

Vitamin D Level in Pediatric Intensive Care Unit (PICU) Patients: Its Relation to Severity of Illness

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Abstract

Background and aim: Vitamin D (Vit D) insufficiency is defined as level less than 30ng/ml, and Vit D deficiency as a level below 20ng/ml. Vit D deficiency is related to higher illness severity and death in adult intensive care unit (ICU) patients. Our study aims to detect the relation between of Vit D level on admission in PICU patients and their Length of Stay (LOS) or duration of mechanical ventilation.

Patients and methods: In a prospective case control study, 30 patients of PICU of the Maternity and Children Hospital (MCH) in Almadinah Almounourah, KSA, were observed for Vit D level in the first 12 hours of their admission.

Results: Vit D deficiency in our study has a prevalence of 56.7%. Of 30 patients, those with Vit D deficiency were 17, 4 had Vit D insufficiency and 9 patients had normal levels.

Conclusions: There is increased prevalence of Vit D in our PICU children and it is significantly associated with LOS and days on ventilator while there it is not significantly associated with mortality rate.

Keywords: Pediatrics; Intensive care; Vitamin D

Abbreviations:

Vit D: Vitamin D; PICU: Pediatric Intensive Care Unite; 25 (OH) Vit D: 25 hydroxyvitamin D; UV: Ultra Violet; ICU: Intensive Care Unite; LOS: Length of Stay; RR: Respiratory rate; O₂: Oxygen; PIM 2: Pediatric index of mortality 2; PRISM III: pediatric risk of mortality III; CRP: C-Reactive Protein; EDTA: ethylene-diamine-tetra-acetic; SD: Standard Deviation; CKD: Chronic Kidney disease

Introduction

Vitamin D (Vit D) is a fat-soluble vitamin functions as a regulator for calcium metabolism. It is stored in our bodies as 25 hydroxyvitamin D (25 (OH) Vit D). We can obtain Vit D from many sources including sun and certain foods. Vit D is formed in the subcutaneous tissue with the help of ultraviolet (UV) B radiation [1]. It is metabolized to 25 (OH) Vit D in the liver, which is the inactive form of Vit D with a half-life of nearly 2 to 3 weeks. In the kidney it is transformed to its active form (1, 25 (OH) Vit D) with a half-life of 4 to 24 hours. Consequently, it is suitable to measure 25 (OH) Vit D because of its long half-life. Vit D level in our body is influenced by darkness of the skin, sun exposure and calcium intake. If 25 (OH) Vit D level is less than 30ng/ml, it is diagnosed as insufficiency but when its level is below 20ng/ml it is deficiency [2]. Deficiency of Vit D is present in 60% of the elderly population [3]. Vit D has also anti-

inflammatory effect and may prevent proliferation of cells. Furthermore, Vit D deficiency is related to heart diseases and malignant disorders [4,5]. Prevalence of Vit D deficiency is from 17% to 79% in adult intensive care unites (ICU) [6]. Severity of illness, bad prognosis and rate of mortality is related to Vit D deficiency in ICU patients but it has no association with duration of stay in the hospital (LOS) [7-10]. Excessive intravenous fluid, extravasation, hypoproteinemia, cachexia, blood acidity, season, age, and dietary intake are factors that may affect Vit D level in critical ill patients [11,12]. We aim in our work to detect the association of Vit D level on admission with LOS and duration of mechanical ventilation in PICU sitting.

Patients and Methods

Prospectively in a case control study, 30 PICU children of the Maternity and Children Hospital (MCH) in Almadinah Almounourah, KSA, were observed for 25 (OH) Vit D level in their plasma in the first 12 hours of their admission. The MCH hospital Ethics Committee approved our study protocol. The study was conduct on PICU patients admitted in the period from start of June 2014 to the end of July 2014 and aged less than 14 years. No blood extraction during the first 12-hour after admission, adrenal, pituitary or hypothalamic disease and the use of systemic steroids in the previous month were the exclusion criteria. Patients were evaluated for the following variables: age, weight, diagnosis, respiratory rate (RR), pulse, blood pressure, O₂ saturation, urine output, and administration of vasopressor agents. Blood cultures

were done in case of clinical indicators of infections or when temperature was > 38 degree Celsius. The Pediatric index of mortality 2 (PIM 2) value and the pediatric risk of mortality III (PRISM III) value were calculated on admission. C reactive protein (CRP), liver and kidney functions were also examined in all patients. Patients' blood samples on ethylene-diamine-tetra-acetic (EDTA) tubes were centrifuged to separate plasma, which was frozen in aliquot at -80 degree Celsius. Vit D level was detected with ELISA apparatus. A written informed consent was taken from the parents of PICU patients involved in this study.

Statistics

Parameters were explained using mean (SD) or median (range). Groups of patients were compared using the Mann-Whitney test for continuous variables and chi-square test for categorical data. A significant p-value was < 0.05.

Variable	Group A		Group B	P value
	Vit D Deficiency (< 20ng/dL) N (%) = 17 (56.7%)	Vit D Insufficiency (20-30 ng/dL) N (%) = 4 (13.3%)	Normal 25 (OH) Vit D level (> 30 ng/dL) N (%) = 9 (30%)	
Age (Months)	29.7 (5-72)	53.8 (12-98)	97.9 (60-124)	0
Gender, Male (%)	12 (70.6%)	4 (100%)	3 (33.3%)	0.03
Assisted Ventilation (%)	9 (52.9%)	1 (25%)	2 (22.1)	0.19
Inotropic/vasopressor support (%)	5 (29.4%)	1 (25%)	3 (33.3%)	0.79
PRIM 2	1.45 (±1.84)	1.2 (±2)	1.4 (±1.3)	0.99
PRISM III	4.3 (±2.04)	3.6(±2.1)	5.3 (±2.2)	0.17
Acute /Acute on chronic renal failure	13 (76.5%)	2 (50%)	2 (22.1%)	0.01
Admission diagnosis				
Cardiorespiratory	11 (64.7%)	2 (50%)	1(11.1)	0.03
Post-operative	4 (23.5%)	1 (25%)	5 (55.6%)	
others	2 (11.8%)	1 (25%)	3(33.3%)	

P value is calculated between 2 groups; Group A children with Vit D deficiency and insufficiency and Group B include those with normal 25 (OH) Vit D. Values are presented as median and range for the age, and mean and SD for PRIM 2, and PRISM III. The remaining values are presented as number and percent.

Table 1: Characteristics of PICU patients and admission diagnosis according to 25 (OH) Vit D level.

Variable	Group A		Group B	p value
	Vit D Deficiency (< 20ng/dL) N = 17	Vit D Insufficiency (20-30 ng/dL) N = 4	Normal Vit D level (> 30 ng/dL) N = 9	
PICU LOS (days)	14 (3-25)	15 (11-22)	9 (3-20)	0.02
Days on Ventilator	8 (2-17)*	5^	10 (3-17)#	0.01
Actual Mortality N (%)	1 (4.7%)	0	1 (11.1%)	0.52

*N = 9), ^(N = 1), #(N = 2)
P value is calculated between 2 groups; Group A; children with Vit D deficiency and insufficiency and Group B; include children with normal Vit D. Values are presented as median and range.

Table 2: Relation between 25 (OH) Vit D level and PICU LOS, duration of ventilation and actual mortality.

Results

A total of 53 patients were admitted to the PICU at MCH in Almadinah Almounourah during a one-month study period. Vit D

levels were described in 30 (57%) children; of these 19 boys and 11 girls with mean age 53.4 months and range (5-124). Of the study

population, Vit D deficiency was detected in 17 patients, 4 patients had insufficiency and 9 patients were normal.

Characteristics of the study population and admission diagnosis according to Vit D levels on admission are shown in Table 1. Patients with Vit D deficiency/insufficiency were more to be younger ($p = 0.0$), boys ($p = 0.03$), and have renal impairment ($p = 0.01$). Patients with Vit D deficiency or insufficiency had significantly (p value = 0.03) more cardiopulmonary diagnosis on admission than both postoperative and other causes of admission.

Relation between Vit D level and PICU LOS, and duration of mechanical ventilation is shown in Table 2. There was a significant relation between Vit D deficiency and LOS ($p = 0.02$), duration on mechanical ventilation ($p = 0.01$) but there was no significant association between 25 (OH) Vit D deficiency and the actual mortality ($p = 0.52$).

Discussion

Our results show that 56.7% of PICU children have a Vit D deficiency and 13.3% have a Vit D insufficiency on admission. This incidence is more than what published before. [9,13,14] Our study is done in a tertiary level hospital, which serves a large population areas including rural and suburbs. Consequently, this higher incidence of 25 (OH) Vit D deficiency may be explained by less optimum medical care for most children, lower socioeconomic levels, higher use of toxic substances, low intake of Vit D from foods, obesity, different illnesses specially malabsorption disorders and in general the poor exposure to sunlight which is attributed to higher atmospheric temperature and most families do not expose their children to sunlight instead they keep children in air conditioned closed places either daycare, schools, or homes most time of the day. Similar to another study [14], our study found a relation between Vit D deficiency and an increased LOS among PICU patients. Although other study [7] showed no relation between LOS and Vit D deficiency which may be attributed to a large number of study population than our study. Similarly, our study showed also an association between Vit D deficiency and days on mechanical ventilation, which may be explained by the role of Vit D in maintaining muscle tone and preventing accumulation of respiratory secretion. Besides, Vit D has a role in maintaining body immunity, so its deficiency decreases the immunity and increases the risk of sepsis with respiratory failure and the need of mechanical ventilation. In our study there is a relation between Vit D deficiency and either risk of death in PICU patients or the actual mortality, which is in contrast with other studies [15,16] that may be explained by the small population in this analysis in relation to population of other studies.

We found a significant association between young age and male gender with Vit D deficiency in contrary to other studies where 25 (OH) Vit D is related to old age and female gender [17,18]. But these studies were multi-centric with large population number and on adult populations which may explain that difference. In our study 76.5% and 50% of children with acute or acute on chronic kidney disease (CKD) and have Vit D deficiency and insufficiency consequently which is consistent with the findings of other published studies [19]. Our study shows also significant association between cardiopulmonary diagnosis on admission and Vit D deficiency among PICU patients but it is not significantly associated with either postoperative admission or any other admission diagnosis.

Conclusions

In our study population there is high percentage of Vit D deficiency in PICU patients. These data show also that there is significant association between LOS and days on ventilator with 25 (OH) Vit D deficiency while it is not significantly related to death in PICU patients.

Limitations of Study

It is a single center study with small number of population in comparison to other studies. Besides, we did not take sequential samples of Vit D levels instead we used its level on admission, which may be affected by pre-admission factors. This study is done in summer, when most people avoid sun here in Saudi Arabia and keep their children mostly in air-conditioned places. This may be reflected on the high percentage (56.7%) of Vit D deficiency in our study but it indicates the need for healthy way of living and more exposure to sunlight with good dietary supplementation of Vit D, specially, for children.

Recommendations of Study

Our study showed high prevalence of Vit D deficiency among PICU patients and its significant association with increase the LOS and the need for mechanical ventilation. These findings reflect the need for healthy way of living and more exposure to sunlight with good dietary supplementation of Vit D, specially, for children. These results also draw attention to the need of Vit D supplementation for PICU patients as it will decrease their LOS and their need for mechanical ventilations.

Future Studies

For better analysis of the relation between Vit D level and LOS, ventilators days and mortality rate, a prospective randomized case control study on PICU patients is planned to be done with sequential measurement of Vit D level and randomized therapy of those with Vit D deficiency to determine the effect of Vit D therapy on LOS, ventilator days and mortality rate.

Conflict of Interests

The authors declare no conflict of interests for the data published in this manuscript.

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