

Estimation of Ionized Calcium Concentration in Critically Ill Patients

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ABSTRACT:

BACKGROUND:

Hypocalcaemia is a commonly encountered problem in critically ill patients, and it has been shown to correlate with increased ICU stay and mortality.

OBJECTIVE:

This study is to estimate serum ionized calcium level and to evaluate whether calcium adjusted for albumin accurately predicts ionized calcium concentrations.

PATIENT AND METHOD:

Cross sectional study conducted to 47 randomly selected adult patients admitted in Baghdad teaching hospital/ ICU from June 2014-october 2014. Ionized Ca level was determined using ion-specific electrode methodology, on heparinised plasma. The total Ca concentration was adjusted for serum Albumin.

RESULTS:

From total 47 patients, 40 patients were showed low serum calcium level (mean 6.79 mg/dl), and 14 were showed low corrected s.calcium (mean 7.77 mg/dl).

Low serum albumin was independently associated with hypocalcaemia on admission. 30 patients (63.83%) reported low total S. alb. mean s. albumin where 2.8mmol.

KEY WORDS: Ionized calcium,serum albumin,albumin corrected ratio,hypocalcaemia,hypo-albuminaemia.

INTRODUCTION:

Hypocalcaemia is common electrolyte disturbance in critically ill patients. The reported prevalence varies significantly between studies due to differences in the population studied and the cut off values used, with published figures ranging from 15% to 88%^(1,2) in adult patients and prevalence ranges from 12 to 74% in paediatric population^(3,4)

Calcium is a critical intracellular messenger and regulator of cell function. About 99 % of calcium exists in skeleton and rest 1 % in extracellular space. About half of this exists as free ionized calcium (iCa), essential for important functions of the body like neuromuscular excitability, homeostasis, cellular structural integrity and enzymatic activity⁽⁵⁾. Measurement of ionic calcium is more specific as it is unaffected by factors like hypalbuminaemia and acid base

disturbances, unlike total calcium levels. The relationship between total calcium and ionic calcium concentration is not always linear and may lead to false interpretation by measurement of total calcium levels alone^(6,7)

Multiple mechanisms for hypocalcaemia in the critically ill have been described: precipitation into tissues, complex formation with citrate from blood products or lactate. Dilution of plasma induced by administration of massive amounts of intravenous fluid in a resuscitative effort is reported to be an important cause of hypocalcaemia in trauma patients^(8,9). Decreased bone resorption, calcium chelation, calcitriol deficiency, decreased secretion or action of parathyroid hormone with or without hypomagnesaemia, and increased urinary calcium excretion contribute to drug-induced hypocalcaemia⁽¹⁰⁾. Spurious low concentration of calcium can be detected following the administration of gadolinium based contrast, as gadolinium interferes with calorimetric based calcium assays, while ionized calcium concentration measurements remain unaffected⁽¹¹⁾.

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IONIZED CALCIUM CONCENTRATION

The consequences of decreased serum ionized calcium are numerous, since calcium has an essential role in different cellular functions, including muscle and myocardial contractility, vascular tonus, enzyme activation and hormone release, neurotransmission, membrane potentials and blood coagulation, and as a critical intracellular messenger^(12, 13,14).

PATIENT AND METHOD:

Single centre Cross sectional study conducted to 47 randomly selected adult patients admitted in Baghdad teaching hospital ICU for period from June 2014-october 2014. For all patients admitted to ICU calculate Acute Physiology and Chronic Health Evaluation, All blood tests were carried out as part of routine clinical practice and consisted of daily serum chemistry, without tornicate blood sample taken from the patients and sending the sample by heparinized plasma method to lab for calculate ionized Ca level which determined by using ion-specific electrode

methodology. The total Ca concentration was adjusted to serum Albumin

RESULTS:

47 patients' data were included in this study, the mean i.Ca. level 6.7978 mg/dl, 40 patients (85.11%;tab.2) showed low serum calcium level (mean 6.79mg/dl, p=0.00001;tab.1), 7 patients (14.89%;tab.2) were normocalcaemic (mean 7.657 mg/dl;tab2), 28 showed low corrected s.calcium (mean 7.77mg/dl, p=0.000002;tab.2).

Low serum albumin was independently associated with hypocalcaemia on admission. 30 patients (63.83%;tab.2) reported low total s.alb, mean s. albumin where 2.8mmol.

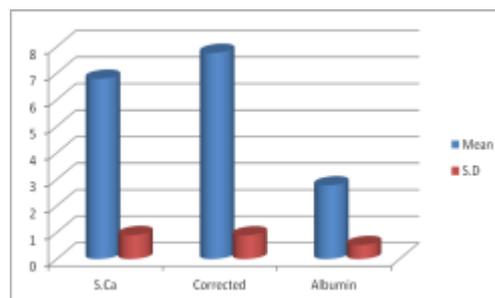
Albumin appeared not truly affecting the level of calcium. In normoalbuminic group (36.17%;tab.2) had pre corrected calcium level of (14.89%;tab.2) and post corrected calcium level of (40.43%;tab.2) while hypoalbuminic group (63.83%;tab.2) had a pre corrected calcium level of (85.11%;tab.2) and a post corrected calcium level of(59.57%;tab.2) ,this changes nearly same in normal and low albumin level.

Table 1: Prevalence of hypocalcaemia before and after correction.

One-Sample Statistics						
	N	Mean	Std. Deviation	Std. Error Mean	P value	Degree of freedom
Serum Calcium (mg/dl)	47	6.7978	.90591	.13505	0.00001	44
Corrected Serum Calcium	47	7.7738	.89535	.13347	0.000002	44
Serum Albumin	47	2.7800	.53112	.07918		

Table 2: Incidence of hypocalcaemia before and after correction.

	Normal	Low	High
PreCorrection S.Ca ⁺²	14.89%	85.11%	0
PostCorrection S.Ca ⁺²	40.43%	59.57%	0
s.alb	36.17%	63.83%	0



DISCUSSION:

Our study showed that hypocalcaemia is very common in critically ill patients (as high as 59.5% in our cohort). No specific Risk factors for hypocalcaemia had been seen. Chernow et al., had identified sepsis, renal failure and postabdominal surgery as risk factors for

hypocalcaemia. Zaloga et al., found ionized hypocalcaemia in 30% of cases of Gram-negative sepsis and in none of those cases of sepsis caused by Gram-positive bacteria⁽¹⁵⁾. In a study by Vivien B (2005) hypocalcaemia is frequently seen in severe trauma patients, and colloid-

induced haemodilution, severe shock and reperfusion ischaemia appear to be important causative factors⁽¹⁴⁾.

As a secondary finding, this study confirmed that a low adjusted calcium concentration is relatively a poor surrogate for identifying critically ill patients with low ionized calcium concentrations, despite its widespread use for this purpose. The adjustment of total calcium is based on a formula incorporating the relationship between total calcium and albumin^(16,17), derived from the linear regression equation and the difference of the patient's albumin from the population average^(18,19). There are a number of plausible physiological explanations for adjusted calcium being a poor predictor for ionized calcium in critically ill patients. They include alterations in pH affecting calcium-albumin binding, deranged serum concentrations of phosphate, which chelates calcium, or changes in blood concentrations of citrate and fatty acids^(20, 21, 22)

As to start administration of calcium gluconate early to patients with hypocalcaemia and critical presentation show better prognosis^(23,24), multicentre cohort studies with early calcium administration (at first four days) and try to normalize the level show good result in surviving of the patients^(25,26).

CONCLUSION:

Hypocalcaemia is a common problem in critical ICU patients, and this may lead to increase periods of ICU stay with higher mortality rates, at all there is no specific Risk factors for hypocalcaemia had been seen. However, patients severely hypocalcaemic on admission whose calcium failed to rebound to normal having a higher mortality and may be targeted for more intervention.

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