Viewpoint

Urgent Right Heart Catheterization in Cardiogenic Shock: Let us Spread this Idea

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Cardiogenic shock (CS) is defined by the presence of signs and symptoms of low tissue perfusion associated with systolic blood pressure (BP) < 90mmHg, according to the European Society of Cardiology. Within the different types of shock - cardiogenic, distributive, hypovolemic, and mixed - CS is responsible for up to 66% of shock cases in intensive care units and occurs due to poor perfusion secondary to low cardiac output. The most prevalent etiology is ST-elevation myocardial infarction (STEMI); other causes include acute chronic heart failure, valvular diseases, and arrhythmias.[1,2]

In-hospital mortality from CS associated with STEMI can reach 36% in cases not associated with a heart attack, 31%. Furthermore, effective treatment is related to understanding the disease mechanism and classifying the patient into phenotypes, which will impact the implemented therapy.[1-3]

The patient must be monitored using the maximum available parameters, including clinical perfusion assessment with micro and macro hemodynamic parameters, control of urine output, electrocardiogram, and echocardiogram. Invasive monitoring with a pulmonary artery catheter (PAC) can provide even more precise data, such as cardiac output, pulmonary and systemic vascular resistance, and pressures in the right and left chambers, assisting in therapeutic decision-making.[3] (Figure 1)

Pulmonary artery catheter and cardiogenic shock

CS can be divided into four phenotypes according to blood volume and peripheral perfusion, and PAC data are essential for adequately characterizing the phenotype and institution of treatment. The wet profile is when the pulmonary artery occlusion pressure (PAOP) is > 18 mmHg, and the dry profile is when the PAOP is < 18 mmHg. Regarding perfusion, we classify the patient as hot if a cardiac index (CI) >2.5 L/min/m^2 is identified or cold when the CI is < 2.5 L/min/m^2.[3] (Figure 2)

Contemporary clinical trials have debated the role of PAC as a diagnostic and monitoring tool in patients with CS.

Keywords

Swan Ganz Catheterization; Catheterization; Cardiogenic Shock

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Manuscript received September 30, 2023, revised manuscript October 05, 2023, accepted October 05, 2023

DOI: https://doi.org/10.36660/abchf.20230076

In 2005, the ESCAPE Trial was published, which showed no difference in mortality with the use of PAC. However, the patients included in the study were not in CS (profile C), which most likely influenced the results.[4]

More recently, experts strongly advocate using PAC, as contemporary evidence suggests that invasive hemodynamic assessment assisting in decision-making by the shock team has translated into lower mortality in CS, which currently reaches 50%.[5]

The evolution of ventricular assist devices (VAD) and the improvement in expertise in their management have brought a new perspective to the use of PAC. A study with 1,414 patients with CHD showed lower in-hospital mortality with PAC when data on complete hemodynamic parameters such as right atrial pressure (RAP), pulmonary artery systolic, and diastolic pressure (PSAP and PDAP, respectively) were available. PAOP, pulmonary arterial saturation, and cardiac output (CO). The study showed that better pre-implantation hemodynamic assessment of the VAD improved patient survival. Invasive hemodynamic parameters are fundamental for choosing the best VAD or combination of them.[5]

Mohammed Osman et al. reinforce the benefit of using PAC in 2021. The study showed that patients with CS who underwent invasive monitoring had better in-hospital survival, more implanted devices, and a greater chance of progressing to heart transplantation.[6]

Despite attempts to develop less invasive monitors, no alternative device provides such a comprehensive assessment of circulatory performance as the PAC. This was evidenced in a meta-analysis by Peyton and Chong, which demonstrated low agreement between the PAC and four other less invasive CO monitoring devices. Using the pulmonary artery catheter, it is possible to estimate preload, avoid volume overload, and measure CO, guiding the use of inotropes. Estimating vasomotor tone by calculating vascular resistance and titrating the need for vasoactive drugs is also possible. Furthermore, this catheter allows the measurement of pulmonary pressures, which undoubtedly helps manage right ventricular heart failure, a condition associated with high mortality.[7] (Figure 1)

Clinical trials and perspectives

Multiple prospective randomized clinical trials and systematic reviews have not shown overall mortality benefits related to any ICU monitoring device.[8] However, retrospective studies that used large databases have shown a benefit in monitoring with PAC. A recently published meta-analysis included 12 studies and showed lower in-hospital mortality in patients with CHD and decompensated HF as the etiology of shock.[9]

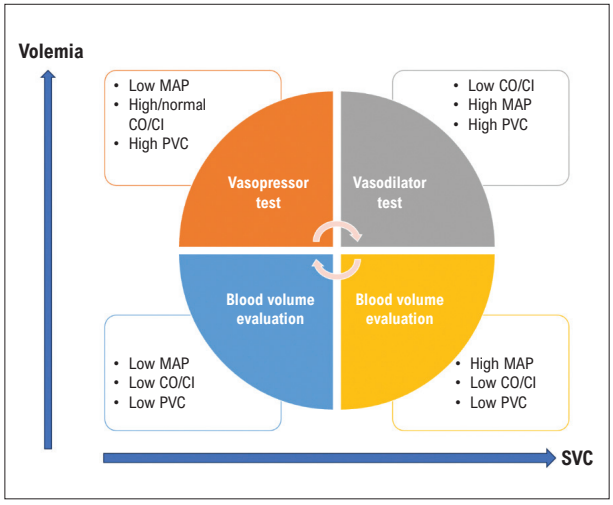

Figure 1 – *Phenotypes of cardiogenic shock and suggested therapy in patients with cardiogenic shock. SVC: systemic vascular resistance.*

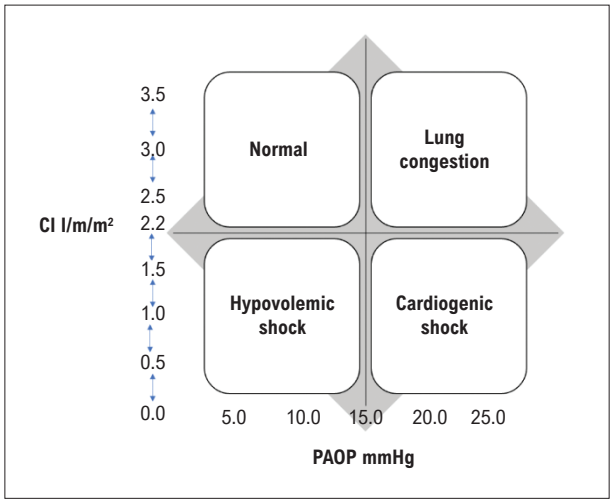

Figure 2 – *Hemodynamic profiles based on PAC. Source: Adapted from Forrest, Diamond and Swan et al.[11] CI: cardiac index; PAOP: pulmonary artery occlusion pressure.*

Despite the absence of robust studies with greater statistical power, these diagnostic monitoring techniques continue to be routinely used in clinical practice. Compared to other monitors (such as POCUS, pulse oximetry, and invasive BP), the PAC has already been thoroughly evaluated, and the negative result of the ESCAPE Trial does not diminish its usefulness as a diagnostic and monitoring tool, especially in the context of CS.

Due to greater access to VADs, the use of algorithms with hemodynamic parameters has grown, and the elucidation of the shock subtype helps in patient management and the best choice of ventricular assist device. With PAC, evaluating the right ventricle with the pulmonary artery pulsatility index is possible, which helps prognosticate RV failure during VAD implantation.

Possible explanations for the results found

The results found in previous clinical trials can be explained by three main hypotheses: first, the use of PAC may not lead to changes in therapies (without influence on treatment, there are no changes in outcomes); second, treatment changes did not result in better outcomes due to the severity of the patients; or third, the included patients did not meet criteria to be classified as having CS.

As we have seen, recent observational studies suggest that when we carry out interventions guided by the PAC and with shock teams, especially in patients with more severe stages (SCAI D and E), there is a significant difference in mortality (28.4% vs. 35%, aOR 0.79, p = 0.017).[10] From these observations, we can infer that an intervention guided by PAC in appropriate patients and with good use of information impacts relevant clinical results.

Conclusion

Contemporary evidence supports the use of PAC in patients with CS, which is still the best monitoring strategy and diagnostic tool currently available for patients with CS, especially in more severe ones, in cases of right ventricular dysfunction, and in patients undergoing ventricular assist devices.

Author Contributions

Conception and design of the research; Acquisition of data; Analysis and interpretation of the data and Writing of the manuscript: Savaris SL, Siqueira SRR, Lima IGCV; Critical revision of the manuscript for important intellectual content: Savaris SL.

Potential conflict of interest

No potential conflict of interest relevant to this article was reported.

Sources of funding

There were no external funding sources for this study.

Study association

This study is not associated with any thesis or dissertation work.

Ethics approval and consent to participate

This article does not contain any studies with human participants or animals performed by any of the authors.

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