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Original Research Article

Comparative Study of Pressure Control Ventilation versus Volume Control Ventilation in Pediatric ICU Patients Needing Mechanical Ventilation for Oxygenation and Airway Pressure

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Conflict of interest: Nil

Abstract:

Introduction: Over three-fifths of all 2.3 million child deaths in India in 2005 were caused by five conditions: pneumonia, prematurity & low birthweight, diarrhoeal diseases, neonatal infections and birth asphyxia & birth trauma. Out of these causes pneumonia accounts for 19 percent of under-five mortality. A large percentage of these pneumonia patients require mechanical ventilation due to respiratory failure. Hence Mechanical ventilation is an important aspect of management of children in pediatric intensive care unit. There is a paucity of literature about the preferred mode of ventilation in children. Hence we planned this study to compare VCV with the current standard of care PCV.

Material & Methods: The current study was in a 60 bedded pediatric ward with 10 bedded pediatric ICU and 10 bedded neonatal ICU. Randomisation was done by allocation of patients in two groups, with 65 participants in each group. one group will receive volume control ventilation and another group will receive pressure control ventilation. Patients 3 months to 12 years requiring mechanical ventilation and patient relatives giving consent for the trial were included in this study. Inability to wean from experimental strategies (e.g. nitric oxide), severe chronic respiratory disease, morbid obesity, lack of commitment to life support and less than 12 hours of ventilation were excluded from the study.

Results: The mean age of patients enrolled for Group VC is 32.24 +/- 38.16 months and for group PC is 37.36 +/- 39.27 months. There was no significant difference in heart rate, systolic blood pressure, mean temperature, mean PaO2/FiO2 ratio, urine output, urea, total leucocyte count, potassium, serum sodium, serum bicarbonate, bilirubin, Glasgow coma scale, SAPS score across the two groups of patients enrolled for the study ($p>0.05$). The PaO2 /FiO2 ratio in VC group is significantly higher in the VC group compared to the PC group as P value is 0.001.

Introduction

The millennium development goal 4 had a target to reduce the under-five mortality rate by two-thirds in the period between 1990 and 2015. Over three-fifths of all 2.3 million child deaths in India in 2005 were caused by five conditions: pneumonia, prematurity & low birthweight, diarrhoeal diseases, neonatal infections and birth asphyxia & birth trauma.[1,2] Out of these causes pneumonia accounts for 19 percent of under-five mortality.

A large percentage of these pneumonia patients require mechanical ventilation due to respiratory failure. Further, mortality rate in ventilated PICU children can be quite high- Lee et al recently found that 56% the ventilated children died (REF).[3]

Hence Mechanical ventilation is an important aspect of management of children in pediatric intensive care unit. There is a paucity of literature about the preferred mode of ventilation in children. Most of the existing protocols and beliefs were historically extrapolated from adult research. Pediatric intensivists worldwide prefer pressure controlled ventilation (PCV). However, there is emerging evidence that Volume controlled ventilation (VCV) may provide better outcomes. Hence we planned this study to compare VCV with the current standard of care PCV.[4]

Objectives

To compare whether pediatric patients requiring mechanical ventilation does volume control ventilation improve oxygenation as compared to pressure control ventilation.

Material & Methods

The current study was in a 60 bedded pediatric ward with 10 bedded pediatric ICU and 10 bedded neonatal ICU. Randomisation was done by allocation of patients in two groups, with 65 participants in each group. One group will receive volume control ventilation and another group will receive pressure control ventilation. Patients 3 months to 12 years requiring mechanical ventilation and patient relatives giving consent for the trial were included in this study. Inability to wean from experimental strategies (e.g. nitric oxide), severe chronic respiratory disease, morbid obesity, lack of commitment to life support and less than 12 hours of ventilation were excluded from the study. Statistical data entry was done in excel sheet and analysis was done using STATA 12 statistical software. Statistical Analysis was reported using number and percentages for categorical variables. Mean and standard deviation for the continuous variables. All patients were subjected to standard treatment and interventional protocols. Consent was taken from the relatives before enrolling the patient for the study.

Interventions – The guidelines which was followed while ventilating a patient are as follows:

a) Choose the Mode-Control every breath if plan for heavy sedation and muscle relaxation. Whenever a breath is supported by the ventilator, regardless of the mode, the limit of the support is determined by: • Volume limited: - preset tidal volume; • Pressure limited: preset PIP.
b) Fi02-start at 100% and quickly wean down to a level < or 60% (to avoid O2 toxicity) depending on O2 requirement. 60% may be a starting point.
c) I:E ratio – normally set at 1:2-1:3. Higher inspiratory times may be needed to improve oxygenation in difficult situations (inverse ratio ventilation), increasing the risk of air leak. Lower rate and higher expiratory time-1:3-1:4 may be needed in asthma to allow proper expiration due to expiratory obstruction.
d) Trigger Sensitivity- set at 0 to 2. Setting above zero is too sensitive; triggered breath from ventilator will be too frequent while too negative a setting will increase work for patient to trigger a ventilator breath.
e) Volume Limited-Tidal Volume – 6 ml/kg with a goal to get to 4-6 ml/kg. If leak present around ET tube, set initial tidal volume to 8ml/kg. These lung-protective strategies recruit atelectatic areas while preventing over-distention of normal lung parenchyma.
f) At any point of time during the hospital stay if the treating physician decided to change the mode of ventilation thereby changing the arm to which the patient was randomised, this will be treated as treatment failure. The outcomes will be analysed both by intention to treat and per protocol method.
g) The findings were recorded in the proforma and tabulated in the master chart. The results were analyzed and discussed in detail. All statistical analysis was done by statistical software SPSS 20.

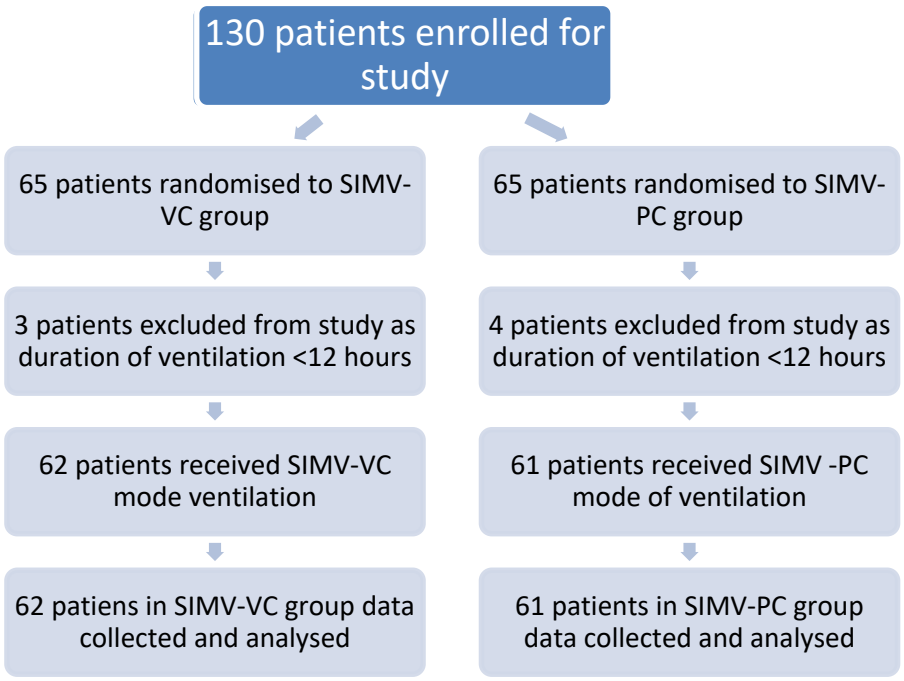

Figure 1:

Results

Table 1: Demographic Profile

GROUP		VC	PC	P value
Age		32.24 +/- 38.16	37.36 +/- 39.27	0.73
Gender	Male	32	31	0.71
	Female	30	30	

The mean age of patients enrolled for Group VC is 32.24 +/- 38.16 months and for group PC is 37.36 +/- 39.27 months. There was no significant difference between the age of patients enrolled for the study as the P value was 0.733. Similarly, There were 32 males in group VC and 31 males in group PC, 30 females in group VC and 30 females in group PC. There was no significant difference between the no of male and female patients enrolled for the study as the P value was 0.713. Hence the two groups are comparable in terms of age and gender.

Table 2: Basic profile of both the group

Group	VC	PC	Pvalue
Heart Rate	122 +/- 22.84	120 +/- 22.89	0.40
Systolic Blood Pressure	95.96 +/- 11.40	96.62 +/- 12.19	0.30
Temperature	37.98+/- 0.87	37.92 +/- 0.89	0.31
PaO2/FiO2 ratio on admission	101.77+/- 36.91	102.01+/- 39.41	0.035
Urine output(ml/kg/hr)	0.82 +/- 0.31	0.91 +/- 0.30	0.10
Urea (mg/dl)	29.90 +/- 15.63	27.67+/- 22.83	0.63
Total leucocyte count /cu mm	12161 +/- 7584	12750 +/- 7849	0.42
Potassium (mg/dl)	4.31 +/- 0.75	4.31 +/- 0.75	0.46
Serum Sodium	142.32 +/- 7.36	141.98 +/- 6.85	0.26
Serum Bicarbonate	16.46 +/- 3.08	16.09 +/- 3.23	0.64
Bilirubin (mg/dl)	0.92 +/- 0.854	0.73 +/- 0.348	0.11
Glasgow coma scale	13.77 +/- 2.08	13.88 +/- 2.20	0.76
SAPS score	19.89 +/- 0.35	20.24 +/- 0.40	0.51

There was no significant difference in heart rate, systolic blood pressure, mean temperature, mean PaO2/FiO2 ratio, urine output, urea, total leucocyte count, potassium, serum sodium, serum bicarbonate, bilirubin, Glasgow coma scale, SAPS score across the two groups of patients enrolled for the study (p>0.05).

Table 3: PaO2 /FiO2 ratio

Group	Oxygenation Index	Pvalue
VC	96.01 +/- 15.51	0.002
PC	84.31 +/- 15.69	

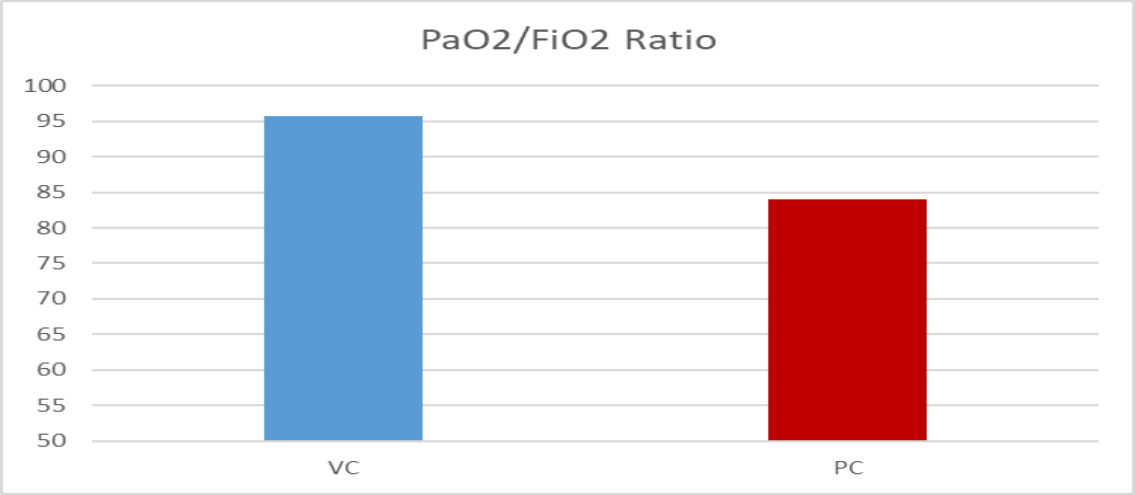

Figure 2:

The PaO2 /FiO2 ratio in VC group is significantly higher in the VC group compared to the PC group as P value is 0.001 .

Discussion

The mean heart rate of patients enrolled for Group VC was 122 +/- 22.84 beats/min and for group PC was 120 +/- 22.89 beats/min. The mean systolic blood pressure of patients enrolled for Group VC is 95.96 +/- 11.40 mm Hg and for group PC is 96.62 +/- 12.19 mm Hg.

The mean temperature of patients enrolled for Group VC is 37.98 +/- 0.87 degree centigrade and for group PC is 37.92 +/- 0.89 degree centigrade. The mean PaO2/FiO2 ratio of patients enrolled for Group VC is 101.77 +/- 36.91 and for group PC is 102.01 +/- 39.41. The mean urine output of patients enrolled for Group VC is 0.82 +/- 0.31 ml/kg/hr and for group PC is 0.91 +/- 0.30 ml/kg/hr. The mean blood urea of patients enrolled for Group VC is 29.90 +/- 15.63 mg/dl and for group PC is 27.67 +/- 22.83 mg/dl. The mean total leucocyte count of patients enrolled for Group VC is 12161 +/- 7584 /cu mm and for group PC is 12750 +/- 7849/ cu mm. The mean serum sodium of patients enrolled for Group VC is 142.32 +/- 7.36 mg/dl and for group PC is 141.98 +/- 6.85 mg/dl. The mean serum bicarbonate of patients enrolled for Group VC is 16.46 +/- 3.08 mEq and for group PC is 16.09 +/- 3.23 mEq. The mean GCS score of patients enrolled for Group VC is 13.77 +/-2.08 and for group PC is 13.88 +/- 2.20. There was no significant difference in heart rate, systolic blood pressure, mean temperature, mean PaO2/FiO2 ratio, urine output, urea, total leucocyte count, potassium, serum sodium, serum bicarbonate, bilirubin, Glasgow coma scale, SAPS score across the two groups of patients enrolled for the study (p>0.05). Thus the two group were comparable. The mean PaO2 /FiO2 ratio in VC group is 96.01 +/- 15.51 and in PC group is 84.31 +/- 15.69 . The PaO2 /FiO2 ratio in VC group is significantly higher in the VC group compared to the PC group as P value is 0.001 (using student t test). Thus improved oxygenation was observed in Volume control mode as compared to pressure control mode Similar results were also found seen in the study conducted by Sarkar C et al, where The results of outcome variables were suggestive of improved oxygenation but raised airway pressure in VC group compared to PC.

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