Profile of fluid balance in the first 48 hours and duration of mechanical ventilation in pediatric intensive care unit

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Abstract. Mechanical ventilation is the highest respiratory support in critical condition. The study showed that 64% children need mechanical ventilation at least 24 hours. Prolonged mechanical ventilation can increase mortality and morbidity rate. The most common complication that happened from prolonged mechanical ventilation is ventilator-associated lung injury and ventilator-associated pneumonia. To lessened the risk of complications, one of the solutions was decreased the duration of mechanical ventilation. Factors that have been proposed to correlate with the duration of mechanical ventilation was a fluid balance. Study shows that positive fluid balance correlates with decreased oxygenation, prolonged mechanical ventilation, longer hospital length of stay and mortality of children. This is a prospective observational study in children 1 month to 18 years old who admitted to PICU Haji Adam Malik General Hospital Medan, Sumatera Utara, Indonesia. We conducted this study to show the profile of fluid balance and duration of mechanical ventilation in the pediatric intensive care unit. Fluid balance is a routine procedure in PICU, so it is expected that information on fluid balance and duration of mechanical ventilation can be used for further adjustment to improve the outcome in the intensive care unit.

1. Introduction
Mechanical ventilation is one of the most common therapy in the intensive care unit (ICU) for infants, children, and adults. [1] Study shows that up to 64% of admitted children requiring ventilation for at least 24 hours with higher hospital cost and mortality rate compared to children without mechanical ventilation. [2]

Prolonged postoperative mechanical ventilation is associated with complications and can increase the risk of morbidity and mortality. Previously reported risk factors associated with prolonged mechanical ventilation in children undergoing pediatric congenital heart surgery include prolonged cardiopulmonary bypass time, delayed sternal closure, healthcare-associated infections, noninfectious pulmonary complications, including, and the need for reintubation. It may contribute to increased resource utilization and worse neurodevelopmental outcomes in children. [3]

Prolonged mechanical ventilation was associated with various complications that could increase the duration of mechanical ventilation which one of the most common was ventilator-associated lung injury (VILI) and ventilator-associated pneumonia (VAP). [4] The incidence of pneumonia increased among patients in the intensive care unit compared to wards. Ventilator pneumonia can increase mortality from 24-50%, and can reach as big as 76% when an infection caused by high-risk pathogens. [5] Acute
lung injury (ALI) has a mortality rate 22-65% and it also caused almost 2500-9000 children died every year in America. [6] One of the approaches to prevent the injury caused by mechanical ventilation was by decrease the duration of mechanical ventilation. There are many strategies to controlled it such as sedation protocol and ventilation weaning by using spontaneous breathing. [7,8] Measured outcomes such as fluid balance also associated with the duration of mechanical ventilation. [9]

Observational study shows positive fluid balance within 24 hours increased the risk of acute lung injury and mortality rate where smaller studies indicated that decrease of lung extravascular fluid associated with a better outcome in patients. [6] The study shows an association of positive fluid balance in the first 3 days of illness with increased duration of mechanical ventilation and mortality in children with ALI. [10] Another study also found more than 15 percent fluid overload to be associated with worse oxygenation, increased duration of mechanical ventilation and increased PICU length of stay. [11]

2. Methods and Materials

2.1. Patients and methods
A prospective observational study was conducted on children who admitted in the PICU H. Adam Malik General Hospital Medan, periods in March – August 2019. All subjects will be asked for parents' approval after an explanation about the condition of the disease. The study was conducted after approval of the Health Ethics Committee from the Faculty of Medicine, Universitas Sumatera Utara and Ethics Committee H. Adam Malik Hospital Medan. Patients with renal replacement therapy, burn injury patients, and patients who already use mechanical ventilation prior transferred to the hospital were excluded.

2.2. Method of Data Collection
- All patients who meet the inclusion and exclusion criteria are taken as subject.
- Demographic data such as age, gender, weight, height, previous medical history, physical examination, and diagnosis are recorded.
- Blood samples are taken for a complete blood count, blood gas analysis, kidney function test, lactate in the first 24 hours admission in PICU.
- Sputum culture was taken after 48 hours of mechanical ventilation.
- Duration of mechanical ventilation, blood pressure, and PaO2/FiO2 are recorded.
- The calculation of PELOD-2 score is done within 24 hours of admission in PICU.
- The calculation of PIM2 score is done within 24 hours of admission in PICU.
- The calculation of fluid balance during 48 hours of mechanical ventilation.

2.3. Statistical analysis
Univariate analysis was done to determine the distribution of characteristics of research subjects with mechanical ventilation. Numeric variables were expressed as median (minimal-maximal) because of non-normality data distribution and categorical variables were expressed as frequency and percentage. Data were analyzed using Statistical Package for Social Sciences (SPSS) version 22.

3. Result
During the study period, 109 subjects were chosen based on inclusion and exclusion criteria from a minimal sample of 171 children. We had 61 (56%) male and 48 (44%) female subjects. The median age of the subject was 5 years old (range 1 month to 17 years old). The nutritional status assessment was carried out and majority were well nourished (n=51, 46.8%). Postoperative management was the most common indication for mechanical ventilation, contributing to 37.6% and followed by central nervous system disorder with 17.4%. The mortality rate from this study was 42.2%. All baseline characteristics of children with mechanical ventilation can be seen in table 1.
Table 1. Baseline characteristic of children with mechanical ventilation.

| Indicator | n = 109 |
|-----------|---------|
| Age (years), median (min-max) | 5.0 (0.08 – 17) |
| Gender (n, %) | |
| - Boys | 61 (56) |
| - Girls | 48 (44) |
| Body weight (kg), median (min-max) | 15 (2.8-60) |
| Body height (cm), median (min-max) | 113 (45-166) |
| Nutritional status (n, %) | |
| - Severe malnutrition | 34 (31.2) |
| - Mild-moderate malnutrition | 15 (13.8) |
| - Well-nourished | 51 (46.8) |
| - Overweight | 9 (8.3) |
| Mechanical ventilation indication (n, %) | |
| - Respiratory disorder | 13 (11.9) |
| - Cardiovascular disorder | 7 (6.4) |
| - Neurological disorder | 19 (17.4) |
| - Circulation disorder | 18 (16.5) |
| - Nephrology disorder | 11 (10.1) |
| - Postoperative management | 41 (37.6) |
| Outcome (n, %) | |
| - Move to the ward | 63 (57.8) |
| - Death | 46 (42.2) |

Duration of mechanical ventilation that was observed has a median 4 days (range 2 to 35 days) and mostly under 7 days (n= 81, 74.3%). Ventilator-associated pneumonia (19.3%) and atelectasis (4.6%) were the major complications observed in our study. The fluid balance assessment shows large variation with median 1.6% (range -31.7% to +9%). Positive fluid balance was found in 61 subjects (56%) dan negative fluid balance in 48 subjects (44%). The outcome of patient in the pediatric intensive care unit was commonly assessed using PELOD-2 score and PIM2 score. This study shows that the lowest PELOD-2 score was 3 and the highest was 20 where the lowest PIM2 score was 0.82% and the highest was 96.8%. (Table 2)

Table 2. Parameter of mechanical ventilation.

| Indicator | n = 109 |
|-----------|---------|
| Duration of mechanical ventilation, median (min-max) | 4 (2-35) |
| - Less than 7 days (n, %) | 81 (74.3) |
| - More than 7 days (n, %) | 28 (25.7) |
| Fluid balance, median (min-max) | 1.6 (-31.7-9.0) |
| - Positive, (n, %) | 61 (56) |
| - Negative, (n, %) | 48 (44) |
| Complication | |
| - Ventilator-associated pneumonia (n, %) | 21 (19.3) |
| - Atelectasis (n, %) | 5 (4.6) |
| PELOD-2 score, median (min-max) | 8 (3-20) |
| PIM2 score, median (min-max) | 9.54 (0.82-96.8) |

All patient that using mechanical ventilation was checked for isolated microorganism to diagnose ventilator-associated pneumonia (VAP) from sputum culture (n=33, 30%). The most common organism isolated from sputum culture was *Acinetobacter baumanii* (n=9, 8.3%). (Table 3)
Table 3. The causative organism from sputum culture.

| Organisme                      | n (%)  |
|-------------------------------|--------|
| Klebsiella pneumoniae         | 8 (7.3) |
| Acinetobacter baumanii        | 9 (8.3) |
| Staphylococcus aureus         | 1 (0.9) |
| Enterobacter cloacae          | 1 (0.9) |
| Pseudomonas aeruginosa        | 6 (5.5) |
| No growth                     | 8 (7.3) |

4. Conclusion
Positive fluid balance was found often in patients with mechanical ventilation. Most patients have less than 7 days of mechanical ventilation duration. Further data are needed to assess whether positive fluid balance correlates with the duration of mechanical ventilation.

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