The Use of a Noninvasive Hemoglobin Monitor for Volume Kinetic Analysis in an Emergency Room Setting

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Background

Distribution and clearance of an infused bolus can be studied by repetitive sampling of invasive total hemoglobin (tHb) using volume kinetic equations. Pulse CO-Oximetry, a recent advancement in patient monitoring that allows for the continuous and noninvasive estimation of hemoglobin concentration (SpHb), would greatly facilitate the scientific and clinical use of the volume kinetic parameters. In the present study, we examined whether serial measurements of SpHb in an emergency room setting can be used to calculate distribution volume (V) and clearance (Cl) rate of an infused bolus.

Methods

This was a prospective, observational study of patients in 2 age groups admitted for various reasons to the emergency room of a tertiary care center. IV catheters were placed in both arms of the subjects to induce plasma volume expansion by infusion of a buffered crystalloid glucose solution and for withdrawing venous blood samples for analysis of tHb at 0, 5, 10, 15, 30, 45, 60, 75, and 90 minutes after start of infusion. During these interventions, subjects were simultaneously monitored by pulse CO-oximetry for measurement of SpHb (Masimo Radical-7, Rev E ReSposable sensor). Bias, precision, and limits of agreement were calculated in Bland-Altman plots to compare the accuracy of SpHb with invasive tHb measurements. Using volume kinetic (pharmacokinetics for fluids) equations, V and Cl were determined.

Results

Thirty patients (14 from the young group with a mean age of 30 years, and 16 from the geriatric group with mean age of 84 years) were enrolled in the study. When all data were included, this yielded 242 data pairs with a bias of -0.47 (95% confidence interval, -0.62 to -0.32) between SpHb and tHb. However, 5 patients were omitted because of low quality signals, leaving 193 hemoglobin data pairs for further analysis. Bias was then -0.24 (95% confidence interval, -0.39 to -0.09). The biases show that the device on average slightly underestimates tHb values. The precision of SpHb decreases when the low signal quality indicator is present. For the 27 subjects for whom the V and Cl were calculated, there were no significant differences in the estimation of the distribution volumes using either tHb or SpHb values. Clearance constants were also estimated, but with less accuracy.

Conclusions

Our data show that SpHb by Pulse CO-Oximetry may be used to calculate volume of distribution in an emergency room setting.