

Special issue on cardiac arrest: toward precision resuscitation and integrated prognostication

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Cardiac arrest remains one of the most complex and lethal syndromes in emergency and critical care medicine. Despite decades of iterative guideline refinement, technological innovation, and expanding systems of care, survival with favorable neurological outcome remains unacceptably low across most healthcare settings worldwide. Although current international algorithms emphasize standardized early chest compressions, defibrillation, and airway management, yet there is increasing recognition that a “one-size-fits-all” paradigm insufficiently captures the complex and dynamic pathophysiology of cardiac arrest.

This Special Issue of *Emergency and Critical Care Medicine* is dedicated to recent advances and persistent challenges in cardiac arrest, with a particular focus on innovations in resuscitation, individualized management strategies, and prognostication. As Guest Editors, we sought contributions that move beyond algorithmic uniformity and instead interrogate the biological, physiological, and system-level determinants that ultimately shape survival and neurological recovery after cardiac arrest.

Reframing airway management: from device-centric to system-oriented care

Airway management during cardiopulmonary resuscitation remains one of the most debated domains. The first manuscript reveals a paradox: whereas endotracheal intubation (endotracheal intubation secures the airway), it may inadvertently

compromise outcomes through interruptions in chest compressions and prolonged “no-flow” intervals.^[1]

The accompanying scholarly^[2] response advances this debate by reframing airway management as a quality-controlled intervention rather than a binary device choice. The proposed framework—anchored in interruption budgets, competence thresholds, and physiological verification—represents a critical conceptual advance. It emphasizes that outcomes depend less on the airway device itself than on how, when, and by whom it is deployed. This systems-based perspective aligns with the growing emphasis on measurable quality metrics and equitable implementation across heterogeneous healthcare environments.

Biomarkers and neuroprognostication: navigating complexity and variability

Accurate neuroprognostication after cardiac arrest remains an unresolved challenge. The review on neuron-specific enolase (NSE) provides a nuanced and critical appraisal of its role, highlighting substantial variability in thresholds, timing, and methodological considerations. Importantly, it exposes the limitations of relying on absolute biomarker values in isolation.^[3]

The emerging concept of dynamic biomarker trajectories, including NSE ratios over time, offers a more refined approach to capturing evolving neuronal injury. Moreover, the recognition of biochemical heterogeneity—particularly the distinction between NSE isoenzymes and the confounding effects of hemolysis—underscores the necessity of multidisciplinary collaboration between clinicians, laboratory scientists, and methodologists.

Complementing this, the study on hemoglobin-to-red cell distribution width ratio introduces a novel integrative biomarker reflecting both inflammatory and hypoxic burden.^[4] Its association with short-term mortality reinforces the importance of multidimensional risk stratification that transcends traditional single-parameter models.

Hemodynamic-metabolic coupling: expanding the resuscitation paradigm

Beyond cardiac arrest itself, the inclusion of septic cardiomyopathy highlights an important conceptual extension: the interplay between hemodynamic stabilization and cellular metabolism. The proposed shift toward metabolic resuscitation challenges the longstanding dominance of fluid-centric strategies.

This work emphasizes that macrocirculatory normalization may mask persistent microcirculatory and mitochondrial dysfunction. The introduction of metabolic indicators—such as lactate/pyruvate ratios—and targeted interventions, including mitochondrial support therapies, represents an innovative and potentially transformative direction.^[5] This perspective resonates strongly with cardiac arrest physiology, where reperfusion injury and metabolic failure critically influence outcomes.

Data sharing is not applicable to this article as no datasets were generated or analyzed during the current study.

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Imaging and functional monitoring: toward bedside precision

The integration of bedside ultrasound into postresuscitation care is exemplified by a study demonstrating the prognostic value of left ventricular ejection fraction (LVEF). The identification of LVEF as an independent predictor of neurological outcome reinforces the concept of cardio-cerebral coupling, whereby myocardial dysfunction directly impacts cerebral recovery.^[6]

Importantly, the additive value of LVEF to established clinical scores (CASPRI, MEWS) highlights the potential of multimodal models to enhance prognostic accuracy. These findings advocate for routine incorporation of point-of-care echocardiography into early postresuscitation assessment.

Similarly, the investigation of automated pupillometry underscores both the promise and limitations of quantitative neurological monitoring. Although higher Neurological Pupil Index values correlate with favorable outcomes, the overlap between outcome groups cautions against over-reliance on single thresholds. Instead, these tools should be integrated into a multimodal prognostication framework, combining clinical, electrophysiological, biochemical, and imaging data.^[7]

Special circumstances and system-level considerations

The inclusion of studies on heat stroke and peri-intubation hemodynamics broadens the scope of this issue, emphasizing that cardiac arrest often occurs within complex systemic and environmental contexts. Predictive models incorporating biomarkers such as cardiac troponin I and inflammatory indices illustrate the growing role of integrated risk modeling in acute care.^[8]

The randomized trial on preintubation hemodynamic optimization further highlights the challenges of translating physiological rationale into clinical benefit. The absence of significant differences between intervention strategies serves as a reminder that interventions must be evaluated within the complexity of critically ill populations, where multiple competing mechanisms influence outcomes.^[9]

Future directions: integration, personalization, and equity

Collectively, the contributions in this Special Issue converge on several key priorities for the future cardiac arrest research and care:

1. Physiology-guided resuscitation

Moving beyond fixed algorithms toward adaptive strategies informed by real-time physiological data, including capnography, ultrasound, and metabolic markers.

2. Standardization of research metrics

Harmonizing definitions and reporting standards—particularly for interventions such as airway management—to improve comparability and translational impact.

3. Multimodal prognostication

Integrating biomarkers, imaging, and functional assessments into cohesive models that better reflect the complexity of postcardiac arrest syndrome.

4. System and competence-based implementation

Aligning clinical recommendations with provider skill, resource availability, and healthcare system capabilities to ensure safe and equitable care.

5. Translational and molecular insights

Expanding research into the molecular and metabolic mechanisms underlying ischemia-reperfusion injury to identify novel therapeutic targets.

Conclusion

This Special Issue reflects a field in transition—moving from standardized protocols toward precision, integration, and accountability in resuscitation science. The evidence presented herein challenges entrenched paradigms, introduces innovative methodologies, and underscores the necessity of multidisciplinary collaboration.

Ultimately, improving outcomes after cardiac arrest will depend not only on advancing individual interventions but on orchestrating them within coherent, patient-centered systems of care. By bridging physiology, technology, and clinical practice, the work featured in this issue contributes meaningfully to that goal and sets the stage for the next generation of resuscitation science.

Conflict of interest statement

Both authors holding editorial positions of the journal were not involved in peer review or editorial decision-making regarding this manuscript. Independent peer review was performed by external reviewers. The authors declare no additional conflict of interest.

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