



Do in-hours or off-hours matter for extubating children in the pediatric intensive care unit? ☆☆☆☆



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ARTICLE INFO

Available online xxxx

Keywords:

Children

Extubation

Mechanical ventilation

Outcomes

Pediatric intensive care

ABSTRACT

Purpose: Several studies have suggested worse outcomes for patients requiring medical care at night or on weekends. However, whether or not children should be extubated only during in-hours has not been studied yet. We sought to compare outcomes and complications of in-hours versus off-hours extubated patients.

Methods: We prospectively included all children receiving invasive mechanical ventilation (MV) in a pediatric intensive care unit. Off-hours extubations included patients who were extubated at nighttime (8:00 PM–7:59 AM) plus weekends/holidays whereas the in-hours extubations included regular daytime weekdays (Monday to Friday: 8:00 AM–7:59 PM).

Results: Of the 480 patients, 346 (72%) were extubated during in-hours period and 134 (28%) were extubated during off-hours. In-hours patients spent a longer time to have planned extubation and had a longer MV duration and pediatric intensive care unit stay compared to those extubated at off-hours. Kaplan–Meier curve showed that in-hours patients were more likely to have a longer time until the first extubation (log-rank test: $P = .006$, HR: 5.05).

Conclusion: Patients extubated at off-hours had more favorable outcomes with similar complications rate compared with those extubated at in-hours. These results provide no support for delaying extubations until in-hours period. Further studies are required to confirm these findings.

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Abbreviations: CI, Confidence interval; COMFORT b, COMFORT behavior scale; FLACC, Face, Legs, Activity, Cry, Consolability scale; HR, hazard ratio; IQR, interquartile ranges; MV, mechanical ventilation; PICU, pediatric intensive care unit; PRISM, Pediatric Risk of Mortality score; PELOD, Pediatric Logistic Organ Dysfunction score; VAP, ventilator-associated pneumonia.

☆ The authors have not disclosed any potential conflict of interest.

☆☆ This study received no financial support, including any departmental funds.

★ Contributor's statement: Dr da Silva: conceptualized the idea, coordinated data collection, performed the analyses, drafted the initial manuscript, reviewed and revised the manuscript, and approved the final draft as submitted. Dr Reis: coordinated data collection, contributed to the initial analyses, reviewed the manuscript, and approved the final draft as submitted. Dr Suelotto Fonseca: assisted with data collection, conducted critical review of the manuscript. She has approved the final draft of the manuscript as submitted. Dr Fonseca: assisted with the coordination of the data collection, assisted with study design and critical review of the manuscript and approved the final draft as submitted.

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1. Introduction

Several studies have showed that the day of the week or time of day of the hospital admission may negatively influence the neonatal mortality [1,2] and in certain acute medical conditions [3,4].

The organizational structure of a pediatric intensive care unit (PICU), including a decreased physician-to-patient ratio, different nursing/patient ratios, unavailability of board-certified intensivists and difficulty in obtaining complex diagnostic tests or therapies, may account for the higher risk of worse outcomes over the weekend [5]. In addition, while the absence of daily rounds by a board-certified intensivist is associated with a threefold increase in mortality [6], increased nurse staffing is associated with lower hospital mortality and adverse patient events [7]. Other reasons for worse outcomes may include judgment errors related to physical and mental fatigue from night shifts [8,9] and overwork [10]. Despite these findings, whether or not patients should be extubated only during in-hours have been poorly studied. While we have not identified pediatric literature addressing this issue, a previous study in adult ICU patients showed that extubations during night time hours had no impact on patient outcomes when compared with those patients extubated during daytime hours [11].

On one hand, extubating patients during off-hours, as soon as they meet weaning parameters, may decrease complications, such as pneumonia and reduce the length and cost of ICU stay [11]; on the other hand, off-hours extubations may lead to poorer outcomes as a consequence of possible fragmented patient care. Therefore, if extubation time has impact on patient outcome, this would have important implications for intensivists and health-care administrators involved in ICU staffing as well as health-care policy makers and insurance providers. Based on a previous study in adults [11], we hypothesized that the time or day of extubations would have no effect on pediatric patient outcomes. The aim of this study was to compare the outcomes (length of mechanical ventilation and PICU stay) of in-hours (weekday and daytime extubations) versus off-hours (weekends plus nighttime) extubations in mechanically ventilated children.

2. Methods

2.1. Study design and setting

This was a non-concurrent prospective cohort study comprising patients receiving ventilation between January 1, 2011, and December 31, 2015, admitted to an eight-bedded PICU of a tertiary hospital. The PICU is not designed to handle specialist congenital heart surgery or burn cases, and bone marrow and solid organ transplants are not performed in the hospital. The local institutional review board approved the study and waived the need for informed consent from the children's parents.

2.2. Inclusion and exclusion criteria

All consecutive patients aging between 1 month and 16 years, requiring mechanical ventilation for at least 24 hours were eligible for enrollment. Patients were excluded if they were younger than 30 days, were transferred to another PICU. Also, considering that unplanned extubations have a negative impact on study outcomes [12], we opted to exclude these patients from our analysis. Additionally, patients with a tracheostomy or that were going to receive a tracheostomy were not eligible. In-house pediatric intensivists 24/7, along with respiratory therapists and registered nurses experienced in critical care cared for all patients. A consultant and a pediatric intensivist provided PICU medical coverage during weekdays daytime and one pediatric intensivist provided coverage during the night shifts and weekends/public holidays. The nurse to patient ratio was always 1: 2.

All patients who had at least one extubation attempt were analyzed. Only the first extubation try was analyzed. Off-hours extubations were defined as extubation occurring during nighttime (between 8:00 PM and 7:59 AM) or weekends (from 8:00 AM Saturday until 7:59 PM Monday) or during public holidays. In-hours extubations were defined as those occurred during regular weekdays from Monday to Friday from 8:00 AM to 7:59 PM next day.

2.3. Data collection

Data were extracted from a prospectively maintained database designed to register information of all planned and unplanned extubations in the PICU. This database is part of our continuous quality improvement program of monitoring and reducing unplanned extubation events [12].

The following data were collected: patient characteristics at admission, admission diagnosis category; severity of illness at admission (Pediatric Risk of Mortality II) score [13] and Pediatric Logistic Organ Dysfunction score [14], level of sedation prior to extubation (COMFORT score), total duration of mechanical ventilation, length of PICU and hospital stay. The following laboratory data were collected for the last recorded data point prior to extubation: arterial pH, arterial P_{CO_2} and PO_2 , arterial oxygen tension/fractional inspired oxygen ratio (PaO_2/FiO_2) and oxygenation index ($OI = [\text{mean airway pressure}/PF \text{ ratio}] \times 100$). Ventilator-associated pneumonia (VAP) was defined according

to the Centers for Disease Control and Prevention and the National Healthcare Safety Network [15].

2.4. Weaning from mechanical ventilation

Respiratory therapist assessed patients twice a day to identify those candidates for extubation. Patients were considered at weaning process if they fulfilled the following criteria: resolution or improvement of the respiratory failure cause, hemodynamic stability (absence or progressive decrease of vasoactive drugs), adequate level of consciousness, spontaneous respiratory effort, discontinued sedatives, no significant metabolic and electrolyte imbalances, presence of cough reflex, adequate gas exchange with $PEEP \leq 8$ cmH₂O and $FiO_2 \leq 0.4$. Once a decision to extubate had been made, patients were considered ready for extubation if they tolerated at least 30 min of minimal ventilator support defined as follows: (1) continuous positive airway pressure of 5 cm H₂O or (3) pressure support ventilation adjusted for the endotracheal tube size. The weaning management and the final extubation decision were made at discretion of the attending physician. Extubation failure (reintubation) was defined as the planned removal and reinsertion of an endotracheal tube within 24 hours. Sedation and analgesia were routinely addressed by the COMFORT behavior scale [16] and FLACC (Face, Legs, Activity, Cry, Consolability scale) [17].

2.5. Outcome measures

The primary outcome measure was the length of mechanical ventilation until the first planned extubation. Secondary outcomes included overall duration of mechanical ventilation and length of PICU stay (PICU LOS).

2.6. Statistical analysis

Descriptive statistics were performed for all variables. Results are expressed as numerical values and percentages for categorical variables, and as medians and quartiles (25th–75th percentile) for continuous variables. The median difference and 95% confidence interval (CI) was calculated when appropriate. Comparisons between in-hours and off-hours extubation groups were based on the Mann-Whitney *U* test for continuous variables and χ^2 test for categorical variables or Fisher's exact test if one expected that the cell value would be less than 5 (categorical variables). Kaplan–Meier survival analysis was used to compare the time to first planned extubation, total length of mechanical ventilation and PICU stay, while log-rank tests were used to examine differences between curves. Patients who died were censored in the primary analysis. Cox proportional hazards regression was used to adjust for clinical variables that can affect the time to the first planned extubation. Corresponding hazard ratio (HR) and 95% CIs were reported. We used an analogous approach to analyze the overall length of mechanical ventilation and PICU stay.

Pearson correlation coefficient (*r*) was used to examine the relationship between time to first planned extubation and overall time of mechanical ventilation.

All statistical tests were 2-tailed, and a $P < .05$ was considered significant. Data were analyzed with the Statistical Program for Social Sciences (Chicago, IL), version 16.0, software.

3. Results

3.1. Patient characteristics

During the study, there were 1765 PICU admissions. Of these, a total of 768 (43.5%) patients were mechanically ventilated. Among these patients, 288 were excluded for the following reasons: mechanical ventilation <24 hours ($n = 96$), unplanned extubations ($n = 82$), transferred while still intubated ($n = 39$), age < 30 days ($n = 27$), tracheostomized

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