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Managing hemodynamic instability – If you want to know cardiac output, you need to measure it!

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According to a recent consensus definition circulatory shock is "typically associated with evidence of inadequate tissue perfusion on physical examination" [1]. Frequent thorough clinical examination and evaluation of available physiologic variables is therefore recommended in patients with findings suggestive of shock for the initial assessment and re-evaluation of the response to treatment [1,2].

While physical examination is ubiquitously used to assess the cardiovascular system in patients with hemodynamic instability, literature evaluating the diagnostic accuracy of physical examination is very limited [3].

In this context, the study by Eyeington and colleagues [16] published in this issue of the journal asks a clinically relevant question: Are clinicians able to correctly estimate cardiac index in hemodynamically unstable hospital-ward patients who trigger an emergent rapid response team call?

In a single-center prospective observational study, the authors demonstrated that the level of agreement regarding cardiac index categories measured with a non-invasive monitoring system and estimated using clinical examination by members of the rapid response team was poor. The authors measured cardiac index non-invasively using a finger cuff technology, namely the Clearsight System (Edwards Lifesciences, Irvine, CA, USA) that uses the volume clamp method (also known as vascular unloading technique) to estimate stroke volume using pulse wave analysis and provide real-time cardiac index values [4]. The study basically shows that intensive care unit-based clinicians are unable to correctly identify the presence of a low or high cardiac index when assessing the hemodynamic status of a patient after a rapid response team call and that the measurement of cardiac index provides additional information that cannot be obtained by clinical assessment. This finding is of clinical relevance because knowing the cardiac index is crucial for making a differential diagnosis of the type of circulatory shock in patients with cardiocirculatory failure [5]. Most clinical judgement estimated patients to be hypovolemic and hence lead to fluid boluses being given to these patients. This tendency to almost always believe that a patient needs fluid during an emergency response is probably a common behavior pattern around the world and may be something that harms rather than benefits certain patients.

When discussing the clinical value of traditional physical examination techniques, these should simply be considered as a diagnostic test that needs to be properly learnt (including their limitations) and not as an "art" that is passed down from one generation of physicians to another [6]. The initial assessment of hemodynamically unstable patients using physical examination has been shown to have low diagnostic accuracy in distinguishing the type of circulatory shock [7]. In addition, physical examination signs and tests indicative for hypovolemia or hypervolemia have poor diagnostic accuracy regarding the intravascular volume status [8-10]. Furthermore, the ability of intensive care unit physicians to correctly predict the hemodynamic status of a patient using physical examination is limited and advanced hemodynamic monitoring has major influence on therapeutic decisions [11]. Several studies have demonstrated that diagnostic accuracy of a physician's "educated guess" of cardiac output is around 50%, much like "flipping a coin" [3].

Given the limited accuracy of clinical examination, it is recommended to perform further hemodynamic assessment of cardiac function in patients with circulatory shock if the clinical examination does not lead to a clear diagnosis [1]. Cardiac function might primarily be assessed using echocardiography and invasive advanced hemodynamic monitoring methods in complex patients not responding to initial therapy [1]. While estimation of cardiac output and volume status was initially limited to only the operating room and the critical care unit, new, easy to use, non-invasive methods will – in the near future –

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allow advanced hemodynamic monitoring on the hospital-ward [12,13]. Eyeington and colleagues, therefore, provide us with an encouraging study which, though limited in numbers, maybe the way to the future in early resuscitation and understanding of shock physiology by first responders on the regular floor. A word of caution is that we are not there yet and that non-invasive hemodynamic monitoring systems need to be meticulously evaluated and validated before they can be recommended for routine clinical use [14]. In addition, the impact of using these technologies on patient centered outcomes has yet to be defined, as is also noted by this study and needs to be balanced against the additional costs associated with their implementation.

The diagnostic accuracy and clinical value of physical examination of the hemodynamic status, on the other hand, might be improved by developing and evaluating structured clinical examination approaches that combine a variety of clinical signs [3,15].

When in doubt with the clinical estimation of cardiovascular status in patients with hemodynamic instability we propose that –if you really want to know cardiac output– you need to measure it!

Conflicts of interest

BS collaborates with Pulsion Medical Systems (Feldkirchen, Germany) as a member of the medical advisory board and received honoraria for giving lectures and refunds of travel expenses from Pulsion Medical Systems. BS received research support from Edwards Lifesciences (Irvine, CA, USA). BS received institutional research grants, unrestricted research grants, and refunds of travel expenses from Tensys Medical (San Diego, CA, USA). BS received honoraria for giving lectures and refunds of travel expenses from CNSystems Medizintechnik (Graz, Austria).

AKK collaborates with Medtronic (Boulder, CO, USA) as a member of the steering committee of the PRODIGY trial, scientific advisor, and on the executive advisory board for the respiratory monitoring division and received research support and honoraria for speaking engagements from Medtronic. AKK has received research support and honoraria for speaking engagements from La Jolla pharmaceuticals (La Jolla, CA, USA). AKK serves as a scientific advisor for CAE healthcare (Saratoga, FL, USA).

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