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Radiographer Reporting of Chest Radiograph in Rural Health Unit: A Potential Practice in the Philippines

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ABSTRACT
The role of radiographers has evolved to encompass clinical image reporting. In the Philippines, the radiographer role in chest radiograph reporting is not yet established. This paper focuses on the performance of two groups of Filipino radiographers in rural health units (RHUs). This prospective comparative study invited 20 radiographers from five RHUs in Mindanao, Philippines to take part. A total of 1,000 chest radiographs were selected, with a normal to abnormal case ratio of 1:1. Of the 500 abnormal images, 250 cases were Tuberculosis (TB). All images were initially reported by radiologists for concordance and the subsequent radiographer reports were compared with sensitivity, specificity, and agreement rates calculated. One group of radiographers (n=10) attended a 10-week chest reporting education programme. Mean sensitivity, specificity, and agreement rates for radiographers who attended the education programme were 97.6%, 96.7%, and 97.1%, respectively for all cases with mean sensitivity, specificity, and agreement rates for radiographers without training, slightly lower at 90.3%, 91.3%, and 90.8%, respectively. For TB cases, mean sensitivity, specificity, and agreement rates for radiographers with training were all 95.5% compared to those of radiographers without training at 83.8%, 87.8%, and 85.8%, respectively. This study provides evidence that radiographers in the Philippines have the potential to accurately report chest radiographs to a reasonable standard when compared to the radiologist gold standard. Those participants with prior education performed to a higher standard than those without which may have positive implication for future practice and extension of the current radiographer role. Deployment of appropriately trained radiographers may help to augment capacity in diagnostic pathways and to improve radiological services in rural areas.

KEYWORDS: chest; clinical; Philippines; radiographer; reporting; rural health

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1. Introduction

Chest radiography is a valuable tool in the assessment of pulmonary parenchyma, airways, heart, lungs, and chest wall [1]. It allows rapid identification of cavitation, consolidation, masses, and other processes, which are highly suggestive of disease [2]. Tuberculosis (TB) is one of the most debilitating lung diseases and chest radiography can provide reliable and valid diagnostic results [3,4]. In 2019, an estimated 10 million fell ill from TB and 1 million died worldwide [5]. The burden is most pressing in developing countries comprising a large proportion of rural communities [6]. Current targets for the 'End TB Strategy' of the World Health Organization (WHO) are challenged due to poverty and limited access to healthcare services and workforce [7]. In rural areas where residents are at high risk of death from chronic respiratory diseases, chest radiography allows early detection of lung abnormalities, with improved clinical outcomes through early institution of therapy [7-9]. Despite the provision of necessary TB diagnostic imaging provision within rural areas, delay in diagnosis persists [10,11]. Radiologists are the medical professionals responsible for the reporting of chest radiographs and provision of the definitive diagnosis. As observed in the practice, there is a shortage of radiologists in rural and remote health units but as existing evidence shows, slow reporting of diagnostic results was one of the significant determinants for delays in TB diagnosis [12,13]. This raises the question whether radiographers who carry out the chest x-ray procedure could extend their practice to provide an immediate reporting of the resultant image to allow more timely diagnosis?

Radiographer reporting is a popular practice involving diagnostic image interpretation in several countries in the world, including the United Kingdom (UK), Canada, Australia, Norway, and Denmark [14-18]. Prior research has demonstrated that radiographers are capable of reporting chest radiographs to a very high standard. In a UK study, the adult chest radiograph reporting performance of radiographer was examined in clinical practice [19]. Based on the analysis, there was high agreement for the interpretation of chest radiographs between the radiographer and radiologist (92-96%). Clinical reporting of adult chest radiographs by the radiographers was also assessed following a post-graduate reporting programme [20]. A total of 100 chest radiographs were analyzed and results revealed a high agreement rate between radiographer and radiologist (89%) with mean specificity of 95.9% and mean sensitivity of 95.4%. Existing evidence has provided positive indications that radiographers have the ability to produce clinical reports of the chest radiographs to a standard comparable to radiologists.

In the Philippines, the radiographer role in reporting of chest radiographs is not yet established. To date, radiographers as allied health professionals have been working under the traditional and existing roles in image acquisition and processing [21]. As technology is continuously changing and demands for diagnostic imaging are increasing, consideration of clinical competencies of the radiographers should be explored specific to potential for extension into the area of radiographer chest reporting for rural health units (RHUs).

The RHUs in the Philippines are dedicated to provide free basic healthcare services for the rural communities. Like other countries, the RHUs are required to

deliver equitable, responsive, and sustainable health services to disease-vulnerable areas. Given the higher death rate in rural compared to urban communities, strategic management of healthcare delivery which includes an increase in capacity and upgrading of skills of medical professionals such as radiographer, should be considered [22].

The relentless and continuing rise in the demand for radiological services especially in rural areas, is partly accounted for by the surge in the number of respiratory diseases. This coupled with the delay in diagnosis of a leading cause of death worldwide (including the Philippines) and the positive indication for role extension, warrants the need for expansion of the clinical competency of Filipino radiographers through clinical reporting of chest radiographs in RHUs. To the best of the authors knowledge, no published work has attempted to explore radiographer reporting performance in the Philippines. Hence, the aim of this study was to focus upon evaluation of chest radiograph reporting performance of Filipino radiographers in RHUs, based on sensitivity, specificity and agreement rates as compared with radiologists.

2. Methodology

This was a prospective comparative study of 20 radiographers from five RHUs in Mindanao, Philippines. In the study, satellites of provincial and regional hospitals that are situated in rural areas were considered RHUs according to the Demographic and Health Surveys (DHS) model of WHO. Permission letters were sent to the administrators of the RHUs in April 2020 and approval was obtained a month after. A total of 43 radiographers were employed in the RHUs at that time. However, only 20 of them were invited to take part in July 2020 based on the selection criteria. The selection criteria included: he or she should have a license to practice Radiologic Technology in the Philippines, have at least two years of working experience, and have received no formal training or any post-graduate education to date. Four radiographers participated in the study in each RHU. All of them agreed to participate in the study by signing the written consent form. The Institutional Ethics Review Committee (IERC) of Iligan Medical Center College approved the study protocol.

Prior to commencement of the study, the cohort was divided in to 2 groups, Group 1, radiographers (n=10) with no education programme and Group 2 (n=10) radiographers who underwent a 10-week trial education programme for chest radiograph reporting. Because there were four radiographers per RHU, two of them were allocated in Group 1 while the remaining were allocated in Group 2. Therefore, a total of 10 radiographers were allocated in each group (2 radiographers x 5 RHUs). The radiographers in Group 2 were unaware of the trial program to eliminate potential bias. Table 1 presents the demographic characteristics of participants in each group.

The chest reporting education programme was introduced by the researchers to the adminstrators of the RHUs as the first step for service improvement utilising their currently employed radiographers. The outline of subjects in the trial programme was created by an educator in radiography who has more than 10 years of experience in the academe. The content of this outline was checked and validated by four medical

Table 1. Demographic characteristics of study participants.

Demographic Characteristics	Group 1 (n=10)	Group 2 (n=10)
Age, in mean ± SD years	29.4 ± 2.1	28.2 ± 1.9
Length of experience, in mean ± SD years	4.5 ± 1.3	4.7 ± 1.1
Sex ratio, male : female	2:3	2:3

professionals (radiography quality specialist, academic curriculum specialist in radiography, radiographer, radiologist) in April 2020. The facilitators of the programme were radiologists with at least 10 years of experience. The programme consisted of series of lectures on chest anatomy, pathology, and practical demonstration of pathological process identification. The programme required Group 2 to attend 8-hours per week, for 10 consecutive weeks on Sundays.

A total of 1000 images were retrospectively extracted from the Picture Archiving and Communication System (PACS). Each of the RHUs contributed 200 images. Images and associated radiological reports were formally identified as normal and abnormal by the radiologists. The images were collected from chest radiographs saved from January 2020 to September 2020 with the ratio of normal to abnormal cases 1:1. Of the 500 abnormal cases, 250 were identified as TB while the remaining half included 15 abnormal conditions similar to those included within a previous study [20]. Table 2 shows the distribution of pathologies included in the study.

Two radiologists with at least 10 years of experience reported all radiographs independently and reports were subsequently compared with previous reports to ensure agreement. The normal chest radiographs included 20 cases of normal variant (dextrocardia) which is known to be misleading and confusing. This inclusion was based on previous studies [23,24]. Each image was reviewed and manually coded with alphanumeric characters. These characters represented the radiological report of the radiologists which served as the gold standard for comparative analysis. Only the images with alphanumeric characters, age, gender, and clinical history were retained for clinical reporting. The details on age, gender, and clinical history are deemed as important during diagnostic image interpretation of radiologists and should be included during radiographer reporting [23,24]. All names were anonymized to ensure confidentiality of patient information.

All 1000 images were digitally sent to participating RHUs via the radiography department head. Because the patients' volume in the RHUs is high in the morning and early afternoon, reporting was conducted in the late afternoon, which allowed diagnostic image interpretation of 10 images per day for five days per week. The radiographer reporting spanned 20 weeks. The radiographers were provided with the images and were asked to make a decision whether the image was normal or abnormal. If the case was interpreted as abnormal, the name of the pathology was asked. Interpretation of the images by each radiographer was conducted independently. The same screen and room lightning were utilized during the conduct of image interpretation.

Table 2. Distribution of chest pathologies.

Chest Pathologies	Frequency	Percentage (%)
TB	250	50.0
Subphrenic abscess	35	7.0
Fibrosing alveolitis	24	4.8
Asbestosis	24	4.8
Mass	24	4.8
Heart enlargement	24	4.8
Pleural calcification	24	4.8
Lung collapse	14	2.8
Silicosis	14	2.8
Pulmonary calcification	13	2.6
Lymphangitis	11	2.2
Neurofibromatosis	11	2.2
Consolidation	10	2.0
Emphysema	8	1.6
Pneumothorax	7	1.4
Pneumoconiosis	7	1.4
Total	500	100.0

Reports of radiographers were compared with the gold standard and classified in four categories, True Positive (TP), True Negative (TN), False Positive (FP), and False Negative (FN). Based on the information, agreement, specificity, and sensitivity rates were calculated using Equations 1-3.

$$Agreement\ (\%) = \frac{number\ of\ reports\ in\ agreement}{number\ of\ reports} x\ 100 \quad (1)$$

$$Sensitivity\ (\%) = \frac{TP}{TP+FN} x\ 100 \quad (2)$$

$$Specificity\ (\%) = \frac{TN}{TN+FP} x\ 100 \quad (3)$$

Outcome variables were stratified by groups, radiographers who did not receive training (Group 1) and Group 2, who received training. All responses were summed, and an external radiologist verified the calculated sensitivity, specificity and agreement rates for all images and TB pathology. Independent t-tests were used to compare differences in the sensitivity, specificity, and agreement rates of both groups performance. A p-value below 0.05 was considered significant.

3. Results

Mean sensitivity, specificity, and agreement rates for all cases stratified by study group are shown in Table 3. The total number of FN (n=966) errors were significantly

Table 3. Sensitivity, specificity and agreement rates for all cases.

Group	Data				Results (%)		
	TP	TN	FP	FN	Sensitivity	Specificity	Agreement
1	9034	9127	873	966	90.3	91.3	90.8
2	9756	9665	335	244	97.6	96.7	97.1

Table 4. Sensitivity, specificity and agreement rates for TB cases.

Group	Data				Results (%)		
	TP	TN	FP	FN	Sensitivity	Specificity	Agreement
1	2096	2194	306	404	83.8	87.8	85.8
2	2386	2388	112	114	95.5	95.5	95.5

higher than FP (n=873) errors for Group 1 (p=0.005). For radiographers included in the training programme (Group 2), FP (n=335) errors were significantly higher than FN (n=244) (p=0.009). Mean sensitivity and specificity for Group 1 were 90.3% and 91.3%, respectively. The values were lower compared to Group 2 at 97.6% and 96.7%, respectively (p=0.012). Mean agreement rates for Group 1 was 90.8% compared to Group 2 (97.1%) (p=0.005).

Mean sensitivity, specificity, and agreement rates for TB cases stratified study group are shown in Table 4. A significant difference was shown in the total number of FN errors (n=404) compared with FP (n=306) errors for Group 1 (p=0.006). In contrast, there was minimal difference for FP (n=112) and FN (n=114) errors for Group 2 (p=0.091). Mean sensitivity, specificity and agreement for Group 1 were 83.8%, 87.8%, 85.8% respectively with a significant difference shown (p=0.024) between Group 2 at 95.5%, 95.5% and 95.5% Mean agreement rate for Group 1 was significantly lower at 85.8% compared to Group 2 at 95.5% (p=0.008).

4. Discussion

This study provides evidence that radiographers have the potential to accurately report chest radiographs in the Philippines. Concurring to the present study, the performance in interpreting chest radiographs of radiographers who have two years postgraduate education, received personal mentoring from radiologists, and have at least one-year experience in reporting, was promising in a previous study [19]. A total of 100 chest radiographs were independently analyzed and a high concordance rate of 92-96% was reported between the radiographer and radiologists. In this study, very high sensitivity, specificity, and agreement rates were reported. Although the radiographers who received a 10-week training programme obtained higher sensitivity, specificity, and agreement rates, it should be noted that those radiographers without training still have produced nearly the same rates. This is highly suggestive that even if radiographers do not receive formal training, their prior theoretical knowledge and practical skills may have allowed them to distinguish normal from abnormal chest radiographs.

This study failed to control for the prior knowledge and experience learned by the participating radiographers in practice that could have influence their reporting skills; however, it could be noted that the added value of formal training could strengthen the competency of radiographers in diagnostic image reporting. In a previous study, an objective structured examination (OSE) was administered to radiographers who undergo an accredited postgraduate training program [20]. The OSE intended to assess the reporting performance of radiographers. Results revealed that there is a high agreement rate (89%) between the radiographer and radiologist. Although no direct comparison was conducted, mean specificity (95.9%) and sensitivity rates (95.4%) were high among the radiographers. Sensitivity, specificity, and agreement rates of trained radiographers in the present study were comparable to these values. Therefore, formal training could be one notable factor contributing to a high reporting performance of radiographers in RHUs.

High sensitivity, specificity, and agreement rates were also noted in the reports of TB cases among the radiographers. At present, no published study has attempted to determine these rates. It was clearly difficult to compare the present results with other literature. To the knowledge of the author, there is no direct evidence that could explain these results. However, it could be gleaned that radiographers who receive training yield higher sensitivity, specificity, and agreement rates in reporting compared to non-trained radiographers. Despite this comparison, the two groups still have an acceptable agreement rate. Their performance could be accounted for by the nature of their imaging roles in rural communities. In these areas, radiographers frequently performed chest radiographs in patients who have existing TB condition; hence, clinical experience in visualizing similar TB appearances of chest radiographs could influence their high level of reporting performance.

The FP and FN errors committed by the radiographers generally correspond to the errors made by radiologists reported in several studies [25-28]. It could be noted that one of the common missed diagnoses of the radiographers was TB based on FN errors (N=518) committed in all TB cases for the two groups of radiographers. This could imply that more emphasis should be placed in training radiographers into TB case identification, including differentiating pathologies with similar appearance to TB.

In the Philippines, RHUs are currently challenged with the low number of radiologists who interpret images. Location of RHUs could be a factor that could explain this phenomenon since most of the radiologists are employed and living in urban areas, where tertiary hospitals are concentrated. In practice, radiographers in RHUs send chest radiographs to radiologists via email and the results are available a week after for most private RHUs, while at most two weeks for government RHUs. Hence, physicians who need expedite the report to allow commencement of early intervention of therapy/treatment are required to wait a couple of days. As more patients with respiratory problems present to RHUs, chest radiographs with an immediate radiological and/or radiographer report are highly essential. This study is the first work to provide evidence that radiographer reporting of chest radiographs could be a potential practice in RHUs in the Philippines. Chest reporting education programmes could be developed in the future to fortify the skills of radiographers in RHUs.

5. Conclusion

The increasing demand of radiological services, coupled with low number of radiologists in RHUs in the Philippines requires role extension of radiographers. The present study shows that radiographers in RHUs have the potential to accurately report chest radiographs in the Philippines, specifically in reporting positive TB cases. Radiographers who receive a 10-week training program obtained higher sensitivity, specificity, and agreement rates than radiographers without training. With formal training, reporting radiographer would be able to play an essential role in reporting chest abnormalities in rural areas. However, this practice requires extensive quality control by the radiography heads and continuous skills enhancement. In the current practice, the radiographer reporting is still not established in the Philippines. But formal training coupled with sustainable in-RHU professional development programme could be the next step in realizing this great leap. This study may be repeated in the future to determine the effectiveness and identify potential limitations of training programme. To this end, reporting performance of radiographers by years of working experience may be assessed to better devise strategic planning for possible chest radiographer reporting.

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Conflict of Interest Statement

The authors declare no conflict of interest.

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