Experience of Adapting the Emergency Medical System of Ukraine Under Conditions of Prolonged Full-Scale War

Expérience de l'adaptation du système médical d'urgence de l'Ukraine dans des conditions de guerre à grande échelle prolongée

Experiência de adaptação do Sistema Médico de Emergência da Ucrânia em condições de guerra prolongada em grande escala

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Abstract

Introduction: The full-scale war in Ukraine, which began in February 2022, posed unprecedented challenges to the emergency medical services (EMS) system and necessitated its transformation. These changes occurred immediately after the COVID-19 pandemic, effectively against a backdrop of already limited resources. Key challenges affecting EMS operations included: a significant increase in civilian trauma cases; a large number of mass casualty incidents; safety risks for EMS personnel; extensive destruction of medical infrastructure; threats of chemical, biological, radiological, and nuclear (CBRN) nature.

Despite these challenges, the EMS system adapted and continues to function effectively. This article briefly describes the main challenges and the approaches used to address them.

Objective: To describe the key challenges faced by EMS during a prolonged full-scale war and to summarize practical solutions that support operational continuity and scalable emergency response capacity.

Materials and Methods: Operational data and statistics from the State Institution "Ukrainian Scientific and Practical Center of Emergency Medical Care and Disaster Medicine" for 2022–2025 were analyzed.

A descriptive narrative review was conducted based on aggregated data and organizational examples from Ukraine during 2022–2025, as well as international approaches to maintaining essential health services, strengthening system resilience, and developing national Emergency Medical Teams (EMT) networks.

Results: Seven main groups of critical challenges were identified: mass casualty incidents and a sharp increase in civilian trauma cases; CBRN threats; destruction of medical infrastructure; the need for large-scale long-distance interhospital transfers of critically ill patients; safety risks to EMS personnel; limited time and resources for training under new programs; fragmented data systems and the need for rapid analytics. Practical responses included: integration of national EMTs and surge capacity models; establishment of medical hubs and medical transport coordination centers; development of intensive evacuation systems (including ICU buses); standardization of routing; strengthening personnel safety (armored vehicles, electronic warfare protection, tactical adjustments); accelerated modular training programs; digitalization and vertical crisis management structures; regulated interaction between civilian and military medicine.

Conclusion: Adaptation to prolonged conflict requires transitioning from one-time response to a managed resilience model: proactive threat analysis, deployment of national disaster medical teams, protected logistics, systematic workforce training, and real-time data for decision-making.

Keywords: emergency medical system; limited resources; prolonged emergency; full-scale war; disaster medical teams; CBRN; adaptation.

Résumé

Introduction: La guerre à grande échelle en Ukraine, débutée en février 2022, a posé des défis sans précédent

https://doi.org/10.25761/anaisihmt.559

au système de services médicaux d'urgence (SMU) et a nécessité sa transformation. Ces changements sont survenus immédiatement après la pandémie de COVID-19, dans un contexte de ressources déjà limitées. Les principaux défis affectant les opérations des SMU incluaient : une augmentation significative des cas de traumatismes civils ; un grand nombre d'incidents à victimes multiples ; des risques pour la sécurité du personnel des SMU ; la destruction étendue des infrastructures médicales ; des menaces de nature chimique, biologique, radiologique et nucléaire (CBRN). Malgré ces défis, le système SMU s'est adapté et continue de fonctionner efficacement. Cet article décrit brièvement les principaux défis et les approches utilisées pour y répondre.

Objectif: Décrire les principaux défis auxquels le SMU a été confronté lors d'une guerre prolongée à grande échelle et résumer les solutions pratiques qui soutiennent la continuité opérationnelle et la capacité d'intervention d'urgence évolutive.

Matériels et méthodes: Des données opérationnelles et des statistiques de l'Établissement d'État «Centre scientifique et pratique ukrainien de soins médicaux d'urgence et de médecine des catastrophes» pour 2022–2025 ont été analysées. Une revue narrative descriptive a été réalisée sur la base de données agrégées et d'exemples organisationnels provenant de l'Ukraine entre 2022 et 2025, ainsi que des approches internationales pour maintenir les services de santé essentiels, renforcer la résilience du système et développer les réseaux nationaux d'équipes médicales d'urgence (EMT).

Résultats: Sept principaux groupes de défis critiques ont été identifiés : incidents à victimes multiples et augmentation brutale des cas de traumatismes civils; menaces CBRN ; destruction des infrastructures médicales ; besoin de transferts interhospitaliers à grande distance pour les patients gravement malades; risques pour la sécurité du personnel SMU; temps et ressources limités pour la formation selon les nouveaux programmes ; systèmes de données fragmentés et besoin d'analyses rapides. Les réponses pratiques incluaient: intégration des EMT nationaux et modèles de capacité de renfort ; établissement de pôles médicaux et de centres de coordination du transport médical ; développement de systèmes d'évacuation intensive (y compris des bus de soins intensifs) ; standardisation des itinéraires ; renforcement de la sécurité du personnel (véhicules blindés, protection contre la guerre électronique, ajustements tactiques) ; programmes de formation modulaires accélérés ; digitalisation et structures de gestion de crise verticales ; interaction régulée entre médecine civile et militaire.

Conclusion: L'adaptation à un conflit prolongé nécessite de passer d'une réponse ponctuelle à un modèle de résilience gérée : analyse proactive des menaces, déploiement des équipes médicales nationales de catastrophe, logistique protégée, formation systématique du personnel et données en temps réel pour la prise de décision.

Mots-clés: système médical d'urgence ; ressources limitées ; urgence prolongée ; guerre à grande échelle ; équipes médicales de catastrophe ; CBRN ; adaptation

Resumo

Introdução: A guerra em grande escala na Ucrânia, que começou em fevereiro de 2022, colocou desafios sem precedentes ao sistema de serviços médicos de emergência (EMS) e exigiu a sua transformação. Essas mudanças ocorreram imediatamente após a pandemia de COVID-19, efetivamente em um contexto de recursos já limitados. Os principais desafios que afetaram as operações do EMS incluíram: aumento significativo de casos de trauma em civis; grande número de incidentes com múltiplas vítimas; riscos à segurança do pessoal do EMS; destruição extensa da infraestrutura médica; ameaças de natureza química, biológica, radiológica e nuclear (CBRN).

Apesar desses desafios, o sistema EMS adaptou-se e continua a funcionar de forma eficaz. Este artigo descreve brevemente os principais desafios e as abordagens utilizadas para enfrentá-los.

Objetivo: Descrever os principais desafios enfrentados pelo EMS durante uma guerra prolongada em grande escala e resumir soluções práticas que apoiem a continuidade operacional e a capacidade escalável de resposta a emergências.

Materiais e Métodos: Foram analisados dados operacionais e estatísticas da Instituição Estatal "Centro Científico e Prático Ucraniano de Cuidados Médicos de Emergência e Medicina de Desastres" para o período 2022–2025. Foi realizada uma revisão narrativa descritiva com base em dados agregados e exemplos organizacionais da Ucrânia durante 2022–2025, bem como em abordagens internacionais para manutenção de serviços essenciais de saúde, fortalecimento da resiliência do sistema e desenvolvimento de redes nacionais de Equipes Médicas de Emergência (EMT).

Resultados: Foram identificados sete grupos principais de desafios críticos: incidentes com múltiplas vítimas e aumento acentuado de casos de trauma em civis; ameaças CBRN; destruição da infraestrutura médica; necessidade de transferências interhospitalares de longa distância de pacientes criticamente enfermos; riscos à segurança do pessoal do EMS; tempo e recursos limitados para treinamento em novos programas; sistemas de dados fragmentados e necessidade de análises rápidas.
As respostas práticas incluíram: integração das EMTs nacionais e modelos de capacidade de resposta rápida; estabelecimento de polos médicos e centros de coordenação de transporte médico; desenvolvimento de sistemas intensivos de evacuação (incluindo ambulâncias ICU móveis); padronização de rotas; fortalecimento da segurança do pessoal (veículos blindados, proteção contra guerra eletrônica, ajustes táticos); programas acelerados de treinamento modular; digitalização e estruturas verticais de gestão de crises; interação regulamentada entre medicina civil e militar.
Conclusão: A adaptação a conflitos prolongados exige a transição de uma resposta pontual para um modelo de resiliência gerida: análise proativa de ameaças, implantação de equipes médicas nacionais de desastre, logística protegida, treinamento sistemático do pessoal e uso de dados em tempo real para tomada de decisão.

Palavras-chave: sistema médico de emergência; recursos limitados; emergência prolongada; guerra em grande escala; equipes médicas de desastre; CBRN; adaptação

Introduction

Prolonged military conflicts and complex emergencies generate simultaneous medical, logistical, and governance pressures on healthcare systems. The Russian full-scale invasion of Ukraine, which began in February 2022, has affected all aspects of societal functioning, including the healthcare system. Unlike traditional emergencies or natural disasters, which are typically localized and time-limited, armed conflict is characterized by prolonged duration, wide geographic distribution, and unpredictability [1].
These features impose unique requirements on healthcare institutions, demanding structural, procedural, and workforce adaptations to maintain operational functionality and quality of care.
International frameworks emphasize the importance of maintaining continuity of essential health services during crises [2], as well as transitioning toward health system resilience—defined as the capacity to prevent, detect, adapt, respond, and recover without compromising the quality or accessibility of services [3,4].
Evidence from other conflict-affected settings indicates that healthcare systems frequently experience shortages of equipment, medications, and personnel, leading to reduced access to medical care for the population [5,6]. Ukraine faced similar systemic constraints. However, the Ukrainian emergency medical services (EMS) system was required to simultaneously address several interconnected challenges: ensuring uninterrupted care for the civilian population, adapting to the continuous increase in mass casualty incidents resulting from large-scale missile, unmanned aerial vehicle (UAV), and explosive attacks, and preparing for emerging threats, including chemical, biological, radiological, and nuclear (CBRN) incidents.

Objective

The objective of this article is to describe the key challenges faced by EMS during a prolonged full-scale war and to synthesize practical solutions that enable the maintenance of operational continuity and the scaling of emergency response capacity.

Materials and Methods

This study adopts a qualitative descriptive design integrating elements of operational research and health systems analysis to systematically interpret aggregated EMS performance data within a real-world, high-intensity conflict setting. This methodological approach is consistent with established frameworks in operational research and qualitative health systems analysis in complex emergency settings [7].
The analysis draws on aggregated national-level operational data reflecting the functioning of the Ukrainian EMS system during the period 2022–2025. The dataset comprises key indicators, including response times, incident typologies, patient volumes, medical evacuation activities, infrastructure damage, and personnel safety metrics. These statistical data were obtained through routine EMS reporting systems and institutional monitoring frameworks, specifically from the reporting systems of regional emergency medical care centers to

the State Institution "Ukrainian Scientific and Practical Center of Emergency Medical Care and Disaster Medicine of the Ministry of Health of Ukraine," which serves as the national coordinating body for emergency medical care and disaster medicine. Due to martial law, these data are currently unavailable to the general public.
In addition, an analysis was carried out of internal documents describing organisational strategies and operational decisions taken at national level. These documents were selected on the basis of their relevance to operational decision-making, the performance of the emergency medical services system, and the implementation of response strategies during the study period.
Access to the aforementioned data and documents has been authorised by the authorities responsible for managing these sources.

The primary dataset was derived from two key national-level sources:

1. Form No. 22 ("Annual Report of Emergency Medical Service Station"), approved by the Order of the Ministry of Health of Ukraine No. 999 dated November 17, 2010. This is a standardized national reporting form completed annually by all regional EMS centers and submitted to the State Institution "Ukrainian Scientific and Practical Center of Emergency Medical Care and Disaster Medicine," which serves as the national coordinating body. The Center aggregates these reports into a unified national dataset.
2. The Analytical Dashboard of Emergency Events, a centralized digital reporting and monitoring system developed with the support of the World Health Organization at the request of the Ukrainian EMS system. This platform collects structured, event-based data submitted by regional EMS centers in real time during emergency incidents. It enables longitudinal analysis of incident characteristics, operational response, and system performance across defined time periods.

In addition, publicly available data on damage to healthcare infrastructure, including the number of damaged and destroyed healthcare facilities, were obtained from official reports published by the Ministry of Health of Ukraine. These data were used to complement the analysis and to contextualize the operational challenges faced by the EMS system. https://moz.gov.ua/uk/ponad-2400-ob-yektiv-medichnoyi-infrastrukturi-poshkodzheni-abo-zrujnovani-vnaslidok-povnomasshtabnoyi-vijni

An iterative thematic synthesis approach was applied to integrate operational data and documented practices. Analytical coding was conducted using an inductive framework, allowing patterns of challenges and response strategies to emerge from the data. These were subsequently organized into higher-order thematic domains based on their frequency, operational significance, and impact on system performance. Coding was performed iteratively, with categories refined through repeated comparison of data sources and operational patterns.
These frameworks were employed as interpretive lenses to support analytical consistency, strengthen conceptual coherence, and enhance the external validity and transferability of the findings to other complex emergency and conflict-affected settings.
Given the use of aggregated data and the operational nature of the dataset, no individual-level patient information was included. Potential limitations include variability in regional reporting practices, the use of aggregated indicators, and constraints in data integration across multiple information systems. However, these limitations reflect the inherent conditions of data collection in dynamic conflict environments and do not substantially affect the interpretive value of the findings.

Results

Since the onset of the armed conflict in February 2022, specialists of the State Institution "Ukrainian Scientific and Practical Center of Emergency Medical Care and Disaster Medicine of the Ministry of Health of Ukraine" have conducted systematic analyses of statistical indicators and operational characteristics of EMS delivery.
It is important to recognize that the challenges confronting the EMS system were not static but evolved dynamically in response to both the intensity and the character of hostilities. As the conflict progressed, patterns of injury, operational risks, and resource constraints changed significantly, requiring continuous adaptation of operational strategies and management practices. Over the period 2022–2025, systematic analysis of operational data, incident reports, and emergency response practices allowed the identification of seven principal categories of challenges, each exerting compound and mutually reinforcing effects on operational capacity, logistics, and decision-making processes within the EMS system.
Foremost among these challenges was the extraordinarily high incidence of mass casualty incidents (MCIs). These events were primarily driven by missile strikes,

UAV attacks, and the detonation of explosive devices targeting civilian infrastructure. Unlike traditional disaster scenarios, such events often occurred repeatedly within the same geographical areas and within short time intervals, producing waves of casualties that overwhelmed local emergency response capacity. This pattern created sustained and unprecedented pressure on EMS dispatch systems, triage mechanisms, and hospital surge capacity, forcing emergency services to operate under conditions of prolonged high-intensity demand.

Concurrently, the EMS system faced persistent and multifaceted emergency threats related to CBRN hazards. These risks were particularly associated with the proximity of nuclear power plants, large-scale hydraulic infrastructure such as dams, industrial chemical facilities, and the potential release of hazardous substances following military attacks. The presence of these hazards significantly increased the complexity of threat assessment, response planning, and responder safety protocols. EMS personnel had to maintain readiness not only for trauma care but also for potential CBRN exposure scenarios requiring specialized protective equipment, decontamination procedures, and coordination with civil protection and military authorities.

These operational challenges were further compounded by widespread damage to healthcare infrastructure. Hospitals, emergency departments, and ambulance bases were repeatedly damaged or destroyed during hostilities. In addition, a significant number of EMS vehicles were damaged or rendered inoperable, reducing fleet availability and constraining response capacity. Such damage directly affected operational efficiency, extended response times, and disrupted established medical evacuation routes, particularly in regions experiencing frequent attacks.

Simultaneously, the EMS system was required to support large-scale evacuations of civilians from frontline regions and conduct long-distance interhospital transport of critically ill patients. These evacuations often involved the transfer of patients across multiple administrative regions or even international borders, requiring complex coordination between EMS dispatch centers, hospitals, and national coordination structures. The logistical burden of such operations was intensified by shortages of adequately trained EMS personnel and limited availability of specialized transport units capable of supporting critically ill patients during prolonged transfers.

Personnel safety remained one of the most persistent and complex operational concerns. EMS teams frequently operated in environments characterized by ongoing security risks, including repeated strikes, UAV incursions, and attacks on transport routes. Such conditions introduced continuous operational risk and required the rapid implementation of protective measures, including modified deployment protocols, enhanced situational awareness procedures, and the use of protective transport strategies designed to reduce exposure during response operations.

Under these conditions, the EMS system was compelled to implement accelerated training and retraining programs for large cohorts of personnel. Rapidly changing operational conditions, evolving threats, and the need to replace personnel who were injured, mobilized to other roles, or exhausted by prolonged service required flexible training strategies. These programs often combined modular education, simulation-based exercises, and threat-specific training modules designed to rapidly prepare responders for complex operational environments.

Finally, fragmented data systems and the existence of multiple, often inconsistent sources of operational information significantly limited real-time situational awareness. Data related to casualties, available resources, evacuation capacity, and hospital bed availability were frequently distributed across separate systems that lacked interoperability. This fragmentation complicated the coordination of emergency response and highlighted the urgent need for integrated data platforms and operational analytics capable of supporting timely, evidence-informed decision-making at both operational and strategic levels.

Taken together, these challenges illustrate the systemic pressures placed on the EMS system during prolonged high-intensity conflict and underscore the necessity of adaptive management frameworks, integrated data systems, and flexible operational structures capable of maintaining resilience under extreme conditions.

During the analyzed period: 1,619 healthcare facilities were damaged and 214 were destroyed; 175 ambulances were damaged and 261 were destroyed; among EMS personnel, 48 fatalities and 211 injuries were recorded. These figures illustrate the substantial operational burden and losses within the system. Importantly, prolonged warfare fundamentally alters operational dynamics. Even when healthcare facilities remain structurally functional, service accessibility becomes dependent on security conditions, transport logistics, and effective flow management.

The challenges faced by the EMS system evolved over time, influenced by the intensity and nature of hostili-

ties. Nevertheless, analysis of implemented practices during the period 2022–2025, allowed the identification of six interconnected operational principles, which collectively underpin the strategic and tactical resilience of the EMS system. The first principle, risk-oriented planning, emphasizes the systematic identification of threats, scenario-based planning, and the establishment of clearly defined escalation and de-escalation triggers, thereby ensuring proactive preparedness in complex operational environments. A second principle, surge architecture, focuses on the rapid expansion of capacity through the coordinated use of a national EMT network, mobile modules, and strategic reserves, enabling the system to absorb sudden increases in demand without compromising care quality. Medical evacuation as a distinct operational subsystem constitutes a third principle, with structured routing, the establishment of medical hubs, coordination centers, specialized teams, and dedicated transport platforms, all designed to optimize patient flow and clinical outcomes under crisis conditions. The fourth principle treats personnel safety as a quality component, integrating protected transport, threat mitigation tools, tactical deployment protocols, and structured incident management, thereby safeguarding the human resources essential for operational continuity. Fifth, continuous iterative training is maintained through modular programs, simulation-based exercises, threat-specific training, and the development of trainers, ensuring that personnel maintain both competence and adaptability in rapidly evolving scenarios. Finally, real-time data for governance is prioritized through standardized data collection, integration of multiple information sources, operational dashboards, and a vertical crisis-management structure, thereby supporting informed decision-making and strategic oversight. Collectively, these principles provide a cohesive framework for operational planning and execution, reflecting a mature, evidence-based approach to EMS resilience in high-intensity environments.

Table 1 presents the identified challenges and corresponding operational solutions. This structured approach enabled the Ukrainian EMS system to remain highly flexible and adaptive under conditions of prolonged full-scale war.

Table 1: Typical operational solutions implemented to mitigate key challenges arising during prolonged warfare

Challenge	Operational Responses (Examples)	Conditions for Success / Key Performance Indicators
Mass casualty incidents	Prehospital triage and stabilization; standardized routing algorithms; deployment of national EMTs to reinforce capacity.	Unified clinical protocols; established incident command system; time from call to stabilization; prehospital mortality rate.
CBRN threats	Preparedness for operations in warm and cold zones following primary decontamination; secondary decontamination procedures; training in personal protective equipment (PPE) use and deployment of temporary structures.	Availability of trained response teams; adequate PPE supply; deployment time; number of secondary contaminations among personnel.
Destruction of infrastructure and transport assets.	Establishment of backup base locations; deployment of mobile modules; distributed stockpiles; repair and maintenance loops; standardized communication and energy supply protocols.	Communication reliability; fuel and energy reserves; fleet operational readiness; proportion of available EMS teams.
Evacuation of critically ill patients	Establishment of medical hubs; centralized coordination center; specialized transport teams; ICU-capable transport platforms (ICU buses/mobile intensive care units); interregional transfer pathways.	Transparent dispatch and coordination system; defined transfer criteria; time to receiving facility; rate of in-transit complications.
Personnel safety	Armored transport vehicles; electronic countermeasure systems and UAV threat mitigation tools (where available); training on secondary strike risks; adaptive deployment tactics; structured incident reporting.	Injury and fatality rates among personnel; incident frequency; compliance with safety protocols.
Training capacity constraints	Modular training programs; training-of-trainers (ToT) approach; incorporation of distance learning components; mass-casualty simulation exercises; integration of civilian and military medical training.	Number of personnel trained; proportion completing simulation-based training; competency assessment outcomes.
Data and analytics	Standardized minimum data sets; integration of multiple data sources; real-time dashboards; rapid executive summaries for leadership.	Data completeness and timeliness; decision-making interval; accuracy of demand forecasting

One of the most scalable approaches in a prolonged emergency context is the establishment and development of an adequate number of national EMTs as the foundation of surge response capacity. The underlying logic is that successive waves of mass casualties should be primarily managed through national capacities operating under unified standards, ensuring operational self-sufficiency and the ability to reinforce both prehospital and hospital levels of care. Alongside the expansion of the EMT network, it is essential to ensure a clear vertical command structure during emergencies and a regulated framework for coordination between civilian and military medical services. Without such governance mechanisms, even available resources may be utilized inefficiently due to competition for hospital beds, transport assets, and personnel.

Discussion

The operational responses described in this study demonstrate that adaptation of EMS in a prolonged conflict environment should not be conceptualized as a discrete "wartime contingency plan." Rather, it represents a continuous and iterative cycle of risk management, organizational learning, and operational adjustment. In high-intensity conflict settings, where the nature and scale of threats evolve rapidly, the sustainability of EMS performance depends less on rigid predefined plans and more on the system's capacity to dynamically reconfigure its structures, processes, and resource allocation mechanisms.

The experience observed during the period 2022–2025 indicates that several system-level capacities become particularly critical in maintaining operational continuity under conditions of sustained armed conflict. These capacities collectively shape the resilience of the EMS system and determine its ability to maintain essential health services while simultaneously responding to large-scale emergencies [8,9].

First, the ability of the EMS system to rapidly shift between operational modes emerged as a fundamental organizational capability. In conflict environments, EMS services must continuously alternate between routine emergency care delivery and large-scale incident response. Such transitions often occur within very short timeframes and require flexible dispatch systems, scalable triage mechanisms, and surge resource allocation. The ability to dynamically reconfigure operational structures allows EMS systems to absorb sudden increases in demand while preserving core service functions. This adaptability is particularly important in settings where repeated mass casualty incidents occur alongside ongoing routine emergency medical needs.

Second, the management of evacuation processes and inter-level patient routing constitutes a central operational challenge. Large-scale emergencies generate complex patient flows that must be coordinated across multiple levels of the healthcare system. In this context, structured evacuation pathways, clearly defined referral networks, and coordinated medical transport systems become essential components of system resilience. Effective routing mechanisms reduce treatment delays, prevent the overloading of individual hospitals, and allow critically injured patients to reach appropriate levels of care in a timely manner. In prolonged conflict environments, where regional healthcare capacity may fluctuate due to infrastructure damage or resource shortages, flexible and adaptive evacuation strategies are particularly important.

Third, the protection of personnel and transport assets represents a critical prerequisite for maintaining operational continuity. Unlike conventional disaster scenarios, conflict environments expose EMS teams to persistent security risks, including repeated attacks, aerial threats, and hazardous transport corridors. As a result, personnel safety must be integrated into operational planning as a core component of quality and risk management. Protective measures may include modifications of deployment protocols, situational awareness training, enhanced communication systems, and the use of protected or strategically routed transport assets. Protecting human resources is particularly important because the effectiveness of EMS systems ultimately depends on the availability and operational readiness of trained personnel.

Fourth, the rapid deployment of trained EMTs has proven to be an essential mechanism for strengthening surge capacity. National EMTs can provide flexible and scalable medical support during periods of heightened demand, complementing existing hospital-based services and supporting overwhelmed local emergency systems. The development of nationally coordinated EMT networks enables the rapid mobilization of trained personnel, standardized equipment, and deployable medical infrastructure. In the context of prolonged conflict, such teams not only enhance emergency response capacity but also contribute to maintaining continuity of care when local healthcare facilities become compromised.

Finally, timely access to reliable data plays a decisive role in supporting effective decision-making during complex emergencies. Fragmented information systems and delayed reporting can significantly hinder operational coordination and resource allocation. The integration of standardized data collection mechanisms, real-time operational dashboards, and centralized coordination platforms enables decision-makers to monitor evolving situations, assess resource availability, and implement evidence-informed operational adjustments. In high-pressure environments characterized by rapidly changing conditions, data-driven governance becomes an essential component of system resilience.

Taken together, these operational capacities illustrate that EMS resilience in conflict settings is determined not only by the availability of physical resources but also by the system's organizational flexibility, coordination mechanisms, and ability to continuously learn from operational experience. The Ukrainian experience demonstrates that sustained adaptation, institutional learning, and integration of operational data into strategic decision-making are key elements in maintaining EMS functionality under conditions of prolonged armed conflict.

International frameworks for maintaining essential health services emphasize the need to reorganize service flows and prioritize critical functions during crises. The concept of health system resilience further requires institutionalization of an all-hazards risk management approach. In conflict settings, these principles must be complemented by strict adherence to international humanitarian law and established practices for the protection of healthcare services [10, 11].

A key practical implication is that EMS should be conceptualized as an integrated operational platform that connects prehospital response, medical evacuation, communication and data systems, and coordinated governance structures. Investments in digitalization, specialized transport platforms, standardized protocols, and workforce training generate multiplier effects across the entire health system, strengthening both routine service delivery and surge capacity.

Conclusions

Prolonged and complex emergencies necessitate a shift from reactive response paradigms toward a managed resilience framework, characterized by scenario-based planning, clearly defined escalation and de-escalation triggers, and strategically maintained reserves, thereby enabling anticipatory and adaptive operational capacity.

National EMTs should be recognized as the central pillar of surge capacity, fully embedded within both the EMS architecture and the wider healthcare system to ensure coordinated, scalable, and system-wide responses during periods of acute demand.

The evacuation of critically ill patients requires a dedicated governance and operational framework, comprising medical hubs, centralized coordination centers, specialized multidisciplinary teams, and transport platforms equipped for intensive care, to maintain continuity of care under high-risk conditions.

Personnel safety must be institutionalized as a core quality standard, integrating protected transport assets, adaptive operational protocols, and structured incident reporting mechanisms, thereby safeguarding staff and sustaining operational readiness.

The systematic digitalization of data and standardized collection protocols is essential to accelerate decision-making, enhance situational awareness, and optimize the allocation of critical resources in dynamically evolving emergency contexts.

Ethics Approval

No research involving individual patient data was conducted for this review. The manuscript is based solely on aggregated operational information and descriptions of organizational strategies. Therefore, ethical committee approval was not required. The authors declare that they have been authorized to use data that is not publicly available through the institutional channels responsible for its management.

Conflict of Interest

The authors declare that they have no conflict of interest.

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