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Short Communication

Changes in Renal Indices among Children under Mechanical Ventilation

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Abstract

Purpose: To compare renal indices in patients under mechanical ventilation and controls not undergoing the procedure.

Methods: In this comparative study, the authors determined and compared levels of serum creatinine, urine volume and glomerular filtration rate (GFR) in a group of 80 patients under mechanical ventilation and a control group of 50 patients admitted in the pediatric intensive care unit (PICU) at Tabriz Children's Hospital.

Results: Urine volume in 16% of patients in the mechanical ventilation patient group was less than 0.3 ml/kg/h (based on RIFLE formula) while in the control group, there was no decrease in urine volume and there was a significant difference between the two groups. Creatinine levels greater than 3 times normal size, was found in both groups and in mechanical ventilation group 3.7% of the patients had an increased amount of creatinine while there was no statistically significant difference between the two groups. Increased creatinine levels in the mechanical ventilation group, was in the range of previous studies. All patients in the mechanical ventilation group with a decrease in GFR above 75%, died.

Conclusion: Critically ill children admitted to PICU undergoing mechanical ventilation are at risk of acute renal failure and changes in urine volume could be used as an alerting measure for acute renal failure in these patients.

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Introduction

Acute renal failure is a relatively common phenomenon in critically ill patients admitted to the PICU. Although the prevalence is between 1 to 15 percent, but its association with increased mortality risk for these patients is approximately 78% [1].

The possibility of infection in patients with acute renal failure is three times greater than those who are not suffering from acute renal failure [2]. Other complications of acute renal failure is anemia and respiratory failure. Respiratory failure and invasive treatments such as mechanical ventilation can lead to worsening renal failure, increased mortality, and increased length of stay in the hospital [3].

Valta et al. (1999) conducted a study and showed that among 50 children who were bedridden in PICU under mechanical ventilation, 12.8 percent of them had creatinine increase 1.5 times more than the amount before ventilation after 24 hours.

Thaker specified that 27.8 percent of children who were under mechanical ventilation had creatinine increase more than 0.3 mg/dl in comparison with before ventilation after 48 hours [2].

In the study of Hoste et al on 40 mechanically ventilated children, they showed that 15.8 percent of them had decrease in urine volume less than 0.3 ml/kg/h after 48 hours [4].

Ranier et al. showed that mechanical ventilation causes various changes in neural-hormonal system; that increases sympathetic response, activates Renin-angiotensin-aldosterone system and increases vasopressin secretion. These effects cause contraction of renal vessels and systemic vessels and leads to sodium and liquid re-absorption increase; also, this way blood flow of kidney and filtration rate of kidneys are increased [5]. In the study of Harken et al. on 50 mechanically ventilated children, 14.7% had GFR decrease more than 50% (during the first 24 hours after ventilation beginning) [6].

In the survey by Dannaho et al. from 40 children under

mechanical ventilation in PICU, 5.7% had creatinine increase more than 3 times that 81% of them passed away [7].

Methods

It was a comparative study conducted through years 2009 and 2010, in which, 80 patients under mechanical ventilation were enrolled to be compared with 50 controls with respect to some renal indices. The patients in mechanical ventilation group were selected through a consecutive convenient sampling of those transferred from pediatric emergency care unit to intensive care unit (ICU) and mechanically ventilated for at least 72 hours since PICU admission.

Control group comprised of 50 children including the patients bedridden in intensive care unit. None of the control group patients had received invasive interventions for improvement of breathing conditions.

The participants underwent scholarly monitoring of clinical and laboratory status focused on renal function assays at least for a period of 72 hours

Creatinine of these patients in a period of at least 72 hours since PICU admission was under control and the volume of urine and serum creatinine was measured. All cases which had electrolyte or water disorder or the patients under treatment with nephrotoxic drugs were excluded from the study.

Independent t-test and chi-square tests were used to analyze data. A p-value less than 0.05 was considered as statistically significant.

Ethical Considerations

All the tests of this study were among the routine tests of intensive care unit of Tabriz children hospital and Foley catheter placement for urine collection is also used usually for all hospitalized patients in this unit. No extra financial costs or physical operation has been applied.

The children suffering from cardiac insufficiency, serve congenital malformation, using nephrotoxic drugs while the research, dehydration or existence of surgical symptoms such as peritonitis or existence of colostomy fistula or disposal of intangible fluids via skin such as burn or disposal of fluid in third space such as severe edema or edema in fluids disposal from capillary leak such as septic shock or chronic renal failure and patients gotten doses more than 10 mcg/kg/min of dopamine or patients under CPR were excluded from the study.

Mechanical ventilation based on indication: is applied for patients including apnea and breathe insufficiency along with oxygen pressure decrease less than 50 mm Hg and/or carbon dioxide pressure increase more than 60 mm Hg which does not response to non-aggressive respiratorics.

For these patients, creatinine is recorded as soon as they enter and while confinement according to the day after confinement. The amounts exceeding the normal rate according to the age is calculated via the following formula:

$$\text{PCR (mg/dl)} = 0.18 + 0.032 * \text{age (year)}$$

Results

All 130 participants including 80 mechanically ventilated children (MVC) and 50 control group children were investigated by the end of study period. Mean age of participants was 15.53± 2.76 months for mechanically ventilated children and 13.56± 2.95 months for control group without statistically significant difference (P= 0.5). Boys comprised 43 % and 41 % of the participants in MVC and control groups respectively and the remainder were girls.

Urine volume was less than 0.3 ml/kg/hr in 0.16 % of the MVC group, while such a decrease of urine volume was not observed in control group. The observed difference between the two groups was found to be statistically significant (P<0.01). Considering the comparison of creatinine above three times in two groups, 3.7% of patients in MVC group had increased creatinine while there was not such an increase in control group. There was not any statistically significant difference observed and the creatinine increment was within the expected range. Out of the 80 patients in MVC group, 14 children (17%) had a 50-25% decrease in GFR, while in control group one

patient had 50-25% decrease in GFR (P= 0.03).

Ventilation for 48 hours has not any significant effect on electrolyte changes.

Mean serum sodium level in MVC group was 135.25± 1.78 mEq/L and mean serum sodium level in control group was 137.25± 1.55 mEq/L (P= 0.5). Mean serum potassium levels in MVC group and control group were 4.8± 0.75 mEq/L and 4.7± 0.44 mEq/L respectively without a statistical significance (P= 0.45).

Two patients under ventilation who had decreased GFR more than 75% after 48 hours, died in hospital. After 48 hours, ventilation of two patients (3.7%) with decreased GFR was above 75%. From these patients, 8 (10%) children in MVC group had a decrease in urine volume. ventilation for 24 to 48 hours was not found to be associated with metabolic acidosis and blood pressure changes of the patients in case group.(P=0.43 and 0.32 respectively)

Discussion

Renal and electrolytic complications are well known phenomena in patients bedridden in intensive care units that ignoring these factors could lead to higher mortality and length of stay or imposing large expenses on patients. It has been shown that ventilated patients in pediatric intensive care units children (PICU) had different levels of kidney functionality.

According to the results of previous research conducted in this field, patients with renal failure have tendency for infection, anemia, acidosis and electrolyte disorders. The present study also showed that child patients under ventilation have significant renal failure according to investigations on decrease of urine volume. Also, there was a statistically significant association between renal failure and mortality rate. In the study by Pannu measuring urine volume in ventilated patients after 48 hours, it became clear that from 50 patients, 6 people i.e. 12 percent of total patients had a decrease of less than 0.3 ml/kg/hr in urine volume, however in our study the prevalence was 16% [8].the percentage of mechanically ventilated patients after 48 hours, who had more than 75% decrease in GFR was 1.5 In the study of Harken et al., while it was 3.7 in our study.

Hebert et al. investigated creatinine level in mechanically ventilated patients in the first 24 hours and found that 11.5% of patients had their creatinine level increased more 1.5 times (being checked every 6 hours) but unfortunately it was impossible for us to measure creatinine every 6 hours [9,10]. Ranier et al. showed that nearly 13.9% of ventilated patients had their urine volume decreased to less than 0.3 ml/kg/hr after 48 hours of ventilation, and the present study just confirmed the issue [5]. In the research by Valta, there was a statistically significant association between electrolyte changes and infection rate among ventilated patients with renal failure, while in present study, there was not such a significant relationship.

Preibe showed that from 60 patients being under ventilation for 48 hours, three patients (5%) had increased creatinine more than three times above normal rate which was not significant and the result was same as the present study [11]. In the study by Rabb et al. on 50 mechanically ventilated patients after 48 hours, it was shown than 3.5% of them got decreased GFR more than 75% while the results were consistent in the present study [12]. Hoste et al. didn't find an association between ventilation and concentrations of sodium and potassium among 60 studied patients, while in the present study such an association was not explored [4]. In line with our study, Meldrum et al. showed that the rate of infection in 60 ventilated patients after 48 hours didn't increase significantly [7]. Consistent with our study, Imai et al in a study on 50 patients under mechanical ventilation, found that 15.7% of them had decreased urine volume below 0.3 ml/kg/h after 48 hours that was quite consistent with our results [13].

The present study showed that mechanically ventilated patients have decreased urine volume to less than 0.3 ml/kg/h after 24-48 hours of ventilation which was considered significant. Also, considering the creatinine level and GFR after 48 hours the

prevalence of renal failure was 3.7% which is in consonant with previous studies. Unfortunately, all the patients with an increase in creatine level of more than 3 times baseline (renal failure) died.

Suggestions: It is recommended to assess urine volume of mechanically ventilated patients in the first 48 hours, as an important index of renal failure. In case of availability of laboratory facilities and if required, creatinine investigation and GFR determination in first 24 hours is also very helpful to determine renal failure. Using kidney protective methods as preventative action such as adjusting dosage of drugs and regulating nephrotoxic drugs and preventing dehydration and also using vasoactive medicine for mechanically ventilated patients could be useful to prevent kidney complications.

Conflict of interests: The authors declare no conflict of interest.

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