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ORIGINAL RESEARCH

Adapted Anatomical Image Criteria for PA Chest Radiographs at Managil Teaching Hospital, Sudan 2023

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Background: Owing to its importance in detecting airway, lung, heart, blood vessel, and bone problems, chest radiography is the most prevalent diagnostic test. To ensure accuracy, the images must be evaluated technically. Once images are sufficiently good, radiologists can interpret radiographs more confidently and clinicians can diagnose them accurately. We aimed to evaluate and improve the technical posteroanterior (PA) chest X-ray (CXR) procedure.

Methodology: A Retrospective, Prospective observational audit conducted at Managil Teaching Hospital and adjacent private radiology clinics in the 1st cycle 21 CXR was gathered and compared to the American College of Radiology (ACR) standards, and an initial Microsoft Excel® analysis identified substantial radiographic quality issues. Based on these findings, radiology staff training was ensued, and clinicians used a predesigned questionnaire to check the completeness of the requested image. Moreover, the department publicly posted posters defining quality PA CXR requirements based on ACR guidelines. These interventions were followed by data collection and analysis in the 2nd cycle with 41 CXR. The total sample size of the study was 62 patients.

Results: A total of 41 CXR images were included in the study, 21 in the 1st cycle and 20 in the 2nd cycle, in the first cycle the collected data were compared with the ACR standards, A significant improvement was observed in most areas after the 2nd cycle, for instance the first criteria was the CXR should be Performed at full inspiration it was only in 67.20% during the 1st cycle and 90% in the 2nd cycle.

Conclusion: The medical audit shows that the quality improvement efforts of the Managil Teaching Hospital have improved the PA CXR technicalities. Following the standards of the American College of Radiology (ACR) standards, the audit showed improvements in most anatomical imaging criteria post-intervention.

Keywords: clinical audit, radiology, chest X ray, quality improvement

Introduction

A clinical audit is a methodical evaluation of patient treatment and outcomes that aims to enhance the quality of care by comparing it to specific standards. The changes were implemented at specified locations. Additionally, ongoing surveillance is employed to verify enhancements in the healthcare provision.[1]

An audit evaluates regular activities to ensure that patients are receiving efficient services or treatment and that a consistently high standard of care is being provided. By following a systematic procedure that involves establishing

63

standards, observing practices, evaluating outcomes, communicating results, and implementing changes when needed, we can assess whether we are providing an appropriate level of care to our patients.[2]

Radiological audits have several advantages. A patient dosage audit is typically conducted following the implementation of a new imaging system, and should be performed at regular intervals. Furthermore, the rationale for a particular radiographic operation can be audited. Image quality is a critical feature of diagnostic imaging. Receiver operating characteristic (ROC) curve analysis is often considered the most reliable method for assessing picture quality in identifying a known disorder. One drawback of the ROC analysis is that it requires knowledge of the ground truth, which is often not readily accessible. Furthermore, for the ROC approach to function well, the pathology must be close to the threshold of detection by the observer.[3]

To be practically relevant, a clinical assessment of picture quality should possess not only accuracy and precision, but also a reasonable level of speed and cost-effectiveness when conducted in a clinical setting. A different method of ROC analysis is visual assessment of the sharpness of significant anatomical features. These structures can serve as the foundation for imaging criteria as specified by the European Commission.[4,5] An essential benefit of visual grading is that observers may evaluate nearly any radiograph as long as the imaging criteria are appropriately chosen and have validity and relevance to the observer. Visual grading features[6] and regression[7] are two practical applications of visual grading approaches in health care settings. Both methods assume that the ability to identify diseases is linked to the accuracy of the reproduction of crucial anatomical details.

Assessing the quality of radiographic images in Sudan encounters notable obstacles and advancements. A study emphasised prevalent problems such as insufficient patient posture and centering, which are the main causes for image rejection, mirroring worldwide patterns where these variables significantly contribute to subpar image quality.[8]

In Sudan, there are ongoing efforts to enhance the quality of radiographic images by assessing the radiation doses received by patients and the overall image quality during routine radiography examinations. This involves evaluating adherence to global standards to guarantee both safety and diagnostic efficiency.[9]

Chest radiography is the most commonly used diagnostic X-ray investigation method, largely owing to its essential role in detecting abnormalities or diseases of the airway, lungs, heart, blood vessels, and bones.

Improving the radiographic image quality can significantly enhance patient's care and clinical outcomes in terms of accurate diagnosis, reduced need for retake and enhanced treatment planning.

Conducting a technical assessment of radiographic images is crucial for confirming their suitability. When images reach a high level of quality, radiologists can interpret them with more certainty. Furthermore, a precise clinical diagnosis can be established. This will ultimately result in effective patient care and enhancement of clinical results.

Aim and Objectives

To evaluate and improve the quality of PA Chest radiographs at Managil Teaching Hospital, to assess the adequacy of the PA Chest Radiography and implementing appropriate changes to improve the quality of PA Chest X-rays.

The Standard

According to the American College of Radiology (ACR)[10] and the European Commission (EC),[4] a specific set of anatomical imaging criteria for chest radiography must be adopted.

PA chest radiographs should meet the criteria shown in Table 1.

Methodology
Audit Design

This was a retrospective prospective observational study. We retrospectively studied the existing CXR in the archive of the radiology department, and after the orientation sessions were conducted, we studied the new CXR.

Table 1 The Standard Criteria from American College of Radiology for PA Chest Radiograph

No.	The Criteria
Criteria 1	Performed at full inspiration
Criteria 2	Symmetrical reproduction of the thorax
Criteria 3	Medial borders of scapulae to be outside the lung fields
Criteria 4	Appropriate exposure
Criteria 5	Visualization of both apices
Criteria 6	Visualization of the whole rib cage above the diaphragm
Criteria 7	Visualization of lateral costophrenic angles
Criteria 8	Image annotations should not obscure lung fields
Criteria 9	Appropriate collimation

Audit Area/Population

Managil Teaching Hospital, Managil locality, Gezira State, Sudan. Which comprise the main health provider sector at the locality with a capacity of over 200 beds, the audit also included three adjacent private radiological clinics operated by radiology technicians. The audit population comprised the PA CXR in Managil Teaching Hospital and three clinics from July to September 2023.

Sample Size and Sampling Technique

A total of 62 PA chest radiographs were collected during the study period, 21 in the 1st cycle and 41 in the second cycle, which is within the recommended sample size of the Royal College of Radiology, using the convenience sampling method. In the first cycle, we included all samples found within the hospital's radiology department, which included eight CXR, as most hospital data were lost because of maintenance procedures. Private clinics provided 13 CXR samples. However, in the 2nd cycle 24 CXR samples were obtained from the clinics and 17 samples were obtained from the hospital, which was attributed to the machine undergoing maintenance and not working at full capacity.

Data Collection Methods and Analysis

Data collected from the radiology department and private clinics were assessed for completeness and adequacy by trained doctors (medical practitioners and residences) using a premade checklist based on the Guidelines from American College of Radiology and European Commission. The collected data were analyzed using Microsoft Excel 2016. The data analysis plan included a master sheet, data cleaning by removing duplications, handling missing values and correcting errors, descriptive statistics through frequency distribution, summary measures, and the data displayed in tables. Responding to the 1st cycle findings, we initiated targeted training sessions for radiology department staff. Additionally, posters outlining specific criteria for quality PA chest X-rays were based on the ACR and EC guidelines. The 2nd cycle was conducted after the orientation sessions.

Ethical Clearance

Ethical clearance was obtained from the ethical committee at Managil Teaching Hospital and locally from the health affairs at Managil locality. Informed consent was obtained from all participants in the study. The ethical guidelines of the Declaration of Helsinki were followed in this study.

Table 2 The Percentage Change in the PA Chest X-Ray Criteria Pre and Post-Intervention is Depicted Where the X-Axis is Numbered by the Standard Criteria

Criteria	First Cycle	Second Cycle
Performed at full inspiration	67.2%	90%
Symmetrical reproduction of the thorax	62.4%	100%
Medial borders of scapulae to be outside the lung fields	48%	85.3%
Appropriate exposure	91%	95%
Visualization of both apices	96%	96%
Visualization of the whole rib cage above the diaphragm	77%	100%
Visualization of lateral costophrenic angles	72%	80%
Image annotations should not obscure lung fields	62%	100%
Appropriate collimation	38.4%	92.6%

Acknowledgement

Results

A Total of 62 PA chest radiographs were collected during the auditing period. 21 were in the first cycle and 41 were in the second cycle. The samples were collected from the hospital's radiology department and three adjacent private radiology clinics, and the collected data were compared against the ACR standard criteria (Table 1) for PA chest radiographs. In the 1st cycle 67.2% of the radiographs were performed during full inspiration, 62.4% had symmetrical reproduction of the thorax, 48% had medial borders of the scapulae outside the lung fields, and only 38.4% had appropriate collimation. In the 2nd cycle however 90% of radiographs were obtained during full inspiration. One hundred% had symmetrical reproduction of the thorax, 85.3% had medial borders of the scapulae outside the lung fields, and 92.6% had appropriate collimation. As shown in (Table 2).

Discussion

Maintaining radiographic images at the highest standards is necessary for the diagnosis of various diseases and pathologies. CXR are among the most requested radiographic images, and it is necessary to ensure that they fulfil the standard criteria. In order for a clinical audit to achieve success, it must be conducted in a timely and cost-efficient manner within a clinical setting, which was accomplished by us.

During the 1st cycle of the images was poor during the first cycle of the audit, as is evident from the results.

In the 1st cycle of the audit, 67.2% of the radiographs were performed during full inspiration, which was obtained by direct observation of the CXR; this percentage of the 1st cycle can be attributed to several confounding variables, and multiple factors among them are the indifference of the radiology staff at the hospital and clinics regarding the importance of the matter, as stated by most of them. In the 2nd cycle however, there was a 22.8% increase in the percentage of images with full inspiration, indicating the success of the orientation sessions and direct dialogue with the staff. Approximately 62.4% of the images had symmetrical reproduction of the thorax, another low percentage in an important criterion of CXR image quality that yields missing information and an informed diagnosis, the 2nd cycle results in 100% of the cases having symmetrical reproduction of the thorax, which was the target. Two of the weakest aspects in the 1st cycle were the medial borders of the scapulae outside the lung fields and appropriate collimation, which were 48% and 38.4%, respectively, and were improved by 85.3% and 92.6%, respectively, which is an acceptable percentage for the 2nd cycle of the audit. In

66

Clinical Audit 2024:16

the 1st cycle of visualization of the whole rib cage above the diaphragm, 77% and image annotations should not obscure the lung fields, and 62% were tremendously improved and reached 100% in the 2nd cycle.

Visualization of lateral costophrenic angles constitutes the weakest area of improvement by far as it was 72% and became 80% in the 2nd cycle which is below the optimum, possibly because the introduced changes and illustrated criteria were too much to comprehend in one instance, as some criteria could be forgotten or purposely neglected.

The main finding of this quality improvement process was the success of the implemented changes in enhancing the quality and adequacy of chest radiographs at the Managil locality.

Conclusion

In light of the medical audit conducted, it is evident that the quality improvement interventions deployed at the Managil Teaching Hospital have yielded substantial advancements in the technical aspects of PA chest X-ray processes. Abiding by the established standards of the Royal College of Radiology (RCR), the audit revealed an enhancement in almost all adopted anatomical imaging criteria post-intervention.

The success of this audit underscores the value of continual assessment and training in clinical settings. It is an affirmation that with concerted efforts and adherence to international best practices, it is feasible to elevate the standards of patient care, even in routine diagnostic procedures such as chest radiography. The anticipated long term impact of the implemented changes include the reduction of radiation exposure, improving the image quality and educational benefits.

Recommendations

In order to sustain the implemented changes the following recommendations are made:

- All radiology staff members should know the standard of PA chest X-rays.
- Consider further training sessions and staff education programs on a regular basis.
- Distribute additional posters containing the standard of the PA chest X-ray.
- Requirement of completing a Re-audit every 12 months.

Disclosure

The authors report no conflicts of interest in this work.

References

1. Nhs. What is clinical audit ? (University Hospitals Bristol). UHBristol Clin Audit Team- Version 3; 2009:1–6.
2. E-Learning ISRRT. Available from: https://www.elearning.isrrt.org/mod/book/tool/print/index.php?id=349. Accessed July 12, 2024.
3. Tesselaar E, Dahlström N, Sandborg M. Clinical audit of image quality in radiology using visual grading characteristics analysis. *Radiat Prot Dosimetry.* 2016;169(1):340–346. doi:10.1093/rpd/ncv411
4. Commission E. EUR96 European guidelines on quality criteria for diagnostic radiographic images, European Commission, EUR 16260 EN, giugno 1996. Eur 16261EN; 1996:71. Available from: https://publications.europa.eu/en/publication-detail/-/publication/d229c9e1-a967-49de-b169-59ee68605f1a. Accessed July 12, 2024.
5. European Comission. European guidelines on quality criteria for computed tomography European guidelines on quality criteria. *Eur 16262 En.* 1999;1999:1–71.
6. Båth M, Månsson LG. Visual grading characteristics (VGC) analysis: a non-parametric rank-invariant statistical method for image quality evaluation. *Br J Radiol.* 2007;80(951):169–176. doi:10.1259/bjr/35012658
7. Smedby Ö, Fredrikson M. Visual grading regression: analysing data from visual grading experiments with regression models. *Br J Radiol.* 2010;83 (993):767–775. doi:10.1259/bjr/35254923
8. Kjelle E, Chilanga C. The assessment of image quality and diagnostic value in X - ray images: a survey on radiographers' reasons for rejecting images. *Insights Imaging.* 2022;2022:1.
9. Ahmed NA, Suliman II, Tsapaki V, Rehani MM. Patient dose and image quality evaluation in common radiographic examinations in Sudan. In: *World Congress on Medical Physics and Biomedical Engineering, September 7-12, 2009, Munich, Germany: Radiation Protection and Dosimetry, Biological Effects of Radiation.* Berlin Heidelberg: Springer;2009:564–566. doi:10.1007/978-3-642-03902-7_161
10. Spies W. Practice parameter for the performance of pulmonary scintigraphy. *Am Coll Radiol.* 2014;1076:1–9.