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Prevalence of Hyponatremia in Patients with Moderate to Severe Bronchiolitis

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Author`s Contribution

[1,2]Substantial contributions to the conception or design of the work; or the acquisition, [4,6]Active participation in active methodology, [3]analysis, or interpretation of data for the work, [5]Drafting the work or revising it critically for important intellectual content, [3]Final Approval

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ABSTRACT

Objective: To estimate the frequency and severity of hyponatremia in infants hospitalized with moderate–severe bronchiolitis and to assess its association with the severity of disease and length of stay (LOS).

Methodology: It was a single-centre cross-sectional study of consecutive infants with moderate–severe bronchiolitis conducted at Pediatric Medicine Department, Federal Government Polyclinic (FGPC) Hospital, Islamabad, from 01-11-2023 to 30-04-2024. Patients were selected by clinical diagnosis using Pediatric Respiratory Severity Score (PRESS) at presentation. Serum sodium was measured and hyponatremia categorized by standard thresholds. Associations with clinical severity and LOS were tested with chi-square and correlation analyses. Multivariable logistic regression was applied to adjust for confounding variables like age and gender. SPSS version 27 was used for analysis and a P<0.05 was considered significant.

Results: Data of total of n=135 eligible infants were analysed. Hyponatremia was found in 62.2% of cases (mild 63.1%, moderate 36.9%, severe 0%) and was significantly associated with bronchiolitis severity (P<0.001) and longer durations of hospital stay (P<0.001). Serum sodium showed a strong negative correlation with PRESS (r=-0.712; P<0.001) and LOS (r=-0.594); P<0.001). In multivariable adjusted models, severe (vs moderate) bronchiolitis carried markedly greater odds of a higher hyponatremia category (aOR 6.27; 95% CI 2.25–17.45; P<0.001).

Conclusions: In infants with bronchiolitis, a low admission serum sodium levels track with higher PRESS and longer LOS. An admission sodium check is recommended along with PRESS-based triage. This will help in identifying children who need closer observation.

Keywords: Bronchiolitis; Hyponatremia; Paediatric; PRESS; Length of stay; Isotonic fluids.

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Introduction

Bronchiolitis is the most common lower respiratory tract infection in infancy. It is marked by acute inflammation and obstruction of small airways with overproduction of mucus and bronchospasm. Clinical presentation generally includes tachypnoea, retractions, crackles/wheeze, and feeding difficulty.[1,2] While respiratory syncytial virus (RSV) is a predominant aetiology, other viruses such as rhinovirus, parainfluenza, and human metapneumovirus also involves in seasonal burdens.[3,4] In 2015 there were an estimated 33.1 million episodes of RSV-associated acute lower respiratory infection (LRTI) in under 5 years children.[5] These findings align with later reports highlighting RSV as a major cause of paediatric hospitalizations and mortality worldwide.[6] Diagnosis is largely clinical; routine chest radiography and broad viral testing infrequently change management in uncomplicated cases.[2,7] Patterns of clinical practice and outcomes vary across centres and health systems.[8] The Paediatric Respiratory Severity Score (PRESS) offers a practical approach to standardize grading in emergency and inpatient settings. It includes clinical signs like respiratory rate, oxygen saturation, work of breathing, and feeding/hydration for assessment of severity.[9]

Management remains predominantly supportive Oxygenation, hydration and nasal suctioning are the main initial stay. Bronchodilators, corticosteroids, MgSO4 and antibiotics show inconsistent benefits in unselected infants.[2,7,10] In moderate and severe disease high-flow nasal cannula (HFNC) improves physiologic parameters in situations of failing standard oxygen therapy.[11,12]

Electrolyte disturbances, particularly hyponatremia, are increasingly recognized in paediatric respiratory infections, including bronchiolitis. In a large single-centre cohort of around four thousand paediatric respiratory infection admissions, hyponatremia occurred in 13.5% and correlated with markers of inflammation and longer hospital stay.[13] Among hospitalized bronchiolitis infants, hyponatremia was 17.4% in one tertiary-care series.[14]

Locally relevant data from Pakistan show lower burden: hyponatremia was present in 4.9% at admission.[15] Non-osmotic arginine vasopressin release (triggered by hypoxemia, hypercapnia, stress, and nausea) and iatrogenic free-water exposure are key drivers of hyponatremia. Clinical consequences range from feeding intolerance and lethargy to prolonged recovery have been observed in hyponatraemic cases.[16] Despite substantial disease burden, standardized evidence from Pakistan on the prevalence and clinical impact of hyponatremia in bronchiolitis is limited, especially when severity is graded with PRESS. Comparability with prior studies and local applicability is limited due to variable hyponatremia definitions, timings of sodium measurement, and illness severity mix across studies.[13-15]

Present study is a cross-sectional study of infants with moderate to severe bronchiolitis in local settings, using PRESS for standardized severity assessment. Mian objectives were to determine the frequency of hyponatremia in this cohort, and to evaluate its association with PRESS (clinical severity) and length of hospital stay (LOS

Methodology

This descriptive cross-sectional study was conducted at the tertiary-care Pediatric Medicine Department, Federal Government Polyclinic (FGPC) Hospital, Islamabad, from 01-11-2023 to 30-04-2024. The study followed the Declaration of Helsinki and received prior approval from the Ethical Committee of Federal Government Polyclinic Hospital, Islamabad (Approval letter No. FGPC. 1/12/2023, dated 30-10-2023). A written informed consent was obtained from caregivers of all the children finally included in the study. A sample size of 135 patients was calculated using the WHO sample-size calculator (version 1.1a), assuming a disease prevalence of 78%,[15] a 95% confidence level, and an absolute precision of 7%. Infants aged ≥1 to ≤24 months with clinically diagnosed moderate to severe bronchiolitis at presentation were enrolled.

Diagnosis and severity were assessed using the Pediatric Respiratory Severity Score (PRESS), which scores respiratory rate (<45/min = 0; 45–60/min = 1; >60/min = 2), ambient-air oxygen saturation (>95% = 0; 95–90% = 1; <90% = 2), chest retractions/nasal flaring (none = 0; present = 1; present with nasal flare = 2), and feeding ability (normal = 0; reduced = 1; strongly reduced = 2); severity was categorized as moderate (PRESS 4–6) and severe (PRESS ≥7). A detailed clinical history was obtained from caregivers. Each infant underwent a thorough physical examination, and medical records were reviewed with particular attention to factors influencing electrolyte balance. Children with comorbidities, which could potentially alter sodium homeostasis—cardiac, renal, chronic respiratory, metabolic, or liver disease were excluded, along with those with a history and record of recent use of medications that could affect serum sodium.

Infants presenting to the OPD and ER were consecutively assessed. As shown in Figure 1, 198 infants were screened; exclusions were due to failure to meet inclusion/exclusion criteria (n=23), and comorbidities/drugs affecting sodium balance (n=19). Few caregivers did not give consent (n=9), and follow-up reports were not complete in twelve (n=12) cases. The final analysis included 135 eligible participants. At admission, demographics, clinical parameters, and PRESS were recorded on standardized forms, and a venous blood sample was obtained for electrolytes. Hyponatremia was defined as serum sodium <135 mmol/L and subclassified as mild (130–134 mmol/L), moderate (125–129 mmol/L), and severe (<125 mmol/L). Length of hospital stay (LOS), was documented prospectively.

Data was analyzed in SPSS v27: descriptive statistics summarized cohort characteristics for continuous (mean ± SD) and qualitative variables (frequency/percentages). Bivariate analyses (Pearson correlations and independent-samples t-tests) evaluated associations among sodium, PRESS score, and LOS; categorical associations were tested with chi-square (χ^2) test. A multivariable binary logistic regression was applied to estimate the independent association between disease severity and hyponatremia category while adjusting for potential confounders like age and gender. Results are reported as adjusted odds ratios (aOR) with 95% confidence intervals (CI). A two-sided $P < 0.05$ was considered significant in all cases. Microsoft

excel 2021 and SPSS version 27 were used for data entry and analysis purpose.

Results

A total of 135 eligible infants were included in the final cohort. The participants comprised 96 males (71.1%) and 39 females (28.9%). Most were admitted via the emergency department (ER), and the majority presented with moderate disease (78/135, 57.8%). Hyponatremia was observed in 84 (62.2%) of the study participants, with 63.1% classified as mild and 36.9% as moderate. No cases of severe hyponatremia were observed in the present study cohort (Table I).

Chi-square analysis demonstrated a significant association between the category of hyponatremia and bronchiolitis severity ($P < 0.001$). A higher proportion of PRESS-severe patients (55.8%) was observed in the moderate hyponatremia group, whereas most PRESS-moderate patients (82.9%) were in the mild hyponatremia group. These proportions are illustrated in Figure 2d. Serum sodium levels differed significantly between moderate and severe disease (mean difference 3.4 mmol/L; 95% CI 1.9–4.7; $P < 0.001$).

Table I: Descriptive statistics of demographics and patient characteristics.

Variables	Number	percentage
Gender		
Males	96	71.1
Females	39	28.1
Mode of admission		
OPD	34	25.2
ER	101	74.8
Bronchiolitis severity		
Moderate	78	57.8
Severe	57	42.2
Hyponatremia		
Absent	51	37.8
present	84	62.2
Mild	53/84	63.1
Moderate	31/84	36.9
	Mean	**Std. Dev**
Age (months)	9.5	5.8
Length of Hospital stay (days)	4.81	2.2
Sodium (mmol/L)	133.6	4.4
PRESS score	5.1	1.4

Length of hospital stay (LOS) was significantly longer among infants with moderate compared to mild hyponatremia (mean difference 2.5 days; 95% CI 1.8–3.3; $P < 0.001$), and among those with severe compared to moderate disease (mean difference 1.5 days; 95% CI 0.8–2.2; $P < 0.001$). These trends are shown in Figures 2a, 2b, and 2c.

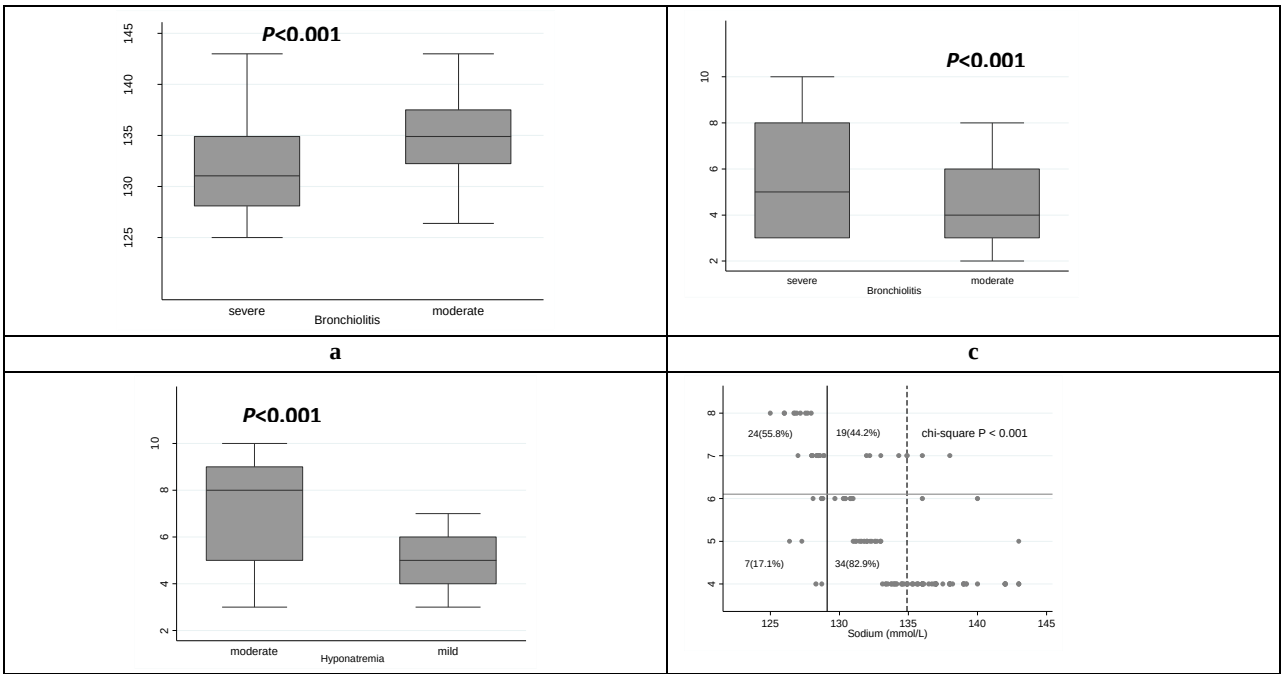

Figure II: a, b, c: Box plots showing distribution and association of variables, **a**: between disease severity and serum sodium levels (mmol/L), **b**: between disease severity and LOS (days) and **c**: between degree of severity of hyponatremia and LOS (days). **d:** scatter plot showing association between hyponatremia severity and disease severity. Solid black line is at 129 mmol/L (left < than 129 and >125 mmol/L) dashed black line is at 135 mmol/L (right ≥1 35 mmol/L) and grey solid line indicates PRESS score slightly above 6 (below 4-6 and up 7-8)

Table II: Multivariable logistic regression analysis.

Variables	B	S.E.	Wald	df	Sig. [*P*-value]	Exp(B) [OR]	95% C.I. for OR	
							Lower	Upper
Age	-.015	0.044	0.12	1	0.727	0.99	0.904	1.073
Gender	-.639	0.596	1.15	1	0.283	0.53	0.164	1.696
Severity of hyponatremia	1.836	0.522	12.35	1	**<0.001**	**6.27**	2.252	17.450

Correlation analyses revealed a strong negative correlation between serum sodium levels and PRESS scores ($r = -0.712$; $P < 0.001$), a strong positive correlation between LOS and PRESS scores ($r = 0.597$; $P < 0.001$), and a strong negative correlation between LOS and serum sodium levels ($r = -0.594$; $P < 0.001$).

After adjusting for age and gender using multivariable logistic regression (Table II), severe bronchiolitis was independently associated with increased odds of more severe hyponatremia (adjusted OR 6.27; 95% CI 2.25–17.45; $P < 0.001$). Age and gender did not show an independent significant association ($P > 0.05$).

Discussion

In this single-centre cohort of infants with moderate–severe bronchiolitis (n=135), hyponatremia at admission was observed in 62.2% (84/135). This prevalence lies between estimates from different studies of broader mixed LRTI cohorts and severe disease contexts. A Korean series encompassing 3,938 paediatric respiratory-infection admissions reported 13.5% hyponatremia. The figure is lower than rate observed in the present study, most likely due to inclusion of milder infections and diagnoses beyond bronchiolitis.[13] In a bronchiolitis-only study, among inpatient cohort, hyponatremia was present in 17.4% cases.[14] In a Karachi based study of 103 bronchiolitis admissions reported hyponatremia in only 4.9% of cases, substantially lower than most series and present study estimate.[15] This discrepancy likely reflects a case mix (inclusion of mild presentations) and proactive use of isotonic fluid. A Nepalese LRTI cohort (including bronchiolitis) reported 47.5% hyponatremia, aligning with the expectation that case-mix results in higher estimations.[16] Additional contemporary cohorts support present study findings. An Iranian single-centre inpatient study (n=61) reported hyponatremia in 47.5% of bronchiolitis admissions.[17] An Indian tertiary care cohort (n=245) found hyponatremia in 21.2%.[18] The distribution of hyponatremia severities in present study cohort (mild 63.1%, moderate 36.9%, severe 0%) are similar to category patterns in Nepal (among hyponatraemic cases 65.8% mild, 26.3% moderate, 7.9% severe), the Egyptian paediatric intensive care unit (PICU) study (19% mild, 10% moderate, 3% severe) and the Iranian study (mostly mild).[16,17,19] Observed differences across studies possibly arise from severity spectrum and inclusion criteria. Sodium levels thresholds and sample timing (admission, nadir, serial measures) could also be the reason of difference across studies. Additionally, fluid practices (isotonic vs hypotonic maintenance) can possibly lead to difference in category distributions.

Hyponatremia was found to be independently associated with clinical severity in the present study, with a clear gradient towards higher PRESS. After adjustment for age and sex, severe bronchiolitis carried more than six-fold higher odds of severe hyponatremia ($P<0.001$) compared with moderate disease. Chi-square testing confirmed a significant association between hyponatremia category and bronchiolitis severity ($P<0.001$). These patterns mirror observations from a Nepalese cohort where hyponatremia tracked with greater need for ventilation and slower resolution of hypoxia in more severe LRTIs.[16] An Egyptian PICU study also reported similar results in which hyponatremia coincided with higher severity of LRTIs with higher rate of mechanical-ventilation use and mortality.[19] Although the Turkish bronchiolitis series did not use PRESS, hyponatraemic infants required more intensive support, consistent with severity gradient observed in present study.[14] The Iranian study[17] demonstrated decreasing mean serum sodium levels with greater clinical severity ($P=0.013$). The Indian study[18] reported hyponatraemic children presented with more severe clinical features. Variation in effect sizes likely reflects acuity windows (PICU vs ward), use of standardized severity assessment tools (PRESS used in some but not all studies), exclusions of comorbidities and whether analyses relied on admission, nadir or serial measures of sodium levels.[13-15,19]

Length-of-stay (LOS) also differed by sodium status in the present study: compared with mild hyponatremia, moderate hyponatremia was associated with longer LOS ($P<0.001$). Consistently, severe bronchiolitis was also

associated with longer LOS (P<0.001) when compared to moderate disease. Correlation analyses demonstrated a strong negative correlation between serum sodium and PRESS (P<0.001), a strong positive correlation between LOS and PRESS (P<0.001), and a strong negative correlation between LOS and sodium (P<0.001). Concordant reports are seen elsewhere like in the Korean mixed-LRTI cohort, hyponatremia predicted prolonged hospitalization after adjustment;[13] hyponatraemic infants with bronchiolitis had longer stays in the Turkish[14] and the Nepalese series[16] (P < 0.05). Absolute LOS differences vary, likely due to system factors such as ward vs PICU pathways, different discharge criteria, bed-flow pressures, differential access to HFNC/PICU (which can shorten or extend LOS independent of sodium).[8,11-16]

Taken together, these data and the external literature point in the same direction. In infants with bronchiolitis, a low admission Na^+ tracks with higher PRESS scores and longer LOS.[20] An admission sodium check is recommended along with PRESS-based triage. This will help in identifying children who need closer observation (e.g., earlier senior review, PICU admissions, or lower threshold for HFNC). It is also recommended to repeat sodium within 12–24 if initial Na^+ <135 mmol/L or if clinical status worsens. Delaying IV fluids unless clinically necessary to reduce free-water exposure and maintenance on isotonic fluids if essential, should be the preferable strategy. This is especially important when hypoxemia or feeding issues raise syndrome of inappropriate antidiuretic Hormone Secretion (SIADH) risk. For hyponatraemic patients nasal suctioning, oxygenation, and early enteral hydration should be prioritized. Physicians must ensure stable Na^+ trend, room-air oxygen saturation targets, and adequate oral intake before discharge along with guidance to caregivers on hydration and warning signs.

There are several limitations of present study to be acknowledged. Its design (single-centre, cross-sectional design) limits its external validity primarily to children presenting to similar tertiary-care settings in Pakistan and comparable resource constraint settings. Selection bias is possible in a hospital-based cohort that may over-represent severe disease; to reduce this, consecutive recruitment was made of all eligible presentations within the study period. Information bias was minimized through standardized PRESS scoring protocols, staff training with operational definitions, use of a single accredited laboratory platform for electrolytes, and duplicate data entry with random 10% verification to limit abstraction errors. Admission sodium levels were measured only and no serial measurements or nadir values were available, so longitudinal risk assessment could not be possible. PRESS was applied on admission only and no inter-rater reliability and repeat scoring over time was performed. Biomarkers of non-osmotic ADH or inflammatory mediators were not tested to further explore the biological pathways. Potential confounding by age and sex was addressed by multivariable modelling in secondary analyses. Despite adjustment for age/sex, other covariates (viral subtype/coinfection, nutrition, hydration status) may influence sodium and outcomes. Present study focused on short-term outcomes (LOS) and no post-discharge events or readmissions rates were recorded. It is recommended to carry out prospective multicenter studies directing towards validation of a PRESS–sodium decision aid and test whether early sodium trajectories (0–48 h) add prognostic value.

Conclusion

In infants with bronchiolitis, a low admission serum sodium levels track with severity of disease and longer duration of hospitalization. It is recommended to get an admission sodium check along with PRESS-based triage. This will help in identifying children who need closer observation. Prospective multicenter studies are recommended directing towards validation of a PRESS–sodium decision aid and test whether early sodium trajectories (0–48 h) add prognostic value.

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