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CORRESPONDENCE

The "stressed blood volume" revisited

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To the Editor,

"Sometimes it is possible to get a correct answer for the wrong reasons. However, the hazard is that one is likely to get other answers that are incorrect if one starts with a faulty premise".[1]

The recent comprehensive review by Gelman and Bigatello[2] focuses on flow, pressure, and volume interrelationships in the venous system and the fluid responsiveness concept. The former is analyzed in terms of components of total venous volume ("stressed", Vs, and "unstressed", Vu) and Guyton's model of "venous return", without mention of the critical analyses that dispute the interpretation of Guyton's data.[1,3-5]

The authors think of Vs and Vu as coexisting circulating and non-circulating volumes, respectively—on the basis that flow cannot occur at zero transmural pressure (P_{TM})—followed by a pressure-volume (P-V) diagram (Figure)[2] with a simplified depiction of the lumped venous system showing the Vu upstream to Vs, which resides in the vicinity of the right atrium.

But the graph image in their figure[2] (Figure) does not represent a functional relationship between variables; instead, it is an intuitive view not consistent with the physics of hydrodynamics. Pressure within a compliant chamber is uniform, meaning that all the volume is "stressed" when Ptm > 0. Their distinction—really only an abstract interpretation of the P-V curve—between "components" has no actual physical correlate. Furthermore, the concept of blood reservoirs does not

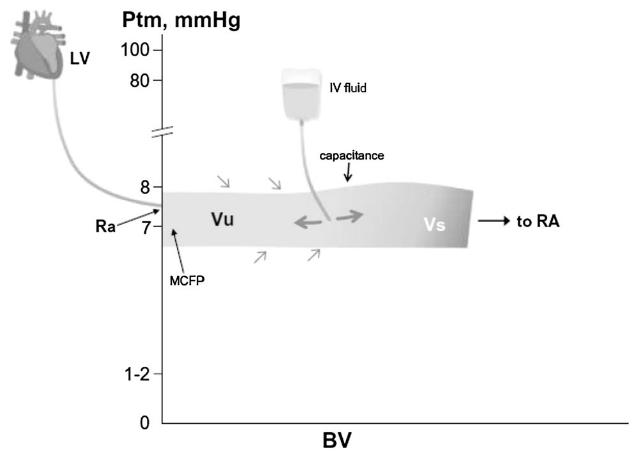

Figure The "single vein" model as described in Gelman.[2] A simplified depiction of the lumped venous system with a P-V (elastance) graphic, where no functional correlation between variables is indicated; Vu appears upstream to Vs, which would be inconsistent with the pressure decline across the venous system related to steady-state flow and also with the conventional view of the elastic compartment at mean systemic pressure draining the venous return through the venous resistance, quantitatively described by Guyton's equation. BV = blood volume; IV = intravenous; LV = left ventricle; MCFP = mean circulatory filling pressure; Ptm = transmural pressure; Ra = arterial resistance; RA = right atrium; Vs = stressed volume; Vu = unstressed volume. Used with permission from: *Gelman S, Bigatello L.* The physiologic basis for goal-directed hemodynamic and fluid therapy: the pivotal role of the venous circulation. Can J Anesth 2018; DOI: 10.1007/s12630-017-1045-3[2]

This letter is accompanied by a reply. Please see Can J Anesth 2018; 65: this issue.

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imply that its volume is "at rest"[2]; when analyzing steady states, flow traverses equally every cross-sectional area of the circuit.

Pressure along the vascular paths from aorta to vena cavae continues a shallow decline after the precipitous fall along the pathway through arterioles to post-capillary vessels. It is only in the last portion of the pathway that volume within the vessels may be insufficient to fill the vessels to the point that they are stressed. This is the only segment in which becoming "unstressed" is a practical problem, for it is the first to reach that condition if volume is translocated upstream or being lost. Once these vessels collapse with P_{TM} falling to zero, hemodynamics become more complicated because they then impose high resistance to flow and compromise cardiac preload. The appropriate concern about volume distribution, then, is to assure that a sufficient fraction of the total volume remains within these large conduits.

Doubtlessly, the venous side of the circulation plays a pivotal role in cardiovascular control: the vasculature of the organs buffer changes in flow and blood volume[3-5] and maintain cardiac preload by adjusting its capacitance.[5] Nevertheless, the ideas of Vs and Vu being physically separated mechanical energy for steady cardiac output coming from stretched vascular compartments or "hydraulic isolation" of the arterial and venous systems[2] have no physical or physiologic basis.

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Conflicts of interest None declared.

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