Methods Used by General Practitioners to Interpret Chest Radiographs at District Hospitals in the City of Tshwane, South Africa

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Abstract

Introduction: A chest radiograph is one of the first-line diagnostic tools for general practitioners (GPs) to diagnose, monitor treatment, and predict the outcomes of diseases. In district hospitals, after clinical examination, GPs refer patients for imaging in the X-ray department. Radiologists specialize in interpretation of radiographs and provide a gold standard radiologist report to help diagnose support and influence patient management. A shortage of radiologists restricts continuity in radiology services and causes a delay in diagnosis, compromising the overall quality of service to patients. GPs are mandated to perform image interpretation on all chest radiographs taken at district hospitals and they sometimes request assistance from radiographers.

Aim: The aim of this study was to explore methods used by GPs to interpret chest radiographs at district hospitals in the City of Tshwane, in South Africa.

Methods: A qualitative, exploratory, and descriptive case study method of inquiry, with convenience sampling was used. Under discussion, the case studies were reconstructed in terms of themes. Recurring themes in these case studies were expounded and linked within the literature.

Results: Results obtained from a sample of 15 participants showed that GPs used a free global search to scan radiographs without a preconceived orderly pattern. Their only training on image interpretation occurred during undergraduate education and training.

Conclusions: It was concluded that the methods used by GPs for interpretations of chest radiographs were not systematic in approach, resulting in omission in identifying abnormalities in some structures of the chest/thoracic region. The researcher recommends that all GPs need continuous in-house training to acquire the knowledge of the systematic method of evaluating chest radiographs.

Introduction

Currently, South Africa (SA) has several major public health concerns, facing a quadruple burden of disease. The quadruple burden of disease has resulted in an increased demand for medical care for patients infected with HIV/AIDS, along with tuberculosis; providing maternal and child care; treating high levels of violence and injuries; and treating a growing burden of noncommunicable diseases [1]. To meet the increased need for treatment, the SA government plans to implement the National Health Insurance (NHI) financing system. The NHI aims to provide essential health care to all South Africans regardless of their employment status on a sustainable and equitable basis. Implementing the NHI requires a complete overhaul of SA's health care system, and it is appropriate that innovative service delivery models are explored and tested to improve health status [2].

In the South African health care system, patients usually enter the system at a primary level through local clinics where they are examined by general practitioners (GPs). If necessary, patients are referred for imaging examinations at X-ray departments at district hospitals. Effective service delivery in hospitals and management of patients depends on the ability of X-ray departments to provide timely, adequate diagnostic radiography services. The shortage of qualified radiologists is of concern in SA and globally [3,4]. Radiologists are specialists responsible for providing an accurate diagnostic report to support and influence patient management.

In SA, GPs use chest radiographs as a diagnostic tool to diagnose, monitor treatment, and predict outcomes for many abnormalities, including managing complications associated with tuberculosis and HIV [5]. Chest radiographs are often difficult to interpret because of different conditions presenting with similar clinical features, atypical radiographic presentations, and the broad spectrum of pulmonary diseases encountered in SA [6]. Diagnostic imaging aims to demonstrate pathological processes beyond the scope of clinical examinations. Ideally, all chest radiographs should be reported by a senior clinician or radiologist at an early stage or during admission.

A systematic approach to image interpretation provides structure to the process of identifying abnormalities and improves the ability to evaluate and comment on relevant findings. The ABCs systematic assessment approach shown in Table 3 is adapted from Chan et al [7]. A systematic approach for viewing chest radiographs ensures no important structures are ignored or omitted, and minimizes the risk of missing any abnormalities [7]. The initial evaluation of any chest radiograph should include a determination of the technical adequacy of the examination to confirm that it is of adequate quality for interpretation. This step is often overlooked, which can lead to both overdiagnosis that may simulate lung disease, and underdiagnosis. The second step is to systematically search for abnormal patterns in all structures of the chest, and the last step is to describe abnormal patterns identified [8,9].

To minimize interpretation errors, chest radiographs should be viewed under optimal viewing conditions. Suitable luminance and ambient light conditions of viewing boxes affect the detection accuracy of radiographs. When light intensity is lower than needed, the eye loses power to detect small objectives [10]. Viewing boxes with low brightness will limit visual acuity and reduce the ability to perform adequate evaluation of radiographs' details [10]. To analyse chest radiographs, clinicians require knowledge of normal thorax anatomy, common anatomical variants, and the physiology of chest diseases. Radiographs should also be analysed in conjunction with the medical history of the patient, including previous

radiographs, if available and other diagnostic results, such as laboratory results for blood tests, or sputa tests, electrocardiograms and respiratory function tests [11].

In SA, optimal analysis of radiographs is complicated by high rates of staff turnover in the public health system. The high rate of turnover means that the workforce is dominated by junior medical practitioners on short-term contracts [12]. Junior medical practitioners are expected to interpret the images taken at district hospitals and provide a patient management plan based on their diagnosis. When faced with complicated cases, junior medical practitioners request assistance from their colleagues and may send radiographs to tertiary hospitals to get a radiologist report. This process may take four to six hours, or even days, and patients may be asked to return another day when the X-ray report is ready, or they may be referred to a tertiary hospital for the X-ray examinations. This study was motivated by the fact that the shortage of specialists in district hospitals does not always allow for timely analysis of images.

In the city of Tshwane, radiographers from district hospitals had previously informed the researcher of incidents where GPs requested assistance in identifying abnormal patterns on radiographs. Etheredge [13] highlighted that SA radiographers often found themselves in a precarious situation when requested to interpret chest radiographs in the absence of a radiologist. In contrast to radiologists, GPs have basic interpretation and reporting skills and radiographers have interpretation skills but are not permitted to provide formal reports, only a voluntary informal verbal opinion is allowed in SA [14].

Van de Venter et al [15] explored experiences of radiographers and medical practitioners in reporting during after-hours in trauma units. Results showed that radiographers contributed significantly to more holistic health care and positive patient outcomes in trauma units [15]. When comparing short-term medical staff and radiographers employed for more than ten years in government hospitals, Du Plessis and Pitcher [16] found that the senior radiographers achieved 81.5%, a significantly higher reporting accuracy and sensitivity than medical officers. Gqweta [12] found that junior medical practitioners in public health care facilities lacked the knowledge to interpret chest radiographs. In this study, we explored the methods and challenges experienced by GPs to interpret chest radiographs at district hospitals in the City of Tshwane.

Methods

Permission to conduct the study was obtained from all the Chief Executive Officers and Heads of Departments at the district hospitals. The Ethics Committee of the Faculty of Health Sciences, University of Pretoria, approved the study (93/2017).

We used a qualitative, exploratory and descriptive case study method of inquiry. The qualitative case study approach facilitated exploration of methods used by GPs to interpret chest radiographs from a variety of data sources. Case studies provided an opportunity to gain a deep holistic view of current practices of GPs.

This study was set in three district hospitals in the city of Tshwane. We focussed on the casualty and outpatient departments as chest radiographs of new patients were interpreted in these departments.

In total, 40 GPs (N = 40) render health services at these district hospitals in Tshwane, who were all informed about the study by their clinical managers. The GPs on duty were informed that a researcher was scheduled to collect data on a particular day. At each hospital, a maximum of five GPs were available on the day shift. We sampled 15 participants in total (n = 15). Participation was voluntary. We used a convenience sample at all hospitals. We did not assess the accuracy of findings, but rather assessed the procedure followed to interpret images and get to the findings. We excluded repeat radiographs and only assessed the methods used to interpret radiographs taken for the first time.

We collected data using structured observations, taking notes, and from audio recorded individual interviews. Data collection started with orientation and then introductions and exchange of contact details. The researcher clarified any expectations regarding nonattribution, sharing of data, and any other issues raised by the participants. Participants signed consent forms, including permission for audio recording. We recorded demographic data, including age, gender, and work experience of each participant, as a fundamental building block for identifying and tracking gaps in quality of care [17].

The researcher took the role of nonparticipant observer resulting in unbiased, reliable, detailed observations [17]. We adapted a checklist of actions adopted from Spradley's [18] checklist for observations. Action items observed were identifying the projections, observing viewing conditions and image quality according to McQuillen [19]. The participants were requested to explain actions noted during the observation phase. Participants explained image viewing on viewing boxes and explained how they determined image quality. Focal sampling was used when conducting observations, each participant was observed for a specified time and all actions recorded during that time [20].

In addition to observations, we conducted individual interviews using a process adapted from Kasunic [21]. The interviewer used a set of preplanned questions as an interview guide, allowing for a systematic, comprehensive, and efficient interview process. In closing the interview, the interviewer reviewed the key points, and action items, and confirmed accuracy with the participant. The participant was invited to provide feedback on the interview process. The interviewer thanked the participant and requested permission for any future contact should this be necessary [21].

The interview guide comprised the following questions:

- Describe the methods GPs use to interpret chest radiographs. The researcher requested the participant to explain the method they used to evaluate and identify abnormal patterns on chest radiographs.

- Discuss challenges experienced during interpretation of chest radiographs.

- Describe the training you have in interpreting chest radiographs.

- Describe any support or training given to GPs in interpreting chest radiographs.

Data were collected in the consultation rooms, away from colleagues and patients. Two researchers participated in each interview [21]. One researcher acted as interviewer and took notes as questions were answered, whereas the research assistant was responsible for audio-

recording participants' responses. The participants' names were not recorded during data collection.

The researcher used the criteria recommended by McQuillen [19] to evaluate the GPs as they explained how they interpret images. The listed factors for evaluating image quality (Table 2) included anatomy of interest, removable artifacts, breathing technique, exposure factors, and identification of patient, position of chest, anatomical markers, and part position. Anatomical coverage, according to Chan's [7] ABC's system approach of image interpretation included the airways, breast tissue, cardiac, costophrenic/cardiophrenic angles, diaphragms and gas bubble, hila, lung tissue, surrounding tissue, and skeleton (Table 3).

Table 1. Demographic Characteristics of General Practitioners Who Analysed Chest Radiographs in Casualty and Outpatient Departments in District Hospitals in Tshwane District, South Africa (n = 15)

Demographic Information	**GPs (n = 15)**	
Age in years:		
20–29	6	40%
30–39	6	40%
40–49	3	20%
Experience:		
Community service	8	53%
1–4 y	0	0%
(5–9 y)	4	27%
(10+ y)	3	20%

GPs, general practitioners.

Table 2. The Factors Assessed by General Practitioners to Check the Quality of Chest Radiographs Taken in Casualty and Outpatient Departments in District Hospitals in Tshwane District, South Africa (n = 15)

Factors Assessed for Adequacy (McQuillen) [16]	**GPs n = 15**	
Views done:		
Posteroanterior (PA)	15	100%
Lateral:	On request	
Image evaluation		
Anatomy of interest (AOI)	7	47%
Artefacts	0	
Breathing	2	13%
Exposures	9	60%
Identification	4	27%
Position	3	20%
Markers	0	
Orientation	3	20%

GPs, general practitioners.

Table 3. Pattern Analysis Used by General Practitioners to Interpret Chest Radiographs Taken in Casualty and Outpatient Departments in District Hospitals in Tshwane District, South Africa (n = 15)

Structures Analysed for Chest Interpretation	GPs n = 15	
Artefacts (nonremovable)	0	
Airways	7	47%
Breast tissue	0	
Cardiac	10	67%
Costophrenic/cardiophrenic angles	4	27%
Diaphragms	5	33%
Gas bubble	0	
Hila	4	27%
Lung tissue	12	80%
Surrounding tissue	4	27%
Skeleton	13	87%

GPs, general practitioners.

The demographic data were organized, collated, and quantified. The frequency of various behaviours noted on the checklists were noted and displayed in tabular form. Explanation building is a special type of pattern matching relevant to analysing exploratory data. In this study, “explaining” refers to the process of building a set of causal links and process tracing on how GPs interpreted chest X-ray images. Explanation building is a hypothesis-generating process aimed at generating ideas for further study [22].

We used Yin's [22] strategy to follow the theoretical propositions that led to the case study. The propositions helped plan, focus on the most relevant data, namely data pertaining to challenges, training, and support on interpretation of chest radiographs. Using content analysis, audio-recorded data were transcribed verbatim. The initial coding involved a line-by-line analysis. Pieces of text that addressed the propositions were identified and coded. The codes were grouped according to relationships that fitted the categories. Categories were classified into patterns that formed themes.

Results

Demographic Information

Most participants were younger than 39 years and were newly qualified, with less than one year of work experience (Table 1). In SA, newly qualified medical practitioners complete a compulsory community service (CS) for a period of 12 months in public health facilities at different provinces. Practitioners are allocated according to health care needs rather than according to available supervision, as determined by the National Department of Health [23]. CS primarily aims to improve the supply of professional health personnel in underserved areas, thereby improving health service provision to all South Africans [23].

Observation Phase

All chest radiographs need to be evaluated for image quality so that technical deficiencies are not mistaken for abnormalities. After imaging, the radiographers will evaluate images for quality of diagnostic value before sending the radiographs to the referring GP for reporting. The referring GP should also be able to evaluate the quality of chest radiographs before

embarking on pattern recognition. Table 2 indicated all the factors recommended by McQuillen [19] for assessment when evaluating the quality of chest radiographs that formed the observational checklist.

As reflected in Table 2 , lateral view radiographs were only carried out on request. Lateral views are indicated when there is an obvious abnormality seen on the posteroanterior (PA) view and when the referrer suspects abnormality. This is departmental protocol, practiced in all district hospitals, to save on costs [24].

Table 3 indicates the methods used by GPs while analysing abnormal patterns on chest radiographs. Participants most often omitted evaluations of hemidiaphragms, hila, soft tissue around the chest, and the costophrenic and cardiophrenic angles (Table 3).

Our results showed that GPs did not have a system to evaluate all structures in the chest for abnormalities. GPs spent most time investigating salient structures such as the skeleton and the heart. Each participant had a different approach, with some participants stopping to search as soon as an abnormality was identified.

Interviews

Interview questions were preplanned and categorized, to reveal in-depth information on causal links, and tracing the process on how chest radiographs are interpreted in district hospitals. The themes indicated in Table 4 were formed from interview responses.

Table 4. Categories and Themes Identified From the Responses of General Practitioners When Asked How They Interpret Chest Radiographs Taken in Casualty and Outpatient Departments in District Hospitals in Tshwane District, South Africa (n = 15)

Themes	Categories
1. Methods used to interpret chest radiographs	Image evaluation
	Pattern recognition
2. Challenges experienced during chest radiographs interpretation	Viewing conditions
3. Mechanisms to support interpretations of chest radiographs	Colleagues
4. Training you have in image interpretation of the chest	Undergraduate training

Discussion

We assessed how GPs in district hospitals in Tshwane, SA, analysed chest radiographs. Our findings reveal that GPs did not always evaluate the quality of images adequately, nor did they interpret images using a systematic pattern recognition approach. These results are not surprising because most GPs were newly qualified and had less than one year of work experience. Most GPs had only received undergraduate training in the interpretation of radiographs. Our findings indicate that most GPs entering the public health care system require intensive training on analysing chest radiographs.

Methods Used to Interpret Chest Radiographs

McLaughlin [25] reported on several systematic image interpretation methods in different settings. One such method was using a mnemonic-based search pattern consisting of ABCDEs. Chan's [7] ABC system of radiological assessment provides a simple and logical, easy-to-remember, systematic approach to searching for abnormalities on radiographs. The

ABC systematic assessment of chest radiographs includes image evaluation and pattern recognition [7]. The systematic approach also serves as a checklist for those who have limited or no experience and can be used for teaching and auditing [7, 26, 27]. Similarly, Kok et al [28] supported the use of a mental checklist and a fixed order of inspection of radiographic images. Checklists in structured reporting may increase diagnostic accuracy [29]. Checklists are proposed by other researchers as a tool to reduce diagnostic error; they provide an alternative to reliance on intuition and memory in solving the complexity of diagnostic reasoning, which often involves making sense in a limited time under uncertain conditions [30].

Participants responded on methods used to interpret chest radiographs:

PARTICIPANT: "…we do not have a guideline of how to interpret a chest x-ray".
PARTICIPANT: "…there is an approach to x-rays as part of a presentation to say this is what you look for, this is how you approach it but as to whether people are following the guidelines, that's a difficult one to say because people work as individuals…"

Image Evaluation Criteria to Obtain Good-Quality Images

The quality of all radiographs should be evaluated to ensure correct positioning and technical accuracy, which includes anatomical inclusion, projection or orientation, rotation, inspiration or breathing, penetration, and the presence of removable and nonremovable artefact. In this study, some GPs did not evaluate radiographs for the following technical factors: part position, inspiration, and rotation. Thus, the diagnostic accuracy of the image compromised. These radiographs could have had technical deficiencies that lead to misdiagnosis. All GPs who interpret images should be able to evaluate the quality of images before searching images for abnormalities. Evaluating the quality of images should help identify normal anatomical variants that could be mistaken for abnormal patterns. For example, patients with scoliosis may not demonstrate the traditional indicators of a correctly positioned PA and lateral view, and the thoracic region will appear rotated by conventional evaluation.

Paakkala [31] reported that poor image quality was the primary source of error made by less-experienced doctors when interpreting conditions such as cardiac insufficiency and inflammatory changes in chest radiographs. In the United States, Singh [32] confirmed that poor image quality was one of the factors contributing to radiological errors. Pinto et al [33] suggested that exposure factors in x-rays are important because they influence the ability to detect lesions to diagnose lung cancer. Kurtz et al [34] advised that only images that are adequately exposed and patients correctly positioned should be interpreted to avoid perceptual errors. Berlin [35] also reported on a legal case where overexposed radiographs were interpreted, and a pulmonary nodule was missed, resulting in an incorrect diagnosis.

In this study, only 20% of GPs commented on the orientation of the image. It is standard procedure that chest radiographs are performed PA. Orientation should be labelled if supine or anterior-posterior views are performed to inform the reader that a magnification factor should be considered during diagnosis.

In this study, the district hospitals followed a protocol that radiographs are only taken in PA projection and laterals on request. This is not ideal because standard procedure in radiography is that both PA and lateral radiographs must be available to make accurate chest diagnosis especially when the medical practitioners are nonradiologists. Any abnormality seen on the

left or right side of the patient on a PA view must also be seen either anterior or posterior on the lateral view. Lateral radiographs are particularly useful in assessing the retrosternal and retrocardiac airspaces. Pinto [33] and Shah [36] also suggested that lateral chest radiographs are important when diagnosing lung cancer because they reveal lung neoplasms retrospectively better than frontal projection. Similarly, Quekel [37] indicated that lateral radiographs had a 2–4% better detection rate for lung cancer compared with frontal chest radiographs.

Pattern Recognition

Once the initial review confirms that image quality is adequate, pattern recognition follows. Interpreting a chest radiograph remains as much a science as an art, and using the systematic approach, frequently and consistently, allows GPs to be comfortable, accurate, competent, and quick in identifying abnormal patterns on radiographs. In this study, GPs used different search strategies for each patient, some searched for abnormal patterns in the midline and worked their way outward, and others vice versa. Other GPs simply gazed at the entire film without searching all areas but searched for salient structures such as the skeleton on a chest radiograph when the lungs are more important to analyse. In addition, GPs spent more time examining normal anatomy on suboptimal images (Table 2) for all the structures that were given attention.

Comments on how abnormal patterns are identified:

PARTICIPANT: "… I check the obvious and then go according to what is expected".
PARTICIPANT: "… so I think we are very lax about it we don't do it systematically we all doing it in a rush using natural lighting. You quickly scan for major problems…"

According to Fraser [38], there are two methods of searching for abnormal patterns on chest radiographs. A direct search following a specific pattern of inspection or a free global search in which the radiographs are scanned without a preconceived orderly pattern [37]. The global search is a method used by experienced radiologists and requires the flexible use of search strategies as a function of immediate visual information. Waite et al [39] suggested that the global search method was advantageous when used by expect radiologists compared with inexperienced image interpreters. According to Waite et al [39], expert radiologists scan paths with fewer fixations, less coverage of the image, fewer saccades, and arrival at the abnormalities is performed faster when compared with inexperienced image interpreters. Auffermann et al [40] commented that novices, who are unable to generate a fast and accurate global impression of an image, may benefit from an orderly and comprehensive search pattern. If image interpreters adhere to a specific order or search pattern when inspecting anatomical structures, they may achieve more coverage of the image, reducing the omission of abnormalities.

One of the participant's responce on the systematic assessment approach of image interpretation:

PARTICIPANT: "For me I would say I was taught the system at school but I'm not really using the system. … I think we need more classes to be able to focus on the system all the time…"

In this study, GPs routinely omitted certain structures while evaluating images, including diaphragms, hila, soft tissue around the chest, and the costophrenic and cardiophrenic angles (

Table 3). According to Renfrew et al [41], abnormalities embedded in soft tissues around the chest may be missed if the clinician does not know the anatomy of the chest. Soft tissue abnormalities include thoracic lesions that were identified during an abdominal examination or pleural, pulmonary, and mediastinal lesions incidentally encountered during a radiological study of the spine, thoracic bones, or shoulder girdle.

Challenges Experienced During Chest Radiograph Interpretation

Optimal viewing conditions facilitate the identification of radiographic details, reducing the need for retakes, saving costs and limiting radiation dose. Viewing boxes facilitate optimal viewing conditions, thus enhancing accurate interpretation of conventional radiographs. In this study, viewing boxes were not working in some of the settings, and GPs had to use electrical room lighting at night and sunlight during the day to view radiographs. Studies by Nyathi [42] have shown that suboptimal viewing conditions affect the ability to detect low-contrast lesions. According to Singh [32], in the United States, inadequate room lighting for viewing and reading radiographs contributed to radiological errors. To improve viewing conditions, quality control of the equipment has to be performed regularly.

Comments on image viewing conditions are as follows:

PARTICIPANT: “Ja(yes), the viewing boxes are not working, sometimes we use sunlight so viewing images at night is a challenge.” PARTICIPANT: “we use viewing boxes—sometimes it is not working—we use room lighting…”

Mechanisms to Support Interpretation of Chest Radiographs

Our results showed that support mechanisms were in place to support reporting of complicated chest radiographs. GPs in district hospitals were able to consult with colleagues, which included all other GPs, radiographers, and consultants in the same district hospital. If no one could help, then complicated cases were referred to a tertiary hospital or radiographs were sent to a radiologist in a tertiary hospital. Sending radiographs to tertiary hospitals often resulted in longer waiting and reporting times.

Comments on the support available are as follows:

PARTICIPANT: “… so far you'll only rely on the colleagues around but if no one can help you in this hospital, you have to phone … Follow the referral procedure.” PARTICIPANT: “I've got other doctors helping and are working under supervision of senior doctors.”

According to Wright [43], junior doctors may misdiagnose chest radiographs if not supported by other health care professionals. He suggested that radiographers are ideally suited to play this supportive role because they took the actual radiograph. Van de Venter, du Rand and, Grobler [15] reported that radiographers significantly contributed to holistic heath care and positive patient outcomes by reporting on trauma radiographs [15].

Mehdipoor et al [44] mentioned that electronic tools, such as picture archive systems and teleradiology, could be used as support systems to send chest radiographs with acute pathologies to specialist radiologists.

Training in Image Interpretation of the Chest

Woznitza [45] revealed that trained radiographers were able to provide definitive clinical reports for skeletal and chest radiographs with the same diagnostic accuracy as consultant radiologists [42]. According to Hazell, Motto, and Chipeya [46], structured educational programs in image interpretation and report writing improved radiographers' reporting accuracy to provide better quality reports. Literature has shown that with postgraduate training, radiographers can support GPs in interpreting chest radiographs [45, 46].

We identified how GPs in our setting allocated attention across images, which may inform the training of GPs and the development of effective interventions. According to Chen et al [47], perceptual learning is the ability to extract information from the image based on experience and practice. Development of perceptual skills to achieve perceptual competence and expertise requires training by exposing the trainees, in this case the GPs, to recognize abnormalities on radiographs using visual dimensions including contrast sensitivity, spatial resolution, and image orientation [47].

Comments made by participants regarding a lack in image interpretation of the chest are as follows:

PARTICIPANT: "… oh yes … a casualty doctor looks at the X-ray, he makes an interpretation, admits the patient to the ward, the next day, we will have some blood results and you will see that the results do not necessarily show the infection that was interpreted on X-rays."

According to Christiansen [48], Danish junior medical practitioners and medical students who received basic clinical education did not meet the minimum requirements for radiological diagnostic skills to interpret chest radiographs. Mehdipoor et al [44] in Iran added that both newly qualified and experienced practitioners were unable to diagnose acute pathologies on chest radiographs correctly.

When asked about any training they had in image interpretation, the answer was as follows:

PARTICIPANT: "… last training was in medical school, as of now you use your experience."

All the participants agreed that they needed more training in interpreting chest radiographs.

Example:

PARTICIPANT: "I think I could do with just continuous education to remind ourselves more …"

Conclusion

Our results indicated that the GPs in district hospitals rapidly checked for any obvious abnormalities within the first few minutes of viewing radiographs. Once an abnormality was identified, they stopped the search, potentially missing additional abnormalities and resulting in omission errors. GPs did not use a systematic approach to interpret chest radiographs. Poor

viewing conditions, and subsequent poor image quality, can potentially result in diagnostic errors.

Most of the participants in this study were young, aged between 29 and 39 years. In terms of work experience, more staff members were newly qualified, still doing their CS, with experience of less than one year. Most participants had received training in image interpretation during their undergraduate studies. The more experienced participants (5–10 years) often fulfilled a supportive role. According to van der Gijp et al [49], experience is a necessary, but insufficient, indicator of expert performance. GPs from the same hospital supported one onother and complicated cases were sent to radiologists in teriary hospitals. This could compromise waiting time, resulting in poor disease management.

Recommendations

GPs require continuous in-house training in using a systematic approach to interpret chest radiographs and provide immediate radiology service. Adequate interpretation will reduce patient waiting time, as well as improve patient management. Training should focus on improving the methods used to search for abnormal patterns. New methods should include learning a criteria to evaluate the quality of chest radiographs before systematically searching all structures of the thoracic cage for abnormal patterns, a procedure called pattern recognition. Development of perceptual skills to achieve perceptual competence and expertise requires training by exposing the trainees to visual dimensions such as contrast sensitivity, spatial resolution, and image orientation.

Instead of using lectures or instructional videos to teach GPs how to use a systematic approach, Hales and Pronovost [50], and Marcovici and Taylor [51], recommended checklists that are organized in a systematic fashion to ensure that all steps in a complex procedure are considered. Several authors [52, 53, 54, 55] support the argument that checklists are potentially useful instruments that can be used to reduce omission errors for clinicians of all levels of expertise, but in particular for inexperienced medical practitioners. Checklists are a potentially important tool to improve radiology education in the medical curriculum.

Further Studies

This study could be the initial step or baseline study in a project to improve the methods used by GPs to interpret chest radiographs. Further studies could evaluate the effect of the intervention proposed to reduce omission errors and to compile a checklist to facilitate accurate interpretation of chest radiographs.

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