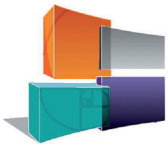
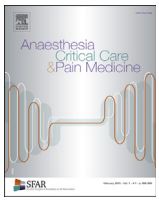
Anaesth Crit Care Pain Med 34 (2015) 41–44



SFAR
Société Française d'Anesthésie et de Réanimation



Original article

Implementation of lung ultrasound in polyvalent intensive care unit: Impact on irradiation and medical cost

L. Zieleskiewicz [a,*], A. Cornesse [a], E. Hammad [a], M. Haddam [a], C. Brun [a], C. Vigne [a], B. Meyssignac [a], A. Remacle [b], K. Chaumoitre [c], F. Antonini [a], C. Martin [a], M. Leone [a]

[a] Department of anesthesiology and critical care medicine, Nord hospital, AP–HM, Aix Marseille university, Marseille, France
[b] Department of medical informatics, Nord hospital, AP–HM, Aix Marseille university, Marseille, France
[c] Department of radiology, Nord hospital, AP–HM, Aix Marseille university, Marseille, France

ARTICLE INFO

Article history:
Available online 5 March 2015

Keywords:
Radiograph
Computed tomography scan
Ultrasound
Lung
Critical care

ABSTRACT

Objective: To determine the effect of implementing a daily lung ultrasound round on the number of chest radiographs and chest computed tomography (CT) scans in a polyvalent intensive care unit (ICU).
Study design: Retrospective study comparing two consecutive periods.
Patients: All patients hospitalized for longer than 48 hours in a polyvalent ICU.
Methods: Implementation of a daily lung ultrasound round after a short educational program. The number of chest radiographs and chest CT scans and the patient outcome were measured before (group PRE) and after (group POST) the implementation of a daily lung ultrasound round.
Results: No demographic difference was found between the two groups, with the exception of a higher severity score in the group POST. For each ICU stay, the number of chest radiographs was 10.3 ± 12.4 in the group PRE and 7.7 ± 10.3 in the group POST, respectively ($P < 0.005$) The number of chest CT scans was not reduced in the group POST, as compared with the group PRE (0.5 ± 0.7 CT scan/patient/ICU stay versus 0.4 ± 0.6 CT scan/patient/ICU stay, $P = 0.01$). The ICU mortality was similar in both groups (21% versus 22%, $P = 0.75$)
Conclusion: The implementation of a daily lung ultrasound round was associated with a reduction in radiation exposure and medical cost without altering patient outcome.

Diagnosis imaging is a frequent procedure in intensive care unit (ICU). The large prescription of chest radiographs is associated with increased radiation exposure [1–3]. The recourse to computed tomography (CT) scans exposes to potential harmful mobilization [4]. Restrictive use of chest radiographs was associated with better diagnostic and therapeutic efficacies without affecting outcome [5–7]. Lung ultrasound provides more information than chest radiographs [8–13]. Its performance is close to that of chest CT scan, without radiation exposure [8,10,14]. In ICU, the introduction of lung ultrasound has been associated with a reduced use of chest radiographs [15].

Clinicians are sometimes reluctant to abandon daily routine chest radiograph. The loss of information is a concern explaining the broad use of chest radiograph. We hypothesized that the routine use of a daily lung ultrasound round may have resulted in a decrease of chest radiograph prescription, without affecting the patient outcome. The first goal of our study was to determine the effect of a daily bedside ultrasound round on the number of chest radiographs. The secondary goal was to assess the effect of this procedure on the number of CT scan and medical cost.

1. Materials and methods

We conducted a retrospective study in a 15-bed-ICU of a tertiary hospital (928 beds). According to the French legislation (articles L. 1121-1 paragraph 1 and R. 1121-2, Public Health Code), informed consent and approval by the Ethics Committee were waived due to the retrospective nature of the study. All the patients

* Corresponding author.
E-mail addresses: laurent.zieleskiewicz@ap-hm.fr (L. Zieleskiewicz), aline.cornesse@gmail.com (A. Cornesse), emmanuelle.hammad@ap-hm.fr (E. Hammad), malik.haddam@ap-hm.fr (M. Haddam), clement.brun@ap-hm.fr (C. Brun), coralie.vigne@ap-hm.fr (C. Vigne), bertrand.meyssignac@ap-hm.fr (B. Meyssignac), anne.remacle@ap-hm.fr (A. Remacle), kathia.chaumoitre@ap-hm.fr (K. Chaumoitre), francois.antonini@ap-hm.fr (F. Antonini), claude.martin@ap-hm.fr (C. Martin), marc.leone@ap-hm.fr (M. Leone).

http://dx.doi.org/10.1016/j.accpm.2015.01.002
2352-5568/

with an ICU stay > 48 hours hospitalized from May 1, 2011 to May 1, 2012 were included in the study. A before/after model was applied to a cohort of patients hospitalized in ICU for longer than 48 hours, as following:

- in group PRE, we included the patients admitted to the ICU from May 1, 2011 to October 31, 2011. During this period, lung ultrasound was an uncommon practice in our ICU. The team member did not receive a specific training about this procedure. With respect to chest radiographs, the system was based on an on-demand practice without strict written protocol to monitor the prescriptions. Chest CT scans were performed on the decision of the senior physician (Fig. 1);
- in group POST, we included the patients admitted to the ICU from November 1, 2011 to May 1, 2012. During this period, the residents were briefly trained by ultrasound certified physicians. This training consisted on a 2-hours theoretical lecture [16–20]. At the bedside, about 20 lung ultrasound exams were then performed under the supervision of a senior. The signs related to normal lung, interstitial syndrome, lung consolidation, pneumothorax and pleural effusion were identified. After this training, on a daily basis, a resident was affected to a "lung ultrasound round". During this round, she or he performed an on-demand lung ultrasound exam as requested by her or his senior physician.

The ultrasound findings were reported to the senior physicians during the daily round. With respect to chest radiographs and CT scans, no protocol was implemented in the ICU about diagnosis imaging (Fig. 1).

The lung was examined in semi-seated position with an abdominal probe (C5-1, Philips CX 50 CompactXtreme [Philips Medical systems™, Suresnes, France]). Twelve lung regions were assessed in each patient, and the Lung Ultrasound Score was calculated [19]. Pleural effusion, interstitial syndrome, pneumothorax and consolidation were identified during the ultrasound examination. All the findings were collected in a dedicated electronic database. Chest radiographs and CT scans were still prescribed on-demand. Radiographs that were performed from 8:00 (am) to 10:00 (am) and on admission were considered as routine chest X-rays. Other radiographs were considered as unscheduled chest X-rays. Physicians were unaware of the study. Thus, the study measured the effect of ultrasound implementation on chest radiograph prescription without implementing effective guidelines.

We extracted from our database the following variables: age, sex, simplified acute physiology score (SAPS) II, reason for admission, mechanical ventilation duration, duration of ICU stay, duration of hospital stay, ICU mortality, and hospital mortality. The number of chest radiographs, the features of chest radiographs (emergent or elective), and the number of chest CT scans were collected.

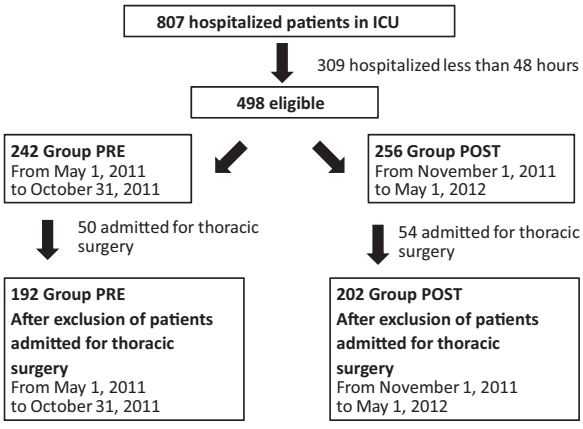


Fig. 1. Study flowchart. ICU: intensive care unit.

Statistical analysis was performed using R software version 2.13. Univariate analysis of before/after data was performed using Mann–Whitney and Chi^2 tests. Data are expressed as medians and interquartiles or means and standard deviations. A value of P below 0.05 defined the significance. As chest radiographs or chest CT scans were often directly demanded by thoracic surgeons for personal use, a subgroup analysis was conducted after excluding the patients undergoing ICU after thoracic surgery.

2. Results

As show in the flow chart of the study, 498 patients met the criteria for inclusion (Fig. 1). Medicine, surgery, and trauma were the causes of admission in 46%, 19%, and 35% of the cases, respectively The demographic features were similar in the two groups, with the exception of SAPS II (Table 1). The durations of mechanical ventilation, ICU stay, and hospital stay did not differ in the two groups. The ICU mortality rate was 21% in the group PRE, as compared with 22% in the group POST ($P = 0.75$) (Table 1).

For each ICU stay, the absolute number of chest radiographs was 10.3 ± 12.4 in the group PRE and 7.7 ± 10.3 in the group POST, respectively ($P < 0.0005$) (Table 2). The effect was maximal in the last quarter (Fig. 2). Of note, the absolute number of unscheduled chest radiographs was similar in both groups (3.7 ± 3.9 *vs.* 3.4 ± 3.5, $P = 0.27$). With respect to chest CT scan, the number of procedures change 0.5 ± 0.7 CT scan/ICU stay in the group PRE to 0.4 ± 0.6 CT scan/ICU stay in the group POST ($P = 0.01$) (Table 2).

After exclusion of 104 patients admitted to the ICU after thoracic surgery, the absolute number of chest radiographs (for

Table 1
Characteristics of patients and outcome.

Variables	PRE ($n = 242$)	POST ($n = 256$)	P
Age (years)	54 [38–66]	56 [41–69]	0.11
Male (%)	182 (75)	177 (69)	0.15
SAPS II	32 [22–44]	36 [26–49]	0.005
Admission diagnosis, (%)			
Trauma patient	96 (40)	79 (31)	0.01
Surgical patient	51 (21)	41 (16)	0.01
Medical patient	95 (39)	136 (53%)	0.01
Duration of ICU stay (day)	5 [3–11]	5 [3–10]	0.5
Duration of hospital stay (day)	20 [10–33]	18 [10–31]	0.72
Duration of mechanical ventilation (day)	1 [0–6]	2 [0–7]	0.09
ICU mortality (%)	51 (21)	58 (22)	0.75
Hospital mortality (%)	62 (25)	71 (27)	0.66

Results are expressed as median and interquartiles or absolute number and percentage. SAPS: simplified acute physiology score; ICU: Intensive care unit; PRE: before daily lung ultrasound implementation; POST: after daily lung ultrasound implementation.

Table 2
Number of chest radiographs and computed tomography (CT) scan during the intensive care unit (ICU) stay according to the study period (PRE: before daily lung ultrasound implementation; POST: after daily lung ultrasound implementation).

	PRE ($n = 242$)	POST ($n = 256$)	P
Number of chest radiograph/ICU stay	10.3 ± 12.4	7.7 ± 10.3	< 0.0005
Number of unscheduled chest radiograph/ICU stay	3.7 ± 3.9	3.4 ± 3.5	0.27
Number of chest CT scan/ICU stay	0.5 ± 0.7	0.4 ± 0.6	0.01

Results are expressed as mean and standard derivation.