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Nurse workload and inexperienced medical staff members are associated with seasonal peaks in severe adverse events in the adult medical intensive care unit: A seven-year prospective study

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ABSTRACT

Objective: Our purpose was to identify potential organizational factors that contributed to life-threatening adverse events in adult intensive care unit.
Methods: A prospective, observational, dynamic cohort study was carried out from January 2006 to December 2013 in a 20-bed adult medical intensive care unit. All patients admitted to the intensive care unit and who experienced one or more selected life-threatening adverse events (mainly unexpected cardiac arrest, unplanned extubation, reintubation after planned extubation, and readmission within 48 h of intensive care unit discharge) were included in the analysis. Negative binomial regression was used to model how human resources, work organization, and intensive care activity influenced the monthly rate of selected severe adverse events. Data were collected from local and national databases.
Results: Overall, 638 severe adverse events involving 498 patients were recorded. Adverse events increased seasonally in May, November and December ($p < .001$ vs other months). The proportion of inexperienced nurses and doctors' working hours could not explain these seasonal peaks of adverse events. Multivariate analysis identified bed-to-nurse ratio and the arrival of inexperienced residents or senior registrars as being independently associated with the rate of adverse events (incidence risk ratio = 1.36 (95% confidence interval, 1.05–1.75), and 1.07 (95% confidence interval, 1.01–1.13), respectively; $p = .01$ in both cases). According to this model, a one-unit increase in the day–night shifts carried out by each nurse per month tended to reduce the rate of adverse events (incidence risk ratio = 0.60 (95% confidence interval, 0.36–1.01), $p = .05$). Severity at intensive care unit admission did not influence the rate of adverse events (incidence risk ratio = 1.02 (95% confidence interval, 1.00–1.04), $p = .12$).

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Conclusions: Results identify nurse workload and the arrival of inexperienced residents or senior registrars as risk factors for the occurrence of life-threatening adverse events in the adult medical intensive care unit. Limiting fluctuations in bed-to-nurse ratio and providing inexperienced medical staff members with sufficient supervision may decrease severe adverse events in critically ill patients.

What is already known about the topic?

- Intensive care unit organization could impact human errors and patient outcomes.
- However, the relationship between adult intensive care unit organization (workload, working patterns and hours, night work, shift lengths for caregivers, turnover, and human resources including inexperienced staff members) and severe, life-threatening adverse events remains unclear.

What this paper adds

- The results of this study indicate that the bed-to-nurse ratio and the arrival of inexperienced residents or senior registrars are the main organizational factors contributing to the occurrence of life-threatening adverse events in an intensive care unit located in a tertiary teaching hospital. Moreover, the rate of severe adverse events was more strongly influenced by work organization factors than by severity of illness.
- Optimizing work organization by limiting fluctuations in bed-to-nurse ratio and providing inexperienced medical staff members with sufficient supervision may decrease the frequency of life-threatening adverse events in the intensive care unit. Future research to build dynamic indicators of safety in the intensive care unit should take better account of work organization factors.

1. Introduction

Many life-threatening adverse events occur in the adult intensive care unit despite monitoring in this environment and the high density of caregivers (Ksouri et al., 2010). Indeed, intensive care units are identified as high-risk structures because the diagnostic and therapeutic procedures performed there are complex, many people are involved in decision management, and multiple severe organ failure may occur in critically ill patients. Adverse events, defined as iatrogenic injuries or complications that are provoked by medical management rather than the patient's underlying disease, occur in about one-third of cases in adult intensive care unit patients (Baker et al., 2004; Garrouste-Orgeas et al., 2008). The reported rate of various adverse events in the intensive care unit is highly variable among prospective studies (Kane-Gill et al., 2005; Ksouri et al., 2010; Pagnamenta et al., 2012; Romero et al., 2013; Rothschild et al., 2005; Valentin et al., 2006, 2009, 2013) although most reported adverse events are medication administration errors without serious consequences for the patient (Garrouste-Orgeas et al., 2010; Pagnamenta et al., 2012; Rossi and Edmiston, 2012; Valentin et al., 2006). Moreover, the reporting of in-intensive care unit medication errors seems to follow a seasonal cycle (Pagnamenta et al., 2012). Patient-related risk factors associated with in-intensive care unit adverse events are old age, a high severity score at intensive care unit admission, and long intensive care unit stay, whereas intensive care unit-related risk factors include a high patient-to-nurse ratio, high nursing workload, caregivers' sleep deprivation, communication failure, and understaffing (Bucknall, 2010; Ksouri et al., 2010; Pagnamenta et al., 2012; Valentin et al., 2006; Steyrer et al., 2013). Human error occurs during the implementation phase of healthcare procedures in about three-quarters of all cases in the intensive care unit and the risk of error is cumulative (Baker et al., 2004; Bracco et al., 2001; Steyrer et al., 2013). The avoidability of adverse events occurring in the intensive care unit varies considerably among studies because the avoidability reported by caregivers is influenced by their psychological defence mechanisms and safety culture (Bracco et al., 2001; Garrouste-Orgeas et al., 2015; Heavner and Siner, 2015; Kopp et al., 2006; Laurent et al., 2014; Osmon et al., 2004; Pelieu et al., 2013; Rothschild et al., 2005). Adverse events affect morbidity, intensive care unit stay and costs, but do not seem to influence in-intensive care unit mortality (Kaushal et al., 2007; Ohta et al., 2014; Rothschild et al., 2005). The multicenter cohort study IATROREF found no significant association between the number of medical errors and intensive care unit death, although patients who had more than two adverse events had a higher risk of death than those who had not had an adverse event (Garrouste-Orgeas et al., 2010). Therefore, the rate of life-threatening adverse events may be an important indicator of patient safety in the intensive care unit.

1.1. Contribution of organizational factors

Much effort has been made in the past two decades to improve the systems for preventing and limiting the effects of in-intensive care unit adverse events. System-based approaches to determine how the error occurred are essential. These approaches include standardized mortality and morbidity meetings and root cause analyses, which lead to improvements in safety culture, although they have several limitations in the intensive care unit (Garrouste-Orgeas et al., 2012; Higginson et al., 2012; Hosein et al., 2013; Nguyen et al., 2010; Pelieu et al., 2013; Ranji and Shojania, 2008; Scanlon and Karsh, 2010). Automation, computerisation, double checking, and bundles of care also reduce human error (Garrouste-Orgeas et al., 2012; Ranji and Shojania, 2008; Scanlon and Karsh, 2010). However,