Optimization of cardiac output by incremental fluid administration is associated with iatrogenic hemodilution and a paradoxical decrease in oxygen delivery

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Background and Goal of Study: Fluid administration causes iatrogenic hemodilution that may lead to avoidable blood transfusions [1]. We examined the effects of incremental fluid loading on the oxygen delivery (DO2) and on lab (BHb) and non-invasive (SpHb) hemoglobin levels.

Materials and Methods: After informed consent, 40 adult patients undergoing major gastrointestinal or vascular surgery were included. Oxygen saturation (SpO2) and SpHb were continuously measured by a Radical-7 Pulse CO-Oximeter (Masimo Inc.). BHb and PaO2 were intermittently measured (ABL800 Radiometer). Cardiac output (CO) and stroke volume (SV) were continuously measured by the Vigileo monitor. DO2 was calculated as COx((Hbx1.38xSpO2)+(PaO2x0.0031)). Baseline values were recorded after induction of anesthesia (T0) and 5 min after the administration of a 250 ml colloid fluid challenge (FC) (T1). In patients whose SV increased ≥ 10% compared to T0, another FC was given and all parameters recorded 5 minutes after its completion (T2). The same protocol was repeated at T2 and T3. Student’s paired and unpaired tests, Wilcoxon signed rank test and ANOVA were used where appropriate.

Results and Discussion: All 40 patients received one FC (T1), 33 patients received 2 FC’s (T2), and 22 patients received 3 FC’s (T3). Figure 1 represents the mean ± SD of SpHb, BHb, CO and DO2 during the study and the number of patients studied at each time point. There was a gradual increase in the mean SV between T0-T1, T1-T2, and T2-T3. However, the DO2 increased significantly only from T0-T1, remained unchanged between T1-T2, and decreased between T2 and T3. There was a statistically significant decrease in mean SpHb and BHb after each FC. In patients who received 3 FC the SpHb and the BHb decreased by 1.66±0.67 and 1.7±0.7 g/dL, respectively. This decrease in Hb values explains the observed decrease in the DO2.
Conclusion(s): Fluid loading in goal-directed therapy may cause a paradoxical decrease in DO2 due to iatrogenic hemodilution, which is reflected by a real-time decrease in the SpHb trend, similar to the intermittent BHb trend.