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Hemodynamics: Could it be Sometimes the Dark Side of the Moon?

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Abstract

Hemodynamic monitoring has built its developement on the needing to know whether enough oxygen from the lung reaches the cells and carbon dioxide flows back to be excreted. Since they travel within the blood flow, attention focused on the amount of blood circulating through the vessels (i.e. the volemia) and how it circulates. But our habit is still to use "old and static" parameters (central venous pressure, pulmonary capillary wedge pressure) or only blood pressure and heart rate to guide our fluid therapy. One reason may be that we are still not so confident with new technology of hemodynamic measurement, in many cases. Another cause may be the incredulity towards the new devices. There is a big gap between clinical research studies evaluating these monitors and clinical practise that need to be filled by unquestionable results derived from large multicenter trials in order to break the fog that causes doubts and perplexities in their use.

«Not everything that counts can be counted and not everything that can be counted counts»

[Albert Einstein]

Mini Review

Upper gastrointestinal bleeding (UGIB) is common and potHemodynamic monitoring has built its developement on the needing to know whether enough oxygen from the lung reaches the cells and carbon dioxide flows back to be excreted. Since they travel within the blood flow, attention focused on the amount of blood circulating through the vessels (i.e. the volemia) and how it circulates. We learned that blood volume is the sum of intra-vascular volume and blood circulating into the organs (i.e., tissue perfusion) and represents almost 10% of body weight. A normal "standard" adult subject has 5-7 L of blood, near 70% of which circulates into the veins, [1]. Volemia undergoes a complex regulation which involves the neuroendocrine system, the gastrointestinal apparatus, kidneys, lungs, bone marrow and skin: they regulate the input and output of fluids, the hematocrit and blood components, [1]. Simplifying to the maximum, when output is greater than input we tend to replace the loss with fluids.

The first time a fluid was intravenously administered was during the Cholera pandemic of the XIX century, [2]. Then the normal saline solution 0.9% was reported as the best fluid and was adopted worldwide, [3]. During the 1920s physicians started to use Hartmann's Solution, nowadays named Ringer Lactate. Finally, after the Second World War, Human Albumine entered the list of fluids for shock treatment, [4,5]. As that list got longer, the choice of treatment became more and more debatable, because each fluid has own characteristics and different effects on hemodynamics.

"The decision to administer supplemental intravenous fluids to the patient at risk is built upon the belief that additional volume expansion will, or will not increase cardiac output.", [6]. In fact, when circulatory instability occurs, generally we aim firstly to restore the cardiovascular balance giving fluid to the patient, without caring of the long-term consequences (i.e. organ failure and mortality).This habit has been revisioned and debated during the last decade, particularly about hydroxyethyl-starch (HES) and 0.9% saline solution, [7]. To complicate the issue the "Boldt Case" broke out, [8].

Some questionsarise. May be correct to think that many conclusions arisen from the studies of Boldt were wrong?What do we do withthe informations derived from those trials?Several medicine text-books reported those conclusions. Those books need to be rewritten? Furthermore, we cannot use HES anymore

so widley after its restrictive indications were released, [9]. Then, how can we be sure that the results from those trials, which also studied HES-based fluid therapy, can be still appliable bed-side?

Time break. Let's go back again to Physiology. When we try to measure blood volume we refers to circulating blood volume (CBV) and mainly to the portion that perfuses organs, the so called Effective Circulating Volume (ECV) of the arterial circulation. It depends not only on Cardiac Output (CO) but on vascular resistances too, [10]. Often we refer to Volemia as CBV and we try to measure it by several devices. Since our main target is to know whether a sufficient amount of blood reaches the cell (i.e. tissue oxygen delivery), Technology focused its production on arterial measurement systems or cardiac function assessment. Many devices provide data about blood flow fluctuation during respiration to predict fluid responsiveness (FR), forgetting the venous side of the circulation, where near 70% of volemia circulates. We know that CO depends also on venous blood return (VBR), [1]. Ultrasound measurement of inferior vena cava (IVC) diameter and its variation during the phases of respiration (i.e. Caval Index, CI) may be an acceptable compromise to know how much blood goes back to the right side of the heart. But also CI has its own limitations that if forgotten provide mis-interpretation [11].

Out of such an amount of hemodynamic measurement systems how many times do we use them to guide our fluid therapy (FT) bed-side? Cecconi et al., found that most often we still adopt only blood pressure (BP), heart rate (HR)or Central Venous Pressure (CVP) as guides for FR (near 70% and 24% and 57% of cases, respectively) [12].

A further question arises: Why to spent so much money to buy sophisticated devices if we won't use them?

Three possible answers: 1) We use BP and HR as guides for FT because we have not advanced monitoring system in our hospital; 2) We still use BP and HR because we are not confident with other measurements and/or we don't believe in such devices; 3) Routinely we use BP and HR but in case of very complicated clinical situations we employ advanced tools.

Despite the first response may translate into dangerous management of critically ill patients, it could be the Institutional Policy with a view to cost saving (particularly in a little peripheral hospital), forgetting that even the complicated patient is spending. The second answer may derive from a not sufficient participation to educational courses about hemodynamic monitoring. Most often such events are very expensive and each Department could permit few staff doctors to participate, unless the physician does so at his own expense or by sponsors.

The main cause of the unbilief on device measurements, particularly the less invasive ones, may be the inconclusive Literature about their validation trials [13]. The third situation may be the most dangerous. In fact, waiting for an advanced crtitical condition to adopt a closer monitoring may be life-threatening. Early goal directed fluid therapy provides a better outcome but need to be monitored to reach the aim of life saving and cost-saving [14,15]. Finally, different hemodynamic impairments and patients may require an appropriate type of tool. Not every type of monitoring system fits every type of critical patient. If we face with pulmonary hypertension, Pulmonary Artery Catheter may be the correct choice, but in case of adult respiratory distress syndrome (ARDS) it may be very helpful to know the extravascular lung water (EVLW), for instance, and then Transpulmonary Thermodilution technique may be the best option. Hence the needing to be confident with different hemodynamic tools to do the best choice according the clinical situation may be the best policy and of common sense.

In summary, we try to measure something that we don't know so well by devices not always reliable, invasive (and potentially dangerous for the patients) and expensive, to which we are not so confindent in many cases. Conversely, several studies showed that monitoring fluid therapy (whatever the system we choose) may save many lives and then be economically saving. Hence, we have to use instruments to know merits and defects but in which we trust and make them the guide of our therapy, if properly validated: we can read too much trials including few patients, published also in Journals with high impact factor.

On the other hand, Technology-Hemodynamics educational courses should be less expensive to contribute to a wider adoption of such devices, even in little hospitals where treat critical patients is more difficult and forces doctors to tranfer the patient (i.e. cost expensive) to a greater hospital where he may receive the best treatment. To quote M.R. Pinsky and D. Payen, monitoring does not save life by itself, [16]. But it may be reasonable to think that monitored therapy does, as long as we know what to measure and how [17]. It may be very difficult and dangerous to treat not well understood clinical situations, monitored by inaccurate tools. Just like a piloting an airplane with an inaccuarate altimeter. There is a "...big gap between clinical research studies evaluating these monitors and clinical practise" [17], that need to be filled by unquestionable results derived from large multicenter trials in order to break the fog that causes doubts and perplexities in their use.

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