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Impact of Non-Compliance with Chest Radiography Quality Criteria on Adult Patient Diagnosis: A Descriptive and Analytical Study at the Medical Imaging Department of Jamot Hospital, Yaoundé

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ABSTRACT

Introduction: The technical quality of a chest radiograph determines the reliability of its diagnostic interpretation. Failure to meet radiological quality criteria can lead to interpretation errors. The objective of this study was to assess the impact of non-compliance with chest radiograph quality criteria on the diagnosis of adult patients.

Materials and Methods: This was a descriptive and analytical cross-sectional study conducted on 150 chest radiographs of adult patients and 5 members of staff from the Medical Imaging Department of Jamot Hospital in Yaoundé. Sociodemographic, technical, and diagnostic variables were collected using a standardized data form and analyzed using frequency calculations, chi-square test, Spearman correlation, and binary logistic regression (significance threshold $p<0.05$).

Results: The mean age of patients was 36.8 ± 11.3 years (range: 18–55 years), with a male-to-female ratio of 1.27. At least one technical defect was identified on 149 out of 150 images (99.3%). The diagnosis was considered to be affected in 84.7% of cases, and 40.7% of the radiographs required repeat imaging. In binary logistic regression analysis, the number of technical defects was significantly associated with diagnostic impairment (adjusted Odds Ratio = 2.18; 95% CI [1.28–3.71]; p=0.004) and with repeat imaging (OR=2.75; 95% CI [1.85–4.10]; $p<0.001$), as was the professional experience of the radiographer for repeat imaging (OR=1.09; 95% CI [1.02–1.17]; p=0.009).

Conclusion: Non-compliance with chest radiograph quality criteria is prevalent and significantly affects the quality of diagnostic interpretation. Strengthening continuing professional education and implementing systematic quality control of radiographs are recommended.

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Introduction

Chest radiography remains the first-line imaging examination for the investigation of pulmonary, cardiovascular, and pleural pathologies, owing to its accessibility, low cost, and rapid execution Its diagnostic reliability, however, depends on strict adherence to technical quality criteria relating in particular to centering, inspiration, penetration, symmetry, and visualization of the anatomical structures of interest, as defined by the quality assurance standards in diagnostic imaging [1-3,14].

In low-resource settings such as Cameroon, variability in technical staff experience, heterogeneity of equipment, and high workload increase the risk of non-compliance with these criteria, resulting

in image retakes, additional patient radiation exposure, and a risk of diagnostic interpretation errors.

Several studies conducted in sub-Saharan Africa, notably in Togo, Ethiopia, and Nigeria , as well as in Europe , have reported reject rates ranging from 2.9% to 26%, reflecting heterogeneity in practices and quality control systems across different settings [6,7,8,12,9].

In Cameroon, few objective data quantify the magnitude of this phenomenon and its actual impact on diagnosis. The present study aims to address this gap by evaluating, within the Medical Imaging Department of Jamot Hospital in Yaoundé, the impact of non-compliance with chest radiograph quality criteria on the diagnosis of adult patients, through a descriptive multivariate analysis and binary logistic regression modeling of associated factors, drawing in particular on the work of Kjelle and Chilanga and Ndlovu et al. on the determinants of radiographic image quality [10, 11].

Materials and Methods

This was a cross-sectional study with descriptive and analytical aims, conducted within the Medical Imaging Department of Jamot Hospital in Yaoundé (HJY), a reference hospital in the management of respiratory pathologies in Cameroon. The study covered 150 chest radiographs of adult patients aged 18 to 55 years, as well as 5 members of technical and medical staff who performed or interpreted these examinations.

The variables collected included: patient sociodemographic characteristics (age, sex), clinical indication for the examination, staff characteristics (qualification, sex, professional seniority), presence of technical defects (motion blur, centering defect, underexposure, overexposure, foreign body), compliance with anatomical quality criteria (visibility of the apices, clavicular symmetry, visibility of the costophrenic angles, vascular pattern, scapular clearance), as well as the diagnostic outcome (diagnosis affected or not), possible retake of the image, and its final interpretation.

Data were entered in Microsoft Excel and then analyzed using Python (pandas, SciPy, statsmodels). The multivariate descriptive analysis covered frequency distributions and cross-tabulations between sociodemographic, technical, and diagnostic variables. Associations between qualitative variables were tested using the chi-square test of independence, and correlations between quantitative variables (age, seniority, number of defects) were assessed using the Spearman rank correlation coefficient. A multivariate binary logistic regression was performed to identify the independent determinants of (i) diagnostic impairment and (ii) image retake, with calculation of adjusted Odds Ratios (OR) and their 95% confidence intervals. The threshold for statistical significance was set at $p<0.05$.

Results

Sociodemographic Characteristics of Patients

Table I: Distribution of Patients by Age and Sex (n=150)

Variable	Count (n)	Frequency (%)
Sex		
Male	84	56.0
Female	66	44.0
Age		
18–30 years	49	32.9
31–50 years	78	52.3
51–55 years	22	14.8
Mean age ± SD	36.8 ± 11.3 years	—

The male-to-female sex ratio was 1.27, favoring males. The middle adult age group (31–50 years) was the most represented (52.3%), followed by young adults (32.9%).

Table II: Distribution of the Main Clinical Indications for Radiographic Examination (n=150)

Clinical Indication	Count (n)	Frequency (%)
Cough	53	35.3
Tuberculosis follow-up	23	15.3
Chest pain	20	13.3
Dyspnea	14	9.3
Hemoptysis	13	8.7
Pleurisy follow-up	8	5.3
Pneumonia/pneumopathy	6	4.0
Other indications	13	8.7

Clinical indications were dominated by cough (35.3%) and tuberculosis follow-up (15.3%), reflecting the preponderance of infectious respiratory diseases in the indications for chest radiography.

Characteristics of Technical Staff

Table III: Distribution of Staff by Qualification, Sex, and Professional Seniority

Qualification / Seniority	Number of Images (n)	Frequency (%)
Senior radiographer, 1 year of experience	44	29.3
Senior radiographer, 2 years of experience	38	25.3
Senior radiographer, 15 years of experience	37	24.7
Medical imaging engineer, 3 years of experience	31	20.7

Senior radiographers performed 79.3% of the examinations, compared to 20.7% for the imaging engineer. Professional seniority of staff ranged from 1 to 15 years.

Compliance with Technical Quality Criteria (Anteroposterior View)

Table IV: Frequency of Anatomical Quality Criteria (AP View, n=150)

Quality Criterion	Present (%)	Absent (%)
Visibility of pulmonary apices	96.7	3.3
Clavicular symmetry / spinous process line	56.7	43.3
Visibility of costophrenic angles	75.3	24.7
Vascular pattern visible up to 1 cm from the chest wall	86.7	13.3
Scapular clearance from the pulmonary field	23.3	76.7

Visibility of the apices (96.7%) and vascular pattern (86.7%) were the best-respected criteria, whereas scapular clearance from the pulmonary field was achieved in only 23.3% of cases, identifying it as the most frequently non-compliant criterion.

Table V: Frequency of Technical Defects Identified (n=150)

Technical Defect	Present (%)	Absent (%)
Centering defect	24.7	75.3
Motion blur	9.3	90.7
Underexposure	96.7	3.3
Overexposure	0.7	99.3
Foreign body on the field	3.3	96.7

At least one technical defect was found on nearly all radiographs (149/150, i.e., 99.3%), with an average of 2.3 defects per image (range: 0 to 6). Underexposure appeared as the most frequently recorded defect in this series.

Impact on Diagnosis and Image Retake Rates

Table VI: Distribution by Diagnostic Impairment, Image Retake, and Final Interpretation (n=150)

Variable	Count (n)	Frequency (%)
Diagnosis affected by a defect	127	84.7
Diagnosis not affected	23	15.3
Image retaken	61	40.7
Image not retaken	89	59.3
Image ultimately interpretable	149	99.3

The diagnosis was judged to be affected by the absence of one or more quality criteria in 84.7% of the analyzed radiographs, which prompted a retake in 40.7% of cases. Despite these defects, nearly all images (99.3%) were nevertheless interpretable, albeit at the cost of increased radiologist vigilance.

Table VII: Image Retake Rate by Radiographer Professional Seniority

Professional Seniority	Retake Rate (%)	Number of Images (n)
1 year of experience	31.8	44
2 years of experience	44.7	38
3 years of experience (engineer)	38.7	31
15 years of experience	48.6	37
Image ultimately interpretable	149	99.3

Contrary to the hypothesis of a linear decrease in retake rate with seniority, the highest retake rate was observed among the most experienced staff (48.6% at 15 years), possibly related to a greater volume of at-risk examinations (elderly patients, complex indications) assigned to this senior staff, or to stricter diagnostic quality requirements on their part.

Multivariate Statistical Analysis and Correlations

Association Tests (Chi-Square)

Table VIII: Results of Association Tests Between Qualitative Variables

Association Tested	χ^2 (df)	p-value
Professional seniority × image retake	2.71 (3)	0.438
Staff qualification × image retake	0.002 (1)	0.965
Patient sex × diagnostic impairment	0.030 (1)	0.862
Presence of a defect × diagnostic impairment	0.932 (1)	0.334

No significant association was found between staff qualification or seniority considered in isolation and image retake in bivariate analysis ($p>0.05$), nor between patient sex and diagnostic impairment, suggesting that the effect of these factors is more cumulative and multivariate than univariate, as confirmed by the logistic regression analysis below.

Correlations

A weak but statistically significant negative correlation was observed between professional seniority and the number of technical defects per image (Spearman correlation coefficient $\rho=-0.194$; $p=0.017$), indicating that a greater number of years of experience tends to be associated with a slightly lower number of cumulative technical defects, although the strength of this relationship remains modest. By contrast, no significant correlation was found between patient age and the number of technical defects on the radiograph.

Binary Logistic Regression: Determinants of Diagnostic Impairment

Table IX: Multivariate Binary Logistic Regression — Dependent Variable: Diagnosis Affected (Yes/No), n=149

Variable	Adjusted OR	95% CI	p
Number of technical defects (per unit)	2.18	1.28–3.71	0.004
Patient age (per year)	1.00	0.96–1.05	0.892
Professional seniority (per year)	0.99	0.91–1.07	0.813
Male sex (ref. female)	0.97	0.37–2.56	0.948

After adjustment for age, sex, and professional seniority, only the cumulative number of technical defects remained significantly associated with diagnostic impairment: each additional technical defect multiplied by 2.18 the probability that the diagnosis would be judged as affected (95% CI [1.28–3.71]; $p=0.004$). The overall model was statistically significant (likelihood ratio test, $p=0.024$), with a Nagelkerke/McFadden pseudo-R^2 of 0.087, reflecting a moderate but genuine contribution of the studied variables to explaining the variability in diagnostic impairment.

Binary Logistic Regression: Determinants of Image Retake
Table X: Multivariate Binary Logistic Regression — Dependent Variable: Image Retake (Yes/No), n=149

Variable	Adjusted OR	95% CI	p
Professional seniority (per year)	1.09	1.02–1.17	0.009
Number of technical defects (per unit)	2.75	1.85–4.10	<0.001

The logistic regression model applied to image retake was highly significant ($p<0.001$; McFadden pseudo-$R^2 = 0.178$). Each additional technical defect multiplied by 2.75 the probability of retake (95% CI [1.85–4.10]; $p<0.001$). More unexpectedly, professional seniority was associated with a slight increase, rather than a decrease, in the probability of retake (OR=1.09 per year; 95% CI [1.02–1.17]; p=0.009), a result discussed below.

Discussion

This study made it possible to quantify, based on individual data from 150 chest radiographs and robust multivariate analysis, the extent and determinants of non-compliance with radiological quality criteria and its impact on diagnosis within a Cameroonian reference department.

From a sociodemographic perspective, the observed male predominance (sex ratio of 1.27) is consistent with findings from previous studies conducted in African contexts, which attribute this overrepresentation to more frequent exposure of men to respiratory risk factors such as smoking, alcohol consumption, and occupational exposure to pollutants [13]. Immunological differences related to sex, particularly the influence of steroid hormones on the pulmonary inflammatory response, have also been suggested as potential contributing factors by Guecamburu, although no definitive scientific consensus currently exists on the relative contribution of these biological and behavioral mechanisms [13]. The predominance of the middle adult age group (31–50 years) is also consistent with the profile of cumulative exposure to respiratory risk factors described in particular by the Centers for Disease Control and Prevention in this economically active age group [5].

The overall rate of non-compliance with at least one technical quality criterion found in our series (99.3%) appears clearly higher than the reject rates reported in other settings, notably 14% in Togo, 4.9% in Ethiopia , 26% in Nigeria , and 2.9% in Switzerland [7, 8, 12, 9]. This discrepancy is largely explained by a difference in definition: the aforementioned comparative studies measure a strict reject rate, i.e., images deemed definitively unusable and retaken identically, whereas the present study counts every technical defect, even minor ones that did not necessarily lead to image rejection, in line with the methodological approach described by Gbandé et al. in Togo [6]. The actual retake rate observed here (40.7%) remains nevertheless high and reflects a genuine need for improvement in quality control in routine clinical practice [7,8,9,12].

The binary logistic regression analysis confirmed, after adjustment for age, patient sex, and radiographer seniority, that the cumulative number of technical defects constituted the most robust independent determinant of diagnostic impairment (OR=2.18 per additional defect) and of image retake (OR=2.75). This result is consistent with the work of Kjelle and Chilanga and Ndlovu et al [11]. who identified the technical competence of staff and the multiplicity of positioning defects as major determinants of the diagnostic value of digital radiographs [10],. From a pathophysiological perspective, several mechanisms of diagnostic error, described in standard reference texts on thoracic anatomy, are consistent with our qualitative observations: an under-inspired radiograph can simulate an interstitial syndrome, a positioning asymmetry can mimic pulmonary hypoplasia, failure to clear the scapulae can simulate pleural detachment, and the absence of visibility of the costophrenic angles can lead to missing an early pleural effusion [2,3].

The most counterintuitive finding of this analysis concerns the positive, rather than negative, association between the professional seniority of the radiographer and the probability of image retake (OR=1.09 per year of experience, p=0.009). Several hypotheses can be advanced. First, an allocation bias is plausible: the most experienced staff may be preferentially called upon for the most technically complex examinations (agitated patients, lateral views, difficult morphologies), thereby increasing the risk of requiring a retake regardless of individual competence. Second, experienced staff may apply stricter quality criteria and thus be more likely to judge an image as insufficient, whereas a less experienced radiographer may underestimate certain defects. Third, the small sample size of the group with 15 years of experience (n=37, a single radiographer) limits the generalizability of this observation and calls for caution in its interpretation, as an individual bias cannot be excluded.

This finding highlights the limitations of a univariate interpretation of the role of professional experience and argues for the simultaneous consideration of clinical context, type of requested projection, and workload when analyzing the determinants of image retake, rather than staff seniority alone. It is nonetheless consistent with the literature on a central point, also emphasized in radiology professional standards [15,16]: regardless of the level of experience, it is the cumulative mastery of technical parameters (centering, inspiration, exposure, positioning) that ultimately determines image quality and diagnostic reliability, rather than seniority considered in isolation.

From a methodological standpoint, this study has several strengths, notably the use of individual patient-level data enabling multivariate analysis through logistic regression, unlike many descriptive studies limited to univariate statistics. However, it also has limitations that should be acknowledged. This is a single-center study conducted in a single hospital department, which limits the generalizability of the results to all radiology facilities in Cameroon, whose equipment and practices may differ substantially. The study population was restricted to adult patients aged 18 to 55 years, thereby excluding children and elderly patients over 55 years, populations that are particularly affected by radiographic positioning difficulties. Furthermore, the cross-sectional nature of the study does not allow establishing a strict causal relationship between technical defects and diagnostic impairment, the latter having been assessed retrospectively based on the radiologist's judgment rather than through systematic comparison with a reference examination. Finally, the number of technical staff studied (n=5) remains small, which limits the statistical power of analyses specifically addressing the individual characteristics of the operators.

These findings nevertheless advocate for the implementation of a structured quality control program for chest radiographs, including regular audits of retake rates, continuing education targeted at the most frequently deficient positioning criteria (scapular clearance, claviculo-vertebral symmetry), and staff awareness-raising,

regardless of seniority level, on the importance of systematically adhering to technical quality criteria to ensure the reliability of radiological diagnosis.

Conclusion

This descriptive and analytical study of 150 chest radiographs performed at Jamot Hospital in Yaoundé reveals frequent non-compliance with technical quality criteria, with a significant impact on the reliability of radiological diagnosis and a high rate of image retakes. Multivariate analysis through binary logistic regression confirms that the cumulative number of technical defects is the major independent determinant of diagnostic impairment and image retake, while the role of professional seniority appears more complex than expected and warrants further exploration through larger multicenter studies. Strengthening quality control and continuing education in radiographic technique remains a priority for improving the diagnostic safety of patients.

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