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A mathematical model of parathyroid hormone response to acute changes in plasma ionized calcium concentration in humans. (English summary)


Summary: “A complex bio-mechanism, commonly referred to as calcium homeostasis, regulates plasma ionized calcium (Ca^{2+}) concentration in the human body within a narrow range which is crucial for maintaining normal physiology and metabolism. Taking a step towards creating a complete mathematical model of calcium homeostasis, we focus on the short-term dynamics of calcium homeostasis and consider the response of the parathyroid glands to acute changes in plasma Ca^{2+} concentration. We review available models, discuss their limitations, then present a two-pool, linear, time-varying model to describe the dynamics of this calcium homeostasis subsystem, the Ca-PTH axis. We propose that plasma PTH concentration and plasma Ca^{2+} concentration bear an asymmetric reverse sigmoid relation. The parameters of our model are successfully estimated based on clinical data corresponding to three healthy subjects that have undergone induced hypocalcemic clamp tests. In the first validation of this kind, with parameters estimated separately for each subject we test the model’s ability to predict the same subject’s induced hypercalcemic clamp test responses. Our results demonstrate that a two-pool, linear, time-varying model with an asymmetric reverse sigmoid relation characterizes the short-term dynamics of the Ca-PTH axis.”

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