ORIGINAL ARTICLE

ASSESSMENT OF THE SKILLS OF PAEDIATRIC RESIDENTS IN INTERPRETING EMERGENCY PAEDIATRIC RADIOGRAPHS

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ABSTRACT

Background: *Paediatrics Emergency ward is one of the critical wards in hospitals Overcrowding and the urgent nature of the patients make Emergency rooms a particularly challenging area.   Therefore, fast and accurate diagnosis is very crucial & mandatory for proper patient management. So, Paediatrics residents, working in the Paediatric emergency section are required to have a basic interpretation of emergency radiographs for swift management. This study assessed the skill level of Paediatrics residents in interpreting emergency radiographs.*
Methods: *A Cross-sectional study was conducted among Paediatric residents in TikurAnbesa Specialized Hospital (TASH). Ten radiographs (7 Chest X-rays, 2 abdominal, and one extremity X-ray) were selected based on the most commonly seen emergency cases residents are expected to diagnose. The x-rays were displayed in Power-Point and residents were asked to complete a questionnaire. A consultant radiologist also interpreted the images in the same setting. The data was then analyzed by using SPSS 25.0.*
Results: *A total of 79 Paediatrics residents were enrolled in this study. Only 32 (40.5 %)of the residents had a good skill level of interpretation with a 73% accuracy rate which was very low. The overall discrepancy rate was 49.6%. The sensitivity of the residents in detecting abnormal radiographs was 72 (91.1 %) with a specificity of 34 (43 %). A significant association was found with the year of residency*
Conclusions: *S*kills of residents in interpreting radiographs were very low even if Paediatric emergency cases in the institution where this research was done constitute the largest proportion.*
Keywords: *Residents' skill, interpretation of x-rays, emergency patients. Ethiopia*

INTRODUCTION

Clinical decisions based on wrong interpretations have potential implications for patient care but there are situations where action must be taken immediately before formal verified reading is done by a radiologist. So, in most emergency departments immediate image interpretations are being done by non-radiology physicians. This is particularly important in identifying immediate life-threatening traumatic and non-traumatic emergencies. Even if there are reports of discrepancies between radiologists and primary care and emergency physicians, the rate of discrepancy is found to be variable.(1-3).

Imaging's are ordered and interpreted for immediate clinical decisions 24 hours a day by emergency physicians be it, Paediatrics residents, Paediatricians, or emergency physicians and the proper interpretation plays a key role in patient care(4).

Paediatric residents, as primary physicians at Paediatric ER, are required to preliminarily interpret emergency imaging & decide on the management of patients. Therefore, knowing the Paediatrics residents' competency level in interpreting emergency radiographs is very important (5).

It has been shown that a clinically significant rate of misinterpretation may occur when radiographs are interpreted with emergency physicians and the rate of misinterpretation is also affected by the level of training and type of radiographs interpreted(6). Emergency medicine faculty and supervised residents are capable of providing highly accurate rates of plain radiograph interpretation when adjusted for clinical significance and actual impact on patient care. Shared responsibility between EM faculty and radiologists operating in an appropriate system serves to prevent adverse patient outcomes as a result of radiograph misinterpretation.

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In addition, the introduction of a quality assurance system also improves image interpretation and avoids adverse patient outcomes from misinterpreted radiographs(7, 8).

Prior studies have revealed differences in physician's capacities in interpreting emergency X-rays compared to reading by radiologists. They have found that formal reporting of ED radiographs by the radiology department detects several clinically important abnormalities that have been overlooked and also detected several incorrect interpretations that may lead to further unnecessary investigations (9-11).

The routine practice of the institution where this study was conducted is that emergency imaging is done at any time in the day. The moment the radiographs are taken, they will be accessible to all through the picture archiving and communication software (PACS) and the referring physician can review the studies even before the patient arrives back to the emergency room. Formal radiologist interpretation may take some time to be available with the study, so those who are handling emergency cases are expected to quickly review emergency imaging for fast decisions. This study then assessed the skill of Paediatric residents in interpreting emergency Paediatric radiographs.

MATERIALS AND METHOD

Methodology
Study design and study population
This study is an institutional-based cross-sectional study done on residents who are being trained in Paediatrics and child health program. All Paediatrics residents at all levels of training were included in the study. There were a total of 83 Paediatrics residents. Among this 32 are year I residents, 32 year II, and 19-year III residents. All residents who consented to participate in the research were included in the study. A total of 79 residents were included.

Data collection procedure
A short survey was done in the Paediatrics emergency section to determine the common emergency visits in the unit that need emergency radiographs. The first 10 common emergency Paediatrics conditions that need radiographs as part of the workup were identified and radiographs were collected from the picture archiving and communication software of the department of radiology which clearly showed the selected 10 conditions. Pictures were changed from DICOM to JPEG format after optimal adjustment of the sharpness and brightness of the images without losing their contrast. Cases then were prepared using PowerPoint slides and questions for each image were printed on paper for participants to write their response.

The responses were corrected based on the interpretations of the same radiographs by a consultant radiologist in the same setting. Then the results were entered into the SPSS version 25.

Data processing and analysis
The collected data were entered into the SPSS version 25 and checked for completeness. Data were analyzed for the correctness of the interpretations and associations were made between accuracy and level of training and confidence of accuracy of interpretations were also assessed.

The overall accuracy of a diagnostic test can be assessed by detecting the Area Under Receiver Operator Curve (AUROC). The Receiver Operator Curve (ROC) is generated by piloting the sensitivity (TP) against 1-specificity (FP). Then the area under the curve was identified. A test that is not better than a chance will lie on a diagonal line with an AUROC of 0.5. The perfect test will have a value of 1. The AUROC of 1 is 100% sensitive and specific. A result less than 0.5 indicates the test is not accurate at all, a value from 0.5 to 0.7 is considered to have low accuracy. A result above 0.7 has medium to high accuracy.

Ethical clearance
Ethical clearance was given from the department research and ethics committee and participation in the study was based on volunteerism and participant identifiers were not used in the data collection and results were displayed in groups.

RESULT

A total of 79 Paediatrics residents were enrolled in this study. The proportion of male residents was 33 (41.8%) with a female proportion of 46 (58.2%). R1 and R2 residents were 32 (40.5%) and 28 (35.4%), respectively, while R3 residents were 19 (24.1 %).63 (79.7%) took radiology training in their undergraduate training but none of them took radiology training during the time of postgraduate trainings.70 (88.6%) of the residents believed that level of training they got is not adequate for interpreting results of the x-ray, and 63 (79.7%) responded they don't feel capable of reading x-ray results.

Overall score in correctly detecting x-ray findings
The case that was answered correctly by most was the x-ray of intestinal obstruction, by 73 (92.4%) of the residents. Pleural effusion was the second most correctly detected case in 69 (87.3%), followed by lobar pneumonia 67 (84.8%). The case that was missed by most residents was pneumoperitoneum detected by only 11 (13.9 %) of the residents followed by mediastinal mass, which was detected by only 22 (27.8%) of the residents.

Pulmonary edema was also detected only by 23 (29.1%). Another important observation was tension pneumothorax was missed by 30 (38%) of the residents (Table 1).

Table1: The proportion of correct and incorrect interpretation of the cases

Case	Correct n (%)	Incorrect n (%)
Pneumothorax	49 (62)	30 (38)
Normal	34 (43)	45 (57)
Pleural effusion	69 (87.3)	10 (12.7)
Pulmonary edema	23 (29.1)	56 (70.9)
Cavitation and con-solidations	39 (49.4)	40 (50.6)
Pneumoperitonium	11 (13.9)	68 (86.1)
Intestinal obstruction	73 (92.4)	6 (7.6)
Mediastinal mass	22 (27.8)	57 (72.2)
Radial fracture	60 (75.9)	19(24.1)
Lobar pneumonia	67 (84.8)	12 (15.2)
Total	**447 (56.6)**	**343 (43.4)**

No resident correctly interpreted all the cases. Two residents correctly identified 9 cases out of the ten. The majority of the residents 47 (59.5%) identified 1-5 of the ten cases. Only 32 (40.5%) identified 6 and above cases correctly (Table 2). As we can see from the table the sensitivity to detect an abnormality on x-ray is 72 (91.1 %). In this case, the specificity is the probability of the resident's in identifying a normal x-ray as normal it is 34 (43%). From the above table we can also drive the following measures: True negative (TN) (n) 43%, false positive (FP), 45 (57%), true positive (TP) (n) 91.1% , and false (FN), 7(8.9%) Table – 2.

Table 2: Number of correctly interpreted cases (overall score out of 10) and the ability of residents' in detecting a normal from abnormal X-rays in general

Categories of correctly interpreted cases		N (%)
Poor skill	1 - 5	47 (59.5)
Good skill	6 - 10	32 (40.5)

Responses of the residents when a normal x-ray is displayed

		N (%)
Response	Normal	34 (43)
	Abnormal	45 (57)

Responses of residents when abnormal x-ray is displayed

Response	Abnormal	72 (91.1)
	Normal	7 (8.9)

The AUROC for the resident's clinical accuracy in identifying a normal from an abnormal x-ray was 0.73. This means the overall accuracy of the residents in identifying a normal from an abnormal x-ray at gross level is 73%, Figure 1.
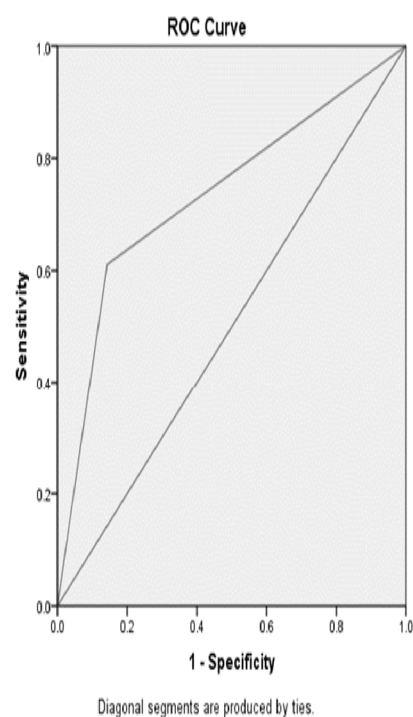

Figure 1: The AUROC for detecting normal x-rays from abnormal.

The sensitivity for clinical skills of the residents in detecting pulmonary edema was 23 (29.1%), and the specificity was 9 (11.4%). The response is remarkable for very high rates of false-positive 70 (88.6%) and false-negative 56 (70.9%) rates. The AUROC was 0.47; indicating the overall accuracy of the residents in detecting cardiogenic pulmonary edema is 47%, even lower than the chance result. The ROC lied almost on the diagonal line.

The sensitivity for detecting lobar pneumonia was 67 (84.8%) and the specificity was 34 (43%). The result is characterized by a high false-positive rate, 46 (57%). The AUROC was 0.49, indicating an overall accuracy of 49%.

The x-ray of pneumothorax was misinterpreted by most residents as pneumonia 9 (30 %), followed by dextrocardia, and CPAM. The normal x-ray was mostly confused with increased pulmonary vascular marking and pulmonary hypertension 19 (42.2 %), Asthma 7 (15.5 %), hilar LAP,7 (15.5 %) and pulmonary edema,6 (13.3 %). The pleural effusion x-ray was missed by only 10 (12.7%) residents, and was read as cardiomegaly in 4(40 %), pneumonia 3(30 %), pneumothorax 1(10 %) and as the right side effusion in 2 (20 %).

The x-ray of pulmonary edema was misinterpreted mostly as Pulmonary TB by 34 (60.7 %) residents and the rest as multifocal pneumonia,14 (25 %) which could have significant management difference. The x-ray showing mediastinal mass was also misread mostly as cardiomegaly,16(28.1 %), CHD,15(26.3 %), dextrocardia,7(12.3 %), lung mass,4(7%), PAPVR (scimitar sign) 4(7 %). There were 19 participants who missed radial fracture. The radial fracture was mistaken mostly for ulnar fracture 10(52.6 %), followed by fibular fracture 3(15.8 %), Rickets 2(10.5 %), and chronic osteomyelitis 2(10.5 %). The lobar pneumonia was confused with pleural effusion 9(75 %) and Tuberculosis 3(25 %).

Associations between variables

The rated confidence levels showed only 8.9% of the residents were 100% sure about their interpretation, 44.3% were 75% sure about their interpretation. The level of confidence was below 50% for the rest of 53.2% of the residents. Statistically, a significant association was found with the year of residency and confidence level (P-value = 0.02). 63.2% of R3s' scored above 5, followed by R2s' (39.3%), and R1s' 25%. (P-0.02,OR-3.8). Among those residents whose overall score was <5, 73% had a certainty level of less than 50%. (P-0.044, OR-2.7, CI, 1.02-7.4). However, undergraduate training, duration of clinical service before residency, presence of radiologist while working as GP, and feeling able to read independently did not appear to create statistically significant differences in interpretation skills of the residents (Table 3).

Table 3: Association of skills with variables

		Number of correct responses		P	OR	95%CI
		>5 n (%)	<5 n (%)			
Year of residency	R1	8 (25)	24 (75)	0.020	3.8	1.2-11.9
	R2	11(39.3)	17 (60.7)			
	R3	12 (63.2)	7 (36.8)			
Level of confidence	<50%	10(27)	27 (73)	0.044	2.7	1.02-7.4
	>50%	21 (50)	21 (50)			
Experience as GP	1-2YRS	26 (40)	39 (60)	0.84	1.14	0.31-4.18
	>2YRS	5 (35.7)	9 (64.3)			

DISCUSSION

This study showed that radiographs with intestinal obstruction, pleural effusion, and pneumonia were the three common diagnoses that were correctly identified by participants. Pneumoperitoneum, mediastinal mass, Pulmonary edema and tension pneumothorax were misinterpreted by most participants. Level of training is positively associated with accuracy of interpretation and undergraduate training, duration of clinical service before residency, presence of radiologist while working as GP and feeling able to read independently did not appear to create statistically significant differences in interpretation skills.

Radiographic examinations frequently contribute important information to the medical decision-making process occurring in the emergency department. Often radiographs are initially interpreted by an emergency medicine physician or Paediatric residents, and decisions are made based on this initial interpretation. In many institutions, the radiographs are subsequently interpreted by a radiologist with some means of resolving discrepancies that arise from this second interpretation(12) or as a quality assurance mechanism.

The reported discordance rate of Paediatrics emergency physicians and radiologists radiograph interpretation have a wide range, varying from 3.7% to 26% with clinically significant discordance rate between 0.8% and 7%. In our study, the overall discordance rate was 34 (43%) which is very high. This may be explained by differences in the sample size, and residents were not given pertinent clinical information which may improve their skill of interpretation by providing clues to the diagnosis. (13-15). The level of training in undergraduate medical education will also contribute to the high discrepancy observed in our study. In almost all Ethiopian Medical Schools, radiology is given as a minor course with only three weeks of attachment.

In our study the sensitivity of the residents in detecting abnormal radiographs was 72 (91.1%) with the specificity of 34 (43%). The false-positive rate was 46 (57%) and the false-negative was 7 (8.9%). The lower specificity coupled with a high false-positive rate decreased the overall accuracy to 73%. Even though the sensitivity of 72 (91.1%) seems to be high, it cannot be used to judge the skills of the residents in interpreting radiographs. This is because telling the radiograph as abnormal at a gross level without further specification can be achieved by even the most junior physicians.

False-positive (overdiagnosis) readings rather than false-negative (underdiagnosis) readings are common among the residents. The higher false-positive rate among the residents strongly correlate with a lack of knowledge and confidence in excluding the presence of abnormal radiographs and setting the patient as not having the suspected abnormality (16).

The significances of sensitivity and specificity are different in different situations and factors, such as the prevalence of the disease. In an area where the prevalence of a disease is very high, specificity is more important than sensitivity. The selected cases in this study also reflect the most common conditions encountered in the emergency department. Similarly, the importance of sensitivity and specificity of clinical skills of physicians is dependent on varieties of factors, such as the need for urgent intervention, the need for aggressive forms of treatment, and others.

Some of the conditions commonly encountered in clinical practice are time-sensitive and need urgent interventions, such as tension pneumothorax. The clinical skills of the physicians should be very sensitive in such situations and specificity may not be as important (17, 18).

In our study, the sensitivity of the residents to detect pneumothorax was 62% with false-positive rate of 38%. Given that pneumothorax is a common encounter, needs urgent intervention, and also easily treatable, physicians should have very high sensitivity to identify it even with physical examination alone before radiographs are requested. Our study showed 38% false positivity. The skill needed to identify pneumothorax from radiographs is not complex. This shows a significant radiographic skill gap in interpreting basic and practical radiographic findings that are very important in emergency decision-making. Therefore, urgent strategies should be implemented to alleviate the problem (15, 19).

In other situations, both sensitivity and specificity are equally important. As an example, a high sensitivity to detect pneumonia is good, but it should as well be specific enough to identify pneumonia from heart failure (19, 20). In our study, the sensitivity and specificity of detecting pneumonia from radiographs were 84.8% and 43% respectively. The false-positive rate was 57% which reduced the overall accuracy resulting in a low total accuracy (AUROC) of 0.49.

The sensitivity and specificity of the residents in detecting radiographic features of pulmonary edema and associated cardiac abnormalities were very low, 23 (29.1%), and 9 (11.4%) with corresponding high false negative and false positive rates, 70 (88.6%) and 56 (70.9%), respectively. AUROC was 0.47. Almost all of the residents who misinterpreted the findings of pulmonary edema misinterpreted it as pneumonia or miliary TB. This shows identifying radiographic features of pneumonia from pulmonary edema is the most difficult commonly encountered problem among the residents (21). One prior study identified certainty on a particular CXR as being associated with the successful interpretation of that CXR which is similar to the finding in our study.(22).

We found out that the skill of radiographic interpretation among Paediatrics residents to be low compared with other studies showing poor sensitivity and a high false-positive rate. This will lead to potential patient mismanagement. The most common confusion among participants was differentiating pulmonary edema and pneumonia and tuberculosis. Participants were not certain about their interpretation of radiographs even if the degree of certainty improved with the level of training. This study is done in single institution and the number of participants is low for extrapolation of the findings. Participants were not given the patients history which contradicts the actual scenario the residents are working which is known to affect interpretations.
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Based on the observations we made in our study, despite the limitations mentioned above, basic interpretation skill training should be in place for all new residents who are joining the program. There should be a mechanism for regular feedback for radiographs interpreted in emergencies which will serve also as a quality assurance mechanism.

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