Original Research Article

A study of vitamin D levels in critically ill children

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Abstract

Objectives:

1. To assess the correlation between Vitamin D levels and critical illness.
2. To study correlation between Vitamin D and risk of mortality through PRISM III criteria.
3. To study demographic details associated with Vitamin D levels.

Methodology: A prospective observational hospital based study was conducted over a period of 18 months in 100 critically ill children fulfilling the inclusion criteria. The samples were used for Vitamin D estimation using Electro-Chemiiluminescence and Vitamin D levels were classified as per the Endocrine Society recommendations. **Results:** In our study, there was statistically very highly significant association between PRISM score with vitamin D deficiency.There was statistically very highly significant association between PRISM score with outcome (P<0.001).The deficiency was associated with increased length of stay in the ICU. Vitamin D deficiency is frequent in critically ill children, and it is related to both morbidity and mortality. **Conclusion:** Variables from this short study showed statistically significant associations between severity of critically ill children and serum vitamin D levels(p<0.001). Health education on the importance of sunlight exposure of young children should be reinforced in mothers and the general community. Vitamin D supplementation should be advocated in order to prevent the morbidity and mortality secondary to critically illness, which globally contribute to morbidity worldwide.

Keywords: Critically ill; 25-hydroxyvitamin D3

Introduction

Vitamin D is an imperative hormone that is essential for optimal health[1]. Vitamin D is a fat-soluble vitamin obtained from either diet(food or supplements) or synthesized by skin, with skin as the predominant source[2].The major role of vitamin D is bone mineralization and calcium metabolism, by way of its endocrine like actions[2,3]. The non classic function includes regulation of cell proliferation and differentiation, regulation of hormone secretion and the regulation of immune function. These effects take place on a cellular level and are directly substrate-dependent on the 25(OH)D level[2]. 25(OH)D is the major circulating form of vitamin D with a half-life of 2-3 weeks and its levels are the best available indicators of vitamin D status[4]. Vitamin D is a prohormone, and the active form $1,25(OH)_2D$[2]. Serum $1,25(OH)_2D$ is tightly regulated by PTH, serum calcium and fibroblast growth factor 23[5].

$1,25(OH)_2D$takes its action via the vitamin D receptor (VDR) that is expressed in many tissue types. Furthermore, most of these cells express the 25(OH)D-1a-hydroxylase (CYP27B1, a mitochondrial P450 enzyme) and produce the active hormone calcitriol for autocrine use within the target cell itself. Also, vitamin D is now shown to have an important role in fighting infections by increasing antimicrobial peptide (AMP), cathelicidin antimicrobial peptide (CAMP) and defences in the body[2]. Many gene encoding proteins that regulate cell proliferation, differentiation and apoptosis are shown to be modulated at least in part by vitamin D[6].

The recent focus of Vitamin D is on its role in non skeletal conditions including immunity[7].

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Vitamin D deficiency is widely prevalent in a subclinical form in children and Adults[8]. Vitamin D deficiency (VDD) is a prevalent condition affecting over one billion people worldwide,and appears to be one of the most under-diagnosed and under-treated dietary insufficiencies[9]. There is evidence to suggest that subclinical vitamin D deficiency is common in India despite lying in low latitude and having plentiful sunshine. vitamin D deficiency in children documented inseveral studies is as high as 75-90%[10]. In India, community based studies showed prevalence of vitamin D deficiency is 50-90%[11].

Modern day life styles have significantly reduced the total duration of sun exposure in children. UV B rays, having shorter wavelength, tend to scatter earlier or later in the day and hence cutaneous vitamin D synthesis is maximum between 10 AM and 3 PM, the time when most of the children are either in school or indoors[12,13,14]. Besides the sun, exposure to endocrine disrupting chemicals such as bisphenol A and phlalates, which are widely used industrial compounds found in several commercial products, may alter serum 25(OH)D3.These chemicals have been found to modify the expression of cytochrome P450 and CYP27B1 genes in mice. Therefore, Exposure to common chemicals found in Western society may also be a contributing factor to the rise in vitamin D deficiency[15]. Vitamin D levels surveyed in critically children, have often show different and contradictory results.Therefore, we expanded the study to survey all critical illnesses in the pediatric intensive care unit(PICU) and its relationship with disease severity.

Materials and methods

Study design

Prospective observational study

Duration of study

1 October 2019 to 31 October 2021(24 months).

Sample size
100

Source of data
All cases of critically ill patients as per inclusion and exclusion criteria admitted in PICU Basaveshwar teaching & general hospital and Sangameshwar teaching & general hospital Kalaburgi in the study duration.

Inclusion criteria
1. Age 1 month to 18 years.
2. Children admitted to PICU.

Exclusion criteria
1. Less than 1 month.
2. Patient not affordable to investigate for Vitamin D

Method of collection of data
It's a hospital based descriptive study. Children admitted in paediatric ICU at Basaveshwar and Sangameshwarhospital , will be participating in this study as per the inclusion and exclusion criteria.
Written informed consent of the child's parent or legally accepted representative will be obtained. A detailed history and physical examination will be done according to a predesigned proforma to determine the severity of illness. Age of the child will be recorded in completed years.
Then blood will be drawn and Vitamin D levels will be estimated by Electrchemiluminescence immunoassay(ECLIA).

Statistical data analysis
Statistical data was analyzed by IBM SPSS 20.0 version software. Collected data were spread on excel sheet and prepared master chart. Through the master chart tables and graphs were constructed. For quantitative data analysis t-test was applied. For qualitative data analysis chi-square test and chi-square with Yates correction tests were applied for statistical significance. If P-value was less than 0.05 considered as significant.

Results
In our study, out of 100 children maximum number of cases 51 (51.0%) were belongs to the age group of 2-10 years, followed by 30 (30.0%) of cases belonged to the age groups of 1mon-1 year and 19 (19%) of cases belonged to the age group of 11-19 years. The mean age of cases was 5.14 years. Majority of children 72 (72.0%) were belongs to the lower middle class, followed by 18 (18.0%) of children were belongs to middle class, 9 (9.0%) of children were belongs to lower class and 1 child belongs to upper middle class.In the present study 71 (71.0%) of children had deficiency of Vitamin D at the time of PICU admission. Furthermore, lower 25(OH)D levels are associated with higher PRISM III scores (Table no.1).

Table no.1 Relation between PRISM III score and vitamin D deficiency

PRISM III score	Stages	Number of cases	Vitamin D deficiency	
			No.	%
0—5	Stage 1	38	19	50.0%
6—10	Stage 2	26	21	80.8%
11—15	Stage 3	15	12	80.0%
16—20	Stage 4	11	9	81.8%
21—25	Stage 5	8	8	100.0%
26—30	Stage 6	1	1	100.0
> 30	Stage 7	1	0	0.0
Total	--	100	100.0	
χ2 –test value, P-value	χ2 = 19.56 P = 0.001 VHS			

Our study reveals that, maximum number 37 (37.0%) of children were diagnosed neurological, followed by 26 (26.0%) of children were diagnosed respiratory, 23 (23.0%) of children were admitted due to infections, 20 (20.0%) of children were suffering with nutritional problems, 17 (17.0%) of children were diagnosed gastrointestinal, 8 (8.0%) of children were diagnosed renal and 6 (6.0%) children each were diagnosed with cardiovascular and endocrine disease respectively (Table no.2).

Table no.2 Reason for PICU admission in relation with vitamin D deficiency

Diagnosis	No. of children	Vitamin D deficiency	
		No.	%
Respiratory	26	16	61.5%
Neurological	37	29	78.3%
Cardiovascular	6	5	83.3%
Renal	8	6	75.0%
Gastrointestinal	17	13	76.4%
Nutritional	20	15	75.0%
Endocrine	6	4	66.7%
Infections	23	20	86.9%
χ2 –test value, P-value	**χ2 = 11.83 P = 0.008 HS**		

Study reveals that, out of 100 sample children 67 (67%) of children were cured and discharged from the hospital. Whereas 33 (33.0%) of children died. There was statistically very highly significant association between outcome of children and serum vitamin D levels (P<0.001) (Table no.3).

Table no.3 Association between outcome and serum vitamin D levels

Outcome	No.	Vitamin D level			χ2 –test value, P-value
		Deficiency [< 19]	Insufficiency [20-29]	Sufficiency [≥ 30]	
		No. (%)	No. (%)	No. (%)	
Discharged	67	39 (58.2%)	16 (23.9%)	12 (17.9%)	$\chi 2_{yates}$ = 17.82 P = 0.000 VHS
Died	33	32 (97.0%)	1 (3.0%)	0 (0.0%)	
Total	100	71	17	12	

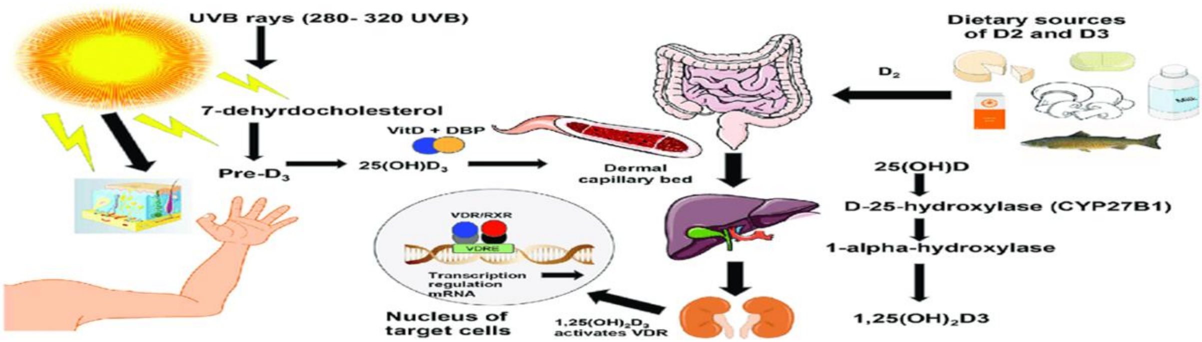

Figure no. 1 Sources and synthesis of vitamin D

Conclusion

The primary objective of this study was to estimate the prevalence of Vitamin D deficiency in a group of critically ill children, and the secondary objectives was to correlate vitamin D status with pediatric risk of mortality III (PRISM III) scores.

There was statistically very highly significant association between PRISM score with vitamin D deficiency.There was statistically very highly significant association between PRISM score with outcome (P<0.001).

The deficiency was associated with increased length of stay in the ICU. Vitamin D deficiency is frequent in critically ill children, and it is related to both morbidity and mortality

Results from this study conclude that deficiency of vitamin D is a risk factor Critical illness in PICU admission. Education regarding the importance reinforced to mothers and the general community. Also, foods rich in vitamin D-rich should be advocated in order to prevent the morbidity and mortality.

Approximately 50% of critically ill children have Vitamin D deficiency at the time of PICU admission, Vitamin D deficiency was further determined to be associated with longer duration of stay, severity, multiple organ dysfunction, and mortality in the PICU setting.

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