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2022 Symposium Presentation

Microcirculation versus Macrocirculation in Cardiogenic

Shock

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Abstract

Macro- and microcirculation are important parameters in cardiogenic shock. Microcirculation is relevant for monitoring organ function and prognosis. Serum lactate might be the best daily life parameter to assess microcirculation, and the crude 8-hour value can be used for outcome prediction. Any treatment should consider the consequences of microcirculation and macrocirculation.

Keywords: microcirculation, macrocirculation, lactate, cardiogenic shock

Background

The terms micro- and macrocirculation refer to blood flow in vessels smaller than and greater than 100 micrometers, respectively. All forms of shock involve a vicious cycle centered around impaired microcirculation.¹ Organ function, perfusion, and failure all depend on microcirculation status. In cardiogenic shock, reduced cardiac output leads to hypoxia and acidosis. Atonia of the capillaries follows and leads to relative hypovolemia, creating a cycle of microcirculatory disorders. Thus, physicians must know how to assess microcirculation. The diagnostic tools have been reviewed.² This paper focuses on the tools of serum lactate and intravital microscopy.

Serum Lactate

Lactate is the alarm marker. In a large cohort of critically ill patients, arterial lactate levels above 1.4 mmol/L were associated with an increased risk of admission to the intensive care unit and hospital mortality.³ The IABP-Shock II trial reported that serum lactate levels greater than 4.6 mmol/L were associated with a higher risk of 30-day mortality

($P < .001$) in the cardiogenic shock population.⁴ After investigation, we determined that the best cutoff value regarding 30-day mortality is a baseline serum lactate level of 4.6 mmol/L.

Lactate clearance can also be used to assess lactate levels. A large study of more than 7000 patients with increased lactate levels compared different strategies to assess lactate clearance.^{5,6} One measure uses the delta-24 lactate levels, where the maximum lactate level on day 1 is compared to the maximum level on day 2. A dramatic difference was found at the 19% mark, indicating that a 19% change in lactate levels over one day has a strong prognostic role regarding short- and long-term mortality ($P < .001$). In the IABP-Shock II trial, lactate levels from survivors and non-survivors were compared at baseline, 0-8 hour clearance, and after 8 hours.⁷ Survivors had lower lactate levels at baseline ($P < .001$), and a negative clearance was found in non-survivors (-0.4). The crude 8-hour values can discriminate between groups, as survivors have significantly lower lactate levels (5.1 versus 1.7, $P < .001$). Of note, the area under the curve calculation was highest for the crude 8-hour values, and lactate levels at that timepoint can be used in daily practice.

Intravital Microscopy

Intravital microscopy is an imaging technique that uses dynamic, real-time three-dimensional, tissue-level images in vivo. Multiple devices are now on the market. Daniel de Backer was the first to use intravital microscopy in patients with septic shock and to provide a detailed description of how it can document impaired microcirculation.⁸ Also, in patients with cardiogenic shock, video images can be derived from the sublingual mucosa and taken at the patient's bedside.⁹ The images show that sustained microcirculation is associated with very low mortality rates compared to impaired microcirculation, which has a much higher 30-day mortality rate ($P < .001$). Analysis of sublingual images can even predict future lactate levels in these patients.

Impact on Treatment

In cardiogenic shock, micro- and macrocirculation are impaired; thus, it is of crucial importance to assess how treatment strategies affect not only macrocirculation but also microcirculation. For example, of catecholamines, epinephrine is not the first choice for treatment because it also affects microcirculation.¹ Epinephrine triggers strong vasoconstriction and limits organ perfusion; thus, alternatives that are less harmful to microcirculation are preferred.

Further, a clinical study using therapeutic hypothermia in cardiogenic shock patients assessed the effects of hypothermia on microcirculation hemodynamics.¹⁰ While the results were neutral, they underscore the importance of collecting microcirculatory parameters as endpoints in clinical studies. Macrocirculation often refers to blood pressure, so vasopressors and inotropic support should be titrated to reach a mean arterial pressure of around 65 mmHg, but not higher. Regulation and monitoring of microcirculation are more complex.¹¹ Monitoring lactate levels is one strategy to identify microcirculation abnormalities, but further research is needed.

Conclusion

Macro- and microcirculation are important parameters in cardiogenic shock. Microcirculation is relevant for monitoring organ function and prognosis. Serum lactate might be the best daily life parameter to assess microcirculation, and the crude 8-hour value can be used for outcome prediction. Any treatment should consider the consequences of microcirculation and macrocirculation.

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