

Endotypes of Hypotension in Critically Ill Patients

Brian Nelson¹, Harsha Agashe¹, Jerry Korten¹, Marc Zemel¹, Karim Kouz², Bernd Saugel^{2,3}

¹Retia Medical Systems, Inc., White Plains, NY, USA. ²Department of Anesthesiology, Center of Anesthesiology and Intensive Care Medicine, University Medical Center Hamburg-Eppendorf, Hamburg, Germany.

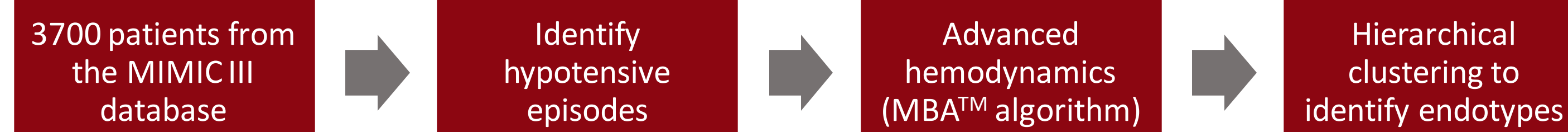
³Outcomes Research Consortium, Cleveland, OH, USA.

Background

Hypotension in critically ill patients is associated with death and complications including acute kidney and myocardial injury. In clinical practice, the underlying cause of hypotension is often not clear. Consequently, the hypotension is mainly symptomatically treated with fluids and vasopressors. Causal treatment would require the diagnosis of the root cause of hypotension. We, therefore, aimed to investigate if a data-driven approach without imposing a-priori definitions of different shock types can help identify endotypes of hypotension. We applied machine learning methods to a large public database of ICU patients to determine if distinct, physiologically meaningful endotypes of hypotension can be identified from advanced hemodynamics.

Methods

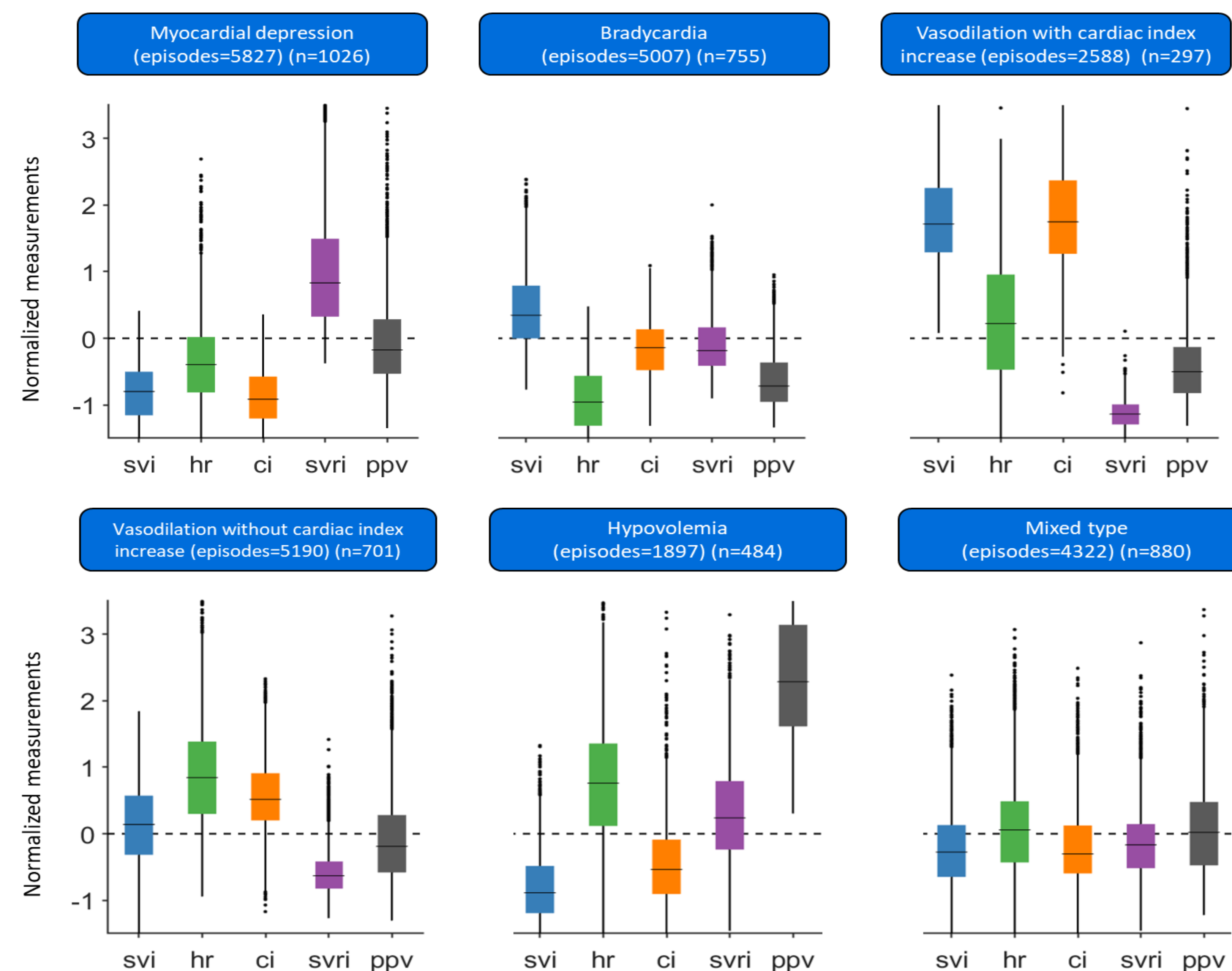
This was a retrospective analysis of data from 3700 ICU patients, available via the publicly available MIMIC III waveform database¹. The data consisted of patients in the coronary care, cardiac surgical, trauma and post-surgical, as well as medical intensive care units. We used heart rate (HR), cardiac index (CI), stroke volume index (SVI), systemic vascular resistance index (SVRI), and pulse pressure variation (PPV) to perform hierarchical clustering of hypotensive episodes to identify endotypes of hypotension. A hypotensive episode was defined as mean arterial pressure ≤ 65 mmHg for at least 5 minutes.



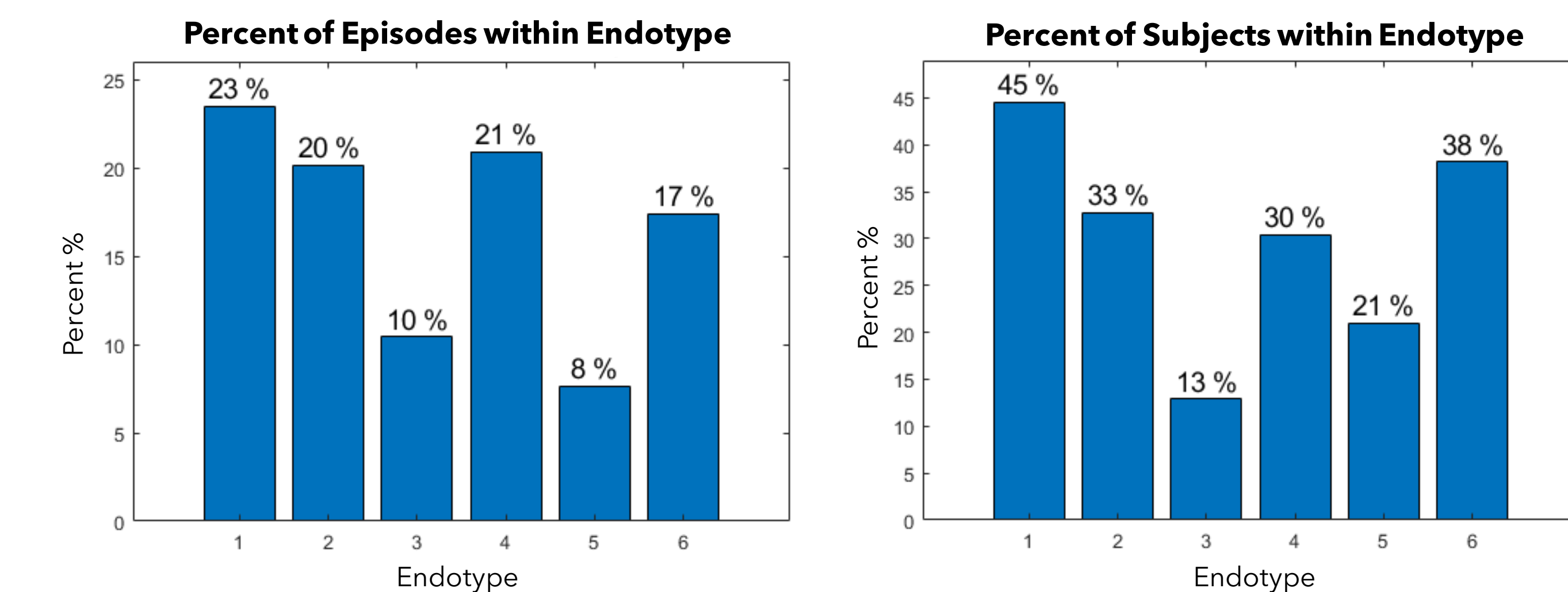
Results

A total of 24831 hypotensive episodes were identified in 2304 patients, with a median ICU length of stay of 6.8 days [IQR 2.9 – 13.9 days]. Hierarchical clustering revealed six distinct endotypes of hypotension which we labeled based on their hemodynamic profiles as: 1) myocardial depression; 2) bradycardia; 3) vasodilation with cardiac index increase; 4) vasodilation without cardiac index decrease; 5) hypovolemia; and 6) mixed type. These endotypes and their characteristics closely resemble previous results from a similar analysis of intraoperative data from abdominal surgery patients.²

Endotypes and their hemodynamic signatures



Endotype Incidence



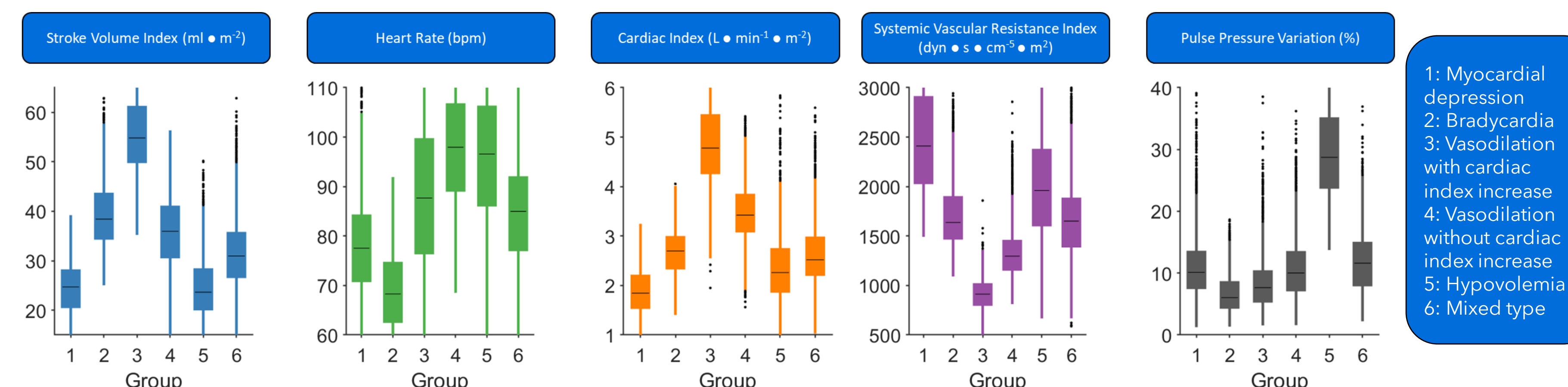
Conclusion

Hierarchical cluster analysis of data from 2304 patients in mixed ICUs identified six endotypes of hypotension. While different causes of shock are expected physiologically, our results characterize these endotypes in a data-driven manner and highlight the importance of advanced hemodynamic monitoring in addition to standard blood pressure and heart rate monitoring.

References

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- Kouz K, Brockmann L, Timmermann LM, Bergholz A, Flick M, Maheshwari K, Sessler DI, Krause L, Saugel B. Endotypes of intraoperative hypotension during major abdominal surgery: a retrospective machine learning analysis of an observational cohort study. Br J Anaesth. 2023 Mar;130(3):253-261. doi: 10.1016/j.bja.2022.07.056. Epub 2022 Dec 6. PMID: 36526483.

Nominal Variable Values



- 1: Myocardial depression
- 2: Bradycardia
- 3: Vasodilation with cardiac index increase
- 4: Vasodilation without cardiac index increase
- 5: Hypovolemia
- 6: Mixed type