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Original Research Article

A PROSPECTIVE STUDY OF VITAMIN D STATUS AND CLINICAL OUTCOME OF CHILDREN AGED 1 MONTH TO 12 YEARS WITH RESPIRATORY ILLNESS ADMITTED IN PAEDIATRIC INTENSIVE CARE UNIT AT TERTIARY CARE HOSPITAL

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ABSTRACT

Background: Acute respiratory infections (pneumonia and related illnesses) are a leading cause of illness and death among young children worldwide. Vitamin D is increasingly recognized as a key modulator of the immune system, promoting antimicrobial peptide synthesis and dampening excessive inflammation. Several studies suggest that children admitted to intensive care frequently have vitamin D deficiency (VDD), which may worsen infection outcomes. This study aimed to determine the prevalence of VDD and its association with illness severity and outcomes in pediatric patients with respiratory illness in the PICU. **Materials and Methods:** This is a prospective observational study over 12 months (July 2024–June 2025) in the PICU of Government General Hospital, Kakinada (tertiary care hospital). Seventy-five children (age 1 month–12 years) admitted with acute respiratory illness were enrolled. Children with chronic lung disease, steroid use, poisoning, or endocrine disorders were excluded. On admission, serum 25-hydroxyvitamin D [25(OH)D] was measured by chemiluminescence immunoassay. Vitamin D status was categorized as deficient (<20 ng/mL), insufficient (20–30 ng/mL), or sufficient (>30 ng/mL). Clinical data collected included age, sex, diagnosis, severityofrespiratoryillness, length of PICU/hospital stay, respiratory support needed, and outcomes. Statistical analysis used descriptive statistics, chi-square tests for categorical variables, and Spearman's correlation, with $p<0.05$ as significant. **Result:** Of 75 children (mean age ~3 years, 40 boys, 35 girls), 45 (60%) were vitamin D deficient, 19 (25.3%) insufficient, and 11 (14.7%) sufficient. Common diagnoses were bronchopneumonia (34.7%) and lobar pneumonia (29.3%). The median PICU stay was ~5 days, with 52% staying ≤5 days. VDD was significantly associated with severe illness: children with VDD more often had prolonged PICU stay (>5 days) compared to those with sufficient levels ($p=0.008$), and longer overall hospital stay ($p<0.05$). VDD was far more common in patients with severe respiratory illness(85%) compared to 16% of mild illness. 97.7%of children with vitamin D deficiency required respiratory support, whereas only 27.2% of vitamin D suffiecient children required respiratory support. In-hospital mortality was low (2/75, both VDD) and not statistically different by vitamin D status. **Conclusion:** Vitamin D deficiency was common (60%) in this PICU respiratory cohort and correlated strongly with illness severity, duration of hospital stay , and need for respiratory support. This suggests that routine assessment and correction of vitamin D deficiency might help to improve outcome of critically ill children with respiratory infection.

INTRODUCTION

Acute lower respiratory infections (pneumonia and bronchiolitis) remain the single largest infectious cause of childhood mortality, accounting for roughly 14% of all under-five deaths globally.[1] The burden is especially high in low- and middle-income countries. In India, pneumonia claims hundreds of

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thousands of young lives each year, despite being largely preventable and treatable. Underlying this high burden, malnutrition and immune vulnerability contribute significantly to severe illness. Vitamin D has long been known for calcium homeostasis, but it also has potent immunomodulatory effects.[2] Experimental studies show that vitamin D induces antimicrobial peptides (like cathelicidin) and regulates cytokine responses in macrophages and epithelial cells.[2,3] These properties are thought to reduce the risk or severity of infections, including bacterial pneumonia. In infants and children, vitamin D deficiency (VDD) has been associated with higher rates of respiratory tract infections.[4]

Critically ill children often have poor nutritional reserves, and several studies report very high rates of VDD in pediatric intensive care populations.[5,6] For instance, a recent international study protocol notes that roughly 50% of PICU admissions have 25(OH)D <20 ng/mL. Some observational studies have linked low vitamin D to worse outcomes such as sepsis or prolonged ICU stays.[7,8] A systematic review found VDD was associated with greater need for inotropic support and higher mortality in critically ill children. However, data remain limited and varied, especially in South Asian settings. This prospective study investigates the relationship between vitamin D status at PICU admission and clinical outcomes in children aged 1 month to 12 years admitted with respiratory illness at a tertiary hospital in India.

MATERIALS AND METHODS

Study design and setting: A prospective observational study (July 2024–June 2025) was conducted in the Paediatric Intensive Care Unit of Government General Hospital, Kakinada (Andhra Pradesh), a tertiary care hospital. Ethical approval was obtained from IEC and informed consent was secured from parents or guardians.

Participants: Children aged 1 month to 12 years admitted to PICU with acute respiratory illness (including pneumonia, bronchiolitis, bronchopneumonia, etc.) were included in the study. Exclusion criteria include chronic pulmonary disease (e.g., asthma, cystic fibrosis), respiratory distress due to poisoning or trauma, recent systemic steroid therapy (within 1 week), and known endocrine disorders (pituitary, adrenal, thyroid). A sample size of 75 was preplanned, based on prior reported VDD prevalence (~84.7%) and statistical considerations.

Data collection: On PICU admission, demographic and clinical data were recorded, including age, sex, nutritional status, primary diagnosis, and presenting vital signs. Socioeconomic status was categorized using the Modified Kuppuswamy scale. The severity of respiratory illness was classfied using the Pediatric Respiratory Severity Score (PRESS), a validated tool in PICU. The need for respiratory support (none, oxygen by mask, CPAP/BiPAP, NIV or mechanical ventilation) was noted. Blood samples were drawn at admission for routine lab tests like CBC , LFT ,RFT , and Chest x-ray taken to all children and Serum vitamin D was measured by a chemiluminescence immunoassay (CLIA) on a Cobas 6000 analyzer. Protocol treatment was given for respiratory illness and patient were followed throughout hospital stay and final outcome was recorded in terms of hospital stay and discharge or death.

Vitamin D categorization: Based on established cutoffs, vitamin D status was defined as deficient (<20 ng/mL), insufficient (20–30 ng/mL), and sufficient (>30 ng/mL). All laboratory assays were calibrated and quality-controlled as per manufacturer protocols. Physicians were blinded to vitamin D results during care (no supplementation was provided as part of this observational study).

Statistical analysis: Descriptive statistics summarized patient characteristics and vitamin D status. Categorical variables are reported as number (percentage) and compared using Chi-square or Fisher's exact test. Continuous variables (e.g. length of stay) are expressed as median (IQR) as appropriate; comparisons were made using Student's t-test or Mann-Whitney U test. Associations between categorical factors (e.g. vitamin D status vs. severity category) were tested by Chi-square. Correlation of continuous variables was evaluated by Spearman's rho. A two-sided p-value <0.05 was considered statistically significant. Statistical analyses were performed using SPSS (v21.0).

RESULTS

Patient characteristics: A total of 75 children met inclusion criteria. [Table 1 and 2] show the age and gender distribution of population. The majority of children are in the age group of 2–5 years (44%), followed by 1 month–2 years (40%) and 5–12 years (16%). Bronchopneumonia (26 patients, 34.7%) followed by lobar pneumonia (22, 29.3%);and bronchiolitis (16%) [Table 3] are the most common causes of respiratory illness.

Vitamin D status: Overall, 45 children (60.0%) were vitamin D deficient (<20 ng/mL), 19 (25.3%) were insufficient, and 11 (14.7%) were sufficient. The prevalence of deficiency was similar across genders (60% in boys vs. 60% in girls; p=0.87) and showed no significant variation by age group. Notably, vitamin D deficiency was present in 53% of 1–2 year old children, 58% of 2–5 year old children, and 83% of 5–12 year old children, but this difference did not reach statistical significance (p=0.36). There was no significant association between vitamin D deficiency and prior respiratory illness. The median 25(OH)D level for the group was ~18 ng/mL (IQR 12–25).

Severity of illness: In the study population with vitamin D deficiency, according to PRESS SCORE, 18 (24.0%) had mild, 22 (29.3%) had moderate, and 35 (46.7%) had severe acute respiratory illness at admission [Table 4]. Vitamin D deficiency strongly correlated with severity of illness. Among children,

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85.7% of children with severe illness, 54.5% of children with moderate and only 16.7% of children with mild respiratory illness had vitamin D deficiency. This is statistically highly significant with p value <0.001 .

PICU and hospital stay: 39 (52.0%) stayed for ≤5 days and 36 (48.0%) stayed for >5 days. 55.6% of vitamin D defiecient children and 46.7% of vitamin D suffiecient children had PICU stay >5 days (p=0.008). 91.1% of children with vitamin D defiecient in contrast to 7.2% % of children with vitamin D suffieciency had prolonged hospital stay. This association between lower vitamin D and extended hospital stay was statistically significant (p<0.05).

Respiratory support: Fourteen children (18.7%) required no respiratory support, 42 (56.0%) required 1–3 days of support (oxygen/CPAP), and 19 (25.3%) required >3 days (including ventilation). Vitamin D deficiency was associated with a much higher rate of support: among VDD children, 44/45 (97.8%) needed some form of respiratory assistance, whereas only 27/30 (90%) of the non-VDD group did (p=0.01). 13/45 (28.9%) VDD children required prolonged respiratory support (>3 days) compared to only 6/30 (20.0%) of vitamin D Sufficient children.

Table 1: Age Group vs Serum Vitamin D Levels

Age Group	<20 ng/mL	20–30 ng/mL	30–100 ng/mL	Total
1month – 2years	16	8	6	30(53%)
2 – 5years	19	9	5	33(57%)
5 – 12years	10	2	0	12(83%)
Total	45	19	11	75

Table 2: Gender vs Serum Vitamin D Levels

Gender	<20	20–30	30–100	Total
Male	24	11	5	40(60%)
Female	21	8	6	35(60%)
Total	45	19	11	75

Table 3: Etiology of respiratory illness.

Diagnosis	No.	Percentage
Bronchitis	6	8.0%
Bronchiolitis	12	16.0%
Bronchopneumonia	26	34.7%
Lobar Pneumonia	22	29.3%
Tuberculosis	4	5.3%
Croup	3	4.0%
Empyema	2	2.7%
Total	75	100%

Table 4: Association between vitamin-D status and severity of respiratory illness.

Severity of Illness (PRESS Score)	Vitamin D <20 ng/mL	Vitamin D 20–30 ng/mL	Vitamin D 30–100 ng/mL	Total
Mild	3(16.6%)	11(61.1%)	4(22.2%)	18
Moderate	12(54.5%)	7(31.8%)	3(13.6%)	22
Severe	30(85.7%)	1(2.8%)	4(11.4%)	35
Total	45	19	11	75

Chi-square test: p < 0.0001 (Highly significant)

Table 5: Association Between Vitamin D Status and Clinical Outcome Parameters.

Clinical Outcome Parameter	Vitamin D Deficient (<20 ng/mL)	Vitamin D Insufficient (20–30 ng/mL)	Vitamin D Sufficient (30–100 ng/mL)	p-value
PICU stay >5 days	25	1	3	0.008
Hospital stay >10 days	9	0	0	0.013
Respiratory support >3 days	13	0	6	<0.001
Mortality	2	0	0	0.492

Two children with diagnosis of severe bronchiolitis in the age group of 1month to 2 years expired.

DISCUSSION

In this cohort of 75 Indian children with acute respiratory illness, vitamin D deficiency was extremely common (60%), mirroring findings from other PICU populations.[5,6] A recent international trial protocol noted VDD (25(OH)D<20 ng/mL) in roughly half of critically ill children. The prevalance of VDD in this study is similar to the canadian series report where 50-70% of critically ill kids had VDD, this is in contrast to turkish series which found VDD in 16.6% and insufficiency in 53.3%.[9] The high prevalance of VDD reflects both limited sun exposure during illness and baseline nutritional deficiencies in many children. These results underscore that VDD is endemic among sick children in intensive care, consistent with global data.

In this study, there is a strong association between VDD and severity of respiratory illness. 86% of

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children with severe respiratory illness were vitamin D–deficient, compared to only 17% of children with mild illness. This difference is highly statistically significant ($p<0.001$). Children with VDD had longer ICU and hospital stays and required intensive and prolonged respiratory support.[7] These findings align with the idea that vitamin D supports host defense and that deficiency may impair immune response. Indeed, vitamin D has been shown to regulate cytokines and enhance innate immunity, which could blunt the severity of pneumonia.[2,3] The data is highly consistent with meta-analyses and cohort studies linking VDD to worse PICU outcomes: a systematic review found that VDD was associated with higher odds of requiring inotropes and increased mortality in PICU patients.[5,8] Although the mortality in this study was too low for meaningful comparison, the need for prolonged respiratory support among VDD children suggests an overall trend toward more complicated course of illness, similar to other reports of sepsis and shock in vitamin D–deficient patients.

In contrast, factors like age, sex, prior respiratory illness, and socioeconomic class did not show significant associations with vitamin D level in this study. This suggest that vitamin D deficiency is endemic and critical illness and acute stressors may overwhelm these background variables. It is noteworthy, however, that older children (5–12 years) in this sample had a higher percentage of deficiency, possibly reflecting less supplementation and more sequestration with age. Several studies have noted that VDD is more frequent in older children and adolescents, especially in South Asia.[10]

Results of this study have potential clinical implications. The high prevalence of VDD and its correlation with disease severity and clinical outcome suggest that early measurement of vitamin D could serve as a useful marker of disease severity and clinical outcome. Given that vitamin D is safe and inexpensive, and prevalance of VDD is very high, clinicians should consider periodic evaluation for vitamin D status and supplementation of all children. Ongoing trials (such as the VITdALIZE-KIDS trial) are testing whether rapid repletion can improve outcomes. In the meantime, emphasizing adequate vitamin D status (through diet or sunlight exposure) remains prudent. Future research should explore whether prophylactic vitamin D or in-hospital supplementation can reduce the burden of PICU respiratory disease, especially in high-risk populations.

Limitations: This single-center observational study cannot prove causality. The sample size, while adequate to detect associations with severity, was small for rare outcomes like mortality. This study lacked a healthy control group for baseline comparison. Seasonal and nutritional status of study population were not quantified. Nonetheless, the associations observed were strong and biologically plausible.

CONCLUSION

Vitamin D deficiency was prevalent among children admitted to the PICU with respiratory illness in this setting. Deficient children had severe lung disease, required prolonged respiratory support, and stayed longer in intensive care. These findings, in line with emerging literature, highlight vitamin D status as a modifiable factor in pediatric critical care. Routine screening and appropriate supplementation could potentially improve clinical outcomes in this vulnerable population.

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