REVIEW ARTICLE

# THE ROLE OF NEUROSURGERY IN ARMED CONFLICTS

## Neurochirurgia w obliczu konfliktów zbrojnych

**Miłosz Chwiałkowski**

*Military Institute of Medicine – National Research Institute, Department of Neurosurgery, Poland*

**Miłosz Chwiałkowski – 0000-0002-7235-8875**

**Abstract**

Neurosurgery, as a surgical subspeciality, frequently fulfils a crucial role during armed conflicts. The specific nature of craniocerebral injuries poses a challenge in diagnostic and therapeutic management. An analysis of military operations in recent years underscores the importance of developing and investing in neurosurgical resources within the military healthcare services.

**Streszczenie**

Neurochirurgia jako dziedzina zabiegowa odgrywa istotną rolę podczas konfliktów zbrojnych. Specyfika urazów czaszkowo-mózgowych jest wyzwaniem w odpowiednim procesie diagnostyczno-terapeutycznym. Analizując działania militarne ostatnich lat, warto mieć na względzie rozwój oraz inwestowanie w zaplecze neurochirurgiczne wojskowej służby zdrowia.

**Keywords:** neurosurgery; war; traumatic brain injury

**Słowa kluczowe:** neurochirurgia; wojna; pourazowe uszkodzenie mózgu

**DOI** 10.53301/lw/209995

**Received:** 26.08.2025

**Accepted:** 28.08.2025

**Published:** 15.09.2026

**Corresponding author:**
Miłosz Chwiałkowski
Military Institute of Medicine – National Research Institute, Department of Neurosurgery
128 Szaserów St., 04-141 Warsaw
e-mail: milosz.chwialkowski@gmail.com

### Introduction

Armed conflicts pose significant challenges for both military and civilian healthcare systems. Evolving combat methods and novel technologies alter the nature of injuries sustained by those directly involved in military operations. As a specialty involved in trauma care, neurosurgery must adapt to meet these challenges. The head and spine are among the most frequently injured anatomical regions on the battlefield, underscoring the critical role of this medical subspeciality in preserving life and improving outcomes in patients with moderate to severe war-related trauma.

### Discussion

Over the years, numerous treatment protocols have been developed for patients with traumatic brain injury (TBI), spinal cord injury, and peripheral nerve injury. However, in an era of continuous changes and advancements in clinical care, some of these protocols, such as the Guidelines for Field Management of Combat-Related Head Trauma, which was last revised in 2005 (Brain Trauma Foundation), require updating. Military conflicts over the past century have contributed to the development of neurosurgical practice. One example is the technique of surgical debridement of head wounds, which has shifted from a maximal to a minimal approach [1, 2].

Explosions are presently the most common cause of battlefield head injuries, accounting for more than half of all TBIs. In contrast, earlier conflicts, such as the Vietnam War, were characterized by a much higher proportion of gunshot wounds. Currently, gunshot wounds rank second. TBIs remain the leading cause of death on the battlefield [2]. It was already during World War I, when Harvey Cushing, one of the pioneers in global neurosurgery, recommended early treatment of patients with craniocerebral injuries as close to the battlefield as possible, an approach that reduced mortality by half.

In subsequent years, during military operations in Iraq, the concept of damage control neurosurgery emerged, encompassing the management of intracranial haemorrhage, evacuation of intracranial haematomas, and early wound debridement. Considering armed conflicts after 2000, decompressive craniectomy (DC) has been the most commonly employed treatment for patients with head trauma. It is worth noting, however, that this procedure is not indicated in every case. Knowledge of standard, non-invasive approaches for elevated intracranial pressure (including the use of hypertonic saline and mannitol) remains essential [3, 4]. The choice of treatment modality is largely guided by the widely used Glasgow Coma Scale (GCS), with aggressive therapy recommended for patients scoring 4–7. Decisions regarding invasive treatment require surgical personnel to be familiar with appropriate incision techniques, such as a trauma flap, Kempe incision, or Souttar incision, to preserve tissue integrity, minimize skin complications, and ensure adequate access to the cranial cavity [5]. This is particularly important in complex injuries involving the facial skeleton and skull base, where adequate bony opening, cranialization of the frontal sinuses, and water-tight dural closure are crucial [6]. Postoperative complications may include nervous system infections, epilepsy, and cerebrospinal fluid leakage [7]. It is important to note that nearly one-third of head injury patients may experience concomitant vascular complications. Traumatic intracranial aneurysms can lead to sudden death in the days following head injury; therefore, vascular imaging (e.g. angiography) should be considered in these patients. The devastating impact of war on children is a profound tragedy, as this population is at particularly high risk of death from TBI compared with adults. Clear guidelines for the management of paediatric battlefield-related head trauma are currently lacking. Furthermore, long-term sequelae, including depression, learning difficulties, impaired concentration, and aggression, may have profound developmental consequences [8]. It is worth noting that patients with severe TBI are at risk of coagulopathy requiring blood transfusion [1].

The management of spinal injuries is determined by the presence of neurological deficits. In facilities close to the front line, decompression and control of cerebrospinal fluid leakage are the primary priorities for these patients.

Peripheral nerve injuries, which affect 3–10% of patients with limb injuries depending on the source, represent another important neurosurgical challenge. Appropriate management of battlefield-related peripheral nerve injuries is crucial for ensuring a rapid return to military service and, consequently, maintaining optimal combat capability. The causes of these injuries range from gunshot wounds, backpack palsy, and the use of restraints on prisoners to explosions, which currently represent the most common cause. Peripheral nerve injuries can often be overlooked in patients with multiple organ injuries and concomitant brain damage who present with impaired consciousness. Typically, under wartime conditions, they do not require immediate surgical management, but rather delayed treatment after 2–3 months. Access to adequate diagnostic facilities, including electrophysiological and imaging techniques, is also important [9, 10].

The rapidly growing number of individuals requiring urgent medical attention poses a major challenge to healthcare services, which are often already strained even under peacetime conditions. The destruction of infrastructure and disruption of supply chains further exacerbate this situation. From a neurosurgical perspective, maintaining an adequate supply of equipment and materials, including surgical microscopes, craniotomy instruments, dural substitutes, and haemostatic materials, is essential [5]. Experience from the armed conflict in Ukraine has revealed some fundamental shortcomings, such as interruptions in electricity supply (e.g. preventing the use of surgical microscopes) and difficulties in sterilizing surgical instruments [11]. Doctors are often forced to perform procedures beyond the scope of their speciality [12]. Given that general surgeons account for the vast majority of physicians working under battlefield conditions, greater emphasis should be placed on training in basic neurosurgical procedures for craniocerebral injuries [2, 13]. Many civilian medical facilities may be repurposed into frontline hospitals during armed conflict, which underscores the importance of educating medical personnel and exchanging experience [14].

Another challenge is the growing number of patients requiring long-term therapy, including rehabilitation, necessitating a significant expansion of neurological rehabilitation facilities. From the perspective of comprehensive care for TBI patients, institutions providing access to a full range of services, enabling treatment of complex injuries (maxillofacial surgeon, neurosurgeon), as well as long-term complications related to post-traumatic vascular malformations (interventional radiology department), play a key role [15]. Imaging diagnosis is crucial for making prompt and appropriate therapeutic decisions. Accessibility is by all means the most important aspect. Portable computed tomography (CT) scanners can represent an excellent solution, as they help avoid the need for long-distance transport of the injured, as well as facilitate accurate diagnosis and further treatment in the frontline setting [16].

## Conclusions

Given the high incidence of craniocerebral injuries and the critical importance of early intervention in reducing mortality and improving patients' long-term quality of life, the presence of a neurosurgeon within the medical personnel of the armed forces appears to be essential.

## References

1. Maroufi SF, Sohrabi H, Dabbagh Ohadi MA, et al. Neurosurgery in 21st-century wars in the Middle East: narrative review of literature. World Neurosurg, 2022; 166: 184–190. doi: 10.1016/j.wneu.2022.07.134
2. Asfaw ZK, Greisman JD, Comuniello B, et al. Global neurosurgery advances from trenches to bedside: lessons from neurosurgical care in war, humanitarian assistance, and disaster response. Mil Med, 2024; 189(3–4): e532–e540. doi: 10.1093/milmed/usad170
3. Le TD, Gurney JM, Singh KP, et al. Trends in traumatic brain injury among U.S. Service Members deployed in Iraq and Afghanistan, 2002–2016. Am J Prev Med., 2023; 65(2): 230–238. doi: 10.1016/j.amepre.2023.01.043

4. Durrani S, Nathani KR, Mualem W, et al. The impact of major military war campaigns on neurosurgery: informetric data and time-trend analysis. World Neurosurg, 2022; 168: e240–e252. doi: 10.1016/j.wneu.2022.09.085
5. Splavski B. Personal reflections of a war neurosurgeon. World Neurosurg. 2024; 183: 76–78. doi: 10.1016/j.wneu.2023.12.031
6. Sirko A, Berlin C, Tsang S, et al. Wartime penetrating traumatic brain injury of the anterior skull base involving the paranasal sinuses: a single-center, first-year experience from Dnipro, Ukraine. J Neurosurg, 2024; 142(3): 829–838. doi: 10.3171/2024.6.JNS24852
7. Hanafi I, Munder E, Ahmad S, et al. War-related traumatic brain injuries during the Syrian armed conflict in Damascus 2014–2017: a cohort study and a literature review. BMC Emerg Med., 2023; 23(1): 35. doi: 10.1186/s12873-023-00799-6
8. Aguirre AS, Rojas K, Torres AR. Pediatric traumatic brain injuries in war zones: a systematic literature review. Front Neurol, 2023; 14: 1253515. doi: 10.3389/fneur.2023.1253515
9. Seddighi A, Nikouei A, Seddighi AS, et al. Peripheral nerve injury: a review article. International Clinical Neuroscience Journal, 2016; 3(1): 1–6. doi: 10.22037/icnj.v3i1.12016
10. Howard IM, Sedarsky K, Gallagher M, et al. Combat-related peripheral nerve injuries. Muscle Nerve, 2025; 71(5): 768–781. doi: 10.1002/mus.28168
11. Okon II, Rehman IU, Amir MA, et al. Addressing neurosurgical challenges in war conflict countries. Neurosurg Rev. 2024; 47(1): 390. doi: 10.1007/s10143-024-02655-y
12. Dubinski D, Kolesnyk V. War in Ukraine: a neurosurgical perspective. Acta Neurochir (Wien), 2022; 164(12): 3071–3074. doi: 10.1007/s00701-022-05388-3
13. Sirko A, Valadka AB, Yadav G, et al. Neurokirurgisk behandling av stridsrelaterade hjärnskador [Neurosurgical management of combat-related penetrating traumatic brain injury – lessons from 10 years of war in Ukraine]. Lakartidningen, 2025; 122: 24113. Swedish
14. Loskutov OA, Pylypenko MM. The courage of Ukrainian hospitals and Intensive Care Units in the first months of the Russia-Ukraine war. Intensive Care Med, 2022; 48(6): 790–792. doi: 10.1007/s00134-022-06694-1
15. Sirko A, Cherednychenko Y, Dowlati E, et al. Early multimodal neurointerventional and neurosurgical management of penetrating craniocerebral injuries: wartime experience from Ukraine. J Neurosurg, 2025; 143(2): 431–442. doi: 10.3171/2024.10.JNS241938
16. Illemann NM, Illemann TM. Mobile imaging trailers: A scoping review of CT and MRI modalities. Radiography (Lond), 2024; 30(2): 431–439. doi: 10.1016/j.radi.2023.12.008