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ORIGINAL INVESTIGATION

Full-Time ICU Staff in the Intensive Care Unit: Does It Improve the Outcome?

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Abstract

OBJECTIVES: Patients with various severities are cared for in the intensive care unit (ICU) by an experienced ICU physician. We aimed to assess whether there is any difference in intubated ICU patient management when undertaken by a 24-hour intensivist versus a periodic experienced specialist in the ICU.

MATERIAL AND METHODS: A retrospective, cross-sectional, observational study was done in a tertiary teaching hospital ICU. Patients receiving invasive mechanical ventilation (IMV) were classified into: group 1, managed by an experienced ICU pulmonary specialist during night shifts in 2006-2007, and group 2, managed by an intensivist around the clock in 2011. Patients were excluded if they were <18 years old, tracheostomized, or transferred from another ICU. Patient demographics and ICU data (IMV duration, sedation doses and duration, weekend extubation, ICU severity score [APACHE II], length of ICU stay, and mortality) were recorded, and groups were compared.

RESULTS: In group 1, 131 of 215 IMV patients were included in the study, and in group 2, 294 of 374 patients were included. The sedation infusion rate, duration of IMV, self-extubation rate, and lenght of stay (LOS) of ICU were significantly increased in group 1 compared with group 2 (72.5% vs. 40.8%, $p<0.0001$; 152 vs. 68 hours, $p<0.001$; 24.4% vs. 13.9%, $p<0.006$; 13 vs. 8 days, $p<0.0001$, respectively). The weekend extubation rate and APACHE II scores were significantly lower in group 1 compared with group 2 (7.1% vs. 25.3%, $p<0.0001$; 22 vs. 25, $p<0.017$, respectively). Mortality rates were similar in the two groups (35.9% vs. 37.4%, $p=0.76$).

CONCLUSION: A 24-hour intensivist appears to be better for decreasing IMV duration and LOS in the ICU. These results may be useful to address decreasing morbidity and, as a result, cost of ICU stays by 24-hour intensivist coverage, especially for patients with IMV.

KEY WORDS: Twenty-four-hour intensivist, length of ICU stay, mortality

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INTRODUCTION

The intensive care unit (ICU) is available 24 hours a day, 7 days a week (24/7) for admission of critically ill patients. The importance of the 'golden' hours for initial assessment and timely management of critically ill patients in the ICU is well known. The 24-hour availability of an intensivist may result in more prompt and accurate diagnostic evaluation and appropriate therapeutic decisions.

The models of organization and management of ICUs are different in several countries, and even from hospital to hospital, there is a large difference with respect to training [1]. There is a controversial approach to mandatory 24-hour versus on-demand intensivist staffing [2,3].

Several studies suggest that an around-the-clock intensivist improves ICU outcomes with respect to decreased morbidity and mortality [4-8]. However, this around-the-clock intensivist model is expensive due to the shortage of intensivists [9-11], although it has been shown to be better for the intensivist with respect to decreasing 'burnout' [12]. We proposed that this model might be more relevant in intubated patients with acute respiratory failure and undergoing invasive mechanical ventilation (IMV).

We selected IMV management in critically ill patients to show the importance of 24-hour intensivist presence in the ICU. We compared the 24-hour intensivist with the standard model of ICU staffing in the management of IMV and ICU outcomes. We hypothesized that the use of sedation, duration of IMV, and ICU length of stay (LOS) would be less with intubated patients with 24-hour intensivist staffing, compared with periodic intensivist presence in the ICU.

This study was presented as a poster at the 23th ERS Annual Congress, 2013 European Respiratory Journal; P2447, September 2012, Barcelona, Spain.

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MATERIAL AND METHODS

Study Design

This retrospective cross-sectional observational study was done in a tertiary teaching hospital medical level III ICU.

ICU Management

From January 2006 to December 2007, a 10-bed ICU was managed by four intensivists (pulmonary specialists) during the day on weekdays. Twenty-two night shifts were conducted by 11 pulmonary specialists who were trained with at least 1 month in the ICU, and eight nightshifts were conducted by four intensivists. Further ICU management is summarized in Figure 1.

After January 2011, our working model was changed to 24-hour intensivist presence implemented by shift work for a 22-bed medical level III ICU (Figure 1). The same pool of intensivists supplied the day and nightshifts.

Patient Selection

Patient selection, exclusion criteria, and stratification are summarized in Figure 2 as a flowchart. We included all consecutive eligible IMV patients and grouped patients from 2006-7 as group 1 and those from 2011 as group 2.

Variables

The primary outcome variable in the ICU was mortality, and secondary outcomes were the need for sedation, duration of IMV, and ICU LOS. The primary exposure variable was 24-hour intensivist coverage in the ICU.

Causes of acute respiratory failure were defined as exacerbation of COPD [13], pneumonia [14], heart failure (acute cor pulmonale, acute left-sided heart failure) [15,16], post-resuscitation, tracheal stenosis, and others (pulmonary embolism, pneumothorax, acute cerebrovascular events, trauma, interstitial pulmonary fibrosis, and destroyed lung). Also, severe sepsis/septic shock [17], acute respiratory distress syndrome (ARDS) [18], postoperative acute respiratory failure [19], and acute renal failure were recorded as comorbid conditions.

The Acute Physiological and Chronic Health Evaluation (APACHE) II score was used as an ICU severity index [20].

Potential confounders in patients with IMV are summarized in Figure 2.

Mechanical Ventilation and Sedation

After intubation due to respiratory failure, mechanical ventilation management was performed using conventional methods. The decision over need for sedation was based on patient-ventilator asynchrony and agitation, with an increased risk of self-extubation. Sedation was done by intermediate doses or infusion of midazolam 0.02-0.1 mg/kg/h, propofol 1-3 mg/kg/h, and fentanyl 0.7-10 mcg/kg/h. If intermediate doses were needed more than every hour, infusion was initiated. The Richmond Agitation Sedation Scale (RASS) was used for infusion and assessment of the daily need for sedation [21]. After cessation of sedation and meeting the extubation criteria, patients were extubated after a successful 30-min spontaneous breathing trial [22]. If the patient extubated himself without a physician decision, we defined this as self-extubation. Post-extubation failure was defined by previous guidelines based on clinical criteria [22].

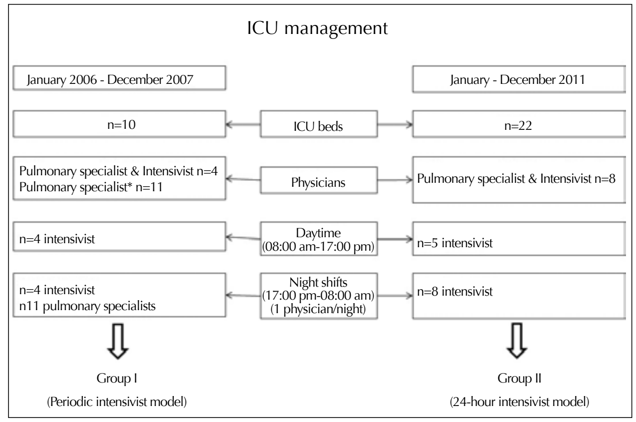

Figure 1. Intensive care unit organization

*Trained at least one month at the ICU

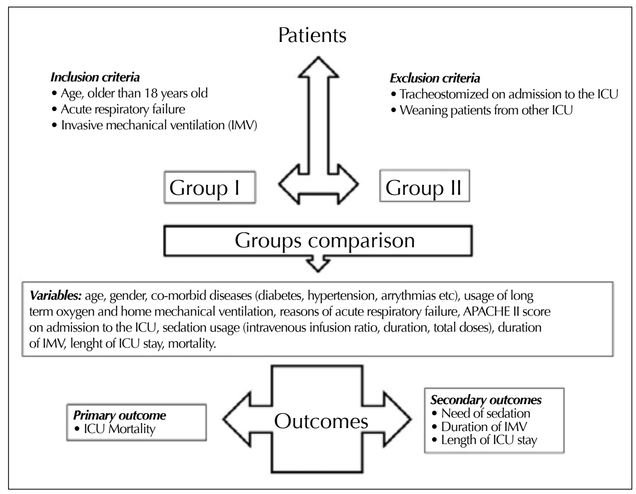

Figure 2. Flowchart of study subject involvement and stratification of groups

Statistical Analysis

Descriptive analyses were used for patient demographics and ICU data. Groups were compared with the Mann-Whitney U-test for non-parametric continuous variables and the chi-square test for dichotomous variables. The median and interquartile ratio were used for continuous variables. Count and percentage were used for non-parametric values. Parametric values were defined as the mean (plus or minus standard deviation). P value <0.05 was accepted as statistically significant.

RESULTS

In the study period, 131 patients in group 1 (periodic intensivist) and 294 patients from group 2 (24-hour intensivist) were included into the study. Patient demographics, comorbid diseases, domiciliary long-term oxygen, and ventilator use are summarized in Table 1. Age and gender did not differ between the two groups.

Patients in the two groups were compared according to the reasons for acute respiratory failure on admission to the ICU and comorbid conditions (Table 2). COPD exacerbation,

Table 1. Patients demographics

	Group 1 (n=131)	Group 2 (n=294)	p values
Gender, male/female	89/42	196/98	0.80
Age, years, median (IQR)	67 (58-73)	70 (58-76)	0.95
Domiciliary oxygen therapy, n (%)	34 (26)	107 (36.4)	0.035
Domiciliary ventilator therapy, n (%)	9 (6.9)	39 (13.3)	0.054
Comorbid diseases, n (%)	125 (95.4)	283 (96.3)	0.68
COPD/asthma	82 (62.6)	154 (52.4)	0.14
Cancer	23 (17.6)	44 (14.9)	0.50
Cor pulmonale	55 (42.0)	92 (31.3)	0.032
Diabetes mellitus	18 (13.7)	71 (24.1)	0.015
Hypertension	40 (30.5)	138 (46.9)	0.002
Atrial fibrillation	25 (19.1)	72 (24.5)	0.22
Coronary artery disease	15 (11.5)	70 (23.8)	0.003
Cerebrovascular disease	5 (3.8)	24 (8.2)	0.14

IQR: interquartile ratio; COPD: chronic obstructive pulmonary disease

Table 2. Causes of respiratory failure and comorbid conditions

Causes of respiratory failure, n (%)	Group 1 (n=131)	Group 2 (n=294)	p values
Acute exacerbation of COPD/asthma	33 (25.1)	36 (12.2)	0.001
Pneumonia	75 (57.3)	186 (63.3)	0.24
Heart failure	2 (1.5)	18 (6.1)	0.046
Post-resuscitation	9 (6.8)	22 (7.4)	0.82
Tracheal stenosis	6 (4.5)	2 (0.6)	0.012
Others	6 (4.8)	30 (10.4)	-
Comorbid conditions, n (%)			
Severe sepsis	114 (87.0)	265 (90.1)	0.34
Septic shock	25 (19.1)	104 (35.4)	0.001
Acute renal failure	38 (29.0)	97 (33.0)	0.42
ARDS	12 (9.2)	41 (13.9)	0.17
Postoperative ARF	19 (14.5)	29 (9.9)	0.024

COPD: chronic obstructive pulmonary disease; ARDS: acute respiratory distress syndrome; ARF: acute respiratory failure; Others (group 1/group 2): pulmonary embolism (2/4), pneumothorax (2/5), acute cerebrovascular disease (1/5), trauma (1/3), end-stage interstitial fibrosis (0/8), destroyed lung (0/5)

tracheal stenosis, and postoperative respiratory failure were significantly higher in group 1 compared with group 2 (P values were 0.001, 0.012, and 0.024, respectively). Although there were similar rates of severe sepsis in the two groups, the septic shock rate was significantly higher in group 2 (p=0.001) (Table 2).

Table 3 summarizes the ICU data from the two groups. The duration of mechanical ventilation and ICU LOS were significantly lower in group 2 than in group 1 (p values were 0.001 and 0.0001, respectively). The rates of midazolam and fentanyl were significantly lower in group 2 than in group 1 (p values were 0.0001 and 0.0001, respectively). Although similar mortality rates were seen in the two groups, APACHE II score on admission to the ICU was higher in group 2 (p=0.017).

DISCUSSION

In the present study, implementation of 24-hour intensivist staffing appeared to result in a significant decline in IMV duration and length of stay in the ICU, despite a similar mortality rate.

These results provide further evidence that a 24/7 intensivist can dynamically manipulate the ventilator settings 24 hours a day to shorten IMV duration. This has been indicated in other studies comparing ICU management with an intensivist-directed (closed model) versus open model [22,23]. In the open model, patients are cared for by primary physicians, with or without the assistance of intensivists. In this system, it became evident that there were too many doctors giving too many orders-hence, creating a chaotic environment for the nurses. However, in the closed ICU model, patients were treated primarily by intensivists, and this type of management appeared to shorten the length of mechanical ventilation [24]. Very recently, Wise and coworkers showed that the intermediate severity of patients with IMV had a significantly shorter ICU LOS when the ICU was intensivist-directed as opposed to primary physician-directed (7.2 versus 10.6 days, respectively) [24]. In the present study, more severe ICU patients with IMV had a significantly shorter ICU LOS with the 24-hour intensivist model than with the periodic one (8 versus 13 days, respectively). The duration of IMV and ICU stay depend mainly on the severity of the patients' clinical status and the use of sedation. Kress and colleagues showed that the overuse of sedation in patients with IMV can prolong MV duration in the ICU [25]. They found that daily interruption of sedatives significantly decreased the MV days when compared with continuous infusion of sedative (4.9 versus 7.3 days, respectively) [25]. In the present study, the percentage of patients with continuous sedative drug infusion was significantly lower in the group with a 24-hour intensivist than in the group with a periodic intensivist (40.8% versus 72.5%).

Twenty-four-hour intensivist coverage of an ICU allows the intensivist to continuously make important decisions on patient management, such as changing medication, quitting sedation, and extubation. These are especially important in the 'off hours' (4:00 PM to 08:00 AM and the weekend) in the ICU [26]. In one study, the authors stated that implementation of the weaning process on weekends shortened sedation usage and IMV duration [27]. In the present study, the percentage of weekend extubation was 3 times higher in the 24-hour intensivist model than in the model with a periodic intensivist (25.3% versus 7.1%).

Several studies have shown the impact of 24-hour intensivist staffing on decreasing the ICU LOS [2,8,28]. These studies all

Table 3. Intensive care unit data of groups

	Group 1 (n=131)	Group 2 (n=294)	p values
APACHE II, median (IQR)	22 (18-28)	25 (20-31)	0.017
MV duration, h	152 (52-371)	68 (32-136)	0.001
Sedation			
Sedation as infusion, n (%)	95 (72.5)	120 (40.8)	0.001
Midazolam infusion, n (%)	92 (70.2)	120 (41.0)	0.001
Midazolam infusion rate, median (IQR)	5 (3.5-6.4)	3.7 (2.7-5.0)	0.001
Fentanyl infusion, n (%)	21 (16.0)	32 (10.9)	0.14
Fentanyl infusion rate, median (IQR)	50 (40.1-64)	25 (25-38.9)	0.001
Extubation Trial	(n=87)	(n=201)	
Extubation failure, n (%)	35 (39.8)	51 (25.1)	0.012
Weekend extubation, n (%)	6 (7.1)	51 (25.3)	0.0001
Self-extubation, n (%)	32 (24.4)	40 (13.9)	0.0006
ICU duration, day	13 (5-32)	8 (4-12)	0.0001
Mortality, n (%)	47 (35.9)	110 (37.4)	0.76

APACHE II: Acute Physiological and Chronic Health Evaluation II; MV: mechanical ventilation; ICU: intensive care unit; IQR: interquartile ratio

showed that 24-hour intensivist staffing decreased the ICU LOS and hospital stay. In the present study, ICU LOS was significantly shorter in the 24-hour intensivist model than in the periodic intensivist model. The LOS in the ICU also depends on the number of intensivists in the ICU [29,30]. Dara and coworkers researched the effect of the intensivist-ICU bed ratio on ICU performance, as measured by ICU and hospital mortality, and ICU LOS [30]. They recorded 4 time periods according to intensivist-to-bed ratio (1:15, 1:7.5, 1:9.5, and 1:12). Also, their ICU was staffed by critical care fellows and third-year and first-year internal medicine residents, and the total ICU physician-to-bed ratios were 1:1.3, 1:1, 1:1.4, and 1:1.7. The longest LOS in the ICU was observed with an intensivist-to-bed ratio of 1:15 (12.3, 9.5, 9.7, and 9.2 days, respectively for the 4 ratios), with no difference in mortality rate [30]. In the present study, the intensivist-to-bed ratio and physician-to-bed ratio in group 1 (periodic intensivist) and group 2 (24-hour intensivist) were similar (1:2.5 and 1:4.4, respectively). Also, our LOS in the ICU and mortality results were similar to those of Dara and coworkers.

A systematic review published in 2002 showed that out of 15 studies, 14 showed a decline in the ICU mortality rate with high-intensity physician staffing (mandatory intensivist consultation or all care directed by an intensivist) [4]. Garland and coworkers compared the periodic model of intensivist ICU staffing with 24-hour intensivist presence (implemented by shift work) and showed no effect on ICU mortality [12]. Very recently, Wallace and coworkers researched night-time intensivist staffing and mortality among critically ill patients [6]. They found that night-time intensivist staffing reduced the mortality when compared with the low-intensity daytime staffing model (no intensivist or elective intensivist consultation), but there was no further reduction in mortality in the ICU with high-intensity daytime staffing [6]. In contrast, Garland and coworkers compared the model of periodic intensivist ICU staffing, with 24-hour intensivist presence (implemented by shift work) and showed no effect on ICU mortality [12]. Our study showed a similar mortality rate between the two groups, but the 24-hour intensivist model had a significantly greater APACHE II score and 2 times more patients with septic shock than the periodic intensivist model. Our results indicate that ICUs should address 24-hour intensivist coverage to decrease mortality.

There are some limitations to this study. First, the 24-hour intensivist model was compared by using historical controls, but recently, Garland et al. compared 24/7 intensivist staffing with a crossover design in both an educational and government hospital [12]. In their study, they showed no differences in mortality and ICU stay in the two-hospital model. Historical study results are still similar with crossover prospective studies. Second, in our study, the intensivists covered eight night shifts per month in the periodic model. These eight nights were not consecutive, and for this reason, we thought that it may be comparable with the 24/7 intensivist model.

The strength of this study was the comparison of the most difficult patients in the ICU, who were intubated and received mechanical ventilation. Thus, the impact of the 24-hour intensivist would be more obviously clarified.

In conclusion, a 24-hour intensivist must be available in a high-intensity level III ICU. This is important to shorten IMV duration and allow prompt diagnosis and management of especially severe events, such as septic shock. All of these measures will decrease the length of ICU stay, mortality, and cost. However, in reality, the shortage of intensivists makes it difficult to implement this 24-hour coverage. Governments need to develop health policies to increase the number of intensivists and to improve their working conditions, such as salary and work-free days.

Ethics Committee Approval: Because of retrospective design, ethics committee approval was not received for this study.

Informed Consent: Written informed consent was obtained from patient or relative who participated in this study.

Peer-review: Externally peer-reviewed.

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