

LETTER



Intensive care units during the Ukraine war: challenges and opportunities

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Dear Editor,

The Russian invasion of Ukraine has become the biggest war in Europe since World War II and has already led to hundreds of thousands killed and injured [1]. During a year of war, Russia has carried out more than 16 thousand missile, bomb, and drone attacks, causing thousands of severe blast and burn injuries. Ninety-seven percent of attacks were directed at civil infrastructures, destroying nearly 50% of the electric infrastructure. The medical infrastructure also suffered significantly: 1218 healthcare institutions were damaged and 173 were completely ruined; nearly 1% of medical personnel left the country and more than 100 were killed [2]. Therefore, the main challenges in different medical fields, especially in the intensive care units (ICUs), became: (1) safety and resource issues—organization of shelters, patients transfer to the shelters, patient selection and evacuation to safer regions of Ukraine or abroad; alternative electricity sources (installation and use of fuel generators and accumulators), patient care in low-resource and low-personnel conditions (provision of medication, water, food reserves, oxygen sources in the shelter, personnel education and rotation); (2) pain management and long-term consequences—managing and rehabilitating a massive number of patients with severe acute and chronic pain, and psychiatric disorders; (3) resistant wound infections management (Table 1).

During the year of war, the ICU contingent changed significantly: the huge number of trauma patients were distributed to hospitals, which have never managed trauma before, so they needed to educate personnel and

gain new experience. On the other hand, chronically ill and oncologic patients are being admitted to hospitals in more severe conditions than previously, as often they have no access to prescribed medications or primary care providers. However, the main problems we face, in caring for critically ill patients are safety issues, pain management, and resistant wound infections.

Safety and resource issues

The main challenge during wartime is safety, and it becomes very difficult to even imagine safety when we speak about highly dependent ICU patients. To set up shelters for the critically ill, we organized alternative ICUs in the hospital basement (underground) or on the first floor (in this case with windows protection). Afterward, both patients and all the necessary equipment, and personnel were transferred there. As it became crucial not to forget some equipment or medications, we introduced equipment and medication checklists for every critically ill patient. Also, we selected and prepared patients for evacuation to safer regions or abroad. For 1 year of war, more than 2000 Ukrainian patients have been transferred to European Union (EU) Medevac Hub in Rzeszów by train and then airlifted to hospitals across Europe to receive specialized care via the largest EU Civil Protection Mechanism. To maintain the function of ventilators, infusion pumps, vital monitors, etc., we established powerful electric generators in all major hospitals, which are used mainly for ICUs and operating theatres. Since approximately 30% of personnel left the hospital to move abroad or to other Ukrainian regions, those who stayed had to get prepared to manage critically ill patients, even though they were obstetricians or urologists, not intensivists. We also had a huge deficit of technical personnel, so doctors and nurses had to clean the hospital, cook food or service the equipment. As it became very unsafe to travel through Kyiv, Chernihiv,

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Table 1 ICU during the Ukraine war: main challenges and opportunities from our experience

	Challenges	Opportunities
Patients' population	The number of severe trauma patients increased dramatically Chronic/cancer patients are being admitted to hospitals in more severe conditions due to difficulties with primary care access	Opportunities to get new competences and experience Telemedical consultations from world experts in the field Live consultations and surgery for difficult cases Selected patients could be transferred to specialized centers abroad for further treatment
Safety and resource issues	Need to organize the ICU in the shelter and transfer all equipment and patients there Need for alternative electricity sources installation (attacks on electric infrastructure) Medication, water, food reserves provision	Equipment and medication checklists for every critically ill patient were introduced Humanitarian aid provides necessary medication and equipment Selected patients could be transferred to specialized centers abroad or within Ukraine for further treatment
Pain management and long-term consequences	Thousands of patient with acute pain, which becomes chronic in 80% of cases Thousands of patients require rehabilitation Millions have mental health issues Insufficient patient and personnel education, lack of standards implementation Lack of acute and chronic pain services Underfunded and undeveloped rehabilitation and mental health services	Pain management standardization at all levels of treatment Psychological support at all levels of treatment Rehabilitation capacities development Patients and family-focused education Personnel education Acute and chronic pain services organization
Resistant wound infections management	Deep soft-tissue infections and osteomyelitis are very common in blast-trauma patients Lack of antibiotic therapy guidelines for patients with blast injuries and deep soft-tissue infections Heterogeneity in the used antibiotics dosages and combinations in different hospitals	Implementation of national antibiotic therapy standards for patients with blast injuries and deep soft-tissue infections Unique experience in the management of blast injuries associated soft-tissue infections Telemedical system development within Ukraine and outside

and Kharkiv cities when surrounded by Russian forces and under artillery strikes, most personnel lived in the hospital, and some took children or pets with them.

Wartime is a huge challenge for critically ill patients and ICU personnel. The main objective is to organize equipped shelters, transfer patients safely, and prepare them for evacuation. On the other hand, it is a good opportunity for personnel to get new competencies and to establish safe practices. Colleagues from all over the world have been helping to teach the doctors, providing online courses, as well as live workshops in safer regions of Ukraine. The World Telehealth Initiative and other humanitarian missions have implemented a sizeable telemedical network that connects clinicians inside and outside Ukraine to assist with combat trauma and other acute care in hospitals and on the front lines. These networks help manage difficult patients and select the patients for further transfer to specialized centers.

Pain management and long-term consequences

Acute and chronic pain management has become one of the most significant problems during the war in Ukraine. Approximately 80% of ICU patients injured during war experience severe pain [3]. Pain becomes chronic in

nearly 83% of combatants with blast injuries and 75% with gunshot wounds [4]. Post-traumatic stress disorder (PTSD) develops in 82% of traumatized combatants, becoming a national challenge in the future years. It is obvious that early effective pain management is an important component of intensive care for the war-injured [5], as it improves the outcomes and decreases PTSD incidence [3, 4, 6].

Since 2018, we have a national protocol for perioperative pain management. Although its acceptance reaches 60%, only a few hospitals in Ukraine have acute pain services, and those report better results in pain management. During war times, it becomes even more difficult due to large surges of trauma patients and personnel deficits. The main challenges regarding acute pain management in critically ill trauma patients during wartime are undiagnosed and undertreated neuropathic pain, insufficient use of prolonged regional anesthesia techniques, insufficient patient and personnel education, lack of standards implementation, underuse of nonpharmacologic techniques and psychological support (including antidepressants prescription). Based on Ukraine's experience and using the United States Army's Pain Management Task Force guidelines [7], it is critically important

to standardize medical care and pain management at all levels of treatment, implement a multimodal interdisciplinary approach, maintain patients and family-focused education, personnel education, and organize acute pain services.

Since Russia invaded Ukraine, thousands of people were in need of rehabilitation and near 10 millions suffered from PTSD. Unfortunately, Ukraine is saddled with one of Europe's most underfunded rehabilitation and mental health services. So now, creating a modern rehabilitation system is a big challenge, which requires a lot of funding, resources, and personnel. The first lady of Ukraine, Olena Zelenska, has advocated mental health treatment as a priority for our country. But to get this right, capacity must be built across the whole system.

Resistant wound infections management

Since 2021, we have had a national standard on antibiotic therapy prescription and de-escalation in Ukraine, although it does not include antibiotic therapy guidelines for patients with blast injuries and deep soft-tissue infections. The Joint Trauma System also gives no clear guidance for the treatment of combat trauma-related infections [8]. Combat injuries, especially from blast-related trauma, are usually more complicated than civilian trauma.

Deep soft-tissue infections and osteomyelitis develop in 50–75% of blast-trauma cases and result in substantial mortality [8, 9]. The most common pathogens, which caused wound infections during the war in Ukraine, are *Pseudomonas aeruginosa* (22.5%), *Proteus mirabilis* (21.3%), *Staphylococcus aureus* (23.8%), *Streptococcus pyogenes* (18.8%), and *Escherichia coli* (13.8%); with resistant wound infections increasing mortality up to 12% [10]. Almost all patients receive antibiotics from the first day of injury, with nearly 80% being carbapenems, often in combination with vancomycin or fluoroquinolone. As the patient moves from one hospital to another at the stages of evacuation, there is little antibiotic stewardship and heterogeneity in the used dosages and antibiotics in different hospitals. Highly variable antibiotic prescriptions have resulted in selective resistance for frequently used and currently effective antibiotics. Resistant infection also causes delays in patient transfer to specialized centers and surgical treatment due to the need of isolation.

So, the solutions which could be effective in the short term are: (1) implementation of national antibiotic therapy standards for patients with blast injuries and deep soft-tissue infections; (2) documentation and monitoring of antibiotic stewardship, and resistant strains prevalence at the national level; (3) personnel education on infection prevention and management; (4) popularization of

telemedical consultations with experts within Ukraine and outside.

Take-home message

The main challenges during wartime are staying safe and standardizing medical care at different treatment stages, considering extremely low resources. The long-term impact of war on the management of critically ill patients is unknown. However, pain management, long-term consequences, and wound infections are the most significant problems. On the other hand, war has opened some new opportunities. With the help of our international colleagues, we could select and evacuate patients to continue their treatment in other countries; a lot of experts come to Ukraine to help manage difficult cases here, and Ukrainian doctors have immense possibilities for education, telemedical consultations, experience exchange, and cooperation [10].

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