Cost Containment in the Intensive Care Unit: Chest Roentgenograms

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Citation

G Diaz-Fuentes, R Rosen, L Menon. *Cost Containment in the Intensive Care Unit: Chest Roentgenograms*. The Internet Journal of Pulmonary Medicine. 2004 Volume 5 Number 2.

Abstract

This was a prospective control study to evaluate the effect of guidelines for obtaining CXR in a medical intensive care unit (MICU) and its effect on cost reduction. During the intervention period CXRs were done following guidelines compared to daily CXRs in the control period. Portable CXR cost was estimated at $22.

Results: 4.18 and 2.34 CXRs were done per patient in the control and study group respectively, with a cost saving of $42 per pt. With approximately 1200 yearly admissions, this would represent a savings of $50,361 per year. No differences were observed in complications or outcome in both groups. Conclusions: Adherence to guidelines for ordering CXR in the MICU seems to be a safe and a cost saving practice. Each MICU should determine the frequency of routine CXRs for their specific population. The use of these guidelines should be done in conjunction with other measures to reduce cost.

INTRODUCTION

Control of health care costs and improvement of clinical outcomes are laudable goals for medical intensive care units (MICU). Development and use of practice guidelines help to decrease the variation in treatments between providers, patients with similar disorders, improve efficiency and quality of care. CXR is one of the most frequent tests ordered in any MICU. Critically ill patients have frequent portable CXRs done in order to monitor changes in cardiopulmonary anatomy, status, or complications due to mechanical devices ([1]). However, the usefulness of the routine CXR for daily monitoring of these patients is less clear and the cost-effectiveness of this practice has not been confirmed. The purpose of this project was to develop and implement clinical practice guidelines for CXR in the MICU in a inner city teaching hospital and to evaluate their impact for a four week period.

Methods: Bronx Lebanon Hospital is a 350-bed tertiary teaching hospital with a twenty-one-bed MICU. House staff provide care under the supervision of the Service attending. At the time of the study the unit was not a closed unit. Routine daily CXR has been the policy for each patient. The films are reviewed during morning rounds and used to plan the management for each patient.

This was a prospective study done between October and November of 1996. There was an initial four weeks control period followed by four weeks of study period where the guidelines for CXR were implemented. All the CXR and medical records during the control and the study period were evaluated by a MICU attending.

The guidelines' development team consisted of one radiologist and three MICU attending physicians. The indications to order CXR during the study were as follows:

a) Insertion of central venous line, pulmonary artery catheter or intra-aortic balloons,
b) Endotracheal, tracheostomy or chest tube insertion,
c) Hypoxemia or hemodynamic instability of unexplained etiology,
d) Post cardio-pulmonary resuscitation,
e) If the patient did not have any of the above indications, CXRs were obtained twice a week in mechanically ventilated patients. All patients had an admission CXR unless one had been done in the 12 hours prior to admission and no changes were noted in their clinical condition

Teaching sessions for house staff and nurses and dissemination of a pocket version of the guidelines were done to facilitate implementation.

Portable Chest films: In order to arrive at a conservative estimate of cost of each portable chest film the cost for each

of the following factors was considered:

a) Film (assuming single AP projection)
b) Processing
c) Technologist time for the radiology department and portable film
d) Clerical and file room staff
e) Radiologist interpretation
f) Distribution and charting of reports

Capital depreciation and other overhead costs were not included. Accepting the fact that all calculations of this type are very rough and, to a degree, dependent on the institution in which the studies are performed, the cost of a CXR in the department at our institution is approximately $16 compared with $22.85 for the portable film. The difference in cost between a portable and department study relates to the cost of a technologist, since technologist time is the only variable. Possible additional cost related to the need to repeat examinations for unsatisfactory films is not being considered in this study..

RESULTS

There were 76 patients in the control period and 102 patients in the study period; the mean age was 47 and 49 in the control and the study period respectively. The indications for MICU admission and outcome can be seen in table 1.

Figure 1

Table 1: ICU Admitting Diagnosis and Mortality

Diagnosis	Control n=76 (%)	Study n=102 (%)
Pulmonary	39 (51 %)	40 (39 %)
Septic Shock	7 (9 %)	15 (15 %)
Neurologic	13 (17 %)	16 (16 %)
Cardiac	4	9
Metabolic	2	5
ESRD/RF	2	3
Others	9 (12%)	14 (14%)
Mortality	10 (13%)	24 (24%)

ESRD, end stage renal disease; RF, renal failure

Pulmonary diseases followed by neurological diseases were the most common admitting diagnosis in both groups. During the study period more patients were admitted with septic shock than in the control period (15 % vs. 9%). There was a trend for higher mortality in the study group; nearly half of the patients that died in both groups, died in the first 48 hours of admission.

The indications for CXR in each group can be seen in table 2. As expected, more CXR were obtained in the control group. The reduction in CXRs in the control group was due mainly to less routine CXRs. This remained significant despite a higher number of CXR ordered post- procedures.

Figure 2

Table 2: Indications for chest roentgenograms

Variable	Control	Study
PROCEDURES (TOTAL)	56 (18%)	102 (43%)
CVP/SG/IABP	29	51
Intubation/Tracheostomy	15	35
Thoracentesis/CT	7	14
FOB	5	2
Post CP arrest	1	2
Change in condition	1	10
Admission without CXR	60 (19 %)	92 (38 %)
Routine-daily vs. bi-weekly	200 (63 %)	33 (14 %)
TOTAL CXRs	318	239

CVP: central venous pressure; SG: Swan Ganz; IABP: intraaortic balloon pump; CT: chest tube; FOB: fiberoptic bronchoscopy; CP: cardiopulmonary.

Evaluation of those patients on mechanical ventilation (MV) in each group and CXR requirements shows that the proportion of patients on MV was similar in both group. As expected, majority of CXR were obtained in mechanical ventilated patients.

Cost for CXR was calculated and can be seen in table 3.

Figure 3

Table 3: Number and cost of chest roentgenograms

Variable		Control n=76 (%)	Study n=102 (%)
Number of Patients on MV		45 (59 %)	57 (56 %)
CXR	TOTAL CXRs	318	239
	On MV patients	228	191
	Non-MV patients	90	48
CXR	Per patient (TOTAL)	4.18	2.34
	Per patient on MV	5.06	3.35
	Per patient non-MV	2.90	1.06
Cost CXR	TOTAL Cost	$7,266.30	$5,461.15
	Cost Per patient	$95.50	$53.45

MV: mechanical ventilation

The estimated cost of a portable CXR was calculated to be $22.85 at our institution. During the study period there was a cost saving of 1.84 CXRs/per patient ($42 per patient).

The length of the stay (LOS) in the MICU was similar for patients in the control and the study period. The mean LOS for intubated patients in the control period was 7.26 days (range 1-24 days) compared with 7.3 days (range 1-25 days) in the study period. Non-ventilator patients had a shorter LOS, 3.45 days (range 1-10 days) for the control group versus 3 days (range 1-8 days) for the study group.

There was no change in management in those patients undergoing daily versus non routine CXR. See table 4.

Figure 4

Table 4: Indications for CXR and Impact on management

Indications for CXR	Control	Study
Routine	200 daily CXR	33 Bi-weekly CXR
Change in management	20 (10%)	5 (15%)
Change in condition	2	12
Change in management	1(50%)	2 (16%)
Post procedures	56	102
Change in management	7 (13%)	8 (8%)
Admission CXR	60	92
Total x-rays	318	239
Length of Stay	7.26 days	7.3 days

All those patients that had CXRs done for acute change in condition or as routine daily or bi-weekly CXR and required change in management were on mechanical ventilation. Post procedural CXRs findings in both groups that triggered a management change were all related to a reposition of an invasive device.

DISCUSSION

The usefulness of daily routine CXR in the intensive care unit is debatable. The increasing cost of medical care led us to evaluate the necessity for daily routine chest films. Several investigators ([1,3,5,6,8]) have suggested that routine daily CXRs are valuable and have an impact in the management of patients, especially those requiring mechanical ventilation or suffering from unstable cardiopulmonary diseases. Unsuspected radiological findings have been reported in 20 to 65% of routine CXRs ([4, 6]).

Strain et al ([3]) evaluated 507 daily routine CXRs in an ICU setting; 15% revealed an unsuspected abnormality leading to changes in the management in 93% of those patients. Bekemeyer et al reported that of 716 routine CXRs performed in a respiratory ICU, 9.9% demonstrated abnormalities which prompted further diagnostic procedures and 18% led to changes in therapy. Another study evaluating the effects and net cost of routine CXRs in an ICU concluded that the routine of daily chest films is effective and cost saving ([8]). In this study there were 80 findings in 72 routine CXRs that prompted an action in 20 of the findings. Two of the 20 actions represented a potentially life threatening condition (reposition of an endotracheal tube). The cost saving was predicted on the basis of the increase in the length of ICU stay due to delay in the detection of radiological abnormalities.

The value of post-procedural chest-x-rays was evaluated by Gray et al ([7]) and supported the need for routine films after endotracheal intubation and multi lumen catheter insertion. Tarnoff et al ([2]) evaluated the value of post-tracheostomy CXRs; 4% of 220 CXRs revealed new findings with no patient requiring change in management.

Three newer studies ([9,10,11]) looking at the utility of routine CXRs and the effect of a reduction in the use of routine CXRs in the ICU setting revealed that the practice of daily CXRs in the ICU, including those patients on mechanical ventilation is not justified. They did not find any differences in length of stay, outcome, morbidity or mortality.

Our results support the need of post-procedural CXRs. Thirteen and eight percent of the post-procedural CXRs in the control and the study period respectively revealed misplacement of invasive devices that could be potentially life threatening. We recommend that admission and post procedural CXRs should still be done. Most of the cost saving can be achieved by changing the practice of daily CXRs to a more patient specific requirement. If we look only at the differences in number of chest films done for routine daily versus bi-weekly in the control versus study group, those patients in the control group got at least three times more CXRs that those in the study group.

The incidence of new findings that required change in management was significantly lower that the one reported by Krivopal et al, 26% versus 15% ([10]). This could be attributed to the fact that in our study we did biweekly CXRs as a “new routine” evaluation of the patients.

We conclude that changing from the daily routine chest film to a more patient centered practice will not only help in the cost savings for the patients and the institutions but will be more in keeping with practice of evidence based medicine. The use of a 48 to 72-hours interval for radiological examination could be a safe practice in patients who are relatively stable. Those patients with stable cardiopulmonary status and not requiring mechanical ventilation could have CXRs done at a longer time interval.

In our MICU, with an annual admission rate of 1200-1500 patients this could represent a potential saving of ~ $50,361. We continue to recommend the post procedural film to evaluate position of invasive devices. In this price sensitive, managed care environment, simple cost cutting measure such as reported in this study, and re assessment of so called

routine tests and medications can help in easing financial pressures especially in teaching hospitals.

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