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Routine chest radiography in intensive care: impact on decision-making

Radiografia de tórax de rotina em terapia intensiva: impacto na tomada de decisão

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ABSTRACT

Objective: This study determined the prevalence of clinical abnormalities in chest radiographs and its relationship with decision-making in intensive care.

Methods: This prospective cohort study involved nonconsecutive patients who were admitted to the intensive care unit at the Hospital Universitário Professor Polydoro Ernani de São Thiago of the Universidade Federal de Santa Catarina. Imaging tests in the intensive care unit (ICU) were assessed daily between February and May 2011 and divided according to the reason for hospitalization, the type of test requested, anatomical segment under assessment and the purpose of the request. The imaging tests were interpreted by intensivists and subsequently divided according to the

detected abnormalities and changes in medical care. The chi-squared test was used for statistical analysis.

Results: The study sample included 106 patients. A total of 447 imaging tests were assessed, 425 of which were anteroposterior chest radiographs. An average of 4.01 radiographs per patient was obtained. Among the requested radiographs, 79.3% were normal, and 35.2% of abnormal radiographs did not prompt changes in medical care.

Conclusion: Most of the radiographs performed in the intensive care unit exhibited no statistically significant clinical alterations, and the radiographs that revealed abnormalities did not necessarily lead to changes in medical care.

Keywords: Intensive care; Chest radiography; Routine diagnostic tests

INTRODUCTION

Intensive care units (ICU) use imaging tests for the complementary diagnostic evaluation of admitted patients, the post-acute event monitoring of tubes and catheters after procedures, and daily monitoring. As with any medical procedure, the potential benefits to the patient must be weighed against the risks of a particular examination. Patients who are admitted to the ICU exhibit particular characteristics, including confinement to the bed and the inability to assume postures for specific radiographic positioning. In addition, patient transportation to the radiology service requires planning and human resources and generates additional risk.⁽¹⁻³⁾

The advantages and disadvantages of the imaging methods that are requested should be weighed, and whether the results may change the established medical care should be considered. The factors influencing the decision to order imaging and other tests in the ICU includes the clinical complexity of the case, the ease of performing the test, and the subjectivity of the attending physician for

This study was conducted at the Hospital Universitário Professor Polydoro Ernani de São Thiago, Universidade Federal de Santa Catarina - UFSC - Florianópolis (SC), Brazil.

Conflicts of interest: None.

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routine clinical or academic purposes.⁽⁴⁾ A consensus on the indications for chest radiographs in an ICU covers a variety of situations.

Studies of the number of chest radiographs in an ICU, which are the majority of requested imaging tests requested, have revealed no statistical relationship to justify daily radiographs in critical patients, regardless of the severity of the clinical condition.⁽⁵⁻¹⁰⁾ Therefore, requests for diagnostic tests should be based on clinical justifications and the possibility that the test results would change established medical care.

The present study assessed the performance of routine chest radiographs on patients who were admitted to the ICU at the Hospital Universitário Professor Polydoro Ernani de São Thiago of the Universidade Federal de Santa Catarina (HU/UFSC) and verified the relevance of radiographic findings in decision-making in the ICU.

METHODS

A prospective cohort study of nonconsecutive patients who were admitted to the ICU of the HU/UFSC and underwent imaging tests was conducted between January 31 and May 13, 2011, following approval by the UFSC's Ethics Committee on Human Research. The ICU had 10 beds and treated adult clinical and surgical patients, but not polytrauma and postoperative cardiac surgical patients. The type and number of imaging tests that were performed on each patient was verified on weekdays during the data collection period. Tests that were performed on weekends and holidays were not collected immediately but were cataloged on the first subsequent working day.

The patients or their legal representatives signed the informed consent form. The reason for patient admission into the ICU was identified, and the test results were cataloged. ICU admission reasons were divided into groups according to the patient's main therapeutic requirement: Group 1: hemodynamic support; Group 2: mechanical ventilation; Group 3: monitoring during the postoperative period of elective surgeries with no clinical indication for ICU assistance, but who were referred to the unit due to surgical risk. The following tests were assessed: regular radiographs, computed tomography (CT) scans, magnetic resonance imaging (MRI) scans, and ultrasounds. The following categories of anatomical segments were assessed: head and neck, thorax, abdomen and pelvis, and limbs. The reasons for the tests were defined as diagnostic investigation, monitoring after a procedure (e.g., intubation, tracheostomy, insertion of nasoenteral or nasogastric tubes, and central venous

access), ICU admission checking, routine with no specific clinical indication, and the monitoring of mechanical ventilation. The indication noted on the standard diagnostic test ordering form at the HU/UFSC under the "clinical indication" field were allocated into the aforementioned categories.

The information in the patient's records, which was recorded by the attending physician, was considered for the categorization of imaging tests according to the detected abnormalities, and radiological reports were not consulted directly. Alterations were classified as pulmonary and pleural abnormalities (e.g., parenchymal consolidations, infiltrates, atelectasis, pleural effusion and pneumothorax) or alterations in devices (e.g., selective bronchial intubation with endotracheal tubes, bent tubes, and malpositioned venous accesses). A category was also created for when the attending physician reported no abnormalities in test results.

The imaging tests were classified according to changes or the maintenance of medical conduct based on the obtained results. Changes in medical conduct were assessed according to clinical progress or the medical prescriptions that were recorded in the patient's records. This conduct was classified as pharmacological (administration of vasoactive or inotropic drugs, adjustments in sedoanalgesia, antimicrobial therapy and intravenous hydration) or ventilatory (adjustments in mechanical ventilation parameters). Tests that did not lead to changes in medical conduct were allocated in an independent group.

Chi-squared and Student's *t* tests were applied for statistical analysis using StatCalc software.

RESULTS

A total of 173 patients were admitted to the ICU at the HU/UFSC during the study period. Sixty-seven of these patients were not included in the study because they were admitted on weekends and holidays, or they spent less than 1 day in the ICU.

The sample included 106 patients (51.9% male) who were subjected to 447 imaging tests. Table 1 presents the demographic and clinical characteristics of the patients whose test results were assessed in the present study. The patients had a mean age of 54.4 years (range 18 to 88 years, standard deviation – SD=17.45). Hospital mortality was 34.9%. Thirty-seven patients from the study sample died (mean age of 61.5 years). The mean age of patients who were discharged from the ICU was 50.5 years ($p=0.001$). Table 1 also illustrates that hemodynamic support and

mechanical ventilation were the most common reasons for ICU admission. Patients between 40 and 60 years of age were the most prevalent during the study period. Among the assessed radiographs, 20.7% were abnormal. The smallest proportion of radiological findings occurred in patients who were older than 60 years of age (15.3%) Patients younger than 40 years of age exhibited the highest percentage of detected abnormalities on imaging tests (28.7%).

Table 1 - Clinical and demographic characteristics of the patients

Variables	N (%)
Male	55 (51.9)
Age	
Younger than 40 years	21 (19.8)
Between 40 and 60 years	44 (41.5)
Over 60 years	41 (38.7)
Need for admission into the ICU	
Hemodynamic support	38 (35.8)
Ventilatory support	33 (31.1)
Postoperative	28 (26.4)
Other causes	7 (6.7)
Length of stay in the ICU	
Less than 24 hours	29 (27.3)
Between 2 and 5 days	42 (39.6)
Between 6 and 10 days	14 (13.2)
More than 10 days	21 (19.9)

ICU – intensive care unit.

The majority (425 of 447) of imaging tests were anteroposterior chest radiographs with the patient lying on the bed. The remaining 22 tests were CT scans of the chest or skull, ultrasounds or radiographs other than anteroposterior chest radiographs. No MRIs were requested for the studied patients. Classifications and statistical analyses were performed on chest radiographs only because this test constituted approximately 90% of the performed tests.

An average of 4.01 radiographs per patient was obtained. Most of the radiographs (22.9%) were requested within the first 24 hours in the ICU, and a decrease in

the number of requests was observed as the number of days of hospitalization increased. Figure 1 illustrates the quantitative evolution of requests for radiographic tests according to the day of hospitalization.

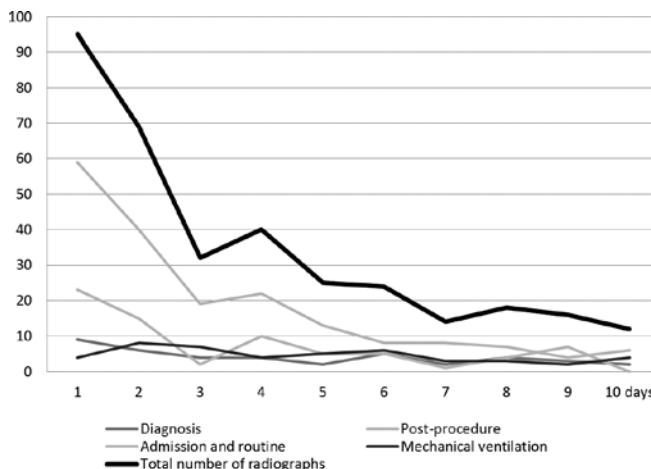


Figure 1 – Evolution of the number of radiographs requested according to indication and day of hospitalization.

Approximately half of the radiographs were requested for routine and admission checking, and 12.7% of the radiographs were requested for diagnosis.

Radiographic abnormalities that were or were not detected by the attending physician are presented in table 2. Most (68.5%) of the requested radiographs for diagnosis exhibited no detectable abnormalities, which was a statistically significant proportion compared to the requested radiographs for admissions control (p<0.05).

Table 3 presents a list the changes in medical conduct according to the observed radiographic abnormality. No changes in medical care were observed in 99.4% of the cases in which radiographic images were normal. Changes in medical care were observed in 69.2% of radiographs that exhibited pleuropulmonary alterations and 92.3% of radiographs that exhibited malpositioned devices. A statistically significant relationship between changes in medical care for normal and abnormal radiographs

Table 2 - Proportion of results according to clinical indication

Indication	Results of the radiographs requested				Total N (%)	p value
	Normal radiographs N (%)	Pleuropulmonary alterations N (%)	Malpositioned devices N (%)	Others N (%)		
Diagnostic investigation	37 (68.5)	13 (24.1)	4 (7.4)	-	54 (100)	<0.05
Inpatient monitoring						
After a procedure	77 (81.0)	12 (12.6)	5 (5.3)	1 (1.1)	95 (100)	NS
Admission and routine	173 (80.1)	37 (17.1)	3 (1.4)	3 (1.4)	216 (100)	NS
Mechanical ventilation	50 (83.3)	9 (15.0)	1 (1.7)	-	60 (100)	NS
Total	337 (79.3)	71 (16.7)	13 (3.1)	4 (0.9)	425 (100)	

NS - nonsignificant.

was observed ($p < 0.001$). Statistical significance in the abnormal categories was noted on radiographs that exhibited pleuropulmonary alterations ($p < 0.05$) and malpositioned devices ($p < 0.05$).

Table 3 - Medical conduct according to the radiographic alterations detected by the attending physician

Results	Maintained conduct N (%)	Changed conduct N (%)	Total	Statistical test (p value)
Normal radiographs	335 (99.4)	2 (0.6)	337	<0.001
Altered radiographs				
Pleuropulmonary alterations	29 (40.8)	42 (69.2)	71	<0.05
Malpositioned devices	1 (7.7)	12 (92.3)	13	<0.05
Others	1 (25)	3 (75)	4	NS
Total	366 (86.1)	59 (13.9)	425	

NS - nonsignificant.

DISCUSSION

Chest radiography is an indispensable tool that complements therapy in critically ill patients. However, the indiscriminate ordering of imaging tests, especially tests that are justified solely by a routine need, is considered inadequate by many authors, which supports the suspension of protocols that request daily radiological tests.^(5-7,9-11)

The demographic and clinical aspects in the present study outlined the population that is attended by the HU/UFSC. The mean age was over 50 years and admissions were primarily clinical. Higher mean ages have been reported in European^(5,7,10) and North American^(6,9) hospitals, which may be associated with the increased life expectancy in countries in the northern hemisphere.

Patients aged 40-60 years constituted the majority of patients with imaging tests in the present study sample, and this group exhibited the longest hospitalization in the ICU. Conversely, the majority of patients who were hospitalized for 2 to 5 days were older than 60 years of age. The majority of chest radiographs were requested for patients between 40 and 60 years of age. Patients in younger age groups exhibited a significantly lower hospital mortality rate. Fewer tests than average were requested for younger patients because they spent less time in the ICU. Fewer tests than average were also requested for elderly patients, and this may be because these patients spent less time in the ICU, died before other patients, and were discharged from the ICU to receive palliative care in the infirmary, and likely presented with a more serious clinical condition upon admission. Note that the latter reason is an assumption,

as no severity scores, such as the Acute Physiology and Chronic Health Evaluation II (APACHE), were assessed these patients.

The majority of radiographic examinations were requested within the first 5 days of ICU admission. A higher diagnostic uncertainty during this period can be presumed, and patients may have become "chronically critical" and required less investigation after 5 days of hospitalization; this is also an assumption because Sepsis Related Organ Failure Assessment (SOFA) was not performed in these patients. No studies were identified in the reviewed literature that would allow for a better discussion of these results.

The present study demonstrated that the majority of performed radiological tests were chest radiographs. This result may be due to the greater ease in the performance of the test, the obtaining of the film after the exam, the short interval of time between the test request and the results, and its low cost.⁽¹²⁾ All radiographs were performed using an anteroposterior incidence, which is not the gold standard for lung assessment, but it can be performed in severely ill patients who are confined to the bed and admitted to the ICU.⁽¹⁾

The results of the categorized tests in the present study demonstrated that most of the altered radiographs were requested for diagnostic investigation after admission to the ICU. Exams that were requested for patient monitoring during a hospital stay were mostly normal. Previous studies of sets of radiographs that are requested as part of the daily routine and following clinical justification reveal a significantly larger proportion of detected abnormalities in clinically indicated radiographs.^(9,10) Normal radiographic exams that are obtained after a medical procedure indicate that the procedure was appropriate. Graat et al.^(5,7) noted that the greater proportion of detected abnormalities for malpositioned devices on clinically indicated radiographs was not due to errors in technique but rather to the reduced size of the sample. In addition, the quality of radiological exams in the ICU may not be very good; Lucchesi et al.⁽¹⁾ explained that the poor quality of these tests is due to the patient position on the bed during the exam, the shorter distances between the film and the image focus, possible technical deficiencies of portable devices, and problems with the revelation of the radiographic film.

Interestingly, no changes in pharmacological or ventilatory conduct were performed following evaluations of normal and abnormal radiographs. Graat et al.⁽⁵⁾ revealed an increase in the percentage of therapeutic changes based on radiographic images after the abandonment of the daily chest radiograph protocols. The same result has been

demonstrated by Krivopal et al.,⁽⁹⁾ but patients were separated into distinct and simultaneous groups. Other studies have demonstrated the prevalence of nonpharmacological and nonventilatory interventions, such as mechanical adjustments of venous access, endotracheal tubes and feeding tubes, following radiographic examinations.^(6,10)

The clinical severity of critically ill patients and the need for invasive procedures and invasive ventilatory support requires a differentiated surveillance in these patients. Ventilator-associated pneumonia may be more difficult to assess, and it requires a series of clinical data to confirm the diagnosis. Chest radiographs do not present good specificity in these cases,^(13,14) and radiographs may only assist, but are not essential, for the evaluation of condition severity.⁽¹⁵⁻¹⁷⁾

The ICU at the HU/UFSC has no guidelines for the performing of daily radiographs on patients, even patients who undergo invasive procedures. This institution is a teaching hospital for both medical school and medical residency, and a greater number of requested tests would be expected for academic purposes and to better consolidate medical conduct.⁽⁴⁾ However, the medical literature indicates that this conduct does not demonstrate sufficiently significant clinical values, and the transition from the daily performance of radiographs to the ordering of clinically indicated radiographs does not produce higher mortality rates or longer stays in the ICU.⁽⁷⁾ The majority of requested biochemical tests are not associated with prognosis or relevant changes in medical conduct.⁽⁴⁾ Complementary tests, including laboratory and imaging tests, are the third largest source of expenditures in the ICU,⁽¹⁸⁾ and viable alternatives and simpler measurements should be created to optimize budgets, time and medical care. The adoption of more trustworthy and faster complementary tests⁽¹⁹⁻²³⁾ and conduct⁽²⁴⁻²⁶⁾ that avoids the routine ordering of chest radiographs has been recommended.

The small number of assessed radiographic exams is a limitation of the present study. One justification is the small number of patients that were included in the sampling period. The difference between the number of patients who were admitted during the proposed period of study (n=173) and those patients who were non-consecutively included in the study sample (n=106) should be noted. This difference may have been due to the profile of the patients who were admitted to the sector. Many of these patients were transferred from other hospitals, and some patients remained in the ICU less than 24 hours. Another negative factor was that activities, such as physical therapy maneuvers and the traction of tubes and venous accesses for better positioning, were not included in the medical conduct group. Official reports, which would allow for

greater safety in the adoption medical conduct, are not requested from radiologists in the studied ICU service. However, Chambliss et al. have demonstrated significant agreement between radiographic interpretations from radiologists and intensivists pediatricians.⁽⁸⁾

CONCLUSION

The majority of the chest radiographs that were performed in critically ill patients in the ICU revealed no clinical abnormalities, and most of the radiographs that were considered abnormal by the attending intensivist did not produce changes in medical conduct.

Author contributions: Gustavo Catalan Ruza conducted data collection, and composed and wrote the draft of the article. Rachel Duarte Moritz contributed to the text review, statistical analyses and the formulation of conclusions. Fernando Osni Machado contributed to the research methodology and data interpretation.

RESUMO

Objetivo: Verificar a prevalência de alterações clínicas nas radiografias de tórax e sua relação com a tomada de decisões em terapia intensiva.

Métodos: Coorte prospectiva, que envolveu pacientes internados não consecutivamente na unidade de terapia intensiva do Hospital Universitário Professor Polydoro Ernani de São Thiago, da Universidade Federal de Santa Catarina. Entre os meses de fevereiro e maio de 2011, foram avaliados diariamente os exames de imagem solicitados na unidade de terapia intensiva, sendo divididos conforme a razão de internação, o tipo de exame solicitado, o segmento anatômico estudado e a finalidade da solicitação. Posteriormente, segundo interpretação do médico intensivista, os exames foram divididos segundo alteração detectada e mudança em conduta médica. A análise estatística foi feita segundo o teste do qui-quadrado.

Resultados: Foram envolvidos 106 pacientes pela amostragem. Foram avaliados 447 exames de imagem, sendo 425 radiografias de tórax em incidência anteroposterior. Obteve-se média de 4,01 radiografias por paciente internado. Dentre as radiografias solicitadas, 79,3% foram interpretadas como normais. Das radiografias alteradas, 35,2% não suscitaram alteração em conduta.

Conclusão: A maioria das radiografias solicitadas e realizadas na unidade de terapia intensiva não apresentou alterações clínicas estatisticamente relevantes, e as que demonstraram alterações não necessariamente propiciaram mudança em conduta.

Descritores: Terapia intensiva; Radiografia torácica; Testes diagnósticos de rotina

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