

2022

## Microcirculation versus Macrocirculation in Cardiogenic Shock

Christian Jung

Heinrich-Heine-Universität Düsseldorf, christian.jung@med.uni-duesseldorf.de

Follow this and additional works at: <https://digitalcommons.library.tmc.edu/josh>



Part of the [Cardiology Commons](#), and the [Critical Care Commons](#)

---

### Recommended Citation

Jung, Christian (2022) "Microcirculation versus Macrocirculation in Cardiogenic Shock," *Journal of Shock and Hemodynamics*: Vol. 1(1) :e2022115

Available at: <https://digitalcommons.library.tmc.edu/josh/vol1/iss1/5>

This Symposium Proceeding Paper is brought to you for free and open access by the University of Texas Health Sciences Center at Houston (UTHealth) at DigitalCommons@TMC. It has been accepted for inclusion in *Journal of Shock and Hemodynamics* by an authorized editor of DigitalCommons@TMC. For more information, please contact [digitalcommons@library.tmc.edu](mailto:digitalcommons@library.tmc.edu).

## 2022 Symposium Presentation

# Microcirculation versus Macrocirculation in Cardiogenic Shock

**Christian Jung, MD, PhD**

Heinrich-Heine-Universität Düsseldorf, Germany

**Email:** Christian.Jung@med.uni-duesseldorf.de

*Received August 27, 2022*

*Published September 16, 2022*

## 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.<sup>1</sup> 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.<sup>2</sup> 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.<sup>3</sup> 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.<sup>4</sup> 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.<sup>5,6</sup> 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.<sup>7</sup> 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.

©2022 The Author(s). This is an open access article published under the terms of the Creative Commons Attribution-NonCommercial 4.0 International License (<https://creativecommons.org/licenses/by-nc/4.0/>), which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided that the original author(s) and the publication source are credited.

## 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.<sup>8</sup> Also, in patients with cardiogenic shock, video images can be derived from the sublingual mucosa and taken at the patient's bedside.<sup>9</sup> 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.<sup>1</sup> 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.<sup>10</sup> 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.<sup>11</sup> 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.

## References

- [1] Jung C, Kelm M. Evaluation of the microcirculation in critically ill patients. *Clin Hemorheol Microcirc.* 2015;61(2):213-24. doi: 10.3233/CH-151994.
- [2] Jung C. Assessment of microcirculation in cardiogenic shock. *Curr Opin Crit Care.* 2019;25(4):410-416. doi: 10.1097/MCC.0000000000000630.
- [3] Vellinga NAR, Boerma EC, Koopmans M, et al. Mildly elevated lactate levels are associated with microcirculatory flow abnormalities and increased mortality: a microSOAP post hoc analysis. *Crit Care.* 2017;21(1):1-9. doi: 10.1186/s13054-017-1842-7.
- [4] Jung C, Fuernau G, de Waha S, et al. Intraaortic balloon counterpulsation and microcirculation in cardiogenic shock complicating myocardial infarction: an IABP-SHOCK II substudy. *Clin Res Cardiol.* 2015;104(8):679-87. doi: 10.1007/s00392-015-0833-4.
- [5] Masyuk M, Wernly B, Lichtenauer M, et al. Prognostic relevance of serum lactate kinetics in critically ill patients. *Intensive Care Med.* 2019;45(1):55-61. doi: 10.1007/s00134-018-5475-3.
- [6] Jung C, Bueter S, Wernly B, et al. Lactate clearance predicts good neurological outcomes in cardiac arrest patients treated with extracorporeal cardiopulmonary resuscitation. *J Clin Med.* 2019;8(3):374. doi: 10.3390/jcm8030374.
- [7] G Fuernau, M Lehrke, C Jung, et al. GLP-1 is an independent predictor of long-term mortality in patients with myocardial infarction complicated by cardiogenic shock – a substudy of the IABP-SHOCK II trial. *Eur Heart J.* 2020;41(Supp 2). doi.org/10.1093/ehjci/ehaa946.1848.
- [8] Sakr Y, Dubois MJ, De Backer D, Creteur J, Vincent JL. Persistent microcirculatory alterations are associated with organ failure and death in patients with septic shock. *Crit Care Med.* 2004;32(9):1825-31. doi: 10.1097/01.ccm.0000138558.16257.3f.
- [9] Jung C, Jung F, Kelm M. The microcirculation in hypoxia: The center of the battlefield for oxygen. *Clin Hemorheol Microcirc.* 2016;63(3):169-72. doi: 10.3233/CH-1663301.
- [10] Fuernau G, Beck J, Desch S, et al. Mild hypothermia in cardiogenic shock complicating myocardial infarction. *Circulation.* 2019;139(4):448-457. doi: 10.1161/CIRCULATIONAHA.117.032722.
- [11] Bakker J, Ince C. Monitoring coherence between the macro and microcirculation in septic shock. *Curr Opin Crit Care.* 2020;26(3):267-272. doi: 10.1097/MCC.0000000000000729.