Frequency of metabolic acidosis in children admitted to pediatric intensive care unit of a tertiary care hospital, Karachi: Prospective observational cohort study

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Abstract

Objective: Metabolic acidosis (MA) is the most frequent acid-base disorder in the pediatric intensive care unit (PICU). The aim of this study is to determine the frequency of MA in children on admission in the first 24 h of PICU.

Methods: A prospective observational cohort study was conducted in a closed PICU from August 2015 to June 2016. All consecutive children who admitted to PICU were screened for MA. MA is defined as base deficit (BD) ≥ −5 mEq/l. Demographic data, clinical variables, and blood gas data were collected on structured data collection sheet and appropriate statistical test applied for analysis.

Results: A total of 200 children were enrolled in the study. The mean age was 63.20 ± 61.31 months and males were 56%. The frequency of MA in our cohort was 44%. The mean BD was 10.4 ± 4.9 in a group of MA as compared to −2.34 ± 5.4 in group without MA. The use mechanical ventilation, inotropic support, and renal support were higher in MA cohort as compared to cohort without MA. The mortality rate was also high in group of MA as compared to other groups (25% vs. 12.5%) (P = 0.014).

Conclusion: The frequency of MA is high in critically ill children on admission to PICU, and it is associated with increased length of stay and high mortality rate.

Keywords: Base deficit, metabolic acidosis, mortality, pediatric intensive care unit

BACKGROUND

Acid-base disorders are common in intensive care units. Metabolic acidosis (MA) is the most common acid-base abnormalities in critically ill patients. MA is reported about 65% in adult intensive care unit and 46% of all children admitting to pediatric intensive care unit (PICU). MA can be measured as pH, base deficit (BD), serum bicarbonate, anion gap, or strong anion gap in the published literature. MA is at least a contributory factor to organ dysfunction, altered oxygen delivery, increased respiratory workload in spontaneously breathing patients, decreased adenosine triphosphate (ATP) production, and impairment of immune response. Large bodies of data demonstrated that the high BD in various acute critical care conditions such as...
hypovolemic shock, septic shock, and severe trauma can help in early detection of abnormal physiological internal milieu and prompt intervention can improve the outcome. The presence of MA is associated with higher morbidity and mortality.[4,5] The etiology of MA in critically ill or injured children is the result of the primary disease or the effects of organ dysfunctions. Several papers have reported the incidence of MA on admission to intensive care unit.[1,3,8] There is a paucity of data on the frequency of MA in critically ill children.[2,6] The objective of this study is to assess the frequency of MA prospectively in critically ill or injured children on admission to a multidisciplinary PICU of a tertiary care hospital.

METHODS

This is a prospective observational study conducted in PICU of Agha Khan University Hospital (AKUH), Karachi, from August 2015 to June 2016 after approval of Local Ethical Review Committee (4371-Ped-ERC). This is a descriptive and noninterventional study. The PICU of AKUH is a 12-bedded closed, multidisciplinary cardiothoracic unit, with annual admission approximately 1200 per year. This PICU is equipped with advanced technology, including blood gas analyzer with one to one nursing and has a fellowship training program in pediatric critical care medicine. All children (age from 1 month to 16 years old) admitted to PICU during the study were enrolled for the study. The arterial blood gas was done within the first 24 h of admission on Cobas 6000 (Roche Diagnostics, Indianapolis, USA) after obtaining informed consent. The MA for study purpose is defined as BD ≥5 on arterial blood gas sample.[6] The frequency of MA on admission to our PICU was 22% during 3 months from our PICU database (unpublished data). The sample size is calculated on 22% of patients admitted to pediatric ICU with MA. Using 95% confidence interval, and absolute precision of 0.06, we need 184 pediatric ICU patients to detect MA. The following data were collected on structured data collection sheet: demographic variables such as age and gender, clinical data including admitting diagnosis, PRISM III score (for severity scoring system), presence of organ dysfunction, intensive care unit interventions for organ supportive care and outcome data as the presence of MA, length of stay and survival as alive or expired on this admission. The patients stayed <24 h in PICU and patients with respiratory acidosis were excluded. Data were expressed either as frequency or percentages and appropriate statistical test were applied for analysis using SPSS version 19. P < 0.05 is considered statistically significant.

RESULTS

During the 8-month study, 200 patients were admitted to PICU. The baseline patients’ characteristics were described in Table 1. The mean age was 63.20 ± 61.31 months and almost more than half were male (56%). The most admitting diagnostic categories were acute cardiovascular dysfunction including shocks (27%), acute neurological illnesses (22%), and acute respiratory illnesses (15.5%). The presence of MA on admission was observed in 44% (88) during the study among critically ill or injured children. The mean BD was observed 3.5, 10.4, and 2.3 among all children, exposed (the presence of MA) and unexposed (the absence of MA), respectively. The average PRISM III score, use of intensive care therapies and length of PICU stay was higher among cases as compared to control. However, they were not statistically significant except the use of mechanical ventilation (P = 0.036). The mortality rate was higher in children with MA (18.5%) as compared to children without MA (12.5%) (P = 0.014).

DISCUSSION

We observed the presence of MA in critically ill or injured children in 44% on admission to our PICU. Kim et al. reported 61% of MA on admission in critically ill or injured children based on corrected anion gap from a multidisciplinary PICU.[2] Durward et al. investigated 540 blood gas measurements in their PICU, 46% of the sample size has MA based on sodium and chloride difference.[2] The clinical parameters for the assessment of tissue hypoperfusion such as blood pressure, urine output, and capillary refill are the late signs.[8] The delay in the recognition of shock increased the rate of mortality in acutely ill patients. Many clinical reports showed that the presence of MA especially lactic acidosis is used as a surrogate marker of early resuscitation and predictor of mortality in septic shock and postcardiac surgery.[9,10] The blood lactate level is not readily available in many settings especially in resource-limited countries. The BD can be used as an alternative of lactate in the early recognition of high-risk clinical scenario, guide in the appropriate resuscitative measures and may improve the

Table 1: Patients’ characteristics

| Variable               | All, n (%) | MA+, n (%) | MA−, n (%) | P    |
|------------------------|------------|------------|------------|------|
| Numbers of patients    | 200 (100)  | 88 (44)    | 112 (56)   |      |
| PRISM III              | 16.6±8.4   | 17.7±9.8   | 15.8±7.8   | 0.036|
| Use of MV              | 120 (60)   | 60 (68)    | 59 (53)    |      |
| Use of inotropes       | 103 (51)   | 44 (50)    | 59 (53)    |      |
| LOS                    | 4.6±4.9    | 5.5±6.5    | 3.9±3.9    | 0.014|
| pH                     | 7.3±0.14   | 7.2±0.15   | 7.3±0.09   |      |
| BD                     | −3.5±8.1   | −10.4±4.9  | −2.3±5.4   |      |
| Mortality              | 37 (18.5)  | 23 (26.1)  | 14 (12.5)  | 0.014|

MA: Metabolic acidosis, MV: Mechanical ventilation, BD: Base deficit
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Outcome of acute critically ill patients. The use of “BIG score” has been used in the assessment of severity as well as prognostication of pediatric polytrauma includes BD, international normalized ratio, and Glasgow coma scale.\(^{[11]}\)

BD is defined as the amount of strong base that must be added to each liter of fully oxygenated blood to return the pH to 7.40 at a temperature of 37°C and a PCO\(_2\) of 40 mmHg. Smith et al.\(^{[12]}\) have reported that the high BD on admission is associated with higher organ dysfunction scores and higher mortality rate. Montassier et al.\(^{[13]}\) also reported that the BD can be used as a screening tool in adult sepsis in emergency room for prompt resuscitative measures and a higher level of care. There is a limited published pediatric data on BD in acutely ill children.

There were several limitations in our study, including small sample size, single-center, and limited data. The strength of this study is the prospective cohort and from a developing country.

CONCLUSION

The frequency of Metabolic Acidosis is high in critically ill children on admission in PICU and it is associated with increased length of stay and high mortality rate.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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