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Systematic Review

Preliminary clinical evaluation (PCE): A transnational scoping review of current radiography practice

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ABSTRACT

Introduction: Image interpretation by radiographers has gained widespread recognition; however, current evidence provides very limited knowledge of the state and scope of practice transnationally. This study therefore sought to explore the current state and scope of preliminary clinical evaluation (PCE) practice to further understand international best practices in terms of policy, training and education, and practice competence of radiographers when carrying out PCE.

Method: A comprehensive literature search was completed via federated electronic databases (EBSCOhost and Web of Science) and professional radiography platforms for journal articles and policy or practice guidance documents, respectively. Data were charted from eligible studies following screening of articles in accordance with the predefined eligibility criteria. Themes were generated using inductive narrative analysis.

Results: Thirty-one peer reviewed articles and 5 radiography practice policy documents were identified. Over 60% of the included studies were carried out in the United Kingdom and Australia with about 60% focused on projectional radiography of the appendicular and axial skeletons. Three main themes were developed and included: scope of PCE practice and implementation; PCE proficiency indicators; factors influencing PCE participation and performance.

Conclusion: Gaps exist around defined scope of practice, standardisation, commenting format and compliance with policy. There is very limited evidence around PCE practice in cross-sectional imaging, thus, it is difficult to ascertain the current state and scope of practice internationally. There is a need for countries to develop standard commenting frameworks as well as enforcement of compliance. Additionally, more research is required to ascertain the competence and benefits of PCE practice within cross sectional imaging.

RÉSUMÉ

Introduction: L'interprétation des images par les radiographes est de plus en plus reconnue; cependant, les données actuelles ne fournissent qu'une connaissance très limitée de l'état et de la portée de la pratique à l'échelle transnationale. Cette étude a donc cherché à explorer l'état actuel et la portée de la pratique de l'évaluation clinique préliminaire (ECP) afin de mieux comprendre les meilleures pratiques internationales en termes de politique, de formation et d'éducation, et de compétence pratique des radiographes lors de l'exécution de l'ECP..

Méthodologie: Une recherche documentaire complète a été effectuée via des bases de données électroniques fédérées (EBSCOhost et Web of Science) et des plateformes de radiographie professionnelle pour les articles de journaux et les documents d'orientation politique ou pratique, respectivement. Les données des études admissibles ont été consignées dans un tableau après vérification des articles conformément aux critères d'admissibilité prédéfinis. Des thèmes ont été générés à l'aide d'une analyse narrative inductive.

Résultats: 31 articles évalués par des pairs et 5 documents de politique de pratique de la radiographie ont été identifiés. Plus de 60% des études incluses ont été réalisées au Royaume-Uni et en Australie, et environ 60% d'entre elles portaient sur la radiographie par projection des squelettes appendiculaire et axial. Trois thèmes principaux ont été développés: la portée de la pratique et de la mise en œuvre de l'ECP; les indicateurs de compétence de l'ECP; les facteurs influençant la participation et la performance de l'ECP.

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Conclusion: Il existe des lacunes en ce qui concerne la définition du champ d'application de la pratique, la normalisation, le format des commentaires et le respect de la politique. Il existe très peu de données sur la pratique de l'ECP dans l'imagerie transversale, et il est donc difficile de déterminer l'état actuel et le champ d'application de la pratique à l'échelle internationale. Il est nécessaire que les pays développent des cadres de commentaires normalisés et qu'ils veillent au respect de la politique. En outre, des recherches supplémentaires sont nécessaires pour déterminer les compétences et les avantages de la pratique de l'ECP dans le domaine de l'imagerie transversale.

Keywords: Radiographer commenting; Image interpretation; Preliminary clinical evaluation; Preliminary image evaluation; Magnetic resonance imaging; Computed Tomography; Radiography

Introduction

Clinical imaging practice has evolved significantly and this is largely driven by advances in technology, evolving disease profiles, healthcare access, education quality and the advent of artificial intelligence [1–3]. These, coupled with the global shortage of radiologists, have led to changes in the radiographer's scope of practice, ranging from increased responsibilities to role extension [4]. A major benefit of this is job satisfaction of radiographers, improved patient care, and allowance of radiologists to focus on more complex medical tasks and interventions. Notably, roles such as radiographer-led discharge [5], vetting and treatment verification [6] and particularly, image interpretation are now embedded in the radiographer's scope of practice within jurisdictions [7,8]. Consequently, radiographers have had to continually adapt to the changing trends of their profession to remain competitive on the global stage [9,10] by aligning education and training to bridge potential skill gaps [11,12].

Radiographer commenting or image interpretation has become a threshold graduate competency, and accordingly embedded in clinical radiography education internationally [13-17]. The COVID-19 pandemic radiological image reporting backlogs coupled with the chronic shortage of radiologists [7,18] further supported the rationale for the formalisation of radiographer role extension [18,19]. into preliminary clinical evaluation (PCE)/preliminary image evaluation (PIE) and image reporting. A national review of radiological image reporting in the National Health Service (NHS) in England revealed serious concerns about image reporting times including delayed treatments, unreported scans and missed diagnoses [20]. Similarly, in Australia, Eastgate and Colleagues [21] reported a minimum of 84 h delay between radiological image acquisition and reporting for plain film imaging. These concerns highlight potential gaps in practice and the need to reinforce the implementation of radiographer commenting and clinical reporting systems to augment efforts targeted at delivery of timely and safe care.

Radiographer image interpretation dates to the late 1970s in a form commonly known as red dot [22] which has developed into radiographer commenting and clinical reporting (Table 1) [23,24]. Beyond mitigating ambiguous communication and increasing diagnostic confidence, radiographer commenting has reduced the impact of radiologist's report delays [25], clinical error, and improved the quality of care [26]. Consequently, this has enhanced efficiency and cost-effectiveness [27]. Additionally, PCE benefits a multi-disciplinary approach to radiographic image interpretation [28,29] as well as improved abnormality detection and overall diagnostic accuracy [29-35]. Accordingly, a joint publication by the Royal College of Radiology (RCR) and the Society and College of Radiographers (SCoR, UK) emphasised the need for radiographers to contribute to interpreting medical images via PCE and reporting to influence patient management [30,36].

As previous reviews [37-39] were limited to projectional radiography and local level practices, it remains unclear what the scope and current state of PCE practice is internationally and across other imaging modalities such as MRI and CT. Additionally, a recent study in a low-resource setting suggests a theory-practice gap in radiographer PCE due to limited teaching and misalignment of educational processes [40]. Similarly, a related study in the UK also shows that <30% of the NHS trusts that participated in the study practice PCE [41]. These pieces of evidence suggest variations in knowledge regarding the state of PCE and issues worth considering during the development and implementation of PCE.

This review is therefore aimed at exploring the current radiographer PCE practice from a global perspective across MRI, CT, and projectional radiography to inform recommendations towards influencing policy, professional practice, education, and future research.

Method

A scoping review [42,43] following Arksey and O'Malley's framework [44] as updated by Levac et al. [45] was employed. Key components of this methodological framework include identification of the research question, searching for relevant evidence, charting of evidence, data collation, summarising of results and reporting [46]. This approach allowed for the mapping of the current evidence regarding the topic in terms of regional distribution, their nature, features, and volume. Evidence reporting followed the Preferred Reporting Items for Systematic Reviews and Meta-Analysis Extension for Scoping Reviews (PRISMA-ScR) checklist [47].

Sources searched

A three-step search framework [48] recommended by the Joanna Briggs Institute (JBI) was employed. The search was

Table 1
Radiographic image interpretation terminologies and definitions [19,20].

Terminology	Definition
Red Dot System	This system employs a red sticker or asterisk (*) affixed on a radiological image to denote a potential abnormality or pathology.
Radiographer Abnormality Detection system (RAD)	This system is an abnormality 'flagging' system in which the radiographer will digitally affix an asterisk (*) to a radiological image to signal a potential abnormality.
Preliminary Clinical Evaluation (PCE)/Preliminary Image Evaluation (PIE)	This is a briefly written radiographer's comment to communicate what they believe could be an abnormality/pathology to the referral. Of note, this is not a definitive radiological report.
Radiographer Report	This is a definitive radiological report written by a trained clinical reporting radiographer.
Clinical Reporting /Radiologist's Report	This is a definitive written radiological report written by a Radiologist

conducted across electronic databases including (Academic Ultimate, Medline/PubMed, CINHAL and SCOPUS) through a federated search engine (EBSCOhost) [49]. Further searches were completed across Web of Science (all databases), Google Scholar and the reference list of eligible articles. Guidance and practice/policy documents that were not found through any of the databases and sources searched, were sourced from the relevant professional/organisations' websites.

Search strategy

A systematic search strategy developed in consultation with an expert librarian was employed to identify relevant articles and policy documents from the sources. This ensured the appropriateness and robustness of the search protocol [48]. The medical subject heading (MeSH) was used to identify and develop keywords. Using this search strategy, an independent electronic search was completed by the lead researcher (MA) between September 2023 and December 2023. Additional search was carried out by (MA/TA) in June 2024 to update the results. Boolean operators (AND/OR), truncators (*/?) and keywords: [(radiographer) AND (abnormality detection OR RAD OR image interpretation OR preliminary image evaluation or PIE OR preliminary clinical evaluation OR PCE) AND (X-ray OR Magnetic Resonance Imaging OR MRI OR Computed Tomography OR CT or cross-sectional imaging OR medical imaging OR radiography OR diagnostic imaging)] were used for the search. The search results and references were managed using Microsoft Excel 365 (Version 2405 Build 16.0.17628.20006) and Endnote reference manager (version 21), respectively. The key terms underpinning the concept of radiographer image interpretation are defined in Table 1.

Article selection

Article selection was in accordance with predefined inclusion and exclusion criteria (Table 2). Inclusion criteria were guided by the Population, Concept and Context (PCC) framework [50] to ensure that only studies relevant to the research aim were included (Table 3). Briefly, to be eligible, an article or policy document must be in the English language and explore concepts pertaining to radiographer PCE or PIE. Additionally, radiography practice policy and guidance documents from countries where the relevant studies were found were included to ascertain the scope and compliance with PCE practice.

All studies involving clinical reporting radiographers or clinical reporting or ultrasound reporting and radiographer abnormality detection systems (RADs) such as the 'red dot' were excluded. Commentaries, opinion pieces, case reports, case series, book chapters and letters to the editor were excluded.

Data charting/extraction

A data charting table in keeping with JBI's data extraction template was created to record key information relevant to the research aim and objectives. Key study data extracted included authors' name and date of publication, country, imaging modality, study aim, research design, population/sample size, findings and conclusion related to the research questions (Table 5). key data extracted from the policy documents were the country of origin, the date of publication, the professions regulatory body, the substantive PCE policy on the scope of practice (Supplementary Table 1).

This approach allowed the state of evidence, emerging themes, and research gaps to be identified. In keeping with scoping reviews, no quality assessments were done on the included articles.

Data synthesis

A parallel-results convergent data synthesis [51] was employed. This involved independent analysis and tabulation of the results from the included studies. The synthesized results were then integrated to generate summary outcomes [51] using inductive narrative analysis [52]. The narrative analysis provided rich insight into the results and helped to uncover themes.

Results

The electronic databases search yielded 1941 articles and policy documents after irrelevant articles were removed (Fig. 1). After title and abstract screening, 1883 articles were excluded. Following this, 47 articles and 5 policy documents were retained for full-text assessment for eligibility. Thirty-one (31) articles and five (5) policy documents were included after the

Table 2
Inclusion and exclusion criteria and justifications for inclusion or inclusion criteria.

Inclusion criteria	Exclusion criteria	Justification
Articles that are accessible via EBSCOhost, web of science and other sources.	-	These databases host several other databases and include articles that explored preliminary image/preliminary clinical evaluation and related publications.
Grey Literature (practice standards/policy documents) readily available and accessible via databases, google scholar and the relevant professional bodies' websites.	-	Grey literature was included to increase the search range to accommodate relevant non-peer reviewed articles such as policy/practice guidance documents.
Articles published between 2013 and 2023	-	Articles published within the last 10years are of interest as the focus of the study is on current state and scope of practice. Historically, PCE was first implemented in the UK and the practice and policy guidelines provides that the practice be fully implemented from 2013 and beyond.
Publications that specifically focused on non-reporting radiographer PIE/PCE or their synonyms in MRI, CT and projection radiography	Publications that discuss RAD systems, clinical reporting and ultrasound reporting. Publications that discussed PCE/PIE among clinical reporting radiographers and non-radiographers only.	Clinical reporting and Radiographer Abnormality Detection-RAD systems such as red dot was not the focus of this scoping review. Besides, ultrasound imaging involves clinical reporting and therefore excluded.
English Language	Other languages that may require translation to English	To avoid cost associated with language translation
All countries where radiographer PCE practice have been studied and documented in both peer reviewed journal articles or grey literature (policy/practice guidance).	-	To give a global overview of PCE practice and allow comparison of international best practices and to identify gaps in current practice
Primary evidence of qualitative, quantitative and mixed methods designs, retrospective audits, literature reviews, policy/guidance documents that explored the research questions.	Commentaries, editorials, opinion pieces, letter to the editor, case reports and non-PCE policy documents	To produce factual and credible evidence

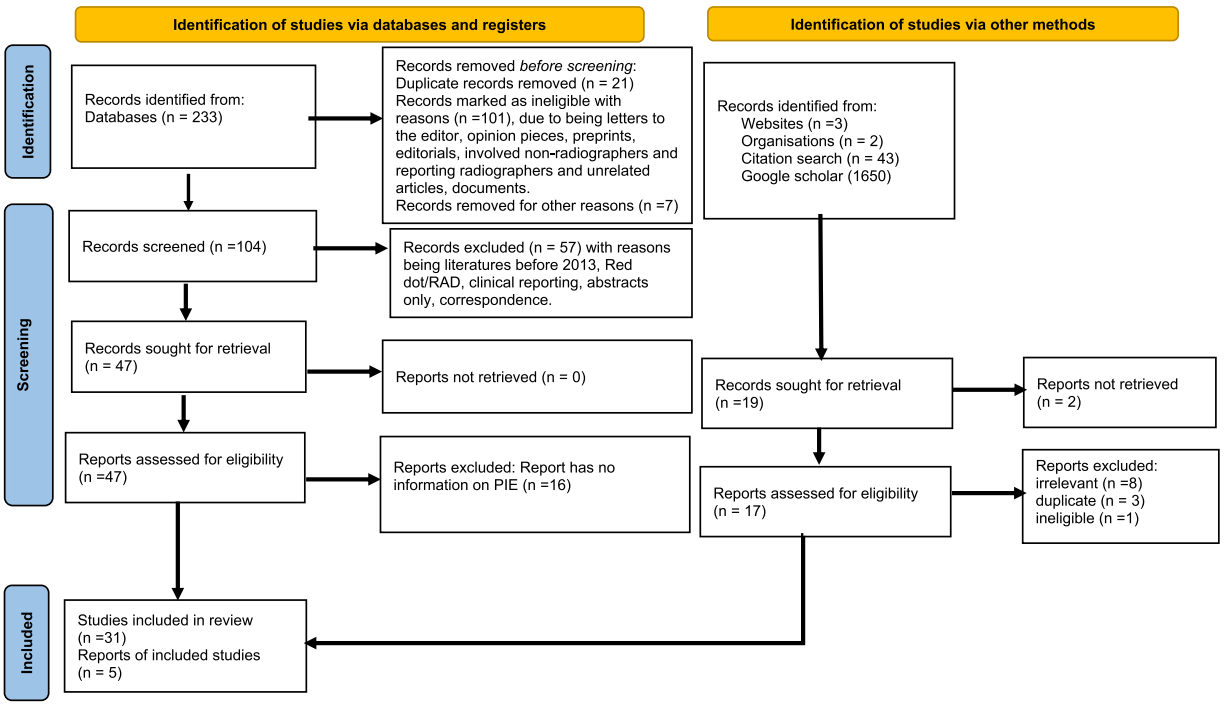

Fig. 1. PRISMA-ScR flow diagram for new systematic reviews which included searches of databases, registers, and other sources [53].

Table 3
Population, Concept and Context (PCC) in relation to radiographer PCE practice.

Population	Non-reporting radiographers
Concept	Preliminary Clinical Evaluation (PCE) /Preliminary Image Evaluation (PIE)
Context	X-ray/projection radiography, MRI, CT

Table 4
Distribution of the included articles based on regional anatomy.

Body part	Sum of Frequency (n)	Percentage (%)
Axial/Appendicular skeletons	38	60
Chest	12	19
Brain	9	14
Abdomen	4	7
Total	63	100

predefined inclusion criteria were applied. The articles encompassed studies from Australia, Europe, Africa, and Asia: with the majority from the United Kingdom (50%) followed by Australia (17%), South Africa (10%) and Singapore (7%) respectively (See supplementary Figure 1). PCE-specific policy documents were retrieved for UK and Australia while radiography practice documents with PCE embedded were retrieved for United States, Nigeria, and South Africa respectively (see supplementary Table 1).

Varied research designs were used across the studies and this included: service evaluation ($n = 2$) qualitative study ($n = 4$), Survey ($n = 2$), retrospective analysis/audit/study ($n = 6$), experimental study ($n = 1$), prospective study/longitudinal/observational ($n = 6$), action research ($n = 1$), pre- and post-test intervention ($n = 2$), and literature reviews ($n = 3$) and policy document ($n = 5$).

The key aims explored across the studies relate to the radiographer's competency, knowledge, accuracy, state of practice, implementation, and methods of radiographer PCE skills development. Over 80% of the studies focused on PCE in projectional radiography (Table 5). Similarly, 60% of the studies focused on axial and appendicular skeletons with the rest being soft tissue including brain, chest, and abdomen (Table 4). The body of research on PCE is current and has been on the ascendency within the last decade (See supplementary Figure 2).

Three broad themes were developed based on the studies aims and outcomes as follows:

Theme 1. Scope of practice and practice implementation

Theme 2. Preliminary clinical evaluation proficiency indicators

Theme 3. Factors influencing PCE participation and performance

Theme 3. was further developed into subthemes 1 and 2 as follows:

Subtheme 1. *Education, training and experience*

Subtheme 2. *Training and learning method*

Discussion

This scoping review collated evidence on radiographer PCE practice globally. The current evidence[15,17,27,36,37,39,40,53–73] demonstrate a growing popularity of radiographer image interpretation globally, driven by the shortage of radiologists [74]. The United Kingdom and Australia have the highest number of publications compared to the rest of the world (see supplementary figure 1). This could be attributed to the practice of PCE being well established and legally recognised in the UK and Australia as evident by the availability of PCE-specific policy and practice documents in these countries (See supplementary Table 1). Radiographers globally demonstrate proficiency at performing PCE on plain film imaging. Although, limited evidence on cross-sectional imaging from the UK shows radiographers competence is comparable to that of consultant radiologists. This finding however may be difficult to generalize as they were mostly single centre studies involving limited population of radiographers [38,62,70,72] (Table 4). Additionally, the current practice is predominant in emergency plain film radiography. As shown in this review, over 80% of all the included studies were conducted in plain film imaging with the rest on limited anatomical areas in MRI and CT [38,62,70,72]. More research is therefore required to understand the current state and scope of practice in cross-sectional imaging. Given that cross sectional imaging, including CT and MRI, are critical in diagnosing life-threatening conditions, it is imperative that radiographers working within these modalities can recognise and comment on images they produce appropriately to support ongoing patient care. Although, a limited study from the UK demonstrates radiographers could provide PCE on MRI and CT, the findings from these studies may not be applicable to other settings due to difference in radiography education and training models as well as variations in healthcare systems.

Theme 1: scope of practice and practice implementation

The scope of PCE practice, varies transnationally although, this is not clear for countries without national PCE-specific policy or guidance. The scope of practice is either documented in PCE-specific guidance or embedded in radiography practice documents (Supplementary Table 1). The variations are in terms of range of examinations or cases the radiographer could provide a first line interpretation for. These variations may stem from the differences in healthcare policies, practices and needs. For instance, while in the UK radiographers are required to provide immediate PCE on all medical images they produce [22], in Australia, the scope is limited to radiographers' communication of urgent and unexpected findings to the referrer [13]. Similarly, in Nigeria, radiographers are required to describe radiographic appearances in a written format to the physician or clinician despite legal restrictions [75] whereas, for the USA, the

radiographer may communicate urgent radiological findings to the supervising radiologist. For countries without PCE guidance, the research mostly focused on ascertaining the attitude, benefits, and competence of radiographers in image interpretation performance. [38,40,53,58,63,64,66,67,69,71,73] For most countries, such as Oman, South Africa, Namibia, Singapore, and Fiji; where practice is at the developmental stages, the evidence showed the practice is implemented within local hospitals despite lack of national policy guidance (Table 5). In Oman, for example, despite no licensing system and radiography practice competency framework [76], Al Shiyadi and Wilkinson [53] highlighted implementation and practice of radiographer image interpretation in local hospitals.

The UK was the first country to formally implement PCE; the practice is however not widely applied across NHS Trusts as recommended by both the professional [22] and the regulatory body [78]. A survey across 31 UK NHS trusts in 2023 showed that, contrary to the PCE frameworks [22], only 26% of the Trusts practice PCE with about 90% still practicing the red dot system [41]. Thus, suggesting noncompliance with policy that may be attributed to poor implementation or lack of policy enforcement and legal frameworks to support practice as compared to Australia where practice is mandated by national law [79]. Other potential factors include lack of stakeholder support, absence of targeted education and training, lack of self-confidence and role clarification [39,40,61]. Policy makers therefore need to tackle these challenges, including developing appropriate educational and training support programmes as well as provision of role boundaries for radiographer's participation in PCE.

Limited research [71,72] from South Africa and the UK, however, shows that radiologists are supportive of radiographers interpreting certain cases. A South African study reported radiologists support radiographers commenting on chest and musculoskeletal radiographs [71] while in the UK study also shows that radiologists were supportive of radiographers reviewing brain MRI of suspected metastatic brain lesions [72]. Equally, radiographers have also demonstrated willingness to contribute to image interpretation as a prospect to enhance healthcare delivery through diagnostic support, career development, job satisfaction and to bridge the radiologist shortage gap [77]. These findings further lend support to the need for PCE implementation frameworks and legal backing [37,38,59].

Theme 2: preliminary clinical evaluation proficiency indicators

Globally, radiographers demonstrates high accuracy, sensitivity, and specificity in interpreting medical images on various anatomical parts and imaging [38,58,63,64,66,67,69,71,73]. Overall, radiographers' PCE accuracy, sensitivity, and specificity ranged between 70 and 100%, 70–90% and 70–100% respectively [38,58,63,64,66,67,69,71,73]. These indicate good quality competence and further supports the notion that radiographers are well placed to provide first line image interpretation to support ongoing patient care. This competence may be developed either from undergraduate studies or within clinical practice [17]. Albeit these studies were limited in scope, they provide insight into the current state of PCE and competency from a global perspective.

Notwithstanding, the consistently high accuracy, sensitivity and specificity of radiographers commenting across multiple studies; these observations equally highlight areas requiring emphasis in PCE training, education, and implementation as shown by Alexander-Bate et al. [15]

Again, there is significant gap on cross sectional imaging (CT & MRI) in this context due to limited literature. Nonetheless, related studies in the UK involving small samples of MRI radiographers show their PCE competency level and accuracy is comparable to that of consultant radiologists [70,72].

Theme 3: factors influencing pce participation and performance

PCE participation and performance is influenced by several factors including education, training, image interpretation learning approaches, and its value on patient outcomes. This is particularly evident in low resource settings where the practice is being developed or implemented.

Subtheme 1: education, training and experience

Training and education were identified as key factors that influence radiographers' PCE participation transnationally [27,63,65–67,70]. Lidgette and colleagues [55] demonstrate a strong correlation between training and PCE participation-positive influence on PCE performance accuracy [55]. Conversely, Varrier et al. [59] reported a strong PCE performance with very high accuracy among radiographers without a specific PCE training. Of note, these studies involved samples from two different countries with samples of different educational characteristics. Thus, the impact of training on PCE performance could be significantly based on the state of implementation and the specific imaging practice.

Further, it has been reported that years of clinical experience does not have significant influence on PCE performance. For example, two UK studies involving radiographers of mixed clinical experiences (experienced and newly qualified) indicate that both groups appeared well equipped in PCE practice with no variation in the performance accuracy [55,57]. Image interpretation is a threshold graduate competence in the UK and embedded in undergraduate radiography education curriculum. As a result, newly qualified radiographers gain the relevant image interpretation skills during their undergraduate education. This might explain the parity in the performance of both experienced and newly qualified radiographers as observed by a previous similar study [17] which demonstrate a strong correlation between undergraduate education and PCE confidence among newly qualified radiography graduates.

Within the context of MRI and CT, training may have a significant impact on image interpretation abilities and accuracy as demonstrated by various pieces of research [38,62,70,72]. A longitudinal study [62] on radiographer providing PCE for intraluminal pathology for CT colon (CTC) concluded that

Table 5
Details of peer reviewed journal articles included in the study.

Reference	Anatomical region/Imaging specialty	Research aim	Research design	Population/sample size/study duration	Key findings	Conclusions	Emerging themes
Alexander-Bates et al. 2021 [15] Journal of Medical Radiation sciences Australia	• Appendicular skeleton • X-ray	Determine the most common radiographer PIE false-negative interpretations.	Retrospective clinical audit.	• No. of radiographers not indicated. • 2402 images. • 24 months	The most frequent false-negative radiographer PIEs were within the upper and lower distal extremities. Specifically, the phalanges and exams revealing multiple injuries reported high levels of misinterpretation	These findings provide valuable insights into areas of emphasis when providing image PCE education.	Proficiency: Areas of common errors to inform intervention.
Al Shiyadi & Wilkinson 2020 [53] Radiography Oman	• Appendicular skeleton	Investigated role extension for radiographers in Oman, and to evaluate radiographers and the radiologists' opinions and attitudes toward role extension	cross sectional study	• 13 major hospitals • 189 Radiographers. • 77 Radiologists	80.4% radiographers and 63.3% radiologists responded. 53.3% of radiographers are involved in role extension. 21% radiographers are involved in image interpretation.	Radiographer role extension activities are widely implemented at hospitals in Oman and that radiographers have sufficient skills and education to participate in this role extension.	Opinion and attitudes towards supporting radiographer role expansion
Bain etal.2017 [56] Radiography United Kingdom	–	Evaluated the usage of peer-assisted learning in image interpretation	Literature review	• Medical students and radiographers	Identified variations between the two professional disciplines.	Lack of extensive evidence base in relation to interprofessional peer-assisted learning, thus, justifies the need for further research to develop evidence base.	Intervention: Impact of learning approach on performance
Bradbury et al. 2019 [57] Radiography United Kingdom	• Abdomen • X-ray	Determined the accuracy of radiographers' performance in PCE taxonomy for emergency abdominal imaging to assess the feasibility to extend current practice	Experimental study	• 32 radiographers of varied pay bands: 11 band 5 s, 16 bands 6 s and 5band 7 s. • 30 abdominal radiographs.	Participants demonstrated good sensitivity in recognising prominent findings on abdominal radiographs. The evidence supports the feasibility of expanding the current practice regarding the implementation of a scheme of abdominal radiograph PCE.	Additional research with a larger participants' and a lower abnormal case prevalence would be beneficial to the limited research base.	Proficiency: Influence of performance towards expansion of scope

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Table 5 (*continued*)

Reference	Anatomical region/Imaging specialty	Research aim	Research design	Population/sample size/study duration	Key findings	Conclusions	Emerging themes
Brown et al. 2019 [23] Journal of Medical Radiation Sciences Australia	• Appendicular and Axial (chest and abdomen) skeleton • X-ray	Determined the accuracy of radiographer PIE in clinical practice within an emergency department over 12 months	Prospective longitudinal study	• 35 Radiographers. • 6290 radiographs • 12months.	Scope of image review: Pneumothorax, Pneumoperitoneum, foreign body, bony fractures, knee lipohaemarthrosis, posterior elbow effusion, joint dislocation, or subluxation. Sensitivity- 71.1%, specificity-98.4%, Accuracy-92.0%	Radiographers provided a consistent PIE service while maintaining a high diagnostic accuracy; thus, could complement in emergency referrer's diagnosis when a radiologist's report is unavailable during patient treatment. PIE promotes a reliable enhancement of the radiographer's role with the multi-disciplinary team.	Proficiency, value, and impact on patients' care
Budhu et al. 2023 [71] Radiography South Africa	• Chest, Musculoskeletal (MSK) • X-ray	Explored the knowledge and training required by diagnostic radiographers, according to radiologists, for the interpretation of radiographs.	Qualitative design (Interview)	• 3 Consultant radiologists	The consensus is that radiologists are supportive of radiographer role expansion to include interpretation of chest and MSK in rural settings and	Radiologists are supportive of radiographers interpretating images, however, think the scope of practice be limited to chest and MSK.	Skill gap, opinion on competency required towards scope of practice.

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Table 5 (*continued*)

Reference	Anatomical region/Imaging specialty	Research aim	Research design	Population/sample size/study duration	Key findings	Conclusions	Emerging themes
Del Gante et al. 2021 [58] Radiography Singapore	• Appendicular skeleton • X-ray	Examined the accuracy of radiographer image interpretation comment in Singapore to establish whether the combination of a blended and self-directed experiential learning can equip radiographers to provide accurate diagnostic comments on emergency plain appendicular skeleton radiographs. Assessed whether the number of images read was associated with radiographer accuracy and if the radiographer's retained performance over time.	Retrospective analysis	• 13 radiographers • 16,483 x-rays. • 18 months	Radiographers who received blended and experiential learning in RADS provide accurate diagnostic comments on emergency appendicular skeleton x-rays.	A combined blended and experiential learning approach can prepare radiographers to provide diagnostic opinions on appendicular skeleton x-rays.	Proficiency: influence of skillset on performance towards learning approach
Ekpo, Egbe & Akpan2015 [66] Radiography Nigeria	• Chest • X-ray	Investigated the performance of Nigerian radiographers in interpretation of chest x-rays and to examine whether age, years since qualification and sector of practice influence performance.	Retrospective study	• 51 Radiographers. • 50 cases (23 normal and 27 abnormal) • 2 months	Mean location sensitivity was 88.9. Mean specificity and sensitivity: 79.8 and 76.9 There is no relationship between age and performance. There is positive relationship between number of years of experience, private practice, and performance.	Nigerian radiographers can correctly interpret chest x-rays to a reasonable degree, and performance is associated with number of years since qualification and the sector (private) of practice	Proficiency: capability and factors influencing performance.

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Table 5 (*continued*)

Reference	Anatomical region/Imaging specialty	Research aim	Research design	Population/sample size/study duration	Key findings	Conclusions	Emerging themes
Harcus & Stevens 2023 [41] Radiography United Kingdom	• chest, abdomen, Appendicular skeleton	Provided an updated assessment of current practice based upon a previous 2008 study.	Cross sectional online survey	• Departmental and reporting radiographer leads. • 31 NHS Trusts	90% practice red dot and 26% PCE. Skeletal radiographs were most reviewed (90%; $n = 28$) followed by chest (58%; $n = 18$) and abdomen (32%; $n = 10$). Observed marked variation in education however, there is not much development in PCE practice.	Significant conclusions cannot be made due to inadequate sample size; however, the findings may support justification for further research and consideration in relation to implementation and potential standardisation of abnormality detection system.	State of practice
Hazell, Motto & Chipeya 2015 [69] Journal of Medical Imaging and Radiation Sciences South Africa	• Appendicular skeleton • X-ray	Examined the level of impact image interpretation and relevant terminology training would on the accuracy and descriptive comments provided on musculoskeletal images by South African radiographers.	Pre- and Post-test	• 9 Radiographers • 100 skeletal images • (50% abnormal cases)	Significant improvement in image interpretation performance accuracy, specificity, and sensitivity post-training. Accuracy improved from 71.04% to 78%, Sensitivity improved from 83.73% to 87.28%, Specificity improved from 59.62% to 70.34%	Radiographer pattern recognition and construction of comments could enable diagnostic radiographers to improve their accuracy and the ability to provide a descriptive comment on image following training.	Impact of training on performance accuracy

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Table 5 (*continued*)

Reference	Anatomical region/Imaging specialty	Research aim	Research design	Population/sample size/study duration	Key findings	Conclusions	Emerging themes
Howard 2013 [61] Radiography United Kingdom	• Musculoskeletal • X-ray	Investigated the perception of community hospital-based radiographers in Northeast Scotland regarding the practice of Radiographer commenting on MSK trauma images	Qualitative exploratory study	• 8 Radiographers from multiple sites	There is practice of radiographer commenting in the community	Radiographer commenting should be supported by ongoing training, and radiologist involvement in mentoring could provide radiographers with a valuable support mechanism. The voice of all radiographers regarding this extended role must be heard by professional leaders to ensure that the skills and education required for radiographer commenting are provided and subsequent patient care is not compromised.	Perception regarding practice
Karera et al. 2023 [40] – Radiography Namibia		Explored the experiences of graduates from one higher education institution in a low-resource context about their image interpretation training.	Qualitative phenomenological study	• 10 Radiographers	Participants' experiences revealed a theory-practice gap in image interpretation, misalignment of educational processes due to limited teaching approach, clinical education, and assessment strategies. Significant variations between expectations and clinical realities during and after training. Radiographer image interpretation is recognised as a relevant area for role extension in this low-resource setting.	While these findings are specific to the experiences of the participants, similar research in a comparable context and implementing competency-based image interpretation assessments could help identify gaps and guide interventions towards addressing shortcomings.	Experiences regarding training and practice

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Reference	Anatomical region/Imaging specialty	Research aim	Research design	Population/sample size/study duration	Key findings	Conclusions	Emerging themes
Karera et al. 2024 [77] Radiography Namibia	–	Explored the perception and knowledge of low-resource setting-based radiographers' regarding the potential role in image interpretation	Descriptive qualitative design (interview)	• 14 Radiographers	Theme 1: uncovered prospects for enhanced healthcare delivery through improved diagnostic support, bridging radiologist shortages, career development and fulfilment as positive outcomes of radiographer role extension. Theme 2: shown potential PCE implementation barriers which included radiographer resistance and reluctance, limited training, lack of professional trust, and legal and ethical bottlenecks	Positive Perception about radiographer participation in PCE with potential hurdles	Perception of impact of role
Lata et al. 2022 [67] Journal of Medical Radiation Sciences Fiji	• Chest • X-ray	Assessed the accuracy of radiographers in interpreting adult chest X-ray at the Colonial War Memorial Hospital (CWMH) in Fiji.	–	• 14 radiographers. • 40 cases evaluated	Mean Sensitivity-(89.5%), Specificity- (72.9%) and overall Accuracy-(81.6%). Accuracy in naming pathology and its location are 33.6% and 45.7% respectively.	Without any formal training, and practice, the current results suggest the radiographers can perform normal/abnormal triage of CXRs within a test setting.	Proficiency
Lewis et al. 2024 [73] Radiography New Zealand	• Appendicular skeleton • X-ray	Assessed the impact of intensive training on radiographers' PCE performance accuracy, sensitivity, and specificity in emergency extremity x-ray.	Pre-post-intervention design	• 7 Radiographers • 2 Days	Post-intervention improved accuracy, sensitivity, and specificity by; 3.33%, 3.99% and 6.13%.	Intensive training improved radiographers' PCE sensitivity, specificity, and accuracy. However, further research is required to ascertain clinical ability of PCE performance	Impact of training intervention on performance

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Reference	Anatomical region/Imaging specialty	Research aim	Research design	Population/sample size/study duration	Key findings	Conclusions	Emerging themes
Lidgette et al. 2023 [55] Radiography United Kingdom	• Appendicular skeleton • X-ray	Explored the impact of local training on radiographers' PCE involvement and accuracy of performance during a trial period	Retrospective quantitative small scale pilot study	• 10 Radiographers (5 senior radiographers who received PCE training and 5 newly qualified radiographers who did not receive any training. • 796 cases, 528 received PCE. • 19weeks	Strong association between PCE training and participation but does not appear to influence accuracy of PCE performance.	Both experienced and recently qualified radiographers appear well equipped to provide accurate PCE for adult appendicular trauma X-rays.	Intervention: Impact of training on performance.
Lockwood & Dolbear 2018 [70] Radiography United Kingdom	• Brain, • Knee • spine • Magnetic Resonance Imaging	Evaluated the performance of radiographers in interpretating of magnetic resonance imaging (MRI) of brain, spine and knee examinations following a nine-month work based postgraduate MRI module.	Prospective study	• 27 radiographers. • 1620 MRI image interpretations	Radiographers' mean accuracy, sensitivity, and specificity post training for: Brain: 86.7%, 84% and 89.7% respectively. Spine: 86.4%, 90.2%, and 75.3% respectively Knee: 80.9%, 83.3% and 74.3% respectively	radiographer's demonstrated skills in brain, spine, and knee MRI image interpretation. These skills are not to replace radiologist reporting but to meet regulating body standards of proficiency, and to assist decision making in communicating unexpected serious findings, and/or extend scan range and sequences. Further research is required to investigate the impact of these skills on adjusting scan protocols or flagging urgent findings in clinical practice.	Impact of training intervention on skill development and performance

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Reference	Anatomical region/Imaging specialty	Research aim	Research design	Population/sample size/study duration	Key findings	Conclusions	Emerging themes
McDaid, Eccles & Yorke 2023 [72] Radiography United Kingdom	• Brain • Magnetic Resonance Imaging	Evaluated the ability of radiographers to review MRI mages to reduce waiting times in patients without brain metastasis	Prospective observational study	• 11 MRI Radiographers reviewed MRI images. • 8 Radiographers and 6 Radiologists completed online questionnaires	Despite lack of training, radiographers demonstrate ability to review images with high sensitivity and specificity comparable to radiologists.	Radiologists and radiographers agreed on radiographers screening brain metastasis, and this could be implemented following a programme of training for radiographers	Proficiency: Impact on role expansion and value for patient management
Murphy et al. 2019 [39] Journal of Medical Radiation Sciences Australia	–	Investigated radiographic image interpretation by Australian radiographers and the barriers to implementation.	Literature review	• 926 articles screened. • 19articles eligible.	Research exploring radiographers' image interpretation performance employed a variety of methodological designs with accuracy, sensitivity and specificity values ranging from 57 to 98%, 45 to 98% and 68 to 98%, respectively. Primary barriers to radiographic image interpretation by radiographers included lack of accessible educational resources and support from both radiologists and radiographers	Australian radiographers can undertake PIE; however, educational, and clinical support barriers limit implementation. Access to targeted education and a clear definition of radiographers' image evaluation role may drive a wider acceptance of radiographer image evaluation in Australia.	State of practice and barriers to PCE implementation
Ofori-Manteaw & Dzidzornu 2019 [63] Radiography Ghana	• Appendicular skeleton • X-ray	Determined and compared the ability (accuracy, sensitivity, and specificity) of radiographers and junior doctors in interpreting appendicular trauma radiographs both before and after training.	Action research	• 8 radiographers • 12 junior doctors. • 30 images	Improves diagnostic results for patients and streamline their care pathway. All research participants exhibited interest in training to transition from PCE to reporting.	With a well-structured training programme, radiographers and junior doctors could improve on their accuracies in radiographic abnormality detection and commenting on trauma radiographs.	Proficiency: impact of intervention on performance

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Reference	Anatomical region/Imaging specialty	Research aim	Research design	Population/sample size/study duration	Key findings	Conclusions	Emerging themes
Petts et al. 2023 [68] Journal of Emergency Medicine Australia	• Appendicular skeleton • X-ray	Compared and combined the image interpretation accuracy of emergency clinicians and radiographers.	–	• All ED clinicians and radiographers • 838 cases • 3 months	Radiographer's mean sensitivity, specificity, and accuracy: 80%, 98% and 92%, respectively. Emergency clinician's mean sensitivity, specificity, and accuracy: 82%,95% and 89%. Combined mean sensitivity, specificity, and accuracy: 90%, 93% and 92%.	Addition of radiographers' comments, emergency clinicians' image interpretation can be more accurate. Highlights the value of a radiographer's interpretation that can complement an emergency clinician's interpretation when a radiologist's report is not available.	Proficiency: impact and value of interprofessional image interpretation
Rimes et al. 2019 [62] Radiography United Kingdom	• Colon • Computed Tomography	Evaluated the competency of radiographers providing PCE for intraluminal pathology of computed tomography colonography (CTC)	Retrospective audit	• 2 Radiographers. • 1815 images. • 37 months	97.0% of Radiographers PCE demonstrates a strong agreement with the radiologists' report.	Trained radiographers can provide PCE on CTC of intraluminal pathology	Proficiency in PCE performance
Stevens 2020 [60] Radiography United Kingdom	• Appendicular skeleton • X-ray	Assessed radiographers' ability to provide a brief description of radiographic abnormalities by evaluating their structure and brevity	Service evaluation	• 48 radiographers. • 21 Samples	Use of too many words in PCE commenting with reduced descriptive content which mismatch the reading level of the gold standard. Suggested areas of improvement in practice include introduction of a comment-forming model with additional education	Dedicated training preceding PCE implementation and participation, to standardise comment structure, could improve the effectiveness of the PCE system.	Proficiency: method of commenting

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Reference	Anatomical region/Imaging specialty	Research aim	Research design	Population/sample size/study duration	Key findings	Conclusions	Emerging themes
Stevens & Whites 2018 [17] Radiography United Kingdom	–	Examined the confidence of newly qualified radiographers with regards to their ability to recognise (red dot) and describe (PCE) traumatic radiographic abnormalities, as well as how they perceived their undergraduate training in these areas	Online quantitative survey	• 85 newly qualified radiographers.	Demonstrates strong correlation between undergraduate training and confidence however, almost a third of participants are not confident in describing abnormalities. 30% of participants thought PCE training at undergraduate level was not suitable, and 55% thought PCE training on placement was not suitable.	Red dot training at university and placement is considered suitable-positively impacts confidence. Views on PCE training are more variable. University level PCE training positively impacts confidence in describing abnormalities, but commenting training on placement is recognised as an area for improvement. Bigger research is suggested to gain further understanding of any issues hampering widespread PCE implementation.	Confidence and capability: Impact of undergraduate education on performance
Stevens & Thompson 2022 [65] Radiography United Kingdom	• Chest • X-ray	Evaluated radiographers' ability to localise traumatic Chest X-ray pathologies and provide a PCE for these cases.	Observational study	• 9 Radiographers • 58 cases. • 20 positive cases. • 12months	Pooled sensitivity-(78.9%–78.8%), Following training: specificity-(79.0%–89.9%) and accuracy-(78.9%–86.0%) respectively.	Improvements in performance were evident for most participants' abnormality localisations and PCE scores, following training and highlighted areas that may require further training, such as detecting superimposed or subtle abnormalities.	Proficiency, impact of intervention on performance

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Reference	Anatomical region/Imaging specialty	Research aim	Research design	Population/sample size/study duration	Key findings	Conclusions	Emerging themes
Stevens & Thomson 2018 [36] Radiography United Kingdom	• Appendicular skeleton • X-ray	Evaluated the abnormality detection performance and accuracy of commenting in newly qualified radiographers.	Service evaluation	• 5 Radiographers • 58 cases • 41 normal and 17abnormal • 2moths	Pre- and post-training scores were 0.619 (0.516, 0.737) and 0.703 (0.622, 0.852) respectively. Paired T-Test showed significant statistical difference between pre- and post-training outcomes.	Training positively impacts on participants' ability to localise and accurately describe fractures. Implementation of abnormality detection training should be considered during preceptorship periods. Due to the small sample size, it is inappropriate to suggest these findings are representative of all graduate radiographers	Proficiency: Impact of intervention on performance
Tay & Wright 2018 [64] Radiography Singapore	• Appendicular skeleton • X-ray	Investigated the value of an in-house PCE program developed in a Singapore hospital over a two-year period.	Longitudinal-observational study	• 48 radiographers: Control group (CG) and additional training group (ATG) • 12 months	Mean accuracy of both groups (ATG vs CG) Is very similar at phase one (70v71%). Higher mean sensitivity for ATG compared to that of CG (83v72%) while the CG has higher mean specificity (68v56%). Marked improvement in the mean accuracy for the ATG over CG following a year of mentorship support (86v70%) motivated by a marked increase in mean specificity from 56 to 87%. 43% of the ATG could deliver exceptional standards for accuracy, sensitivity, and specificity, ready and able to provide reliable PIE evaluation, versus none of the CG.	In-house programmes could be a cost-effective method to skills development and ideally appropriate to preceptorship and new employee orientation to measure, develop and monitor PIE performance.	Value and impact of intervention on performance monitoring

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Reference	Anatomical region/Imaging specialty	Research aim	Research design	Population/sample size/study duration	Key findings	Conclusions	Emerging themes
Tonk et al. 2023 [37] Journal of Medical Radiation Sciences Australia	• X-ray	Determined if PIE in the form of written radiographer comments is of value to the Australian healthcare system.	Narrative review	–	Studies have suggested that there is a significant need for commenting due to increased imaging service pressures, radiologist shortages and reporting delays. Radiographers appear well placed and desire to provide accurate initial input with evidence that this would be valued and appreciated within the multidisciplinary team. Radiographer commenting has also been demonstrated to reduce diagnostic and communicative errors with the potential to enhance patient management. Finally, it was shown that participation in image interpretation practices can enhance recruitment, retention, and job satisfaction among radiographers.	The current literature reinforces the need for the implementation of radiographer commenting within the Australian healthcare system.	Value of commenting approach on healthcare delivery
Van de Vanter & ten Ham-Baloyi 2019 [38] Radiography South Africa	• Brain, chest, skeleton • X-ray • Computed Tomography	Determined the current knowledge on the accuracy, experiences, influence of training, and potential impact on patient management of image interpretation/reporting by South African diagnostic radiographers.	Systematic review	• 6 Articles eligible	Most of the included studies focussed on determining the accuracy of radiographers' ability to interpret radiographic images of the skeleton, chest, and computed tomography scans of the head.	Findings comparable to the international literature and supports formal PCE by radiographers and suggests that image interpretation could significantly contribute to patient management. Policymakers should develop suitable educational programmes and commence discussions into the role boundaries of radiographers that participate up this role in the clinical environment.	Knowledge, proficiency influence of intervention on performance and patient management

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Reference	Anatomical region/Imaging specialty	Research aim	Research design	Population/sample size/study duration	Key findings	Conclusions	Emerging themes
Verrier et al. 2022 [59] Radiography United Kingdom	• Appendicular and Axial skeleton • X-ray	Assessed the radiographer's interpretation of skeletal trauma radiographs in clinical practice. Determined if there was any difference in ability to interpret appendicular and axial radiographs. To assess the appropriateness of PCE implementation.	Retrospective analysis	• 23 radiographers. • 762 examinations. • 128 cases reviewed	There was Inter-observer consistency with no variations between reviewers. Radiographers without specific PCE training were able to provide RD and PCE to a high standard. Higher accuracy in appendicular skeleton compared to axial skeleton.	This evidence supports local PCE implementation, contributes to the wider research to justify transition towards PCE and identifies the necessity for local axial image interpretation training.	Proficiency: Influence on performance towards implementation
Wright & Reeves 2016 [27] Radiography United Kingdom	• Appendicular skeleton • X-ray	Presented a longitudinal study of the image interpretation skills of student radiographers from enrolment to graduation and the implications for the profession and the NHS in terms of reliable abnormality detection to aid service improvement in Accident and Emergency (A&E) departments	Longitudinal study	• 36 student radiographers • 20 images (50% abnormal cases)	Novice radiographers have a range of natural image interpretation skills; accuracy 35(85%), sensitivity 45 (100%), specificity 15 (85%), mean ROC 0.691. Graduates presented a narrower range; accuracy 60 (90%), sensitivity 40 (100%), specificity 60 (90%), mean ROC 0.841.	Image interpretation testing at the point of UCAS entry is a useful indicator of future performance and is a recommended factor for consideration as part of the selection process.	Skill development and value and impact on service delivery.

trained radiographers could provide PCE for CTC intraluminal pathology. Two other studies [70,72] on radiographers providing MRI PCE both support the value of training in the enhancement of the radiographer's skills in MRI PCE. As affirmed by the above studies, it is therefore, imperative to incorporate mandatory PCE training into radiographer preceptorship programmes and routine continuous professional development (CPD).

Subtheme 2: training and learning method

Peer-assisted learning, blended learning and experiential learning were tested to ascertain their influence on radiographer PCE performance. The findings using these methods varied across studies. For instance, peer-assisted learning was thought to be beneficial to developing image interpretation skills however, the evidence [56] from a UK study yielded variable outcomes among the participants compared. Thus, the impact of this learning approach could not be fully concluded due to limited evidence.

A Singapore study by Del Gante et al. [58] on the other hand demonstrated a strong association between PCE performance accuracy with blended and experiential learning approaches. In line with this, in-house mentorship programmes had also shown great promise in PCE performance with increased levels of sensitivity and specificity [64]. These findings are consistent with a related study where the impact of digital training tool on non-radiographers' image interpretation was positive [80]. These studies provide an international perspective into how different learning approaches could influence image interpretation performance and therefore should be considered when designing image interpretation training and education programmes. It is, however, imperative to carefully consider which approach works best for a particular group of professionals.

Conclusion

The study explored preliminary clinical evaluation transnationally. The pieces of evidence present a global perspective of PCE comprising of countries within 4 different continents: Europe, Africa, Asia and Oceania. Likewise, the international evidence shows a growing body of research in the area primarily due to global radiologists' shortage, change in population dynamics, radiographer role extension and its benefits to both the radiographer and patient care, and the quest to maximize human resources.

Most of the included studies were conducted in the United Kingdom, followed by Australia due to these countries already having well-established policies and practice guidance to support the implementation. It was observed that practice of PCE currently seemed to be focused on plain film radiography contrary to practice guidance, thus limiting the scope of practice and created a knowledge gap in the areas of magnetic resonance imaging and computed tomography.

There is very strong evidence across all the studies to suggest that radiographers are competent and willing to extend their role to support patient care via participation in preliminary image evaluation. However, due to limited research on cross sectional Imaging (CT and MRI), it is difficult to draw conclusions on the radiographer's competence in these modalities as with x-ray imaging.

Despite the benefits of PCE, there seems to be challenges with implementation, such as compliance stemming from resistance from some stakeholders, lack of role distinction including gaps in education and training.

Of note, education and training had shown some promise in skills enhancement of radiographer participation in PCE while experience does not influence radiographers' competence and accuracy.

Future research must therefore focus on cross sectional imaging and development of comment-forming models and systems for PCE practice.

Limitations

This review included only studies conducted within the last 10 years therefore, there is the possibility of omitting some studies that might be relevant to this review. Also, there is very limited studies on cross-sectional imaging; thus, makes it very difficult to ascertain the state of practice including the competence of radiographers within this subspeciality. Future primary research focusing on cross-sectional imaging radiographers internationally would benefit understanding of international best practices and would help ascertain competency gaps to inform education and training. Additionally, research on developing a user-friendly, simple yet robust commenting framework for cross-sectional imaging must be considered.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.jmir.2024.101815.

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