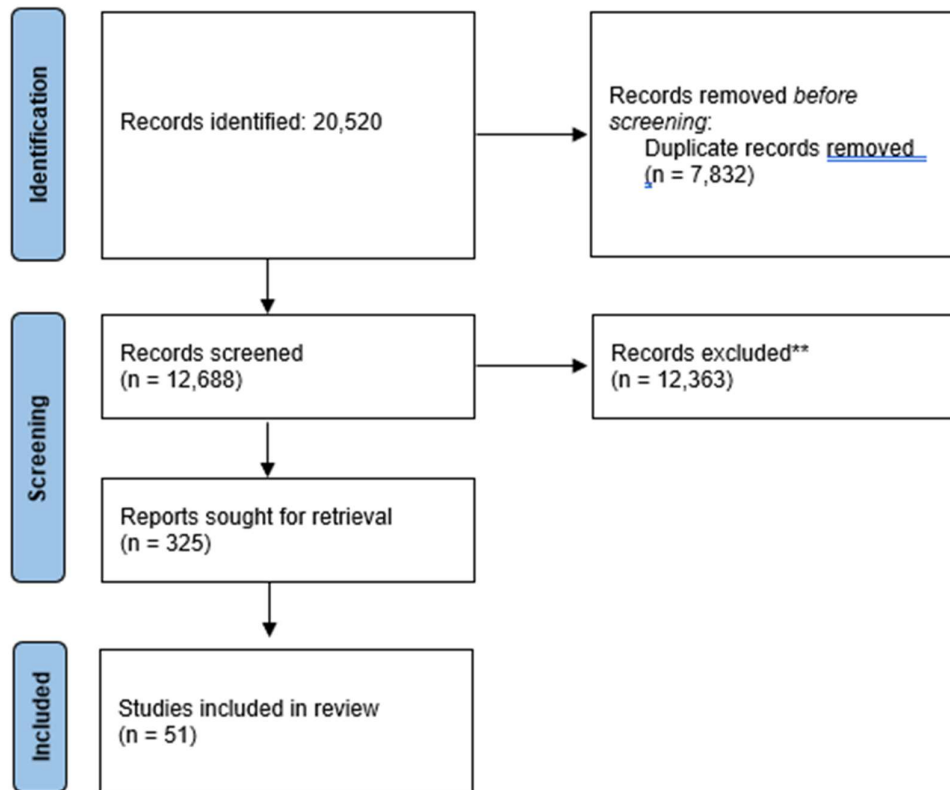


Figure 4. Articles retrieved and screened for inclusion in the review

2.2.2 Chapter 4: Student radiographers' perceptions of evidence-based practice during clinical placements: Implications for health professional education

In [Chapter 4](#), I sought to understand more about how students' placement experiences affect their ability to implement evidence-based practice. I conducted focus groups to capture a rich understanding of collective experiences as they related to evidence-based practice during clinical placement (O.Nyumba et al., 2018). Focus groups were conducted with student diagnostic radiographers, in order to gain a better understanding of placement experiences. In Australia, radiography students are required by the Medical Radiation Practice Board of Australia to demonstrate clinical learning across a breadth of practice settings (MRPBA, 2019), and this occurs within a relatively short time frame. This means that these students are uniquely placed to have experienced and be able to discuss a range of clinical settings. The intention was that the diversity of experiences that students brought would enhance the authenticity of the study (Connelly, 2016).

These focus groups were transcribed verbatim and reflexive thematic analysis as described by Braun and Clarke (2022) and displayed in Figure 5 was employed to analyse the focus group transcripts and audio recordings. Reflexive thematic analysis was chosen as it is a well-established, theoretically

flexible data analysis technique that has rigorous processes that aligned with our research question and epistemological stance (Braun & Clarke, 2021). The analysis and subsequent theme development was an iterative process. Data were approached inductively and latently, with insights drawn from the data to deeply understand the significance within our context (Braun & Clarke, 2022). During the analysis process, several mechanisms were employed by myself and my supervisory team in order to ensure the rigour of the study. For example, peer debriefing was utilised during team meetings to enhance credibility and reflexivity, which will be expanded on in [Section 2.3](#) (Connolly, 2016).



Figure 5. Visual representation of the stages of Reflexive Thematic Analysis as described by (Braun & Clarke, 2022)

2.2.3 Chapter 5: Enhancing evidence-based practice in health professions education: evaluation of an applied curriculum intervention

In [Chapter 5](#) I sought to understand how we can improve the education of diagnostic radiographers to enhance the translation of evidence-based practice. To do this, I developed an applied educational intervention that was grounded in the pedagogical theory discussed in Section 1.4 and Section 1.5. This intervention aimed to enhance student radiographers' knowledge and skills, practices, and attitudes related to evidence-based practice. Chapter 5 presents the evaluation of this intervention.

I employed a mixed methods convergent parallel design, with a pragmatic approach to recruitment, based on students' availability after the intervention (Sunderji & Waddell, 2018). For this evaluation I utilised pre- and post- intervention surveys and focus groups. The quantitative survey tool, the Student Evidence-Based Practice Questionnaire, was chosen as it had been validated and has been utilised to

understand health professions student populations previously (Upton et al., 2016). Additionally, of the existing tools, the sEBPQ was one of the few tools available that adequately cover all stages of the evidence-based practice cycle.

Responses were grouped into four primary domains, and numerical summary statistics were presented for each of these. To reduce potential sources of bias such as social desirability and perceived coercion, the survey was anonymous, (Larson, 2019) meaning that data from the pre- and post- timepoints were treated as independent. Cronbach's alpha was utilised to measure internal consistency among the domains, as the low number of participants prevented the use of factor analysis as the gold standard test for internal consistency. This in turn presented a limitation as data could not be paired, a concept that will be further discussed in [Section 7.3](#), limitations.

The focus groups were conducted at the completion of the intervention to gain a deeper understanding of students' experiences. This allowed me the opportunity to understand the complexity and reasoning behind students' quantitative responses (Wasti et al., 2022). The semi-structured interview questions were developed in line with the evidence-based practice cycle described in [Section 1.2](#), and with specific reference to the components of the intervention that facilitated learning in each of these areas. These data were then analysed utilising reflexive thematic analysis (described above in [Section 2.2.2](#)) due to its alignment with the research question, conceptual framework and researcher epistemology (Braun & Clarke, 2022).

2.2.4 Chapter 6: Assessing evidence-based practice among Australian radiographers: A self-report survey

In [Chapter 6](#) I sought to understand more deeply the current knowledge and skills, practices and attitudes of Australian diagnostic radiographers towards evidence-based practice. To do this I ran a national survey of diagnostic radiographers utilising a validated survey instrument, the evidence-based practice questionnaire (Upton & Upton, 2006). This tool is the practitioner version of the student tool utilised in [Chapter 5](#) and was selected as it had been previously utilised nationally among healthcare professionals and internationally with radiography populations. (Kyei et al., 2015; Nalweyiso et al., 2019; Upton & Upton, 2006; Upton et al., 2012). Respondents self-reported their confidence level in response to a series of questions relating to evidence-based practice. These were grouped into three primary domains: knowledge and skills, practices, and attitudes. Numerical summary statistics were used to assess these domains, and inferential statistics were used to examine the effect that demographic factors had on individuals' evidence-based practice tendencies.

2.3 Quality measures

In [Section 2.1](#), I outlined my motivation for undertaking this doctoral thesis. Transitioning to an academic career pathway has highlighted to me the importance of conducting high quality research, making this endeavour an invaluable opportunity to learn and apply research methodology. Thus, understanding and implementing quality measures became a focal point for me. Reflecting on my epistemological stance, it is important to consider quality from this perspective. Embracing a lens of social constructivism, means that the quality measures employed must align with this standpoint.

Qualitative research has historically emphasised quality from a positivist or post-positivist lens, prioritising concepts like replicability and minimising bias (Varpio et al., 2017). However, contemporary discourse on quality measures has evolved beyond this view, particularly when research is approached from constructivist stances. I approached my data with active reflexivity – recognising that as a researcher I bring my knowledge, background and perspective to the analysis of data. Furthermore, methodological decisions and the research context inherently shaped and influenced the outcomes of my studies and therefore must be considered (Olmos-Vega et al., 2023).

2.3.1 Personal reflexivity

To better understand how my personal experiences have shaped and influenced my research, I share below a short narrative autobiography. This concept, originally developed within autoethnography, has been subsequently utilised in many forms of qualitative research (Barrett et al., 2020; Ellis, 2004).

My experiences as a radiographer and an academic were the genesis for my research journey and shaped the research questions I chose to ask and how I've approached this topic more broadly. I acknowledge that I've always been a little black and white – if things “should” be done in a certain way, I generally do them that way and have little time for excuses as to why they can't.

Thinking back to my time as a clinical radiographer, working at a large metropolitan teaching hospital, I often found that corners were cut, and things weren't done the way they should have been. When I would advocate for change, this would tend to be met with apathy. As I entered the mid-stages of my career, I was trying to decide on my future direction, and was seriously considering delving into the world of research. At this point, I was taken aside by my chief radiographer and told that this was a poor career choice. I was told, “Radiographers don't do research, it's not our place” and that higher degrees by research were not eligible for upgrades or promotions in the same way that modality training and a coursework master's would be.

When I transitioned into academia, I thought that I'd found my people, that surely those who generate research would be the best at implementing it themselves? I found myself thrown in the deep end, teaching lectures and tutorials to diagnostic radiography students with no formal training on how to be a good educator. Whilst I had the content expertise, I most certainly was ill-equipped when it came to effective pedagogical techniques. Over the years, through engaging in the scholarship of teaching and learning I have (I hope) become a better educator.

These experiences have shaped the directions of my research, from my original interest in the research topic, including my drive and passion for implementing evidence-based practice in diagnostic radiography. I want to see practice improved, I want to see clinical diagnostic radiographers supported to do research and believe that this is fundamentally important for our profession. I want to see student radiographers set up for success and I want to enable radiography educators to do this. This is something that was important for me to keep front of mind during my analysis, particularly the thematic analysis in [Chapter 4](#) and [Chapter 5](#).

2.3.2 Interpersonal reflexivity

Interpersonal reflexivity requires the researcher to consider relationships and how they may impact on the research being undertaken, paying particular consideration to potential power imbalances and the effect this can have on results (Finlay, 2002; Olmos-Vega et al., 2023). In each of the individual studies included in this thesis, I made a concerted effort to recognise the importance of the relationships and potential power imbalances between the researchers and participants. In [Chapter 4](#), I was the facilitator for these focus groups and recognise that this may have affected the data collected. I had strong existing relationships with many of these students and had supported them through many of their placement experiences as a placement academic at the time. To minimise the potential impact, we ensured that the ground rules were carefully established at the beginning of the session, and I leveraged my relationship with participants as both a placement academic at the university and the placement support officer that had seen many of these participants through difficult times on placement. I believe this helped to create an open dialogue in which participants were open to sharing their experiences. Within this context I was an insider researcher, able to harness my credibility and rapport with my participants and understand the participants' experiences deeply due to my familiarity (Mercer, 2007).

In [Chapter 5](#), my relationship with these participants was different: I had developed the intervention being tested and was responsible for grading these students' papers, I was in a more senior position and had less of a pre-existing relationship with the students outside of the unit in which the

intervention was run. Whilst data collection occurred after the assessment grading, I decided to have another member of the research team that wasn't directly involved in the delivery of the intervention facilitate the focus groups to ensure that participants felt comfortable discussing all elements of the intervention and to minimise any potential power imbalances. I was then able to bring my insider knowledge to the data analysis, using techniques such as active reflexivity, peer debriefing and triangulation to avoid potential bias (Greene, 2014). Additionally, recruitment for the quantitative data collected in this study was handled by a staff member that was not directly involved with the project at all to minimise any perceived coercion.

2.3.3 Methodological reflexivity

Methodological reflexivity involves ensuring alignment between a researcher's epistemological stance and the methodology utilised, recognising that quality markers for rigour may look different depending on this stance (Olmos-Vega et al., 2023). Throughout both my thesis and the publications arising from it, I have clearly articulated my epistemological standpoint and have explained how this influenced my research. Social constructivism by its ontological nature asserts that one's reality is shaped by personal experiences (Varpio et al., 2017). I argue that this viewpoint aligns well with evidence-based practice as one must integrate various forms of evidence, including, importantly, the patient perspective. Patient perspectives are shaped by their own realities and diverse influences that may not always align with empirical evidence. To apply evidence-based practice, practitioners must navigate these different and sometimes competing forms of evidence to make clinical decisions.

I chose the Melnyk and colleagues (2010) seven-step model of evidence-based practice as it aligned with my own views on the topic and is more holistic than the traditional five-step model set forth in the Sicily Statement (Dawes et al., 2005). I do recognise that utilising a model that is not the predominant model within the literature creates its own limitation in terms of making direct comparisons with existing literature, which was a challenge I faced throughout. My research seeks to address recommendations from the Sicily Statement (Dawes et al., 2005), however I have chosen to adopt a more comprehensive model of evidence-based practice (Melnyk et al., 2010). I made this choice as I believe that the recommendations are worthwhile and will advance the area of evidence-based practice, particularly in relation to education.

2.3.4 Contextual reflexivity

Contextual reflexivity refers to the efforts of researchers to explain their research within their historical and cultural context (Walsh, 2003). This was particularly pertinent within my study, and I have made a concerted effort throughout this thesis to describe the context in which these studies have taken place. Diagnostic radiography in Australia is a growing profession, with a complex history

of subordination and apathy (Lewis, 2003; Yelder & Davis, 2009). Within Australia, it is well established that there is little interest in research by clinical radiographers, and that radiographers often have a tendency to assume that techniques are evidence-based even when this is not necessarily the case (Chau et al., 2022; Rawle et al., 2023). The context in which this research has taken place is explored more deeply in [Section 1.6](#), *The Australian diagnostic radiography context: culture and professionalisation*, in addition to being interwoven throughout the publications arising from this thesis and the discussion in [Chapter 7](#).

Following the references from Chapter 2, will be the next chapter, *Knowledge translation: Radiographers compared with other healthcare professionals*. This literature review will establish the current state of knowledge translation in diagnostic radiography and compare this with other healthcare disciplines to establish key learnings that can be applied to a diagnostic radiography context.

Chapter 2 References

- Baethge, C., Goldbeck-Wood, S., & Mertens, S. (2019). SANRA—a scale for the quality assessment of narrative review articles. *Research Integrity and Peer Review*, 4(1), 5. <https://doi.org/10.1186/s41073-019-0064-8>
- Barrett, A., Kajamaa, A., & Johnston, J. (2020). How to ... be reflexive when conducting qualitative research. *The Clinical Teacher*, 17(1), 9-12. <https://doi.org/10.1111/tct.13133>
- Braun, V., & Clarke, V. (2021). One size fits all? What counts as quality practice in (reflexive) thematic analysis? *Qualitative Research in Psychology*, 18(3), 328-352. <https://doi.org/10.1080/14780887.2020.1769238>
- Braun, V., & Clarke, V. (2022). *Thematic analysis : a practical guide*. SAGE.
- Chau, M., Brown, E., Beldham-Collins, R., & Anderson, N. (2022). Research demographics of Australian medical radiation practitioners. *Journal of Medical Imaging and Radiation Sciences*, 53(4), 591-598. <https://doi.org/10.1016/j.jmir.2022.07.009>
- Connelly, L. M. (2016). Trustworthiness in Qualitative Research. *Medsurg Nursing*, 25(6), 435-436. <http://ezproxy.library.usyd.edu.au/login?url=https://www.proquest.com/scholarly-journals/trustworthiness-qualitative-research/docview/1849700459/se-2?accountid=14757>
- https://sydney.alma.exlibrisgroup.com/openurl/61USYD_INST/61USYD_INST:sydney?genre=article&issn=10920811&title=Trustworthiness+in+Qualitative+Research&volume=25&issue=6&date=Nov%2FDec+2016&atitle=Trustworthiness+in+Qualitative+Research&spage=435&sid=ProQ%3Ahealthcompleteshell&author=Connelly
- Dawes, M., Summerskill, W., Glasziou, P., Cartabellotta, A., Martin, J., Hopayian, K., Porzsolt, F., Burls, A., & Osborne, J. (2005). Sicily statement on evidence-based practice. *BMC Medical Education*, 5(1), 1. <https://doi.org/10.1186/1472-6920-5-1>
- Dennett, A. M., Cauchi, T., Harding, K. E., Kelly, P., Ashby, G., & Taylor, N. F. (2021). Research interest, experience and confidence of allied health professionals working in medical imaging: a cross-sectional survey. *Journal of medical radiation sciences*, 68(2), 121-130. <https://doi.org/10.1002/jmrs.432>
- Ellis, C. (2004). *The ethnographic I: A methodological novel about autoethnography*. Rowman Altamira.
- Finlay, L. (2002). Negotiating the swamp: the opportunity and challenge of reflexivity in research practice. *Qualitative Research*, 2(2), 209-230. <https://doi.org/10.1177/146879410200200205>
- Green, B. N., Johnson, C. D., & Adams, A. (2006). Writing narrative literature reviews for peer-reviewed journals: secrets of the trade. *Journal of Chiropractic Medicine*, 5(3), 101-117. [https://doi.org/10.1016/S0899-3467\(07\)60142-6](https://doi.org/10.1016/S0899-3467(07)60142-6)
- Greene, M. J. (2014). On the inside looking in: Methodological insights and challenges in conducting qualitative insider research. *The qualitative report*, 19(29), 1-13.
- Kyei, K., Antwi, W., & Suapim, J. (2015). Evidence-based practice in radiography: attitudes, beliefs, knowledge and practices of radiographers in Ghana. *Omics J Radiol*, 4(176), 2.
- Larson, R. B. (2019). Controlling social desirability bias. *International Journal of Market Research*, 61(5), 534-547. <https://doi.org/10.1177/1470785318805305>
- Lewis, S. J. (2003). *Ethics and the professional status of radiography in Australia a qualitative comparison of Australian and United Kingdom radiographers* [University of Sydney].
- Melnyk, B. M., Fineout-Overholt, E., Stillwell, S. B., & Williamson, K. M. (2010). Evidence-based practice: step by step: the seven steps of evidence-based practice. *Am J Nurs*, 110(1), 51-53. <https://doi.org/10.1097/01.NAJ.0000366056.06605.d2>
- Mercer, J. (2007). The challenges of insider research in educational institutions: wielding a double-edged sword and resolving delicate dilemmas. *Oxford Review of Education*, 33(1), 1-17. <https://doi.org/10.1080/03054980601094651>
- MRPBA. (2019). Medical radiation practice accreditation standards. In.

- Nalweyiso, D. I., Kabanda, J., Mubuuke, A. G., Sanderson, K., & Nnyanzi, L. A. (2019). Knowledge, attitudes and practices towards evidence based practice: A survey amongst radiographers. *Radiography*, 25(4), 327-332. <https://doi.org/https://doi.org/10.1016/j.radi.2019.03.004>
- Nightingale, J. P. P. M. D. C. R. (2016). Establishing a radiography research culture – Are we making progress? *Radiography (London, England. 1995)*, 22(4), 265-266. <https://doi.org/10.1016/j.radi.2016.09.002>
- O.Nyumba, T., Wilson, K., Derrick, C. J., & Mukherjee, N. (2018). The use of focus group discussion methodology: Insights from two decades of application in conservation. *Methods in Ecology and Evolution*, 9(1), 20-32. <https://doi.org/https://doi.org/10.1111/2041-210X.12860>
- Olmos-Vega, F. M., Stalmeijer, R. E., Varpio, L., & Kahlke, R. (2023). A practical guide to reflexivity in qualitative research: AMEE Guide No. 149. *Medical Teacher*, 45(3), 241-251. <https://doi.org/10.1080/0142159X.2022.2057287>
- Rawle, M., Pighills, A., Mendez, D., & Dobeli, K. (2023). Radiographic technique modification and evidence-based practice: A qualitative study. *Journal of medical radiation sciences*, 70(1), 56-63. <https://doi.org/10.1002/jmrs.616>
- Sunderji, N., & Waddell, A. E. (2018). Mixed Methods Convergent Study Designs in Health Professions Education Research: Toward Meaningful Integration of Qualitative and Quantitative Data. *Acad Med*, 93(7), 1093. <https://doi.org/10.1097/acm.0000000000002241>
- Upton, D., & Upton, P. (2006). Knowledge and use of evidence-based practice by allied health and health science professionals in the United Kingdom. *Journal of allied health*, 35(3), 127-133.
- Upton, P., Scurlock-Evans, L., Stephens, D., & Upton, D. (2012). The adoption and implementation of evidence-based practice (EBP) among allied health professions. *International journal of therapy and rehabilitation*, 19(9), 497-503. <https://doi.org/10.12968/ijtr.2012.19.9.497>
- Upton, P., Scurlock-Evans, L., & Upton, D. (2016). Development of the Student Evidence-based Practice Questionnaire (S-EBPQ). *Nurse Educ Today*, 37, 38-44. <https://doi.org/10.1016/j.nedt.2015.11.010>
- Varpio, L., Ajjawi, R., Monrouxe, L. V., O'Brien, B. C., & Rees, C. E. (2017). Shedding the cobra effect: problematising thematic emergence, triangulation, saturation and member checking. *Medical Education*, 51(1), 40-50. <https://doi.org/https://doi.org/10.1111/medu.13124>
- Vygotskii, L. S., & Cole, M. (1978). *Mind in society : the development of higher psychological processes*. Harvard University Press.
- Walsh, R. (2003). The Methods of Reflexivity. *The Humanistic psychologist*, 31(4), 51-66. <https://doi.org/10.1080/08873267.2003.9986934>
- Wasti, S. P., Simkhada, P., van Teijlingen, E. R., Sathian, B., & Banerjee, I. (2022). The Growing Importance of Mixed-Methods Research in Health. *Nepal J Epidemiol*, 12(1), 1175-1178. <https://doi.org/10.3126/nje.v12i1.43633>
- Yielder, J., & Davis, M. (2009). Where radiographers fear to tread: Resistance and apathy in radiography practice. *Radiography*, 15(4), 345-350. <https://doi.org/https://doi.org/10.1016/j.radi.2009.07.002>

Chapter 3: Knowledge translation: Radiographers compared with other healthcare professionals

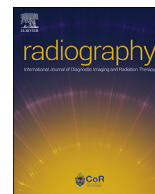
3.1 Introduction

In [Chapter 1](#), I argue for the critical importance of translating evidence into practice within the field of diagnostic radiography, and explore the disciplinary culture that influences diagnostic radiography in Australia. Due to the paucity of evidence relating directly to knowledge translation within diagnostic radiography, I turned to the literature from other healthcare disciplines in order to understand how this could be applied within diagnostic radiography.

This chapter, in the form of a published paper, describes the findings of a narrative literature review. I compare knowledge translation in diagnostic radiography with that in other healthcare disciplines, highlighting key insights from other disciplinary contexts that can be applied within the context of diagnostic radiography. I illuminate the current knowledge to practice gap within diagnostic radiography and argue that this is influenced by our professional culture.

As diagnostic radiographers, we can learn from the fields of knowledge translation and implementation science. This paper aims to synthesise literature from the fields of knowledge translation and implementation science and describe which ideas should be adapted and applied within diagnostic radiography in order to better apply evidence in practice.

The ethics approval letter for this research can be found in [Appendix 4](#) and the peer review for this publication can be found in [Appendix 5](#).



Narrative Review

Knowledge translation: Radiographers compared to other healthcare professionals

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ARTICLE INFO

Article history:

Received 10 March 2020

Received in revised form

11 June 2020

Accepted 12 June 2020

Available online 14 July 2020

Keywords:

Evidence-based practice

Evidence-based radiography

Knowledge translation

Implementation science

Diagnostic radiographer

ABSTRACT

Objectives: This narrative review examines the current status of evidence-based practice and knowledge translation in diagnostic radiography. It explores knowledge translation efforts in the allied health professions aimed at systematically implementing evidence-based practice and suggests ways that these may be applied within diagnostic radiography.

Key findings: Knowledge translation in diagnostic radiography is in its infancy with numerous examples of key findings of rigorous studies not implemented in practice. Utilising frameworks, models and theories to systematically translate knowledge into evidence-based practice has been shown to be effective in other allied health professions. Whilst few studies in diagnostic radiography report utilising these systematic approaches to implementing evidence-based practice, those that do, show promising results. Attitudes towards evidence-based practice within diagnostic radiography are becoming more positive and it is important to use this positive shift in attitudes to create real evidence-based change in the profession.

Conclusion: The potential benefits of systematically translating knowledge into evidence-based practice in diagnostic radiography are wide reaching with positive implications for our patients, the profession and wider community. Leaders at all levels of radiography must work towards implementing evidence-based practice in their daily work.

Implications for practice: Systematic approaches to knowledge translation should be adopted and reported in diagnostic radiography in order to more effectively translate knowledge into evidence-based practice.

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Introduction

Within healthcare there is a known gap between the best available evidence and clinical practice.^{1,2} Where the highest forms of evidence should guide best practice, legacy practices often persist. Translating this evidence or knowledge into practice is called knowledge translation (KT). KT seeks to “address the gap between what is known from research and knowledge synthesis and implementation of this knowledge by key stakeholders with the intention of improving health outcomes and efficiencies of the health care system”.³ Changing clinicians’ behaviour can be

challenging but whilst the barriers to implementing best practice are well researched in disciplines such as medicine and nursing^{4,5} less research exists specific to diagnostic radiography (DR).

Evidence-based practice (EBP) is a fundamental cornerstone of modern healthcare. Its importance has been enshrined in radiographer codes of practice internationally.^{6,7} Evidence-based radiography (EBR) has been defined as “radiography informed and based on the combination of clinical expertise and the best available research-based evidence, patient preferences and available resources.”⁸ The aim of both EBP and EBR is to provide the best possible outcomes for patients. Within allied health professions, attitudes to EBP tend to be positive, however insufficient time and underdeveloped skills appear to hinder KT efforts.^{9,10} Radiographers self-report lower levels of the skills that are required for EBP (i.e., research and information technology skills, critical analysis, and the ability to apply evidence in context), compared with other

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allied health disciplines and tend not to spend much time engaging with published literature.^{9,11} When compared to medicine, nursing, and some other allied health professions, radiography has required University degree level qualification for a short period of time, with this level of education only becoming commonplace in the 1990's. These factors may contribute to why the research that is produced within DR is often slow to be translated into practice, with recent studies showing that EBR is not widely implemented.¹¹ Conducting research and translating it into practice is an important professional responsibility^{8,12,13} as this translation has positive effects on a wide range of parties, especially our patients.

We know from other healthcare disciplines that KT, in order to create evidence-based change, is a slow process that requires meticulous planning and implementation.¹⁴ This literature review will compare KT in DR to KT in other disciplines in order to identify potential ways in which to better translate knowledge to practice in DR. It will do this by first examining the current state of EBR, then by providing specific examples of the knowledge to practice gap within radiography, and finally exploring KT strategies that are being used effectively in other health professions to illustrate how these could apply within DR.

Methods

This narrative literature review examines literature about EBP in DR from earliest records until 2020. A narrative approach was selected due to its ability to broadly and comprehensively “describe the history or development of a problem or its management”.¹⁵ The authors adopted a cyclical, iterative search approach, and sought the advice of a librarian to develop the search strategy and select databases. Medline and CINAHL databases were searched using keywords (see Table 1). After the first stage (database search) was completed, a second stage (‘snowball’ search) began. Starting with the existing journal articles, the authors checked the reference list and citing articles to identify any additional articles that may have been omitted from the first stage of the search.

Background

Evidence-based radiography

It is acknowledged that EBR has not well practiced and that a substantial knowledge to practice gap exists.^{8,16} In 2006, a sample of 70 radiographers in the United Kingdom were surveyed about their knowledge and use of EBP; 68.6% of those surveyed rated their knowledge of clinical effectiveness and evidence-based practice as low.⁹ These attitudes are slowly beginning to change with a more recent survey of 83 Ugandan radiographers utilising the same survey tool showing that this level decreased; with only 43% of respondents rating themselves as low.¹⁷ Whilst the second survey,

indicates fewer radiographers perceived ‘low’ levels of EBP knowledge, this clearly remains a concern for almost half the respondents. Radiographers are known to have a tendency to rely on their clinical expertise and protocols rather than justify their decisions using current research evidence¹⁶ and report being more willing to act on advice from a colleague than from a journal article.⁹ There is a perception amongst radiographers that their ability to change current practice is limited and that a greater incentive is required in order for change to occur.¹⁰ Even when departmental protocols are evidence-based, radiographers have a tendency to apply practices learned during their training, even if these may be outdated, rather than follow departmental protocols.¹⁸

A significant problem arises when best practice changes over time and the training that radiographers received is no longer current. For example, the recent position statement of the American Association of Physicists in Medicine (AAPM) on the Use of Patient Gonadal and Fetal Shielding is well researched and based in current evidence.¹⁹ However, the position statement has created dissent among the radiographic community and a survey of the Advanced Health Education Centre's readership indicated that 86% of radiographers would continue to shield their patients even if their department adopted a no shielding policy.²⁰ While professional bodies representing radiologists²¹ and medical physicists²² have been quick to adopt the position statement, those representing radiographers such as the American Society of Radiologic Technologists, have “heard from several members and facilities that do not agree with the recommendation”²³ and as such have decided not to adopt the recommendations at this time. Despite evidence that shielding their patients may be more harmful than beneficial,^{24,25} some radiographers choose not to implement the evidence-based recommendation and continue with their legacy practice.

Despite some resistance, there is evidence that attitudes to EBR and research within DR are changing. Although historically radiographers have not considered research a necessary element of their professional career,²⁶ more recent studies have shown emerging positive attitudes, the following three studies were included as exemplars of recent reflections of international views within radiography in relation to EBP. A total of 63% of surveyed Norwegian radiographers agreed that radiography related research is important and that radiographers should take a leading position.²⁷ A 2013 study of radiographers in Ghana indicated that 60% were interested in undertaking research.²⁸ Furthermore, 84% of surveyed Singaporean radiographers agreed that conducting research would be beneficial to their department.²⁹ Radiographers who participate in research related activities are more likely to implement EBP and have a research-oriented way of working.

Potential explanations for some changes in attitude are the transition of radiography to a degree level qualification, the

Table 1
Search strategy.

Cohort (OR)	(OR)	(OR)
Radiography	Evidence based practice	Change management
Radiographic technician*	EBP	Organisational/organizational change
Radiologic technician*	Research ADJ3 translation	Organisational/Organizational culture
Radiologic technologist	Quality improvement	Behavioural change
Radiologic technology	Implementation ADJ3 research	Organisational/organizational efficiency
Diagnostic radiographer*	Knowledge translation	Tertiary care centre*
Medical radiation scientist*	Translational research	Organisational/organizational innovation
Radiographer*		
Medical Imaging Tech*		
Radiology personnel		

*Serves as the truncation operator.

professionalisation of radiography and role advancement for radiographers.³⁰ Internationally there has been a strong push towards the professionalisation of DR.¹³ There has been a historical tendency in DR to rely heavily on input and advice from other professions such as radiologists, medical engineers, and physicists, as research relating to the practice of diagnostic radiographers tends to come from these professions. However, with greater professional standing comes greater responsibility and there is a need for radiographers to have a more substantial input into the evidence base for the profession.^{13,31}

Systematic approaches to knowledge translation in health

Approaching KT in a systematic way has proven advantageous in other healthcare professions, leading to the promotion and use of numerous frameworks, models, and theories.^{32–35} Systematic approaches aim to inform KT efforts in order to help ensure the best possible likelihood of successful implementation. Many systematic approaches exist; including for example, the Promoting Action on Research Implementation in Health (PARiHS) Framework, Practical Application of Clinical Evidence System (PACES), and the Theoretical Domains Framework (TDF), and each has been used in different contexts to guide, understand, or evaluate implementation.^{36–38} Scott et al. explored the advantages of systematic approaches, explaining that they may “inform the development and delivery of interventions; guide evaluation; explore moderating factors and causal mechanisms; and facilitate a better understanding of the generalizability and replicability of implementation interventions.”³⁴

There is a plethora of evidence from the discipline of implementation science that suggests that systematic approaches to KT are effective at both improving clinician knowledge and changing clinician behaviour.^{33,35,39,40} A recent systematic review identified 49 different KT models, frameworks and theories, varying in their applicability and validity.⁴¹ However, the reasoning behind why a particular KT approach was selected and applied is often not reported.^{34,42} The overwhelming number of theories can create a challenge at the clinical level when choosing the most appropriate method of implementing an evidence-based change.¹⁴ In response to this, Nilsen proposed a taxonomy (see Fig. 1), for these models

based on the aim of the change agent.¹⁴ Clinicians may select their desired outcome, whether that be guiding translation, understanding influencing factors or evaluating an implementation attempt that has already taken place. The taxonomy then guides the clinician to the most appropriate type of framework, model or theory.

Strategies that are multi-faceted and active in their nature are the most effective in creating a desired change.^{34,35} A systematic review of KT interventions in allied health found that although education is one of the most common interventions used to create change, when it is used in isolation, it has a limited impact.³⁴ Close examination of the barriers to change and carefully planned strategies to overcome those barriers is key to a successful translation.^{1,43} It is important to note that the nature of barriers and facilitators of change are dynamic and interrelated and this nature must be considered when planning strategies.⁴⁴

Discussion

The knowledge to practice gap in radiography

A complex professional culture exists within radiography where medical dominance and protectionism are prevalent.⁴⁵ This includes a deferral to radiologists in decision-making and a tendency to cede to referral patterns even when radiographers judge that a particular imaging test may not be appropriate. Bairstow et al. found that ‘56% of patients had evidence of inappropriate diagnostic practice’⁴⁶ and a 2016 study examining justification of CT and MRI showed that 6.54% of examinations were either unjustified or had questionable justification.⁴⁷

An example of this is the prevalence of unjustified abdominal x-rays on patients presenting with acute abdominal pain in line with the Royal College of Radiologists guidelines.^{48–52} Whilst radiographers attribute this to medical dominance, it is a professional requirement for radiographers to justify examinations. Despite this requirement, the application of justification of examinations in practice remains inconsistent among radiographers, meaning that up to 56% of examinations are inappropriate and are carried out to the possible detriment of patients.⁵³

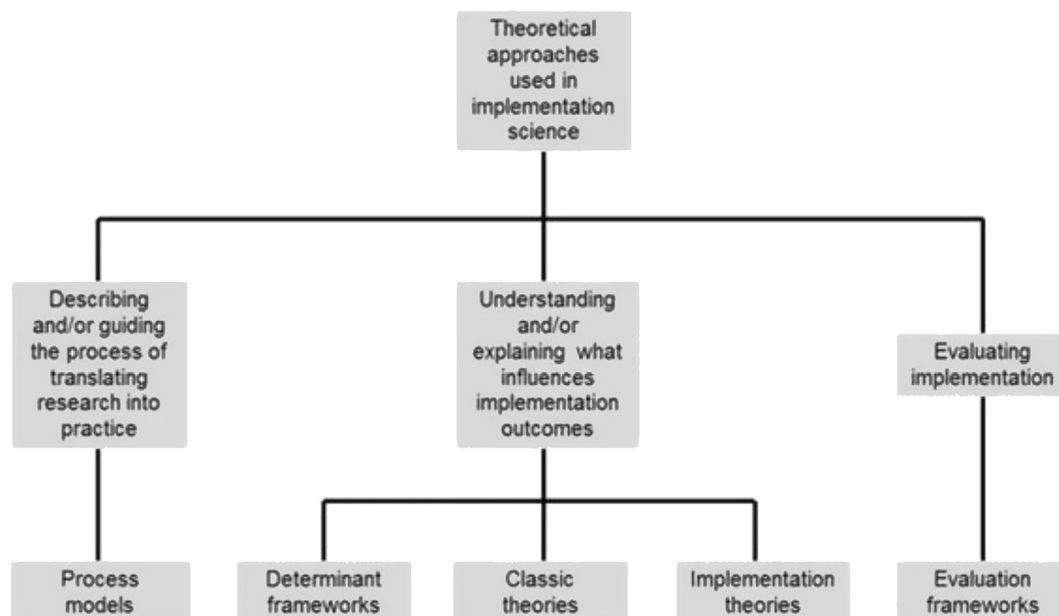


Figure 1. Nilsen's taxonomy for classifying theoretical approaches used in implementation science.¹⁰

An example of the knowledge to practice gap in radiography that could be easily implemented by radiographers with arguably minimal external issues is an adaption of the technique utilised during radiography of the clavicle as examined by McEntee and Kinsella.¹⁸ This study demonstrated statistically significant reductions in organ radiation dose to the eyes and breast as well as increased image quality when utilising a postero-anterior (PA) as opposed to an antero-posterior (AP) projection technique for clavicle imaging as well as demonstrating increased image quality.¹⁸ Despite the known benefits, radiographers have not appeared to implement this into their practice.¹⁸ A possible explanation may be a lack of confidence on the part of radiographers of this unfamiliar positioning technique and the possible associated increased repeat rate.¹⁸ However, given the professional aptitude of radiographers, this barrier should be easily overcome with education and training.

These are just two of the many examples within radiography where a knowledge to practice gap exists. The impact of the underuse of available evidence has broad implications for a wide range of stakeholders. Patients, policymakers, clinicians, educators, and researchers alike stand to benefit from a strong shift towards EBR. If we examine the example of changing technique in radiography of the clavicle, the positive impact is clear; our patients receive significantly reduced doses to highly radiosensitive organs.⁵⁴ In the example of unjustified abdominal imaging, the impact of not adhering to known best practice has wider implications than patient dose. The financial benefits in the form of saving unnecessary procedures have impacts at a local level within departments, and on a broader level within the healthcare budget.⁵¹

Educators aim to equip their students with the necessary skills to become evidence-based practitioners. However, strong social forces mean that students and new graduates quickly adopt the dogma of departments that often self-replicate and reinforce their practices as a result. Higgins, Robinson and Hogg note that “initiating a successful research culture requires clear goals and effective leadership”.⁵⁵ This requires strong leadership from senior radiographers and managers in order to ensure knowledge translation is supported in the clinical environment. The opportunities for positive change within the profession of DR are vast. It is therefore important to consider what radiographers may learn from other healthcare disciplines in relation to KT.

Knowledge translation in diagnostic radiography

There is no ‘one size fits all’ model, framework or theory for translating knowledge into practice within healthcare broadly or indeed within radiography. Different groups within the radiography community need to approach this translation in different ways in order to create the cultural shift required. Utilising Nilsens’ taxonomy from Fig. 1,¹⁴ it may be most beneficial for heads of departments to focus on guiding the translation process by using process models, for example the Ottawa Model.⁵⁶ Professional bodies could focus on exploring the influences of implementation within radiography. A determinant framework such as the revised Theoretical Domains Framework³⁸ would provide a good starting point. Individual radiographers wishing to ensure that their practice is evidence-based may utilise a simplified model such as Strauss and Sackett’s five step framework for applying EBP.⁵⁷

Little evidence currently exists regarding explicit KT strategies within DR. Whilst it is likely that many of the principles discussed above will apply in a DR context this is yet to be examined within the profession. Various authors proposed that utilising the Strauss and Sackett five step framework for applying evidence-based medicine may be useful in DR and some have presented several hypothetical scenarios detailing how this may be applied.^{12,54,57,58}

This model may be useful on a small scale to individual clinicians looking to improve their own performance, however strategies to help foster KT on a broader scale within departments and the profession will also be required.

A recent example of radiographer-initiated implementation is outlined in a report on premedication for heart rate-controlled CT Coronary Angiography.³⁷ The authors describe a successful implementation of a premedication protocol using the PACES and Getting Research into Practice (GRiP) audit and feedback tools. A three phase implementation strategy consisting of stakeholder engagement, design and implementation, and follow up audit, was utilised in order to successfully guide and evaluate this implementation. The study achieved a high compliance rate with the change implemented that was in line with evidence-based standards. Similar to many implementation reports from other disciplines, the justification for the use of these particular tools is not discussed in the report. Implementation initiatives within DR need to be reported more consistently and with justification of the model, framework or theory used so that evidence is generated as to which approaches are the most effective.

The way forward for evidence-based radiography

EBR is a professional requirement. How do we enable, encourage and educate radiographers to be evidence-based practitioners? How do we create cultural change that empowers radiographers to assert their knowledge in a context that has long been overshadowed by medical dominance?

Early career radiographers seem to adapt quickly to the dogma of departments,¹⁶ with a recent Australian study finding that allied health professionals’ confidence in applying EBP drops in the first five years of clinical practice.⁵⁹ This finding reflects a missed opportunity for building EBP within the radiography community. Perhaps fostering a more active and positive research culture within the profession by linking this more strongly with continuing professional development would promote mid-career radiographers’ interest levels in research and EBR. By strongly integrating research into radiographers’ formal University training this proactive research culture may be fostered within the profession.⁵⁵ Investing additional resources in preparing student radiographers in the application of evidence-based practice may help to change the culture of the profession long-term. Pedagogic interventions that have been suggested for use in radiography education include role modelling from academic staff, service user involvement in preparation for practice, facilitated reflection, and problem-based learning.^{8,60,61} Much research is currently being undertaken that examines embedding research into university curriculum. Further research as to how we can better equip students to have the confidence to apply these skills rather than adapting to the status quo of their department once they have graduated and entered practice is required.

Two emergent groups have been shown to have more positive attitudes towards better utilising findings from research into clinical practice.¹⁶ The first group are senior radiographers who have had experience in research related activities. The second group are the new generation of radiographers who typically may have higher level qualifications (bachelors and masters). Supporting senior radiographers to mentor junior colleagues to participate in research and apply EBP is imperative. This can be done by ensuring that departmental protocols are evidenced based, that research activity is embedded into position descriptions for senior and consultant radiographers, by providing additional training and workload recognition for all staff and recognising research and EBR as ‘business as usual’.

Changing clinical practice is a slow and complex process that requires careful strategizing, effective leadership, and collaboration across the profession. This process may be facilitated by the use of a systematic approach informed by an appropriate KT model, theory, or framework. As KT is in its infancy within radiography, we can learn from the experiences of other allied health professions, where a systematic approach has proven beneficial.

Conclusion

It is imperative that we conduct further research into the effectiveness of specific KT strategies to create an evidence based for knowledge translation in diagnostic radiography. A significant challenge in the coming years will be ensuring that we have effective leadership that enables and encourages senior radiographers and the newer generation to embed a culture of research and EBR within the profession. Researchers and clinicians must work together to ensure that relevant clinical questions are being investigated using appropriate methods and that recommendations are implemented. Implementing EBR stands to positively affect the profession, our patients, and the broader community. Radiography has a long way to go in terms of implementing evidence-based research into everyday clinical practice, but we must capitalise on the positive attitude shift to create the change within the profession that is so clearly required.

Conflict of interest statement

None.

Acknowledgements

This work was supported by an Australian Society of Medical Imaging and Radiation Therapy Research Scholarship. The funding source was not involved in study design, data collection, analysis or interpretation, in the writing of this manuscript or in the decision to submit the article for publication.

References

- Grimshaw JM, Eccles MP, Lavis JN, Hill SJ, Squires JE. Knowledge translation of research findings. *Implement Sci* 2012;7:50. <https://doi.org/10.1186/1748-5908-7-50>.
- Grol R, Grimshaw J. From best evidence to best practice: effective implementation of change in patients' care. *Lancet* 2003;362:1225–30. [https://doi.org/10.1016/S0140-6736\(03\)14546-1](https://doi.org/10.1016/S0140-6736(03)14546-1).
- Graham ID, et al. Lost in knowledge translation: time for a map? *J Continuing Educ Health Prof* 2006;26:13–24. <https://doi.org/10.1002/chp.47>.
- Brown CE, Wickline MA, Ecoff L, Glaser D. Nursing practice, knowledge, attitudes and perceived barriers to evidence-based practice at an academic medical center. *J Adv Nurs* 2009;65:371–81. <https://doi.org/10.1111/j.1365-2648.2008.04878.x>.
- Cabana MD, et al. Why don't physicians follow clinical practice guidelines? A framework for improvement. *Jama* 1999;282:1458–65. <https://doi.org/10.1001/jama.282.15.1458>.
- Technologists, I. S. R. T. Code of ethics, <<https://www.isrrt.org/code-ethics>> [No Date].
- Australia, M. R. P. B. A. (2014).
- Hafslund B, Clare J, Graverholt B, Wammen Nortvedt M. Evidence-based radiography. *Radiography* 2008;14:343–8. <https://doi.org/10.1016/j.radi.2008.01.003>.
- Upton D, Upton P. Knowledge and use of evidence-based practice by allied health and health science professionals in the United Kingdom. *J Allied Health* 2006;35:127–33.
- Joyce M, O'Leary D. The increased source to image-receptor distance technique: what is preventing implementation in clinical practice? *J Med Imag Radiat Sci* 2014;45:260–8. <https://doi.org/10.1016/j.jmir.2014.04.003>.
- Abrantes AFCL, et al. Evidence-based radiography: a new methodology or the systematisation of an old practice? *Radiography* 2020;26:127–32. <https://doi.org/10.1016/j.radi.2019.09.010>.
- Murphy CN, Sharp RL. Evidence-based practice for medical radiation Technologists. *J Med Imag Radiat Sci* 2009;40:148–54. <https://doi.org/10.1016/j.jmir.2009.09.006>.
- Sim J, Radloff A. Profession and professionalisation in medical radiation science as an emergent profession. *Radiography* 2009;15:203–8. <https://doi.org/10.1016/j.radi.2008.05.001>.
- Nilsen P. Making sense of implementation theories, models and frameworks. *Implement Sci* 2015;10:53. <https://doi.org/10.1186/s13012-015-0242-0>.
- Green BN, Johnson CD, Adams A. Writing narrative literature reviews for peer-reviewed journals: secrets of the trade. *J Chiropractic Med* 2006;5:101–17. [https://doi.org/10.1016/S0899-3467\(07\)60142-6](https://doi.org/10.1016/S0899-3467(07)60142-6).
- Ahonen S-M, Liikanen E. Radiographers' preconditions for evidence-based radiography. *Radiography* 2010;16:217–22. <https://doi.org/10.1016/j.radi.2010.01.005>.
- Nalweyiso DI, Kabanda J, Mubuuu AG, Sanderson K, Nyanzi LA. Knowledge, attitudes and practices towards evidence based practice: a survey amongst radiographers. *Radiography* 2019;25:327–32. <https://doi.org/10.1016/j.radi.2019.03.004>.
- McEntee MF, Kinsella C. An examination of practice during radiography of the clavicle. *Radiography* 2010;16:125–30. <https://doi.org/10.1016/j.radi.2009.12.002>.
- Medicine, A. A. o. P. i. AAPM position statement on the use of patient gonadal and fetal shielding. 2019. <https://www.aapm.org/org/policies/details.asp?id=468&type=PP>.
- Online, A. H. E.. What would you do? Stop shielding your patients?. 2018. <https://aheonline.blog/2018/01/15/what-would-you-do-stop-shielding-your-patients/>.
- Radiology, A. C. R. ACR endorses AAPM position on patient gonadal and fetal shielding. 2019. <https://www.imagewisely.org/News/General/ACR-endorses-the-AAPM-position-on-patient-gonadal-and-fetal-shielding>.
- Physicists, C. O. M. P.. COMP endorses AAPM position statement on the use of patient gonadal and fetal shielding. 2019. <https://www.comp-ocpm.ca/english/news/comp-endorses-aapm-position-statement-on-the-use-of-patient-gonadal-and-fetal-shielding.htm>.
- Technologists, A. S. o. R.. ASRT board of directors provides update on gonadal and fetal shielding position. 2019.
- Frantzen MJ, et al. Gonad shielding in paediatric pelvic radiography: disadvantages prevail over benefit. *Insight Imag* 2012;3:23–32. <https://doi.org/10.1007/s13244-011-0130-3>.
- Lee MC, Lloyd J, Solomito MJ. Poor utility of gonadal shielding for pediatric pelvic radiographs. *Orthopedics* 2017;40:e623–7. <https://doi.org/10.3928/01477447-20170418-03>.
- Challen V, Kaminski S, Harris P. Research-mindedness in the radiography profession. *Radiography* 1996;2:139–51. [https://doi.org/10.1016/S1078-8174\(96\)90005-X](https://doi.org/10.1016/S1078-8174(96)90005-X).
- Vikestad KG, Hafskjold L, Kjelle E, Sebuodegard S, Hofvind S. Radiographers' opinions on radiography research in Norway - a national survey. *Radiography* 2017;23:135–40. <https://doi.org/10.1016/j.radi.2016.12.006>. London, England: 1995.
- Botwe B. Research engagement and attitudes of Ghanaian radiographers. *World J Medicine Med Sci* 2013;1:128–35.
- Ooi C-C, Lee SH-E, Soh BP. A survey on the research awareness and readiness among radiographers in Singapore General Hospital (SGH). *Radiography* 2012;18:264–9. <https://doi.org/10.1016/j.radi.2012.06.004>.
- Malamateniou C. Radiography and research: a United Kingdom perspective. *Eur J Radio* 2009;1:2–6. <https://doi.org/10.1016/j.ejradi.2008.12.003>.
- Smith T, Lewis S. Opportunities for role development for medical imaging practitioners in Australia: part 1 - rationale and potential. *Radiographer: J Aust Instit Radio* 2002;49:161–5.
- Grimshaw JM, et al. Effectiveness and efficiency of guideline dissemination and implementation strategies. *Health Technol Assess* 2004;8(III-iv):1–72.
- Menon A, Korner-Bitensky N, Kastner M, McKibbin KA, Straus S. Strategies for rehabilitation professionals to move evidence-based knowledge into practice: a systematic review. *J Rehabil Med* 2009;41:1024–32. <https://doi.org/10.2340/16501977-0451>.
- Scott SD, et al. Systematic review of knowledge translation strategies in the allied health professions. *Implement Sci* 2012;7:70. <https://doi.org/10.1186/1748-5908-7-70>.
- Bero LA, et al. Closing the gap between research and practice: an overview of systematic reviews of interventions to promote the implementation of research findings. The Cochrane Effective Practice and Organization of Care Review Group. *BMJ* 1998;317:465–8. <https://doi.org/10.1136/bmj.317.7156.465>.
- Kitson AL, et al. Evaluating the successful implementation of evidence into practice using the PARIHS framework: theoretical and practical challenges. *Implement Sci: IS* 2008;3:1. <https://doi.org/10.1186/1748-5908-3-1>.
- Mander GTW. Computed tomography coronary angiography with heart rate control premedication: a best practice implementation project. *JBI Database Sys Rev Implement Rep* 2017;15:1968–76. <https://doi.org/10.11124/jbisir-2016-003270>.
- Cane J, O'Connor D, Michie S. Validation of the theoretical domains framework for use in behaviour change and implementation research. *Implement Sci* 2012;7:37. <https://doi.org/10.1186/1748-5908-7-37>.
- Eccles M, Grimshaw J, Walker A, Johnston M, Pitts N. Changing the behavior of healthcare professionals: the use of theory in promoting the uptake of research

- findings. *J Clin Epidemiol* 2005;**58**:107–12. <https://doi.org/10.1016/j.jclinepi.2004.09.002>.
40. Hakkennes S, Dodd K. Guideline implementation in allied health professions: a systematic review of the literature. *Qual Saf Health Care* 2008;**17**:296–300. <https://doi.org/10.1136/qshc.2007.023804>.
 41. Prihodova L, Guerin S, Tunney C, Kernohan WG. Key components of knowledge transfer and exchange in health services research: findings from a systematic scoping review. *J Adv Nurs* 2019;**75**:313–26. <https://doi.org/10.1111/jan.13836>.
 42. Michie S, et al. Making psychological theory useful for implementing evidence based practice: a consensus approach. *Qual Saf Health Care* 2005;**14**:26. <https://doi.org/10.1136/qshc.2004.011155>.
 43. Grol R. Personal paper. Beliefs and evidence in changing clinical practice. *BMJ* 1997;**315**:418–21. <https://doi.org/10.1136/bmj.315.7105.418>.
 44. Lau R, et al. Achieving change in primary care—causes of the evidence to practice gap: systematic reviews of reviews. *Implement Sci* 2016;**11**:40. <https://doi.org/10.1186/s13012-016-0396-4>.
 45. Lewis S, Heard R, Robinson J, White K, Poulos A. The ethical commitment of Australian radiographers: does medical dominance create an influence? *Radiography* 2008;**14**:90–7. <https://doi.org/10.1016/j.radi.2007.01.004>.
 46. Bairstow PJ, Persaud J, Mendelson R, Nguyen L. Reducing inappropriate diagnostic practice through education and decision support. *Int J Qual Health Care* 2010;**22**:194–200. <https://doi.org/10.1093/intqhc/mzq016>.
 47. Sobiecka A, Bekiesińska-Figatowska M, Rutkowska M, Latos T, Walecki J. Clinically unjustified diagnostic imaging - a worrisome tendency in today's medical practice. *Pol J Radiol* 2016;**81**:325–30. <https://doi.org/10.12659/PJR.896847>.
 48. de Lacey GJ, et al. Rationalising abdominal radiography in the accident and emergency department. *Clin Radiol* 1980;**31**:453–5. [https://doi.org/10.1016/S0009-9260\(80\)80191-7](https://doi.org/10.1016/S0009-9260(80)80191-7).
 49. Eisenberg RL, Heineken P, Hedgcock MW, Federle M, Goldberg HI. Evaluation of plain abdominal radiographs in the diagnosis of abdominal pain. *Ann Surg* 1983;**197**:464–9. <https://doi.org/10.1097/0000658-198304000-00016>.
 50. Stower MJ, Amar SS, Mikulin T, Kean DM, Hardcastle JD. Evaluation of the plain abdominal X-ray in the acute abdomen. *J R Soc Med* 1985;**78**:630–3. <https://doi.org/10.1177/014107688507800806>.
 51. Morris-Stiff G, Stiff RE, Morris-Stiff H. Abdominal radiograph requesting in the setting of acute abdominal pain: temporal trends and appropriateness of requesting. *Ann R Coll Surg Engl* 2006;**88**:270–4. <https://doi.org/10.1308/003588406X98586>.
 52. Radiologists, R. C. o. Indications for plain abdominal films from the emergency department. 2016. <https://www.rcr.ac.uk/audit/indications-plain-abdominal-films-emergency-department>.
 53. Vom J, Williams I. Justification of radiographic examinations: what are the key issues? *J Med Radiat Sci* 2017;**64**:212–9. <https://doi.org/10.1002/jmrs.211>.
 54. García Villar C. Radiología basada en la evidencia en el diagnóstico por imagen: ¿qué es y cómo se practica? *Radiologí* 2011;**53**:326–34. <https://doi.org/10.1016/j.rx.2011.02.009>.
 55. Higgins R, Robinson L, Hogg P. Unlocking student research potential: toward a research culture in radiography undergraduate learning curricular. *J Med Imag Radiat Sci* 2015;**46**:S6–9. <https://doi.org/10.1016/j.jmir.2015.06.009>.
 56. Logan J, Graham ID. Toward a comprehensive interdisciplinary model of health care research use. *Sci Commun* 1998;**20**:227–46.
 57. Straus SE, Sackett DL. Using research findings in clinical practice. *BMJ* 1998;**317**:339–42. <https://doi.org/10.1136/bmj.317.7154.339>.
 58. Smith T. Evidence based medical imaging (EBMI). *Radiol Technol* 2009;**80**:270–5.
 59. Klaic M, McDermott F, Haines T. How soon do allied health professionals lose confidence to perform EBP activities? A cross-sectional study. *J Eval Clin Pract* 2019;**25**:603–12. <https://doi.org/10.1111/jep.13001>.
 60. Hendry J. Promoting compassionate care in radiography – what might be suitable pedagogy? A discussion paper. *Radiography* 2019;**25**:269–73. <https://doi.org/10.1016/j.radi.2019.01.005>.
 61. Strudwick R, Harvey-Lloyd J. Preparation for practice through service user involvement in the diagnostic radiography curriculum at university campus suffolk. *Int J Pract Learn Health Soc Care* 2013;**1**:37–46. <https://doi.org/10.11120/pblh.2013.00016>.

3.3 Practical recommendations

This preceding paper presented the findings of my narrative literature review, comparing the state of knowledge translation in diagnostic radiography to other healthcare professionals. The insights presented in this paper provide an important foundation for understanding the current landscape and many challenges associated with knowledge translation within the discipline. In order to bridge the gap between theory and practice, I propose below a series of practical recommendations arising from this paper aimed at enhancing the efficacy of knowledge translation within the discipline. These recommendations are based on established strategies from other disciplines with a proven track record of success.

- **Governing and professional bodies and diagnostic radiography departments and private practices** should utilise models, frameworks and theories to guide the translation of evidence-based practice within their settings
 - These knowledge translation efforts should be measured, reported on, and disseminated by diagnostic radiographers to develop our own knowledge base in relation to effective knowledge translation strategies.
- **Diagnostic radiography departments and private practices** should implement formal evidence-based practice mentorship programs, ensuring that early career radiographers are linked with senior staff who are research active.

The next chapter will be *Student radiographers' perceptions of evidence-based practice during clinical placements: implications for health professional education*. This chapter presents my first empirical study for the thesis, an exploration of students' experiences of evidence-based practice during clinical placements. My aim was to better understand how students' experiences during clinical placements affect their ability to implement evidence-based practice.

Chapter 4: Student radiographers' perceptions of evidence-based practice during clinical placements: implications for health professional education

4.1 Introduction

In [Chapter 3](#), I contend that diagnostic radiography has much to learn from other healthcare disciplines in relation to the translation of knowledge into practice. As established in [Section 1.4](#), the integration of evidence-based practice into the clinical curricula holds significant importance. However, after my review of the literature (Di Michele et al., 2020), I understood that the practice that was occurring in clinical environments was often not evidence-based. As such, a critical question remained unanswered:

What is the effect on student learning of clinical educators modelling poor evidence-based practice?

With this question in mind, I wanted to explore the impact that students' experiences during clinical placement had on their capacity and motivation to apply evidence in their practice.

This chapter, in the form of a published paper, presents the findings from a focus group study undertaken with diagnostic radiography students. The study explored these students' experiences of evidence-based practice on clinical placements and examined the implications of these experiences on their future practice. This chapter argues that it is imperative to ensure that diagnostic radiography students receive thorough preparation in evidence-based practice during both their academic on-campus classes and their clinical placements. Additionally, it contends that students' experiences during their clinical placements have an impact on their ability to implement evidence-based practice effectively, and it is therefore critical that universities monitor the quality of their placements.

The ethics approval letter for this research can be found in [Appendix 4](#) and the peer review for this publication can be found in [Appendix 6](#).

Di Michele, L., Thomson, K., McEntee, M. F., Kenny, B., & Reed, W. (2020). Knowledge translation: Radiographers compared to other healthcare professionals. *Radiography (London, England. 1995)*, 26, S27-S32. <https://doi.org/10.1016/j.radi.2020.06.007>

Student radiographers' perceptions of evidence-based practice during clinical placements: Implications for health professional education

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Educating students to become evidence-based practitioners remains a significant challenge in health professional education. Clinical placements form a significant element of curriculum, and the impact of students' work integrated learning experiences on their ability and desire to practice in an evidence-based manner remains largely unexplored. This study used focus groups to explore students' experiences of evidence-based practice (EBP) during clinical placements, the impact of these experiences on their education, and their future EBP tendencies within the profession. Reflexive thematic analysis was utilized to analyze data and three main overarching themes were identified. These themes are education, culture and responsibility and hopes, fears and barriers and they were explored in detail. Improving the teaching of EBP skills within health professional education, which includes the strengthening of the integration of these skills across work-integrated learning curricula, has the potential to enhance the translation of knowledge into practice as these graduates become qualified clinicians within the profession.

Keywords: Education, evidence-based practice, health professional education, clinical placement, radiography

Problem Formulation and Study Aims

Students' work-integrated learning (WIL) experiences during clinical placements form a fundamental element of their education. The structured workplace learning that occurs during a WIL experience allows for theoretical knowledge to be put into practice and for students to enhance the skills relevant to their profession (Martin et al., 2019). WIL is not only accepted but expected in the education of student radiographers. Successful WIL experiences require shared understanding and mutual goals between students, clinical educators and academics (Rowe et al., 2012) with clinical educators and academics working in a complimentary manner in order realize the full potential of the experience (Winchester-Seeto et al., 2016).

Evidence-based practice (EBP) is defined as the integration of current empirical evidence with clinical expertise and patient preferences when making decisions about the care of a patient (Sackett et al., 1996) whilst taking into account the context within which the decision is made. Within academic circles in medical imaging, EBP has been widely accepted as the optimal approach for quite some time (Gambling et al., 2003; Hafslund et al., 2008; Smith, 2008). However, studies note that the translation of EBP within the clinical realm has historically been slow (Ahonen & Liikanen, 2010; Upton & Upton, 2006). In recent years there has been a push towards approaches to better translate evidence into practice within the profession (Brett, 2020; Di Michele et al., 2020).

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Education in the field of medical imaging has undergone a transition in the last 30 years. The predominant model has shifted from a department-based internship to a university degree level qualification and it has been suggested that there is a correlation between the newer generation of radiographers exhibiting more evidence based tendencies than previous generations (Abrantes et al., 2020; Malamateniou, 2009). It remains apparent that there is still a substantial knowledge to practice gap within the profession that needs to be addressed (Ahonen & Liikanen, 2010; Hafslund et al., 2008). A reasoned pedagogical approach to improving the teaching of EBP in medical imaging curricula must therefore be considered.

Evidence-informed health professions education has been gaining momentum in recent years (Maggio et al., 2018; Thomas & Bussi eres, 2021; Tractenberg & Gordon, 2017) as approaching health professional education (HPE) from an evidence-based perspective helps to ensure effective and efficient teaching practices. There has been considerable research into best practice for teaching EBP to students, however there remains a lack of focus on EBP within radiography education (England & McNulty, 2020). Strong evidence suggests that WIL is an effective approach to enhancing the competencies required for EBP among students (Hall  et al., 2021; Thomas et al., 2011; Young et al., 2014). Little research exists that explores how students' WIL experiences affect their perspective of EBP.

Medical imaging students complete a variety of clinical placements, observing and participating in a range of healthcare settings. As such, the purpose of this study is to explore students' experiences of EBP during clinical placements, the impact of these experiences on their education and their perspective of EBP tendencies in the profession.

METHODS

Qualitative Approach and Research Paradigm

This study was approached from a social constructivist lens whereby knowledge is viewed as being shaped by context and collaboration rather than being fixed (Jones et al., 2014). This lens is consistent with EBP as, "the meaning of research evidence and how it fits with a particular client is, therefore, constructed and interpreted by the clinician who acts as an active problem-solver and constructor of personal knowledge" (Thomas et al., 2011, p.225). What constitutes knowledge is an important consideration in this research; opponents of EBP have long articulated a shortfall in relation to the acceptance and legitimacy of qualitative research. Historically, quantitative approaches have been favored within EBP research and this was indeed echoed within the findings of the focus group itself with participants noting that clinicians are more likely to implement evidence-based changes to their practice in relation to radiation safety as opposed to communication. However, qualitative approaches enable deeper understanding of complex issues and varied perspectives and are therefore appropriate to address the aims of this study.

Context

The study site was a university that offers an accredited diagnostic radiography program at both undergraduate (UG) and graduate entry masters (GEM) levels in Australia. To achieve registration upon graduation to the Medical Radiation Board of Australia, students must demonstrate a depth and breadth of clinical experiences within their clinical program. This means having a range of placement experiences that include rural, metropolitan, private sector and public hospital placements. This places students in the position of observing and participating in clinical practice in a variety of settings.

Sampling Strategy

To be eligible to take part in the study, participants were required to be currently enrolled students in a diagnostic radiography program at the University and must have undertaken a minimum of two clinical placement experiences. Recruitment was initiated by an academic who had no ties to the research team in order to reduce any perceived coercion. Interested participants were directed to email a member of the research team (LDM) to receive additional information. Ethics approval was sought and obtained from the Human Research Ethics Committee at the University of Sydney (2016/769).

Data Collection Methods

Data were collected through a short demographic survey and focus group interviews. The demographic survey allowed the researchers to identify the level of placement experience that the participant had undertaken. Participants were then allocated to one of two focus groups with students with similar levels of placement experience. A semi-structured, open ended focus group interview template was developed to guide the focus group discussion. Examples of questions can be found in Table 1.

TABLE 1: Excerpt from semi-structured focus group guide.

Topic	Question
Students' experiences of EBP on clinical placements	• When you've been out on clinical placement in the past, has the practice that you've seen been informed by evidence? • When you've been out on clinical placement in the past, have you seen practice that isn't informed by evidence?
Students' perspectives on EBP	• What do you think the relationship between evidence and clinical practice should be? • Have you noticed any trends on the type of radiographer that tends to be more evidence based?
Students' ability to implement EBP in practice	• How does the practice that you've seen on placement affect your behavior as a radiographer? • What made it easier (or harder) for you to implement EBP on your clinical placements?

Data Collection Instruments, Technologies, and Processing

The research team developed a semi-structured question guide that explored students' understanding of evidence-based practice and their experiences during clinical placements; this guide was peer reviewed by academic colleagues outside of the research team. A member of the research team (LDM) facilitated both focus groups which were audio-recorded and transcribed verbatim by a third party not connected with the research team. The qualitative analysis software NVivo was used to code the transcribed data.

Participant Characteristics

Two focus groups were conducted; the first of these groups contained nine participants in their third year of a four-year undergraduate program. These participants had each completed three clinical placements of six weeks full time, totaling 18 weeks of clinical experience per student. The second focus group contained eleven participants in their final year of a two-year GEM program. These students had each completed four clinical placements; one of these placements was a seven-week part time placement and three were six-week full time. The students in this focus group totaled twenty-two

weeks full time equivalent of clinical experience per student. Demographic data was collected on students' highest level of educational attainment, these results are presented in Table 2.

Data Analysis

Data were analyzed using reflexive thematic analysis (Braun & Clarke, 2022). Theoretical flexibility is a hallmark of reflexive thematic analysis and has been utilized within this study in a way that aligns with the social constructivist lens through which the study was approached. In social constructivism, knowledge and meaning is developed through interactions between both individuals and their broader context. As such, an inductive approach was undertaken to explore latent meanings of data as this was deemed most appropriate to deeply explore the underlying meaning of the experiences of participants and the impact of these experiences on their education.

The first author (LDM) undertook the process of data familiarization by both listening to audio-recordings and reading through transcripts of the focus groups (Braun & Clarke, 2022). Utilising NVivo, initial codes were systematically generated from data segments and codes were then grouped into themes. Theme development was an iterative process whereby initial themes were generated; the codes, data segments and full transcripts were then revisited to further refine the published themes. Theme generation was inductive and latent whereby data was examined for meaning within the context.

Techniques to Enhance Trustworthiness

During the research process, the first author (LDM) kept a reflexive journal to monitor the reflexivity and assumptions being brought to the analysis of materials and to ensure credibility (Braun & Clarke, 2022; Connelly, 2016). To further enhance the credibility, dependability and authenticity of analysis, peer debriefing was undertaken with other members of the research team through team meetings and discussions (Connelly, 2016).

RESULTS

Synthesis and Interpretation and Links to Empirical Data

A total of twenty participants were recruited from both UG and GEM programs and all recruited participants had undertaken a minimum three clinical placement experiences. Table 2 summarizes the demographic data for each focus group. The groups were relatively homogenous demographically with some minor differentiation in relation to the highest level of qualification attained however each student had a different placement mapping and therefore their clinical placement experiences throughout the course of the degree may have differed significantly. There were a range of genders and cultures represented within the study.

TABLE 2: Demographic data summary.

	Focus group 1 n= 9	Focus group 2 n = 11
Highest level of qualification attained		
High school equivalent	7	0
Certificate/diploma	2	0
Bachelors	0	9
Masters	0	1
PhD	0	1
Degree enrolled		
Bachelor of Applied Science (diagnostic radiography)		
Master of Diagnostic Radiography	9	0
	0	11
How long have you studying for your current degree?		
1-2 years	0	11
2-3 years	9	0
3-4 years	0	0
How many clinical placements have you completed?		
3	9	0
4	0	11

Three overarching themes were developed during data analysis: education, culture and responsibility and hopes, fears, and barriers.

Education

This theme looked at education as the starting point of all practitioners' journey with EBP. It explored students' fundamental understanding of EBP as a concept. It discussed the importance of pedagogy in building EBP skills, comparing the training versus education model. It delved into concepts of lifelong learning, critical thinking and looked strongly at challenging knowledge and assumptions. Further to this, it examined the perceived shortfalls of the education that these students have received. Table 3 provides a summary of quotes representing this theme.

Participants within both focus groups had a consistently narrow definition of EBP that did not align with the more generally accepted definitions. They defined EBP as simply applying research-backed evidence in the clinical setting and most strongly equated their own learnings from university with EBP. Participants widely agreed that there was a strong tendency for clinicians within medical imaging to place higher value on the clinical expertise of practitioners than that of research-based evidence and articulated that they perceived this value to be misplaced. Those participants that did discuss clinical expertise as an asset were quickly shut down by their peers within the focus group. No participants articulated a link between clinical expertise and EBP, preferring to explore them as separate concepts.

Many participants perceived that the pedagogical approaches adopted in their academic subjects did not set them up well for implementing EBP in practice nor did they feel it encouraged them towards becoming evidence-based practitioners upon graduation. The perceived didactic teaching approach was viewed negatively by participants and there was a feeling of their potential being limited by this style of teaching. Participants identified the development of critical thinking, learning to assess the quality of research and adapting this research to the clinical environment as fundamentally important to their education however felt that this wasn't well developed in their academic or clinical education. They described a disconnect between the way in which learning occurred during their academic subjects and the development of the skills required to practice in an evidence-based manner.

TABLE 3: Summary of quotes for education theme.

Category	Description	Quote
Understanding of EBP and shortfalls in students' own education	Participants viewed EBP in a very narrow framework, equating it predominantly with empirical research.	Evidence-based practice is more theoretical practice, where it's a perfect world situation, whereas in a clinical practice you don't always get the perfect results (FG1/UG).
	Individuals need to be taught how to critically think and have their knowledge challenged during education to become EB practitioners.	that idea of having what you think that you know challenged, and thinking about the way that we learn things, rather than what we're actually learning is critical to how we set ourselves up to be evidence-based practitioners. I think in particular, how this sort of stratification of experience in practice... becomes concentrated in this sort of myopic way where there are people that have amassed huge amounts of knowledge but if they're not willing to have their knowledge challenged, if we don't get taught how to have our knowledge challenged by the next generation of practitioners, that's why I think it needs to be built into the way we learn (FG2/GEM).
	University teaching may be out of step with current EBP where many students assume what they are taught at university is "correct".	We had hammered into us things like ALARA [as low as reasonably achievable] and that radiation is bad and the reality is, the research is, that it's open to debate at this point... it's the predominant model, it's the model the guidelines are based on, the conservative model, but it's not necessarily the most evidence based (FG2/GEM).
The link between pedagogy and students' ability to become evidence-based practitioners	The way in which education providers teach will have a strong impact on students' ability to be EB practitioners.	I think that something I find really striking in radiography education is the degree to which it's a really sort of didactic learning model, where we ingest, and we rote learn and there's a huge sort of divergence between the extent of critical thinking that we're expected to employ in different subjects (FG2/GEM).
	There is a tendency within the profession to value clinical experience over relevant research, this is often linked to the model of education experienced by that individual.	Lots of radiographers I've dealt with prefer experience over knowledge (FG1/UG).
Students' experiences of EBP on placement and the relationship between these experiences and future tendencies	Participants reported feeling disempowered to implement EBP on placements due to a wide range of barriers.	I don't know that there's any easy way to do it because as a student you've got to adhere to whatever protocol, whatever radiographer is teaching you for that day, whatever the radiologist may want (FG1/UG).
	Clinical educators' skills and attitudes have a large impact on students' experiences.	When you're out there... over and over in a six-week period, you just literally stoop. You don't want to; you just end up at their level (FG2/GEM). It's a lot easier to implement evidence-based practice when you have someone there that encourages you to do it (FG2/GEM).

There was a wide sense of disempowerment that was apparent and consistent across both focus groups when it came to their ability to implement EBP on clinical placement. Participants reported a strong link between the attitudes of their clinical educators and their ability to implement EBP during placement experiences. Participants felt that their ability to implement EBP on placement had a substantial impact on their ability to learn and develop their skills.

Culture and Responsibility

This theme explored participants' perceptions of where responsibility lies for implementing EBP in the clinical setting and reflected on the existing cultures. In order to categorize this further and provide additional structure for analysis this theme was broken down into three sub-themes: individual organizational and professional. Table 4 provides a summary of quotes representing this theme.

Professional

Within this sub-theme participants discussed the role that the profession has on the implementation of EBP. There was a strong sense of hierarchy when it came to the implementation of EBP in the experiences that participants had encountered. Research backed up by a strongly scientific or quantitative foundation was viewed as more important, particularly in relation to radiation dose reduction and paediatric patients. In contrast traditionally qualitative fields were viewed as less important with participants discussing elements such as communication as being a skill that can't be improved with further research. Professional stagnancy received significant attention and participants kept returning to this throughout the discussion. The concept of practitioners continuing to practice in the way in which they were taught was strong and participants noted the ways in which this limits both individual professional development and the advancement of the profession.

Organizational

The barriers to EBP discussed by participants at an organizational level are quite consistent with the barriers reported in other literature. Participants explored both their positive and negative encounters during clinical placement experiences and noted factors that they believed to influence the evidence-based tendencies within departments and wider organizations. There was a very strong sense that for an organisation to have a culture that prioritizes EBP, senior management must be proactive and evidence-based themselves and create structural efforts to support the culture within the department. Participants perceived those organizations that are strong in terms of implementing EBP had a significant advantage over competitors that did not, linking this to cost and efficiency savings.

Participants also described the impact that social forces can have on an individuals' ability to implement EBP. This was again noted in both positive and negative scenarios where participants discussed examples of feeling pressured to implement practice that was not evidence based to conform to the standards of the organisation and alternatively where they were encouraged to explore and implement EBP on their placements.

Individual

There was much debate and little consensus in terms of the ability of an individual to implement EBP in the scenario where an organisation does not prioritize this action. Participants noted a differentiation in the ability of students versus practitioners to implement EBP. Some participants perceived that once the supervision requirements of being a student were lifted and they had the ability to practice independently that they would have more agency to make their own decisions in relation to implementing EBP; other students felt that they were still limited by the organizational priorities in this

respect and that barriers such as time and resources made implementing EBP a continual challenge for individual practitioners.

Participants noted that individuals who are evidence-based in their practice have a competitive advantage when compared with their peers who are not. They felt that individuals who are more evidence-based in their practice were more sought-after employees, were likely to find desirable employment more readily and be able to advance more quickly and work in the areas that they want.

TABLE 4: Summary of quotes for culture and responsibility theme.

Sub-theme AND category	Description	Quote
Professional: Hierarchy of what should be informed by evidence.	Participants noted that there were clear hierarchies in practice when it came to implementing EBP, those ranked more highly were often those that had a more quantitative backing.	What I found in my experience with evidence-based practice was that it was practiced, sort of to the teeth with paediatric patients...but when it strayed away from paediatric patients it just sorts of, you get someone else and then you just completely forget what you just done (FG2/GEM).
Professional stagnancy	Participants noted a strong tendency within professionals to practice in ways the way that they were originally taught rather than in line with EBP and that this limited the ability of the profession to advance.	In some of the places I've just asked senior radiographers 'Why do you do it that way?' and they said 'Well technically one way is better, but we just do it this way because we always have' (FG2/GEM). So, the comment that the field is advancing, that's clear, the technology is improving very quickly, but it feels to me like practice in radiography isn't advancing with the field, because of that attitude of 'Well, we've always done it like that.' Well, if you've always done it like that it means that no matter how far forward the technology gets, you're always going to be practicing it as if it was when you were first taught (FG2/GEM). She was the chief radiographer and she had authority, but everyone respected her and just trusted in her decisions. It just reflects on how the importance of the chief radiographer to implement evidence-based research because she'll also influence the other radiographers too (FG1/UG).
Organizational: Senior managers attitudes affect the whole workplace.	Participants discussed varied experiences in terms of senior management at the placements that they had encountered and how the attitudes of senior management then trickled down through the department.	My impression was, people who had found the position quite a long time ago, secured that position and for want of a better word, stagnated in that position and become senior through that, just longevity, tended to make a less positive working environment which then played on to everybody else being a bit apathetic (FG2/GEM).
Social forces and inbuilt structure	Participants noted the importance of social forces and structural efforts within the department that made it easier or harder to implement EBP.	it also depends on the atmosphere or the attitude of the practice itself to change. At my first placement, I was at a hospital and every two weeks they would have presentations... everyone was friendly... everyone was just chatting about it, they even ask students as well to contribute (FG1/UG).

Competitive advantage for organizations implementing EBP	Participants observed perceived advantages for practices that implemented EBP that allowed them to be stronger than competitors.	I definitely think that evidence-based is important because I had one placement that stood out above the rest, completely because of the fact that they implemented evidence-based on a daily, as a daily routine practice for them. I definitely think that it created a better workflow, everyone agreed with each other, everyone was communicating well (FG2/GEM).
Individual: Individual ability to implement EBP.	There was debate and discussion as to the amount of power that an individual has to implement EBP within their own practice if this is not within the practices' priorities.	you're in control of your own choices and with the SPP [graduate year] year you're in that room by yourself, you can implement your own evidence-base (FG2/GEM). I feel like it goes beyond that, it goes to, if you're not just going to comply with what they want, you lose the job (FG2/GEM).
Competitive advantage for individuals implementing EBP.	Participants felt that individuals who implemented EBP well were a significant asset to the department and noted that they felt this was an advantage when applying for jobs.	to be honest, his knowledge is like the biggest asset they had and if I was like the chief radiographer and I wanted to hire someone I'd grab him straight away because he was just a massive asset to the whole hospital (FG2/GEM).

Hopes Fears and Barriers

This theme explored the participants' hopes and fears. They see themselves as the future of the profession and hope to lead it in a more positive direction however they fear becoming a part of "a cycle of defensiveness about knowledge" (FG2) that they see within the profession. Participants agreed that EBP is fundamentally important to both themselves as professionals and their patients and described a sense of responsibility around implementation and a frustration at the barriers that prevent them from doing so. There was agreement about the early years in the profession being crucial for their development as evidence-based practitioners and they discussed their fears around these formative years, describing a sense of worry around the type of organisation they gain employment at.

Participants passionately articulated their desire to influence change in the profession. They discussed this particularly in relation to professional stagnancy and their view that the culture within the profession needs to change. There was a strong sense of urgency that surrounded this discussion and a sense of impatience from the participants who wanted to see immediate change.

Participants discussed several barriers to their ability to implement EBP on placement which were consistent with the barriers reported in the literature that are faced by professionals within the field of medical imaging. They reported feelings of medical dominance when practicing clinically, time and resource pressure and strong social forces that limited their ability to implement EBP.

TABLE 5: Summary of quotes for hopes, fears, and barriers theme.

Category	Description	Quote
Responsibility around implementing EBP	Participants displayed strongly positive attitudes towards EBP and there was a sense of responsibility among participants to implement EBP.	What we do in the clinical aspect should be based on the evidence. We can't just do whatever we feel like is right. It's got to be based on what's proven to be correct and what's proven to be helpful to the patients (FG1/UG).
Barriers	Participants described feelings of medical dominance which inhibited their ability to practice in their chosen manner.	I feel a lot of it also comes from the radiologists, especially in private practice that you're adhering to. You really have to do what they prefer (FG1/UG).
	Participants described resource shortages that affected their ability to practice in their chosen manner.	Because we're also put under pressure... there's not enough rooms, there's not enough stuff and you just crack and get the patients done (FG2/GEM).
Formative years in the profession are key to ongoing evidence-based tendencies	Participants discussed feeling worried and scared that they will end up like the practitioners that they had seen on placement. They described feeling that the early years in the profession would be integral to their development as evidence-based practitioners.	It depends on where you end up for your SPP [graduate year] and how the people around you practice evidence-based (FG2/GEM). you're all like a sponge at the moment, you will take on the characteristics of your environment (FG2/GEM).
Desire to influence change on the profession	Participants discussed with passion their desire to create change within the profession and help resolve the cultural issues that they had seen during their WIL placement experiences.	I found that, when I was challenged more to succeed and improve myself as an individual and actually change my mind set of how radiography should like improve in the future. (FG2/GEM).
		I just feel as if we're being taught here to change the radiography, sort of, landscape in the next five to ten years. But that's the thing, it's going to happen... but you want it to change now. (FG2/GEM).

DISCUSSION

Education is the Genesis

Participants in this study clearly perceived their academic education as foundational to their ability to implement EBP in practice both as students on clinical placements and into their future careers. The importance of developing the skills required to practice in an evidence-based manner during HPE has been extensively explored in the literature to date (Melnik et al., 2008; Thomas et al., 2011), however there remains no consensus as to the most effective pedagogical approach to teaching EBP (Hallé et al., 2021; Hitch & Nicola-Richmond, 2017; Thomas et al., 2011). Thomas and colleagues (2011) suggest that EBP needs to be well integrated throughout curricula and that approaches that include WIL tend to be most effective. In order to ensure that WIL is effectively reinforcing EBP, it is important to ensure that this common goal is made clear to clinical educators (Rowe et al., 2012). A systematic review of educational interventions for implementing EBP found that there was a lack of high-quality validated instruments to measure EBP education interventions and that interventions reported had a strong

tendency to focus on a single step of EBP education, most commonly critical appraisal (Albarqouni et al., 2018).

There is substantial evidence to suggest that creating a culture of EBP starts with faculty (Amit-Aharon et al., 2020; Fineout-Overholt et al., 2010; Kalb et al., 2015; Melnyk et al., 2008; Milner et al., 2018). Measuring and quantifying the translation of skills in terms of impact on patient outcomes is impossible (Albarqouni et al., 2018) and according to Thomas et al. (2011, p. 263) “teaching interventions have a greater impact on knowledge and skills than they do on sustainable EBP behaviors.” Despite this, there is a demonstrated positive association between the skills required for EBP and individuals’ perceptions of EBP and likelihood to implement EBP in the future. It could be argued that setting students up well with the skills required to address each of the five elements of EBP, including asking a question, searching for evidence, critically appraising the evidence, implementing the evidence and evaluating the implementation (Johnson, 2008), would afford them the best opportunity to become evidence-based practitioners. WIL contexts provide authentic environments for students to explore and implement these skills and are particularly suited for the final two steps of implementing and evaluating EBP in practice. By emphasizing these final two steps within learning outcomes for clinical placements there is a strong potential to strengthen students’ learning and application of knowledge in practice which is a fundamental objective of WIL. Strongly integrating and aligning the concepts of EBP throughout both academic and WIL curricula has the potential to further develop the skills necessary to enact EBP and is vital to producing graduates that will take EBP into their future careers.

Throughout the focus group discussions, participants’ definitions of EBP were consistently narrow and focused strongly on the empirical evidence as the epitome of EBP. The other pillars of EBP, clinical expertise patient preferences, and context (Sackett et al., 1996), were discussed less frequently, less directly, later in the discussion and to a poor reception; participants who did discuss clinical expertise as an asset were shut down by their peers who voiced strong contrary opinions and the social nature of focus group discussions meant that these views were then not explored in significant depth. This finding is consistent with that by Hallé et al. (2021) that students tend to have difficulty with the complexity and uncertainty associated with EBP and tend to view the concept in quite a black and white manner. Further to this there was a perception that more typically quantitative research, for example research addressing radiation dose had a higher value than qualitative research.

The differences between generations of clinicians were discussed, with participants coining the term “tech generation” for the older generation of radiographers who were educated in an apprenticeship model of training. These radiographers whilst having significant time in the profession to hone their skills tend to have less positive attitudes towards EBP and self-rate the skills required for EBP as quite low when compared to other allied health professions (Upton & Upton, 2006).

The Impact and Importance of Culture for Implementing EBP

Participants felt that there was a strong link between workplace culture and their ability to practice in an evidence-based manner, both as students and into their future careers. This perception is strongly supported by literature in social science and psychology that indicates that the attitudes of individuals and the social norms of a workplace strongly affect the uptake of EBP in individual workplaces (Glasman & Albarracín, 2006; Kim & Hunter, 2006; Kraus, 1995; Wallace et al., 2005). This highlights the essential need to ensure that WIL experiences provided to students are high quality and that the expectations of academics and supervisors are well aligned in this respect (Rowe et al., 2012). Participants feared completing their clinical placement or being employed in a workplace that does not

value EBP and becoming influenced by the dogma of the department. Those participants that had had experiences during clinical placements at sites that they perceived had positive EBP cultures discussed feelings of empowerment and noted that these sites often had a strategic advantage over other sites in terms of workflow efficiencies, staff retention and patient outcomes which is supported in the literature (Harding et al., 2017). This innately poses an equity issue for WIL experiences that must be addressed by universities to ensure that students are afforded the same opportunities to learn in EBP supportive environments throughout their degrees. They may do this by being more selective about aligning themselves with organizations that prioritize EBP for placement opportunities. In addition, partnership opportunities may be explored whereby universities can play a more substantial role in helping organizations or professional bodies to expand knowledge translation and enhance EBP within the profession more broadly.

Participants placed the responsibility for workplace culture firmly with management within organizations. Feelings of frustration were clear as the group discussed feeling powerless to affect the changes they perceived as necessary to create a supportive environment for EBP. Participants noted the professional culture within medical imaging felt stagnant. There is a strong possibility that the education of the “tech generation” of radiographers played a substantial role in their attitudes towards EBP and that the current historically poor attitudes towards EBP (Ahonen & Liikanen, 2010; Upton & Upton, 2006) can be attributed to this. There has been a call from many authors that the new generation of radiographers must push through the cultural change required in the discipline (Di Michele et al., 2020; Hafslund et al., 2008; Higgins et al., 2015) and the desire of the participants to do this was clear.

Strengths and Limitations

By utilising a qualitative approach to exploring students’ experiences on placement, this study has explored an important element of students’ EBP education. The use of focus groups allowed the researchers to explore the social elements of this important discussion and observe and report on the group mechanics in terms of social desirability rather than seek to control this element (Smithson, 2000). Throughout the discussion careful moderation was required to ensure that all participants’ voices were given equal opportunity as stronger voiced participants attempted to dominate areas of discussion (Litosseliti, 2003). The nature of the focus group environment and the limitations in terms of time meant that exploring individual experiences on a deep level was not possible, rather the collective experience and shared experiences were explored.

Despite participants coming from a very homogenous sample in terms of their educational background, there was diversity of gender, culture, and placement experiences. The authors recognize that the participants reflected a single healthcare discipline only however feel that many of the themes discussed are applicable across a multidisciplinary context.

CONCLUSION

Overall, the students’ experiences and perceptions of EBP during WIL were widely varied and inequitable. Whilst participants had a clear and strong desire to implement EBP while on clinical placement they felt limited by poor educational preparation and disempowered by workplace cultures and barriers. In order to improve students’ ability to practice in an evidence-based manner, EBP must be taught directly and explicitly, and all five steps addressed in curriculum. The academic and clinical placement units of study must be well aligned and scaffolded across the course of a degree in a way that allows students the opportunity to develop and apply these skills in practice. Universities must address the equity issues within WIL experiences and may do this by selectively partnering with

relevant clinical centers, professional organizations and policy makers. In particular those students with the skills to practice in an evidence-based manner are more likely to do so in their subsequent careers and to have positive attitudes towards EBP thus creating systemic cultural change within the profession. Therefore, it is clear that changes to health professional education and in particular WIL has a significant role to play in this critical future transition and cultural shift to further enhance the uptake of EBP in future.

ACKNOWLEDGEMENTS

Funding for the transcription of focus group data was provided by the Australian Society of Medical Imaging and Radiation Therapy. Elements of this research study were presented as a poster presentation at the European Congress of Radiology 2022.

REFERENCES

- Abrantes, A. F. C. L., Ribeiro, L. P. V., da Silva, C. A., England, A., Azevedo, K. B., Almeida, R. P. P., & Canha Reis, M. V. (2020). Evidence-based radiography: A new methodology or the systematisation of an old practice? *Radiography*, 26(2), 127-132. <https://doi.org/https://doi.org/10.1016/j.radi.2019.09.010>
- Ahonen, S.-M., & Liikanen, E. (2010). Radiographers' preconditions for evidence-based radiography. *Radiography*, 16(3), 217-222. <https://doi.org/10.1016/j.radi.2010.01.005>
- Albarqouni, L., Hoffmann, T., & Glasziou, P. (2018). Evidence-based practice educational intervention studies: a systematic review of what is taught and how it is measured. *BMC Medical Education*, 18, Article 177 <https://doi.org/10.1186/s12909-018-1284-1>
- Amit-Aharon, A., Melnikov, S., & Warshawski, S. (2020). The effect of evidence-based practice perception, information literacy self-efficacy, and academic motivation on nursing students' future implementation of evidence-based practice. *Journal of Professional Nursing*, 36(6), 497-502. <https://doi.org/10.1016/j.profnurs.2020.04.001>
- Braun, V., & Clarke, V. (2022). *Thematic analysis: A practical guide*. SAGE.
- Brettell, A. (2020). Implementing evidence-based practice: A guide for radiographers. *Radiography*, 26, S37-S41. <https://doi.org/10.1016/j.radi.2020.05.013>
- Connelly, L. M. (2016). Trustworthiness in qualitative research. *Nursing*, 25(6), 435-436.
- Di Michele, L., Thomson, K., McEntee, M. F., Kenny, B., & Reed, W. (2020). Knowledge translation: Radiographers compared to other healthcare professionals. *Radiography* 26, S27-S32. <https://doi.org/10.1016/j.radi.2020.06.007>
- England, A., & McNulty, J. P. (2020). Inclusion of evidence and research in European radiography curricula. *Radiography* 26, S45-S48. <https://doi.org/10.1016/j.radi.2020.04.018>
- Fineout-Overholt, E., Williamson, K. M., Kent, B., & Hutchinson, A. M. (2010). Teaching EBP: Strategies for achieving sustainable organizational change toward evidence-based practice. *Worldviews on Evidence-Based Nursing*, 7(1), 51-53. <https://doi.org/10.1111/j.1741-6787.2010.00185.x>
- Gambling, T., Brown, P., & Hogg, P. (2003). Research in our practice—A requirement not an option: Discussion paper. *Radiography*, 9(1), 71-76. [https://doi.org/10.1016/S1078-8174\(03\)00007-5](https://doi.org/10.1016/S1078-8174(03)00007-5)
- Glasman, L. R., & Albarracín, D. (2006). Forming attitudes that predict future behavior: A meta-analysis of the attitude-behavior relation. *Psychological Bulletin*, 132(5), 778-822. <https://doi.org/10.1037/0033-2909.132.5.778>
- Hafslund, B., Clare, J., Graverholt, B., & Wammen Nortvedt, M. (2008). Evidence-based radiography. *Radiography*, 14(4), 343-348. <https://doi.org/10.1016/j.radi.2008.01.003>
- Hallé, M.-C., Bussi res, A., Asseraf-Pasin, L., Storr, C., Mak, S., Root, K., & Thomas, A. (2021). Building evidence-based practice competencies among rehabilitation students: A qualitative exploration of faculty and preceptors' perspectives. *Advances in Health Sciences Education: Theory and Practice*, 26(4), 1311-1338. <https://doi.org/10.1007/s10459-021-10051-0>
- Harding, K., Lynch, L., Porter, J., & Taylor, N. F. (2017). Organisational benefits of a strong research culture in a health service: a systematic review. *Australian Health Review*, 41(1), 45-53. <https://doi.org/10.1071/AH15180>
- Higgins, R., Robinson, L., & Hogg, P. (2015). Unlocking student research potential: Toward a research culture in radiography undergraduate learning curricular. *Journal of Medical Imaging and Radiation Sciences*, 46(3), S6-S9. <https://doi.org/10.1016/j.jmir.2015.06.009>
- Hitch, D., & Nicola-Richmond, K. (2017). Instructional practices for evidence-based practice with pre-registration allied health students: A review of recent research and developments. *Advances in Health Sciences Education*, 22, 1031-1045. <https://doi.org/https://doi.org/10.1007/s10459-016-9702-9>
- Johnson, C. (2008). Evidence-based practice in 5 simple steps. *Journal of Manipulative & Physiological Therapeutics*, 31(3), 169-170. <https://doi.org/10.1016/j.jmpt.2008.03.013>

- Jones, S. R., Arminio, J. L., & Torres, V. (2014). *Negotiating the complexities of qualitative research in higher education: Fundamental elements and issues* (2nd ed.). Routledge. <https://doi.org/10.4324/9780203123836>
- Kalb, K. A., O'Conner-Von, S. K., Brockway, C., Riersen, C. L., & Sendelbach, S. (2015). Evidence-based teaching practice in nursing education: Faculty perspectives and practices. *Nursing Education Perspectives*, 36(4), 212-219. <https://doi.org/10.5480/14-1472>
- Kim, M.-S., & Hunter, J. E. (2006). Attitude-behavior relations: A meta-analysis of attitudinal relevance and topic. *Journal of Communication*, 43(1), 101-142. <https://doi.org/10.1111/j.1460-2466.1993.tb01251.x>
- Kraus, S. J. (1995). Attitudes and the prediction of behavior: A meta-analysis of the empirical literature. *Personality and Social Psychology Bulletin*, 21(1), 58-75. <https://doi.org/10.1177/0146167295211007>
- Litosseliti, L. (2003). *Using focus groups in research*. Continuum.
- Maggio, L. A., Thomas, A., Chen, H. C., Ioannidis, J. P. A., Kanter, S. L., Norton, C., & Artino, A. R., Jr. (2018). Examining the readiness of best evidence in medical education guides for integration into educational practice: A meta-synthesis. *Perspectives on Medical Education*, 7(5), 292-301. <https://doi.org/10.1007/s40037-018-0450-9>
- Malamateniou, C. (2009). Radiography and research: A United Kingdom perspective. *European Journal of Radiography*, 1(1), 2-6. <https://doi.org/10.1016/j.ejrad.2008.12.003>
- Martin, A., Rees, M., Fleming, J., Zegwaard, K. E., & Vaughan, K. (2019). Work-integrated learning gone full circle: How prior work placement experiences influenced workplace supervisors. *International Journal of Work-Integrated Learning*, 20(3), 229-242.
- Melnik, B. M., Fineout-Overholt, E., Feinstein, N. F., Sadler, L. S., & Green-Hernandez, C. (2008). Nurse practitioner educators' perceived knowledge, beliefs, and teaching strategies regarding evidence-based practice: Implications for accelerating the integration of evidence-based practice into graduate programs. *Journal of Professional Nursing*, 24(1), 7-13. <https://doi.org/10.1016/j.profnurs.2007.06.023>
- Milner, K. A., Bradley, H. B., & Lampley, T. (2018). Health professions faculty beliefs, confidence, use, and perceptions of organizational culture and readiness for EBP: A cross-sectional, descriptive survey. *Nurse Education Today*, 64, 5-10. <https://doi.org/https://doi.org/10.1016/j.nedt.2018.02.003>
- Rowe, A., Mackaway, J., & Winchester-Seeto, T. (2012). 'But I thought you were doing that': Clarifying the role of the host supervisor in experience-based learning. *Asia-Pacific Journal of Cooperative Education*, 13(2), 115-134.
- Sackett, D. L., Rosenberg, W. M. C., Gray, J. A. M., Haynes, R. B., & Richardson, W. S. (1996). Evidence based medicine: What it is and what it isn't. *British Medical Journal*, 312 Article 71. <https://doi.org/10.1136/bmj.312.7023.71>
- Smith, T. (2008). Evidence based medical imaging (EBMI). *Radiography*, 14(3), 233-237. <https://doi.org/10.1016/j.radi.2007.02.006>
- Smithson, J. (2000). Using and analysing focus groups: Limitations and possibilities. *International Journal of Social Research Methodology*, 3(2), 103-119.
- Thomas, A., & Bussi eres, A. (2021). Leveraging knowledge translation and implementation science in the pursuit of evidence informed health professions education. *Advances in Health Sciences Education*, 26(3), 1157-1171. <https://doi.org/10.1007/s10459-020-10021-y>
- Thomas, A., Saroyan, A., & Dauphinee, W. D. (2011). Evidence-based practice: A review of theoretical assumptions and effectiveness of teaching and assessment interventions in health professions. *Advances in Health Sciences Education: Theory and Practice*, 16(2), 253-276. <https://doi.org/10.1007/s10459-010-9251-6>
- Tractenberg, R. E., & Gordon, M. (2017). Supporting evidence-informed teaching in biomedical and health professions education through knowledge translation: An interdisciplinary literature review. *Teaching and Learning in Medicine*, 29(3), 268-279. <https://doi.org/10.1080/10401334.2017.1287572>
- Upton, D., & Upton, P. (2006). Knowledge and use of evidence-based practice by allied health and health science professionals in the United Kingdom. *Journal of Allied Health*, 35(3), 127-133.
- Wallace, D. S., Paulson, R. M., Lord, C. G., & Bond, C. F. (2005). Which behaviors do attitudes predict? Meta-analyzing the effects of social pressure and perceived difficulty. *Review of General Psychology*, 9(3), 214-227. <https://doi.org/10.1037/1089-2680.9.3.214>
- Winchester-Seeto, T., Rowe, A., & Mackaway, J. (2016). Sharing the load : Understanding the roles of academics and host supervisors in work-integrated learning. *Asia-Pacific Journal of Cooperative Education*, 17(2), 101-118.
- Young, T., Rohwer, A., Volmink, J., & Clarke, M. (2014). What are the effects of teaching evidence-based health care (EBHC)? Overview of systematic reviews. *Plos One*, 9(1), Article e86706. <https://doi.org/10.1371/journal.pone.0086706>

4.3 Practical recommendations

The preceding paper presented student radiographers' experiences of evidence-based practice during work integrated learning. This paper provides key insights into the impact of culture and education on students' ability to implement evidence-based practice during their clinical education and into the future. Understanding these perceptions is crucial for developing strategies that foster the application of evidence-based practice. Building on the findings of this paper, and based from current standards in terms of reviewing student placement experiences (MRPBA, 2020). I propose the following practical recommendations aimed to improve student radiographers' experiences of evidence-based practice during placement.

- **Universities** should prioritise ensuring positive evidence-based practice role modelling during students' work integrated learning experiences by partnering actively with sites that display positive attitudes towards evidence-based practice and building capacity at these sites.
- **Universities** should ensure adequate review of inequities among students' experiences of evidence-based practice in their work integrated learning placements.

The next chapter will be *Enhancing evidence-based practice in health professions education: evaluation of an applied curriculum intervention*. This chapter reports on the evaluation of the Evidence-Based Practice – Applied Educational Intervention. In this chapter I explore how we can improve the university education of diagnostic radiographers to enhance the translation of evidence-based practices.

Chapter 5: Enhancing evidence-based practice in health professions education: evaluation of an applied curriculum intervention

5.1 Introduction

In [Chapter 3](#), I assert that to enhance evidence-based practice in diagnostic radiography we should utilise and apply the key learnings from knowledge translation in other disciplines to our profession. Building upon this foundation, [Chapter 4](#) expands this discussion with the finding that diagnostic radiography students' ability to implement evidence-based practice during clinical placement was limited by their academic preparation. This raised a new question:

What could educators do to more effectively prepare their students to apply evidence-based practice both on placements and in their future careers?

In [Section 1.4](#), I established that professionals with confidence in the skills required for evidence-based practice are more inclined to implement it effectively in the clinical environment. With this insight, I set out to design, implement and evaluate a curriculum intervention aimed at improving the knowledge and skills of diagnostic radiography students that addressed each stage of Melnyk and colleagues' (2010) 7-step model. My curriculum intervention is grounded in the evidence pertaining to knowledge translation and effective pedagogy. It is designed to foster engagement and accessibility. I have called it the Evidence-Based Practice – Applied Educational Intervention.

This year-long intervention, delivered to second year pre-registration masters students involved firstly a group literature review, which focused on the ask, search, and appraise steps of the evidence-based practice cycle. Students then completed an online learning module focused on implementation science concurrently with a clinical placement where they utilised their placement site to develop a theoretical implementation and evaluation plan. Finally, students disseminated their findings at a conference style presentation day.

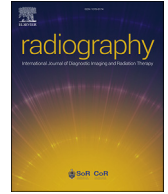
The intervention and its evaluation aim to contribute towards recommendations two, five and three of the Sicily Statement (Dawes et al., 2005). This aim is achieved by ensuring that the full evidence-based practice cycle was taught and assessed (2), a range of methods were utilised (5), and we engaged in empirical exploration of effective pedagogical practices for teaching evidence-based practice (3). This chapter, in the form of a paper currently accepted, presents the results of a mixed methods evaluation of the Evidence-Based Practice – Applied Educational Intervention. The study explored students' experiences of the intervention and compared students' knowledge and skills, practices and attitudes towards evidence-based practice prior to and after the intervention.

The ethics approval letter for this research can be found in [Appendix 4](#).



Contents lists available at ScienceDirect

Radiography

journal homepage: www.elsevier.com/locate/radi

Enhancing evidence-based practice in radiography education: Evaluation of an applied curriculum intervention[☆]

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ARTICLE INFO

Article history:

Received 22 September 2024
Received in revised form
3 December 2024
Accepted 9 December 2024
Available online xxx

Keywords:

Evidence-based practice
Health professional education
Radiography
Radiography education
Curriculum design

ABSTRACT

Introduction: It is imperative that radiography graduates are taught to effectively apply evidence-based practice (EBP) in their clinical careers. Teaching the concept is challenging, as it requires educators to embed and scaffold knowledge and skills across the EBP cycle throughout both academic and clinical curricula. The objective of this study was to evaluate an overarching curriculum level intervention that aimed to enhance student radiographers' knowledge, skills, attitudes and practices towards EBP. This is referred to as the Evidence-Based Practice – Applied Educational Intervention (EBP-AEI).

Methods: The study employed a mixed methods convergent parallel design. Focus groups were used to explore students' experiences of the intervention, and pre and post intervention surveys were used to assess students' knowledge, skills, practices, and attitudes towards EBP. Twelve students participated across two focus groups.

Results: Three themes were defined during analysis: 1. knowledge and skills, 2. it's all about pedagogy!, and 3. clinical implementation on placement. Twenty-three students completed the pre-intervention survey and eighteen completed the post. While the survey results were not statistically significant (potentially due to insufficient power), data from the focus groups suggests that EBP knowledge and skills were acquired by students during the intervention. Attitudes of students towards EBP dropped, likely due to challenges the students experienced during both the academic and clinical aspects of the intervention.

Conclusion: Developing strong curricula is vital to ensure that radiography graduates are able to implement EBP in clinical settings.

Implications for practice: Radiography educators should actively consider the scaffolding of EBP across curricula and partner with clinical sites to ensure that placement experiences are enhancing taught curriculum on this space.

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Introduction

Graduating healthcare professionals who are confident and competent in evidence-based practice (EBP) is crucial for enhancing individual practice and advancing healthcare systems.¹ The importance of explicit and effective EBP training for healthcare professionals has been recognised internationally.² EBP itself is multifaceted and complex, and therefore challenging to teach to health professional students.³

There is a need to actively embed and scaffold EBP throughout radiography curricula.^{4,5} It is imperative that all elements within

the EBP cycle are addressed. Initiatives should be taught across both academic and placement settings to ensure that students can safely acquire, consolidate, and apply EBP skills in clinical settings.^{4,5} Furthermore, no single teaching method has been identified as being more effective than others in increasing EBP competency.⁶ Instead, approaches to teaching EBP should be varied, utilising a combination of methods and technologies, and assessed using appropriate methods to the skills being taught. This may for example include lectures, discussions, team-based learning, problem-based learning, assignments and projects.^{1,4,5,7–9}

To date, literature typically reports on interventions that address between one and three steps of the seven-step EBP cycle.^{10,11} There is a tendency to focus on searching for and critically appraising evidence with a paucity of studies that report on interventions that span the entire EBP cycle. The purpose of this study was to evaluate

[☆] This paper is part of the special issue Current Issues in Radiography Education.

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<https://doi.org/10.1016/j.radi.2024.12.007>

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Figure 1. Visual representation of the seven steps of evidence-based practice as described by Melnyk et al. (2010).

an overarching curriculum level intervention, aimed at increasing EBP skills among radiography students.

Methods

Study design

A social constructivist lens was employed in the design and subsequent analysis of this study. Social constructivism is particularly pertinent to EBP as knowledge must be viewed within the social context, considering individual patient preferences and how different forms of evidence interact with one another.¹² Knowledge cannot be separated from individual social experiences, a concept that the Evidence-Based Practice – Applied Educational Intervention (EBP-AEI) aimed to actively leverage.

Melnik and colleagues¹³ model of EBP was utilised for this study (Fig. 1). This model directly emphasises the commitment to lifelong learning required for practitioners to engage with EBP. It is essential for radiography educators to nurture this spirit of enquiry among students to cultivate a culture of lifelong learning within our profession.^{14–16}

This study was conducted at an Australian metropolitan university offering an accredited, graduate entry master's program in diagnostic radiography. Accreditation standards for this degree require explicit instruction in EBP.¹⁷ Ethical approval was obtained from the University of Sydney (HREC 2022/674).

The study employed a convergent parallel design and purposive sampling.¹⁸ Focus group interviews were conducted to explore

students' experiences of the intervention. These were facilitated by a member of the research team with no connection to the participants. They were conducted after all assessments were completed to foster openness and honesty. Twelve participants took part across two focus group sessions, with care taken to ensure diversity among participants. The groups included a mix of genders, domestic and international students and diverse cultural representation. Participants chose pseudonyms during the focus group to ensure their anonymity.

Quantitative data were collected pre and post intervention in the form of surveys. These surveys sought to determine whether the intervention had an impact on participants' knowledge, skills, practices and attitudes towards EBP.¹⁹ Of 83 students who took part in the intervention, a total of 23 participants took part in the pre-intervention survey and 18 participants in the post-intervention survey giving response rates of 28 % and 22 %, respectively.

The intervention is reported using the Guideline for Reporting EBP Educational interventions and Teaching (GREET) checklist²⁰ found in the [supplementary materials](#) and is displayed in Fig. 2.

Qualitative data

A semi-structured, open ended focus group guide was developed based on Melnyk and colleagues¹² model of EBP and is provided in the [supplementary materials](#). Data were analysed using reflexive thematic analysis as described by Braun and Clarke.²¹ The first author (LDM) undertook a process of data familiarisation, then systematic coding, whereby latent meanings were explored, and themes were defined from these codes. These themes were further refined by revisiting the codes and full dataset. Peer debriefing with the broader research team was utilised on an ongoing basis throughout this process to enhance the credibility, dependability and authenticity of the analysis.²²

Quantitative data

The student Evidence-based Practice Questionnaire (sEBPQ) is a well-established survey tool that has been adapted to measure student practice, attitudes and knowledge and skills related to EBP.¹⁹ To minimise social desirability bias and perceived coercion, the survey was fully anonymous.²³ Therefore, data were treated as independent because responses could not be paired. Statistical analyses were performed using SPSS (Version 28). Scores were aggregated across four EBP subscales, 1) practice, 2) attitudes, 3) retrieving and reviewing evidence and, 4) sharing and applying evidence.

Numerical summary statistics of centre and spread were generated for the four outcome variables, as well as individual subscale items, for both timepoints. Aggregated subscale scores for both timepoints were compared using independent sample t-tests, assuming unequal variances. Normality was graphically inspected through the production of quantile-comparison plots.^{24,25} Results

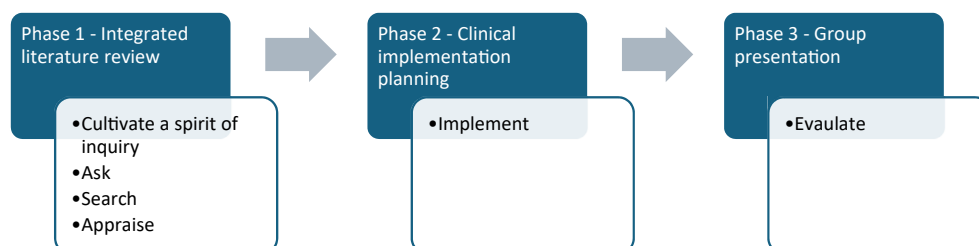


Figure 2. Intervention Phases mapped to Melnyk et al.'s 2010 steps.

were reported as means and standard deviations for the pre and post intervention time points, unstandardised mean differences with 95 % confidence intervals, Glass's Δ standardised effect sizes with 95 % confidence intervals and summary model statistics.^{26,27} Cronbach's Alpha was also calculated to assess the internal consistency, with α values > 0.70 considered acceptable.²⁸

Results

Data are presented firstly from the focus group interviews, followed by the survey data. These results are then synthesized in the discussion section of this paper. During thematic analysis, three primary themes were defined: knowledge and skills, it's all about pedagogy!, and clinical implementation on placement.

Focus groups

Knowledge and skills

This theme explored the knowledge and skills that participants perceived they had gained through undertaking the EBP-AEI. They discussed skill acquisition across all seven steps of the EBP cycle and shared their reflections on learning and applicability to their future careers as healthcare professionals. Additionally, participants discussed developing important professional skills because of the intervention, including leadership, teamwork and communication. A summary of quotes representing this theme is presented in Table 1.

Table 1
Summary of quotes representing "Knowledge and Skills" theme.

Category and Description	Quotation
Defining EBP: Participant definitions of EBP were generally quite narrow, focusing predominantly on the application of empirical evidence.	"Using research as well as peer reviewed articles and academic literature, to gain knowledge" – Mildred "The use of research to better inform evidence for practitioners to utilise in their day-to-day radiography" – Ed
Defining EBP: Example of participant discussing the clinical expertise pillar of EBP.	"Yeah, I think just using research and critical thinking to inform clinical decision making" – Mary
EBP knowledge and skills: Participants discussed learning broadly across the cycle of EBP.	"Well, it was good in learning [to be] more observant and being able to identify areas of improvement in a practice" – Steve "We also got to learn how to do a proper literature search. So using appropriate truncations and Boolean operators, was really useful to narrow our search" – Mary "In the lectures they taught us ... there's some methods that you can use to see if it's qualified as good quality of data." – TL "The 'a-ha!' moment that I had for the plan itself, was figuring out the enablers and barriers to the implementation plan ... when I figured out, oh, so they have barriers and enablers to this plan, I figured that, OK, well, if we can address those types of barriers, then we can implement something!" – Mia "That was actually quite tricky to evaluate our – to come up with a way to evaluate our plan" – Kath "That's what our group tried to do in our presentation, is make sure we saw the relevance as radiographers, and the role that we play from the research that we did ... it was good to look at it in that way, and then share that with others" – Chloe
Professional skills: In addition to skills directly related to EBP, participants described growth in their professional skills including teamwork, leadership and communication.	"We worked with the same group for I think, yeah, the majority of this year, and it really helped us build on that teamwork skill" – Mildred "I think I can see the advantages, because thinking through and developing your implementation plan, I think it would help enhance your capabilities for leadership in the future." – Ed "It was good to figure out ways to share the information that's palatable and easy to understand, and figure out how to share the information so it's not super dry, and gets the point across, and seems relevant to us as radiographers" – Chloe
Reflections on application: Participants reflected on their learning experiences and what they felt they had gained from the intervention.	"So previously I've also taken other units of study in evidence-based practice ... but I found it, yeah, very useful. And realised how hard it is actually to search the literature, and not be biased when answering our group's question. So it was actually quite difficult and I found it quite challenging but also quite rewarding in the end." – Chloe "I think it was useful to learn or see that, because it makes it a little bit less daunting" – Melinda "it's an excellent topic to include in the overall course. Simply because it helps you to bring together and create some coherence in different domains of the – particularly for the MRPBA [medical radiation practice Board of Australia] domains. You can integrate all the information that you've learned throughout the year, assimilate it, put it together, integrate it, and then think about how you would best implement it in your day-to-day practice. So actually, it better makes you informed for me hitting the ground running ... So when you're finished, you're, I don't know, better able to be a successful radiographer than you would otherwise." – Ed

It's all about pedagogy!

This theme explored participants' experiences of learning throughout the EBP-AEI. They discussed aspects of the intervention's flow, describing challenges encountered due to poor initial instruction. Participants emphasised the importance of topic selection and described challenges encountered in the later stages of the EBP cycle when they had chosen a topic that didn't fit well.

Participants identified academic support as integral to their success throughout the intervention, describing it in both positive and negative ways based on their experiences. Additionally, participants from diverse populations noted specific difficulties that they had encountered because of their diversity. Many described experiencing both highs and lows associated with group work, experiencing this element of the intervention differently depending on the group cohesion. A summary of quotes representing this theme is presented in Table 2.

Clinical implementation on placement

This theme explored students' experiences specifically in the implementation stage of the intervention which was linked with a clinical placement. Students used their placement site as a case study to develop a theoretical EBP implementation plan for the key findings of their literature review. Participants had variable experiences when navigating conversations about EBP on placement, with some sites having cultures that fostered these conversations and others that did not. Participants discussed feelings of concern when navigating these conversations with clinical educators who are ultimately responsible for assessing students. A summary of quotes representing this theme is presented in Table 3.

Table 2

Summary of quotes representing "It's all about pedagogy!" theme.

Category and Description	Quotation
Intervention flow: Participants described the challenges associated with poor instruction and overview at the beginning of the intervention, which affected their learning experience.	"At the very beginning, it was hard to see the outlook of where the literature review assignment would go. And how it leads on into the implementation science assignment later on. So it was hard to – I think it wasn't quite as clear at the very beginning, the whole, how everything was interconnected through that way. So, it made it a bit more difficult in that sense." – Steve
Intervention flow: Participants described a sense of disconnect of the dissemination phase of the EBP-AEI.	"It would be interesting or good to know, maybe at the start of the degree, that we'll be doing some evidence-based practice, and doing research and literature, a literature review and things. Because then I think while we're out at our first placements, or just learning about things, we can start coming up with questions or things that we want answered" – Chloe
Topic choice: Participants universally described topic selection as a significant challenge.	"I'd like to add that it [the group dissemination presentation] was a bit out of place, as in we had finished. We thought the literature review was done and dusted, moved on to implementation science. Went on this really long placement; nine weeks. We've almost just forgotten about this ... then out of nowhere 'oh, you need to do this presentation that you did many, many weeks ago' – Mildred
Topic choice: Participants described challenges when their chosen topic did not fit well throughout the duration of the intervention.	"I was going to add on, finding a research topic was, I think, the main struggle initially. In terms of figuring out a topic of the literature, to determine if that topic is an area that we can go into, and it's not too simplistic, or not too complex and out of our field." – Steve
Academic support: Support from academic staff was valued amongst participants however there were diverse experiences of receiving this support when reaching out.	"Given that the implementation plan was building off of our literature review, at least for me, it was a struggle. Because for my placement, with my literature review, it just made no sense at all" – Mia
Diverse student populations: Participants from diverse populations described their additional struggles with aspects of the intervention.	"Once we got into the tutorials, that helped us open the pathway to know the steps and work on them individually with the lecturers" – Margaret
Group work: Diverse experience of group work was represented amongst participants.	"The tutorials, yes, they were very great for us, because we can talk as a team, get feedback from the tutors ... that helped out a lot in the end." – Mia
	"The questions that we were asking to the coordinator, we felt like we weren't getting clear, concise answers back, which just added to the confusion." – Margaret
	"When I started writing my assignment, I feel more confused, more confused, more confused. And I feel like there's lots of students, like myself, who are international students. For us, the language is a big barrier." – Amy
	"I think for me, the best part is to form the group!" – TL
	"I think there was a lot of struggling, a lot of unhappiness within those groups, and just a lot of fighting and stuff. And if we had have known, maybe we would have orientated our group choices more" – Margaret

Table 3

Summary of quotes representing "Clinical implementation on placement" theme.

Category and Description	Quotation
Staff attitudes at placement site: Participants experienced a diversity of attitudes towards their implementations which affected their experience of the implementation phase of the intervention.	"I tried to discuss it with them, people on the placement site. It was not particularly fruitful. They said that, as a student, you would have no influence whatsoever on any decisions ... it's not even worthwhile discussing it." – Ed
Potential impact on assessment: Participants described their concerns about the way in which they presented to their placement site and the potential impact on their placement assessments	"I just quietly observed, and I guess faked it 'til I made it with the assignment. Yeah, so it would be nice, in a perfect world, to be able to properly interact with staff and get their opinion on it. So you can make a really well rounded and honest implementation plan." – Kath
	"I found the people that I was with were very helpful. And this assignment fostered communication with them. I Would have to ask them how things run ... what protocols they do there, what capacity they have at the hospital. So I felt like they were very helpful in that regards. And I couldn't have gotten that information on the internet, I really had to talk to them a lot." – Mary
	"The chief radiographers and staff were really good in helping me break the ideas down and get my head around things. Because they've been in this industry their whole life and have probably implemented changes themselves." – Margaret
	"When you bring in everything that we have to get from our placement, being on our best behaviours, creating a really good presentation of ourselves, getting all our competencies, that in itself is very, very stressful. Let alone coming into a placement where you've just met the people, and being like, 'I have to implement a change!' You're not going to be received very well by those people." – Margaret
	"You don't really feel it's your place to talk. You feel you're sticking your neck out, and stepping where you shouldn't – like overstepping as well. It's quite tricky depending on the attitude at your placement site, and especially because they're marking you. You don't want to – you want to do well in this subject. But you don't want to sabotage your other mark. Yeah, or rub your supervisor the wrong way." – Kath

SEBPQ survey data

Numerical summary statistics of the individual subscale items for the pre and post intervention time points are presented in Table 4. For the pre-intervention time point, the Cronbach's alpha measures for the practice ($\alpha = 0.83$), retrieving ($\alpha = 0.94$), and sharing ($\alpha = 0.92$) subscales were considered acceptable, but unacceptable for the attitude subscale ($\alpha = 0.65$). For the post-intervention time point, the Cronbach's alpha measures for the retrieving ($\alpha = 0.79$) and sharing ($\alpha = 0.81$) subscales were acceptable, but unacceptable for the practice ($\alpha = 0.67$) and attitude subscales ($\alpha = 0.39$). For

the attitude subscale, the low Cronbach's alpha values pre- and post-intervention suggest that the three items comprising the subscale are not strongly correlated with each other, indicating poor internal consistency.

The numerical summary statistics of the aggregated subscales are presented in Table 5. There was insufficient evidence to conclude a difference between the pre- and post-intervention groups for the practice (mean difference = 0.13, $t = 0.39$, $p = 0.70$), attitude (mean difference = -0.52, $t = -1.58$, $p = 0.13$), retrieving (mean difference = 0.46, $t = 1.30$, $p = 0.21$) and sharing (mean difference = 0.43, $t = 0.98$, $p = 0.34$) subscales.

Table 4

Numerical summary statistics and measures of internal consistency for the four subscales (practice, attitude, retrieving, sharing).

		Descriptive statistics							
		N	Mean	95 % CI (Lower - Upper)	Std. Deviation	Std. Error Mean	Median	Minimum - Maximum	Inter-quartile Range
Practice subscale	Pre	23	4.08	3.62–4.54	1.06	0.22	4.33	1.83–5.5	1.33
	Post	18	4.21	3.67–4.75	1.09	0.26	4.25	1–6.33	0.88
Attitude subscale	Pre	22	6.14	5.74–6.53	0.89	0.19	6.33	3.67–7	1.42
	Post	13	5.62	5.03–6.2	0.97	0.27	5.67	3.67–7	1.5
Retrieving subscale	Pre	21	4.63	4.09–5.18	1.2	0.26	4.71	2.14–7	1.71
	Post	12	5.1	4.56–5.63	0.84	0.24	5	3.71–6.43	1.32
Sharing subscale	Pre	21	4.73	4.13–5.34	1.33	0.29	5	2–7	1.9
	Post	12	5.17	4.43–5.9	1.15	0.33	5.3	3.6–6.6	2.45

Table 5

Independent samples t-test results for the four subscale outcomes (practice, attitude, retrieving, sharing) comparing the pre- and post-intervention time points.

		Independent samples t-test									
		t	df	Significance	Mean Difference (Post - Pre)	Std. Error Difference	95 % Confidence Interval of the Difference		Glass's G effect size	95 % Confidence Interval of the Difference	
				Two-Sided p-value			Lower	Upper			
Practice subscale	Equal variances not assumed	0.39	36.19	0.70	0.13	0.34	−0.55	0.82	0.13	−0.49	0.74
Attitude subscale	Equal variances not assumed	−1.58	23.54	0.13	−0.52	0.33	−1.20	0.16	−0.59	−1.29	0.13
Retrieving subscale	Equal variances not assumed	1.30	29.41	0.21	0.46	0.36	−0.27	1.19	0.39	−0.34	1.10
Sharing subscale	Equal variances not assumed	0.98	25.93	0.34	0.43	0.44	−0.48	1.34	0.32	−0.40	1.04

Discussion

During the focus groups, participants described skill acquisition both in terms of EBP skills and in broader professional skills, a notion reinforced by their successful achievement of the learning outcomes of the intervention. This EBP skill acquisition discussed during the focus groups mapped to each element of the EBP cycle, with participants expressing confidence in their abilities in these areas. While the sEBPQ results did not reveal statistically significant changes pre and post intervention, there was an increase in raw score in the retrieving and sharing subscales, (0.46 and 0.43 respectively), consistent with participants' experiences of skill acquisition described in the focus groups. The professional skills that participants identified they had developed during the intervention align with desirable professional capabilities, including teamwork, communication and leadership, helping them to become more rounded professionals as they enter the workforce.¹⁷

Despite experiencing skill acquisition and expressing positive reflections, there was a decline of 0.52 in the attitude subscale. Some of this decline may potentially be attributed to challenges with the roll-out of the intervention and/or negative experiences during clinical placement.²⁹ Participants reported a wide variability in EBP culture at their placement sites which is consistent with other literature in the area.^{30,31} Poor experiences of EBP due to negative role modelling during clinical placements may have, in turn, affected their attitudes towards EBP. Previous studies have linked witnessing EBP during clinical placements as a student as a predictive factor for confidence in implementing EBP in practice among graduates.²⁹

The decline in participants' attitudes brings them closer to the attitudes of the diagnostic radiographers who are responsible for supervising them in the clinical environment. A study utilising the practitioner version of the questionnaire utilised in this study³² reported attitudes of Australian diagnostic radiographers as 5.2 on a 7 point scale.³³ The implementation of EBP can be strongly affected by social settings, cultural norms, and individuals within organisations.^{34,35} When students have poor experiences of EBP on placement, are they being socialised to devalue EBP? A recent

overview of systematic reviews indicated that the primary gaps in EBP pedagogy should be addressed by fostering more collaboration with clinical practice.⁴ While the EBP-AEI aimed to include a clinical focus, perhaps future iterations could involve heightened clinical consultation to increase buy-in of our clinical partners, a concept supported in the literature.^{3,31}

The roll out and evaluation of a new curriculum level educational intervention provides an opportunity for reflection on pedagogical choices made. Participants were encouraged to choose their own topics, aiming to ignite their "spirit of inquiry".¹³ Optimising choice, autonomy, relevance and authenticity was expected to enhance student engagement.³⁶ However, allowing students to choose their topic appeared to cause stress, throughout all phases of the intervention. In future years, offering a curated list of topics may balance autonomy with relevant topic selection.

Limitations

By using a mixed methods approach, this study provided insights into students' experiences of the intervention. However, the quantitative data was limited by the small study population, which meant that despite a good response rate, the small sample size constrained the power of the statistical analysis. Whilst the challenge of underpowered studies is not uncommon in health professional education research,²⁷ this limited the statistical inferences that could be made from the survey data. Survey data were collected anonymously to minimise social desirability bias; however, this approach precluded paired analysis.

Conclusion

This study reports on an evaluation of applied educational intervention aimed at enhancing EBP among radiography students. While the sEBPQ results were not statistically significant, evidence from the focus groups indicates that knowledge and skill acquisition occurred across the EBP cycle. Challenges in the intervention roll-out influenced participants' experiences, highlighting the importance of creating a structure and process that works for

students. Participants' attitudes towards EBP declined during the intervention, aligning them with their professional counterparts. Stronger connections with clinical partners, including structured EBP mentoring on placement may help to reduce the decline in positive attitudes towards the practice. Further research aimed at refining the intervention based on identified challenges and exploring the long-term impact of structured EBP mentoring during placements is warranted to advance EBP education and enhance patient care outcomes.

Acknowledgements

This research was supported by a 2023 research grant from the Australian & New Zealand Association for Health Professional Educators.

The authors acknowledge the technical assistance of Alexandra Green of the Sydney Informatics Hub, a Core Research Facility of the University of Sydney.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.radi.2024.12.007>.

References

- Patelaru AE, Mechili EA, Ruzafa-Martinez M, Dolezel J, Gotlib J, Skela-Savić B, et al. Educational interventions for teaching evidence-based practice to undergraduate nursing students: a scoping review. *Int J Environ Res Publ Health* 2020;**17**(17).
- Glasziou P, Burls A, Gilbert R. Evidence based medicine and the medical curriculum. *BMJ* 2008;**337**:a1253.
- Hallé MC, Bussièrès A, Asseraf-Pasin L, Storr C, Mak S, Root K, et al. Building evidence-based practice competencies among rehabilitation students: a qualitative exploration of faculty and preceptors' perspectives. *Adv Health Sci Educ Theory Pract* 2021;**26**(4):1311–38.
- Nielsen LD, Löwe MM, Mansilla F, Jørgensen RB, Ramachandran A, Noe BB, et al. Interventions, methods and outcome measures used in teaching evidence-based practice to healthcare students: an overview of systematic reviews. *BMC Med Educ* 2024;**24**(1):306.
- Young T, Rohwer A, Volmink J, Clarke M. What are the effects of teaching evidence-based health care (EBHC)? Overview of systematic reviews. *PLoS One* 2014;**9**(1):e86706 [e].
- Howard B, Diug B, Ilic D. Methods of teaching evidence-based practice: a systematic review. *BMC Med Educ* 2022;**22**(1):742.
- Kyriakoulis K, Patelaru A, Laliotis A, Wan AC, Matalliotakis M, Tsiou C, et al. Educational strategies for teaching evidence-based practice to undergraduate health students: systematic review. *J Educ Eval Health Prof* 2016;**13**:34.
- Bala MM, Poklepović Perićić T, Zajac J, Rohwer A, Klugarova J, Välimäki M, et al. What are the effects of teaching Evidence-Based Health Care (EBHC) at different levels of health professions education? An updated overview of systematic reviews. *PLoS One* 2021;**16**(7):e0254191.
- Hornqvist M-ET, Nordsteien A, Fermann T, Severinsson E. Strategies for teaching evidence-based practice in nursing education: a thematic literature review. *BMC Med Educ* 2018;**18**(1):172.
- Albarqouni L, Hoffmann T, Glasziou P. Evidence-based practice educational intervention studies: a systematic review of what is taught and how it is measured. *BMC Med Educ* 2018;**18**(1):177.
- Molena KF, Prado VO, Paulo AC, Dantas RVF, Curi Júnior A, Pedrosa GL, et al. Knowledge changes after applying evidence-based dentistry educational interventions to dental students: a systematic review. *J Dent Educ* 2023;**87**(9):1321–69.
- Thomas A, Menon A, Boruff J, Rodriguez AM, Ahmed S. Applications of social constructivist learning theories in knowledge translation for healthcare professionals: a scoping review. *Implement Sci* 2014;**9**(1):54.
- Melnik BM, Fineout-Overholt E, Stillwell SB, Williamson KM. Evidence-based practice: step by step: the seven steps of evidence-based practice. *Am J Nurs* 2010;**110**(1):51–3.
- Di Michele L, Thomson K, Bell A, Reed W. Educating for the future: bookending evidence-based practice. *Radiography* 2023;**29**(5):958–60.
- Bell SG. Step 0: the spirit of inquiry. *Neonatal Network* 2021;(1):38–9.
- Melnik BM, Fineout-Overholt E, Stillwell SB, Williamson KM. Evidence-based practice: step by step: igniting a spirit of inquiry: an essential foundation for evidence-based practice. *Am J Nurs* 2009;**109**(11):49–52.
- MRPBA. *Professional capabilities for medical radiation practice*. 2020.
- Sunderji N, Waddell AE. Mixed methods convergent study designs in health professions education research: toward meaningful integration of qualitative and quantitative data. *Acad Med* 2018;**93**(7):1093.
- Upton P, Scurluck-Evans L, Upton D. Development of the student evidence-based practice questionnaire (S-EBPQ). *Nurse Educ Today* 2016;**37**:38–44.
- Phillips AC, Lewis LK, McEvoy MP, Galipeau J, Glasziou P, Moher D, et al. Development and validation of the guideline for reporting evidence-based practice educational interventions and teaching (GREET). *BMC Med Educ* 2016;**16**(1):237.
- Braun V, Clarke V. *Thematic analysis: a practical guide*. Los Angeles: SAGE; 2022.
- Connelly LM. Trustworthiness in qualitative research. *Medsurg Nurs* 2016;**25**(6):435–6.
- Larson RB. Controlling social desirability bias. *Int J Mark Res* 2019;**61**(5):534–47.
- Ruxton GD. The unequal variance t-test is an underused alternative to Student's t-test and the Mann–Whitney U test. *Behav Ecol* 2006;**17**(4):688–90.
- Delacre M, Lakens D, Leys C. Why psychologists should by default use Welch's t-test instead of student's t-test. *International Review of Social Psychology* 2017;**30**(1):92–101.
- Lakens D. Calculating and reporting effect sizes to facilitate cumulative science: a practical primer for t-tests and ANOVAs. *Front Psychol* 2013;**4**.
- Cook DA, Hatala R. Got power? A systematic review of sample size adequacy in health professions education research. *Adv Health Sci Educ* 2015;**20**(1):73–83.
- Terwee CB, Bot SD, de Boer MR, van der Windt DA, Knol DL, Dekker J, et al. Quality criteria were proposed for measurement properties of health status questionnaires. *J Clin Epidemiol* 2007;**60**(1):34–42.
- Blackman IR, Giles TM. Can nursing students practice what is preached? Factors impacting graduating nurses' abilities and achievement to apply evidence-based practices. *Worldviews Evidence-Based Nurs* 2017;**14**(2):108–17.
- Di Michele L, Bell A, Thomson K, McEntee M, Kenny B, Reed W. Student radiographers' perceptions of evidence-based practice during clinical placements: implications for health professional education. *International Journal of Work Integrated Learning* 2023;**24**(4):553–66.
- Young T, Rohwer A, van Schalkwyk S, Volmink J, Clarke M. Patience, persistence and pragmatism: experiences and lessons learnt from the implementation of clinically integrated teaching and learning of evidence-based health care – a qualitative study. *PLoS One* 2015;**10**(6):e0131121.
- Upton D, Upton P. Knowledge and use of evidence-based practice by allied health and health science professionals in the United Kingdom. *J Allied Health* 2006;**35**(3):127–33.
- Di Michele L, Thomson K, Bell A, Reed W. Assessing evidence-based practice among Australian radiographers: a self-report survey. *Radiography* 2024;**30**(2):696–701.
- Atkins L, Francis J, Islam R, O'Connor D, Patey A, Ivers N, et al. A guide to using the Theoretical Domains Framework of behaviour change to investigate implementation problems. *Implement Sci* 2017;**12**(1):77.
- Damschroder LJ, Reardon CM, Widerquist MAO, Lowery J. The updated Consolidated Framework for Implementation Research based on user feedback. *Implement Sci* 2022;**17**(1):75.
- CAST. *Universal design for learning guidelines version 2.2 2018*. 2018. Available from: <http://udlguidelines.cast.org>.

5.3 Practical recommendations

The preceding paper evaluated students' experiences of the evidence-based practice – applied educational intervention. In this paper I highlighted the importance of developing students' knowledge and application of evidence-based practice during their formal education in a manner that is pedagogically sound. Furthermore, student participants highlighted (in a similar manner to [Chapter 4](#)) the challenges experienced when implementing evidence-based practice during clinical placements. As such, based on this evaluation I propose the following practical recommendations that offer guidance on curriculum design and collaborative partnerships.

- **Universities** should design and deliver dedicated curricula to train students in all stages of the evidence-based practice cycle to ensure they graduate with the skills required to implement positive change in their practice.
- **Universities** should consider the most effective pedagogical options when delivering evidence-based practice education, drawing on the research pertaining to this.
- **Universities and diagnostic radiography departments and private practices** should invest in partnerships and collaborations based upon evidence-based practice as these could lead to enhanced student outcomes when it comes to evidence-based practice.

The next chapter will be *Assessing evidence-based practice among Australian radiographers: a self-report survey*. This chapter presents a national survey of Australian diagnostic radiographers; it examines the knowledge and skills, practices, and attitudes of these radiographers. This chapter establishes a baseline of Australian diagnostic radiographers' evidence-based tendencies.

Chapter 6: Assessing evidence-based practice among Australian radiographers: a self-report survey

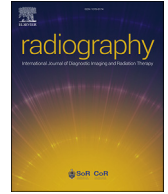
6.1 Introduction

In [Section 1.6](#), I summarised the culture and context of diagnostic radiography within Australia. The findings presented in [Chapter 4](#) and [Chapter 5](#) highlighted a significant variability in the experiences of students across different clinical sites when it came to evidence-based practice. There has been a recent proliferation in research and indeed an international systematic review (Al Balushi et al., 2024) exploring radiographers' evidence-based practice knowledge and skills, practices and attitudes. However, an Australian perspective was yet to be captured.

This chapter, in the form of a published paper, presents the results of a self-report survey conducted among Australian diagnostic radiographers. The survey examines participants' knowledge and skills, practices, and attitudes in relation to evidence-based practice. Establishing a baseline is a crucial step before implementing and evaluating interventions designed to improve practice, ensuring an accurate basis from which to measure change. The survey identified several areas in which radiographers expressed limited confidence in their skills. I argue that improving these skills within the radiography workforce is imperative for the advancement of evidence-based practice in diagnostic radiography in Australia. Furthermore, I advocate for collaboration across countries, given the similarity in results observed across diagnostic radiography contexts internationally.

The ethics approval letter for this research can be found in [Appendix 4](#) and the peer review for this publication can be found in [Appendix 7](#).

- Al Balushi, H., Watts, H., & Akudjedu, T. N. (2024). Research and evidence-based practice in clinical radiography: A systematic review of barriers and recommendations for a new direction. *Radiography*, 30(2), 538-559. <https://doi.org/https://doi.org/10.1016/j.radi.2024.01.012>
- Dawes, M., Summerskill, W., Glasziou, P., Cartabellotta, A., Martin, J., Hopayian, K., Porzsolt, F., Burls, A., & Osborne, J. (2005). Sicily statement on evidence-based practice. *BMC Medical Education*, 5(1), 1. <https://doi.org/10.1186/1472-6920-5-1>
- Melnyk, B. M., Fineout-Overholt, E., Stillwell, S. B., & Williamson, K. M. (2010). Evidence-based practice: step by step: the seven steps of evidence-based practice. *Am J Nurs*, 110(1), 51-53. <https://doi.org/10.1097/01.NAJ.0000366056.06605.d2>
- MRPBA. (2020). Professional capabilities for medical radiation practice. In.



Assessing evidence-based practice among Australian radiographers: A self-report survey

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ARTICLE INFO

Article history:

Received 23 November 2023

Received in revised form

19 January 2024

Accepted 13 February 2024

Available online 24 February 2024

Keywords:

Evidence-based practice

Knowledge translation

Diagnostic radiographer

Evidence-based radiography

ABSTRACT

Introduction: Evidence-based practice (EBP) is essential for ensuring the delivery of effective and efficient healthcare. Despite this, EBP is not always well implemented in the clinical environment. Evidence suggests that the application of EBP is likely impacted by healthcare workers' attitudes, knowledge and skills. While there has been a recent proliferation of international research examining diagnostic radiographers' attitudes towards, knowledge of and skills in EBP, no such research exists in an Australian context.

Methods: This study presents the results of a validated self-report survey, the evidence-based practice questionnaire (EBPQ), administered to Australian diagnostic radiographers. The data were described and aggregated means were calculated for each of the domains. Inferential statistical tests were computed, including Cronbach's alpha, Pearson's correlations and independent t-tests, and Kruskal-Wallis tests.

Results: The aggregated mean for the practice domain was 5.02 (SD 1.104), for the attitudes domain it was 5.41 (SD 1.169), and for the knowledge and skills domain, it was 5.20 (SD 1.177) on a seven-point scale. Significant associations were identified among these domains, with individuals holding higher qualifications and occupying leadership positions more likely to score higher. Additionally, the modality in which an individual primarily practiced appeared to also have an impact on their score. However, no significant correlation was found between any domain and the number of years an individual had been practicing.

Conclusion: This research has established a baseline of Australian diagnostic radiographers' practices, knowledge skills and attitudes towards evidence-based practice.

Implications for practice: This baseline can inform the development of interventions aimed at enhancing the role of evidence-based practice in the sampled population.

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Introduction

Evidence-based practice (EBP) is critical for ensuring optimal healthcare outcomes and has far-reaching implications, ranging from enhanced patient outcomes to improved organisational and economic efficiency. EBP is well established in disciplines such as medicine and nursing; however, its establishment in diagnostic radiography has not been fully investigated.^{1–3}

Existing evidence suggests that healthcare professionals equipped with the knowledge and skills required for EBP tend to exhibit more favourable attitudes towards its adoption and are more inclined to actively integrate evidence into their clinical practice.^{4,5} As

a result, there has been a recent international proliferation of research delving into various aspects of radiographers' practices, attitudes, knowledge and skills, all in pursuit of advancing EBP.^{6–11} These studies have shown substantial differences in the EBP tendencies among radiographers globally. The sources of such diversity are multifaceted, spanning from participants' educational backgrounds to the scope of radiographers' practice in specific geographic regions, and the broader professional culture prevailing within the studied populations. Nevertheless, these studies collectively serve as vital reference points for researchers seeking to improve EBP within their respective contexts. Within an Australian context, a recent study found that radiographers were more inclined to rely on clinical expertise than empirical evidence when making clinical decisions. Additionally, the study revealed a tendency among the diagnostic radiographers surveyed to presume historical techniques were evidence-based, despite a lack of supporting evidence.¹² Furthermore, diagnostic radiographers in Australia have been reported to exhibit limited enthusiasm for research, often marked by a lack of confidence and experience in this area.^{13,14} To

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the best of the authors' knowledge, no study to date has established a baseline for the practices, attitudes, knowledge and skills specific to Australian diagnostic radiographers.

Prior to embarking on any interventions aimed at enhancing EBP within the diagnostic radiography setting, it is imperative that we establish a baseline encompassing diagnostic radiographers' self-reported practices, attitudes, knowledge and skills. This baseline can identify the greatest deficit area, enabling targeted efforts to enhance EBP and assess their impacts. Therefore, the purpose of this study was to establish an EBP baseline for a population of Australian diagnostic radiographers.

Methods

Data collection

The Evidence-Based Practice Questionnaire (EBPQ)¹⁵ is a well-established survey tool. Originally developed for a nursing context and later adopted in allied health, the survey tool has been used extensively across various allied health disciplines, including diagnostic radiography, since its original publication in 2006.¹⁵ It was utilised in this research due to its formal validation and extensive use across allied health including previous use with diagnostic radiographers in the UK and Uganda.^{8,15,16} The test-retest reliability of the tool is reported between 0.8 and 0.92 depending on the subscale.¹⁵ The EBPQ has twenty-one items across three different domains: 1) practices, 2) attitudes, and 3) knowledge and skills. In addition to the EBPQ, demographic data were also collected. The EBPQ was utilised with the permission of the authors and was then scored according to the published scoring instructions.¹⁷ The practice and knowledge and skills domains were scored on 7-point Likert scales, while the attitudes domain was measured using semantic differentials, also on a 7-point scale.

Study design, sample characteristics and data collection

This study employed a cross-sectional design to sample the population of Australian diagnostic radiographers. The survey was open to all currently practicing, diagnostic radiographers in Australia who hold formal registration from the Medical Radiation Practice Board of Australia. Convenience sampling was utilised, and participants were recruited through various strategies. The survey details and online link were initially disseminated by the Australian Society of Medical Imaging and Radiation Therapy (ASMIRT) to all members via email. Additionally, information about the survey was made available at ASMIRT's annual conference in 2023, in a conference presentation and via Twitter (now X) utilising the conference hashtag. Recruitment information was distributed by the Medical Radiation Practice Board of Australia (MRPBA) in its quarterly newsletter and social media recruitment was utilised via Twitter (now X).

The survey was hosted on the online platform Qualtrics and was accessible between October 2022 and May 2023.

Ethical considerations

Ethical approval was sought and obtained from the Human Research Ethics Committee at the University of Sydney (2022/832). The surveys were completely anonymous and securely stored in a password protected research data repository at the University.

Statistical analysis

Statistical analysis was undertaken in SPSS (version 25). Descriptive statistics were applied to the demographic data to create

Table 1
Summary of inferential tests applied to data.

Predictor Variable	Type	Test
How long have you been practicing as a radiographer?	Continuous	Pearsons correlation
What is your highest level of qualification held?	Ordinal	Kruskal-Wallis test
Do you work in a public or private setting?	Binary	Independent t-test
In which modality do you predominantly practice?	Nominal	Kruskal-Wallis test
Do you hold a leadership position?	Binary	Independent t-test

a profile of respondents. Numerical summaries were calculated, and frequency tables were generated. Results from each of the three domains (practices, attitudes, and knowledge and skills) were aggregated to establish an overall mean. Cronbach's alpha was calculated to assess the reliability¹⁸ of each of the three different domains.

Inferential statistics were applied to explore associations between the demographic data and aggregated means as seen in Table 1 with non-parametric tests employed where the assumptions for parametric testing were not met. For this study, statistical significance was reported $P < 0.05$.

Results

Respondent characteristics

A total of 179 participants responded to the survey and after screening for completeness, 131 responses were subsequently analysed. Six responses were excluded as participants did not hold MRPBA registration and 42 responses were removed as the participants completed only the demographic data. Of 18,043 radiographers registered in Australia in March of 2023¹⁹ the 131 responses analysed represents a 0.73% response rate.

There was a diverse spread of responses ranging from newly qualified radiographers to radiographers with more than 20 years of experience (see Fig. 1). Additionally, the highest qualifications attained by respondents ranged from diploma/certificate through to PhD (see Fig. 2). A total of 53% respondents worked in a private setting, while 47% worked in a public setting. Among the respondents, the majority (43%) predominantly practiced in CT, followed by MRI (25%) and general radiography (17%). The remaining respondents primarily practiced in ultrasound, interventional or cardiac lab, mammography or PACS.

Descriptive results

The aggregated mean for the practice domain was 5.02, and a detailed breakdown of the practice domain may be found in Table 2. The aggregated mean for the attitudes domain was 5.41 and data relating to this can be found in Table 3. The aggregated mean for the knowledge and skills domain was 5.20 and the related data can be found in Table 4.

Inferential statistical analysis

The Cronbach's alpha showed good reliability for each domain with all alphas above 0.70 (Practice $p = 0.901$, attitudes $p = 0.746$ and, knowledge and skills $p = 0.959$). The Pearsons correlation displayed no significant correlation for time spent as a practicing radiographer and any of the aggregated means (Practice $p = 0.489$, attitudes $p = 0.762$ and, knowledge and skills $p = 0.452$). An independent samples t-test revealed no statistically significant

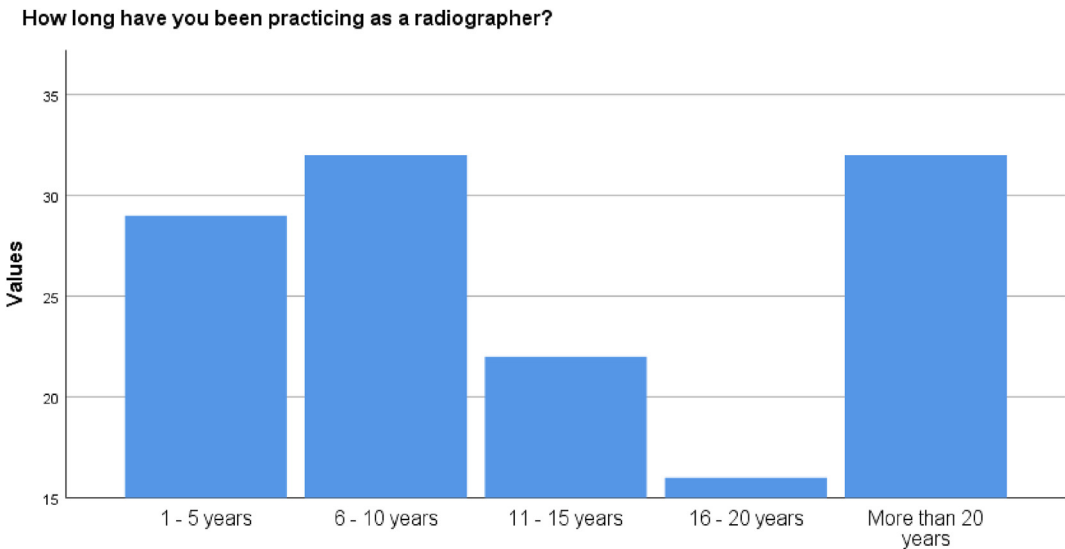


Fig. 1. Time spent as a practicing radiographer.

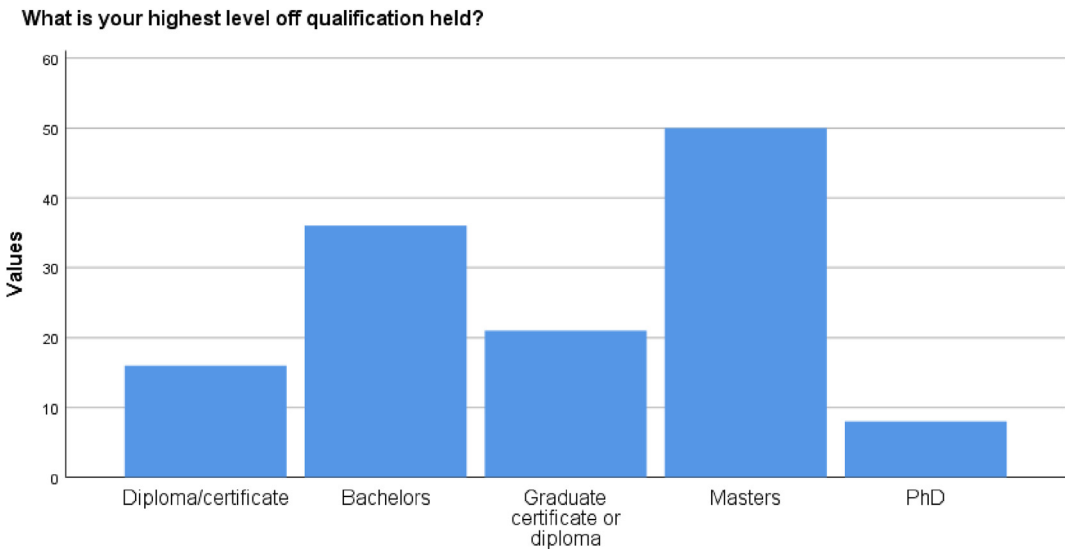


Fig. 2. Highest qualification of respondents.

Table 2
Results for practice domain.

Question	Minimum	Maximum	Mean	Std. Deviation
Aggregated mean – Practice domain	1	7	5.02	1.104
Integrated the evidence you have found with your expertise	1	7	5.21	1.212
Tracked down the relevant evidence once you have formulated the question	1	7	5.18	1.300
Evaluated the outcomes of your practice	1	7	5.13	1.279
Shared this information with colleagues	1	7	5.11	1.351
Formulated a clearly answerable question as the beginning of the process towards filling this gap	1	7	4.97	1.312
Critically appraised, against set criteria, any literature you may have discovered	1	7	4.53	1.590

Practice domain: Considering your practice in relation to an individual patient's care over the past year, how often have you done the following in response to a gap in your knowledge?

difference between whether participants worked in a public or private setting and the aggregated means for practices, attitudes, knowledge and skills. However, a statistically significant difference was observed for knowledge and skills (practice $p = 0.502$, attitudes $p = 0.153$, knowledge and skills $p = 0.040$).

An independent samples t-test showed a statistically significant difference between radiographers in leadership positions and those who do not hold a leadership position. This difference was observed across all three aggregated means (practice $p = 0.003$, attitudes $p = 0.016$, knowledge and skills $p = 0.000$). Individuals in

Table 3
Results for attitudes domain.

Question	Minimum	Maximum	Mean	Std. Deviation
Aggregated mean – Attitudes domain	1	7	5.41	1.169
Evidence based practice is a waste of time. : Evidence based practice is fundamental to professional practice.	1	7	5.96	1.546
I stick to tried and trusted methods rather than changing to anything new. : My practice has changed because of new evidence I have found.	1	7	5.47	1.332
I resent having my clinical practice questioned. : I welcome questions on my practice.	1	7	5.45	1.463
My workload is too great for me to keep up to date with all the new evidence. : New evidence is so important that I make time in my work schedule.	1	7	4.74	1.825

Attitudes domain: Please indicate where on the scale you would place yourself for each of the following pairs of statements.

Table 4
Results for knowledge and skills domain.

Question	Minimum	Maximum	Mean	Std. Deviation
Knowledge and skills	1	7	5.20	1.177
Ability to review your own practice	1	7	5.56	1.354
Sharing of ideas and information with colleagues	1	7	5.50	1.470
Ability to identify gaps in your professional practice	1	7	5.44	1.241
Ability to apply information to individual cases	1	7	5.39	1.268
Ability to determine how useful (clinically applicable) the material is	1	7	5.31	1.381
Knowledge of how to retrieve evidence	1	7	5.28	1.453
Awareness of major information types and sources	1	7	5.24	1.504
Dissemination of new ideas about care to colleagues	1	7	5.22	1.526
Ability to determine how valid (close to the truth) the material is	1	7	5.19	1.426
IT skills	1	7	5.17	1.479
Monitoring and reviewing of practice skills	1	7	5.13	1.389
Research skills	1	7	4.95	1.566
Ability to analyse critically evidence against set criteria	1	7	4.85	1.532
Converting your information needs into a research question	1	7	4.62	1.707

Knowledge and skills domain: On a scale of 1–7 (with 7 being the best) how would you rate your.

leadership roles demonstrated higher scores compared to those without leadership positions.

The Kruskal-Wallis test revealed that the highest level of qualification influenced the aggregated means (practice $p = 0.003$, attitudes $p = <0.001$ and knowledge and skills $p = <0.001$); those radiographers with higher qualifications were more likely to score highly than those with lower qualifications. The Kruskal-Wallis test also revealed that the aggregated means were influenced by the modality in which participants practiced (practice $p = 0.004$, attitudes $p = 0.036$, knowledge and skills $p = 0.001$); modality comparisons are displayed in Fig. 3.

Discussion

This study has shown that Australian diagnostic radiographers scored highest on the attitudes domain (5.41), indicating clear positive attitudes towards EBP. This positive trend is generally consistent among diagnostic radiographers internationally,^{7,9–11,20} with the exception of Ugandan radiographers.⁸ However, it is worth noting that within the attitudes domain there was one item that scored significantly lower (4.74) than the remaining three, “My workload is too great for me to keep up to date with all the new evidence.: New evidence is so important that I make time in my work

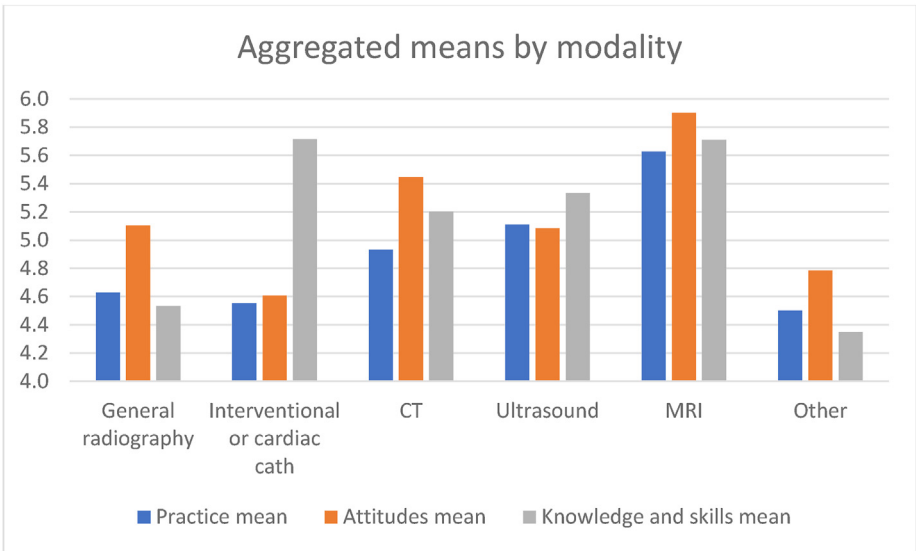


Fig. 3. Aggregated mean by primary modality.

schedule".¹⁷ This finding aligns with the results of Alakhra et al.⁷ who found that the primary barrier to EBP for Jordanian radiographers is time. Additionally, Chau et al.¹³ observed that time presents a substantial barrier for Australian radiographers when it comes to undertaking research.

Many have called for radiographers to be afforded more time to engage in EBP,^{7,13} and the results of this study also provide support for this change. However, we argue that the issue is more complex than simply a lack of time; it involves a lack of prioritisation among both clinicians and managers, resulting in a reduced application of evidence in practice. It has been reported that there is significant variability in the application of EBP within different imaging departments in Australia.²¹ Previous studies have described the workplace culture within medical imaging in Australia by measuring radiographers' productivity in terms of examinations performed,²² an attitude that is not conducive to the application of EBP. As a discipline, we need to reassess professional priorities, emphasising the significance of having up to date, evidence-based practitioners at the forefront of clinical practice, rather than merely focusing on staff that get the job done.

A multifaceted approach is required to address this issue. This includes providing individual practitioners with dedicated time during their workday for staying up to date.^{7,13} Additionally, these individuals must receive adequate training in the skills required for evidence-based practice.²³ Furthermore, priority should be given to incentivising radiographer-led research, including training, funding, and progression opportunities. This approach ensures that research addresses the questions most pertinent to radiographers.²⁴ By implementing these strategies, we can begin to positively impact the research culture within our discipline.

In the UK, radiographers have not perceived that the research culture in their departments is strong.²⁰ Evidence from other disciplines suggests there is significant correlation between an individual's beliefs, their perception of their organisation's culture towards EBP and the extent to which they can implement evidence into their daily practice.²⁵ Developing the culture of organisations and more broadly the profession towards EBP is essential to enhance its application in clinical practice.

A significant positive relationship between higher scores in practices and knowledge and skills and individuals in leadership positions was observed, though interestingly this relationship was not statistically significant for the attitudes domain. It is crucial to ensure that these leaders are not only prepared with the skills required to apply EBP but also selected for their attitudes and enthusiasm to foster positive cultures within their departments to ensure that EBP may flourish. Medical imaging departments with positive EBP cultures have a competitive advantage compared with those with less supportive cultures, as previously reported.²¹

Despite broadly positive attitudes amongst all participants, the practice domain received the lowest score of any domain in the survey (5.02). It has previously been argued that it is imperative for our profession to find ways to leverage these positive attitudes in order to effectively translate our knowledge and skills to more efficiently apply EBP.³ Departmental strategies such as journal clubs, regular CPD presentations, and meetings focused on applying research to practice have been observed as positive strategies in enhancing this culture.²¹

Importantly, positive attitudes and confidence in EBP skills have been shown to be determinants of future EBP application.²⁶ Whilst respondents, on average, scored well in both knowledge and skills and attitudes, there is clearly lower confidence when it comes to the areas of critical appraisal and turning clinical queries into answerable research questions. This lack of confidence was consistent in both the knowledge and skills domain and the practices domain, which is consistent with what has been found among

radiographers internationally.^{7,9,10} Further training and international collaboration for both workforce and future graduates are required in this area to ensure evidence-based practice skills are taught effectively.²³

Limitations

Although this study was distributed to all currently practicing Australian radiographers via the MRPBA newsletter, the response rate was relatively low (0.73%). This low response rate makes it more challenging to make broad assumptions about the population of Australian diagnostic radiographers. Additionally, as with any research using surveys, there is the potential for non-response bias to limit the results,²⁷ as those who are more inclined toward evidence-based practice may have been more likely to participate in the survey. Nonetheless, the sampling strategy used was random with all Australian radiographers having equal opportunity to complete the survey and data collected indicates a good spread of participants across all demographic categories measured. This survey demonstrates a good baseline from which to assess future potential changes to Australian diagnostic radiographers' practices, knowledge, skills and attitudes towards evidence-based practice. It also makes important contributions to understanding potential factors that impact the practices, knowledge and skills and attitudes towards evidence-based practice of diagnostic radiographers.

Conclusion

This research has established a baseline of the practices in, attitudes towards, knowledge and skills of evidence-based practice in diagnostic radiography in Australia. This baseline informs future efforts to enhance evidence-based practice within the profession. Additionally, it can serve as a reference for evaluating these efforts through potential comparisons to the reported data. All three domains returned high scores, although individual items, such as critical analysis skills and the ability to turn clinical queries into answerable research questions, show potential areas for focus and improvement. Targeted strategies may be developed for both current and future diagnostic radiographers to ensure the workforce possesses the necessary skills to effectively adopt EBP. Developing these skills amongst students and the current workforce would be beneficial to explore in future research. In tracking the progress towards enhancing evidence-based practice, this research's reported baseline can serve as a crucial reference, delivering benefits not only to our profession but also the well-being of our patients.

Conflict of interest statement

None.

Acknowledgements

The authors acknowledge the statistical consultation provided by the Sydney Informatics Hub, a Core Research Facility of the University of Sydney and in particular Alexandra Green for her guidance.

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

References

1. Ahonen S-M, Liikanen E. Radiographers' preconditions for evidence-based radiography. *Radiography* 2010;**16**:217–22. <https://doi.org/10.1016/j.radi.2010.01.005>.

2. Hafslund B, Clare J, Graverholt B, Wammen Nortvedt M. Evidence-based radiography. *Radiography (London, England. 1995)* 2008;**14**:343–8. <https://doi.org/10.1016/j.radi.2008.01.003>.
3. Di Michele L, Thomson K, McEntee MF, Kenny B, Reed W. Knowledge translation: radiographers compared to other healthcare professionals. *Radiography (London, England. 1995)* 2020;**26**:S27–32. <https://doi.org/10.1016/j.radi.2020.06.007>.
4. Bridges PH, Bierema LL, Valentine T. The propensity to adopt evidence-based practice among physical therapists. *BMC Health Serv Res* 2007;**7**:103. <https://doi.org/10.1186/1472-6963-7-103>.
5. Estabrooks CA, Floyd JA, Scott-Findlay S, O'Leary KA, Gushta M. Individual determinants of research utilization: a systematic review. *J Adv Nurs* 2003;**43**: 506–20. <https://doi.org/10.1046/j.1365-2648.2003.02748.x>.
6. Abrantes AFCL, et al. Evidence-based radiography: a new methodology or the systematisation of an old practice? *Radiography* 2020;**26**:127–32. <https://doi.org/10.1016/j.radi.2019.09.010>.
7. Alakhras M, Al-Mousa DS, Al Mohammad B, Spuur KM. Knowledge, attitude, understanding and implementation of evidence-based practice among Jordanian radiographers. *Radiography* 2023;**29**:760–6. <https://doi.org/10.1016/j.radi.2023.05.007>.
8. Nalweyiso DI, Kabanda J, Mubuuke AG, Sanderson K, Nyanzi LA. Knowledge, attitudes and practices towards evidence based practice: a survey amongst radiographers. *Radiography* 2019;**25**:327–32. <https://doi.org/10.1016/j.radi.2019.03.004>.
9. Kyei K, Antwi W, Suapim J. Evidence-based practice in radiography: attitudes, beliefs, knowledge and practices of radiographers in Ghana. *OMICS J Radiol* 2015;**4**:2.
10. de Almeida RPP, da Silva CA, Gama ZAdS. Framework for health care quality and evidence-based practice in radiology departments: a regional study on radiographer's perceptions. *J Med Imag Radiat Sci* 2022;**53**:648–58. <https://doi.org/10.1016/j.jmir.2022.09.006>.
11. Moran K, Davis C-A. Pan-Canadian survey of medical radiation technologist's views toward evidence-based practice, research, barriers, and enablers. *J Med Imag Radiat Sci* 2020;**51**:29–39. <https://doi.org/10.1016/j.jmir.2019.11.141>.
12. Rawle M, Pighills A, Mendez D, Dobeli K. Radiographic technique modification and evidence-based practice: a qualitative study. *J Med Radiat Sci* 2023;**70**: 56–63. <https://doi.org/10.1002/jmrs.616>.
13. Chau M, Brown E, Beldham-Collins R, Anderson N. Research demographics of Australian medical radiation practitioners. *J Med Imag Radiat Sci* 2022;**53**: 591–8. <https://doi.org/10.1016/j.jmir.2022.07.009>.
14. Dennett AM, et al. Research interest, experience and confidence of allied health professionals working in medical imaging: a cross-sectional survey. *J Med Radiat Sci* 2021;**68**:121–30. <https://doi.org/10.1002/jmrs.432>.
15. Upton D, Upton P. Knowledge and use of evidence-based practice by allied health and health science professionals in the United Kingdom. *J Allied Health* 2006;**35**:127–33.
16. Upton P, Scurlock-Evans L, Stephens D, Upton D. The adoption and implementation of evidence-based practice (EBP) among allied health professions. *Int J Ther Rehabil* 2012;**19**:497–503. <https://doi.org/10.12968/ijtr.2012.19.9.497>.
17. Upton D, Upton P. Evidence-based practice questionnaire [ND]), <https://ebpq.co.uk>.
18. Tavakol M, Dennick R. Making sense of Cronbach's alpha. *Int J Med Educ* 2011;**2**:53–5. <https://doi.org/10.5116/ijme.4dfb.8dfd>.
19. MRPBA. Registration data table - 31 March 2023. 2023.
20. Watts H, Snaith B. Evidence based practice, research and the diagnostic radiographer role. An exploration of engagement, expectations and attitudes at a single centre. *Radiography* 2023;**29**:124–30. <https://doi.org/10.1016/j.radi.2022.10.014>.
21. Di Michele L, Bell A, Thomson K, McEntee M, Kenny B, Reed W. Student radiographers' perceptions of evidence-based practice during clinical placements: implications for health professional education. *International Journal of Work-Integrated Learning* 2023;**24**:553–66.
22. Lewis S, Heard R, Robinson J, White K, Poulos A. The ethical commitment of Australian radiographers: does medical dominance create an influence? *Radiography* 2008;**14**:90–7. <https://doi.org/10.1016/j.radi.2007.01.004>.
23. Di Michele L, Thomson K, Bell A, Reed W. Educating for the future: bookending evidence-based practice. *Radiography* 2023;**29**:958–60. <https://doi.org/10.1016/j.radi.2023.07.007>.
24. Munn Z. *Why isn't there an evidence-based radiography? Reflections and a call to action*. 26. London, England: Radiography; 2020S14–6. <https://doi.org/10.1016/j.radi.2020.05.005>. 1995.
25. Melnyk BM, Fineout-Overholt E, Giggelman M, Cruz R. Correlates among cognitive beliefs, EBP implementation, organizational culture, cohesion and job satisfaction in evidence-based practice mentors from a community hospital system. *Nurs Outlook* 2010;**58**:301–8. <https://doi.org/10.1016/j.outlook.2010.06.002>.
26. Amit-Aharon A, Melnikov S, Warshawski S. The effect of evidence-based practice perception, information literacy self-efficacy, and academic motivation on nursing students' future implementation of evidence-based practice. *J Prof Nurs* 2020;**36**:497–502. <https://doi.org/10.1016/j.profnurs.2020.04.001>.
27. Berg N. *Non-response bias*. 2005.

Practical recommendations

The preceding paper presented the findings of a national survey of diagnostic radiographers, examining their knowledge and skills, practices and attitudes towards evidence-based practice. Importantly, it provides a baseline of evidence-based practice among Australian diagnostic radiographers which can be utilised to inform attempts to improve in the future. I propose the following practical recommendations based on the findings of my study which aim to improve the application of evidence-based practice among practicing diagnostic radiographers.

- **Professional bodies** should ensure that continuing professional development opportunities strategically target the steps of evidence-based practice in which radiographers feel least confident, namely, converting their information needs into answerable questions, critical appraisal, and research skills.
- **Organisations** should visibly and actively prioritise evidence-based practice to enhance culture. To do this, they must ensure that it is prioritised during recruitment and in performance reviews, and that staff are supported to engage in the process by ensuring they have adequate time and resourcing to do so.
- **Organisations** should prioritise strong positive attitudes towards evidence-based practice in their recruitment of leaders.

The next and concluding chapter of this thesis is the *Discussion*. In this chapter I synthesise the research from my previous chapters and present the key findings and practical recommendations arising from my thesis.

Chapter 7: Discussion

7.1 Introduction

This thesis advocates for change within diagnostic radiography in Australia. Enhancing the application of evidence-based practice in diagnostic radiography holds the potential for significant improvements across various levels: individual, organisational, and professional. By adopting evidence-based practices more effectively, diagnostic radiographers can contribute to solving broader challenges within healthcare.

At an individual practitioner level, the application of evidence-based practice has demonstrated significant benefits. It has consistently been associated with positive outcomes such as increased self-efficacy, job satisfaction and the creation of a more cohesive group environment amongst colleagues (Duangjinda, 2004; Harding et al., 2017; Melnyk, Fineout-Overholt, Gigglesman, et al., 2010). In due course, these attitudes and feelings of confidence then translate into better application of evidence in practice (Abrahamson et al., 2012).

Amidst a context of worldwide radiographer shortages (Nightingale et al., 2023) and increasing professional demands (Francis Health, 2018), enhancing job satisfaction among individual practitioners becomes increasingly crucial. A recent study of burnout rates among medical imaging professionals in Australia found that radiographers experience lower personal achievement scores compared to sonographers and radiologists, and the authors suggested that this may be explained by the lower level of professional autonomy experienced by radiographers (Singh et al., 2017).

As discussed in [Chapter 1](#), professional autonomy among Australian diagnostic radiographers is a known challenge. I propose that increasing the application of evidence-based practice at an individual level could enhance feelings of autonomy and job satisfaction, factors that are significantly correlated with a reduction in staff burnout and increased retention rates of skilled staff, in line with findings from other disciplines (Harding et al., 2017; Melnyk, Fineout-Overholt, Gigglesman, et al., 2010).

When examining organisations, the benefits of implementing evidence-based practices are compelling. Research indicates that such practices have the potential to improve productivity and efficiency, increase staff satisfaction and retention and provide positive financial outcomes (Harding et al., 2017). A recent scoping review assessing the return on investment for evidence-based practice initiatives found that 94% of the articles reported positive returns on investment, and none reported negative outcomes (Connor et al., 2023). Furthermore, patient outcomes are improved with the effective application of evidence-based practice, for example, reduced mortality, decreased

readmissions and length of stay, and increased compliance, among other benefits (Connor et al., 2023; Melnyk & Fineout-Overholt, 2015).

The benefits experienced by individual practitioners and organisations through the adoption of evidence-based practice have a flow on effect to the profession of diagnostic radiography more broadly. Enhancing the application of evidence-based practice will assist in professionalisation, role advancement, and retention of high achieving professionals.

Systematically applying evidence-based practice and taking ownership of our evidence-base are pivotal steps towards enhancing professionalisation. By doing so, diagnostic radiographers can uphold high standards of practice, thereby better serving society and effectively meeting the evolving healthcare needs of the population we serve.

Throughout this work, I have thoroughly examined the intersections of education and culture within our discipline. This final chapter serves to illuminate the path forward by synthesising the findings from previous chapters and situating them within the broader literature. Below I outline the key findings of my research. Although these key findings are presented separately, it's worth noting that each of these concepts is deeply intertwined. I argue that:

1. The widespread adoption of a seven-step model is crucial for advancing evidence-based practice in diagnostic radiography.
2. The quality of students' experiences during work integrated learning placements profoundly influences their readiness for evidence-based practice.
3. Education alone is insufficient without concurrent efforts to address cultural challenges.
4. Cultural factors within clinical settings are pivotal in shaping the implementation of evidence-based practice.
5. Diagnostic radiographers must actively engage in and contribute to building their evidence base.
6. Engaging with knowledge translation and implementation science literature offers practical avenues for advancing evidence-based practice.

I will discuss these six findings, examining their implications for the future of diagnostic radiography. I will also explore the limitations of this thesis and propose directions for future studies that could further enrich our understanding and practice. Before concluding, I will provide practical recommendations for the Medical Radiation Practice Board of Australia, Australian federal, state and territory governments, diagnostic radiography departments and practices, and universities, aimed at

facilitating the enhanced application of evidence-based practice within diagnostic radiography. These practical recommendations will serve as actionable steps to pave the way forward for our discipline.

7.2 Key findings

7.2.1 The widespread adoption of a seven-step model is crucial for advancing evidence-based practice in diagnostic radiography

In [Chapter 1](#), I outlined the use of an expanded model of evidence-based practice that builds on the original frameworks proposed by Dawes et al. (2005) and Melnyk, Fineout-Overholt, Stillwell, et al. (2010) and utilises nomenclature consistent with implementation science. This model has not only provided a theoretical foundation for my research but also holds broader utility for the field of diagnostic radiography. I argue that this model should be widely adopted within diagnostic radiography for use in education, strategic planning and policy development.

The model extends the traditionally accepted Sicily statement (Dawes et al., 2005) by adding additional steps that are particularly relevant to the diagnostic radiography context. These additional steps enhance the applicability and comprehensiveness of the model, ensuring it addresses the challenges and needs of our discipline. This concept is further explored in an invited editorial included as [Appendix 1](#), where I discuss the implications and potential benefits of adopting this seven-step model across the field of diagnostic radiography (Di Michele et al., 2023).

While the best available guidance on teaching evidence-based practice in diagnostic radiography, the European Federation of Radiographer Societies' Statement on the Implementation of Evidence-Based Practice in Undergraduate Curricula (EFRS, 2015), drew on the Sicily statement, I argue that that the seven-step model of evidence-based practice provides a more comprehensive foundation for the implementation of evidence-based practice within radiography curricula and is relevant for use by professional bodies.

The first step of the Melnyk, Fineout-Overholt, Stillwell, et al. (2010) seven-step model is "Cultivate a spirit of enquiry". By explicitly including this step in the cycle, the model highlights the critical importance of lifelong learning as an inherent requirement for evidence-based practice. Lifelong learners are by nature more open to challenging and changing established practices. During my narrative review in [Chapter 3](#), I highlighted the tendency of diagnostic radiographers to adhere to legacy practices, even when presented with contrary evidence (AHE, 2018; ASRT, 2019; McEntee & Kinsella, 2010). However, if we can instil a spirit of enquiry within our profession, making it the norm, rather than the exception, we stand to reap the substantial benefits outlined in [Section 7.1](#).

In [Chapter 4](#), I drew attention to the importance of education as the foundation for establishing this spirit of enquiry and for providing student radiographers with the skills to both challenge current knowledge and have their own knowledge challenged. It is imperative that we set radiographers up with the skills required to be able to do this, as literature indicates that practitioners who are confident in the skills required for evidence-based practice are more likely to implement this in practice (Thomas & Bussi res, 2021). However, in our survey of Australian radiographers (presented in [Chapter 6](#)), it was clear that participants lacked confidence in their ability to convert their information needs into answerable questions, and in their critical appraisal and research skills. Hence, cultivating a spirit of enquiry early in radiographers (while they are still students) and ensuring this is sustained, is essential.

At the other end of the cycle, the importance of dissemination is emphasised in the seven-step model (Melnyk, Fineout-Overholt, Stillwell, et al., 2010). Effective dissemination practices offer several benefits to the profession. Firstly, when more practitioners report on their innovations and knowledge translation efforts, it enhances the evidence base of the profession, ensuring that the clinical questions posed by diagnostic radiographers are addressed. Dissemination strategies that are accessible and meet the needs of diagnostic radiographers such as podcasts, social media and or radiography specific EBP platforms could be considered and their effectiveness assessed. These innovations may then be adapted and adopted by other diagnostic radiographers, facilitating ongoing improvement. Furthermore, and in line with my practical recommendations arising from [Chapter 6](#), active dissemination helps normalise evidence-based practice within the profession, fostering a culture that embraces continuous improvement and critical evaluation. This cultural shift towards evidence-based practice, can lead to higher standards, better patient outcomes, and a more cohesive and informed professional community (see [Section 7.2.5](#) for details).

7.2.2 The quality of students' experiences during work integrated learning placements profoundly influences their readiness for evidence-based practice

As discussed in [Chapter 4](#), there is substantial evidence to suggest that the foundations for creating a culture of evidence-based practice start at university (Amit-Aharon et al., 2020; Fineout-Overholt et al., 2010; Kalb et al., 2015). Further, we know that effective pedagogy for teaching evidence-based practice should involve clinically integrated curricula (Nielsen et al., 2024; Young et al., 2014). Therefore, the experiences of students during their work integrated learning placements and the attitudes of their clinical educators are likely to significantly impact on their perceptions of evidence-based practice. This finding was highlighted by student participant experiences in both [Chapter 4](#) and [Chapter 5](#).

Student participants in [Chapter 4](#) indicated that they felt their ability to implement evidence-based practice while on placement was affected by the clinical site's culture. When this site did not have a strong evidence-based practice culture, participants felt poorly prepared for practicing as clinicians. Consequently, one of the [practical recommendations](#) of Chapter 4 was that universities should proactively partner with clinical sites that have strong evidence-based practice cultures.

This recommendation of proactive partnership is challenging to enact. Firstly, these must be tailored to meet the specific needs of both parties and should include conducting a cultural assessment and facilitating cultural change, which is complex. It may be that using validated survey tools offers an approach for exploring evidence-based practice culture within workplaces, (Landsverk et al., 2023) however, such an approach assumes that clinical sites and educators are able to engage in the process. Whilst auditing clinical placement sites is common both within Australia and internationally in terms of placement quality, this does not typically include an assessment of the evidence-based culture of a clinical site (England et al., 2017; MRPBA, 2019). In line with the findings [of Chapter 4](#) and [Chapter 5](#), within the Australian diagnostic radiography education context, there is significant variation across clinical sites and educators, with some having greater capacity to offer placement experiences that model evidence-based practice.

So then, how can we improve the evidence-based experiences of students while on work integrated learning placements? Given that Oliveira et al. (2024) found that the second most common barrier to completing research among both diagnostic and therapeutic radiographers was the lack of a mentor, perhaps my practical recommendation of building meaningful collaborations between clinical sites and academic institutions in [Chapter 5](#) is the answer. These collaborations would be mutually beneficial, allowing university academics the opportunity to mentor diagnostic radiographers and professional leaders in evidence-based practice application and research, thus, building skill capacity in these areas at clinical sites. This in turn would benefit their students whilst assisting in building research and evidence-based practice capacity more broadly in the discipline, a concept that I will further discuss in [Section 7.2.5](#).

7.2.3 Education alone is insufficient without concurrent efforts to address cultural challenges

When I set out to undertake this PhD, I truly believed that education was the key and that if we could simply train radiography students to be competent and confident in the skills required to implement evidence-based practice, it would be a fait accompli. Along this journey, my perspective shifted. Education, particularly as it pertains to pre-registration clinicians, is important, but perhaps it is not the magical key that I once thought it was. Maybe instead, education is simply one piece of the puzzle,

and it can only achieve so much because once students graduate, their time with us ends and they enter the workforce.

The fears of participants relating to their own application of evidence-based practices when working in an unsupportive culture are real (see [Chapter 4](#)). As one focus group participant described, “you’re all like a sponge at the moment, you will take on the characteristics of your environment”. These student radiographers were fearful for their futures. Despite their staunchly positive attitudes towards evidence-based practice, they felt disempowered to apply the practices that they believed in so strongly. This fear is well-founded; evidence from other allied health disciplines suggests that allied health professionals lose confidence in their skills for evidence-based practice within five years of graduation (Klaic et al., 2019). As with any skill, it’s retention is contingent on practice.

So then, what happens to our graduates as they enter the workforce and why doesn’t our training stand the test of time? Perhaps, like our student participants in [Chapter 4](#) and [Chapter 5](#), these newer, often more impressionable colleagues experience a workplace culture that is not conducive to applying evidence-based practice. As explored in [Chapter 4](#), we know that new graduates are one of two primary groups that are more likely to apply evidence during clinical practice, with the other being senior clinicians that have experience with research (Ahonen & Liikanen, 2010). In my publication and [practical recommendations](#) arising from Chapter 4, I suggest that evidence-based practice mentorship of new graduates by senior radiographers and those who are involved in research should be considered as a strategy to help avoid the documented slump in evidence-based practice arising in the first few years after graduation. Practical recommendations to improve disciplinary culture can be found in [Section 7.5](#).

7.2.4 Cultural factors within clinical settings are pivotal in shaping the implementation of evidence-based practice

Amidst the context of medical dominance and subordination as discussed in [Section 1.6](#) and further explored in [Chapter 3](#) we must be intentional about the way in which professional culture is shaped. Individuals’ ability and desire to apply evidence-based practice are influenced by the organisations in which they practice. In [Chapter 4](#) and [Chapter 5](#), I discuss student participants’ observations that the organisational culture during their work integrated learning placements affected their ability to implement evidence in practice, a finding supported by the literature (Harding et al., 2017). Organisations that do not prioritise evidence-based practice often experience slowed translation of evidence-based practices (Harding et al., 2014). Conversely, in organisations with positive evidence-based practice culture, individual practitioners are more likely to have positive attitudes towards evidence-based practice (Melnik, Fineout-Overholt, Giggelman, et al., 2010). This raises an intriguing

question: do individuals with positive attitudes create strong cultures, or do organisations with strong cultures attract evidence-based individuals? It is likely both.

Both organisational and professional leaders have a significant role to play. In [Chapter 6](#) I found that those in leadership positions within diagnostic radiography were no more likely to hold positive attitudes towards evidence-based practice than other radiographers. One [practical recommendation](#) from Chapter 6 was that leaders within diagnostic radiography must have strong positive attitudes towards evidence-based practice to effectively lead evidence-based organisations. Therefore, an attitudes assessment could be included in the selection criteria for formal leadership positions. As Melnyk (2023) describes, “Leaders and managers are key in building EBP cultures and infrastructures to support EBP” (p. 4). For leaders to effectively foster evidence-based cultures and empower radiographers, they must actively facilitate the creation of supportive structures, invest time, and allocate resources (McNulty, 2018). Strategies for leaders looking to implement this within their own departments may be found in Section 7.5 [Practical Recommendations](#).

Furthermore, the cultures shaped by organisational leaders have implications beyond their clinical departments. In [Chapter 4](#) and [Chapter 5](#) I highlight the importance of students’ work integrated learning placement experiences on their ability to learn and implement evidence-based practice both during placements and into the future. These placement experiences fundamentally shape our future diagnostic radiographers and the cultures of the sites in which they are placed play a major role. The impact of professional culture is intergenerational.

In order to improve our professional culture, I propose a pragmatic strategy for enhancing evidence-based practice culture within diagnostic radiography, outlined in an invited editorial included as [Appendix 2](#) (Di Michele et al., 2024). I advocate for a coordinated strategic effort that enables radiographers to take ownership of our evidence base, a concept that I will discuss in detail in [section 7.2.5](#). This strategy must include visible prioritisation of evidence-based practice; including in recruitment, training and career progression pathways for individuals interested in pursuing research and/or education. Additionally, offering evidence-based practice mentorships may be of benefit, as effective role modelling and mentorships have positive effects in other health professions (Melnik, Fineout-Overholt, Giggelman, et al., 2010; Melnyk et al., 2021; Neep, 2021; Ward et al., 2017).

7.2.5 Diagnostic radiographers must actively engage in and contribute to building their evidence base

For diagnostic radiographers to fully professionalise and adopt evidence-based practice effectively, it is crucial to shift away from our traditional role as consumers of research (Higgins et al., 2015). This shift involves taking ownership of our evidence base and establishing a research culture within the

discipline (Di Michele et al., 2024; Mdletshe, 2023; Nightingale, 2016). Historically, radiographers have relied heavily on evidence generated by other professions (as discussed in my editorial included as [Appendix 1](#)). Whilst this external research is important, it is imperative for radiographers to develop their own evidence base for two key reasons (McNulty, 2018; Nightingale, 2016). Firstly, by conducting research, radiographers ensure that the clinical questions relevant to our practice are being rigorously addressed. Secondly, developing research capacity among radiographers strengthens our profession from within, fostering a culture of enquiry and innovation.

Radiographers' clinical challenges can be unique to the profession and are often overlooked by researchers. Rawle and colleagues (2023) note that practice change within diagnostic radiography is often driven by technological advancement. However as observed by Munn and colleagues (2020), these advancements do not always translate to improvements in patient care. Given the rapid pace of technological evolution in our discipline, it is imperative that research keeps pace to ensure our techniques and clinical practices are based in robust evidence. Further compounding this challenge, is the misconception among many radiographers that historical techniques are based in evidence, when often, they are not (Rawle et al., 2023). Engaging in research allows radiographers to address their own questions directly, and generate relevant evidence, that can then be effectively implemented in practice.

In [Chapter 1](#), I highlighted that despite the growth of formal postgraduate research education in the radiation sciences over the last thirty years, there remains limited interest in research and formal postgraduate training among clinical diagnostic radiographers both in Australia and in other international contexts (Chau et al., 2022; McNulty et al., 2016; Oliveira et al., 2024). Radiographers exhibit low levels of confidence and limited experience in research (Dennett et al., 2021).

Given the inherent intertwining of research skills with evidence-based practice, particularly in the early stages of the cycle, enhancing research proficiency within the profession is crucial to enhancing implementation of evidence-based practices. Both [Chapter 4](#) and [Chapter 5](#) highlight the importance of partnerships between clinical sites and universities. By fostering these collaborations, we can establish research alliances that ensure clinical questions drive our research endeavours. Moreover, clinicians can benefit from mentorship from experienced researchers to develop their own research capabilities (Neep, 2021; Ward et al., 2017).

This research engagement as a profession may well be cyclical, enhancing our discipline's spirit of enquiry (Melnyk, Fineout-Overholt, Stillwell, et al., 2010). If we have more radiographers engaging in research, as a discipline, we develop research capacity and the skills required to implement evidence-

based practice within the workforce. This results in more research being implemented in practice, and the evaluation of this research then leads to additional avenues of research.

7.2.6 Engaging with knowledge translation and implementation science offers practice avenues for advancing evidence-based practice

When translating evidence into clinical practice in diagnostic radiography it stands to reason to turn to a field specifically designed to address this challenge effectively. Implementation science is defined as “the scientific study of methods to promote the systematic uptake of research findings and other evidence-based practices into routine practice” (Eccles & Mittman, 2006, p. 1). Implementation science provides guidance on evidence-based approaches to applying research findings in practice. Implementation science also offers validated mechanisms for achieving practice change, particularly when it comes to the implementation step of the evidence-based practice cycle. In [Chapter 3](#), I acknowledge the complexity of implementation science and knowledge translation, while offering practical guidance as to how various models, frameworks, and theories may be applied within diagnostic radiography. It is not only crucial for our discipline to use these insights to drive practice improvements but also to contribute to this knowledge base. By generating implementation literature specific to diagnostic radiography and its challenges, we can advance our discipline’s evolving needs.

To actively engage in and contribute to implementation science as a discipline effectively, we need to ensure that our workforce and future radiographers are sufficiently trained in knowledge translation skills. One of the key aspects of my educational intervention (evaluated in [Chapter 5](#)) was specific training on implementation science. By ensuring that radiographers have the skills to translate the knowledge they have in clinical settings, we ensure that evidence-based practices have the best opportunity to establish themselves and become standard. In the words of one of my participants “I can see the advantages, because thinking through and developing your implementation plan, I think it would help enhance your capabilities for leadership in the future.”.

In a healthcare system constrained by limited resources, we need to ensure that leaders are equipped with the skills required to implement evidence-based practices successfully. Choosing effective implementation measures is important as it increases the chances of success and optimises strategic resource allocation (Bauer et al., 2015). By operationalising implementation science to inform practice changes, we can significantly enhance the application of evidence-based practice within diagnostic radiography.

7.3 Limitations

Within my studies there were practical and methodological limitations that impacted on my results and conclusions. In this section I will outline these limitations and go on to discuss potential avenues

for future research. Despite the importance of patient perspectives in evidence-based practice, the studies described in this thesis were unable to capture the complexity of patient preferences. I acknowledge that the research pertaining to student education, presented in [Chapter 4](#) and [Chapter 5](#) was limited to a single institution. Despite this, care was taken to ensure diversity among participants, particularly in reference to gender, culture and placement experiences. Whilst the findings of these studies are important, the context must be considered when examining the transferability of these findings to different contexts. Similar studies could be undertaken at a range of institutions both within Australia and internationally to better understand the broader context and identify similarities and differences among settings.

During the focus group data collection for [Chapter 4](#), there were individual participants with strong views who advocated for the importance of empirical data in the application of evidence-based practice. I acknowledge that we likely would have seen different results were this data collected utilising individual interviews. Social desirability is an important influencing factor within focus groups (Smithson, 2000). Given my epistemological stance, I view the social construction of knowledge as paramount, and therefore did not seek to control this aspect as a researcher. Rather, I observed this, ensuring that all participants had an opportunity to be heard and their views respected, and reported on this concept in the resulting paper to ensure that this factor was understood by my readers.

In my study presented in [Chapter 5](#), my statistical analysis of the quantitative data was limited by the design choice not to pair data in the pre and post intervention surveys. This decision was initially made to ensure anonymity of responses for participants, however a consequence was that a greater sample size was required to show an effect. Due to the small cohort of students who were exposed to the intervention, despite a relatively good response rate, the analysis was underpowered to find anything below a very large effect size. Large effect sizes are uncommon in health profession education research so despite a lack of statistical significance, I'm cautious about accepting a null hypothesis (Cook & Hatala, 2015). To mitigate this challenge in future research, similar studies could consider linking pre and post data in a way that maintains and ensures anonymity, incentivising participation, or running the study over multiple years to increase the pool of potential participants. In [Chapter 6](#) I surveyed Australian diagnostic radiographers and unfortunately had a low response rate (0.73%). Whilst pragmatically this was enough from which to draw statistical inferences, a higher response rate would have been preferred. Non-response bias is a real possibility affecting the results of this study, particularly given the nature of the subject (Berg, 2005a). Again, incentivising participation may have been helpful in this study to further assist in increasing the response rate.

7.4 Future research

As discussed in [Chapter 1](#), within the Australian context, career progression pathways are variable depending on a radiographer's geographical location. It would be beneficial to the profession to understand the effect of these differences, in order to implement best practice, and target resources at the most effective strategies. Further comparative research between state-based jurisdictions within Australia, and international comparative research would be useful to understand both the cultural differences within these contexts and the pragmatic implications of these differences. This research could be utilised to inform policy discussion relating to funding allocation for radiographers' award pathways, in turn addressing issues of radiographer satisfaction and professional retention. Furthermore, promoting formal educational pathways for radiographers in all jurisdictions will likely positively impact radiography students' placement experiences.

In [Chapter 4](#) and [Chapter 5](#), I found that students' experiences during their clinical placements have a meaningful impact on their experiences of learning about and applying evidence-based practice during their formal education. To extend this research further, longitudinal studies of this impact would be useful in determining whether this effect is ongoing and how these experiences during their formative year impact their ability to implement evidence-based practice in their clinical careers. This research would assist in helping to place an appropriate priority level on student education as an intervention as opposed to advancements at a professional level.

At the professional level, it would be beneficial to better understand the barriers and enablers to implementing evidence-based practice for diagnostic radiographers working clinically in a range of settings. Understanding the common barriers will help us to develop strategies to mitigate these, leveraging literature from implementation science to do so. Likewise, understanding the factors that enable implementation in clinical site based interventions is also important in order for these factors to be not only supported, but promoted. These areas of further research serve as examples of how and where the literature within the field could be advanced to help improve the implementation of evidence-based practices within diagnostic radiography.

7.5 Practical recommendations

Taking into consideration practical recommendations in Chapters 3 – 6, as well as the overall findings of the thesis, I have developed an overarching set of practical recommendations aimed at enhancing the implementation of evidence-based practice in diagnostic radiography. I therefore recommend that:

- The **Medical Radiation Practice Board of Australia** should explicitly require radiographers to engage with “evaluation” and “dissemination” within Domain 4 of the Professional Capabilities for Medical Radiation Practice (MRPBA, 2020).
- The **Australian government** should significantly reform funding models within medical radiation practice. Current funding models contribute to professional subordination of radiographers and subsequent apathy among practitioners.
- **State and territory governments** within Australia should reform professional awards to ensure career progression pathways for both education and research focused diagnostic radiographers are incentivised.
- **Diagnostic radiography departments and private practices** should ensure their organisational culture is explicitly supportive of evidence-based practice. Ideally, to achieve this:
 - All radiographers should have non-clinical time afforded to them within their workday to engage with different sources of evidence.
 - Staff should be supported to attend and present at conferences and to contribute to literature where appropriate.
 - Formal evidence-based mentorship should be fostered between engaged senior staff and junior and/or new staff.
 - Diagnostic radiographers should be encouraged to upskill with short courses, formal postgraduate coursework and research degrees.
- **Universities** should effectively teach and assess all seven steps of evidence-based practice to ensure that graduates have the requisite knowledge and skills to implement evidence-based practice in their clinical careers.
 - Implementation science should be embedded in curriculum for all diagnostic radiography programs to better prepare graduates to lead clinical change.
- **Diagnostic radiography departments and private practices and universities** should enter mutually beneficial partnerships to develop evidence-based practice and research capacity within the discipline.

7.6 Concluding remarks

Enhanced implementation of evidence-based practice not only stands to benefit our patients and our healthcare systems but serves as a pathway forward for our profession. Evidence-based practice starts with effective education, ensuring student radiographers are adequately prepared to undertake evidence-based practice. This requires solid theoretical underpinning during their time at university and the opportunity to be set up for success during their work integrated learning experiences,

applying and consolidating these skills. However, education alone is not enough, and professional culture must be enhanced with greater prioritisation of evidence-based practice.

By introducing strategies to improve the application of these practices, we will grow diagnostic radiography within Australia. There are ample strategies that have been utilised in other disciplines that serve as a blueprint for a pathway forward. Our governing and professional bodies should provide strategic leadership and a coherent strategy for moving the implementation of evidence-based practice forward within diagnostic radiography, looking to fields such as implementation science and knowledge translation, and adopting strategies from these disciplines. We must build our own knowledge base within these fields, so that the integration of these strategies is tried, tested and reported within diagnostic radiography. In addition, we as radiographers must increase the generation and application of evidence, thus building capacity within the discipline through strong academic and clinical partnerships.

Diagnostic radiographers have the capacity to enhance the application of evidence-based practices but are not currently supported to do so. In order to shift the balance of routine implementation of evidence-based practice from the exception to the norm, we require strong leadership, paired with innovative education, and a culture shift to advance the implementation of evidence-based practice in Australia. In doing so we stand to benefit individual radiographers, our patients, the discipline and healthcare system more broadly.

7.7 Chapter 7 References

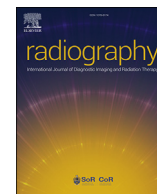
- Abrahamson, K., Arling, P., & Gillette, J. (2012). Does self-efficacy influence the application of evidence-based practice? *Journal of Nursing Education and Practice*, 3(5), 1.
- AHE, A. H. E. O. (2018). *What Would You Do? Stop Shielding Your Patients?* Retrieved 12 December from <https://aheonline.blog/2018/01/15/what-would-you-do-stop-shielding-your-patients/>
- Ahonen, S.-M., & Liikanen, E. (2010). Radiographers' preconditions for evidence-based radiography. *Radiography*, 16(3), 217-222. <https://doi.org/10.1016/j.radi.2010.01.005>
- Amit-Aharon, A., Melnikov, S., & Warshawski, S. (2020). The effect of evidence-based practice perception, information literacy self-efficacy, and academic motivation on nursing students' future implementation of evidence-based practice. *Journal of professional nursing*, 36(6), 497-502. <https://doi.org/10.1016/j.profnurs.2020.04.001>
- ASRT, A. S. o. R. T. (2019). ASRT Board of Directors Provides Update on Gonadal and Fetal Shielding Position. <https://www.asrt.org/main/news-publications/news/article/2019/07/02/asrt-board-of-directors-provides-update-on-gonadal-and-fetal-shielding-position>
- Bauer, M. S., Damschroder, L., Hagedorn, H., Smith, J., & Kilbourne, A. M. (2015). An introduction to implementation science for the non-specialist. *BMC Psychology*, 3(1), 32. <https://doi.org/10.1186/s40359-015-0089-9>
- Berg, N. (2005a). Non-Response Bias. In K. Kempf-Leonard (Ed.), *Encyclopedia of Social Measurement* (pp. 865-873). Elsevier. <https://doi.org/https://doi.org/10.1016/B0-12-369398-5/00038-4>
- Berg, N. (2005b). Non-response bias.
- Chau, M., Brown, E., Beldham-Collins, R., & Anderson, N. (2022). Research demographics of Australian medical radiation practitioners. *Journal of Medical Imaging and Radiation Sciences*, 53(4), 591-598. <https://doi.org/10.1016/j.jmir.2022.07.009>
- Connor, L., Dean, J., McNett, M., Tydings, D. M., Shrout, A., Gorsuch, P. F., Hole, A., Moore, L., Brown, R., Melnyk, B. M., & Gallagher-Ford, L. (2023). Evidence-based practice improves patient outcomes and healthcare system return on investment: Findings from a scoping review. *Worldviews Evid Based Nurs*, 20(1), 6-15. <https://doi.org/10.1111/wvn.12621>
- Cook, D. A., & Hatala, R. (2015). Got power? A systematic review of sample size adequacy in health professions education research. *Advances in Health Sciences Education*, 20(1), 73-83. <https://doi.org/10.1007/s10459-014-9509-5>
- Dawes, M., Summerskill, W., Glasziou, P., Cartabellotta, A., Martin, J., Hopayian, K., Porzsolt, F., Burls, A., & Osborne, J. (2005). Sicily statement on evidence-based practice. *BMC Medical Education*, 5(1), 1. <https://doi.org/10.1186/1472-6920-5-1>
- Dennett, A. M., Cauchi, T., Harding, K. E., Kelly, P., Ashby, G., & Taylor, N. F. (2021). Research interest, experience and confidence of allied health professionals working in medical imaging: a cross-sectional survey. *Journal of medical radiation sciences*, 68(2), 121-130. <https://doi.org/10.1002/jmrs.432>
- Di Michele, L., Bell, A., Thomson, K., & Reed, W. (2024). Evidence-based practice in radiography: A strategy for shifting our culture. *Journal of medical radiation sciences*, n/a(n/a). <https://doi.org/https://doi.org/10.1002/jmrs.801>
- Di Michele, L., Thomson, K., Bell, A., & Reed, W. (2023). Educating for the future: Bookending evidence-based practice. *Radiography*, 29(5), 958-960. <https://doi.org/https://doi.org/10.1016/j.radi.2023.07.007>
- Duangjinda, M. (2004). *The relationship between perceived self-efficacy, perceived barriers to action and health-promoting behaviors of professional nurses in Nonthaburi Province*. Faculty of Graduate Studies, Mahidol University.
- Eccles, M. P., & Mittman, B. S. (2006). Welcome to Implementation Science. *Implementation Science*, 1(1), 1. <https://doi.org/10.1186/1748-5908-1-1>
- EFRS. (2015). EFRS Statement on the Implementation of Evidence-Based Practice in Undergraduate Radiography Curricula. In.

- England, A., Geers-van Gemeren, S., Henner, A., Kukkes, T., Pronk-Larive, D., Rainford, L., & McNulty, J. (2017). Clinical radiography education across Europe. *Radiography*, 23, S7-S15.
- Fineout-Overholt, E., Williamson, K. M., Kent, B., & Hutchinson, A. M. (2010). Teaching EBP: Strategies for Achieving Sustainable Organizational Change Toward Evidence-Based Practice. *Worldviews on evidence-based nursing*, 7(1), 51-53. <https://doi.org/10.1111/j.1741-6787.2010.00185.x>
- Francis Health. (2018). *Medical Radiation Science - Horizons Scanning and Scenario Generation Report*. <https://www.health.nsw.gov.au/workforce/alliedhealth/Documents/medical-radiation-sciences-horizons-scanning-report.PDF>
- Harding, K. E., Porter, J., Horne-Thompson, A., Donley, E., & Taylor, N. F. (2014). Not Enough Time or a Low Priority? Barriers to Evidence-Based Practice for Allied Health Clinicians. *The Journal of continuing education in the health professions*, 34(4), 224-231. <https://doi.org/10.1002/chp.21255>
- Harding, K. P. M. B., Lynch, L. B., Porter, J. P. M. G., & Taylor, N. F. P. (2017). Organisational benefits of a strong research culture in a health service: a systematic review. *Australian Health Review*, 41(1), 45-53. <https://doi.org/https://doi.org/10.1071/AH15180>
- Higgins, R., Robinson, L., & Hogg, P. (2015). Unlocking Student Research Potential: Toward a Research Culture in Radiography Undergraduate Learning Curricular. *Journal of Medical Imaging and Radiation Sciences*, 46(3), S6-S9. <https://doi.org/10.1016/j.jmir.2015.06.009>
- Kalb, K. A., O'Conner-Von, S. K., Brockway, C., Rierson, C. L., & Sendelbach, S. (2015). Evidence-Based Teaching Practice in Nursing Education: Faculty Perspectives and Practices. *Nursing education perspectives*, 36(4), 212-219. <https://doi.org/10.5480/14-1472>
- Klaic, M., McDermott, F., & Haines, T. (2019). How soon do allied health professionals lose confidence to perform EBP activities? A cross-sectional study. *Journal of evaluation in clinical practice*, 25(4), 603-612. <https://doi.org/10.1111/jep.13001>
- Landsverk, N. G., Olsen, N. R., & Brovold, T. (2023). Instruments measuring evidence-based practice behavior, attitudes, and self-efficacy among healthcare professionals: a systematic review of measurement properties. *Implementation Science*, 18(1), 42. <https://doi.org/10.1186/s13012-023-01301-3>
- McEntee, M. F., & Kinsella, C. (2010). An examination of practice during radiography of the clavicle. *Radiography*, 16(2), 125-130. <https://doi.org/https://doi.org/10.1016/j.radi.2009.12.002>
- McNulty, J. (2018). Fostering clinical research in imaging departments. *Health-Managementetorg*, 18(3).
- McNulty, J. P., Rainford, L., Bezzina, P., Henner, A., Kukkes, T., Pronk-Larive, D., & Vandulek, C. (2016). A picture of radiography education across Europe. *Radiography*, 22(1), 5-11. <https://doi.org/https://doi.org/10.1016/j.radi.2015.09.007>
- Mdletshe, S. (2023). Driving professional development and growth through research: a commentary. *Journal of medical radiation sciences*, 70(3), 338-344. <https://doi.org/https://doi.org/10.1002/jmrs.678>
- Melnyk, B. M. (2023). Leaders and managers in nursing and healthcare are key to advancing and sustaining evidence-based practice. *Worldviews on evidence-based nursing*, 20(1), 4-5. <https://doi.org/https://doi.org/10.1111/wvn.12626>
- Melnyk, B. M., & Fineout-Overholt, E. (2015). *Evidence-based practice in nursing and healthcare : a guide to best practice* (Third edition. ed.). Wolters Kluwer Health.
- Melnyk, B. M., Fineout-Overholt, E., Giggelman, M., & Cruz, R. (2010). Correlates among cognitive beliefs, EBP implementation, organizational culture, cohesion and job satisfaction in evidence-based practice mentors from a community hospital system. *Nursing outlook*, 58(6), 301-308. <https://doi.org/10.1016/j.outlook.2010.06.002>
- Melnyk, B. M., Fineout-Overholt, E., Stillwell, S. B., & Williamson, K. M. (2010). Evidence-based practice: step by step: the seven steps of evidence-based practice. *Am J Nurs*, 110(1), 51-53. <https://doi.org/10.1097/01.NAJ.0000366056.06605.d2>

- Melnyk, B. M., Tan, A., Hsieh, A. P., & Gallagher-Ford, L. (2021). Evidence-Based Practice Culture and Mentorship Predict EBP Implementation, Nurse Job Satisfaction, and Intent to Stay: Support for the ARCC(©) Model. *Worldviews Evid Based Nurs*, 18(4), 272-281. <https://doi.org/10.1111/wvn.12524>
- MRPBA. (2019). Medical radiation practice accreditation standards. In.
- MRPBA. (2020). Professional capabilities for medical radiation practice. In.
- Munn, Z., McArthur, A., Mander, G. T. W., Steffensen, C. J., & Jordan, Z. (2020). The only constant in radiography is change: A discussion and primer on change in medical imaging to achieve evidence-based practice. *Radiography (London, England. 1995)*, 26, S3-S7. <https://doi.org/10.1016/j.radi.2020.07.001>
- Neep, M. J. (2021). We can do it: Improving research culture and capacity in medical radiation sciences. *Journal of medical radiation sciences*, 68(2), 105-107. <https://doi.org/https://doi.org/10.1002/jmrs.470>
- Nielsen, L. D., Løwe, M. M., Mansilla, F., Jørgensen, R. B., Ramachandran, A., Noe, B. B., & Egebæk, H. K. (2024). Interventions, methods and outcome measures used in teaching evidence-based practice to healthcare students: an overview of systematic reviews. *BMC Med Educ*, 24(1), 306. <https://doi.org/10.1186/s12909-024-05259-8>
- Nightingale, J., Sevens, T., Appleyard, R., Campbell, S., & Burton, M. (2023). Retention of radiographers in the NHS: Influencing factors across the career trajectory. *Radiography*, 29(1), 76-83. <https://doi.org/https://doi.org/10.1016/j.radi.2022.10.003>
- Nightingale, J. P. P. M. D. C. R. (2016). Establishing a radiography research culture – Are we making progress? *Radiography (London, England. 1995)*, 22(4), 265-266. <https://doi.org/10.1016/j.radi.2016.09.002>
- Oliveira, M., Hogg, P., Di Prospero, L., Lacey, S., El-Farra, S., & Johansen, S. (2024). Research activity among diagnostic and therapeutic radiographers: An international survey. *Journal of Medical Imaging and Radiation Sciences*, 55(2), 232-243. <https://doi.org/https://doi.org/10.1016/j.jmir.2024.02.005>
- Rawle, M., Pighills, A., Mendez, D., & Dobeli, K. (2023). Radiographic technique modification and evidence-based practice: A qualitative study. *Journal of medical radiation sciences*, 70(1), 56-63. <https://doi.org/10.1002/jmrs.616>
- Singh, N., Knight, K., Wright, C., Baird, M., Akroyd, D., Adams, R. D., & Schneider, M. E. (2017). Occupational burnout among radiographers, sonographers and radiologists in Australia and New Zealand: Findings from a national survey. *Journal of medical imaging and radiation oncology*, 61(3), 304-310. <https://doi.org/10.1111/1754-9485.12547>
- Smithson, J. (2000). Using and analysing focus groups: limitations and possibilities. *International journal of social research methodology*, 3(2), 103-119.
- Thomas, A., & Bussi eres, A. (2021). Leveraging knowledge translation and implementation science in the pursuit of evidence informed health professions education. *Advances in Health Sciences Education*, 26(3), 1157-1171. <https://doi.org/10.1007/s10459-020-10021-y>
- Ward, E. C., Hargrave, C., Brown, E., Halkett, G., & Hogg, P. (2017). Achieving success in clinically based research: the importance of mentoring. *Journal of medical radiation sciences*, 64(4), 315-320. <https://doi.org/https://doi.org/10.1002/jmrs.234>
- Young, T., Rohwer, A., Volmink, J., & Clarke, M. (2014). What are the effects of teaching evidence-based health care (EBHC)? Overview of systematic reviews. *PLoS One*, 9(1), e86706-e86706. <https://doi.org/10.1371/journal.pone.0086706>

Appendices

- A1. Invited editorial *Radiography*: Educating for the future: Bookending evidence-based practice



Guest editorial

Educating for the future: Bookending evidence-based practice



The role of a modern radiographer is complex; radiographers are expected to be technically skilled, professional, ethical and have honed their radiation safety and risk management skills.¹ Additionally, they need to excel in communication and collaboration.¹ In each interaction, radiographers apply clinical reasoning, balancing patient needs, clinical expertise, empirical evidence, and practical aspects. This is the very definition of evidence-based practice (EBP).²

Radiographers tend to have positive attitudes towards EBP, however, in busy clinical environments with competing priorities, conducting, or even consuming current research is challenging, and so they are rarely able to prioritise EBP. Radiographers traditionally act as consumers of research,³ and often have low confidence in both their research and EBP skills.^{4–6} Additionally, radiographers do not usually base their clinical decision-making on empirical evidence.⁷ Instead, they tend to rely more heavily on their clinical expertise and are more likely to change techniques based on the advice of a colleague.^{5,8}

Clinical expertise is one of the pillars of EBP, however, an issue arises when that expertise or advice from colleagues is not based on evidence. Rawle and colleagues (2023) noted that radiographers often assume that historical practices are evidence-based, even when they are not, and that technological advancements play a significant role in driving changes in practice.⁸ While technological advancements may drive change, it has been noted that improvements in technology do not always translate into improvements in patient care.⁹

Over time, radiography has developed a culture that tends to be forgiving of practices that are not evidence-based. This culture is deeply complex and rooted in a history of medical dominance that still pervades today. Within radiography, there are ongoing debates surrounding identity, self-esteem and professionalisation.^{10–12} Historically radiographers have been described as having low self-esteem and a lack of professional autonomy, viewing themselves as “just the radiographer”.^{10–12}

Whilst Munn (2020) describes these views as unhelpful and potentially damaging,¹³ we believe that acknowledging the past and learning from it is important. Our history and culture cannot be ignored; however, they need not define our future as a profession. As Munn suggests, “*there is great potential for medical imaging and radiography to embrace EBP and a culture of research*”.¹³

The key to unlocking this potential is education

Most of us are aware of the five-step model of EBP as set out in the Sicily statement i.e. “Ask, search, appraise, apply evaluate”.¹⁴ We

utilise this model to varying degrees in both clinical practice and education. In the context of education, the best way to teach EBP is by ensuring that all five steps are well integrated and constructively aligned throughout the coursework and clinical curriculum.¹⁵ However, could there be more to consider? Now, nearly twenty years on from the development of the Sicily statement, we are in the position to ask, could we do more for EBP?

Melnik et al. (2010) introduced two additional steps to the EBP cycle that bookend the five steps outlined in the Sicily statement. Melnik et al.'s model is displayed in Fig. 1. The proposed model suggests that the prequel to the Sicily statement is cultivating a spirit of enquiry.¹⁶ This emphasises the role of culture in the effective implementation of EBP. As educators, if we can nurture, not only the necessary skills for EBP, but also a genuine desire and commitment to lifelong learning in the next generation of professionals, we can contribute to the cultural shift that is required. It has been observed that high intrinsic motivation is a key predictor of the application of EBP, and faculty members can foster this motivation by exemplifying the concept in their own practice.¹⁷

Additionally, Melnik et al. (2010) propose that dissemination should form an integral part of the EBP process. As educators, it is imperative that we equip students with robust skills beyond those required to practice clinically. This includes providing them with opportunities to develop their ability to write and present effectively, as well as preparing them for the reality of teamwork. The transition from technical on-the-job training to formal university education in radiography has played a significant role in facilitating this shift.^{18,19}

We must acknowledge that as a discipline, we have relied on empirical evidence generated by other disciplines for too long. While this evidence should not be overlooked, depending on it has led to a situation where the research questions explored do not always align with the clinical questions most relevant to radiographers. By establishing our own evidence base, our discipline becomes more equipped to adopt evidence as it is more directly applicable. This is essential to the continued advancement of the profession and will further enhance the EBP culture within radiography. While there is some debate about the importance of embedding research skills in undergraduate curriculum,²⁰ we passionately believe that providing education in this area is vital for the continued development and professionalisation of our discipline.

As our discipline continues to evolve and the role of radiographers becomes increasingly complex, it is the job of educators to prepare our students for success. This responsibility presents us with an opportunity to shape the future of radiography. We

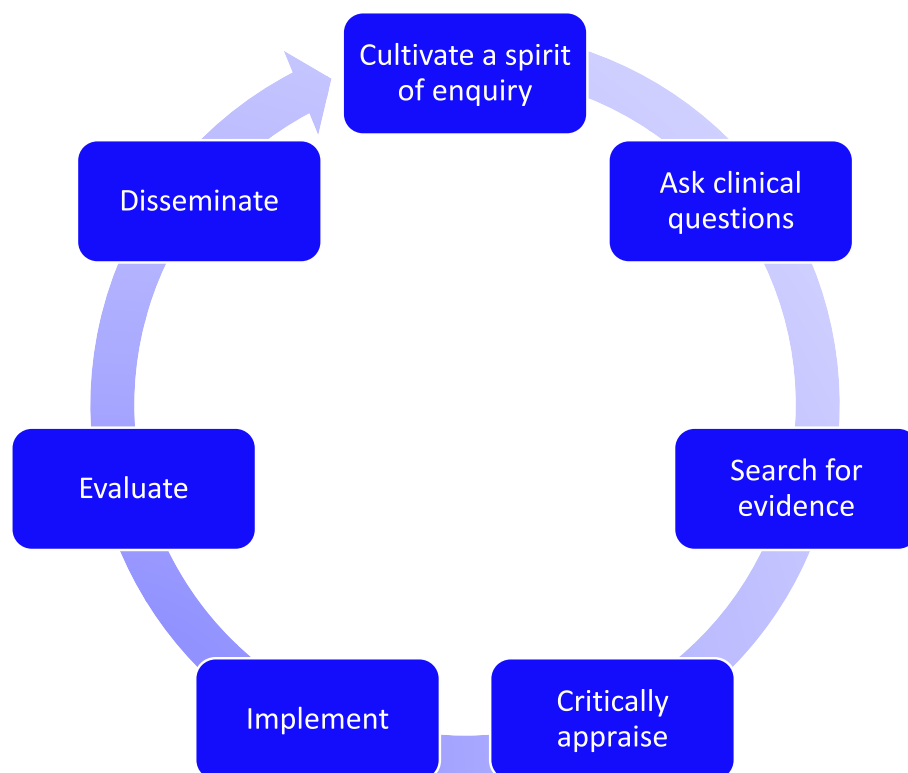


Figure 1. Visualisation of Melnyk et al. (2010) model of evidence-based practice.

must cultivate a passion for lifelong learning and a commitment to evidence-based practice in our future professionals, whilst equipping them with the necessary skills to implement and disseminate their findings. In doing so, we elevate the field of radiography. Our role as educators goes beyond simply imparting skills and knowledge; we can inspire, nurturing the spirit of enquiry in our students. We have the privilege of shaping the future of our profession, let us use this privilege to advance evidence-based radiography.

Declaration of generative AI and AI-assisted technologies in the writing process

During the preparation of this work the author(s) used ChatGPT in order to review for clarity and proofread the article. After using this tool/service, the author(s) reviewed and edited the content as needed and take(s) full responsibility for the content of the publication.

References

1. Medical Radiation Practice Board of Australia. *Professional capabilities for medical radiation practice*. 2020.
2. Sackett DL, Rosenberg WMC, Gray JAM, Haynes RB, Richardson WS. Evidence based medicine: what it is and what it isn't. *BMJ (Clinical research ed.)* 1996;**312**:71–2. <https://doi.org/10.1136/bmj.312.7023.71>.
3. Higgins R, Robinson L, Hogg P. Unlocking student research potential: toward a research culture in radiography undergraduate learning curricular. *J Med Imag Radiat Sci* 2015;**46**:S6–9. <https://doi.org/10.1016/j.jmir.2015.06.009>.
4. Chau M, Brown E, Beldham-Collins R, Anderson N. Research demographics of Australian medical radiation practitioners. *J Med Imag Radiat Sci* 2022;**53**: 591–8. <https://doi.org/10.1016/j.jmir.2022.07.009>.
5. Upton D, Upton P. Knowledge and use of evidence-based practice by allied health and health science professionals in the United Kingdom. *J Allied Health* 2006;**35**:127–33.
6. Dennett AM, Cauchi T, Harding KE, Kelly P, Ashby G, Taylor NF. Research interest, experience and confidence of allied health professionals working in medical imaging: a cross-sectional survey. *J Med Radiat Sci* 2021;**68**:121–30. <https://doi.org/10.1002/jmrs.432>.
7. Ahonen S-M, Liikanen E. Radiographers' preconditions for evidence-based radiography. *Radiography* 2010;**16**:217–22. <https://doi.org/10.1016/j.radi.2010.01.005>.
8. Rawle M, Pighills A, Mendez D, Dobeli K. Radiographic technique modification and evidence-based practice: a qualitative study. *J Med Radiat Sci* 2023;**70**: 56–63. <https://doi.org/10.1002/jmrs.616>.
9. Munn Z, McArthur A, Mander GTW, Steffensen CJ, Jordan Z. The only constant in radiography is change: a discussion and primer on change in medical imaging to achieve evidence-based practice. *Radiography (London, England)* 1995;**26**(2020):S3–7. <https://doi.org/10.1016/j.radi.2020.07.001>.
10. Lewis S, Heard R, Robinson J, White K, Poulos A. The ethical commitment of Australian radiographers: does medical dominance create an influence? *Radiography* 2008;**14**:90–7. <https://doi.org/10.1016/j.radi.2007.01.004>.
11. Yelder J, Davis M. Where radiographers fear to tread: resistance and apathy in radiography practice. *Radiography (London, England)* 2009;**15**:345–50. <https://doi.org/10.1016/j.radi.2009.07.002>. 1995.
12. Sim J, Radloff A. Profession and professionalisation in medical radiation science as an emergent profession. *Radiography* 2009;**15**:203–8. <https://doi.org/10.1016/j.radi.2008.05.001>.
13. Munn Z. Why isn't there an evidence-based radiography? Reflections and a call to action. *Radiography (London, England)* 2020;vol. 26:S14–6. <https://doi.org/10.1016/j.radi.2020.05.005>. 1995.
14. Dawes M, Summerskill W, Glasziou P, Cartabellotta A, Martin J, Hopayian K, et al. Sicily statement on evidence-based practice. *BMC Med Educ* 2005;**5**:1. <https://doi.org/10.1186/1472-6920-5-1>.
15. Thomas A, Saroyan A, Dauphinee WD. Evidence-based practice: a review of theoretical assumptions and effectiveness of teaching and assessment interventions in health professions. *Adv Health Sci Educ Theo Prac* 2011;**16**: 253–76. <https://doi.org/10.1007/s10459-010-9251-6>.
16. Melnyk BM, Fineout-Overholt E, Stillwell SB, Williamson KM. Evidence-based practice: step by step: the seven steps of evidence-based practice. *Am J Nurs* 2010;**110**:51–3. <https://doi.org/10.1097/01.NAJ.0000366056.06605.d2>.

17. Amit-Aharon A, Melnikov S, Warshawski S. The effect of evidence-based practice perception, information literacy self-efficacy, and academic motivation on nursing students' future implementation of evidence-based practice. *J Prof Nurs* 2020;**36**:497–502. <https://doi.org/10.1016/j.profnurs.2020.04.001>.
18. Malamateniou C. Radiography and research: a United Kingdom perspective. *Eur J Radiogr* 2009;**1**:2–6. <https://doi.org/10.1016/j.ejrad.2008.12.003>.
19. Di Michele L, Thomson K, McEntee MF, Kenny B, Reed W. Knowledge translation: radiographers compared to other healthcare professionals. *Radiography (London, England)* 2020;**26**:S27–32. <https://doi.org/10.1016/j.radi.2020.06.007>. 1995.
20. England A, McNulty JP. Inclusion of evidence and research in European radiography curricula. *Radiography (London, England)* 2020;**26**:S45–8. <https://doi.org/10.1016/j.radi.2020.04.018>. 1995.

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6 July 2023

Available online 2 August 2023

A2. Invited editorial *Journal of Medical Radiation Science*: Evidence-based practice
in radiography: A strategy for shifting our culture

Evidence-based practice in radiography: A strategy for shifting our culture

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J Med Radiat Sci 00 (2024) 1–3

doi: 10.1002/jmrs.801

Evidence-based practice (EBP) requires practitioners to integrate four primary pillars: clinical expertise, research evidence, patient preferences and pragmatics and context. Due to its nature EBP is challenging, as practitioners must flexibly adapt their knowledge to individual clinical situations to provide the best outcomes for their patients. Evidence-based practice has significant impacts on three key groups; it improves outcomes for patients, increases efficiency for organisations and enhances job satisfaction for individual practitioners.^{1,2}

To facilitate evidence-based practice, practitioners must possess a diverse skillset that extends beyond technical radiography skills, to encompass skills across the EBP cycle. While training and education in EBP are essential for initial skill development and confidence, formal university-based education can only provide a foundation. Beyond skill acquisition, the application of EBP demands that practitioners commit to lifelong learning and prioritise meaningful continuous professional development. Unfortunately, allied health graduates often experience a loss of confidence in their EBP skills within 5 years of graduation.³ The current approach to practice is ineffective in translating evidence-based practices within the field of diagnostic radiography. Why is this, and what actions can we take as a discipline to address it?

Literature from other disciplines suggests that an individual's beliefs and attitudes about EBP significantly influence their likelihood of practicing in an evidence-based manner. Interestingly, the field of diagnostic radiography appears to differ on this point. In this issue, Melesse, Amde and Tezera⁴ provide an overview of EBP in Addis Ababa, Ethiopia. The results of their paper are consistent with the results of our recent survey of Australian radiographers⁵ and a systematic

review of studies of radiographers internationally.⁶ While individual radiographers generally hold very positive attitudes towards EBP, the application of this practice is limited and variable.

Workplace culture plays a crucial role in the implementation of EBP, both in terms of prioritisation and socialisation.^{2,7} A positive EBP culture within organisations affects individuals' knowledge, beliefs, competency and the implementation of evidence-based practices. Moreover, it is positively associated with higher job satisfaction and intention to stay.⁷ Unfortunately, within the field of diagnostic radiography, the literature consistently demonstrates that strong, positive research cultures and EBP cultures are not the norm.⁶ Therefore, there is a pressing need to invest at a professional, organisational and individual level to foster a culture conducive to EBP implementation.

To address the lack of application of EBP in diagnostic radiography, we need coordinated, strategic efforts to improve our professional culture. Radiographers' traditional role has been as consumers, rather than creators of empirical evidence,⁸ with few displaying interest, confidence or experience in undertaking research.^{9,10} Despite an increase in higher level degrees within the profession, very few Australian radiographers undertake formal research training.¹⁰ At a professional level, we must reclaim our knowledge base, by providing targeted funding for radiographers to engage in both research and other EBP activities. To ensure this research is relevant and patient centred, it is crucial to involve patients in the research process. Patient engagement not only enhances the relevance of interventions and cultural sensitivity but also has benefits for both patients and researchers alike.¹¹



To enable this, we must ensure that practitioners are enabled to undertake further studies and research training. A 2022 survey of Australian radiographers showed that only 1.6% of respondents with a medical imaging background had a PhD, which was much lower than the 9.8% among radiation therapists.¹⁰ Efforts must be made to recruit and train talented diagnostic radiographers to engage with high quality research. Moreover, there must be well-defined pathways for career progression and advancement, ensuring the discipline retains high achieving, experienced, evidence-based professionals who are committed to evidence-based practices within the discipline.

A recent scoping review investigating the outcomes of EBP initiatives found that 94% of articles reporting on return on investment showed a positive return, with none reporting negative returns.¹ Positive research and EBP cultures are associated with higher organisational performance, productivity and staff satisfaction and retention.¹² Strong EBP culture builds strong organisations; thus, organisations cannot afford to neglect prioritising and investing in EBP.

At an organisational level, it is crucial to visibly prioritise EBP. Examples of such visibility include integrating EBP in organisational values, job descriptions and key performance indicators. Given that individuals with higher degrees are more likely to maintain EBP confidence,³ prioritising recruitment of individuals with higher degrees may help improve the culture within individual organisations. Additionally, supporting current employees to upskill and undertake further studies will also help organisations in enhancing their EBP practices. It is vital that translational skills are embedded in the curriculum of advanced degrees. This ensures that graduates possess the skills to apply the knowledge gained during their studies within their individual settings, thereby fostering evidence-based change within their departments.

The paper by Melesse, Made and Tezera R⁴ in this issue, along with our Australian study⁵ and an international literature review⁶ all highlight that radiographers struggle to find the time to prioritise EBP. Managers must ensure that every radiographer has dedicated time set aside to engage in EBP activities within their workday and provide adequate channels for dissemination among colleagues. Furthermore, time to actively apply a patient centred, EBP approach to medical imaging must be built into scheduling, ensuring that patient preferences are heard and prioritised.

Individual radiographers also have a role to play. Senior radiographers can act as EBP champions within their organisations. They can actively contribute to the cultural shift and can do this by upskilling, role

modelling and acting as mentors to the next generation of radiographers.⁷ EBP mentorship has been shown to have strong positive impact on implementation.⁷ This mentorship by senior radiographers could assist in the development of the clinical expertise pillar of EBP, helping junior radiographers to develop skills and find the intricate balance between the often-competing pillars of EBP. Likewise, as mentees, junior radiographers can bring their expertise in individual EBP skills to the table, sharing and utilising the EBP skills that they have graduated with more recently from university. By actively employing and refining these skills in the clinical environment, these clinicians are less likely to display the loss of confidence that has been previously reported in other disciplines.³

In conclusion, with solid international baselines as our guide,⁴⁻⁶ it is imperative to implement a resolute strategy for advancing EBP within diagnostic radiography. This entails fostering a pervasive culture of EBP across all levels – professional, organisational and individual. By driving this transformation, we can not only enhance patient outcomes and organisational success but also elevate staff satisfaction and retention. Creating this cultural shift and enhancing the implementation of EBP within the profession ensures a legacy of excellence for generations of radiographers to come.

Conflict of Interest

The authors declare no conflict of interest.

Data Availability Statement

Data sharing not applicable to this article as no datasets were generated or analysed.

References

1. Connor L, Dean J, McNett M, et al. Evidence-based practice improves patient outcomes and healthcare system return on investment: Findings from a scoping review. *Worldviews Evid-Based Nurs* 2023; **20**: 6–15.
2. Melnyk BM, Fineout-Overholt E, Giggelman M, Cruz R. Correlates among cognitive beliefs, EBP implementation, organizational culture, cohesion and job satisfaction in evidence-based practice mentors from a community hospital system. *Nurs Outlook* 2010; **58**: 301–8.
3. Klaic M, McDermott F, Haines T. How soon do allied health professionals lose confidence to perform EBP activities? A cross-sectional study. *J Eval Clin Pract* 2019; **25**: 603–12.
4. Melesse GT, Amde T, Tezera R. Competency in evidence-based medicine and associated factors among

- medical radiology technologists in Addis Ababa, Ethiopia. *J Med Radiat Sci* 2024. <https://doi.org/10.1002/jmrs.777>.
5. Di Michele L, Thomson K, Bell A, Reed W. Assessing evidence-based practice among Australian radiographers: A self-report survey. *Radiography* 2024; **30**: 696–701.
 6. Al Balushi H, Watts H, Akudjedu TN. Research and evidence-based practice in clinical radiography: A systematic review of barriers and recommendations for a new direction. *Radiography* 2024; **30**: 538–59.
 7. Melnyk BM, Tan A, Hsieh AP, Gallagher-Ford L. Evidence-based practice culture and mentorship predict EBP implementation, nurse job satisfaction, and intent to stay: Support for the ARCC© model. *Worldviews Evid-Based Nurs* 2021; **18**: 272–81.
 8. Higgins R, Robinson L, Hogg P. Unlocking student research potential: Toward a research culture in radiography undergraduate learning curricular. *J Med Imaging Radiat Sci* 2015; **46**: S6–9.
 9. Dennett AM, Cauchi T, Harding KE, Kelly P, Ashby G, Taylor NF. Research interest, experience and confidence of allied health professionals working in medical imaging: a cross-sectional survey. *J Med Radiat Sci* 2021; **68**: 121–30.
 10. Chau M, Brown E, Beldham-Collins R, Anderson N. Research demographics of Australian medical radiation practitioners. *J Med Imaging Radiat Sci* 2022; **53**: 591–8.
 11. Merker VL, Hyde JK, Herbst A, et al. Evaluating the impacts of patient engagement on health services research teams: Lessons from the Veteran Consulting Network. *J Gen Intern Med* 2022; **37**(Suppl 1): 33–41.
 12. Harding K, Lynch L, Porter J, Taylor NF. Organisational benefits of a strong research culture in a health service: A systematic review. *Aust Health Rev* 2017; **41**: 45–53.

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A3. Student Evidence-Based Practice Questionnaire & Evidence-Based Practice Questionnaire

The s-EBPQ and EBPQ are freely available at <https://ebpq.co.uk/>

A4. Ethics documents

Research Integrity & Ethics Administration
Human Research Ethics Committee

Friday, 27 January 2017

Dr Warren Reed
Medical Imaging and Radiation Sciences; Faculty of Health Sciences
Email: warren.reed@sydney.edu.au

Dear Warren

The University of Sydney Human Research Ethics Committee (HREC) has considered your application.

After consideration of your response to the comments raised your project has been approved.

Approval is granted for a period of four years from **27 January 2017 to 27 January 2021**

Project title: The implementation of research findings into evidence based practice within diagnostic radiography in Australia.

Project no.: 2016/769

First Annual Report due: 27 January 2018

Authorised Personnel: Reed Warren; Di Michele Laura; Kenny Belinda; McEntee Mark;

Documents Approved:

Date Uploaded	Version number	Document Name
26/10/2016	Version 2	PIS v.2 Final
26/10/2016	Version 2	Participant Questionnaire Form
10/10/2016	Version 2	Recruitment email final
04/08/2016	Version 1	Focus Group Questions
03/08/2016	Version 1	Recruitment flyer
18/07/2016	Version 1	Participant Consent Form

Condition/s of Approval

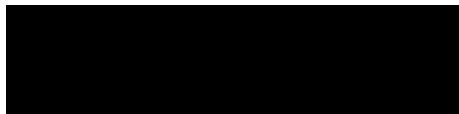
- Research must be conducted according to the approved proposal.
- An annual progress report must be submitted to the Ethics Office on or before the anniversary of approval and on completion of the project.
- You must report as soon as practicable anything that might warrant review of ethical approval of the project including:
 - Serious or unexpected adverse events (which should be reported within 72 hours).
 - Unforeseen events that might affect continued ethical acceptability of the project.
- Any changes to the proposal must be approved prior to their implementation (except where an amendment is undertaken to eliminate *immediate* risk to participants).

- Personnel working on this project must be sufficiently qualified by education, training and experience for their role, or adequately supervised. Changes to personnel must be reported and approved.
- Personnel must disclose any actual or potential conflicts of interest, including any financial or other interest or affiliation, as relevant to this project.
- Data and primary materials must be retained and stored in accordance with the relevant legislation and University guidelines.
- Ethics approval is dependent upon ongoing compliance of the research with the *National Statement on Ethical Conduct in Human Research*, the *Australian Code for the Responsible Conduct of Research*, applicable legal requirements, and with University policies, procedures and governance requirements.
- The Ethics Office may conduct audits on approved projects.
- The Chief Investigator has ultimate responsibility for the conduct of the research and is responsible for ensuring all others involved will conduct the research in accordance with the above.

This letter constitutes ethical approval only.

Please contact the Ethics Office should you require further information or clarification.

Sincerely



Associate Professor Michael Skilton
Chair
Health Review Committee

The University of Sydney HRECs are constituted and operate in accordance with the National Health and Medical Research Council's (NHMRC) National Statement on Ethical Conduct in Human Research (2007) and the NHMRC's Australian Code for the Responsible Conduct of Research (2007).



Discipline of Medical Radiation Sciences
Faculty of Health Sciences

ABN 15 211 513 464

CHIEF INVESTIGATOR NAME

Dr Warren Reed

Room M203

M Block

The University of Sydney

NSW 2006 AUSTRALIA

Telephone: +61 2 9351 9503

Facsimile: +61 2 9351 9146

Email: warren.reed@sydney.edu.au

Web: <http://www.sydney.edu.au/>

**The implementation of research findings into evidence based practice within diagnostic radiography in
Australia.**

PARTICIPANT INFORMATION STATEMENT

(1) What is this study about?

You are invited to take part in a research study about the implementation of research findings into evidence based practice within diagnostic radiography in Australia.

You have been invited to participate in this study because you are a radiographer currently practicing in Australia. This Participant Information Statement tells you about the research study. Knowing what is involved will help you decide if you want to take part in the research. Please read this sheet carefully and ask questions about anything that you don't understand or want to know more about.

Participation in this research study is voluntary.

By giving your consent to take part in this study you are telling us that you:

- ✓ Understand what you have read.
- ✓ Agree to take part in the research study as outlined below.
- ✓ Agree to the use of your personal information as described.

You will be given a copy of this Participant Information Statement to keep.

(2) Who is running the study?

The study is being carried out by the following researchers:

- Dr Warren Reed
Course Director GEM – Medical Radiation Science
Faculty of Health Sciences
The University of Sydney

- Dr Belinda Kenney
Lecturer – Work Integrated Learning
Faculty of Health Sciences
The University of Sydney
- Dr Mark McEntee
Associate Professor – Medical Radiation Science
Faculty of Health Sciences
The University of Sydney
- Mrs Laura Di Michele
Associate Lecturer – Work Integrated Learning
Faculty of Health Sciences
University of Sydney

Laura Di Michele is conducting this study as the basis for the degree of Masters of Applied Science (Research) at The University of Sydney. This will take place under the supervision of Dr Warren Reed, at the University of Sydney.

(3) What will the study involve for me?

If you agree to participate in this study you will be asked to sign the Participant Consent Form.

You will be asked to fill out a written Participant Questionnaire Form which will ascertain demographic detail such as your age range, sex and how long you have been practicing radiography.

You will then be asked to attend a focus group interview. Focus groups are expected to last no longer than two hours and will consist of discussion with 7-10 people surrounding the implementation of evidence based practice in diagnostic radiography within your department. This discussion will be moderated by a member of the research team.

Your responses during this focus group interview will be audio recorded and transcribed. You will be given the opportunity should you wish to read over the transcript of the focus group to ensure its accuracy.

(4) How much of my time will the study take?

Focus groups are expected to take no longer than two hours.

(5) Who can take part in the study?

Only students currently enrolled at the University of Sydney in a Bachelor of Applied Science (Diagnostic Radiography) or Master of Diagnostic Radiography who have completed at least one clinical placement will be eligible to participate in this study.

(6) Do I have to be in the study? Can I withdraw from the study once I've started?

Being in this study is completely voluntary and you do not have to take part. Your decision whether to participate will not affect your current or future relationship with the researchers or anyone else at the University of Sydney.

If you decide to take part in the study and then change your mind later, you are free to withdraw at any time. You can do this by indicating to the facilitator at any time that you would like to cease your participation and leave.

Submitting your completed Participant Consent Form is an indication of your consent to participate in the study.

You may withdraw your responses to your Participant Questionnaire Form if you change your mind about having them included in the study, up to the point that we have analysed and published the results.

If you take part in a focus group, you are free to stop participating at any stage or to refuse to answer any of the questions. However, it will not be possible to withdraw your individual comments from our records once the group has started, as it is a group discussion.

(7) Are there any risks or costs associated with being in the study?

Aside from giving up your time, we do not expect that there will be any risks or costs associated with taking part in this study.

(8) Are there any benefits associated with being in the study?

We cannot guarantee that you will receive any direct benefits from being in the study however the self-reflective nature of the task may aid in professional development along. In addition to this it is expected that the study will benefit the profession of diagnostic radiography.

You will be compensated for kindly giving up your time with a \$50 gift voucher.

(9) What will happen to information about me that is collected during the study?

Demographic details such as your age, sex and how long you have been a practicing radiographer will be collected through the Participant Questionnaire Form. Focus group discussion on your perception of research translation and change management will be audio recorded and analysed. Direct quotations may be utilised in publication where it is possible to ensure your confidentiality.

Audio recordings may be provided to an external service for transcription. All personal information will be kept confidential with the only limitation on this being the researcher's statutory requirements with regard to mandatory reporting under the Australian Health Practitioners Regulation Agency.

Anonymous results and de-identified direct quotations from this study will be published in peer reviewed journal publications, national and international conference presentations and in the higher research degree student researcher's thesis.

All electronic data from this study, including but not limited to audio recordings will be held in a secure, password protected server space by the University of Sydney. All hardcopy data will be stored in a secured filing cabinet in the chief investigators office, M203.

This data will be stored securely for a period of five years post completion of the study.

By providing your consent, you are agreeing to us collecting personal information about you for the purposes of this research study. Your information will only be used for the purposes outlined in this Participant Information Statement, unless you consent otherwise.

Your information will be stored securely and your identity/information will be kept strictly confidential, except as required by law. Study findings may be published, but you will not be individually identifiable in these publications.

(10) Can I tell other people about the study?

Yes, you are welcome to tell other people after participation in the study.

(11) What if I would like further information about the study?

When you have read this information, Warren Reed will be available to discuss it with you further and answer any questions you may have. If you would like to know more at any stage during the study, please feel free to contact.

Dr Warren Reed
Course Director GEM – Medical Radiation Science
+61 2 9351 9503
warren.reed@sydney.edu.au

(12) Will I be told the results of the study?

You have a right to receive feedback about the overall results of this study. You can tell us that you wish to receive feedback by ticking the relevant box on the consent form and providing your email address. This feedback will be in the form of a one page summary. You will receive this feedback after the study is finished.

(13) Has this research project received an external funding?

Yes, this research project has been awarded funding from the Australian Society of Medical Imaging and Radiation Therapy (ASMIRT).

(14) What if I have a complaint or any concerns about the study?

Research involving humans in Australia is reviewed by an independent group of people called a Human Research Ethics Committee (HREC). The ethical aspects of this study have been approved by the HREC of the University of Sydney [*INSERT protocol number once approval is obtained*]. As part of this process, we have agreed to carry out the study according to the *National Statement on Ethical Conduct in Human Research (2007)*. This statement has been developed to protect people who agree to take part in research studies.

If you are concerned about the way this study is being conducted or you wish to make a complaint to someone independent from the study, please contact the university using the details outlined below. Please quote the study title and protocol number.

The Manager, Ethics Administration, University of Sydney:

- **Telephone:** +61 2 8627 8176
- **Email:** ro.humanethics@sydney.edu.au

- **Fax:** +61 2 8627 8177 (Facsimile)

This information sheet is for you to keep

ABN 15 211 513 464

CHIEF INVESTIGATOR NAME*Dr Warren Reed*

Room M203

M Block

The University of Sydney

NSW 2006 AUSTRALIA

Telephone: +61 2 9351 9503

Facsimile: +61 2 9351 9146

Email: warren.reed@sydney.edu.au

Web: <http://www.sydney.edu.au/>**ASSOCIATE INVESTIGATOR NAMES***Dr Belinda Kenney**Dr Mark McEntee**Mrs Laura Di Michele*

The implementation of research findings into evidence based practice within diagnostic radiography in
Australia.

PARTICIPANT QUESTIONNAIRE FORM

Name: _____

What is your highest level of qualification?

Which of the following degrees are you currently completing (please circle one)?

- Bachelor of Applied Science (Diagnostic Radiography)
- Master of Diagnostic Radiography

For how long have you been studying your current degree?

- <6 months
- 6 – 12 months
- 1 – 2 years
- 2 – 3 years
- 3 – 4 years
- 4+ years

What is your most recently completed clinical unit of study?

Undergraduate:

RWIL 1

RWIL 2

RWIL 3

RWIL 4

RWIL 5

RWIL 6

RWIL 7

RWIL 8

GEM:

CS1

CS2

CS3

CS4

Friday, 4 November 2022

Dr Warren Reed
Clinical Imaging; Faculty of Medicine and Health
Email: warren.reed@sydney.edu.au

Dear Warren,

The University of Sydney Human Research Ethics Committee (HREC) has considered your application.

I am pleased to inform you that after consideration of your response, your project has been approved.

Details of the approval are as follows:

Project No.: 2022/674
Project Title: A multi-unit educational intervention to enhance evidence-based practice
Authorised Personnel: Reed Warren; Bell Amani; Di Michele Laura; Thomson Kate;
Approval Period: 04/11/2022 to 04/11/2026
First Annual Report Due: 04/11/2023

Documents Approved:

Date Uploaded	Version Number	Document Name
31/10/2022	2	Canvas announcement text_v2_clean
31/10/2022	2	Canvas announcement with attached PIS_v2_clean

Condition/s of Approval

- Research must be conducted according to the approved proposal.
- An annual progress report must be submitted to the Ethics Office on or before the anniversary of approval and on completion of the project.
- You must report as soon as practicable anything that might warrant review of ethical approval of the project including:
 - Serious or unexpected adverse events (which should be reported within 72 hours).
 - Unforeseen events that might affect continued ethical acceptability of the project.
- Any changes to the proposal must be approved prior to their implementation (except where an amendment is undertaken to eliminate *immediate* risk to participants).
- Personnel working on this project must be sufficiently qualified by education, training and experience for their role, or adequately supervised. Changes to personnel must be reported and approved.
- Personnel must disclose any actual or potential conflicts of interest, including any financial or other interest or affiliation, as relevant to this project.
- Data and primary materials must be retained and stored in accordance with the relevant legislation and University guidelines.
- Ethics approval is dependent upon ongoing compliance of the research with the *National Statement on Ethical Conduct in Human Research*, the *Australian Code for the Responsible Conduct of*



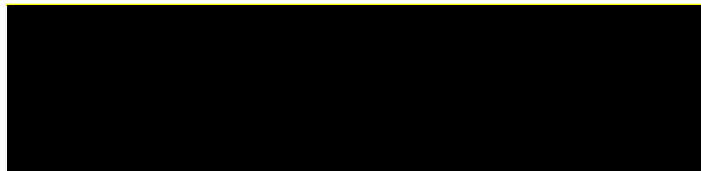
Research, applicable legal requirements, and with University policies, procedures and governance requirements.

- The Ethics Office may conduct audits on approved projects.
- The Chief Investigator has ultimate responsibility for the conduct of the research and is responsible for ensuring all others involved will conduct the research in accordance with the above.

This letter constitutes ethical approval only.

Please contact the Ethics Office should you require further information or clarification.

Sincerely,



Professor Michael Skilton
Chair
Health Review Committee (Low Risk)

The University of Sydney of Sydney HRECs are constituted and operate in accordance with the National Health and Medical Research Council's (NHMRC) [National Statement on Ethical Conduct in Human Research \(2018\)](#) and the NHMRC's [Australian Code for the Responsible Conduct of Research \(2018\)](#)

Participant Information Statement



Research Study: An integrated educational intervention to enhance the evidence-based practice skills of student radiographer

Associate Professor Warren Reed

Discipline of Medical Imaging Science, Sydney School of Health Science, Faculty of Medicine and Health

Email: warren.reed@sydney.edu.au

Mrs. Laura Di Michele (Doctor of Philosophy student)

Email: laura.dimichele@sydney.edu.au

1. What is this study about?

We are conducting a research study that investigates the effectiveness of an educational intervention designed to enhance the evidence based practice capabilities of student diagnostic radiographers. Taking part in this study is voluntary.

Please read this sheet carefully and ask questions about anything that you don't understand or want to know more about.

2. Who is running the study?

The study is being carried out by the following researchers:

- Associate Professor Warren Reed, Program Director – Bachelor of Applied Science (Diagnostic Radiography), Sydney School of Health Science, Faculty of Medicine and Health
- Associate Professor Amani Bell, Speech Pathology, Sydney School of Health Science, Faculty of Medicine and Health
- Dr Kate Thomson, Senior Lecturer, Sydney School of Health Science, Faculty of Medicine and Health

Laura Di Michele is conducting this study as the basis for the degree of Doctor of Philosophy at The University of Sydney.

3. Who can take part in the study?

Students undertaking the Master of Diagnostic Radiography program at the University of Sydney who are in their second of study. All students who are enrolled in this degree will be invited to take part during their second year.

4. What will the study involve for me?

If you decide to take part in this study, you will be asked to complete two short surveys. One of these surveys will be administered at the start of your second year in the program and the other at the completion of your second year.

These online surveys are expected to take 10-15 minutes each, totalling in a 20-30 minute time commitment from you should you decide to take part in both. The survey will ask you questions in relation to your use, knowledge, attitudes and skills for evidence-based practice.

5. Can I withdraw once I've started?

Being in this study is completely voluntary and you do not have to take part.

Your decision will not affect your current or future relationship with the researchers or anyone else at The University of Sydney.

By submitting your survey, you consent to take part in the study. You can withdraw any time before you submit however once your responses are submitted, they cannot be withdrawn. This is because they are anonymous, and we will not be able to tell which one yours is.

6. Are there any risks or costs?

Aside from giving up your time, we do not expect that there will be any risks or costs associated with taking part in this study.

7. Are there any benefits?

You will not receive any direct benefits from being in the study.

8. What will happen to information that is collected?

By providing your consent, you are agreeing to us collecting information about you for the purposes of this study.

Any information you provide us will be stored securely and we will only disclose identifiable information with your permission, unless we are required by law to release information. We are planning for the study findings to be published.

You will not be individually identifiable in these publications.

Electronic data that is generated through participation in this study will be stored securely on a university administered, password protected research drive. Only the researchers named on this PIS will have access to the data.

9. Will I be told the results of the study?

You have a right to receive feedback about the overall results of this study. If you wish to receive an overview of the study findings you will have the option to pass on your email address at the completion of the survey. This feedback will be in the form of a brief lay summary.

10. What if I would like further information?

When you have read this information, the following researcher/s will be available to discuss it with you further and answer any questions you may have:

- Laura Di Michele, Associate Lecturer – Medical Imaging Science, laura.dimichele@sydney.edu.au

11. What if I have a complaint or any concerns?

The ethical aspects of this study have been approved by the Human Research Ethics Committee (HREC) of The University of Sydney [INSERT HREC Approval No. once obtained] according to the *National Statement on Ethical Conduct in Human Research (2007)*.

If you are concerned about the way this study is being conducted or you wish to make a complaint to someone independent from the study, please contact the University:

Human Ethics Manager
human.ethics@sydney.edu.au
+61 2 8627 8176

This information sheet is for you to keep

Participant Information Statement



Research Study: Evidence-based practice in diagnostic radiography curriculum

Dr Warren Reed

Medical Imaging Science, Sydney School of Health Science, Faculty of Medicine and Health

Email: warren.reed@sydney.edu.au

Mrs. Laura Di Michele (PhD student) | Email: laura.dimichele@sydney.edu.au

1. What is this study about?

We're conducting a research study on student experiences of evidence-based practice in curriculum. We're interested in finding out more about your experiences during the second year of the Master of Diagnostic Radiography program. Taking part is optional.

Please read this sheet and ask about things that aren't clear or you want to know more about.

2. Who is running the study?

The researchers conducting this study are:

- Associate Professor Warren Reed, Program Director – Bachelor of Applied Science (Diagnostic Radiography), Sydney School of Health Science, Faculty of Medicine and Health
- Associate Professor Amani Bell, Speech Pathology, Sydney School of Health Science, Faculty of Medicine and Health
- Dr Kate Thomson, Senior Lecturer, Sydney School of Health Science, Faculty of Medicine and Health

Laura Di Michele is doing this study as part of their PhD candidature at The University of Sydney.

3. Who can take part in the study?

We are seeking second year Master of Diagnostic radiography students.

4. What will the study involve for me?

If you decide to participate in this study, you will be asked to participate in a group discussion that relates to your experiences during the second year of the Master of

Diagnostic radiography program, and specifically of the curriculum as it relates to evidence-based practice.

The focus group discussion will take no longer than 1.5 hours and take place on campus at the University of Sydney. These discussions will be audio recorded, transcribed and analysed to help inform educators about the best ways in which to teach evidence-based practice.

5. Can I withdraw once I've started?

Participating in this study is optional and you do not have to take part.

Your decision will have no impact on your current or future relationship with the researchers or anyone else at The University of Sydney.

If you take part in a focus group, you are free to stop at any stage or to refuse to answer any of the questions. However, once the group starts talking, it may not be possible to withdraw your comments from our records due to the group setting.

6. Are there any risks or costs?

Aside from giving up your time, we do not expect that there will be any risks or costs associated with participating in this study.

7. Are there any benefits?

You will be provided with a \$50 gift voucher as a thank you for your time. Additionally, refreshments will be provided to participants. The outcomes of these focus groups will help to inform health professional educators on the best ways in which to teach evidence-based practice.

8. What will happen to information that is collected?

By giving your consent, you agree to us gathering information about you for this study.

Any identifiable information you share us will be securely stored and will only be disclosed with your consent unless we are legally required to release information. We plan to publish the findings of this study. You will not be identifiable in these publications.

We will use Zoom AI to transcribe interviews. This will involve sharing your information with Zoom. We will not share this information with anyone else without your consent unless we are required to do so by law. We will store this information and dispose of it securely following our [Recordkeeping Policy 2017](#). Zoom is owned by Zoom Video Communications, inc. and is located in San Jose, California, US. For more information

about how your information will be handled, please see the University's [privacy webpage](#).

Sharing research data is important for advancing knowledge and innovation. A de-identified set of the data collected in this study may be made available for use in future research.

9. Will I be told the results of the study?

You have the right to hear the results of this study. You can receive a summary by providing your contact details on the consent form. This feedback will be provided as a plain language summary.

10. What if I would like further information?

After reading this information, the researcher/s will be available to have further discussions with you and answer any questions you may have:

- Laura Di Michele – laura.dimichele@sydney.edu.au

11. What if I have a complaint or any concerns?

The ethical aspects of this study have been approved by the Human Research Ethics Committee (HREC) of The University of Sydney [[INSERT HREC Approval No. once obtained](#)] in accordance with the *National Statement on Ethical Conduct in Human Research (2007)*.

If you have any concerns about the study's procedures or would like to make a complaint to someone not involved in the study, please contact the University:

Human Ethics Manager
human.ethics@sydney.edu.au
+61 2 8627 8176

This information is for you to keep

Monday, 19 December 2022

Dr Warren Reed
Clinical Imaging; Faculty of Medicine and Health
Email: warren.reed@sydney.edu.au

Dear Warren,

The University of Sydney Human Research Ethics Committee (HREC) has considered your application.

I am pleased to inform you that after consideration of your response, your project has been approved.

Details of the approval are as follows:

Project No.: 2022/832
Project Title: The self-reported knowledge, skills and attitudes of Australian diagnostic radiographers towards evidence-based practice.
Authorised Personnel: Reed Warren; Bell Amani; Di Michele Laura; Thomson Kate;
Approval Period: 19/12/2022 to 19/12/2026
First Annual Report Due: 19/12/2023

Documents Approved:

Date Uploaded	Version Number	Document Name
01/12/2022		V2 PIS
01/12/2022		V2 Recruitment e-blast
10/10/2022		Survey questions Study phase 2
10/10/2022		Stage 2 questionnaire
07/10/2022		PIS Study stage 1
07/10/2022		Survey questions Study phase 1
07/10/2022		Social media recruitment

Condition/s of Approval

- Research must be conducted according to the approved proposal.
- An annual progress report must be submitted to the Ethics Office on or before the anniversary of approval and on completion of the project.
- You must report as soon as practicable anything that might warrant review of ethical approval of the project including:
 - Serious or unexpected adverse events (which should be reported within 72 hours).
 - Unforeseen events that might affect continued ethical acceptability of the project.
- Any changes to the proposal must be approved prior to their implementation (except where an amendment is undertaken to eliminate *immediate* risk to participants).
- Personnel working on this project must be sufficiently qualified by education, training and experience for their role, or adequately supervised. Changes to personnel must be reported and approved.
- Personnel must disclose any actual or potential conflicts of interest, including any financial or other interest or affiliation, as relevant to this project.
- Data and primary materials must be retained and stored in accordance with the relevant legislation and University guidelines.

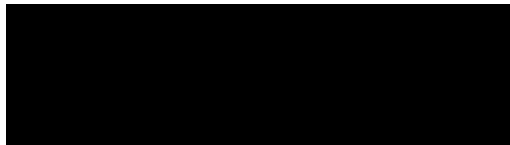


- Ethics approval is dependent upon ongoing compliance of the research with the *National Statement on Ethical Conduct in Human Research*, the *Australian Code for the Responsible Conduct of Research*, applicable legal requirements, and with University policies, procedures and governance requirements.
- The Ethics Office may conduct audits on approved projects.
- The Chief Investigator has ultimate responsibility for the conduct of the research and is responsible for ensuring all others involved will conduct the research in accordance with the above.

This letter constitutes ethical approval only.

Please contact the Ethics Office should you require further information or clarification.

Sincerely,



Associate Professor Haryana Dhillon
Chair
Human Research Ethics Committee (HREC 3)

The University of Sydney of Sydney HRECs are constituted and operate in accordance with the National Health and Medical Research Council's (NHMRC) [National Statement on Ethical Conduct in Human Research \(2018\)](#) and the NHMRC's [Australian Code for the Responsible Conduct of Research \(2018\)](#)

Participant Information Statement

Study phase one



Research Study: The self-reported knowledge, skills, and attitudes of Australian diagnostic radiographers towards evidence-based practice

Associate Professor Warren Reed

Discipline of Medical Imaging Science, Sydney School of Health Science, Faculty of Medicine and Health

Email: warren.reed@sydney.edu.au

Mrs. Laura Di Michele (Doctor of Philosophy student)

Email: laura.dimichele@sydney.edu.au

1. What is this study about?

We are conducting a research study about the self-reported knowledge, skills, and attitudes of diagnostic radiographers in relation to evidence-based practice. Taking part in this study is voluntary.

Please read this sheet carefully and ask questions about anything that you don't understand or want to know more about.

2. Who is running the study?

The study is being carried out by the following researchers:

- Associate Professor Warren Reed, Program Director – Bachelor of Applied Science (Diagnostic Radiography), Sydney School of Health Science, Faculty of Medicine and Health
- Associate Professor Amani Bell, Speech Pathology, Sydney School of Health Science, Faculty of Medicine and Health
- Dr Kate Thomson, Senior Lecturer, Sydney School of Health Science, Faculty of Medicine and Health

Laura Di Michele is conducting this study as the basis for the degree of Doctor of Philosophy at The University of Sydney.

3. Who can take part in the study?

All currently practicing, MRPBA registered Australian diagnostic radiographers are eligible to participate in this study.

4. What will the study involve for me?

If you decide to take part in this study, you will be asked to complete a short survey that should take approximately 10 minutes to complete.

5. Can I withdraw once I've started?

Yes, this study is completely voluntary, and you do not have to take part.

Your decision will not affect your current or future relationship with the researchers or anyone else at The University of Sydney.

By submitting your survey, you consent to take part in the study. You can withdraw any time before you submit however once your responses are submitted, they cannot be withdrawn. This is because they are anonymous, and we will not be able to tell which one yours is.

6. Are there any risks or costs?

Aside from giving up your time, we do not expect that there will be any risks or costs associated with taking part in this study.

7. Are there any benefits?

Participants will be offered the opportunity to go in the draw to win one of 5x \$50 vouchers.

8. What will happen to information that is collected?

By providing your consent, you are agreeing to us collecting information about you for the purposes of this study.

Any information you provide us will be stored securely and we will only disclose identifiable information with your permission, unless we are required by law to release information. We are planning for the study findings to be published.

You will not be individually identifiable in these publications.

Electronic data that is generated through participation in this study will be stored securely on a university administered, password protected research drive. Only the researchers named on this PIS will have access to the data.

9. Will I be told the results of the study?

You have a right to receive feedback about the overall results of this study. If you wish to receive an overview of the study findings, you will have the option to pass on your email

address at the completion of the survey. This feedback will be in the form of a brief lay summary.

10. What if I would like further information?

When you have read this information, the following researcher/s will be available to discuss it with you further and answer any questions you may have:

- Laura Di Michele, Associate Lecturer – Medical Imaging Science,
laura.dimichele@sydney.edu.au

11. What if I have a complaint or any concerns?

The ethical aspects of this study have been approved by the Human Research Ethics Committee (HREC) of The University of Sydney [INSERT HREC Approval No. once obtained] according to the *National Statement on Ethical Conduct in Human Research (2007)*.

If you are concerned about the way this study is being conducted or you wish to make a complaint to someone independent from the study, please contact the University:

Human Ethics Manager
human.ethics@sydney.edu.au
+61 2 8627 8176

This information sheet is for you to keep

A5. Response to reviewers *“Knowledge translation: Radiographers compared with other healthcare professionals”*

Dear Reviewers,

The authors would like to express their most sincere gratitude for your time in reviewing the paper and helpful suggestions offered. The paper has undoubtedly significantly improved as a direct result of the feedback that you provided, and we appreciate your thoughtful perspective. Below is a summary of the changes made in response to your feedback.

Reviewers comment	Addressed by
Reviewer #1	
Line18: Western healthcare Q:Only Western? I think EBP is overall the cornerstone in healthcare	Noted: western amended to modern.
Line35: Other disciplines Q:healthcare disciplines or other fields?	Noted: amended to healthcare disciplines.
Line53: apply practices learned during their training rather Q: is education part not EBP?	Clarified: amended to ‘to apply practices learned during their training, even if these may be outdated rather than follow departmental protocols.’
Line 21/25 Norwegian, Singaporean Q: the question arises why exactly these countries are mentioned? Because it reflects? Because they are ahead here? For some other reason? or no reason?	A recent study from Ghana has also been added to this section. These studies were chosen due to being recent and a reflection of international views within radiography in relation to EBP. In order to make this more clear the following statement has been included: Inserted - the following three studies were included as exemplars of recent reflections of international views within radiography in relation to EBP.
Reviewer #2	
1. Title. Consider changing the title of the manuscript to 'Knowledge translation: radiographers compared to other healthcare professionals'. This to make the paper jump out at the reader/radiography and other healthcare	Noted and title amended to 'Knowledge translation: radiographers compared to other healthcare professionals'.

leaders/future systematic and empirical researchers. It will show the authors have considered the topic from: The point of strength of radiography as a profession in its own right The radiography authors active voice, which recognises knowledge translation is multi-professional and learning is a two way process The content of the paper is worth reading and citing	
2. Abstract and key words. These do not need to change. They are logical and have a coherent flow to enable the reader and researcher to want to read the full paper.	Thank you for your feedback.
3. Introduction. This is good. It sets the scene for the review. Consider to further set the scene, critical evaluation of: The length of time since medical doctors, nurses, radiographers and other AHPs implemented degree level education as entry into professional practice. Reflect on the level of KT based on this. The attitudes, perceptions and barriers to the above professions academic and clinical practitioners on research-informed education, and implementing the research and knowledge translation process. Suggested further reading C, Williams 2013 Attitudes to and perceptions of research for health science lecturers Radiography, 19, 1, 56 - 61 and the subsequent letters of correspondence. R Higgins, L Robinson, P Hogg 2015 Unlocking student research potential: toward a research culture in radiography undergraduate learning curricular- J Med Imaging Radiat Sci Inter-professional relationships between all healthcare professionals, and protectionism between radiologists and radiographers Radiography professionals within the four-tier non-medical hierarchy structure; working in modalities such as CT, fluoroscopy, isotopes, mammography, MRI, plain film and ultrasound; and impacting on the patient pathway - request justification, technique, image interpretation, verbal and written report / descriptive finding, imaging examination conclusion, recommendation for future patient	Thank you for your suggestion, this has been implemented into the second paragraph of the introduction: Inserted - "Radiography as a profession has required University degree level qualification for a reasonably short period of time in relation to medicine, nursing and some other allied health professions." The authors appreciate that research-informed education and the attitudes and perceptions of the academics that teach our students and their barriers to research is an important area of research, however it is beyond the scope of this paper to explore the topic in sufficient depth. This area is well worth the authors looking into as potential future work for publication. Thank you for the suggestion, this great article has a lot to offer the discussion and the reference has been incorporated into both the "Knowledge translation in diagnostic radiography" and "The way forward for KT in DR" section.

management, therapeutic intervention, and discharge. This to reflect the diversity of clinical, research and knowledge translation practice rather than authors' narrow focus on plain film imaging technique. Lead time, for any healthcare evidence-based practice research to go through the knowledge translation phase to the implementation phase in clinical practice to benefit the patient	The authors agree that there is a hugely diverse range of roles played by radiographers within modern clinical practice. The specific examples chosen in the section titled “The knowledge to practice gap in radiography” were just two of many and not intended to provide a complete overview of the area’s in which current clinical practice lags behind best practice as defined in research. The examples chosen were intended to be easily understood to all radiographers regardless of where they sit within their own hierarchy or which modality they may have chosen to specialise in. Examples utilising advanced modalities such as CT, MRI, US etc were avoided as these would not necessarily be easily understandable to every radiographer regardless of their post graduate education. In order to make this clearer to the reader an additional sentence has been included into the section. Inserted - “These are just two of the many examples within radiography where a knowledge to practice gap exists.”
4. Aim. Consider writing the aim as a PICO and then have your current aim as the objectives of analysis, synthesis and reflections of radiography knowledge translation practice compared to other healthcare practitioners	Thank you for the suggestion, the aim has been modified to “This literature review will compare KT in DR to other discipline in order to identify potential ways in which to better translate knowledge to practice in DR.”
5. Methods. If your paper should be redesigned as a qualitative systematic review such as Scott et al (2012, in your reference list) or a more structured narrative review to encompass the wider focus of knowledge translation of the radiography profession compared to the other professions.	The authors see much merit in a systematic review however do not feel that a systematic review at this stage would be possible within the required timeframe of the special issue. The authors currently have a systematic review

	underway looking into KT strategies in allied health that they will be looking to publish in the future. A paragraph on methods has been included in order to help to structure the paper more effectively.
6. Findings. The authors content should be restructured to show a logical and coherent flow of their aim and objectives to allow a scientific approach to the analysis of the intervention and comparator. Include one other radiography task such as mammography	Thank you, we think the re-writing of the objectives, the addition of the methodology, the expansion of the discussion and the re-writing of the conclusion, have all led to a more logical and coherent flow through the paper. The addition of other radiography tasks has been discussed in the authors response to reviewer 2, point 3.
7. Discussion. Create this section to do data synthesis, reflection and recommendations for radiography practice. Evaluate why radiography students are doing Research-informed teaching in their university education but as you show they are not implementing it in practice. Consider: If this is due to when In the early career level being an operator (IRMER) compared to a preceptorship practitioner in other healthcare professions; The practitioner and advanced practitioner levels job plans for all healthcare professions The consultant radiographer and other professions consultant level having a PhD /MD or no PhD and their confidence and peer support to do research and knowledge translation. Protectionism as a barrier and ways to do the paradigm shift	Thank you for your feedback, a discussion section has been added to the paper to provide a more scientific structure and aid in clarity for the reader. Additional discussion of the transition into work from student radiographer has been added as per suggestion. The changes included are too substantial to include in this document and may be found under the subheading 'The way forward for evidence-based radiography'.
8. Conclusion. This is good but will need tweaking based on the major revision.	Conclusion has been substantially modified to reflect the revisions.
9. References. As per suggestions in the introduction section above.	As per comments in introduction section above.
Reviewer #3	
The paper use a narrative review but do not describe search strategy or inclusion/exclusion criteria	Thank you for your comment, a methods paragraph has now been added for clarity.
Evidence based radiography - today Is interesting but just five of the references are newer then 2013?	Thank you for your feedback, the authors have combined these sections due to the major structural changes that have been made to the

A5. Response to reviewers *“Knowledge translation: Radiographers compared with other healthcare professionals”*

Dear Reviewers,

The authors would like to express their most sincere gratitude for your time in reviewing the paper and helpful suggestions offered. The paper has undoubtedly significantly improved as a direct result of the feedback that you provided, and we appreciate your thoughtful perspective. Below is a summary of the changes made in response to your feedback.

Reviewers comment	Addressed by
Reviewer #1	
Line18: Western healthcare Q:Only Western? I think EBP is overall the cornerstone in healthcare	Noted: western amended to modern.
Line35: Other disciplines Q:healthcare disciplines or other fields?	Noted: amended to healthcare disciplines.
Line53: apply practices learned during their training rather Q: is education part not EBP?	Clarified: amended to ‘to apply practices learned during their training, even if these may be outdated rather than follow departmental protocols.’
Line 21/25 Norwegian, Singaporean Q: the question arises why exactly these countries are mentioned? Because it reflects? Because they are ahead here? For some other reason? or no reason?	A recent study from Ghana has also been added to this section. These studies were chosen due to being recent and a reflection of international views within radiography in relation to EBP. In order to make this more clear the following statement has been included: Inserted - the following three studies were included as exemplars of recent reflections of international views within radiography in relation to EBP.
Reviewer #2	
1. Title. Consider changing the title of the manuscript to 'Knowledge translation: radiographers compared to other healthcare professionals'. This to make the paper jump out at the reader/radiography and other healthcare	Noted and title amended to 'Knowledge translation: radiographers compared to other healthcare professionals'.

leaders/future systematic and empirical researchers. It will show the authors have considered the topic from: The point of strength of radiography as a profession in its own right The radiography authors active voice, which recognises knowledge translation is multi-professional and learning is a two way process The content of the paper is worth reading and citing	
2. Abstract and key words. These do not need to change. They are logical and have a coherent flow to enable the reader and researcher to want to read the full paper.	Thank you for your feedback.
3. Introduction. This is good. It sets the scene for the review. Consider to further set the scene, critical evaluation of: The length of time since medical doctors, nurses, radiographers and other AHPs implemented degree level education as entry into professional practice. Reflect on the level of KT based on this. The attitudes, perceptions and barriers to the above professions academic and clinical practitioners on research-informed education, and implementing the research and knowledge translation process. Suggested further reading C, Williams 2013 Attitudes to and perceptions of research for health science lecturers Radiography, 19, 1, 56 - 61 and the subsequent letters of correspondence. R Higgins, L Robinson, P Hogg 2015 Unlocking student research potential: toward a research culture in radiography undergraduate learning curricular- J Med Imaging Radiat Sci Inter-professional relationships between all healthcare professionals, and protectionism between radiologists and radiographers Radiography professionals within the four-tier non-medical hierarchy structure; working in modalities such as CT, fluoroscopy, isotopes, mammography, MRI, plain film and ultrasound; and impacting on the patient pathway - request justification, technique, image interpretation, verbal and written report / descriptive finding, imaging examination conclusion, recommendation for future patient	Thank you for your suggestion, this has been implemented into the second paragraph of the introduction: Inserted - "Radiography as a profession has required University degree level qualification for a reasonably short period of time in relation to medicine, nursing and some other allied health professions." The authors appreciate that research-informed education and the attitudes and perceptions of the academics that teach our students and their barriers to research is an important area of research, however it is beyond the scope of this paper to explore the topic in sufficient depth. This area is well worth the authors looking into as potential future work for publication. Thank you for the suggestion, this great article has a lot to offer the discussion and the reference has been incorporated into both the "Knowledge translation in diagnostic radiography" and "The way forward for KT in DR" section.

management, therapeutic intervention, and discharge. This to reflect the diversity of clinical, research and knowledge translation practice rather than authors' narrow focus on plain film imaging technique. Lead time, for any healthcare evidence-based practice research to go through the knowledge translation phase to the implementation phase in clinical practice to benefit the patient	The authors agree that there is a hugely diverse range of roles played by radiographers within modern clinical practice. The specific examples chosen in the section titled “The knowledge to practice gap in radiography” were just two of many and not intended to provide a complete overview of the area’s in which current clinical practice lags behind best practice as defined in research. The examples chosen were intended to be easily understood to all radiographers regardless of where they sit within their own hierarchy or which modality they may have chosen to specialise in. Examples utilising advanced modalities such as CT, MRI, US etc were avoided as these would not necessarily be easily understandable to every radiographer regardless of their post graduate education. In order to make this clearer to the reader an additional sentence has been included into the section. Inserted - “These are just two of the many examples within radiography where a knowledge to practice gap exists.”
4. Aim. Consider writing the aim as a PICO and then have your current aim as the objectives of analysis, synthesis and reflections of radiography knowledge translation practice compared to other healthcare practitioners	Thank you for the suggestion, the aim has been modified to “This literature review will compare KT in DR to other discipline in order to identify potential ways in which to better translate knowledge to practice in DR.”
5. Methods. If your paper should be redesigned as a qualitative systematic review such as Scott et al (2012, in your reference list) or a more structured narrative review to encompass the wider focus of knowledge translation of the radiography profession compared to the other professions.	The authors see much merit in a systematic review however do not feel that a systematic review at this stage would be possible within the required timeframe of the special issue. The authors currently have a systematic review

	underway looking into KT strategies in allied health that they will be looking to publish in the future. A paragraph on methods has been included in order to help to structure the paper more effectively.
6. Findings. The authors content should be restructured to show a logical and coherent flow of their aim and objectives to allow a scientific approach to the analysis of the intervention and comparator. Include one other radiography task such as mammography	Thank you, we think the re-writing of the objectives, the addition of the methodology, the expansion of the discussion and the re-writing of the conclusion, have all led to a more logical and coherent flow through the paper. The addition of other radiography tasks has been discussed in the authors response to reviewer 2, point 3.
7. Discussion. Create this section to do data synthesis, reflection and recommendations for radiography practice. Evaluate why radiography students are doing Research-informed teaching in their university education but as you show they are not implementing it in practice. Consider: If this is due to when In the early career level being an operator (IRMER) compared to a preceptorship practitioner in other healthcare professions; The practitioner and advanced practitioner levels job plans for all healthcare professions The consultant radiographer and other professions consultant level having a PhD /MD or no PhD and their confidence and peer support to do research and knowledge translation. Protectionism as a barrier and ways to do the paradigm shift	Thank you for your feedback, a discussion section has been added to the paper to provide a more scientific structure and aid in clarity for the reader. Additional discussion of the transition into work from student radiographer has been added as per suggestion. The changes included are too substantial to include in this document and may be found under the subheading 'The way forward for evidence-based radiography'.
8. Conclusion. This is good but will need tweaking based on the major revision.	Conclusion has been substantially modified to reflect the revisions.
9. References. As per suggestions in the introduction section above.	As per comments in introduction section above.
Reviewer #3	
The paper use a narrative review but do not describe search strategy or inclusion/exclusion criteria	Thank you for your comment, a methods paragraph has now been added for clarity.
Evidence based radiography - today Is interesting but just five of the references are newer then 2013?	Thank you for your feedback, the authors have combined these sections due to the major structural changes that have been made to the

The knowledge to practice gap Just two references newer than 2015	paper in response to reviewer 2's comments. Additional references have been added to the paper, please see references 10, 11, 12, 16, 27, 29, 46, 47, 53, 54, 58 in the ammended reference list
Systematic approaches Just one reference newer then 2014	
Knowledge translation Just two references newer than 2015	
The way forward One reference from 2019 the rest is older then 2013	
The paper have an interesting approach and could make us better to understand the "slow process" of EBR. But there is a luck of methodology and references are overall "very old" so it is hard to understand the result and description.	Thank you for your feedback, the authors have added additional structure to the paper and outlined the methodology in order to improve the papers clarity. Additional references added as above.

We trust that the changes made as a result of your feedback have significantly improved the paper and look forward to hearing from you again.

Kind regards,

The Authors.

A6. Response to reviewers "Student radiographers' perceptions of evidence-based practice during clinical placements: implications for health professional education"

Dear Dave and reviewers,

Thank you for the acceptance of our paper "Student radiographers' perceptions of evidence-based practice during clinical placements: implications for health professional education" with minor revisions. We appreciate the opportunity to publish in the *International Journal of Work Integrated Learning* and have addressed your feedback in the table below and attached manuscript.

Relevance to Co-op/WIL and significance of contribution to the literature	
To enhance the contribution of the paper to the sector, it would be useful to include some recommendations on what universities and WIL pedagogy specifically can do to help push the change called for in the paper (namely, promoting EBP with workplaces hosting	Thank you for your feedback. This has been integrated more strongly throughout the discussion and conclusion of the paper (line 296 – 302).

students). The link to WIL needs to be strengthened.	
Use of literature	
Evidence based practice needs to be defined early on in the paper as a non-applied health reader this wasn't clear to me.	Thank you for the feedback this has now been included in the introduction
Methodology and Findings/results	
Methodology - The explanation of the use of reflexive thematic analysis (RTA) is somewhat vague and possibly also a little confused (or presented in a way that was confusing to the reader). For example, Lines 111 to 116 do not give a clear explanation of RTA – and a constructivist approach would more likely be predominantly utilising an inductive RTA approach (e.g., latent meaning explored and open-coding - which is what it sounds like the researcher/s did). A constructivist epistemology would also give emphasis not only to the recurrence of themes but to the meaningfulness/importance ascribed to an issue by the participants (and not what appears in the literature on the topic – which is what the author/s then say when they compared their findings to what already is known on the topic – see Lines 124-125 – which is a more positivist and deductive approach). You can do both inductive and deductive analysis with RTA but you need to clearly explain when and why this each approach was used. The 6 phases sound like they've been followed but some examples of the coding cycles would be helpful to see the iterative and reflexive aspect.	Thank you for your feedback and notes on this. I can see on further reading that I agree and did indeed take an inductive approach. Thank you, I have revised the manuscript accordingly (line 115 and 123).

Discussion, conclusions, implications	
Overall the Discussion section is fine, but it needs to make stronger links to WIL and WIL's role regarding EBP education. I was also left wondering if the workplace culture is an important factor in determining who gets access to EBP education, and the benefits that come with it regarding future employment opportunities, then there is a significant access and equity issue at play here. What are universities doing to address this problem? It can't be left up to graduates to shift a workplace's attitudes to EBP – there is a power imbalance which is acknowledged by the participants in this study – the senior staff dictate how things are done. Other strategies are required – so what can universities and WIL pedagogy do to help push the change called for in the paper? Need to offer some suggestions here to enhance to contribution of the paper.	Thank you for your suggestions, these have been implemented into the discussion (line 296 – 302)
The conclusion could be expanded to explore practical examples of the recommended "integration of academic and clinical curriculum".	Thank you, this has been done (line 327, 388 – 340).
Abstract	
Stronger link to WIL needed to be evidenced in the paper and therefore Abstract.	Thank you, abstract has been revised.
Grammar, Formatting, organization and referencing style	
Typo on Line 29 – misspelt author - it is Winchester-Seeto Typo on Line 37 – university doesn't need capital letter	Thank you, these errors have now been fixed in the manuscript.
Recommend adding to the Conclusion section with an example/s of better preparation for the workplace.	Thank you, this has been done (line 388 – 340) .

Kind regards,

Laura Di Michele

On behalf of:

Amani Bell, Kate Thomson, Mark McEntee, Belinda Kenny, Warren Reed

A7. Response to reviewers "Assessing evidence-based practice among Australian radiographers: a self-report survey"

Dear Dr Meertens,

Thank you for the opportunity to resubmit my manuscript with major revisions for peer review to *Radiography*. I appreciate the time and feedback of yourself and the reviewers and have addressed this feedback in the table below.

Assoc Editor	
In particular, I agree with reviewer 2 that the study needs more discussion of how the results of your survey could actually inform targeted strategies on weaker points that emerged from the survey and any precedence of how a baseline assessment can be a useful exercise.	Thank you for the suggestion I have incorporated more discussion of potential strategies that target the weaknesses observed in the study and have also included more rationale as to why establishing a baseline is an important exercise. These changes can be noted in the introduction, discussion and conclusion sections of the manuscript.
Please also state the p-value threshold used for significance in the statistical analysis section.	This has been added to the suggested section.
I would suggest if you have performed Pearson's correlation analysis, then you should present your results for these, even if not statistically significant.	The Pearson's correlation has now been reported.
Please also submit a copy of the full survey as supplemental materials	The authors do not own the intellectual property of the survey however used it with permission of the survey owners. The survey may be accessed

	online at the following website https://ebpq.co.uk/ which is provided in the reference list (see reference 17).
Reviewer 1	
Suggested requested in attachment	The suggested changes have now been implemented into the manuscript.
Reviewer 2	
While you have made it clear that the study is based on self-reported data, I think you need to make a stronger case for why we can draw meaningful conclusions from data of this nature. You haven't commented on how we can be sure that the actual facts regarding EBP in practice are not under-reported or over-reported by participants.	Thank you for the comment, I have revised the limitations section with the following: Additionally, as with any research using surveys, there is the potential for non-response bias to limit the results, (Berg, 2005b) as those who are more inclined toward evidence-based practice may have been more likely to participate in the survey. Nonetheless, the sampling strategy used was random with all Australian radiographers having equal opportunity to complete the survey and data collected indicates a good spread of participants across all demographic categories measured.
The recommendations from the study need to go further. All you have really said is that ways of enhancing the knowledge, skills, and attitudes of Australian radiographers need to be found (paraphrasing what you've written). The submission would have far greater impact if your recommendations were more specific, and actually gave educators in Australia (and by extension, overseas) something to work with to enhance their curricula and methods of assessment.	Thank you for this observation, I have now incorporated more in-depth recommendations into the discussion section of the paper.

You have stated on several occasions that your study provides a "baseline". but you haven't really explained the purpose of such a baseline. What is its applicability? How will it enhance the implementation of EBP in our profession?	Thank you for this observation, further explanation has now been provided in the introduction and conclusion of the manuscript.
Suggested requested in attachment	The suggested changes have now been implemented into the manuscript.

.I look forward to hearing from you.

Kind regards,

Laura Di Michele