Interstitial Washdown and Vascular Albumin Refill During Fluid Infusion: Novel Kinetic Analysis From Three Clinical Trials

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Research Articles

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Abstract

Background and Aims. Increased capillary filtration may paradoxically accelerate vascular refill of both fluid and albumin from the interstitial space, which are claimed to be edema-preventing. We characterized “interstitial washdown” by kinetic analyses of the hemodilution induced by intravenous infusion of crystalloid fluid during 3 distinct

physiological states.

Methods. The dilution of blood hemoglobin and plasma albumin was compared by population volume kinetic analysis during and after intravenous infusion Ringer´s solution over 30 min in 24 conscious volunteers and 30 anesthetized patients. Data were also retrieved from 31 patients with ketoacidosis from hyperglycemia who received 1 L of

0.9% saline. Greater plasma dilution of hemoglobin as compared to albumin indicated recruitment of albumin.

Results. “Interstitial washdown” increased plasma albumin concentration by 0.6 g/L in volunteers, by 1.0 g/L during anesthesia, and by 0.3 g/L in ketoacidosis patients. The albumin concentration in extravascular fluid returning to the plasma was approximately 29, 29, and 22 g/L during the respective infusions, but decreased to an average of 50% to 75% lower during the subsequent 2-3 h. Pronounced washdown was associated with increased capillary filtration (high k12) and, in conscious subjects, with fluid retention due to restricted urine flow. During anesthesia, the main effect was an increase the nonexchangeable fluid volume (“third-spacing”).

Conclusions. Fluid infusion induces interstitial washdown by accelerated lymphatic flow and an increase in plasma albumin. The mechanism becomes exhausted after 2-3 hours. Albumin refill helps retain infused volume within the vascular compartment.

Full-text

Due to technical limitations, full-text HTML conversion of this manuscript could not be completed. However, the manuscript can be downloaded and accessed as a PDF.

Figures

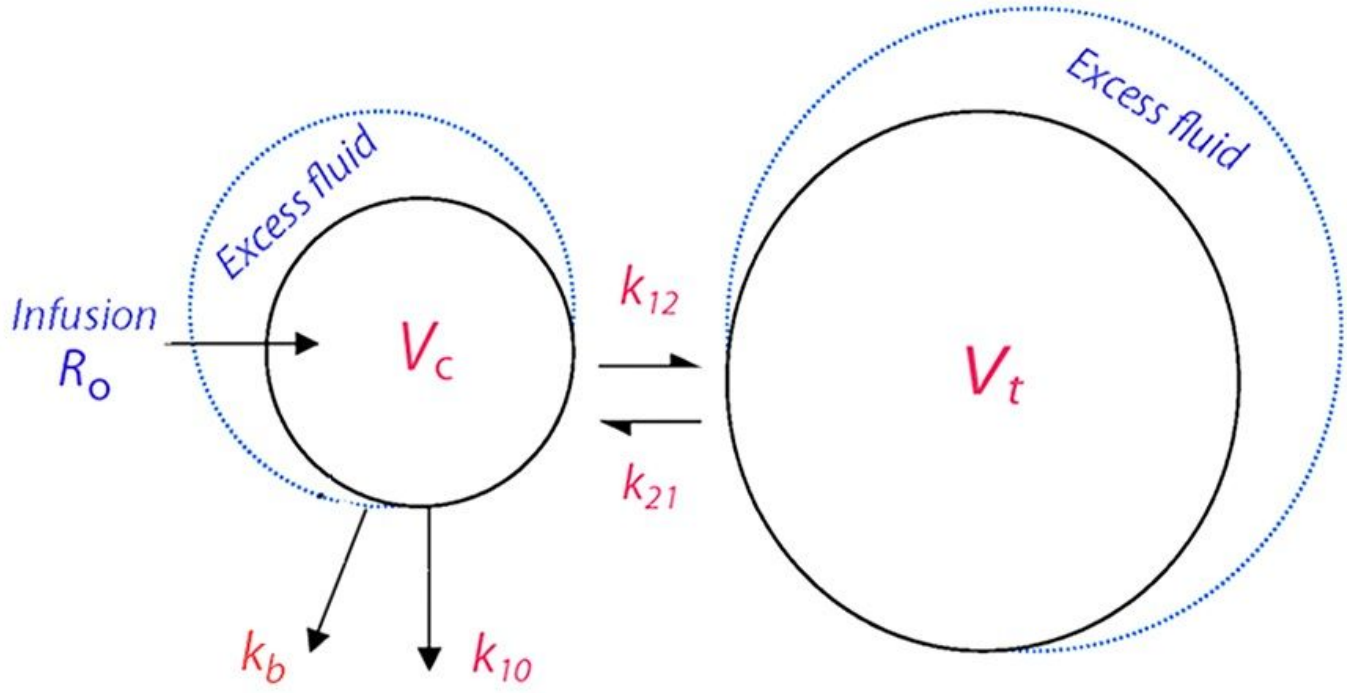

Figure 1

Kinetic model. Schematic drawing of the kinetic model used to analyze the distribution and elimination of Ringer´s solution.

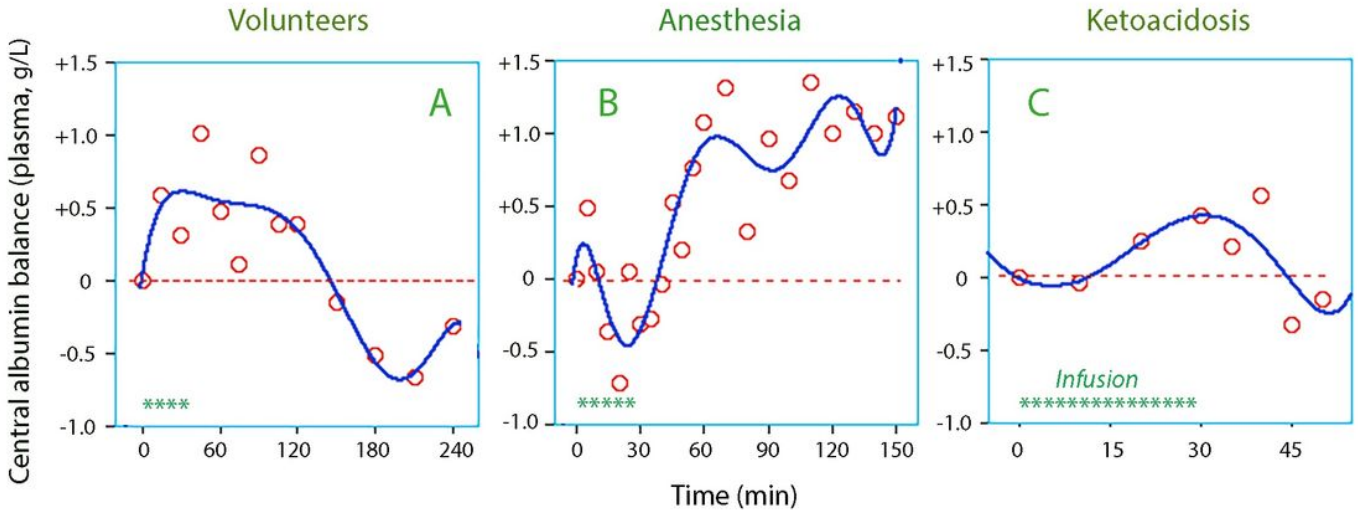

Figure 2

Albumin recruitment during crystalloid fluid therapy. The y axis shows plasma albumin concentration that is due to interstitial washdown. Technically, each data point is the product of the Hb-albumin difference in

plasma dilution and the plasma albumin concentration in (A) 20 volunteers receiving 1.7 L of Ringer´s acetate, (B) 30 patients given 1.7 L of Ringer´s acetate thyroid surgery, and (C) 31 infusions of 1 L of 0.9% saline in patients treated for diabetic ketoacidosis. Each infusion was given over 30 min.

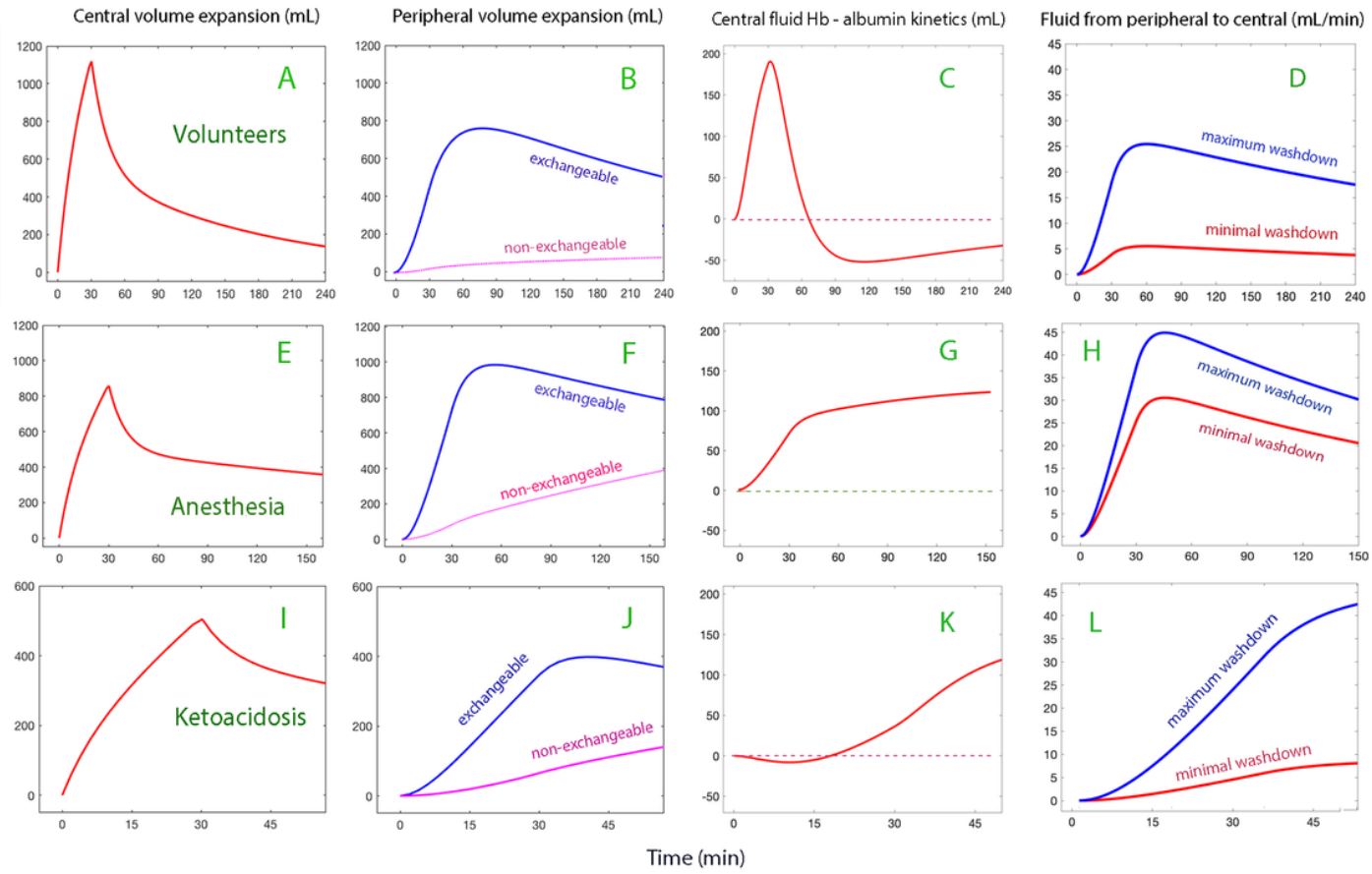

Figure 3

Volume kinetic analyses. These analyses were based on the dilution of blood Hb and shows the distribution of infused fluid between the (A) central and the (B) peripheral fluid compartment, (C) the excess fluid in the central compartment when analyzing the volume kinetics based on Hb minus the volume expansion as obtained when albumin was used as the marker of plasma dilution. (D) return flow of fluid from the peripheral to the central space (the plasma) when contrasting the influence of high-degree versus low-degree interstitial washdown (approximately 5% - 95% span).

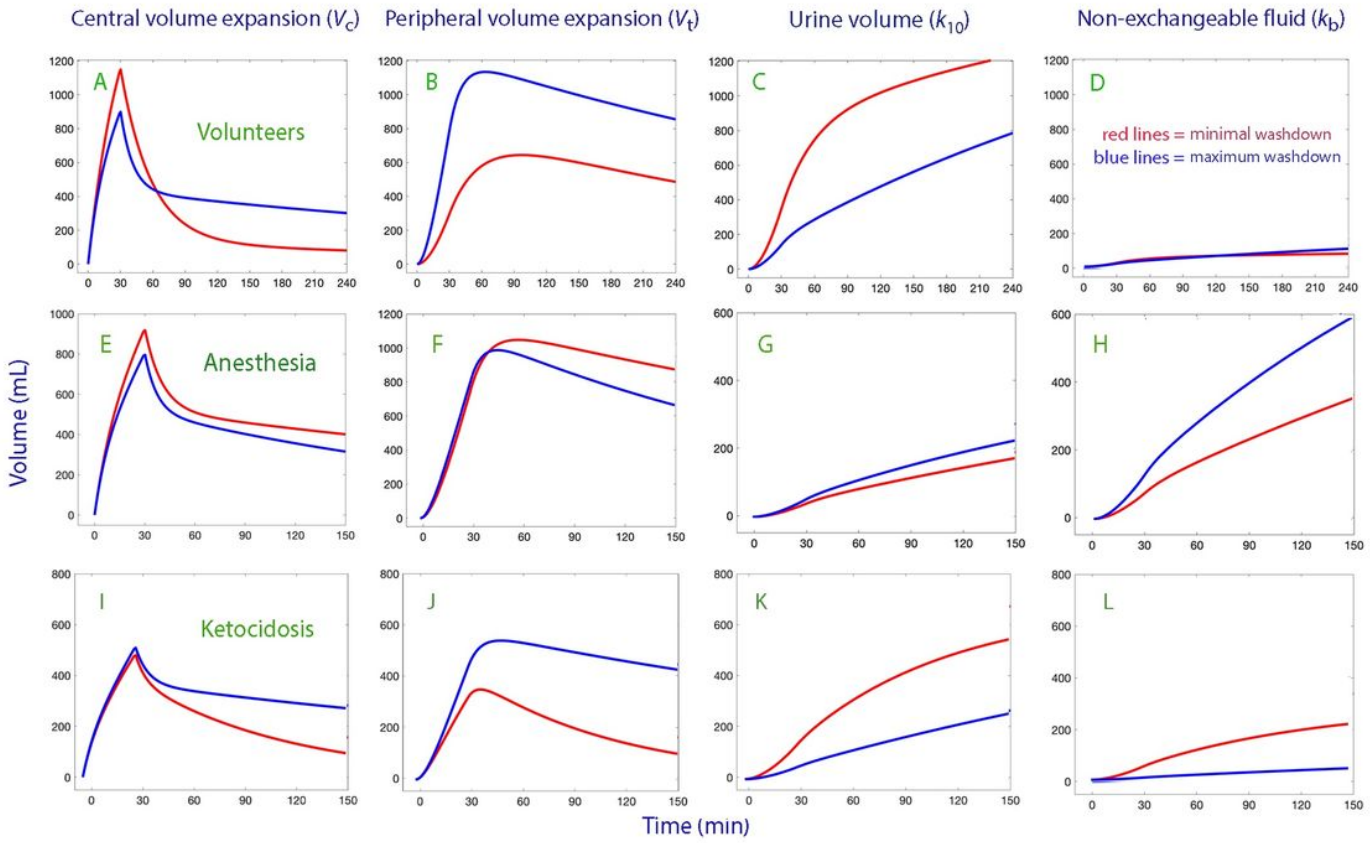

Figure 4

Influence of interstitial washdown on the distribution of crystalloid fluid. Volume kinetic analysis of the fluid distribution when 1.7 L of Ringer´s was infused in volunteers (top row), 1.7 L to patients undergoing surgery (middle row) and 1.0 L of 0.9% saline was given to patients with ketoacidosis (bottom row). All infusions were given over 30 min. All volumes are shown depending on whether the interstitial washdown was in the low or high range (approximately 5% - 95% span). For the volunteers, the range was between -0.10 and +0.10 (mean -0.019), for the anesthesia patients -0.01 to +0.15 (mean, +0.05), and for the patients with ketoacidosis the Hbalbumin difference in plasma dilution varied from -0.10 to +0.40 (mean, +0.046).