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Research Article

Lessons for NATO to Be Learned from Putin's War in Ukraine: Global Health Engagement, Interoperability, and Lethality

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Abstract: The Russian invasion of Ukraine exacts a heavy death toll of preventable morbidity and mortality of warfighters and vulnerable civilian communities. Global Health Engagement (GHE) with partner forces across the entire continuum of care, from the point of injury/wounding to rehabilitation, promote interoperability, medical readiness, and lethality. Owing to Russia's recent tactical and combat movements in Georgia, Ukraine, Belarus, and elsewhere in Europe, GHE activities offered by NATO and unilaterally by member states must increase. Multi-domain attacks by Russia, China, and other malicious actors exacerbate global health security risks and war-related injuries and illnesses. NATO-led GHE activities for warfighting in Ukraine can support foreign policy interests with targeted application and, in return, yield maximum benefits to NATO and member states. Medical readiness, interoperability, and lethality can be achieved through a coordinated effort across all medical actors to standardize the medical evacuation chain, conduct transparent deployment of mobile medical units, and increase access to damage control resuscitation and surgery through echelons of care. Sharing lessons learned helps Ukraine, as well as NATO and its member states. These main themes of effort will reduce preventable morbidity and mortality in support of warfighting and state sovereignty.

Keywords: defense cooperation, Global Health Engagement, GHE, military medicine, medical readiness, Lethality, Ukraine, NATO, health security.

Introduction

Security threats throughout NATO's Eastern flank are significant and disruptive and may require new approaches to maximize outcomes that benefit NATO's strategic objectives and collective defense. Russia poses a major threat to regional security throughout Europe. Deterrence, collective defense, crisis management, and disaster prevention and response are key operations of the NATO alliance.

NATO must support and lead the coordination of Global Health Engagement (GHE) efforts in Ukraine to reduce morbidity and mortality from warfighting and to sharpen both Ukraine and NATO forces' medical readiness. GHE builds a more lethal force by modernizing key capabilities, evolving innovative operational concepts, promoting sustainability, and cultivating workforce talent. Building partnerships and implementing reform directly supports enhanced lethality of the warfighting function.[1] Global Health Engagement activities across NATO and partners offer an opportunity for security cooperation and engagement with second and third-order effects of stability and deterrence and increase medical readiness, interoperability, and lethality against new health threats from infectious disease to peer-on-peer conflict.

For the purposes of this article, standardized NATO terminology has been deployed to consider advancements and describe all echelons of care throughout the evacuation chain.[2] Role 1 basics of medical care include continued tactical field care and initiation of Damage Control Resuscitation (DCR) based on capabilities. Role 2 provides damage control resuscitation and damage control surgery (DCS) with limited intensive care unit capabilities. Role 3 offers comprehensive surgical and advanced levels of care in a theater. Finally, Role 4 provides comprehensive medical care, rehabilitation, and follow-on surgical capabilities as needed for all diagnostics and all patients. Within the first five months of fighting in Ukraine, the most significant gaps remain in the Point of Injury (PoI) / Point of Wounding (PoW) care and tactical evaluation to that of Role 3, including evacuation and critical care transport.

Prior to the Russian hostilities initiated in 2014, Ukraine's emergency services dealt with civilian-focused trauma and emergency medical services with disaster response focused on natural disasters. With the large-scale Russian invasion in February 2022, Ukraine introduced Martial Law, which significantly impacts clinical governance across all defense and healthcare sectors and institutions. The prehospital medical challenges in Ukraine are significant, although very specific.

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1 Derek Licina and Jackson Taylor, "International Trauma Capacity Building Programs: Modernizing Capabilities, Enhancing Lethality, Supporting Alliances, Building Partnerships, and Implementing Reform," *Military Medicine* 187, no. 7-8 (July-August 2022): 172-174, https://doi.org/10.1093/milmed/usab539.

2 For a comprehensive and detailed definition description of the echelons of care, see: Miguel A. Cubano, *Emergency War Surgery*, 5th US Revision (Government Printing Office, 2018).

Ukraine is an emerging lower-middle-income European Nation with an integrated healthcare system prior to the Russian invasion. Before this iteration of Russian violence and invasion in February 2022, Ukraine boasted access to NATO equivalent civilian Role 1, Role 2, and Role 3 levels of care. Ukraine's approach has fostered interoperability across the Armed Forces of Ukraine (AFU) and with multiple civilian disaster and medical institutions. Additionally, Ukraine was well-integrated with road, bridge, rail, and other transportation means for a country that, if you placed it over the eastern United States, would stretch from Missouri to the Atlantic Ocean and from Ohio to Georgia. Ukraine's spanning geography is challenging for medical evacuation when air evacuation is not viable. Air superiority is contested throughout areas of fighting in Ukraine. Multiple medical and hygiene aircraft have been shut down. Despite the Geneva conventions, Russia specifically targets medical evacuation vehicles, personnel, and medical support assets.

Despite the excellent levels of care received in the civilian healthcare sector throughout Ukraine, military medicine and DCR/DCS, including the provision of blood transfusion in the prehospital space, were completely lacking and inadequate for the Russian threat and the impact of the February 2022 invasion. Massive advances have been made with many success stories, but more is required in order to mitigate injuries and ensure the lethality of the Armed Forces of Ukraine (AFU). The clinical learning curve in Ukraine has been extremely steep, and more needs to be done in order to reduce preventable morbidity and mortality.

Basic Definitions

Medical readiness is both individual and institutional. An individual is ready when medically fit to deploy and be in contact with fighting activities. Institutional medical readiness is the ability to deploy and conduct expeditionary medical activities, establish a medical evacuation chain, and provide medical support for deployed personnel. Interoperability within military medicine is very complex. It is not only the ability of recipient and partner nations to work together but, more importantly, for patients to be treated within two distinct and separate systems and receive 100 % the same level of care in both medical forces interchangeably.

The U.S. Department of Defense Instruction (DODI), tacitly accepted across several NATO member states, uses the definition of Global Health Engagement (GHE) as the interaction between the DoD and Partner Nations' armed forces or civilian authorities.[3] The 2017 landmark DODI 2000.30 puts GHE into focus: "...in coordination with the U.S. interagency, to build trust and confidence, share information, coordinate mutual activities, maintain influence, and achieve interoperability in support of U.S. national security policy and military strategy." This DODI goes on to define GHE activities that establish, reconstitute, maintain, or

[3] Office of the Under Secretary of Defense for Policy, "DoD Instruction 2000.30 Global Health Engagement (GHE) activities" (2017).

improve the capabilities or capacities of the partner nation's military or civilian health sector or those of the DoD. Clearly, GHE across not only DoD and NATO member states but, most importantly, NATO partner states such as Ukraine, Moldova, and Georgia are at the forefront of a two-way street of GHE that enables recipient states and provides the U.S. and NATO members with key insight and up to date battlefield data to enhance and focus medical readiness and lethality. Lethality is the ability to influence and neutralize targets kinetically and across the multi-domain battlefield of land, sea, air, space, and cyber.

Historical Background: Past as Prologue

After Russia's 2014 invasion and occupation of Ukrainian territory, Ukraine has been a leading recipient of U.S. military aid in Europe and Eurasia, most notably in humanitarian, medical, and non-lethal security cooperation. The Ukrainian Security Assistance Initiative (USAI) offers a broad menu of security cooperation, and GHE activities are prevalent throughout multiple streams of security cooperation funding. U.S. foreign policy interests and recent legislation from Congress focus on support for the sovereignty, integrity, democracy, and economic stability of Ukraine. This has included countering Russian influence in Europe and Eurasia and countering America's adversaries through sanctions. Upon Russia's recent iteration of war from February 2022, the U.S. and other NATO partner forces have offered tens of billions of dollars worth of additional military and humanitarian aid. However, money and material support will not alone increase Ukraine's sovereignty or improve its interoperability with NATO and lethality of forces – specific collaboration and coordination are required across all force modalities with monitoring and evaluation activities.

State Sovereignty

Relations between NATO and Ukraine began in the early 1990s and have developed into one of the most substantial NATO partnerships marking Ukraine as a "Special Partner." With the onset of the Russia-Ukraine war, cooperation has intensified in critical areas, with GHE a major focus. From NATO's stance, a sovereign, independent, and stable Ukraine, firmly committed to democracy and the rule of law, is key to Euro-Atlantic security. The focus on sovereignty and independence of action is most clearly evidenced regionally with Sweden and Finland's Membership Action Plan (MAP) for NATO membership, historically neutral and non-aligned countries shifting in light of Putin's further advances against the sovereign borders of Ukraine.

Additionally, other NATO partners such as Georgia and, more recently, North Macedonia, until its membership acceptance, also received significant security cooperation in the form of global health engagement activities. Montenegro became a full NATO member in 2017, and Bosnia-Herzegovina received its membership action plan (MAP) in 2010. Both Ukraine and Georgia were issued a verbal promise of a MAP in 2008 at the Bucharest summit. In the past two decades, the NATO enlargement timeline has seen significant growth, strengthening the

alliance, encouraging deterrence of potential adversaries, and providing collective defense against emerging health security threats and diseases, disasters, and a potential Article 5 security event. Global Health Engagement activities can encourage these themes that support strengthening the alliance, encouraging deterrence, and better supporting collective defense through medical readiness and increased lethality. The two leading security partner aspirant nations of Ukraine and Georgia offer case studies in interoperability of NATO military medical standards and systems and a cycle of GHE activities that increase not only the capacity and capabilities of both donor and recipient countries but also encourage information sharing and best practices to strengthen collective defense and deterrence.

Global Health Engagement and the Continuum of Care

For individual patient care in the prehospital and battlefield environment, where an injury occurs, self-aid/ buddy-aid takes place, tactical evacuation care, prolonged field care where needed, followed by resuscitative care – all defining the continuum of medical evacuation Role 1 to Role 4.[4] Any single break or weak link in this evacuation chain, whether from poor interoperability, lower medical readiness, or an overall reduction in force protection, leads to morbidity and mortality increasing precipitously. Additional systems in place to provide this cycle and continuum of care, such as education, prevention practices, rehabilitation, and multiple educational activities and evaluations, are ongoing and run parallel to patient care – even during wartime. The links throughout the disaster cycle and across the continuum of care transcend NATO member and partner state systems. Medical readiness across the alliance requires interoperability and continuous two-way engagement. It helps to reduce preventable morbidity and mortality and supports lethality and deterrence.

The Cycle of Disaster and Patient Care

For direct patient care, prehospital medical services always prepare for and treat the next patient with the true provision of best practices based on evidence and shared data. The disaster cycle is no different; however, instead of dealing with one single patient, the entire system is impacted by crisis and disaster. In the disaster cycle, disaster strikes, there is an immediate response, large-scale intervention, broad relief efforts, a rehabilitation phase restoring basic services, and a reconstruction phase leading to the full resumption of services back to baseline. The mitigation risk assessment and prevention phase, complete with hazard

[4] For the purposes of this article, the standardized NATO terminology and definitions of echelons of care from Point of injury with self-aid and buddy-aid, Role 1 with basic initiation of damage control resuscitation, Role 2 providing damage control resuscitation and limited damage control surgical interventions, Role 3 offering an extensive medical specialty access and continued damage control resuscitation, comprehensive damage control surgery and intensive care capabilities, and finally, Role 4, providing definitive care, rehabilitation and getting patients back to the fight.

mapping and vulnerability assessments, leads to the ongoing preparedness and contingency planning phase, preparing for the next disaster. There is no parallel system between native member states disaster preparedness and response cycles and that of local and national systems. The interoperability across contiguous and non-contiguous states of the new partnership requires persistent health engagement activities. In short, a country preparing, preventing, and responding to a disaster is no different than a prehospital healthcare system preparing, educating, and responding to emergency patients. The cycle is the same for NATO, for a national system, or for a small unit training for tactical response. Due to the unprecedented war launched by Russia, Ukraine requires specific and targeted Global Health Engagement activities to make this disaster and patient cycle more robust, transparent, and accountable and to decrease preventable morbidity and mortality.

What we propose here is that NATO and NATO partners follow the same disaster cycle for Ukraine through Global Health Engagement. These GHE activities broadly include cooperative threat reduction and health security, irregular warfare direct support, stabilization efforts focusing on building partner capacity, foreign disaster relief assistance, focusing on humanitarian aid, force health protection building partner capacity, and finally, humanitarian and civil assistance, focusing on capacity and capabilities of partner forces. The needs are manifest; however, this massive and comprehensive approach will take several years to implement fully.

This GHE guidance seeks to have military-to-military, military-to-civilian, and multi-lateral interoperability efforts, all focusing on collectively building trust and confidence, sharing information, coordinating joint activities and efforts, maintaining influence, and achieving interoperability of forces.

The clear campaign objectives of GHE activities conclude with enhancing readiness, promoting stability and security, improving confidence in partner nation governance, improving interoperability, improving medical force readiness, and strengthening partner nations not only within the military and civilian health center capacity but that of donor medical support capacity and capability. The clinical medicine components of sharing lessons learned are required to provide medical readiness in preparation for future threats. If not shared, these become lessons lost.

How Do GHE and Lessons Learned Save Lives?

With every Russian incursion and attack, preventable morbidity and mortality from battlefield-related injuries due to multi-domain battle continues to rise.

Point of injury care, medical evacuation, and access to far forward Remote Damage Control Resuscitation (RDCR/DCR [5]) and Damage Control Surgery (DCS) underwent a steep learning curve from 2014 to 2016. Tactical Combat Casualty Care (TCCC) training, Global Health Engagement (GHE) with NATO and NATO partner forces grew rapidly. Unfortunately, DCR/DCS remains a challenge for an overwhelming majority of battlefield clinicians, and rapid development and sustainable evacuation chains are inconsistent across the entire line of contact in Ukraine. Clinical stagnation and loss of clinical skills plagued medical staff in Ukraine from 2016 to 2021. Warfighting waned but persisted, while capacity and capability for prehospital medical care fell into skills fade by the reduction in practice, inadequate engagement with NATO medical structures, and poor preparation for a comprehensive Russian threat.

Lastly, the Lessons Learned (LL) from Iraq and Afghanistan have promoted the clinical practice guidelines (CPGs) across NATO from the point of injury care and DCR/DCS right through to Role 4 and prolonged rehabilitation for both physical and behavioral outcomes. However, whether these clinical paradigms need to be adjusted against new hybrid tactical threats from Russia and weapon systems from China remains to be seen. The lessons learned from Iraq and Afghanistan stem from a different adversary, firing weapons not by design, using improvised weapon systems and insurgency tactics, while Russia deploys a conventional top-tier military with advanced weapons systems. With deadly fires by design, it has killed tens of thousands of people throughout Ukraine in the short period from February 2022 to January 2023.

The required Lessons Shared (LS) from Ukraine may impact these CPGs to better account for the new and modern weapon systems and hybrid tactics deployed by Russia and other bad actors to maximize the best medical outcomes. I hope these adjustments and clinical practice guideline changes reduce preventable morbidity and mortality across the entire NATO alliance and partner forces. The maximum benefit and extraction of these lessons learned/ lessons shared through partner forces via Global Health Engagement activities can be optimized to promote NATO strategic interests, as well as deterrence and collective defense across the NATO alliance.

Despite many advancements and lessons learned (and some lessons lost), the 2022 Russian invasion has highlighted growing gaps in point of injury and prehospital medicine for Ukraine's military and at the military-civilian interface, especially for the evacuation chain. Interoperability is challenged and requires both clinical and operational focus, and when performed well in concert on the battlefield can also increase lethality. In an effort to mitigate these lessons lost, AFU must increase its collaboration, coordination, and direct information flow to the NATO Center of Excellence for Military Medicine ("MILMED CoE"), also with that of NATO and NATO partner forces such as country-specific centers of excellence

[5] For the purposes of this article, remote damage control resuscitation and damage control resuscitation are used interchangeably for the prehospital environment, i.e., RDCR = DCR.

for trauma standardization (i.e., Joint Trauma System (JTS) in the U.S. Department of Defense), and patient care in the prehospital space.

Ukrainian Solutions, NATO Standards

The core nucleus of point of injury / point of wounding care revolves around the methodology and clinical approaches of Tactical Combat Casualty Care (TCCC). Effective DCR/DCS cannot occur or be successful without solid TCCC approaches at PoI/PoW. At the point of injury, self-aid and buddy aid are required with the use of an improvised or individual first aid kit (IFAK). The next phase is tactical field and evacuation care, leading to casualty evacuation to a Role 1 medical facility and access and/or *en route care* to a Role 2 medical facility. The medical journey does not end at Role 2 and continues via critical care and en route care and transport from a Role 2 to a Role 3 facility. Without the ability to facilitate rotary and fixed-wing aircraft for the purposes of evacuation, all of the steps can be delayed, and these delays can lead to death. The patients' journey through these echelons of care must always provide additional expanded services at each waypoint. This standardized process not only saves life and limb but also gets warfighters back to the fight and supports lethality. All these steps are required to reduce morbidity and mortality, support returning warfighters to action, and maximize medical outcomes and quality of life.

NATO Standardization

These overriding clinical principles are discussed and described in a 2018 NATO Standard Agreement (STANAG) relating to medical care across the defense alliance. This STANAG references military medicine, echelons of care, needs for an evacuation chain, and basic metrics therein.[6] These military medical standard agreements provide a venue that serves military medical interoperability in times of crisis and disaster. Ukraine is a partner nation of NATO and a potential aspirant nation that ascribes to these standards and is at war with a superior adversary found in the Russian state. Aligning these NATO military medical standards and sharing lessons with NATO will not only support in reducing preventable morbidity and mortality but also enrich and strengthen the NATO defense alliance and its military medical structures, systems, and institutions.

The medical lessons learned to date through Ukrainian loss of life must not be overlooked. It is vital to capture these critical medical data points to streamline NATO medical systems. One highlighted Ukraine's solution to standards adherence with success is that of the Ukrainian Center for Transplant Coordination (UTCC), providing blood for far-forward and prehospital use. UTCC coordinates universal donor O-Negative blood from Western Ukraine to Eastern regions. Can

[6] NATO, "Allied Joint Medical Doctrine for Military Health Care (MHC)," NATO Standard AJMedP-8, Edition A, Version 1 (NATO: NATO Standardization Office (NSO), February 2018), https://www.coemed.org/files/stanags/02_AJMEDP/AJMedP-8_EDA_V1_E_2598.pdf.

NATO be as agile in the event of an Article 5 scenario? Sharing these lessons of far-forward blood transfer in the prehospital space through GHE activities may help to answer this better and many other pressing operational medical questions. An additional lesson learned from the Ukraine war fighting experience occurred in 2014 and 2015 with the first field use of tranexamic acid in the intramuscular (I.M.) route; and advanced and unconventional vascular surgical interventions to save lives, among many others. There are likely several hundred, if not thousands, of anecdotal clinical lessons learned from Ukraine that, if not shared, will be lost.

GHE and Ukraine to Date

2013-2014 political and social unrest lead to mass demonstrations by Ukrainians in the streets and the Russian annexation of Crimea with an invasion and occupation of South-Eastern Ukraine. Under political pressure to deconflict with Russia, non-lethal security/military support in the health/medical domain increased. Through multiple programs offered by European Command (EUCOM), such as Humvee ambulances, the basic point of injury care/TCCC training, and Expeditionary Medical Support (EMEDS) Role 2, the portfolio grew and expanded rapidly over 2014-2016. Additionally, the NATO Partnership for Peace (PfP) academic events relating to medical and health expanded, drawing many health security partners and promoting GHE activities and connections.

In order to meet the increased Russian violence, Role 1 / Role 2 operational activity and capacity increased rapidly as well, with the point of injury care capability increasing with an anecdotal reduction in mortality. The evolution of warfare with Russia and proxy forces continued with an escalation of the types of weapon systems deployed and targets acquired by Russian forces. Within the DoD and Department of State, through the Office of Defense Cooperation (ODC), portfolio management and program sustainability became challenging. A newer and ongoing rehabilitation GHE program brought positive results. However, examples of learning and sharing lessons by NATO and partners are infrequent and limited, and, in some instances, lessons are lost.

Although there are multiple iterations of this GHE cycle in Ukraine, owing to the significant kinetic activity from 2014 onwards, the GHE portfolio assessment is expanding. Ukraine AFU providing a single voice through its military medical institutions will help reduce duplication of requests and efforts and maximize resource allocation through GHE. The expansive 2021 Ukraine Security Assistance Initiative (USAI) provides significant defensive support, with a large element on emergency medical care and medical services serving the continuum of care. With the start of the fiscal year 2022, additional emergency measures support the provision of immediate aid to Ukraine to continue the fight against Russian hybrid and conventional warfare within its own territory, with just under $ 8 billion devoted towards military aid and assistance. This number has increased sevenfold as the fighting continues.

As these iterations of the GHE cycle revolve, some highlighted challenges become very clear. The Armed Forces of Ukraine (AFU) still struggle with lateralized decision-making, leaving many basic decisions about patient care, patient movement, and overall coordination of the medical evacuation continuum centralized or otherwise hierarchical. Additionally, as mentioned previously, the lessons learned/lessons shared (LL/LS) have slowly expanded since 2014. Yet, many clinical, logistical, and operational activities relating to the point of injury care in the medical experience of Ukraine while fighting Russian forces were not recorded, remained unknown, and in some instances, were lost. Weapons systems evolution, trauma registry and information exchange, DCS/ DCR exchange, and interoperability still remain a challenge.

Having said that, currently highlighted positive outcomes must be described: POI survivability increased to 95 % in 2018-2019 through TCCC training and competency for warfighters, the National Association for Emergency Medical Technicians (NAEMT) trainers, and a military-led Emergency Medical Technician (EMT) Basic course continues to train in prehospital medicine; there is a described 20 % of amputee patients returning to active duty compared to 0 % prior to 2014; a reviewed Role 1 was evaluated by the NATO Military Medical Center of Excellence in Budapest. These highlights are significant and likely exist due to GHE activities by NATO and member states. Additional gains must be promoted.

Outcomes and Opportunities

More recently, in addition to the historical GHE results described above, there are gaps but also multiple opportunities. The outpouring of medical and clinical support by foreign volunteers entering Ukraine is significant. The Ministry of Health of Ukraine developed a process in order to obtain clinical governance and temporary certification/licensure for foreign volunteers, although language can be a significant barrier to patient care. Additionally, Ukraine expanded its foreign fighters' group or Foreign Legion with medical support elements. Multiple medical resources and support for vulnerable communities are found within the World Health Organization (WHO), most notably its health cluster methodology. Access to the health cluster will increase interoperability and provide a conduit for medical services across all communities under Martial Law.

Additionally, there are multiple prehospital volunteer medical groups, some that were around before the 2014 fighting and others that expanded later and provided varying levels of clinical service. These volunteer groups provide a greatly needed service by EMTs, nurses, paramedics, physicians' assistants, technician-level personnel, and doctors. In order to continue the provision of clinical care under Martial Law, these medical volunteers must provide in date certification and licensure, obtain their clinical governance from the Ministry of Health (MoH) to practice in their respective scope, and either report directly to MoH or AFU as a unified command. GHE activities related to clinical governance must be expanded and shared.

Tactical Evacuation Care

The Tactical Evacuation phase of care is where casualties are moved from the hostile and austere tactical environment or zero line where they were injured to a more secure location capable of providing advanced medical care. This is extremely challenging in Ukraine as Russia targets specific medical vehicles for annihilation. Coordination of efforts is needed to retrieve patients from the zero line with purpose-built vehicles, coordinate and communicate across volunteer and official groups, thus maximizing medical personnel with support and mitigating the risks to rescuers and patients alike.

The term "Tactical Evacuation" includes both CASEVAC and MEDEVAC; the term tactical evacuation care is the PoI/PoW to Role 1 and includes both MEDEVAC and CASEVAC. Warfighters in Ukraine perish because of planning errors, inadequate evacuation chains, and no access to both CASEVAC and MEDEVAC. In addition, in order to access from the zero line to initiate an evacuation, self-feeding buddy aid at the point of injury must be expanded with additional access to more IFAKs and TCCC standardized training.

En Route Care (Role 1 to Role 2)

Due to the Russian attack and weapons systems deployed, using rotary and fixed-wing aircraft for evacuation is unsafe as the sky is contested. En route care takes place across all platforms of rendering care while transporting a patient to a higher echelon of care and requires specialized training, highly skilled medical personnel, and special equipment. Failure to provide best practices can lead to preventable morbidity and mortality at this critical Role 1 to Role 2 phase.

A critical gap identified for those trauma patients receiving some level of DCR at a Role 1 and requiring complex MEDEVAC to a Role 2 persists. The clinical complexity of this may require a reassessment of tourniquets and peripheral wounds, advanced pharmacotherapy such as sedation, advanced pain management, paralytics, and blood transfusion, management of a chest tube or a central venous line, or management of an intubated and ventilated patient.

Critical Care (Role 2 to Role 3 / Role 4)

Ukraine has a robust civilian critical care prehospital and interfacility transport infrastructure. With so many civilian equivalent Role 2 to Role 4 facilities destroyed, the healthcare system is under extreme stress. Unfortunately, Ukraine lacks the ability to provide critical care transport across the geography of the peri-battlefield environment and throughout the military and civilian evacuation chains at the required volume. Critical care support can be initiated at the entry into the evacuation chain requiring capability and continues through increased levels of care to definitive care en route to a higher echelon of care. The provision of critical care transport across echelons of care for the vulnerable pediatric, adult, and geriatric populations reduces preventable morbidity and mortality.

Mobile Medical Units in Ukraine (MMU)

The acute loss of over 400 healthcare facilities and potentially several thousand medical staff from death and displacement has put an unsurmountable strain on the healthcare system throughout Ukraine. Deploying fit-for-purpose military-grade mobile Role 1 and Role 2 hospitals, providing initial DCR, and more sophisticated DCS and intensive care capabilities are expensive, difficult, and require a lot of training and preparation. However, with appropriate preparation, planning, staffing, and budget, the mobility these MMUs offer, the sheer proximity to the battlefield, and the deployment flexibility can greatly reduce morbidity and mortality.

Since 2014 and more recently, multiple NATO and member states have provided and offered a myriad of MMUs to AFU with varying success. Since February 2022, there have been over five highly advanced Mission ready Role 2 hospitals donated to provide direct support to warfighting. It is unclear where these are deployed, how they plug into the evacuation chain throughout the regions, and whether partner forces can engage and support the daily clinical and operational activities. Through basic operational security, transparently mapping the whereabouts of these MMUs, clearly listing their capabilities and capacity, and providing detailed staffing through echelons of care will enhance emergency medical support and care and help with command and control throughout the evacuation chain.

Chemical, Biological, Radiological, Nuclear, and Ecological (CBRNE) Threats and GHE

The threat of a subthreshold Article 5 event in a NATO or a partner state leading to loss of additional territory and battle initiative remains moderate to high, while the threat of a CBRNE event remains extreme throughout Ukraine and bordering countries. This reality may threaten the legitimacy of the alliance. On an operational and tactical level, sharing medical technology, best practices, and other GHE activities may lead to loss of medical innovation and emerging technology or medical intelligence losses during a health security event such as a new pandemic, emerging infectious disease, or a CBRNE event. Simply stated, sharing medical intelligence with partner states, not yet full members, involves risks. Attribution helps dictate a response to include Article 5 events. Early warning systems, early detection, and clear attribution of any potential CBRNE threat require open and broad GHE communication, access to Partner forces laboratories and diagnostic equipment, and will require a response on a regional and potentially global scale. NATO and the DoD Defense Threat Reduction Agency (DTRA) need access to Ukraine and flows of data and information to best respond and assign attribution in a CBRNE event.

Discussion

Ukraine and Partner nations receive great quantitative and qualitative value in capability, access to partner forces, enhanced deterrence, lethality, and medical readiness by investing in GHE activities. GHE and NATO interoperability are correlated, judging by the current evidence. NATO partner nations participate in GHE activities and offer anecdotes of NATO standards and many other medical and health security-related alternatives to current practice.

The medical evacuation chain for this current iteration of Russian violence is still inadequate, not standardized, nor well integrated at the military-civilian interface, and lacks interoperability where partner forces can plug in, provide in-person support, and augment medical personnel. The evacuation chain will benefit from increasing military medical command and control and integration of these civilian prehospital providers under one command, requiring accountability and transparency in their practice and allowing for clinical data exchange with partner forces. Consolidating military medical command and control (C2) across all defense services, based on evidence and comprehensive geographical assessment of the location of assets, such as recently donated MMUs, Mobile Role 2s, armored ambulances, and a small army of military medical and civilian medical volunteers is required. This will include a list of all areas of operations/ responsibility (AORs), mapping Role 1s and Role 2s, and identifying receiving Role 3s (to include the newly added MMUs and locating the deployed mobile Role 2s from foreign partners). This must also include needs assessment and review of MMUs and forward surgical teams (FST) for the current situation and in planning for future needs in February-September 2023 battle and potential offensive operations. The need for frameshift changes in the quality, quantity, and accessibility of AFU medical teams is manifest.

Additionally, the implementation of medical standards and standardization alignments is extremely challenging for any military medical service. Attempting to provide evidence-based medicine, clinical practice guidelines, and other clinical details while fighting and being actively engaged in war is impossible, even given the hard work already completed. Ukraine urgently needs:

- a complete Ukrainian language translation for the comprehensive DoD Clinical Practice Guidelines (CPGs) for prehospital medicine
- an AFU point of contact for all volunteer medical groups (both national and international)
- a working group for all volunteer medical groups in Ukraine to link and coordinate efforts, provide information sharing and training, and comprise a viable and accountable medical evacuation chain.

Ukraine will likely continue aligning its military medical standards with those of NATO and partner forces. In addition to providing lessons learned and sharing clinical evidence with NATO military medical centers of excellence, it will engage with NATO and NATO nations for direct patient care. The process of receiving

Ukrainian warfighters as patients abroad must be expanded and made sustainable. With support from partner forces, Ukraine's military medical services can conduct a needs assessment for medical evacuation to higher echelons of care—for both warfighters and civilian communities—within Ukraine, to the European Union, and further afield. This will require ground and air evacuation services to neighboring countries such as Romania, Slovakia, Hungary, Poland, and beyond.

Summary and Key Recommendations

The nexus of Global Health Engagement supporting readiness, interoperability, and lethality for NATO and Ukraine is manifest. Support from NATO and partners is required to achieve GHE results better, consolidating military C2 across AFU and other defense services. Through GHE activities, the AFU can also map all areas of operations/ responsibility (AORs), list Role 1s and Role 2s, and identify receiving Role 3s (including MMUs from foreign partners), mobile assets, and hard medical locations. This will enable NATO partners to identify gaps, support pre-existing infrastructure and potentially deploy subject matter experts not only to provide support services but also through direct operational learning.

At a very practical level, the AFU can assign a Point of Contact (PoC) for liaison with the World Health Organization Health Cluster, NATO liaison for medical evacuation of patients out of Ukraine to higher echelons of care to allow for surge capacity for local facilities. It can establish a standard operating procedure (SOP) with all stakeholders and an accountable and transparent medical referral system out of Ukraine into NATO states for patients requiring advanced surgical interventions and rehabilitation to support with surge capacity. Elements of this process started in mid-2022, although no single unified methodology has been applied. Additionally, Ukraine can assign a liaison direct to MILMED CoE and the Joint Trauma System (JTS) for information and lessons learned sharing and battlefield data compilation. Finally, the AFU can assign a point of contact for all volunteer medical groups (both national and international) to reduce duplication of effort and establish a working group for all volunteer medical groups. This will help link and coordinate efforts, provide information sharing and training, and attain a viable, transparent, and accountable medical evacuation chain. This will include all regions and liaisons with the WHO health cluster.

In order to expand early warning and detection systems with more data input and collaboration, medical intelligence and live potential Sentinel events must be shared across AFU, NATO, and DTRA/CDC systems to maximize communication and levels of detection of any CBRNE event.

For clinical collaboration purposes, the AFU can request a complete Ukrainian translation for the comprehensive Department of Defense clinical practice guidelines for prehospital medicine. This translation can be updated annually with two-way communication and lessons learned, adding to CPGs across all uniformed forces.

The AFU should request support from partners to conduct monitoring and evaluation activities with all GHE activities internally and share with partner

forces what works and what is needed based on evidence to maximize support and be accountable to donor nations.

Ukraine may seek the provision of military-civilian medical evacuation platforms, e.g., for expanding rotatory and fixed wing, maritime, and advanced far-forward armored evacuation. The AFU can request medical deployments for NATO and partner forces to Role 2s/Role 3s. NATO may expand its warehousing of CBRNE prevention, response, and training in areas bordering Ukraine, i.e., in Poland, Romania, Slovakia, or Hungary, in order to amass and prepare for potential CBRNE attacks.

Conclusion

Morbidity and mortality among Ukrainian warfighters and vulnerable civilian communities are inversely proportional to quality access to a viable evacuation chain. Global Health Engagement activities have myriad qualitative and quantitative effects. GHE activities align with NATO medical standards and support NATO and partner states. When used and executed efficiently and effectively, GHE can be used as a tool and modality to promote state sovereignty and help save lives in war and conflict. GHE activities provide deterrence, promote collective defense, and strengthen NATO's medical ability, capacity, and capability to respond to threats and disasters and treat patients. GHE strengthens NATO, supports medical readiness, enhances and enables interoperability, and increases the lethality of forces of both NATO and partners such as Ukraine.

More work is needed to integrate such unconventional medical elements into all phases and echelons of care to maximize medical outcomes and benefits. Interoperability is currently lacking. NATO-led GHE activities can support foreign policy interests with targeted applications and yield maximum benefit for both Ukraine and NATO member states. Medical readiness, interoperability, and lethality can be augmented through a coordinated effort across all medical actors to standardize the medical evacuation chain, conduct transparent deployment of mobile medical units, increase access to DCR/DCS through echelons of care, and share lessons learned. These main themes of effort will reduce preventable morbidity and mortality in support of warfighting and state sovereignty.

List of Abbreviations

AOR	Area of Operations / Responsibility
AFU	Armed Forces of Ukraine
CAPES	Capability and Evaluation Assessment
C2	Command and Control
CPG	Clinical Practice Guideline
DCR	Damage Control Resuscitation

DCS	Damage Control Surgery
FST	Forward Surgical Team
JTS	Joint Trauma System
MoH	Ministry of Health
MMU	Mobile Medical Unit
MILMED CoE	NATO Center of Excellence for Military Medicine
MTF	Medical Treatment Facility
NATO	North Atlantic Treaty Organization
PACE	Primary, Alternate, Contingency, and Emergency Plan
RDCR	Remote Damage Control Resuscitation
WHO	World Health Organization

Disclaimer

The views expressed are solely those of the author and do not represent official views of the PfP Consortium of Defense Academies and Security Studies Institutes, participating organizations, or the Consortium's editors.

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