THE QUALITY OF LIFE AND THE HYPOXIA INDICATOR IN SURVIVOR OF PEDIATRIC INTENSIVE CARE UNIT IN THE UNIVERSITY OF SUMATERA UTARA HOSPITAL

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Abstract

The technology development for care and management in intensive care units reduces mortality and increases survivors' survival rate and life expectancy. A significant decrease in mortality rate in patients was related to mechanical ventilation. The hypoxia degree and severity of the respiratory distress are the increase of PaO2/FiO2 ratio and decrease of oxygenation index as predictors of oxygenation sufficiency in arterial blood supply to body tissues. The critical parameter of intensive care unit survivors' quality of life is the Pediatric Quality of Life (PedsQL) Inventory score after survival from the pediatric intensive care unit (PICU). During six months of research observation, eight patients died, and 13 patients survived among 68 patients admitted to pediatric intensive care unit who have ventilatory support. The mean PaO_2/FiO_2 ratio (PFR) in pediatric intensive care survivors who underwent mechanical ventilation was 285, and the mean Oxygenation Index (OI) was 5.07. There was no relationship between PFR and OI with PedsQL score in this study, but we have found a significant correlation between PedsQL and the duration of mechanical ventilation and length of stay in the intensive care unit. The longer mechanical ventilation duration and length of stay in PICU, the lower the pediatric quality of life score.

Keywords: PedsQL, PICU survivors, PaO_2/FiO_2 ratio, oxygenation index

Introduction

Pediatric Intensive Care Unit (PICU) has developed rapid progress in the last few decades, shown by decreased mortality in critically ill children. Surveillance and technological advances have significant involvement in this achievement. The PICU unit aims to observe, treat, and manage pediatric patients within one month to 18 years old who suffer a critical illness, injury, life-threatening disease, or potentially life-threatening illness with a poor prognosis. If the underlying disease is terminal, the patient will not improve the PICU care. With the development of respiratory support and technology of mechanical ventilation, the mortality rate of children under five years old with respiratory failure was decreased from 29% to 7%.[1]

In children, hypoxia degree was shown in PFR (PaO_2/FiO_2ratio) and OI (the mean of respiratory rate x FiO_2/PaO_2) as an accurate predictor of mortality. Mortality risk factors were comorbidities, multiple organ dysfunction, and OI score high in the first 24 hours of acute respiratory distress syndrome (ARDS). The examination based on abnormal peripheral oxygen saturation is a reliable sign of bad outcome in patients with ARDS.[2]

Respiratory failure is the main indication to initiate mechanical ventilation. Respiratory failure is characterized by the inability to maintain oxygenation and/or ventilation with conservative oxygen. Absolute indication included inadequate oxygenation characterized by PaO_2 <55-60 mmHg with FiO_2 >60%, oxygen saturation <90% and inadequate ventilation with respiratory acidosis (hypercapnia, PCO_2>50 mmHg and pH >7.2-7.25. When deciding the use of mechanical ventilation, the clinician must consider the underlying disease, its progression, the clinical assessment of the patient and response to other therapies, and the risks associated with the use of mechanical ventilation.[3]

The ratio of PaO_2/FiO_2 is traditionally used as a marker of pulmonary disease and hypoxia degree, which shows the gas exchange capacity on the alveolar surface and becomes one of the parameters in the diagnosis of ARDS. In children, the definition of ARDS includes the onset of acute hypoxemia, PFR ≤200, and bilateral infiltrates in a chest x-ray. Besides PFR, OI also reflects the hypoxia degree in children. The mortality rate of 6-7% was found in OI with a maximum ≤17 compared to 18% of patients with OI>17.[4]

Currently, advances in PICU trigger a progressive decline of mortality but triggers concern about long terms disability of the survivors.[5] World Health Organization (WHO) defines the quality of life in pediatric (PedsQL) as pediatric perception about his position in life with the context of value and culture in residence and association with expectancy and purpose of life. Quality of life was related to health (health-related quality of life, HRQOL), defined as hope, purpose, and standard of health in general and health

domain.[6,7] PedsQL is an instrument for HRQOL scoring in children with good reliability and validity,[8] and it was beneficial for children with post-treatment in the pediatric intensive care unit.[9]

Materials and Methods

Study Design and Population

This cross-sectional study evaluated the association between mean oxygen ratio and inspiratory oxygen fraction and oxygen index with the score for quality of life (PedsQL) as a prognostic factor in survivors of pediatric intensive care unit patients with mechanical ventilation.

The study was done in the outpatient unit at the University of Sumatera Utara hospital within six months. Samples were patients aged one month to eighteen years old who survived in the pediatric intensive care unit with mechanical ventilation in the hospital. The exclusion criteria in this study were patients who died, were uncommunicable, or refused to be included.

Measures

Subjects were given information about the study, and parents were asked to sign the informed consent form. Parents were given the questionnaire for the database, duration of mechanical ventilation, and length of stay in PICU. Clinicians asked the questions based on the PedsQL questionnaire and calculated the PedsQL score. The PedsQL^{TM} contains 23 items in four scales: physical health (8 items), emotional functioning (5 items), social functioning (5 items), and school functioning (5 items). A psychosocial health score — a combined score of the emotional, social, and school functioning subscales — and a total scale score can be computed. Items are scored on a 5-point Likert scale from 1 'Never a problem' to 5 'Almost always a problem,' with a one-week recall period. Previous research has shown that the reliability and validity of the PedsQL^{TM} are good.[7] Data was documented and analyzed statistically.

Statistical Analysis

Univariate and bivariate analyses were done for the data in this study. Univariate analysis was done for the characteristic distribution data of samples, and bivariate analysis was done for correlation test between the mean PFR and OI with PedsQL score.

Categorical data were calculated with chi-square, and analysis was done with SPSS 20.0 version. P<0.05 with a 95% confidence interval is considered significant in this study.

Ethics

The study was conducted after obtaining approval from the Health Research Ethical Committee of Medical School, Universitas Sumatera Utara.

Results

Thirteen subjects were included in this study, 69% were males, and 31% were female. In this study, 8 (38%) subjects died, and 13 (62%) survived. The nutritional status was well-nourished in 61.5% survived, and 44% died subjects, while others were mild and severe malnutrition. Underlying conditions in PICU were acute disease in 46.1% of cases, and 53.8% of cases were chronic disease with the mean length of stay was eight days in survived cases and five days in not survived cases.

Table 1. Characteristic data of survivor subjects

Age	Gender	Body weight (kg)	Nutrition status	Underlying disease	Length of stay
17 y 9 mo	M	65	Well-nourished	Acute	3 days
7 mo	M	8	Well-nourished	Acute	18 days
9 y 10 mo	M	25	Mild malnutrition	Chronic	6 days
1 y 8 mo	M	5.5	Severe malnutrition	Chronic	24 days
2 y 1 mo	M	9	Mild malnutrition	Acute	7 days
5 y 2 mo	F	16	Mild malnutrition	Chronic	2 days
13 y	M	32	Well-nourished	Chronic	9 days
3 y	M	14	Well-nourished	Acute	8 days
2 y 11 mo	M	12	Mild malnutrition	Acute	11 days
5 y 6 mo	F	15	Well-nourished	Chronic	2 days
2 y 6 mo	M	12	Well-nourished	Acute	6 days
15 y 9 mo	F	58	Well-nourished	Chronic	7 days
1 y 1 mo	F	8.7	Well-nourished	Chronic	8 days

Table 2. Characteristic data of non-survivor subjects

Age	Gender	Bodyweight (kg)	Nutrition status	Underlying disease	Length of stay
1 y 5 mo	F	9.3	Well-nourished	Acute	13 days
3 mo	F	5	Mild malnutrition	Acute	2 days
2 mo	M	4	Mild malnutrition	Acute	12 hours
3 mo	M	6	Severe malnutrition	Acute	12 hours
1 y 7 mo	M	12	Well-nourished	Acute	10 hours
1 mo	M	8	Severe malnutrition	Acute	7 days
1 mo	F	3.5	Well-nourished	Acute	2 days
2 mo	M	2.4	Mild malnutrition	Chronic	23 days
2 mo	M	3	Well-nourished	Acute	10 hours

The tables above show that the mean age of survivor subjects was six years and non-survivor was six months. In the non-survivor group, there were more subjects with mild and severe malnutrition than in the survivor group. Acute diseases were the leading cause of mechanical ventilation support in this group, with the length of stay shorter than the non-survivor (mean = five days).

Table 3. PaO_2/FiO_2 ratio (PFR) and Oxygen Index (OI) in non-survivor subjects

Subject	PaO_2/FiO_2 ratio (PFR)	Oxygen Index (OI)
1	253	3.94
2	196	6.12
3	175	7.42
4	90	18.75
5	133	9
6	470	1.79
7	125	11.93
8	248	10.84
9	220	4.54
Mean	240.33	8.25

Table 3 shows that the PFR in non-survivor were all less than 500, and the mean was 240.33 when the typical ratio was >500. Ratio <300 indicates an acute lung injury, and a ratio <200 indicates a severe intrapulmonary shunt reflecting acute respiratory distress syndrome. The mean OI in this group was 8.25, the OI >5 was correlated with acute lung damage, and OI >8 indicates the severity of lung damage as well as hypoxia. Oxygen index >15 is an indication for mechanical ventilation with a high-frequency oscillatory ventilator (HFOV) and OI >23 for extracorporeal membrane (ECMO).

Table 4. PaO2/FiO2 ratio (PFR), Oxygen Index (OI), and PedsQL in non-survivor subjects

PaO2/FiO2 Ratio (PFR)	Oxygen Index (OI)	PedsQL score			
		Physical	Emotional	Social	School
347	5,76	90.6	85	85	55
177,5	9,01	15.6	20	10	0
328	4,57	96.87	100	95	85
474,2	3,16	15.6	40	15	0
512,5	2,92	59.4	50	40	0
646	1,70	81.25	100	100	80
154	7,79	32	0	0	12
152	4,60	12	0	0	12
182	4,39	32	5	16	12
186	3,22	6	0	0	0
150	4,00	32	0	0	12
203	7,38	1	7	0	14
200	7,50	32	0	12	0
Mean	285	5.07			

Table 4 shows that the mean PFR in the survivor group was 282. PaO_2/FiO_2 ratio <300 indicates acute lung injury with moderate Intrapulmonary shunt. The mean OI in this group was 5.07, corresponding to the PFR showing hypoxia caused by the acute respiratory distress syndrome.

Table 5. Correlation between PedsQL score with PaO_2/FiO_2 ratio and Oxygen Index

	Physical	Emotional	Social	School
PaO_2/FiO_2 ratio*	0.63	0.23	0.75	0.56
Oxygen Index**	0.86	0.16	0.48	0.28
Ventilator day#	0.01	0.01	0.01	0.01
Length of stay	0.09	0.01	0.02	0.02
Significancy	0.63	0.23	0.75	0.56

***** Oneway ANOVA
****** Pearson
# Spearman

There was no significant correlation between PedsQL with PFR and Oxygen Index, but a significant correlation was found between duration of mechanical ventilation and length of stay in PICU with PedsQL (table 5). The length of duration underwent mechanical ventilation, the longer length of stay in PICU, and the lower score of Quality of Life as PedsQL.

Discussion

During the last decades, the improvements of care in critically ill children have reduced mortality and morbidity in the pediatric intensive care unit (PICU), but the long-term disability of the survivors is still unproven. PICU development has contributed to the improved survival of critically ill children.[10] Pediatric Quality of Life Inventory (PedsQL) Core scales assess the physical, emotional, social, and school functioning domains. These measures were feasible, valid, and sensitive to change in a PICU population.[11]

The children who have survived critical illness were at risk of developing physical, cognitive, and psychological impairments that persist for months to years after leaving the hospital. Health-related quality of life (HRQL) and functional abilities were essential to measure the outcomes after hypoxia during the mechanical ventilation event in PICU, as physical disability, cognitive impairment, and psychological disorders.[10-12]

Physical and psychological sequelae and the consequences for the quality of life (QoL) in pediatric survivors might be significant.[12] Awareness of sequelae may result in changes in treatment and support during and after the acute phase.[13] The respiratory failure children in PICU require mechanical ventilation with positive end-expiratory pressure for improving oxygenation.[14,15] The most well-accepted definition of the arterial partial pressure of oxygen ($Pa O_2$) to the fraction of inspired oxygen (FiO_2) as the PFR or PF ratio.[16] Another $Pa O_2$-based index, oxygenation index (OI), has the inherent advantage over the P/F ratio by incorporating the mean airway pressure. A higher OI in itself has been shown to predict mortality independently.[2,16] The Paediatric Acute Lung Injury Consensus Conference recognizes OI to measure the oxygenation based on level of respiratory

support as the primary metric of hypoxia severity in pediatric Acute Respiratory Distress Syndrome. Oxygenation Index has been used to guide escalation of respiratory support from conventional mechanical ventilation to advanced ventilation.[17]

During this study period, 13 children were ventilated in PICU, with a survival proportion of 62%, and mortality was 38% around the subjects. Underlying conditions in PICU were acute disease in 46.1% of cases, and 53.8% of cases were chronic disease with the mean length of stay was eight days in survived cases and five days in not survived cases. The ratio of PaO_2/FiO_2 in non-survivor subjects was all less than 500, and the mean was 240.33 when the standard ratio was >500. Ratio <300 indicates a lung injury, and ratio <200 indicates a severe intrapulmonary shunt.[16-18] The mean OI in this group was 8.25, the OI >5 was correlated with acute lung damage, and OI >8 indicates the severity of lung damage as well as hypoxia.[19-21] There was no significant correlation between PedsQL with PFR and Oxygen Index, but a significant correlation was found between duration of mechanical ventilation and length of stay in PICU with PedsQL (table 5). The longer the duration using mechanical ventilation, the lower score of PedsQL, and the longer length of stay in PICU show the lower score for quality of life. The multicenter cohort of pediatric patients with acute respiratory failure (Watson et al., 2019) has found one-fifth of patients declining functional status from baseline to follow-up. A similar proportion of functionally normal patients at baseline had impaired quality of life scores at follow-up.[22]

Our study has a limitation in that it was conducted cross-sectional research in a single center. Therefore, further cohort studies with a larger sample size are needed to confirm our findings in this study. Furthermore, a more robust study allows identification of other variables that might determine hypoxic conditions and influence the morbidity and mortality during mechanical ventilation in PICU (i.e., duration of mechanical ventilation, presence, and duration of organ dysfunction).

Conclusion

The mean PaO_2/FiO_2 ratio was 285 and Oxygen Index ratio was 5.07 in pediatric survivor with mechanical ventilation in pediatric intensive care unit. PedsQL score in pediatric survivor with mechanical ventilation in pediatric intensive care unit, have depended on the patient's age. This study found no correlation between PFR and Oxygen Index with PedsQL score. A significant correlation was found between PedsQL score and duration of mechanical ventilation using and length of stay in the survivor group. The longer duration of mechanical ventilation and length of stay made the lower score for quality of life.

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Conflict of Interest

The authors declare that they have no conflicts of interest.

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