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ORIGINAL RESEARCH PAPER

General Surgery

MODERN SURGICAL APPROACH TO SHOCK AND RECENT ADVANCEMENTS

KEY WORDS:

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INTRODUCTION

Shock, a critical state of circulatory collapse, arises when inadequate blood flow disrupts oxygen delivery to tissues, triggering cellular hypoxia, dysfunction, and eventual organ failure. If unaddressed, this cascade progresses from reversible metabolic disturbances to irreversible multiorgan failure (MOF), a phenomenon often compounded by "sick cell syndrome"—a state of cellular energy depletion and mitochondrial dysfunction. The window for effective intervention is narrow; delayed recognition or treatment drastically escalates mortality risks.Modern surgical strategies have revolutionized shock management by prioritizing rapid stabilization, precision, and multidisciplinary collaboration. Techniques such as damage control surgery (DCS), resuscitative endovascular balloon occlusion of the aorta (REBOA), and extracorporeal membrane oxygenation (ECMO) now enable clinicians to mitigate hemorrhage, restore perfusion, and support failing organs with unprecedented efficacy. Concurrently, advancements in point-of-care diagnostics and hemodynamic monitoring empower tailored, goal-directed therapies.This article explores the evolving landscape of surgical interventions for shock, emphasizing evidence-based practices, technological innovations, and the indispensable role of interprofessional teams in optimizing outcomes. By integrating timely diagnosis, cutting-edge procedures, and holistic postoperative care, healthcare providers can disrupt the lethal trajectory of shock, transforming what was once a near-fatal condition into a survivable challenge.Circulatory shock leads to cellular and tissue hypoxia resulting in cellular death and dysfunction of vital organs1.

TYPES OF SHOCK-

1. Cardiogenic shock
2. Hypovolemic shock
3. Anaphylactic shock
4. Septic shock
5. Neurogenic shock

The management of cardiogenic, septic, and hypovolemic shock relies heavily on pharmacological agents that restore perfusion and stabilize hemodynamics. Endogenous catecholamines—epinephrine, norepinephrine, and dopamine—remain foundational for their rapid vasoactive and inotropic effects. These are complemented by synthetic catecholamines such as dobutamine (a 1-agonist), isoproterenol (a non-selective -agonist), phenylephrine (a pure -agonist), and milrinone (a phosphodiesterase-3 inhibitor), which have been cornerstones of shock therapy for decades. In complex or refractory cases, adjunctive agents like vasopressin (a vasoconstrictor targeting V1 receptors), selepressin (a selective V1a agonist), and levosimendan (a calcium sensitizer enhancing myocardial contractility) offer targeted support. Emerging therapies, including omecamtiv, mecarbil (a cardiac myosin activator), istaroxime (a dual Na+/K+ ATPase inhibitor and SERCA enhancer), and nesiritide (a recombinant B-type natriuretic peptide), further expand therapeutic options for recalcitrant shock.This review delineates the mechanisms of action, dosing nuances, clinical benefits, and limitations of these agents, while addressing their specific indications and contraindications across shock subtypes. It also evaluates landmark clinical trials—such as the VASST trial for vasopressin in septic shock and the ATHOS-3 study for angiotensin II—that shape modern guidelines. By synthesizing evidence and practical insights, this discussion aims to equip clinicians with strategies to optimize hemodynamic support, balancing efficacy with risks like arrhythmias or tissue ischemia, in critically ill patients.

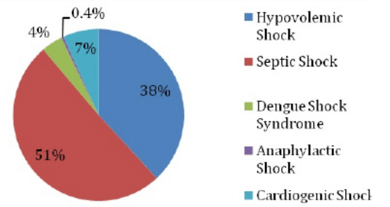

Fig.1-distribution of types of shock among patients)6

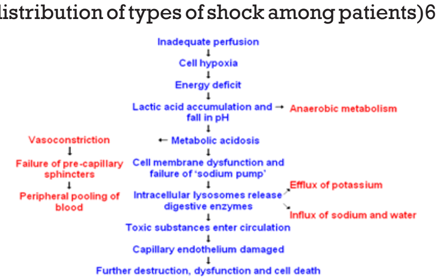

Fig.2. Pathophysiology of shock)7

Shock management has evolved beyond traditional "open-and-repair" approaches, with contemporary surgical strategies prioritizing rapid stabilization, precision, and organ protection. These techniques are tailored to the underlying cause of shock—whether hemorrhagic, distributive, or cardiogenic—and integrate advanced technology, minimally invasive principles, and interdisciplinary collaboration. Below, we explore key advancements reshaping surgical care in shock:

1. Damage Control Surgery (DCS): A Phased Approach
DCS has transformed trauma and critical care by abandoning prolonged definitive repairs in favor of a staged strategy.

- Phase 1 (Immediate Control): Rapid hemorrhage control (e.g., packing, temporary vascular shunts) and contamination containment (e.g., bowel stapling) within 60–90 minutes.

- Phase 2 (Resuscitation): ICU-based reversal of hypothermia, acidosis, and coagulopathy using goal-directed transfusions and thromboelastography (TEG).
- Phase 3 (Definitive Repair): Delayed anatomical reconstruction (e.g., bowel anastomosis, vascular grafts) once homeostasis is restored.

Evidence: Reduces mortality in severe trauma (from ~50% to 20–30%) and abdominal sepsis by mitigating the "lethal triad."

2. RESUSCITATIVE ENDOVASCULAR BALLOON OCCLUSION OF THE AORTA (REBOA)

REBOA offers a less invasive alternative to resuscitative thoracotomy for non-compressible torso hemorrhage.

Technique: Fluoroscopy-free insertion of a balloon catheter via femoral access, inflated in Zone 1 (descending aorta) to temporize bleeding in abdominal/pelvic trauma or Zone 3 (infrarenal) for obstetric hemorrhage.

Advantages: Buys time for definitive surgery while preserving cardiac and cerebral perfusion.

TRIALS: The AORTA registry (2022) shows a 33% survival rate in hemorrhagic shock, though risks include limb ischemia and reperfusion injury.

3. MINIMALLY INVASIVE SURGERY (MIS) IN SHOCK

Laparoscopy and thoracoscopy are no longer contraindicated in hemodynamically unstable patients, thanks to improved imaging and hemodynamic monitoring.

APPLICATIONS:

- Diagnostic: Identify occult bleeding or perforated viscus in septic shock.
- Therapeutic: Laparoscopic suturing of perforated ulcers or evacuation of hemoperitoneum.
- Benefits: Reduced surgical stress, faster recovery, and lower infection rates compared to open surgery.

4. EXTRACORPOREAL LIFE SUPPORT (ECLS) AND ECMO

ECMO bridges patients with refractory cardiogenic or septic shock to recovery or transplantation.

VA-ECMO: Provides full cardiopulmonary support in cardiogenic shock (e.g., post-MI, myocarditis).

VV-ECMO: Oxygenates blood in ARDS-associated septic shock.

Innovations: Mobile ECMO units and heparin-coated circuits minimize complications like bleeding and thrombosis.

Evidence: EOLIA trial (2018) demonstrated survival benefits in severe ARDS, though patient selection remains critical.

5. HYBRID OPERATING ROOMS (HYBRID ORS)

Hybrid ORs combine real-time imaging (CT, angiography) with surgical intervention, enabling one-stop management.

USE CASES:

- Endovascular embolization of bleeding vessels during laparotomy.
- Combined cardiac surgery and stent placement in cardiogenic shock.

Impact: Reduces time-to-intervention and improves outcomes in polytrauma and complex vascular cases.

6. ADVANCED HEMOSTATIC TECHNIQUES

Topical Hemostatic Agents: Fibrin sealants and chitosan-based dressings control diffuse bleeding in coagulopathic patients.

Angioembolization: Superselective catheterization occludes bleeding vessels (e.g., pelvic fractures, GI bleeds) without laparotomy.

REBOA + Embolization: Combined strategies in hybrid ORs optimize hemorrhage control.

7. ROBOTIC-ASSISTED SURGERY

While still emerging, robotics aid in precision tasks (e.g., vascular anastomosis, splenectomy) during shock, particularly in stable or resuscitated patients.

Advantages: Enhanced dexterity, 3D visualization, and reduced surgeon fatigue.

Challenges and Future Directions-

- Resource Limitations: REBOA and ECMO require specialized training and infrastructure, limiting access in low-resource settings.
- Ethics: Balancing aggressive intervention with futility in end-stage shock.
- Next-Gen Tools: AI-driven predictive analytics for real-time decision support and bioengineered organs for transplantation.

Modern surgical techniques in shock emphasize speed, adaptability, and synergy with critical care. From REBOA's role in hemorrhage control to ECMO's life-sustaining capabilities, these innovations have shifted the paradigm from survival to survivorship. However, success hinges on multidisciplinary teamwork, continuous training, and equitable access to technology. As research advances, the integration of robotics, AI, and biotechnology promises to further redefine the boundaries of shock resuscitation.In selected patients with persisting cardiogenic shock under optimised pharmacologic therapy and/or weaning failure from ECLS, commercially available left- or biventricular assist devices (LVAD or BVAD) will provide sufficient organ perfusion for everyday life2.

MONITORING, DIAGNOSIS AND POST OPERATIVE CARE

Modern shock management hinges on a dynamic, data-driven approach that bridges intraoperative interventions with precision postoperative care. Advanced monitoring tools such as point-of-care ultrasound (POCUS) and invasive hemodynamic devices (e.g., PiCCO, Swan-Ganz catheters) enable real-time assessment of cardiac output, fluid responsiveness, and tissue perfusion, guiding tailored resuscitation strategies. These are augmented by continuous lactate clearance monitoring and thromboelastography (TEG) to address occult hypoperfusion and coagulopathy. Postoperatively, goal-directed therapy prioritizes balancing vasopressors, inotropes, and fluid administration to avoid volume overload while maintaining organ perfusion—a paradigm supported by protocols like the Surviving Sepsis Campaign. Enhanced Recovery After Surgery (ERAS) principles are adapted for shock patients4, emphasizing early enteral nutrition, judicious sedation, and mobilization to mitigate ICU-acquired weakness and infections. Technologies like predictive analytics and machine learning further refine risk stratification, flagging complications such as acute kidney injury or ARDS before clinical manifestation. Simultaneously, closed-loop systems for vasopressor titration and remote hemodynamic monitoring enhance safety in resource-constrained settings3. This integration of cutting-edge diagnostics, proactive complication management, and personalized ICU protocols not only improves survival but also reduces long-term morbidity, embodying a shift from reactive to anticipatory critical care. By harmonizing technology with human expertise, clinicians can navigate the delicate balance between aggressive intervention and organ protection, ensuring shock patients transition from survival to meaningful recovery.

ETHICAL CONSIDERATION

The high-stakes nature of shock management, where rapid decisions impact survival and morbidity, raises profound ethical challenges that demand careful balancing of patient autonomy, beneficence, and justice. Informed consent-becomes particularly fraught in emergencies, as patients are often incapacitated, necessitating surrogate decision-makers or reliance on implied consent for life-saving interventions like REBOA or emergent laparotomy. Clinicians must weigh the urgency of action against the ethical imperative to respect patient values, particularly when cultural or religious beliefs—such as refusal of blood products—conflict with standard therapies.A central tension lies in aggressive intervention versus futility. While technologies like ECMO or high-dose vasopressors can bridge patients to recovery, their use in refractory shock may prolong suffering without meaningful benefit. The principle of non-maleficence urges clinicians to avoid "futile care," yet defining futility remains contentious, often requiring multidisciplinary input and advance care planning. Trials such as the EOLIA study underscore the fine line between life-saving support and iatrogenic harm.

Resource allocation further complicates ethics, especially in low-resource settings or during crises like pandemics. Scarce interventions (e.g., ECMO circuits, hybrid ORs) necessitate triage protocols prioritizing patients with the highest likelihood of survival—a utilitarian approach that risks exacerbating disparities. Globally, inequitable access to advanced shock therapies highlights systemic injustices, urging advocacy for equitable training and infrastructure investment.Research ethics also come into play, as enrolling critically ill shock patients in trials poses challenges around consent and vulnerability. Surrogate decision-makers and ethics review boards must ensure studies like the VASST trial balance innovation with patient protection.Ultimately, ethical shock management demands humility, transparency, and a commitment to patient-centered values. By integrating ethics into protocols—from transparent triage frameworks to culturally sensitive communication—clinicians can uphold dignity while navigating the moral complexities of life-and-death care.

CONCLUSION

Shock management has undergone a paradigm shift, driven by innovations such as damage control surgery, REBOA, ECMO, and minimally invasive techniques that prioritize rapid stabilization and organ protection. The condition can arise because of numerous causes, and progresses when the body's homeostatic compensatory mechanisms fail. If not treated correctly, this can lead to a failure of the cardiovascular system, advancing to end-stage shock and death5. These approaches, supported by advanced monitoring tools like POCUS and thromboelastography, enable tailored resuscitation and real-time decision-making. Postoperative care, guided by goal-directed therapy and ERAS protocols, emphasizes recovery while mitigating complications like ICU-acquired weakness. However, ethical challenges—from navigating informed consent in emergencies to addressing resource disparities—underscore the need for patient-centered, equitable care. As technologies like AI and biotechnology evolve, their integration promises to refine precision in shock therapy. Ultimately, success hinges on balancing cutting-edge interventions with ethical humility, interdisciplinary collaboration, and a commitment to translating survival into meaningful quality of life. The future of shock management lies not only in technological prowess but in upholding the dignity and values of those it seeks to heal.

REFERENCES

1. Koya, H. H., & Paul, M. (2023, July 24). Shock. StatPearls - NCBI Bookshelf. https://www.ncbi.nlm.nih.gov/books/NBK531492/#:~:text=Go%20to:-,Etiology,hypovolemic%2C%20cardiogenic%2C%20and%20obstructive.
2. Hauffe, T., Krüger, B., Bettex, D., & Rudiger, A. (2020). Shock Management for Cardio-surgical Intensive Care Unit patient: The Silver Days. Radcliffe Cardiology. https://www.cfrjournal.com/articles/shock-management-cardio-surgical-intensive-care-unit-patient-silver-days?language_content_entity=en
3. Bollino, R., Yu, H., Luppi, D., & Zizzo, M. (2024). Enhanced recovery after surgery (ERAS) in Emergency and Trauma Surgery. In IntechOpen eBooks. https://doi.org/10.5772/intechopen.1004115
4. Gebauer, A., Petersen, J., Konertz, J., Brickwedel, J., Schulte-Uentrop, L., Reichenspurner, H., & Girdauskas, E. (2021). Enhanced recovery after cardiac surgery: Where do we stand? Current Anesthesiology Reports, 11(4), 501–506. https://doi.org/10.1007/s40140-021-00455-4
5. Blumlein, D. (2022, May 12). Shock: aetiology, pathophysiology and management. British Journal of Nursing. https://www.britishjournalofnursing.com/content/clinical-pathophysiology/shock-aetiology-pathophysiology-and-management
6. Yuniar, Irene. (2017). Lactate profiles of pediatric shock patients in Cipto Mangunkusumo General Hospital 2015: a pilot study. Paediatrica Indonesiana. 57. 12. 10.14238/pi57.1.2017.12-7.
7. https://www.physio-pedia.com/Shock