

# The Myths and Facts about Corrected Calcium Levels

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## Dear Editor,

We had a patient, a 63-year-old female, who presented to hospital with a history of loose stools and pain abdomen in the last 4 days. The diagnosis of acute gastroenteritis with dehydration was done. Routine blood investigation was normal except she had hypocalcemia (serum calcium 7.1 mg/dL) along with hypoalbuminemia (serum albumin 1.9 gm/dL). During intensive care unit (ICU) grand rounds, our resident pointed out that though the total calcium was low, the corrected calcium value (using Payne's formula) appeared normal. Is it the correct method to estimate calcium levels or do we need to supplement calcium?

Calcium is the essential nutrient that accounts for 2% of total body weight. About 99% of the calcium in the body is stored in bones and the remaining 1% (8–10 mg/dL) in blood, muscles, and soft tissues. Calcium helps in muscle contraction, immune regulation, blood clotting, and nerve function. In blood, 40% of calcium is bound to albumin and the remaining 60% is free (free calcium). This free calcium is active [ionized calcium (iCa)]. The physiological effects of calcium in the body are through iCa; hence, it is more important than total calcium levels. If we want to know the iCa levels in blood, then we need to check total serum calcium levels so that 60% of that total calcium levels will be iCa. Normal iCa is about 4.5–5.5 mg/dL.<sup>1</sup>

Why iCa is not measured routinely? The reasons are many— (1) the test tubes used to collect blood samples should have heparin as an anticoagulant<sup>2</sup>; (2) the blood sample tube should be covered properly to avoid CO<sub>2</sub> leakage and resultant change in pH (an increase in pH causes more binding of calcium to albumin and the resultant decrease in iCa levels and vice versa)<sup>3</sup>; (3) the sample should be analyzed immediately otherwise the stored sample can undergo anaerobic metabolism and alteration of pH. Hence, iCa is not measured routinely.

About 50–88% of critically ill patients who are admitted to ICU will have hypocalcemia<sup>4</sup> and about 21% of patients will have hypoalbuminemia.<sup>5</sup> The accurate calcium level testing is important because hypo or hypercalcemia is associated with multiple life-threatening complications. The challenge for us is, since we know that 40% of calcium is bound to albumin, does decrease in albumin levels in blood results in low estimated total serum calcium levels. Do albumin levels in our body over/underestimate the total serum calcium levels? In 1973, Payne et al. came up with a solution to estimate the serum calcium level based on serum albumin levels known as the corrected calcium formula.<sup>6</sup>

Corrected calcium formula =

$$\left[ 0.8 \times (\text{Normal albumin levels} - \text{Patient albumin levels}) \right] + \text{Serum calcium}$$

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Normal serum albumin level is 3.4–5.4 gm/dL. So, according to this formula, we need to add 0.8 mg/dL calcium for every 1 gm/dL fall in serum albumin.

Many studies failed to correlate the corrected calcium formula concept for estimating iCa levels.<sup>7,8</sup> Whenever there is a fall in albumin levels in the blood, more calcium will bind to the available albumin and hence the measured total serum albumin remains the same even in hypoalbuminemia (this contradicts the concept of Payne's formula which says that the binding of calcium to albumin is always constant). Even in hypoalbuminemia, the correlation between iCa and uncorrected calcium remains the same.<sup>9,10</sup> Hence, the corrected calcium formulas can underestimate the serum calcium levels and lead to overcorrection of calcium.<sup>11</sup>

Finally, we can conclude that uncorrected calcium level predicts the iCa levels accurately in the blood. If we want to check serum calcium levels, then it is better to check iCa (biologically active) than total calcium. Please do not order a serum albumin test to look for corrected calcium levels.

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