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ORIGINAL ARTICLE

Increasing radiology capacity within the lung cancer pathway: centralised work-based support for trainee chest X-ray reporting radiographers

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Abstract

Introduction: Diagnostic capacity and time to diagnosis are frequently identified as a barrier to improving cancer patient outcomes. Maximising the contribution of the medical imaging workforce, including reporting radiographers, is one way to improve service delivery. **Methods:** An efficient and effective centralised model of workplace training support was designed for a cohort of trainee chest X-ray (CXR) reporting radiographers. A comprehensive schedule of tutorials was planned and aligned with the curriculum of a post-graduate certificate in CXR reporting. Trainees were supported via a hub and spoke model (centralised training model), with the majority of education provided by a core group of experienced CXR reporting radiographers. Trainee and departmental feedback on the model was obtained using an online survey. **Results:** Fourteen trainees were recruited from eight National Health Service Trusts across London. Significant efficiencies of scale were possible with centralised support (48 h) compared to traditional workplace support (348 h). Trainee and manager feedback overall was positive. Trainees and managers both reported good trainee support, translation of learning to practice and increased confidence. Logistics, including trainee travel and release, were identified as areas for improvement. **Conclusion:** Centralised workplace training support is an effective and efficient method to create sustainable diagnostic capacity and support improvements in the lung cancer pathway.

Introduction

Medical imaging has a central role in modern healthcare globally, with imaging needs across all populations and heath economies.[1] It is used by clinicians to guide diagnostic and prognostic decisions across a broad spectrum of patient pathways, especially for patients with suspected cancer. Early, rapid and accurate diagnosis within a cancer pathway is essential so patients have the widest range of treatment options and to minimise patient anxiety when cancer is not the diagnosis.[2] Lung cancer causes a significant burden, and is the leading cause of cancer mortality worldwide.[3] There are poorer outcomes for patients with lung cancer in England compared with those internationally, and when compared to other common tumour sites.[4,5] Some of this variation may be due to the often vague and non-specific symptoms of lung cancer,[6,7] and recent guidance advocates lowering the threshold for investigation in general practice if cancer is suspected to improve early diagnosis.[8]

Diagnostic capacity is frequently identified as a barrier to improved patient outcomes for cancer patients in England, and to meet this need requires significant

increases in imaging activity.[9] The drive for early diagnosis of cancer and the desire within the new care models to manage more patients in the community suggests that the number of imaging investigations performed will only continue to rise. The diagnostic workforce has failed to increase with rising demands. Chronic shortages of consultant radiologists[10] and, to a lesser extent diagnostic radiographers,[11] exist within many imaging departments within the UK. Workforce shortages have contributed to significant numbers of patients, approaching 250,000, waiting more than 30 days for a clinical report in England.[12]

Radiographer clinical reporting has been used for over 25 years by departments in the UK to assist in the provision of an effective, efficient, accurate and patient focused imaging service.[13–16] A robust evidence base demonstrates that appropriately trained radiographers provide accurate clinical reports for a range of examinations and modalities.[17–23] It is estimated that 21% of imaging examinations, including X-rays, magnetic resonance and ultrasound are reported by radiographers who have undertaken appropriate advanced practitioner education and training.[24] However, uptake of radiographer reporting within NHS Trusts is variable, with some departments being exemplars of best practice and others with no or little utilisation of reporting radiographers' skill set outside of ultrasound imaging.[25] Maximising the contribution of the existing workforce is key to delivering the new models of care required to implement the Five Year Forward View.[26] All reporting radiographers must complete accredited post-graduate education to ensure they are safe, accurate and competent practitioners prior to reporting in clinical practice.[27–29]

In this model of medical imaging service development and provision, the trainees' post-graduate education is supported within the workplace with practice reporting and tutorials, traditionally undertaken by radiologists at each individual site. Acute service pressures mean that release of staff to undergo training and education is often challenging. There are, however, clinical departments where radiographers have completed an accredited post-graduate reporting programme and the practice is established and embedded; such departments are able to use the existing resource of reporting radiographers to support future workforce development.[14] The current medical imaging service development and delivery approach was designed for time-efficiency and effectiveness, centralising the work-based learning and support required to support accredited radiographer post-graduate education. Using established and experienced reporting radiographers in a hub and spoke training support model is one approach to increasing diagnostic capacity while minimising impact on scarce radiologist resource for training. The aim of this project was to develop and evaluate a novel hub and spoke model to support a cohort of trainee chest X-ray (CXR) reporting radiographers to support the lung cancer pathway, encouraging trainees' integration theory and practice, as relevant to their workplace.

Methods

The project is an evaluation of a new service and as such the requirement for ethical approval was waived by the Research and Development department. For the purposes of this project a district general hospital describes an acute medical hospital with a range of specialist treatments, whereas a tertiary hospital describes an acute hospital that acts as a regional centre for patients requiring highly specialised care.

A hub and spoke model to deliver centralised work-based tutorials and support was developed to support trainee CXR reporting radiographers as they complete an accredited post-graduate certificate in adult CXR reporting at Canterbury Christ Church University. Course content and structure of the post-graduate reporting qualification has been described previously.[19] Targeted recruitment of 14 trainee CXR reporting radiographer was sought across London. Departmental demographics from recruiting centres, including annual activity, number of CXRs performed and existing reporting radiographers was collated. Traditionally, supportive workplace learning would occur within a trainee's host department and be provided by consultant radiologists. Custom is that recommended engagement and frequency of tutorials is an hour per week with the trainee's nominated consultant radiologist mentor. However, in our hub and spoke model, to maximise efficiency and minimise impact on scarce consultant radiologist resource a schedule of two-hour, fortnightly tutorials was planned, aligned with the curriculum of the post-graduate programme. Additionally, to improve efficiency within the centralised model the majority of tutorials was delivered by experienced CXR reporting radiographers, drawn from centres across the sector. The hub was responsible for the development and co-ordination of the tutorials, development of the content and delivery of the majority of the workplace tutorials and as required by the accredited post-graduate programme. Additional learning was expected of trainees in addition to university attendance and tutorials supported by the hub and spoke model, including practice reporting. This content was outside of the scope of the current project.

A pilot evaluation of key sections of the education process and overall evaluation of the hub and spoke model was undertaken to support the development of the

evaluation tool, a Bristol Online Survey completed by the 14 CXR post-graduate trainees. A realist evaluation approach was used to construct the evaluation, based on the utilisation focused framework of Patton.[30] Experience of the host Trusts was evaluated using the same survey facilitating comparison between trainees' and managers' commentary. Unique responses were coded for trainee (S) and managers (M) for analysis (The evaluation was conducted just prior to final assessment (month 10) of the 12 months post-graduate certificate in adult CXR reporting (Appendix S1).

Results

Trainee recruitment

A cohort of 15 trainee radiographers were recruited from eight Trusts across London, 14 funded centrally (NHS England Diagnostic Capacity Fund) and one department funding an additional trainee. Wide variation in the number of existing CXR reporting radiographers from host Trusts was found. The department demographics are presented in Table 1. One trainee withdrew from the programme due to personal reasons. The trainees recruited to the project had a wide range of radiography experience, summarised in Table 2.

Two centres with established teams of experienced CXR reporting radiographers, Homerton University Hospital and University College London Hospital, formed the *hub* of the model. Project management was undertaken by a consultant radiographer with experience in CXR reporting and post-graduate clinical reporting education, supported with operational issues by an experienced service manager with further support from the Medical Directors and consultant radiologist mentors.

Table 1. Demographics of participating departments.

Hospital type	Annual imaging activity (April 2016–March 2017)	Annual volume of CXRs (April 2016–March 2017)	Number of current CXR reporting radiographers	Trainee CXR reporting radiographers
Tertiary[1]	291,458	56,722	5	2
DGH[1]	166,108	29,415	3	2
Tertiary	649,615	108,593	5	2
Tertiary	524,100	114,025	1	1
DGH	184,424	34,718	0	2
DGH	236,855	57,543	1	2
Tertiary	638,983	60,469	1	2
DGH	196,846	49,682	2	2

CXR, chest X-ray; DGH, district general hospital.
[1]Hub departments.

Table 2. Trainee radiographer demographics.

	Number of trainees
Radiography experience	
2–5 years	3
6–10 years	8
>10 years	3
Previous Post-graduate Education	
Post-graduate Certificate	1
Post-graduate Diploma	4
Master of Science	1
Previous reporting qualification	
Skeletal reporting	5
Other	0

Design of the centralised model

The content and timetable for the work-based tutorials is presented in Table 3. The tutorials format was informed by a transmission model[31] and was a blend of practical image viewing sessions, case-based discussions and a small amount of didactic teaching. Tutorial content addressed the fundamental skills of adult CXR interpretation and key pathological areas as relevant to lung cancer. The content and timing of the tutorials was aligned to the post-graduate certificate curriculum (Table 3), timed for maximum benefit coinciding theory learning together with all possible practice experiences and application to their workplace service delivery.[18,19,32] Key topics, such as search strategy and formulation of a differential diagnosis were delivered in the initial period. Common adult pathologies were grouped together, including infection, lobar collapse, malignancy, interstitial lung disease and CXRs performed in an emergency and intensive/critical care setting. Challenging cases and common errors made in clinical practice were included across the programme as a repeating theme with aim of enhancing competencies, through use of cases drawn from local radiology discrepancy meetings and frequent false positive diagnoses from local audits of CXR reporting. Mock examinations and vivas were prepared for the end of the post-graduate certificate programme, modelled on the rapid reporting examination of the Fellow of Royal College of Radiologist (FRCR) part 2B examinations to consolidate learning and as a preparation for the trainees' final objective structured examination. Emphasis in the tutorial teaching was made not only on the radiographic appearances, but also the role of the CXR and reporting radiographers within the patient pathway and construction of a diagnostic and actionable report.[33]

Table 3. Content of work-based tutorials.

	Topic	Topic
Nov-16	Formulating a differential diagnosis *Radiology Specialist Registrar*	
Dec-16	Basics of chest X-ray interpretation *Reporting Radiographer*	TB versus sarcoid versus lymphoma *Radiology Specialist Registrar*
Jan-17	Mediastinum *Reporting Radiographer*	Review of discrepancy meeting CXRs *Reporting Radiographer*
Feb-17	Lobar collapse *Reporting Radiographer*	Support lines, tubes an ITU CXRs *Reporting Radiographer*
Mar-17	Medical devices *Reporting Radiographer*	Lung cancer – a respiratory perspective *Respiratory Physician*
Apr-17	Trauma/ED CXRs *Reporting Radiographer*	Review of CXR audit cases – false positives *Reporting Radiographer*
May-17	Principles and concepts of CXR interpretation *Thoracic Radiologist*	
Jun-17	Atypical infections *Reporting Radiographer*	Interstitial lung disease *Reporting Radiographer*
Jul-17	Review of CXR audit cases – reporting style *Reporting Radiographer*	Review of discrepancy meeting CXRs *Reporting Radiographer*
Aug-17	Rapid reporting CXRs *Reporting Radiographer*	Rapid reporting CXRs *Reporting Radiographer*
Sep-17	Rapid reporting CXRs *Reporting Radiographer*	
Oct-17	OSCE revision *Reporting Radiographer*	OSCE revision *Reporting Radiographer*

Table 4. Project tutorial evaluation themes.

What	How	Where
Content of tutorials	Mode of delivery	Location of tutorials
Topic detail	Pace of tutorials	Timings of tutorials
Breadth of topics	How knowledge was used in practice	
Professional capacity		

Impact of the centralised model on service delivery

Delivering the work-based learning in a centralised way across the sector resulted in two hours of 'expert' time lost to clinical practice per fortnight for the cohort, rather than eight hours (14 trainees over eight sites) per week using the traditional model. Over the 12 months duration of the post-graduate certificate this produced a net saving of 300 h (traditional tutorials total of 348 h; centralised model total of 48 h).

To increase efficiency of the centralised model further, the tutorials were led by experienced reporting radiographers (Table 3; $n = 17$ sessions, 34 h). These radiographer-led sessions were supplemented with targeted teaching delivered by an eminent thoracic radiologist ($n = 1$ session; 2 h, tertiary hospital based) and a respiratory physician ($n = 1$; 2 h, DGH based) as well as a senior radiologist registrar ($n = 2$ sessions; 4 h, DGH based) to ensure a rounded educational experience. As a consequence, only six hours of radiologist time was used to support a cohort of 14 trainee radiographers.

Evaluation of trainee and manager perceptions of the centralised model

Four service managers (from 8 departments, 50%) responded to the survey thus information should be viewed as providing a trend only, nevertheless a number of responses indicate clear common views held by managers. Thirteen trainees (of 14, 93%) took part in the survey and their line managers also responded. Survey questions were the same for both groups allowing view from two lenses: line managers and trainees.

Managers

All managers indicated that:

- Tutorial content prepared them or their trainees for the final assessment
- Provided opportunity to gain experience from a variety of practitioners
- Department capacity will improve consequent to the X-ray reporting training
- Knowledge and skill levels within the department had improved following training
- Centralised model of training was efficacious

Managers appeared to find the centralised model approach helpful for their trainees; '*Regular sessions allow trainees to remain engaged with the course and protected time to attend is vital to ensuring success*' (*M*25851802). However, some further attention to timetabling would be useful '*Releasing staff in a busy department for tutorials is always going to a challenge. This would have been easier to facilitate if the tutorials had been scheduled at either end of the day rather than in the middle*" *(M*25850879*)*.

Generally (75%, $n = 3$) it was felt confidence in reporting, and training opportunities had increased as a result of having a cohort of peers in the centralised training model. Three managers (75%) agreed that the centralised model of training compared appropriately with other training models, whereas one disagreed and also felt the relevance to the wider context and tutor knowledge was

not applicable. Two (50%) respondents felt that the centralised model allowed better application of knowledge compared with other models, one felt no change and one respondent stated they did not know. One supporting comment indicated the potential beneficial impact for service '*2 additional chest reporting radiographers will ensure that GP and IP chests as well as A and E images are reported within a few days*' *(M*25850879*)*.

Breadth and depth of content covered, and support through the centralised model was considered sufficient compared with other training models by half the respondents (n = 2), whereas others felt not able to comment.

Most managers (n = 3, 75%) considered the centralised training model to be more efficient compared with other approaches, and '*The 2 students seem satisfied at the training provided by the centralised model' (M*25850879*),* but there were caveats. These relate to tutorial delivery in the centralised model compared with other approaches:

- Tutorial timing during the day (1 respondent felt appropriate, 1 less appropriate, others did not know) '*difficulties have arisen with tutorials in the middle of the day as 2 clinical staff are lost for the majority of the day for a 2 h meeting due to lengthy travel times*' *(M*25850879*)*
- Time spent during tutorials (1 respondent recorded appropriate, 1 less appropriate, others did not know)
- Intervals between tutorials (1 appropriate, 1 same, others did not know)
- Location (1 appropriate, 1 less appropriate, others did not know)

Trainees

All trainees (n = 13) agreed the centralised model was:

- Appropriate for training compared with other models they had experienced
- Provided opportunity to gain knowledge from a range of practitioners
- Content was sufficiently covered (search strategy and pathologies)

In the five free text comments relevant to this section of the survey, all trainees found the centralised model's learning environment beneficial compared with other methods.

> *'Content has been excellent – provided from a wide range of tutors on a wide range of topics in intimate learning environments. A much better method of teaching to what I have experienced in the past from courses which don't offer such a method'.*
>
> (S25171724)

> *'The intimate environment gives a more one to one feel with the tutor. It's not just a generic power point so it gives us the opportunity to ask questions and create a more bespoke teaching session.'*
>
> (S25181513)

A majority of trainees (n = 10, 76%) reported the centralised model compared favourably with other approaches, whereas the two others scored 'neither agree nor disagree' and one 'did not know'. While students (n = 12, 92%) reported learning via this model helped them understand reporting in the wider context and found tutors' knowledge sufficient, one of seven free-text comments (below) noted some quality variability. Eleven (84%) trainees agreed it was suitable preparation for the final assessment (the remaining two indicated neither agree nor disagree/do not know).

> *'I would say that some tutorials were very good (e.g. the one that involved the [profession redacted] at [location redacted]). Others were not so good and lacked content'.*
>
> (S25181513)

> *'A wide range of pathologies and normal variants were reviewed during the tutorials. Discussing the physiology helped our understanding of the diseases. Comparing appearances of different pathologies in PA/AP/SUPINE views has prepared us for reporting'.*
>
> (S25181978)

A majority of trainees (n = 10, 76%) felt increased capacity had been achieved and they had seen increased knowledge and skills within their department subsequent to experiencing the centralised training model.

> *'Having two trainees do the course is improving our capacity and general knowledge in the department'.*
>
> (S25251070)

> *'It has developed a much wider understanding of reporting chest X-rays, and also understanding outside the topic as to different clinical details to look for which can cause chest pathologies, etc. this has increased the confidence for reporting as it gives you a greater understanding of the topic'.*
>
> (S25235846)

Eight of the trainees (61%) felt training and practice opportunities had increased in their department and a free text comment illustrates their perception of the nature of impact for service delivery. '*The more people who are confident and competent in reporting there are, the greater the quality of service provided across the board*'. *(S*25171724*)* Trainees with previous experience of image interpretation included five with previous post-graduate reporting qualifications and those with non-accredited image interpretation education. Despite all trainees finding the centralised model of learning

beneficial compared with other approaches, confidence in CXR reporting shows some variation within the group with around half (53%, $n = 7$) feeling increased confidence and 5 feeling the same level of confidence. Regarding translating learning into practice (application of theory to practice), slightly more trainees ($n = 8$, 61%) found the centralised model helpful, whereas four (31%) respondents found it to be the same as other approaches. Nevertheless 92% ($n = 12$) reported the tutorial pace and tutorial support helped consolidate their learning.

Trainees had varying views about the location and timing of tutorials, but were generally (77%, $n = 10$) positive about tutorial duration. While around half found the location appropriate, three (23%) students were less enthusiastic.

> *Some of the tutorial locations haven't been great. One place doesn't have a projector and we are working off just a small computer screen which makes it difficult to see.* (S25181513)

> *Very flexible and appropriate. I was very happy going to other sites which gave us broad knowledge. Quite unique experience. Well done to course organisers tpb* (5172979)

Discussion

The centralised model to support trainee CXR reporting radiographers has been demonstrated to be effective, efficient and generally well rated by trainees and department managers. The fact an additional trainee was funded by a department is evidence of the benefit of the centralised model being perceived by that service. Blended learning, a combination of academic and work-based education, is the established method of reporting radiographer education.[34] Leishman highlighted a lack of reporting radiographer online teaching resources relative to other health professions as a possible barrier to training.[35] Lack of departmental support has also been found to hamper radiographer reporting education,[34] which is particularly relevant given the relative paucity of radiographer CXR reporting in clinical practice when compared to skeletal reporting.[25,36] The centralised support model developed addresses these barriers. Online education is often presented as a method of increasing training capacity. The current model provides additional capacity across a sector and ability to upscale the current model is another asset, and should be the preferred alternative to online education as the centralised model maintains engagement with tutors and a peer support network, previously identified as key requirements for reporting education.

Sustainable diagnostic capacity

Diagnostic capacity is frequently highlighted as a barrier to improved patient care and outcomes,[2,9] with significant reporting backlogs in England[12] identified despite increased spend on outsourced radiology (£47–£53 m) between 2014 and 2015.[10] Ongoing use of outsourced reporting is not cost effective or sustainable, as outsourcing does not improve diagnostic capacity, and reporting backlogs will return as drivers have not been addressed. Use of outsourced reporting also has the potential for a decrease in the clinical relevance of reports due to lack of access to previous imaging and knowledge of local pathways. Increasing the number of reporting radiographers will ensure a sustainable workforce, as this facilitates succession planning and reduces risk to service delivery due to staff attrition.

Trainee and manager satisfaction with the centralised model

Centralised tutorials for trainee CXR reporting radiographers was found to be effective in supporting practitioner development from both trainees' and managers' perspectives. Trainees with previous reporting experience generally rated the centralised model as effective when compared to their previous experience. Centralised tutorials did produce some logistical challenges, with one clinical trainee site further from the two hubs in the current model. Learning from this initial model would be to concentrate the 'spoke' sites within a more closely defined sector or, in addition possibly embrace the use of 'virtual' tutorials using tele-medicine facilities. Centralised tutorial support requires fixed and timetabled sessions to enable trainee attendance. The relative inflexibility of this approach was identified by some managers as a negative, although several of the trainees indicated that this was a positive as this gave protected study time and allowed planning of learning. The spectrum of cases and pathologies, as well as access to a range of tutors, were all positive aspects of the centralised model.

Maximising efficiency and support across a sector

Local delivery of the centralised model provides support across an entire sector in an efficient and effective way.

Utilisation of centres with an existing critical mass of experienced reporting radiographers as the 'hub' allows training to be provided to support those departments currently without any existing service, including those departments who are challenged with a significant

backlog for reporting. The model could easily be adapted to other regional centres and in fact is already readily transferrable. As demonstrated in this evaluation, this centralised reporting radiographer work-based training model is successful. It can be applied to other regional 'hubs' where a critical mass of reporting radiographers exists. To ensure that service delivery at the hub departments is not impacted, appropriate resourcing is required to compensate for lost clinical time used to support other hospitals and for project management of the model. The current model required 0.1 FTE consultant radiographer to manage and co-ordinate the programme and 0.1 FTE reporting radiographer resource to prepare and deliver the tutorials.

Opportunities for patient pathway redesign

By increasing numbers of appropriately trained reporting radiographers to provide reporting for lung cancer, complementing an existing diagnostic imaging service, and additionally releasing radiologists' capacity for wider service provision within the pathway (such as lung biopsy) the time taken for the entire diagnostic pathway is reduced. Training a sufficient cohort of reporting radiographers across a sector creates a core group to provide an ongoing, stable and sustainable service. The additional diagnostic capacity created when these reporting radiographers enter practice may have a positive impact on patient experience and lung cancer diagnostic capacity, for example implementation of immediate reporting of CXRs referred from general practice by radiographers in line with optimal lung cancer pathway.[37,38]

The centralised model developed to support radiographer CXR reporting education has the potential to create additional capacity not only support the existing cancer waiting time targets, including 62 days from referral to treatment,[39] but also the new cancer waiting time target of 28 days from referral from general practice to the patient receiving their diagnosis or have cancer ruled out.[2]

Development of the hub and spoke model, with the additional diagnostic capacity that the trainees will bring to departments upon completion, has been used as an opportunity to revisit current pathways. At University College London Hospital a radiographer reporting hot desk has been established with the additional radiographer reporting capacity provided by the newly qualified practitioners. The 'hot desk' reporting radiographer acts as a central expert contact point for radiographers who acquire an image and are concerned about a significant abnormality. The reporting radiographer will provide an immediate opinion and report to radiographers, hospital clinicians and general practitioners, and guide patient management such as rapid referral to emergency medicine, respiratory medicine in addition to providing an immediate clinical report. Increasing the number of reporting radiographers who can report CXR is a pathway enabler.

Conclusions

The centralised model to support trainee CXR reporting radiographers is an innovative, novel and efficient way to create additional diagnostic capacity and support pathway redesign within lung cancer. This model of working is directly transferrable to across the NHS, other healthcare providers including the independent sector, to other patient pathways and international health settings acknowledging there will need to be adjustment to fit with local needs.

Conflict of Interest

The authors declare no conflict of interest.

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Supporting Information

Additional supporting information may be found online in the Supporting Information section at the end of the article:

Appendix S1. Evaluation questions – novel radiographer chest X-ray training.