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Managing Health Care Resources and Patient Safety in Conflict Zones

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Abstract

Armed conflicts present extreme challenges for health care systems, threatening both the availability of resources and the safety of patients. Health facilities often face infrastructure damage, shortages of medicines and staff, as well as ethical dilemmas related to triage and the allocation of care. In this article, we review key principles of resource management in conflict zones, strategies to maintain patient safety under austere conditions, and lessons learned from recent conflicts, with a focus on Ukraine. We highlight practical approaches, including triage systems, rational drug use, infection control, and staff training, and propose recommendations for building resilient health care systems prepared for crises.

Key Points

- Armed conflicts profoundly disrupt healthcare infrastructure, supply chains, and workforce capacity, creating high-risk environments for patient safety and the delivery of critical care.
- Effective resource management in conflict settings depends on adaptive triage strategies, rational use of medicines and equipment, and preservation of essential life-support systems under austere conditions.
- Innovations such as telemedicine, drone-supported logistics, the use of cognitive aids, and targeted staff training can substantially enhance system resilience and improve patient outcomes, even in resource-constrained and high-threat environments.

Key words: conflict zones, health resources, patient safety, triage, critical care, disaster medicine

INTRODUCTION

Armed conflicts impose extraordinary strain on health care systems, challenging their ability to deliver safe and effective care. Beyond the immediate burden of trauma-related injuries, conflicts disrupt supply chains, damage infrastructure, and create mass displacement of civilians. In such settings, clinicians must operate with limited resources, often improvising to provide life-saving interventions. Maintaining patient safety becomes particularly complex when standard protocols and technologies are unavailable.

In this article, we aim to explore the strategies for managing scarce health care resources while ensuring patient safety in conflict zones. Drawing on international experience and the recent war in Ukraine, we propose practical recommendations relevant to anaesthesiologists, surgeons, nurses, and policy makers.

HEALTH CARE SYSTEM ATTACKS AND RESOURCE SHORTNESS

Due to the ongoing largest war in Europe since the Second World War, Ukraine's government must unite and integrate civilian and military health care systems, making no purely civilian hospital or military. Many doctors who, before the full-scale invasion, worked in civilian secondary or tertiary care facilities are now mobilised to frontline stabilization points or in regional hospitals, treating combat casualties. Thus, the Ukrainian health care system has effectively transformed into a civil-military conglomerate, with personnel, logistics, and protocols often migrating between both domains.

For instance, the state has simplified procedures for integrating combat medics into the civilian health care system, recognizing their field experience and

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granting facilitated access to medical education—one example of system adaptation to wartime realities.[1,2]

As a result, when planning resources and ensuring patient safety, one must consider that civilian hospitals may suddenly find themselves in high-risk zones or forced to provide emergency battlefield surgery.[3]

Between January and June 2025, Russian drone and missile attacks numbered 23,245, causing 6719 civilians to be killed or wounded.[4] Despite international law and rules, health care facilities have become a regular goal for drones, bombs, and missiles attacks. In 2022-2024, more than 2000 attacks were reported, with at least 285 health workers killed and 245 injured.[5,6] The constant presence of drones in the 50 km frontline zone, severely disrupted medical evacuations, forcing medical teams to operate during the night in complete darkness or underground. Russian attacks on electric and gas infrastructure have triggered widespread power and heating deficits.[7]

PATIENT AND PERSONNEL SAFETY

The widespread attacks on Ukraine's infrastructure and health care system have made access to electricity, water, heating, and shelter an urgent priority for all facilities. Due to the huge number of attacks, actions need to be taken quickly and effectively. Since 2022, thousands of shelters have been built or renewed in Ukraine, although a significant need still exists for safe underground shelters, capable of accommodating all patients and personnel, with ventilation, heating, water, food, and electricity sources, as the air attacks usually take from 2 to 12 hours.[8] The main challenge which remains is to build underground elevators for critically ill or demobilised patients; the majority of hospitals do not have enough budget for these.[9]

Medical personnel, who manage critically ill patients in conflict zones, face challenges both for their own and for patients' safety. Evacuating them during airborne attacks and constant drone surveillance is often impossible without individual electronic warfare equipment, installed on vehicles, which is now a mandatory element of every group.[10] Moreover, to care for themselves, instead of wearing surgical suits, they need to wear helmets, portable headlamps, protective glasses, and tactical body armour. In addition, transportation of ventilated patients with haemorrhagic shock, infusions, monitors, and life-support systems is extraordinarily risky.[11] When hostilities last for many hours, relocation becomes not just logistically complex but potentially fatal. Attempting to establish a fully functional intensive care unit (ICU) underground poses enormous technical and financial burdens. One must ensure continuous oxygen supply, vacuum systems, mechanical ventilation, monitoring, infusion pumps, and backup power—all in constrained, often makeshift physical spaces. In many war-affected health systems, attacks on power infrastructure further complicate this; frequent outages demand robust generator support and fuel logistics, which may themselves be compromised by insecurity (Figures 1 and 2).[12]

Critical care in conflict zones highlights that ICU care goes beyond trauma and demands sustained infrastructure resilience even in resource-limited settings.[10] ICU resources are often reduced to a minimal core, with equipment and staff stretched to their limits. In Ukraine, repeated strikes on health facilities and energy networks

Figure 1 – Self-protective ammunition used in near frontline surgical points

intensify these constraints: Ambient power failures and limited fuel make life-support continuity precarious.[13]

For ICU patients during conflict, clinicians must prioritize redundancy systems, tiered levels of care, and decision algorithms for which interventions remain lifesaving versus which may have to be scaled back later.

PRINCIPLES OF RESOURCE MANAGEMENT

Optimal use of health care resources hinges upon principles of triage, prioritization, rational usage, and innovation. Triage and prioritization are basic for resource allocation: When capacity is overwhelmed, patients must be stratified based on survivability, urgency, and resource intensity. Standard mass-casualty triage systems (like START, SALT, or military versions) can be adjusted to local context.[14] This helps doctors give care first to those who have the best chance to survive. In longer conflicts, secondary triage may also be needed—checking patients again over time—so that resources can be moved from those not responding to those with better hope.[15,16]

Figure 2 – Underground surgical point near the frontline

The rational use of medicines and equipment is very important too. In places with low resources, the list of drugs should be short and focus on multipurpose agents. For example, ketamine can work both as anaesthesia and as analgesia, while propofol or thiopental are better kept for special cases. Drugs that are dangerous in small dose errors or need complex monitoring should be avoided if monitoring resources are scarce. For example, medical teams on the first stages of evacuation usually avoid long-acting opioids and peripheral nerve catheters. Reusable equipment is better when sterilisation is possible, and single-use items should be saved for the most critical moments. It is also important to have a plan for keeping the key machines alive—ventilators, infusion pumps, and oxygen supply—with some spare parts stored and simple checklists, so that staff can fix problems quickly. Special-purpose sets, like central venous, surgical airway, massive transfusion, have been shown to be useful in stressful situations, when a lot of severely injured patients have arrived.

More recently, in war-affected low-resource settings, the combination of the World Health Organisation (WHO) Surgical Safety Checklist and an Anaesthesia Equipment Checklist was prospectively evaluated in 6 Ukrainian hospitals: Adoption of both checklists reduced major postoperative complications from 6.9% to 2.4% and 30-day mortality from 1.3% to 0.3% (odds ratio [OR] = 0.32 and 0.35, respectively).[17] These data underscore that, even in conflict zones, low-cost, process-oriented interventions retain high yield.

INNOVATIONS AND TECHNOLOGIES

Drones are used not only to deliver medications and small supplies but also in bleeding assessment and blood transport. Authors of a study in Rwanda showed that unmanned aerial vehicle (UAV) delivery reduced the time to deliver blood products by about 79 minutes compared with road transport, with mean drone delivery around 49.6 minutes and decreased wastage.[18] In another feasibility study, a 36-km drone flight transported blood in 8 minutes, outperforming van delivery in the same route (versus 55 minutes by road), and maintained blood component stability.[19] In simulations, UAV transport of simulated blood was significantly faster than ground transport while maintaining acceptable temperature control (17.1 versus 28.9 minutes).[20] These show the potential of drones to overcome hazardous or blocked roads. In some militarized settings, ground robotic systems are also advanced for casualty evacuation, reducing risk to human medics. Although data are more limited, such systems are increasingly being explored in conflict medicine.

International collaboration and the sharing of innovations represent critical factors in strengthening healthcare delivery in conflict zones. Telemedicine has been widely used to support complex case consultations, both internally –between frontline areas and safer regions within the country –and internationally, enabling timely expert input despite severe resource constraints. In addition, over three years of full-scale war, thousands of patients with complex injuries and conditions were evacuated for specialized treatment and rehabilitation to medical centers worldwide[21]. These cross-border collaborations not only improved individual patient outcomes but also facilitated knowledge exchange, capacity building, and the development of more resilient health systems under conditions of prolonged conflict.

The role of artificial intelligence (AI) in triage is also growing. AI models can analyse vital signs, clinical variables, and imaging to aid prioritization under overload. In disaster and emergency settings, AI-based triage systems have been proposed to improve speed and consistency.[22] A recent review on AI triage notes benefits in prioritization and reduced error rates, though barriers include data quality, bias, and clinician trust.[23] AI-informed triage in chest pain cases shortened emergency department (ED) length of stay and accelerated interventions. AI algorithms on near-infrared spectroscopy signals and clinical parameters offer immediate triage suggestions in combat zones.

Telemedicine has become a vital instrument for sustaining healthcare in settings with limited access to facilities or in high-risk zones. TeleHelp Ukraine is an example of a volunteer initiative connecting physicians inside and outside the country to provide remote consultations for patients in need.[24] Survey data show that 99.2% of Ukrainian clinicians continued using telemedicine during the war, and 56.8% reported that its use even accelerated. The most common tools were instant messaging apps (97.6%) and phone calls (84.8%)—relatively low-tech but highly accessible solutions.[25] Beyond routine consultations, telemedicine supports remote monitoring, specialist guidance, and even psychological support for both patients and health care staff.[25]

The Ukrainian government also legally reinforced its use: Under martial law, patients may receive telemedicine services from international specialists.[26] Another notable program is the Local Health System Sustainability Project, which coordinates telemedicine in hard-to-reach regions, trains providers, and integrates digital solutions into Ukraine's health system.

In this way, telemedicine in wartime functions not merely as an auxiliary tool but often as a lifeline, maintaining the connection between patients, local clinicians, and remote experts.

Of course, in conflict zones, these technologies face serious constraints: limited connectivity, power supply, security of equipment, and algorithm generalizability to war-injury phenotypes. However, they offer promise: Drones overcome logistics impediments, and AI may assist overwhelmed triage decisions, especially when human decision-making is fatigued or time pressured.

PERSONNEL COMPETENCE AND MENTAL HEALTH

Human resources remain the cornerstone of safe medical care in conflict zones. Even with limited equipment, well-trained personnel can adapt protocols, improvise, and provide life-saving interventions. Competence in anaesthesia, intensive care, and emergency surgery is especially critical, as delays or errors can rapidly increase mortality. Simulation-based training, short refresher courses, and deployment of international guidelines adapted to austere conditions have been shown to improve both decision-making and procedural safety. For example, implementation of standardized trauma and anaesthesia checklists significantly reduced preventable errors in low-resource hospitals.[27]

At the same time, the psychological resilience of health workers is under extreme strain. Continuous exposure to mass casualties,

ethical dilemmas in triage, and the threat to personal safety often leads to burnout, anxiety, depression, and posttraumatic stress disorder (PTSD). Data from the war in Ukraine and previous conflicts demonstrate that more than one-third of frontline medical staff show clinically relevant symptoms of psychological distress. Without adequate support, such conditions reduce concentration, increase medical errors, and jeopardize patient outcomes.[28]

Protective strategies include structured peer-support programs, rotation of staff away from high-intensity zones, and access to psychological first aid. Evidence also highlights the benefit of resilience training and mindfulness-based interventions, even in shortened formats adapted to military hospitals. Furthermore, maintaining clear communication channels and ensuring that personnel understand ethical frameworks for triage can mitigate moral injury.[29]

Ultimately, investing in both technical competence and mental health preservation is essential for sustaining care delivery under fire. A workforce that is both skilled and psychologically supported can continue to deliver safe anaesthesia and critical care even in the most austere environments.[30]

DISCUSSION

The experiences of Ukraine, Syria, and Gaza illustrate both the similarities and differences in delivering safe anaesthesia and intensive care under conditions of protracted conflict. In Ukraine, full-scale invasion since 2022 has resulted in targeted attacks on hospitals and critical infrastructure, leading to frequent power cuts, disruption of oxygen supply chains, and overwhelming pressure on ICUs. Reports from Ukrainian hospitals emphasize the difficulty of sustaining ventilatory support during prolonged blackouts and the near impossibility of moving critically ill patients to underground shelters during missile strikes. Nevertheless, strong integration with European medical networks and rapid adaptation of guidelines for austere conditions have supported a relatively high resilience of medical teams.[31,32]

The Syrian conflict, now more than a decade long, has shown how systematic destruction of health infrastructure and mass displacement of civilians lead to chronic shortages of personnel and essential supplies. Field hospitals often functioned without access to anaesthetic gases, reliable oxygen delivery, or trained specialists. Syrian case reports highlight improvised anaesthesia techniques, heavy reliance on ketamine for both sedation and analgesia, and limited capacity for safe airway management. A recurring theme was the reliance on international humanitarian organizations to supply essential drugs and provide telemedicine support, yet even these efforts were frequently constrained by security barriers and logistical blockades.[33]

The situation in Gaza, particularly during escalations of violence, demonstrates another dimension of conflict-related health care collapse. Densely populated areas, frequent mass-casualty incidents, and restricted access to humanitarian corridors create acute surges of patients that overwhelm existing facilities. Evidence from Médecins Sans Frontières and WHO reports indicates that shortages of electricity, water, and essential consumables are persistent and life-threatening.[34] In addition, clinicians in Gaza frequently report profound moral distress due to the impossibility of providing standard-of-care treatment to all patients, with triage decisions often reduced to choosing who receives the last available ventilator or vial of medication.[35]

Comparing across these contexts, several common themes emerge. First, the destruction of infrastructure and supply chains consistently forces clinicians into improvisation, whether with simplified drug regimens or repurposed equipment. Secondly, staff shortages and the psychological burden are universal, with evidence of high levels of burnout and PTSD across all 3 regions.[36] Third, integration with international humanitarian systems and geographic location appears to influence outcomes. Ukraine's closer alignment with European networks provided greater access to updated protocols and external support, while Syria and Gaza faced greater isolation and political barriers.[37]

The collective lessons suggest that strengthening preparedness for conflict medicine requires both technical and systemic strategies. These include prepositioning of essential anaesthesia supplies, training personnel in austere techniques, ensuring redundant power and oxygen systems, and embedding psychological support for staff. Moreover, international solidarity and unimpeded humanitarian access are indispensable for maintaining even a minimal standard of patient safety in prolonged crises.

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