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Evaluation of Serum Potassium and Blood Sugar Changes Following Nebulized Levosalbutamol in Pediatric Patients

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ABSTRACT

Objective: Levosalbutamol is widely used in pediatric patients for the management of bronchospasm. However, its systemic effects on serum potassium and blood sugar levels remain a concern. This study aims to evaluate the effect of nebulized levosalbutamol on serum potassium and blood sugar level in children between 1 year and 12 years of age.

Method: A cross-sectional observational study was conducted from May 2023 to November 2024 at Sharda Hospital, including 64 patients receiving Levosalbutamol nebulisation at 0,20,40 minutes in IPD. Serum potassium and blood glucose levels were measured before and after nebulization. Data was collected using a study proforma to record pertinent information including serum potassium levels, blood sugar levels and heart rate. Other factors that were observed included age, gender and type of respiratory illnesses. The statistical significance of changes was analyzed using paired t-tests, with p values ≤ 0.05 considered statistically significant.

Results: A significant decrease in serum potassium levels was observed post-nebulization ($p < 0.05$), along with a concurrent increase in blood glucose levels ($p < 0.05$). These metabolic changes were more pronounced in younger children and those receiving multiple doses.

Conclusion: Nebulized levosalbutamol induces significant hypokalemia and hyperglycemia in pediatric patients. Clinicians should monitor these parameters, particularly in patients at risk for electrolyte imbalances or glucose metabolism disorders.

Keywords: *Levosalbutamol, Serum Potassium, Blood Sugar, Pediatric, Nebulization*

1. INTRODUCTION

Acute respiratory illnesses (ARIs) are a major cause of morbidity and hospitalization in pediatric patients1, often requiring the prompt administration of bronchodilators to relieve bronchoconstriction. Beta-2 agonists, particularly short-acting beta-2 agonists (SABAs) such as salbutamo[1] and levosalbutamol, are widely used for their rapid bronchodilatory effects. Levosalbutamol, with its more selective β2 action, is preferred in pediatric patients due to its reduced β1-mediated side effects, such as tachycardia and arrhythmias[2].

Despite their therapeutic benefits, beta-2 agonists can lead to adverse metabolic effects, including hyperglycemia and hypokalemia3. These effects occur due to increased cAMP activity, which stimulates glycogenolysis, raises blood sugar levels, and alters intracellular potassium balance. Frequent nebulization with levosalbutamol, particularly in children with

abnormal glucose homeostasis or electrolyte imbalances, may exacerbate these side effects, leading to complications such as muscle weakness, cardiac arrhythmias, and metabolic disturbances.

While studies in adults have highlighted these metabolic effects, research on the pediatric population remains limited4 . Given the widespread use of nebulized levosalbutamol in children, there is a need to evaluate its impact on serum potassium and blood glucose levels. This study aims to address this gap by assessing the clinical importance of monitoring these parameters during nebulization, ensuring safer management of ARIs in pediatric patients.

2. METHOD

This cross-sectional observational study was conducted over a period of 18 months, from May 2023 to May 2024, in the Pediatrics Inpatient Department (IPD) at Sharda Hospital. The study focused on parents of children aged 2-12 years who were admitted in the Pediatrics IPD during this time. A total of 64 parents were included in the study based on inclusion exclusion criteria during study duration. Prior to initiating the research, approval was obtained from the Institutional Ethics Committee, and informed written consent was secured from the parents of all children participating in the study, ensuring voluntary and ethical participation. The study had no conflicts of interest.

Tests conducted included serum potassium and random blood sugar. Levosalbutamol nebulization (dose: 0.31 mg for <4 years, 0.63 mg for >4 years)5 was administered using a jet nebulizer (10 mL capacity, 0.5 mL/min rate, 0.5–10 µm particle size). Under aseptic conditions, 3 mL of venous blood was collected before nebulization (baseline levels) and again after 60 minutes of therapy at 0, 20, and 40-minute intervals, prior to other treatments. Samples were processed in the central laboratory using Vitroz 5600 5.1 (automated biochemistry analyzer). PRESS scoring6 was done to categorize mild, moderate and severe respiratory distress

Statistical analysis : All data, including demographic details, serum potassium and blood sugar levels, and heart rate, were entered into Microsoft Excel and analyzed using SPSS version 22. Normality of continuous variables was assessed using the Kolmogorov-Smirnov test, based on which either the paired t-test (for normally distributed data) or the Wilcoxon sign-rank test (for non-normally distributed data) was applied to compare pre- and post-nebulization values. Quantitative data were expressed as mean and standard deviation, while categorical data were presented as percentages. The Chi-square test or Fisher's exact test was used to compare proportions, with a p-value ≤ 0.05 considered statistically significant. Pearson's correlation coefficient was used to evaluate the relationship between levosalbutamol dosage and changes in serum potassium and blood sugar levels, aiming to elucidate the drug's impact on these biochemical parameters.

3. RESULT AND DISCUSSION:

Table 1: Baseline Characteristics

Characteristics	n = 64
Age	
1-4yrs	30 (46.8%)
4-8yrs	22 (34.4%)
8-12yrs	12 (18.8%)
Gender	
Males	40 (62.5%)
Females	24 (37.5%)
Respiratory distress	
Mild	8 (12.5%)
Moderate	56 (87.5%)
Type of Respiratory illness	
Bronchiolitis	15 (23.4%)

LRTI with wheeze	26 (40.6%)
Reactive airway disease	11 (17.2%)
Bronchial Asthma	11 (17.2%)
Laryngotracheobronchitis	1 (1.6%)

Table 1 shows the baseline characteristics. In our study the majority of children are in the 1–4 years group (46.8%), 34.3% in 4–8 years and 18.7% in 8–12 years. This distribution indicates that nearly two-thirds of the participants are under 6 years of age, which may influence the dosing and clinical response to nebulised levosalbutamol. The gender distribution in the study shows a predominance of males, accounting for 62.5% (40 out of 64) of the sample, whereas females constitute 37.5% (24 out of 64). This skewed distribution might reflect either the epidemiology of the respiratory conditions studied or recruitment trends. Although gender did not significantly influence the dose of levosalbutamol administered, noting the demographic breakdown is important for understanding potential differences in clinical response and for planning subgroup analyses in future research.

Table 2: Descriptive Statistics

Descriptive Statistics						
	n	Minimum	Maximum	Mean	Std. Error	Std. Deviation
Serum Potassium before nebulisation (mEq/L)	64	3.9	5.2	4.763	.0352	.2820
Serum Potassium after nebulisation (mEq/L)	64	3.33	4.90	4.177	.0341	.2728
RBS before nebulisation (mg/dl)	64	89	118	103.97	.74	5.90
RBS after Nebulisation (mg/dl)	64	99	128	115.41	.82	6.59

Table 2 presents the descriptive statistics of key clinical parameters recorded before and after nebulization with Levosalbutamol among the study population (n = 64).

- Serum potassium levels showed a notable decrease post-nebulization, with a mean reduction from 4.763 mEq/L to 4.177 mEq/L. The minimum potassium level dropped to 3.33 mEq/L after nebulization, highlighting a potential risk of transient hypokalemia. Only one patient had significant hypokalemia (2.3mEq/L).
- Random blood sugar (RBS) levels increased following nebulization, with a mean pre-nebulization RBS of 103.97 mg/dL rising to 115.41 mg/dL post-nebulization. This increase suggests a hyperglycemic effect of Levosalbutamol.

Table 3: Serum Potassium Before vs. After Nebulisation with Levosalbutamol in study population

Paired Samples Test							
		Paired Differences			t	df	P-value
		Mean	Std. Deviation	Std. Error Mean			
Pair	Serum Potassium before nebulisation (mEq/L) - Serum Potassium after nebulisation (mEq/L)	0.58516	0.2271	0.02839	20.613	63	0.001

Table 3 shows that the paired t-test for serum potassium reveals a significant decline following nebulisation as described by table 8. The mean serum potassium level dropped from 4.76 mEq/L (SD = 0.2820) before treatment to 4.18 mEq/L (SD = 0.2728) after treatment. This produces a mean difference of 0.58516 mEq/L (SE = 0.02839), with a t-value of 20.613 (df = 63) and a p-value of 0.001 which is statistically significant. The significant reduction supports the pharmacological action of levosalbutamol, which promotes the intracellular shift of potassium. This result is critical for clinicians to monitor, as significant hypokalemia may have clinical implications, particularly in vulnerable pediatric populations.

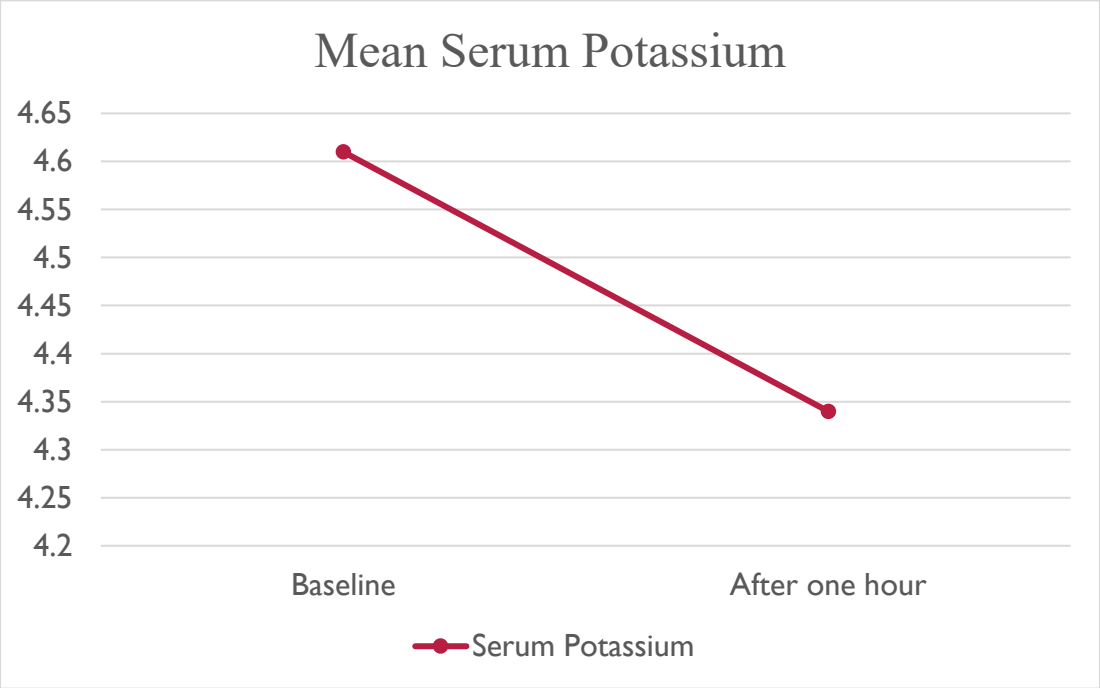

Figure 1 : Mean serum potassium before and after nebulisation with Levosalbutamol in the study population

Figure 1 shows the mean potassium level before and after nebulisation with levosalbutamol.

Table 4: RBS Before vs. After Nebulisation with Levosalbutamol in study population

Paired Samples Test							
		Paired Differences			t	df	P-value
		Mean	Std. Deviation	Std. Error Mean			
Pair	RBS before nebulisation (mg/dl) - RBS after Nebulisation (mg/dl)	-11.437	4.346	.543	-21.055	63	0.001

Table 4 shows that the paired t-test for random blood sugar (RBS) is statistically significant with increase post-nebulisation. The mean RBS rose from 103.97 mg/dL (SD = 5.90) before treatment to 115.41 mg/dL (SD = 6.59) after treatment. The mean difference is -11.44 mg/dL (SE = 0.543) resulting in a t-value of –21.055 (df = 63) and a p-value of 0.001 which is statistically significant. This significant elevation in blood sugar levels aligns with the known metabolic effects of β_2 agonists, which can induce hyperglycemia. Clinicians should be aware of this effect, particularly in patients with predisposing metabolic conditions.

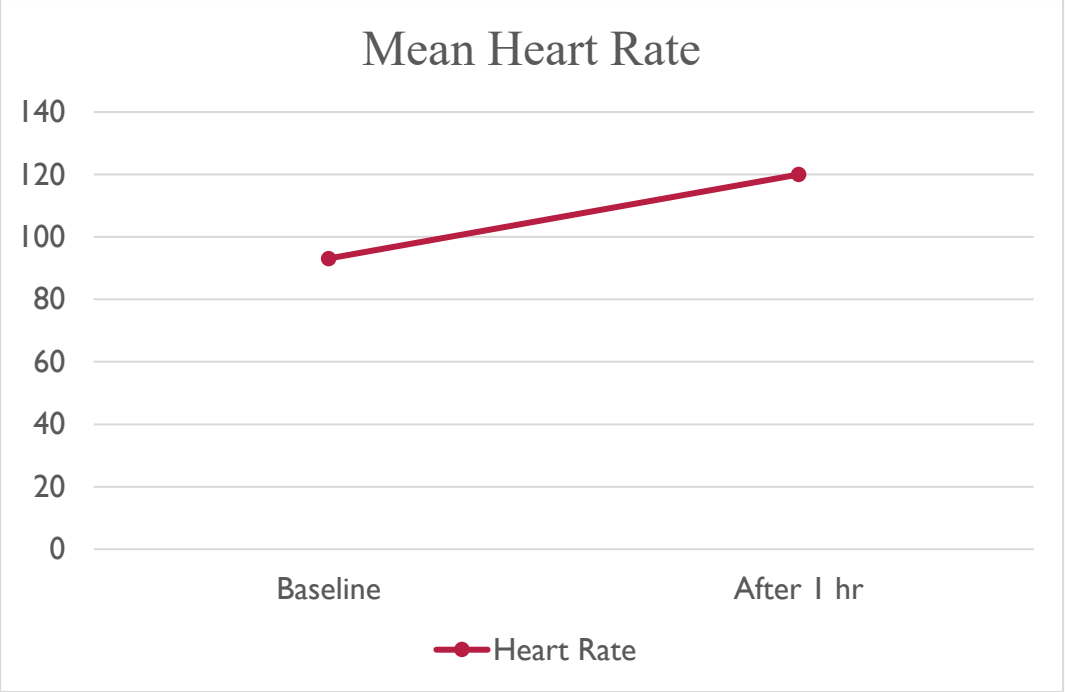

Figure 2: Mean blood sugar levels before and after nebulisation with Levosalbutamol in the study population

Figure 2 shows the blood sugar levels before and after nebulisation with levosalbutamol.

This study aimed to assess the impact of nebulized levosalbutamol on serum potassium and blood sugar levels in children aged 1 to 12 years diagnosed with acute respiratory illnesses. A total of 64 pediatric patients were included in the study. The study evaluated physiological changes pre- and post-levosalbutamol to assess its bronchodilatory benefits and potential side effects. This investigation focused on quantifying the changes in heart rate, serum potassium, and blood sugar levels, providing a detailed insight into the metabolic and cardiovascular responses elicited by the treatment. Understanding these changes is crucial because, while levosalbutamol is widely employed to relieve bronchospasm and improve airway patency, its systemic effects may have significant clinical repercussions, particularly in a vulnerable pediatric population.

A notable increase in heart rate post-treatment aligns with the expected pharmacologic response to β2-agonists. The mean rise of 20.36 bpm is consistent with previous reports, including Phumeetham et al.7, who documented significant heart rate elevations in children treated with high-dose continuous albuterol. Additionally, Ramanathan and Mahalakshmi8 found that levosalbutamol monotherapy produced modest heart rate increases, further supporting our findings. Lahiri9 noted that levosalbutamol tends to cause a smaller HR increase compared to racemic salbutamol, a trend partially reflected in our study. While tachycardia is a recognized side effect, its clinical relevance must not be overlooked, particularly in children with underlying cardiac conditions. The need for careful cardiovascular assessment before and during nebulization is paramount to prevent potential complications, such as arrhythmias or increased myocardial oxygen demand.

The decrease in serum potassium levels following nebulization corroborates established knowledge regarding β2-agonist-induced intracellular potassium shifts. The observed mean reduction of 0.59 mEq/L aligns with findings from Zitek et al.10, who reported a 0.5 mEq/L potassium decrease in healthy adults receiving nebulized albuterol. Similarly, Al-Azzawi et al.4 noted a 0.7 mEq/L drop in asthmatic patients, and Bakolia et al.11 documented a 0.8 mEq/L decrease in pediatric patients. This consistency in findings highlights the necessity for monitoring electrolyte levels, especially in patients requiring repeated nebulization or those with baseline electrolyte imbalances. The potential for hypokalemia to contribute to arrhythmogenesis further emphasizes the importance of proactive electrolyte assessment and correction in high-risk individuals.

The recorded increase in random blood sugar levels underscores the metabolic effects of levosalbutamol. The mean elevation of 11.44 mg/dL, though modest compared to some previous reports, remains clinically relevant. Al-Azzawi et al.4 reported a 1.5 mmol/L (approximately 27 mg/dL) increase in blood glucose levels post-nebulization in asthmatic patients, while Bakolia et al.11 observed a rise of 1.8 mmol/L in pediatric patients. Zitek et al.10 also documented significant metabolic alterations following nebulization in healthy volunteers, reinforcing that even in the absence of overt disease, β2-agonists can significantly impact glucose homeostasis. Awareness of this metabolic impact is crucial in managing pediatric patients, ensuring that glycemic control is maintained, particularly in those predisposed to fluctuations in blood sugar levels.

The moderate PRESS scores observed in the study indicate that while children experienced significant bronchospasm, oxygenation remained largely unaffected. This supports the conclusion that levosalbutamol effectively relieves airway obstruction without exacerbating respiratory distress to a critical level. Ramanathan and Mahalakshmi8 reported that children with moderate asthma exacerbations managed with levosalbutamol had PRESS-like scores that correlated with modest improvements in pulmonary function. Similarly, Sharma et al.12 compared levosalbutamol with racemic salbutamol and noted that improved lung function (as measured by FEV1) corresponded with lower clinical severity scores and fewer adverse events. The relatively uniform PRESS scores within the cohort suggest that the findings are broadly applicable, further validating the study's clinical relevance. Comparisons with prior literature, such as those by Rabbany et al.13 and Ramanathan & Mahalakshmi8, further validate that levosalbutamol can be safely administered with appropriate monitoring. Clinically, these findings advocate for routine monitoring of heart rate, serum potassium, and blood glucose levels to preempt adverse effects and optimize patient safety.

Further research should focus on refining dosing regimens to balance efficacy and safety, particularly in the pediatric population. Investigating adjunctive therapies that mitigate systemic side effects while preserving bronchodilatory benefits could enhance clinical outcomes. Additionally, long-term studies assessing the cumulative effects of repeated nebulization could provide valuable insights into optimizing treatment protocols. Ultimately, the findings of this study contribute to the ongoing effort to improve pediatric respiratory care, ensuring that levosalbutamol administration remains both effective and safe.

These findings are particularly important for guiding dosing strategies and ensuring that the treatment is both effective and safe. Ultimately, the insights gained from this research will contribute to optimizing treatment protocols, enhancing patient safety, and improving outcomes in the management of pediatric respiratory illnesses by balancing the therapeutic benefits of levosalbutamol against its possible metabolic and cardiovascular risks.

What this study adds?

- This study evaluates the systemic effects of nebulized levosalbutamol in children with acute respiratory illnesses, highlighting its impact on serum potassium, and blood sugar levels. While it provides effective bronchodilation, its potential risks necessitate careful monitoring, especially in vulnerable pediatric patients.
- Standardized nebulization protocols, individualized treatment plans, and healthcare provider education on these metabolic effects are crucial to ensuring patient safety and optimizing clinical outcomes.

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