Competency and Confidence in Interpretation of the Chest Radiograph in Junior Doctors and Medical Students

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Abstract

BACKGROUND:

Accurate chest X-ray interpretation is essential in the diagnosis and management of patients presenting with respiratory issues. Overseas studies show that the accuracy and confidence rates of chest X-rays (CXR) interpretation by junior doctors and medical students are low.

AIM:

This study has been designed to determine the competency and confidence of junior doctors and medical students in Eastern Health at interpreting chest radiographs.

METHODS:

Ten chest radiographs were selected from a radiology database and independently verified by a radiologist. An extended-matching style questionnaire was delivered to the medical students and junior doctors via online survey software. The questionnaire consisted of ten chest radiograph images each with a list of fifteen possible diagnoses. Participants were asked to select the correct choice which best described the radiograph and to rate their confidence in each answer.

RESULTS:

Of 67 complete responses, 49 (73.1%) from junior doctors and 18 (26.9%) from medical students achieved overall score of 57.6% vs 56.1% with confidence rates (CR) of 67% vs 58%, respectively. There were no significant differences in overall scores and confidence rates between two populations ($p>0.05$). There was a significant positive relationship between accuracy rates and confidence rates among junior doctors (Pearson's coefficient +0.798, $p=0.006$) and students (Pearson´s coefficient +0.716, $p=0.020$).

CONCLUSION:

This study identified similarities in strength and weakness in CXR interpretations between medical students and junior doctors. There was a positive association between test scores and self-related confidence scores.

Background

Accurate interpretation of the chest radiograph is essential in the correct diagnosis of patients presenting with respiratory complaints (1–4) and may give vital clues in detecting the presence of an underlying systemic disease (5).

Plain radiographs are amongst the most frequently ordered diagnostic imaging examinations and can help solve most diagnostic problems where clinical information alone is insufficient (6).

Despite being a commonly requested investigation, overseas studies have shown that the interpretation of chest X-rays by junior doctors is generally poor (7–9). Junior doctors have also been shown to have the least confidence in their interpretations compared to their more experienced colleagues (9). Accurate reporting on chest radiographs can have a direct influence on patient management (10).

We designed this study to compare the competency and confidence at chest radiograph interpretation of junior doctors and senior medical students at a tertiary Australian Health Service to identify areas where radiology teaching could be improved. To our knowledge there have been no prior Australian studies examining this subject.

Method

Study design

An online questionnaire was designed and distributed to 270 junior doctors and final year medical students from the Eastern Health, a tertiary health service with three acute care campuses in Melbourne, Australia. Junior doctors were in pre-vocational training (Post Graduate Year (PGY) 1 and PGY 2) or PGY 3 residents in medical, general or surgical specialty streams.

The online questionnaire consisted of ten question pages in matching item format prepared using cloud-based survey development software, Survey Monkey (Survey Monkey, San Mateo, USA). We constructed our questions in the Extended Matching Question style. A traditional Extended Matching Questions has four components: a common theme of related concepts, a lead-in, a list of options which are usually length and two or more stem items. EMQs give higher item discrimination and higher reliability estimates and best used for diagnostic reasoning (11), which is of relevance to our study. As the aim of the study was for participants to identify radiographic abnormalities rather than clinical diagnoses, the images were not accompanied by any clinical data.

Each question page on the questionnaire showed one chest radiograph image accompanied by a list of fifteen options. Participants were asked to select the option that best described the radiographic abnormality shown in the image. Participants could only select one response for each chest x-ray, but each option could be selected for more than one question. An answer was required for each question. A correct answer was given a score of 1. For each question, participants were also asked to rate their confidence in their answer either as "random guess", "not confident", "somewhat confident", "very confident" or "certain of diagnosis". This was converted to a numerical score from 1 to 5.

Demographic information on the participant's postgraduate experience level, specialty of interest and undergraduate background was collected at the end of the survey.

No time limit was imposed on the answering of each question, however the time taken to complete the questionnaire was recorded. Once the questionnaire was submitted, participants were not able to review or change their answers.

Image selection

The ten chest x-ray films were selected from the radiology database at Eastern Health by a senior radiographer. They were included one normal chest x-ray and nine abnormal films (Figure 1 - Chest radiographs selected for inclusion into the online questionnaire. The wording is as it appears in the survey and was chosen, where possible, to reflect the radiographic abnormality rather than a clinical diagnosis.. The radiographs demonstrating pathology were chosen to reflect conditions that junior doctors would commonly encounter in acute care medicine. All chest x-rays had been reviewed and reported by a consultant radiologist. The criteria for inclusion for use in the survey were:

(i) Normal or having only one radiographic abnormality present;
(ii) Any abnormality was not so subtle as to be unreasonable for a non-radiologist to recognise;
(iii) The image was of good quality, exposure and free from artefact;

A second consultant radiologist validated the ten films to ensure they met the selection criteria. Four films were discarded due to poor image quality or disagreement with the first radiologist report. Four replacement films were sourced from the database, which were subsequently validated for inclusion into the study by the second consultant radiologist. An example image is provided in Figure 5 below.

Outcome measures

The primary outcomes of interest were the mean overall scores and self-rated confidence scores of the entire cohort, medical students and all junior doctors.

Secondary outcomes included subgroup analyses based on chest radiograph abnormality, post graduate year level, and participants' nominated specialty interest. The cohort's ability to detect a radiographic abnormality, regardless of the accuracy of the diagnosis, and recognise the absence of pathology was also assessed.

Statistical analysis

Responses from participants were exported from Survey Monkey directly into an Excel spreadsheet. JASP, an open source statistical software package, was used for statistical analysis.

Descriptive data included median scores with interquartile range or mean scores and standard deviation. Mean scores were compared between groups using independent samples T-test. Pearson's correlation was used for bivariate analysis for linear association between continuous variables.

P value < 0.05 was considered statistically significant.

For the purpose of calculating the sensitivity and specificity in detecting a radiographic abnormality, a result was considered to be a true positive if the participant selected any response other than "normal chest x-ray" for questions where an abnormality was present, regardless of the actual diagnosis. A true negative result was recorded if the participant correctly identified the normal chest x-ray. 95% confidence intervals were calculated for point estimates.

Results

The questionnaire was distributed to 270 junior doctors and final year medical students and 75 responses were obtained, giving a response rate of 27.8%. 8 responses were excluded from analysis as they were incomplete.

Of 67 complete surveys collected, 49 (73.1%) were from junior doctors and 18 (26.9%) from medical students. The responses from junior doctors include 13 PGY1, 20 PGY2 and 16 PGY3+ hospital medical officers (HMOs).

The median time taken to complete the survey was 10 minutes 33 seconds (7min 30sec – 15 min 43 sec interquartile range (IQR)).

The mean (SD) score for the entire cohort was 57% (13.8%). Overall, junior doctors scored 57.6% compared to 56.1% for medical students with confidence rates (CR) of 67% vs 58%, respectively. There were no significant differences in overall scores and confidence rates between two populations ($p > 0.05$).

Mean scores were similar across experience levels (Figure 3) with PGY3 HMOs trending towards a higher average score, although this did not reach statistical significance ($p = 0.333$).

Both junior doctors and medical students scored highest in diagnosis of lung mass (91% vs 100%) and pleural effusion (98% vs 87%) but lowest in diagnosis of lung collapse (2% vs 0%) and left lower zone consolidation (23% vs 13%) – see Figure 4. These were most commonly misdiagnosed as unilateral lower zone consolidation (50.7% of participants) and as normal chest x-ray (46.3% of participants) respectively.

There was a significant positive relationship between accuracy rates and confidence rates among junior doctors (Pearson's coefficient +0.798, $p=0.006$) and students (Pearson´s coefficient +0.716, $p=0.020$). In addition, junior doctors have higher accuracy and confidence rates in CXR interpretations of widened mediastinum, COPD changes, pulmonary oedema and unilateral upper zone consolidation. However, normal chest x-ray was interpreted more accurately by students than junior doctors 67% vs 47% (CR 56% vs 60%). Participants most commonly misdiagnosed the normal chest x-ray as cardiac failure (Figure 6).

Sensitivity for detecting a radiographic abnormality was calculated to be 94% (91 – 95% 95% CI) with a specificity of 49% (37 – 61% 95% CI).

Discussion

Chest x-rays are difficult to interpret accurately, with previous studies showing that accuracy improved with experience in radiology (12). Junior doctors are frequently called upon to interpret the studies as part of their daily duties. Following and interpreting investigation results appropriately to guide patient management is a core part of the Australian Curriculum Framework For Junior Doctors (13). Junior doctors are likely to be the first required to interpret the radiograph findings and make a diagnosis that will go on to influence patient management. Therefore, making accurate and confident assessment is crucial.

Despite achieving a higher mean score, there was no statistical significance between junior doctors and medical students. This would seem to suggest that after medical school, there is a stagnation in improving diagnostic imaging skills. The heavy workload of a junior doctors

as well as over-reliance on radiologist reports or interpretations by more senior colleagues may be contributing factors. There is slightly better performance from the PGY3 subgroup that includes third year basic physician trainees preparing for written and clinical examinations, possibly benefiting from more structured tutorials that include radiology teaching (14).

Our results are in keeping with a previous American study by Eisen et al in establishing a link between overall certainty and successful chest x-ray interpretation (7). Unlike the previous study, we found no statistical difference in accuracy between experience levels, despite an increase in self-reported confidence. The small sample sizes of the subgroup analyses limits the interpretation of this data.

There was a great variability in the accuracy of diagnoses seen, depending on the type of abnormality present. This is true for both junior doctors and medical students. Although good scores where achieved for diagnosis of some abnormalities such as lung mass and pleural effusion, other important pathologies were missed such as consolidation and lobar atelectasis.

There was a tendency, especially in the junior doctors, to over-interpret the normal chest x-ray. This is reflected in the poor specificity in detecting radiographic abnormalities, suggesting that although the cohort was good at recognizing that an x-ray was abnormal, they were prone to making type I (false positive) errors. This appears to be less of an issue for the medical students.

The performance of the participants in this Australian study are comparable to several published international studies (7,9). Eisen at al evaluated the ability of 145 medical students and medical doctors up to PGY7 level to accurately interpret ten chest radiographs, obtaining a median score of 11 out of 20 (8 - 15 IQR) for the cohort. In our study the median score was 6 out of 10 (5 – 7 IQR). Similarly, in a smaller study of 22 doctors at a Danish Health Service, Christiansen et al presented the cohort with ten chest films with 51% (95% CI 0.43 – 0.58) correct primary diagnoses overall (9). This supports the notion that poor chest radiography interpretation by junior doctors is not a localised problem.

A few limitations inherent in the survey format of our study were identified:

i) The study is vulnerable to selection bias given that it was not mandatory to respond to the survey, there is a potential bias towards those more confident in their abilities responding.

ii) The survey was not administered under examination conditions. However, although no time limit was imposed on completing the survey, the median time taken is well within the 30 to 60 minutes allowed in other studies (7,12).

iii) It was not possible to control or standardise the device on which the images were viewed and it may be possible that they were viewed under suboptimal conditions.

iv) Clinical data was purposely suppressed for this study as the primary aim was to assess the ability to recognise radiographic abnormalities as opposed to clinical diagnoses. However, correct clinical information has been shown to improve the accuracy of the radiology report (15) and our results may be different if clinical information was provided.

Conclusion

Our study obtained 67 responses for a ten question extended-matching style online questionnaire assessing the competency and confidence of junior doctors and students in chest radiograph interpretation. We found no statistical difference in the mean overall scores between the two groups. Self-rated confidence score in their ability was higher in the junior doctors. There was a significant positive correlation between confidence and accuracy. This may indicate a need for more structured radiology teaching aimed at the early post-graduate year levels. Further study in to the factors that influence confidence may lead to improved chest x-ray interpretation.

Acknowledgements

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Tables and Figures

Chest radiographs selected for questionnaire
1. Normal chest X-ray
2. Lung mass
3. Pleural effusion
4. Pneumothorax
5. Widened mediastinum
6. COPD changes / lung hyperinflation
7. Isolated lobar collapse
8. Left ventricular failure/ pulmonary oedema
9. Unilateral lower zone consolidation
10. Unilateral upper lobe consolidation

Figure 1 - Chest radiographs selected for inclusion into the online questionnaire. The wording is as it appears in the survey and was chosen, where possible, to reflect the radiographic abnormality rather than a clinical diagnosis.

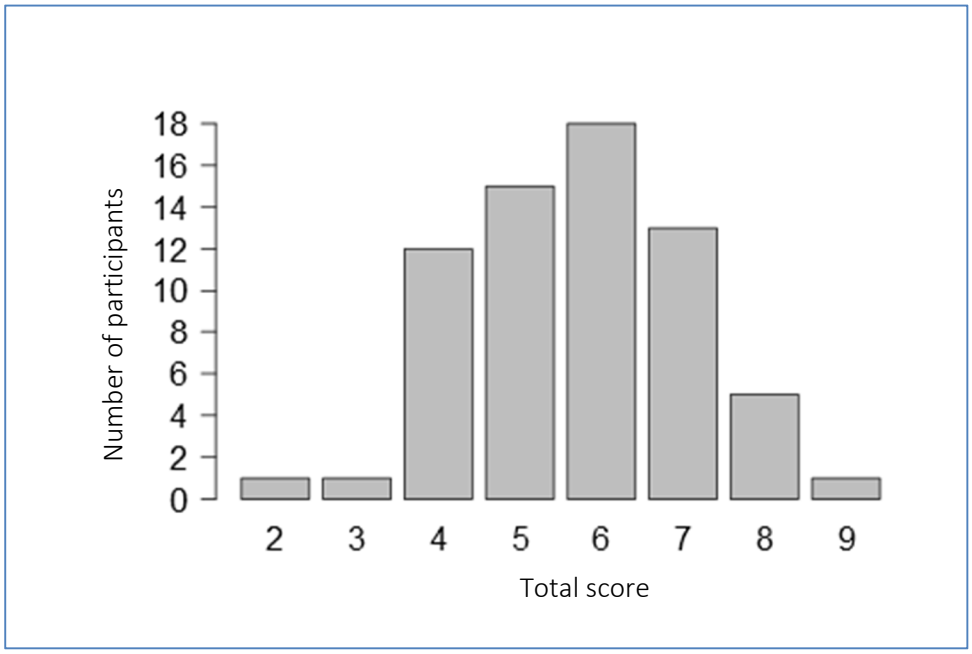

Figure 2 - frequency distribution of total scores for entire cohort

	Medical Students	Junior Doctors	Interns (PGY1)	PGY 2 HMOs	PGY 3 HMOs
Number (%)	18 (26.9%)	49 (73.1%)	13 (19.4%)	20 (29.9%)	16 (23.9%)
Mean score (SD)	5.61 (1.29)	5.76 (1.42)	5.62 (1.76)	5.60 (1.23)	6.1 (1.39)
Confidence Rate	58%	67%	62%	66%	71%

Figure 3 - Mean score out of 10 (standard deviation) comparing medical students with all junior doctors and also by post graduate year experience. Average self-rated confidence is shown for each cohort.

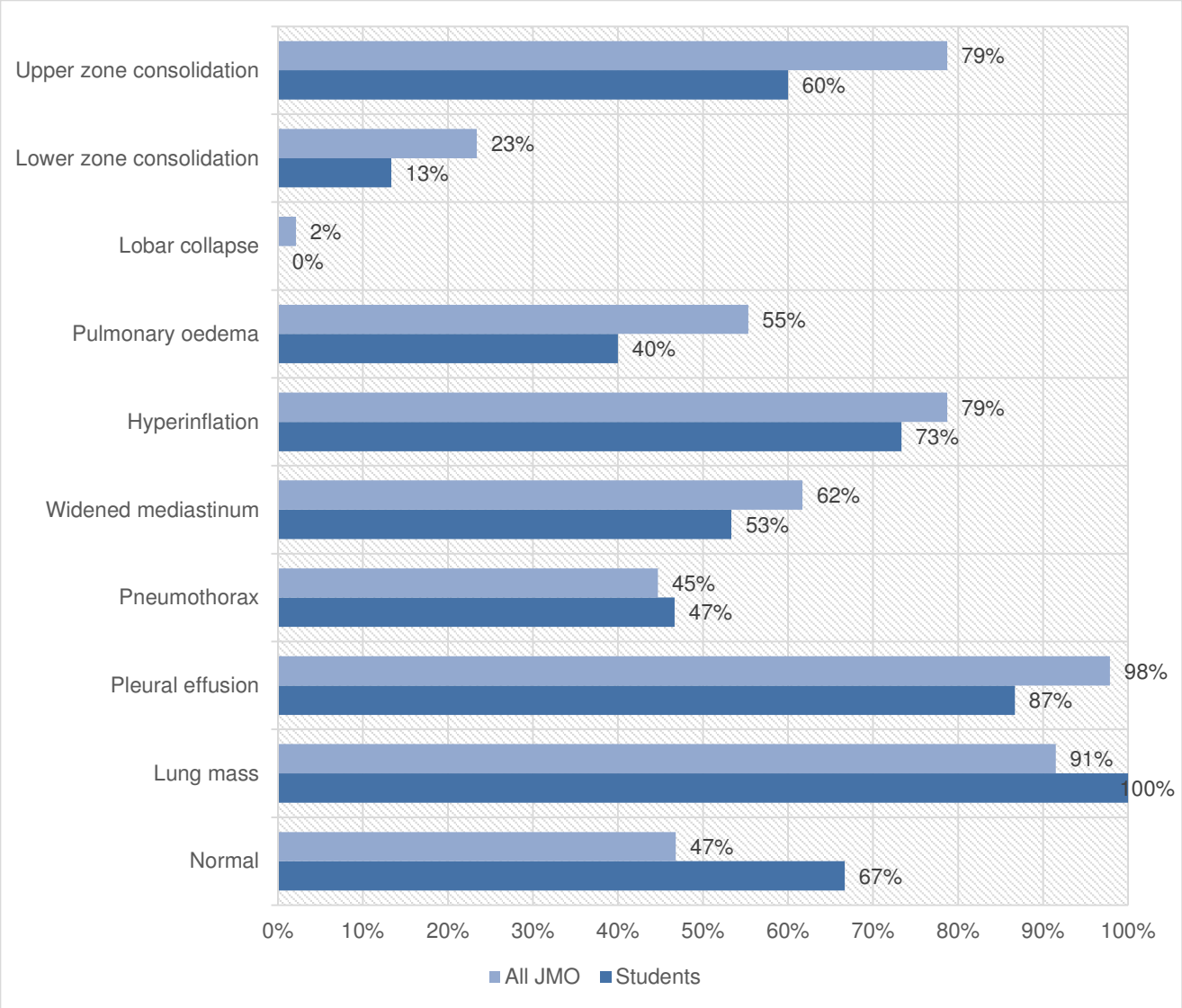

Figure 4 - mean scores for final year medical students versus all junior doctors according to chest x-ray abnormality

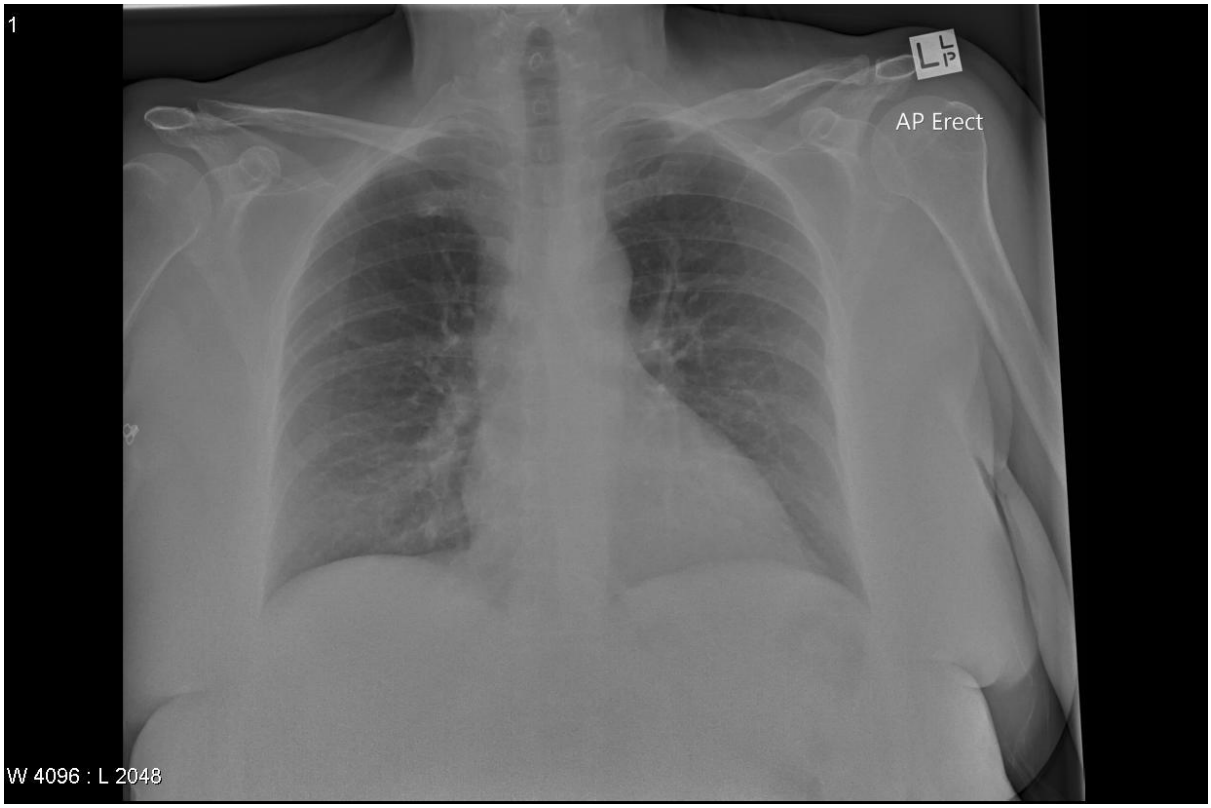

Figure 5 - Example of "normal chest radiograph" used in the survey

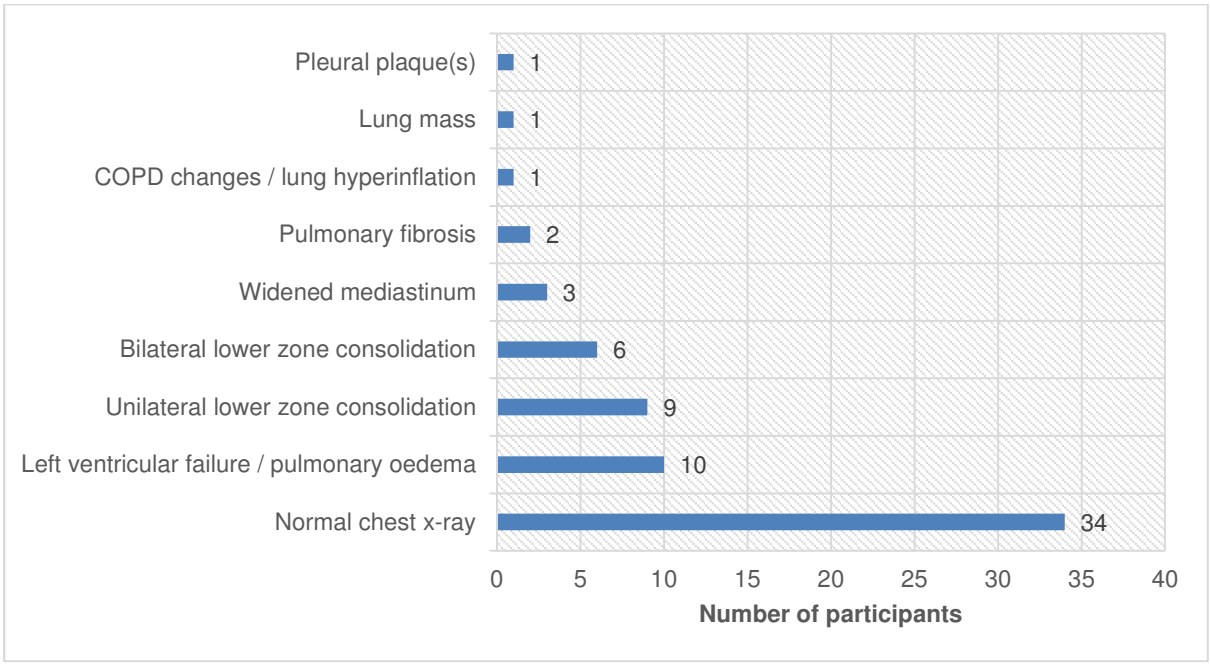

Figure 6 - Diagnoses given for question 1 (normal chest x-ray) by all study participants

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