

This is an Open Access document downloaded from ORCA, Cardiff University's institutional repository:<https://orca.cardiff.ac.uk/id/eprint/126623/>

This is the author's version of a work that was submitted to / accepted for publication.

Citation for final published version:

Abdul-Razak, Wuni, Courtier, Nicholas and Kelly, Daniel 2020. Opportunities for radiographer reporting in Ghana and the potential for improved patient care. *Radiography* 26 (2) , e120-e125. 10.1016/j.radi.2019.09.011

Publishers page: <http://dx.doi.org/10.1016/j.radi.2019.09.011>

Please note:

Changes made as a result of publishing processes such as copy-editing, formatting and page numbers may not be reflected in this version. For the definitive version of this publication, please refer to the published source. You are advised to consult the publisher's version if you wish to cite this paper.

This version is being made available in accordance with publisher policies. See <http://orca.cf.ac.uk/policies.html> for usage policies. Copyright and moral rights for publications made available in ORCA are retained by the copyright holders.



# **Opportunities for radiographer reporting in Ghana and the potential for improved patient care**

## **Abstract**

**Objective:** To explore factors that influence the introduction of role extension in radiography and to discuss its potential for improved healthcare in Ghana.

**Key findings:** Key findings of this review are the lack of literature on role extension in radiography in Ghana. The factors that have influenced the introduction of role extension in radiography globally include a shortage of radiologists, increased demand for radiology services, government policy and radiographer's desire for professional development.

**Conclusions:** Evidence indicates that radiographers can report radiographs as accurately as radiologists and appropriate education improves their performance. Radiographer-led reporting is the professional practise most likely to deliver local patient benefit.

Developments in professional perceptions, training, education and regulation of reporting are required to establish confidence in radiography-led reporting.

**Implications for practice:** Radiographer reporting has the potential to improve patient outcomes, reduce waiting times, increase job satisfaction for radiographers and result in financial savings.

## **Introduction**

Extended working is the post-qualification acquisition of skills or activities that extend healthcare practices by working across professional boundaries.<sup>1,2</sup> The terms role extension and advanced practice are sometimes used interchangeably, but it is instructive to consider them as describing distinct roles: the former being to perform a task, such as image reporting, to a skilled level;<sup>3</sup> the latter signifying a broader set of professional activities , likely to influence wider care pathways.<sup>4</sup>

There are examples of extended roles in nursing and some allied health professions from the US, Canada, UK, and Australia, all of which have advanced nurse practitioner roles and, for example, the assistant radiologist role in the US. Established drivers for extended roles in radiography are an increased imaging workload and shortage of radiologists, coupled with advances in health system technologies and professional aspirations of radiographers.<sup>6-8</sup> Sustained implementation of extended radiography roles in the UK<sup>9</sup> and other developed

countries<sup>10-14</sup> has demonstrated latent benefits to healthcare in terms of reduced patient waiting times, reduced healthcare costs, enhanced job satisfaction for practitioners and increased accuracy of reports.<sup>7,15-26</sup> Despite such benefits, professional divisions endure between radiography and radiology regarding the appropriate scope of practices.<sup>15-17,27</sup>

Developing countries share the generic workload drivers for role extension, but face additional resources constraints<sup>28</sup> and a particular historical development of professional power hierarchies or political/social systems that favour the status quo.<sup>29</sup> This paper evaluates role extension opportunities for diagnostic radiography in Ghana with a focus on image reporting: contexts to this discussion paper being stark deficiencies in radiologist coverage, a substantive backlog of unreported radiographs and the potential for a positive impact from radiographer reporting on societal health in Ghana. Evidence, primarily from the UK, is used to inform a model of radiographer reporting in low resource settings. The UK experience is relevant as Ghana inherited many NHS structures and practices through colonial legacy.

### **The Ghanaian health system**

The Ministry of Health (MoH) formulate policy and provide strategic direction for national healthcare delivery. MoH policies are implemented by the Ghana Health Service (GHS), which is responsible for all health facilities except private, teaching and mission hospitals.<sup>30</sup> The not-for-profit faith-based hospitals, and the few private hospitals, accept the MoH National Health Insurance Scheme. The hierarchy of GHS provision is from national headquarters to regional health directorates/hospitals, district health directorates/hospitals and finally to local polyclinics.<sup>30</sup> Nine of the 10 regional hospitals are equipped with modern digital X-ray machines and a CT scanner. Each of Ghana's 216 district hospitals has a radiology unit including (at least) a general- purpose x-ray unit and ultrasound machine. However, a shortage of radiologists and lack of contingency planning has meant that the MoH has had to train radiographers and midwives in the district hospitals in obstetric ultrasound. This training was implemented in an ad hoc way without a strategic policy.

### **Radiologist provision**

Ghana has a population of about 25 million.<sup>31</sup> However, in 2014, there were only 35 radiologists in the country.<sup>31,32</sup> Select workforce comparators are provided in Table 1.

Despite the number of UK radiologists being considered inadequate<sup>33</sup> it is approximately 70 times the number of radiologists-per-head of Ghanaian population.

<b>Country</b>	<b>Population (million)</b>	<b>Number of radiologists /100,000 population</b>	<b>Number radiographers /100,000 population</b>
<b>Ghana</b>	25	0.14	1.2
<b>Kenya</b>	43	0.47	2.4
<b>UK</b>	60	7	43.3
<b>Greece</b>	11	30	Not available
<b>EU average</b>	19	12	43.9

**Table 1** Comparison of radiologist/radiographer to population ratio in Africa and Europe.<sup>31-37</sup>

The national shortage of radiologists is exacerbated by their uneven distribution across the administrative regions of Ghana (Fig 1).<sup>32</sup> For example, the Northern region accounts for 30% of the total land mass and 10% of the national population,<sup>38</sup> but currently has only two visiting radiologists.<sup>32</sup> Most radiologists are located in the southern capital Accra and in the second city of Kumasi. The skewed distribution of radiologists is compounded for service users by the fact that those regions ill-served by radiologists also have the fewest doctors. For example, the doctor-to-population ratio in greater Accra region in 2015 was 1:7,196, whilst the figure for Upper East region was 1: 30,601.<sup>39</sup>

A net effect of gaps and inequalities in access to radiology services are many unreported radiographs and overburdened doctors with inadequate training to interpret images. Figures are not currently available, but in the (lead) author's wide clinical experience in Ghana, a majority of all radiographs remain unreported with high rates in regions with low doctor-to-patient ratios. The MoH does not currently have a strategy to address the radiologist shortage. The cost to the GHS of employing a senior radiographer is approximately £4000 per annum compared to at least £8,500 for a radiologist.<sup>40</sup> The number of unreported radiographs combined with health economic considerations suggest that Ghana is ripe for an evaluation of radiographer reporting, including the extent to which the political will and other required conditions exist.

### **Radiography in Ghana**

The first radiology unit was established in the Korle Bu teaching hospital in 1929 by the colonial Governor responsible for the Gold Coast.<sup>41</sup> This was principally in response to a nationwide outbreak of tuberculosis amongst workers in the lucrative mining industry.<sup>41</sup> The service then relied upon nurses with a few weeks training to operate radiographic equipment. Now radiography is a degree-level profession with a developing Society of Radiographers (GSR) and a new regulatory body of allied health professions (AHPC).<sup>41</sup> Key educational milestones include: the MoH establishing a school of radiography in 1951; adoption of a modified UK diploma curriculum whilst a UK trained radiographer (Mrs Harriet Dua) was principal; the conversion to University of Ghana status with a bachelor's degree award in 2002 and postgraduate programmes from 2006.<sup>41</sup> In the context of proposing changes to professional boundaries, it is notable that the introduction of a degree programme in Ghana did not meet the same resistance that was seen from the UK DoH and professional stakeholders.<sup>41,42</sup> This was largely due to justification provided by the previous UK experience.

There are currently 300 registered radiographers practicing in Ghana<sup>43</sup> compared to more than 26,000 radiographers registered with the HCPC in the UK (Table 1).<sup>44</sup> In a historical parallel to 1929, the MoH has recently commissioned 52 modern digital x-ray units for installation at district hospitals as part of the national tuberculosis control program.<sup>45</sup> Resource constraints require locally appropriate and innovative approaches to role extension in radiography to match the investment in equipment. We propose a phased approach to role extension by advocating for the initial adoption of radiographer reporting, where the potential impact on access to healthcare is likely to be greatest.

## **Methods**

This discussion paper explores opportunities for radiographer reporting in Ghana and its potential for improved patient care. Relevant literature was identified using a structured search approach. Google Scholar was used to establish current contextual data about the healthcare sector in Ghana and to conduct a scoping search of international literature on role extension in radiography. A comprehensive search of relevant literature was then conducted via Cumulative Index for Nursing and Allied Health Literature (CINAHL) and Medline via Ovid databases and the Radiography journal, as a key professional forum. Keywords used in combination were radiography, radiographer (and international variants

radiologic technologist, x-ray technician, medical radiation technologist, radiologist assistant); role extension (and related terms extended scope of practice, role development, advanced practice, skill mix, non-medical consultants, radiographer reporting and red dot). The search was not limited by date so as to include key historical papers. No geographical limit was applied to include literature from developing countries, however, papers not written in English were excluded. Inclusion criteria were articles that focused on/including the radiographer reporting aspect of role extension with unrestricted accessibility to the full text. Relevant health policy papers were also sought from UK and Ghanaian governments.

Most of the located literature originated from the UK. No empirical papers or opinion pieces were found on role extension in radiography from Ghana. The only African literature was from South Africa and Nigeria. Although a much larger country, Nigeria provides a close geographic, social and economic parallel to Ghana. South Africa is more developed but has commonalities in that both have a severe shortage of radiologists and radiographers are legally barred from producing reports.

Four common themes were identified from the retrieved articles: factors that influence the introduction of role extension; accuracy of radiographer reporting; education and training requirements; benefits of role extension/radiographer reporting. These themes are discussed against the Ghanaian context and the conditions required for local implementation of radiographer reporting considered.



**Figure 1.** Estimated number and distribution of radiologists throughout the administrative regions in Ghana in 2014

## Discussion

### Factors likely to influence successful implementation of role extension

With many unreported radiographs and only 35 radiologists in 2014<sup>32</sup> the key generic requirements for the implementation of radiographer reporting in Ghana are present. A national survey to estimate the proportion of unreported radiographs would help define the problem for service planners. Projection radiographs account for 54.6% of all imaging studies in the UK.<sup>46</sup> It can be assumed that this proportion is significantly higher in Ghana given that there is national coverage of x-ray units, but just 12 MRI<sup>47</sup> and 35 CT scanners.<sup>43</sup> Two thirds of the scanners are located in the capital city Accra, with half the regions having no MRI facilities.<sup>43,47</sup> All regions that do have these modalities have resident radiologists who ensure that all scans are reported on, even at some delay. Consequently, population health benefit is most likely to be realised from concentrating initial role extension efforts on the reporting of projection radiographs.

International literature reveals that perceived or real radiographer shortages are a live concern when seeking how best to meet rising reporting demand: either through role substitution from existing staff groups, or by establishing new roles.<sup>6,48</sup> Current radiographer numbers in Ghana (300) are already inadequate to address existing projection radiograph demand.<sup>44</sup> Fortunately, the workforce is set to expand significantly as the number of universities offering a BSc radiography programme has increased from one to four.<sup>43</sup> However, there will be a delay before the benefit of increased capacity is realised, so we propose that implementing radiographer reporting in regions currently deficient in radiologists is likely to have the greatest impact on patient outcomes, whilst maintaining sufficient radiographers to supervise the new graduates. Radiologists' enthusiasm, and the effect of their pressure/enthusiasm on the radiographer's professional behaviours, are then crucial concerns in terms of the success of implementing radiographer reporting in Ghana.

There appears to have been some supportive radiologists in UK NHS trusts that championed role extension in UK radiography.<sup>6</sup> Despite successful collaboration between the UK College of Radiographers and the Royal College of Radiologists (RCR), the latter has indicated that it still does not believe non-medical reporting of radiographs is a solution to the radiology crisis in Scotland.<sup>6,27</sup> The GSR generally has an excellent working relationship with the Ghana Association of Radiologists (GAR), but the local precedent of strong resistance from



radiologists towards radiographers performing ultrasound scans suggests the GSR should anticipate similar challenges. This resistance to radiographers performing ultrasound scans was seen to be expressed during stakeholder consultations. The GSR's task will ultimately have to present government with evidence that will convince them to amend the law, which currently bars radiographers from providing written reports.

Part of the resistance to radiographer reporting expressed in the literature,<sup>6, 7, 15, 16, 27</sup> is that, as a profession, radiology has argued role extension would limit training opportunities for junior radiologists.<sup>6</sup> In Ghana, experienced radiographers may be considered to be an appropriate resource for the teaching of junior radiologists, as already happens informally in the absence of senior radiologists.

Similar to the transition to a radiography BSc degree in Ghana, the fact that the UK has demonstrated a viable model for radiographer reporting provides the GSR with powerful evidence for this initiative. A fundamental strand of evidence to this case is that vast areas of Ghana still have no radiologists. Nigeria has a similar problem with 44.5% of hospitals surveyed in Nigeria having no radiologists, only 33% had resident radiologists and 22.5% relied on visiting radiologists.<sup>49</sup> The closest evidence available, in terms of geography, regarding radiologists' attitudes comes from a 2009 survey of South African radiologists in the Western Cape area, which reported that 68% supported role extension for radiographers. Furthermore, many were willing to act supportively, for example assessing clinical competence as well as acting as clinical mentors or supervisors as well as offering academic support.<sup>50</sup> These data give some further indication of the level of professional support/resistance that may be expected from radiologists in Ghana.

### **Accuracy of reporting**

There is a significant body of published evidence for the GSR to draw that supports the proposition that suitably trained radiographers can perform reporting to the same standards as radiologists in most areas of imaging.<sup>18, 51-58</sup> International data demonstrates that radiographers, following an accredited postgraduate programme delivered in a robust academic environment, are capable of identifying abnormal chest radiographs and provide a report on abnormal appearances to mean sensitivity and specificity scores of 95.4% (95% CI 94.4–96.3) and 95.9% (95% CI, 94.9–96.7), respectively.<sup>56</sup> Radiographers can report on a broad range of chest pathologies under controlled conditions and show high concordance

with consultant radiologists.<sup>56</sup> Nigerian radiographers have been shown to be able to interpret chest x-rays with mean sensitivity and specificity of 76.9% (95% CI, 65.8–86.4) and 79.8% (95% CI, 65.8–86.4), respectively.<sup>56</sup> The negative disparity in sensitivity and specificity between this study and UK data<sup>48</sup> could be partly because the participants in this study had not undergone formal training in radiograph reporting. Furthermore, the level of accuracy was positively associated with the number of years in practice<sup>56</sup> suggesting the segment of the radiographer workforce to be targeted initially. Evidence of the ability of radiographers to report musculoskeletal (MSK)<sup>18,51-53</sup> CT and MRI across anatomical sites also supports the potential for further role extension.<sup>57-59</sup>

### **Future radiography education requirements**

Extended working requires education that is commensurate to meet the changing needs of local practice.<sup>60</sup> Extensive personal experience of rural and municipal radiography in Ghana by the first author of the current paper provides anecdotal evidence that some radiographers, particularly in rural areas, are already interpreting radiographs on an informal basis, and thus working beyond their official scope of practice. This situation needs to be formalised to ensure compliance with legal frameworks, prioritise patient safety and protect individual practitioners. This would require an undertaking from internal and external partners that radiographer reporting is underpinned by postgraduate level education. This transition may be made more straightforward as Ghana prides itself on using educational curricula similar to those used in the UK.

Some of the requisite clinical knowledge and teaching skills to enable postgraduate programs in the clinical areas required by Ghana, such as radiographer reporting, may best be provided from high knowledge settings in other countries/regions (either online or face-to-face).<sup>61</sup> Radiologists need to be involved, ideally in the development of programmes, lecturing, examining and also, crucially, as mentors to radiographers. Clinical mentorship is likely to be critical to the task of building reporting capacity in the face of staff shortages.<sup>62</sup> Another early priority for HEIs will be to review the undergraduate curriculum to ensure that image interpretation and clinical reporting are included at the foundation level.<sup>63</sup> For example, to start by preparing junior practitioners to provide preliminary comments on MSK radiographs as a foundation for transition to full reporting.<sup>8</sup>

Whatever the exact mix of learning provision, advocacy for radiographer reporting is only likely to be realised if it is spearheaded by the GSR in concert with HEIs.<sup>64</sup> A key structural development in progressing the education agenda is that the GSR (in association with other allied health professions) are advocating for the establishment of a Ghana College of Allied Health Professions. Crucially, a joint legislative instrument has been drafted by the professional bodies with the support of the MoH to ensure that this college becomes a reality.<sup>55</sup> Once established, this college would be responsible for postgraduate education and specialisation, with the overarching mission to improve patient care.

### **Potential to improve access to quality healthcare**

International evidence demonstrates that radiographer role extension can contribute to improved access to healthcare via reduced workload of radiologists, consequential shorter waiting times for patients, and improved rates of reporting and accuracy of reports, as well as increased job satisfaction for radiographers and, health service cost reduction.<sup>15-26</sup>

It is vital for the profession that the case for cost saving is not at the expense of patient outcomes. International evidence suggests that morbidity has not increased with the introduction of radiographer reporting of trauma MSK radiographs, although in some instances there has been a reduction in the number of false negative diagnosis and subsequent patient recalls.<sup>54</sup> It can therefore be assumed that the strategic introduction of radiographer reporting in Ghana could increase the proportion of reported radiographs and hence improve clinical diagnosis and timely treatment interventions that have the potential to reduce patient morbidity and mortality.

Evidence of cost reduction to hospitals through service redesign, role substitution and reduced pay differentials<sup>8</sup> is likely to be particularly important to policy makers in a developing country. Ghana has many competing demands for extremely limited resources and the case for radiographer reporting will be strengthened by drawing on such data-driven arguments in alignment with professional drivers. The patient benefit would be maximised if savings were redistributed within the GHS, for example to further improve patient access via having more staff and equipment. Radiographer-led reporting in the emergency department (ED) has already demonstrated cost effectiveness.<sup>65</sup> That such a chronic shortage of ED beds in Ghana results in some patients being turned away, potentially leading to avoidable deaths,<sup>66</sup> provides a compelling case for radiographer

reporting in this setting in order to reduce the waiting time for reports and so promote early patient discharge.

### **Looking to the future**

The Ghana MoH has already introduced a physician assistant program to help cater for areas with an acute shortage of doctors.<sup>67</sup> The GHS has also trained radiographers and midwives in district hospitals to conduct obstetric ultrasound examinations for pregnant women. These initiatives provide a clear exemplar to embolden the GSR lobby for radiographer reporting in wider settings.

The formation of an Allied Health Professions Council (AHPC) as an independent regulatory body can be a significant development in progressing the radiographer role extension agenda.<sup>41</sup> If basic level practice is not adequately regulated, then the challenges facing extended practice are clear in a context where demonstrating competence will be crucial to persuade radiologists to relinquish professional control on practices such as reporting. The AHPC needs resources to effectively perform its task of regulation. Unfortunately, the MoH has not, so far, seemed willing to provide these. If the AHPC digitised the registration process it is likely more professionals would comply. The current situation where all registrants have to travel to the capital Accra to register/renew their licenses acts as a strong disincentive. Enforcement of registration would be promoted if the AHPC liaised with the Health Facilities Regulatory Authority (HeFRA), which licences all healthcare facilities in Ghana to ensure that their personnel are qualified to practice.

A functioning professional body (GSR), stronger regulatory body (AHPC) and new educational body (Ghana College of Allied Health Professions) could work with radiologists (GAR), the MoH and other influential stakeholders, including patient advocates, to develop a deliverable policy on radiographer reporting (as a prime exemplar of extended working.) To gain professional traction, the policy should be implemented via an agreed protocol that would encompass basic elements such as educational requirements, scope of practice, procedures for reporting, reporting structures and requirements for continuing professional development.<sup>67</sup>

With appropriate postgraduate education focussed on radiographer reporting, there is every reason to believe that Ghanaian radiographers would be able to perform to the same

standards as their counterparts in the UK. A baseline study to determine the current level of competence in image interpretation under controlled conditions is now indicated, as well as identifying image reporting skill/knowledge deficiencies to inform further training. Piloting and evaluation of radiographer reporting initiatives, particularly in regions with low doctor-to-population ratios, could help establish feasibility and would provide early data on effectiveness. Such a staged, data-driven approach is more likely to persuade the MoH to support policy that enables the introduction of locally responsive role extension.

## **Conclusions**

Global drivers for role extension in diagnostic radiography include a shortage of radiologists, increasing workload, technological advancements and shifting health policy. Although no literature or empirical evidence was found on role extension in Ghana, differences in professional structures and resources suggest that the wholesale adoption of existing models may not always succeed in the Ghanaian context. Radiographer projection radiograph reporting is the area of professional practice most aligned with local resources and most likely to improve access to quality healthcare. Developments in professional perceptions, education and regulation of reporting will all be required to establish confidence in stakeholders. Evidence of economic and patient benefits through contemporaneous research and audit should underpin strategic planning for further role extension opportunities in Ghana and contribute to the case for radiographer role extension in developing countries.

## **References**

1. Hardy M, Snaith B. how to achieve consultant practitioner: a discussion paper. *Radiography* 2007 13 265 – 270
2. White P, McKay JC. Guidelines and legal requirements which inform role expansion in radiography. *Radiography* 2002; 8:71e8.
3. Piper K.J, Paterson A.M, Godfrey R.C. Accuracy of radiographers' reports in the interpretation of radiographic examinations of the skeletal system: a review of 6796 cases. *Radiography* 2005 11 27 – 34

4. Snaith B, Milner R.C, Harris M.A. Beyond image interpretation: Capturing the impact of radiographer advanced practice through activity diaries. *Radiography* 22 2016 e233-e238
5. King, R., Tod, A. and Sanders, T. (2017) Development and regulation of advanced nurse practitioners in the UK and internationally. *Nursing Standard*, 32 (14). pp. 43-50. ISSN 0029-6570
6. Price R.C. 2006 Developing practice in radiography and diagnostic imaging PhD University of Hertfordshire
7. Page B, Bernoth M, Davidson R. Factors influencing the development and implementation of advanced radiographer practice in Australia e a qualitative study using an interpretative phenomenological approach. *J Med Radiat Sci* 2014;61(3):142e50.
8. Kelly J, Piper K, Nightingale J. Factors influencing the development and implementation of advanced and consultant radiographer practice. A review of the literature. *Radiography* 2008 14 e71 – e78
9. The College of Radiographers. 1997. Reporting by Radiographers: A Vision Paper. London:
10. Smith T, Yelder J, Ajibulu O, Caruana E. Progress towards advanced practice roles in Australia, New Zealand and the Western Pacific. *Radiography* 2008; 14(Suppl. 1): e20–3. doi: <http://dx.doi.org/10.1016/j.radi.2008.04.002>
11. May L, Martino S, McElveny C. The establishment of an advanced clinical role for radiographers in the United States. *Radiography* 2008; 14(Suppl. 1): e24–7. doi: [http:// dx.doi.org/10.1016/j.radi.2008.04.007](http://dx.doi.org/10.1016/j.radi.2008.04.007)
12. Canadian Association of Medical Radiation Technologists. Advanced Practice in Medical Radiation Technology: A Canadian Framework. Available from: <http://www.camrt.ca/mrt-profession/professional-resources/advancedpractice/>. Updated 17th December 2015. [Accessed 5 December 2018]
13. Australian Institute of Radiography. Pathway to Advanced Practice: summary document and guidelines for application for accreditation 2014. [Updated 1 April 2016.] Available from: <http://www.air.asn.au/advanced.php> [Accessed 5 December 2018]
14. American Society of Radiologic Technology. The practice standards for medical imaging and radiation therapy (Glossary), 2014. [Updated 1 April 2016.] Available from: [http://www.asrt.org/docs/default-source/Practice-Standards-Proposed/\\_glossary\\_postpubliccomment.pdf?sfvrsn=2](http://www.asrt.org/docs/default-source/Practice-Standards-Proposed/_glossary_postpubliccomment.pdf?sfvrsn=2) [Accessed 5 December 2018]
15. Snaith B, Hardy M, Lewis E. Radiographer reporting in the UK: a longitudinal analysis. *Radiography* 2015;21(2):119e23.

16. Field L, Snaith B. Developing radiographer roles in the context of advanced and consultant practice. *J Med Radiat Sci* 2013;60(1):11e5.
17. Buskov L, Abild A, Christensen A, Holm O, Hansen C, Christensen H. Radiographers and trainee radiologists reporting accident radiographs: a comparative plain film-reading performance study. *Clin Radiol* 2013;68(1):55e8.
18. Plessis J, Pitcher R. Towards task shifting? A comparison of the accuracy of acute trauma-radiograph reporting by medical officers and senior radiographers in an African hospital. *Pan Afr Med J* [Online] 2015;21. Available at [http://www.panafrican-medjournal.com/content/article/21/308/full/#.WG99Z\\_mLTIU](http://www.panafrican-medjournal.com/content/article/21/308/full/#.WG99Z_mLTIU). [Accessed 15 May 2019].
19. Reid K, Rout J, Brown V, Forton R, Crawford M, Bennie M, et al. Radiographer advanced practice in computed tomography coronary angiography: making it happen. *Radiography* 2016;22(4):319e26.
20. Torres-Mejía G, Smith R, Carranza-Flores M, Bogart A, Martínez-Matsushita L, Miglioretti D, et al. Radiographers supporting radiologists in the interpretation of screening mammography: a viable strategy to meet the shortage in the number of radiologists. *BMC Cancer* [Online] 2015;15(1). Available at: <https://bmccancer.biomedcentral.com/articles/10.1186/s12885-015-1399-2>. [Accessed 16 May 2019].
21. Lockwood P. An economic evaluation of introducing a skills mix approach to CT head reporting in clinical practice. *Radiography* 2016;22(2):124e30.
22. Milner R, Culpan G, Snaith B. Radiographer reporting in the UK: is the current scope of practice limiting plain-film reporting capacity? *Br J Radiology* [Online] 2016;89(1065). Available at: [http://www.birpublications.org/doi/abs/10.1259/bjr.20160228?url\\_ver%3DZ39.88-2003&rfr\\_id%3Aori%3Arid%3Aacrossref.org&rfr\\_dat%3Dcr\\_pub%3Dpubmed&](http://www.birpublications.org/doi/abs/10.1259/bjr.20160228?url_ver%3DZ39.88-2003&rfr_id%3Aori%3Arid%3Aacrossref.org&rfr_dat%3Dcr_pub%3Dpubmed&). [Accessed 16 May 2019].
23. Lockwood P. Exploring the benefits of magnetic resonance imaging reporting by radiographers: a UK perspective. *J Med Imaging Radiat Sci* 2016;47(2):194e203.
24. Hutton D, Eddy A. How was it for you? What factors influence job satisfaction for band 5 and 6 therapeutic radiographers. *Radiography* 2013;19(2):97e103.
25. Henderson D, Gray W, Booth L. Assessment of a reporting radiographer-led discharge system for minor injuries: a prospective audit over 2 years. *Emerg Med J* 2012;30(4):298e302
26. The NHS Benchmarking Network. View article [online]. 2017. [Nhsbenchmarking.nhs.uk](http://www.nhsbenchmarking.nhs.uk). Available at: <http://www.nhsbenchmarking.nhs.uk/news/view-article.php?id%3D209>. [Accessed 25 May 2019].
27. The Royal College of Radiologists 2017. Radiology workforce crisis in Scotland. <https://www.rcr.ac.uk/posts/radiology-crisis-scotland-sustainable-solutions-are-needed-now> [Accessed on 03 January 2018]
28. [www.medradresearch.wordpress.com/2015/09/](http://www.medradresearch.wordpress.com/2015/09/) [Accessed 25 December 18]

29. Takavarasha, S., Jr., Hapanyengwi, G., Rupere, T., & Zanamwe, N. (2012). The influence of culture on e-leadership in developing countries: Assessing Zimbabwe's capacity gap in the context of e-government. Paper presented at the 1st e-Leadership Conference on Sustainable e-Government and e-Business Innovations. Pretoria, South Africa
30. [www.moh.gov.gh/functions/](http://www.moh.gov.gh/functions/) [Accessed 25 December 18]
31. <https://www.graphic.com.gh/news/general-news/limited-number-of-radiologists-worrying.html> [Accessed on: 22 December 16]
32. [https://www.rcr.ac.uk/sites/default/files/GHD\\_Dr\\_Liz\\_Joekes\\_and\\_Dr\\_Joseph\\_Q\\_uansah.pdf](https://www.rcr.ac.uk/sites/default/files/GHD_Dr_Liz_Joekes_and_Dr_Joseph_Q_uansah.pdf) [Accessed on: 22.December 17]
33. Clinical radiology UK workforce census 2015 report (2016). The Royal College of Radiologists UK.
34. <https://radiology.ucsf.edu/blog/digital-x-ray-go-kenya> [Accessed 16 May 2019]
35. <https://emea.gehealthcarepartners.com/images/pdfs/Rapid-Review--Radiology-Workforce-Review-FINAL.pdf> [Accessed 15 June 2019]
36. <https://radiography.or.ke/>
37. <https://www.myesr.org/eu-international-affairs/imaging-observatory/human-resources>
38. Government of Ghana. Northern. 2017  
<http://www.ghana.gov.gh/index.php/about-ghana/regions/northern> [Accessed 07 January 18]
39. National Development Planning Commission (2016). Implementation of The Ghana Shared Growth and Development Agenda (Gsgda) II, 2014-2017 2015 Annual Progress Report. Government of Ghana, Accra.
40. Ghana, Republic of (2018). Single Spine Salary Structure, Fair Wages and Salaries Commission, Accra: Government Printer.
41. <https://ghanasor.org/history-of-radiography-in-ghana/> [Accessed 01 June 18]
42. Price RC, Edwards H, Heaseman F, Herbland A, Le Masurier SB, Miller L. The Scope of Radiographic Practice 2008, A research report compiled by the University of Hertfordshire in collaboration with the Institute for Employment Studies. University of Hertfordshire, Hatfield, 2009; pp. 168.
43. <https://ghanasor.org/about-us/> [Accessed 15 December 2018]
44. Diagnostic Radiography UK Workforce Report 2014 Published on Society of Radiographers (<https://www.sor.org>) [Accessed 10 July 2018]



45. <http://www.moh.gov.gh/moh-receives-digital-radiology-x-ray-equipment-for-tb-diagnoses/>
46. <https://www.england.nhs.uk/statistics/wp-content/uploads/sites/2/2016/08/Provisional-Monthly-Diagnostic-Imaging-Dataset-Statistics-2017-05-18.pdf> [Accessed 28 May 19].
47. Pierson A. D. Gorleku P.N. Assessment of availability, accessibility and affordability of magnetic resonance imaging services in Ghana. *Radiography* 2017 e75-e79
48. Buchan, J, Ball, J and O'May, F (2000) *Determining skill mix in the health workforce: guidelines for managers and health professionals. Issues in health services delivery*. Discussion Paper 3. Dept. of Organization of Health Services Delivery. World Health Organization: Geneva.
49. Okeji M.C. Udoh E.B. Onwuzu W. S. Appraisal of reporting of trauma images: implications for evolving red-dot system in Nigeria. *ARPN Journal of Science and Technology* 2. 6 2012 533-535
50. Williams I. Reporting trauma and emergency plain film radiographs: Radiologists' support for role extension of South African radiographers. *The South African Radiographer*. 47 1 2009 15-18
51. Brealey S.D, King D.G, Hahn S, Crowe M, Williams P, Rutter P, Crane S. Radiographers and radiologist reporting plain radiograph request from accident and emergency and general practice. *Clinical Radiology* 2005 60 710 – 717
52. Brealey S. Scally A. Hahn S. Thomas N. Godfrey C. Crane S. Accuracy of radiographers red dot or triage of accident and emergency radiographs in clinical practice: a systematic review. *Clinical radiology* 2006 61 604-615
53. Moran S. Warren-Forward H. The diagnostic accuracy of radiographers assessing screening mammograms. A systematic review. *Radiography* 22 2016 137-146
54. Piper K, Cox S, Paterson A, Thomas N, Jeyagopal N, Woznitza N. Chest reporting by radiographers: findings of an accredited postgraduate programme. *Radiography* 2014 20 94 – 99
55. Ekpo E. U. Egbe N. O. Akpan B.E. Radiographers' performance in chest X-ray interpretation: the Nigerian experience. *British Journal of Radiology* 2015 88: 1051
56. Lockwood P. Piper K. Pittock L. CT head reporting by radiographers: Results of an accredited postgraduate programme. *Radiography* 21 2015 e85-e89
57. Brealey S, Piper K, King D, Bland M, Caddick J, Campbell P, Gibbon A, Highland A, Jenkins N, Petty D, Warren D. Observer agreement in the reporting of knee and lumbar spine magnetic resonance (MR) imaging examinations: Selectively trained

- MR radiographers and consultant radiologist compared with an index radiologist. European journal of radiology 2013 82 e597 – e605
58. Lockwood P, Piper K. AFROC analysis of reporting radiographer's performance in CT head interpretation. Radiography 21 2015 e90-e95
59. McNulty J.P Knapp K. M Brown P. Radiography education in the spotlight. Radiography 2017 23 S1-S2
60. <https://blog.bir.org.uk/2017/02/13/breaking-the-mould-how-radiographer-reporting-is-better-for-the-patient/comment-page-1/> [Accessed 25 May 2019]
61. Paterson AM, Price RC, Thomas A, Nuttall L. Reporting by radiographers: a policy and practice guide. Radiography 2004; 10:205e12
62. Hardy M, Johnson L, Sharples R, Boynes S, Irving D (2016) Does radiography advanced practice improve patient outcomes and health service quality? A systematic review. BJR, DOI: 10.1259/bjr.20151066
63. Society and College of Radiographers. Medical image interpretation and clinical reporting by non-radiologists: the role of the radiographer. London: College of Radiographers; October 2006.
64. Hardy M, Hutton J, Snaith B. Is radiographer led immediate reporting service for emergency department referrals a cost-effective initiative? Radiography 2013 19 23 – 27
65. Don't turn patients away, Minister of Health. <http://citifmonline.com/2016/05/18/dont-turn-patients-away-minister-to-hospitals/> [Accessed 02 January2018]
66. Adjase E. T. Physician assistants in Ghana. Journal of the American Academy of Physician Assistants. APR 2015 28(4):15
67. Nightingale J. Developing protocols for advanced and consultant practice. Radiography 2008 14 e55 -e60