

2026 Military Health System
Research Symposium
(MHSRS)

Session: Managing
the Golden Hour &
Beyond: Innovative
TBI Care in
Contested Combat
Environments

Acute Traumatic Subdural Hematoma in Penetrating Brain Injury During Modern Warfare **Lessons for Combat Neurosurgery**

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Andrii Sirko, MD, PhD, DSc (Med)

Rocco Armonda, MD, Col(ret)

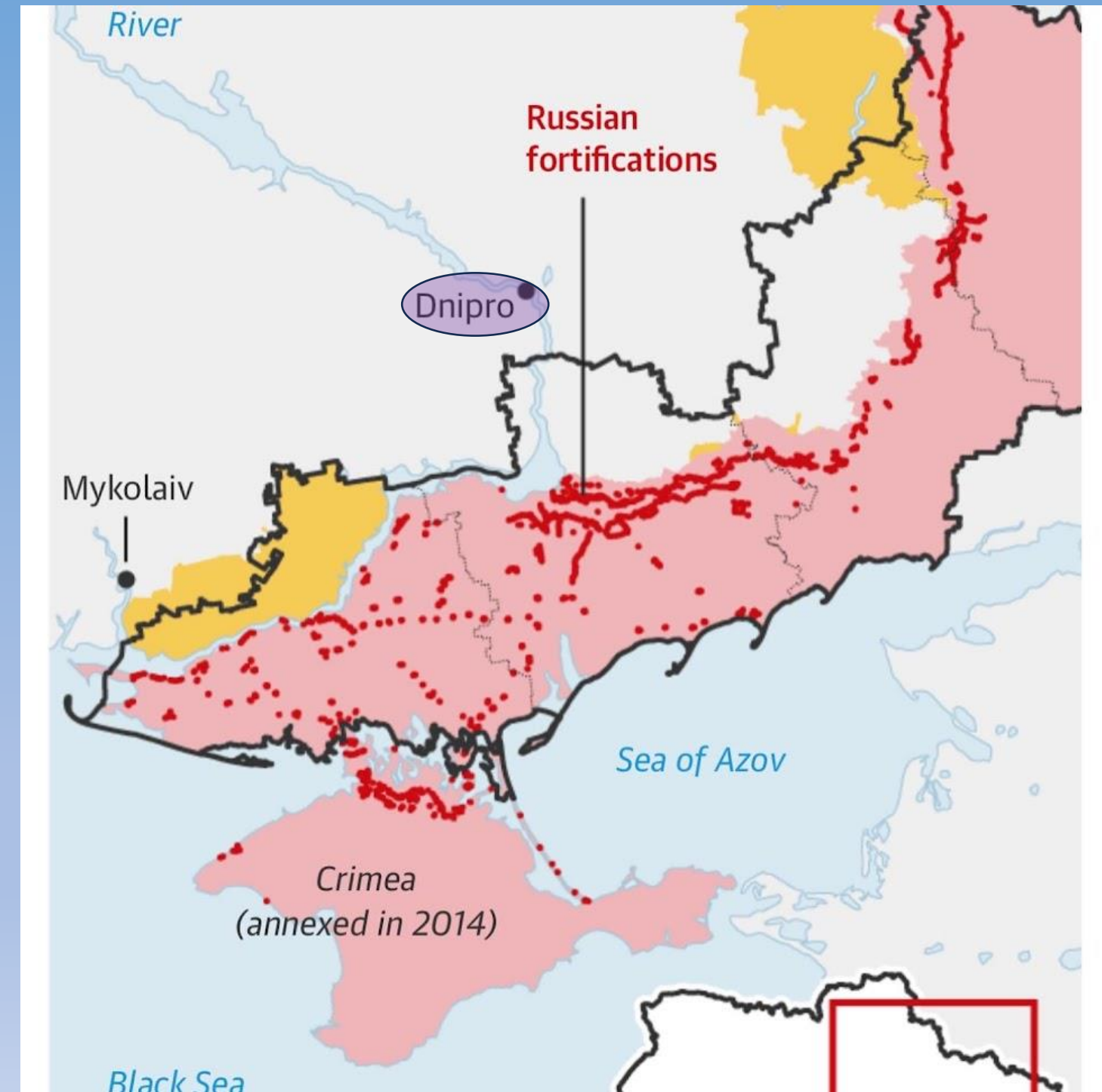


Non-Disclosure

**Alex Valadka, MD,
Andrii Sirko, MD, PhD,
and Rocco Armonda, MD
have no conflicts to
report.**



Red squares: enemy positions at the front line
Distance from Dnipro to the front is less than 100 km



- Since February 2022: approximately 1050 wounded civilians and soldiers per month
- Every day: average of 3 operations for penetrating TBI (range 1-8)



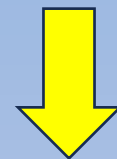
Battlefield, advance surgical group, stabilization point



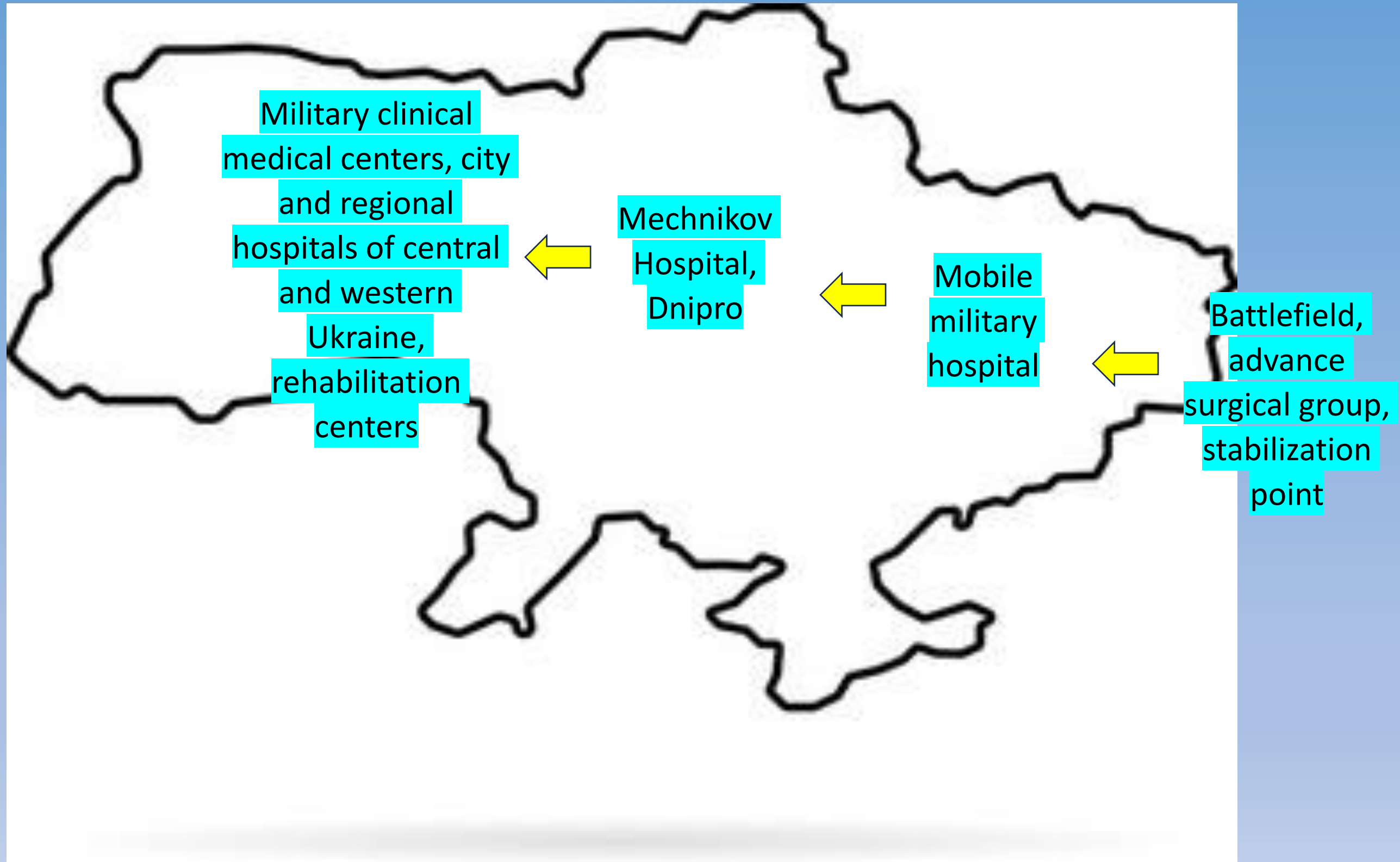
Mobile military hospital



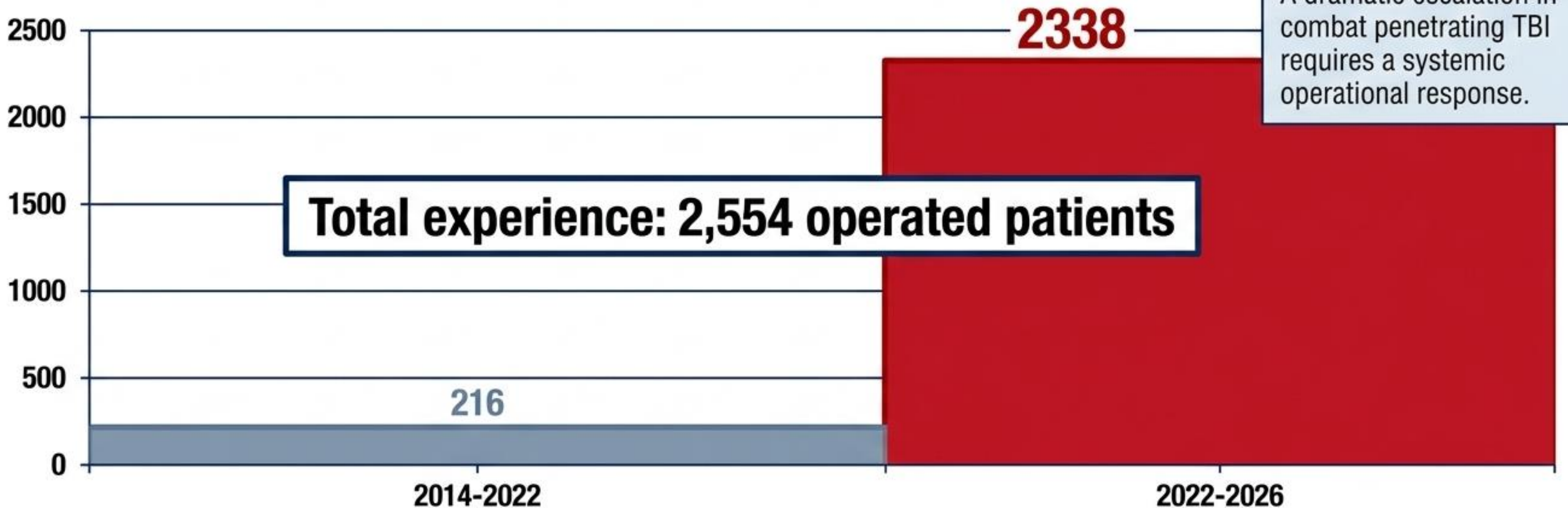
Mechnikov Hospital, Dnipro



Military medical centers, city and regional hospitals of central and western Ukraine, rehabilitation centers



Single Frontline Medical Center: Penetrating TBI Volume



Dossier Note:

A dramatic escalation in combat penetrating TBI requires a systemic operational response.

Peer-Reviewed Academic Validation:

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CLINICAL ARTICLE

Surgical Treatment of Penetrating Wounds After Resuscitation study: a new classification system for penetrating injuries to the posterior fossa

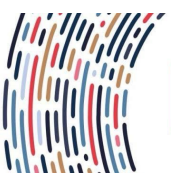
Andrii Sirko, MD, PhD,¹ Jeffrey I. Traylor, MD,² William H. Hicks, BS,² Ghazal Yadav, BS,³ Rocco A. Armonda, MD,⁴ and Alex B. Valadka, MD²

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Journal of
Neurotrauma

The Ukraine War: Traumatic Brain Injury in a Front-Line Hospital

Andrii Sirko,¹ Rocco A. Armonda,² David L. Brody,³ and Alex B. Valadka^{4,*}



Forward Operations: Mobile Field Hospitals (2022-2025)

543
Operated Patients

Intracerebral
Hemorrhage
(38%)

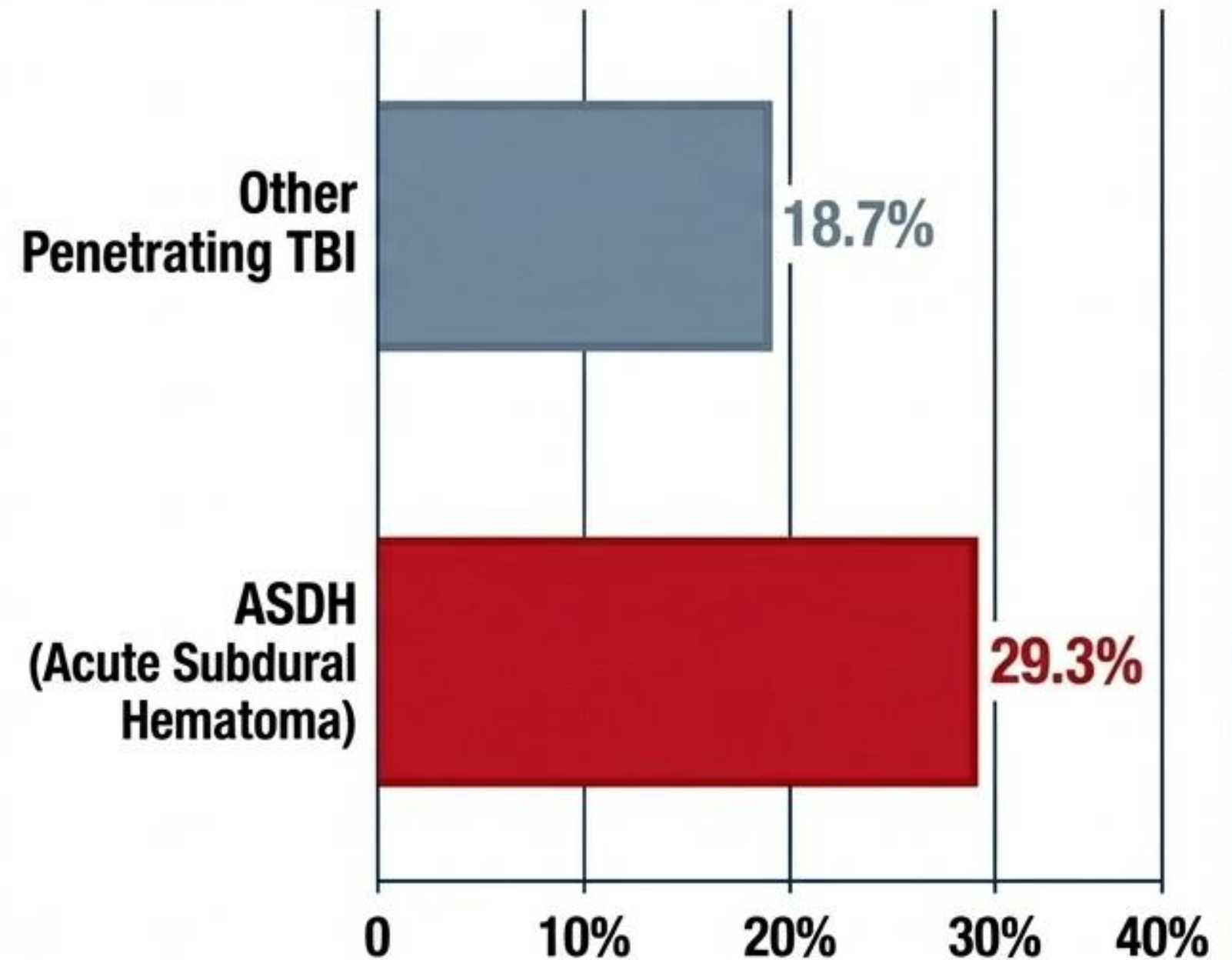
Subdural
Hematoma
(33%)

Penetrating
transventricular
(11%)

Evacuation Rate:
76.6%

Overall Mortality:
22.4%

Postoperative Mortality by Injury Type



ASDH independently increases the odds of death in combat pTBI (OR 1.80; p=0.025).

Paradigm Shift: Civilian vs. Combat ASDH

CIVILIAN

- ✓ Isolated ASDH
- ✓ **Predictable** system
- ✓ **Immediate CT**
- ✓ **Early surgery**
- ✓ **Standard pathways**

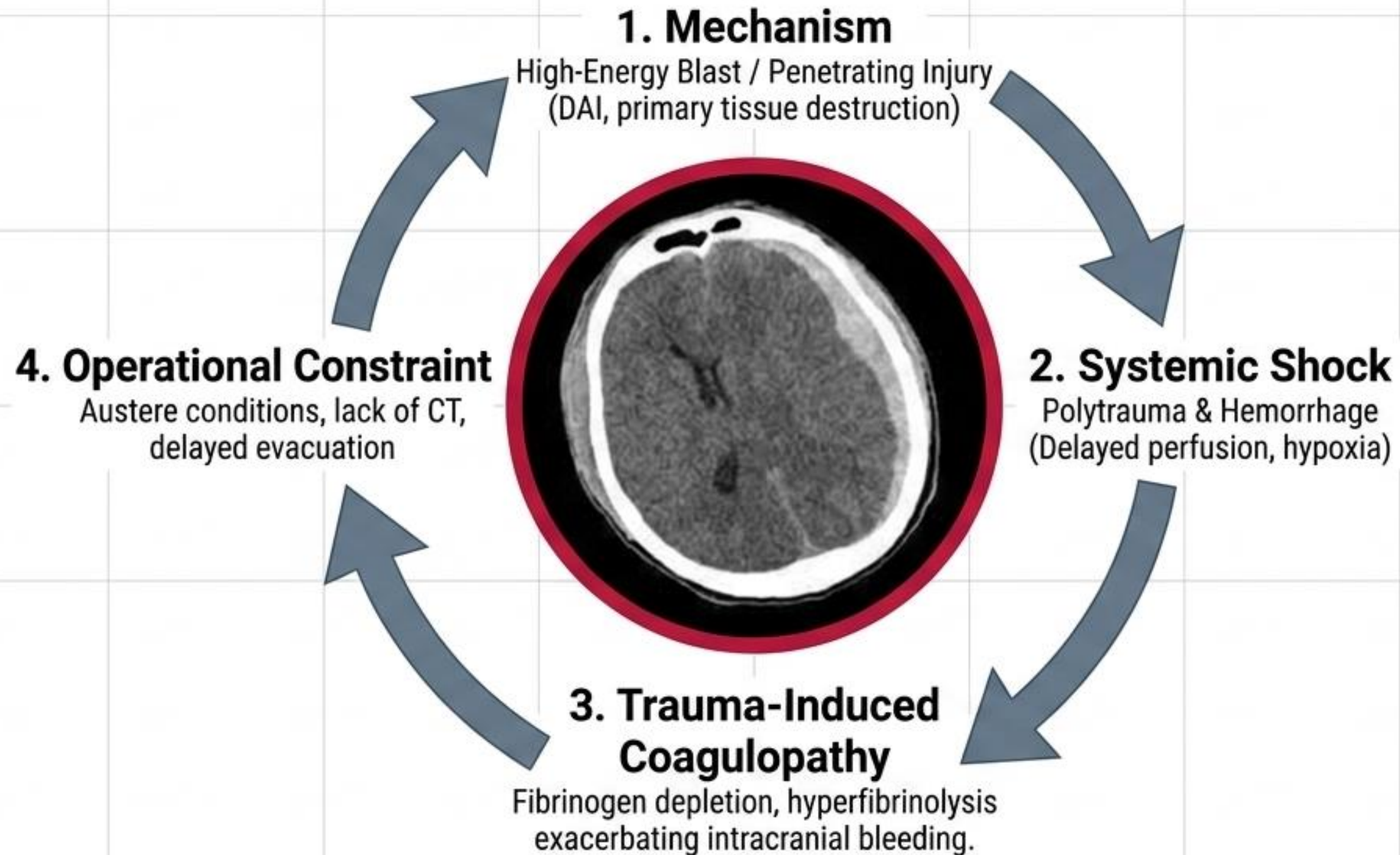
COMBAT

- ⚠ High-energy, **complex** injuries
 - Polytrauma
 - Diffuse Axonal Injury (DAI)
 - Coagulopathy
- ⚠ Austere conditions
- ⚠ Delayed evacuation
- ⚠ Limited CT access
- ⚠ Overwhelmed surgical capacity

↑ ICP → ↓ Cerebral perfusion → Brain death.
Outcome is driven by context, not just the hematoma.



The Vicious Cycle of Combat TBI



Combat ASDH is rarely an isolated clot—it is a systemic cascade demanding simultaneous clinical and logistical intervention.

TIME TO SURGERY DELAY

**The first 100 cases of acute subdural hematoma
from the first year of the full-scale war**

6.5 h

Mean time

6 h

Median

< 40%

Within 5.3 h

Most patients miss the optimal surgical window



The Logistical Constraint: Fighting the Clock



Less than 40% of combat TBI patients reach definitive surgery within the 5.3-hour window.

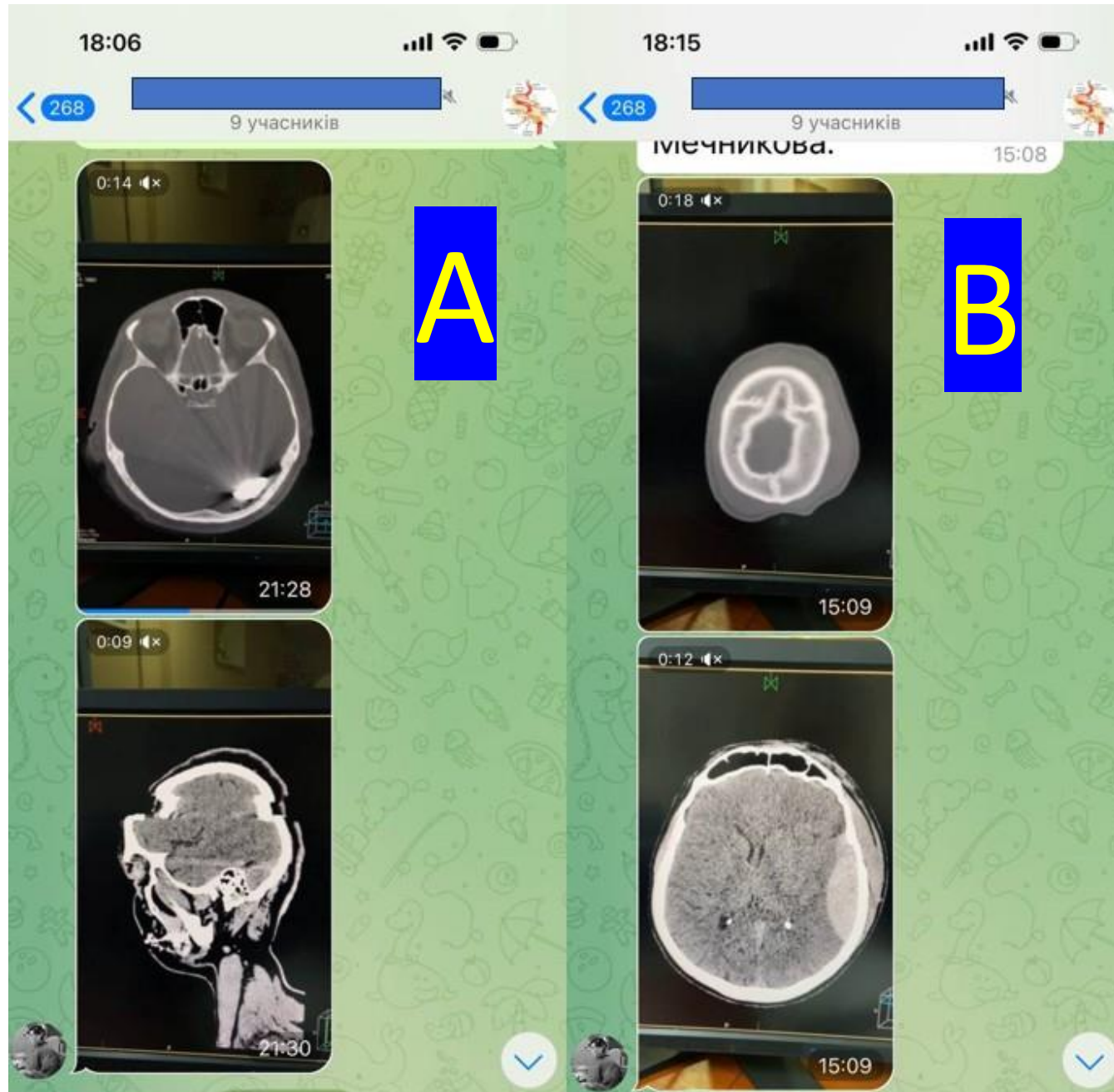


Shackelford et al, Neurosurgery Focus, Dec 2018

TAKEAWAY: Most patients miss the optimal surgical window entirely due to overwhelming pre-hospital and evacuation delays.

Telemedicine in action

- **A 24-hour telemedical consultation system was established** in which military neurosurgeons use closed (protected) groups in **WhatsApp and Telegram** to transmit videos of CT scans to neurosurgeons at MDRCH in order to expedite therapeutic decision-making.
- **9** participants, We have **1 212** photos and **2 136** videos in the database.



- **The patient on the left (A)** has a penetrating wound to the posterior fossa. It was decided to transport the patient immediately to MDRCH for **invasive angiography** and comprehensive neurosurgical debridement and reconstruction.
- **On the right (B)**, a patient with a large combat-related acute epidural hematoma underwent immediate craniotomy at the mobile hospital prior to transfer to MDCRH.

Systemic Interventions: Modifiable vs. Non-Modifiable Factors

Mortality reflects the interaction of unavoidable injury severity with modifiable organizational timing.

	NON-MODIFIABLE (The Given Reality)		MODIFIABLE (The Zone of Action)	
	• High-energy mechanisms • Extensive primary brain destruction • Diffuse Axonal Injury (DAI) • Subarachnoid/Intraventricular hemorrhage  Severe Tissue Destruction Massive Hemorrhage		• Correction of pre-hospital hypoxia/hypotension • Aggressive reversal of Trauma-Induced Coagulopathy • Time to CT / Neurosurgical decompression • Early wound debridement • Mass-casualty system routing	

THE DIAGNOSTIC BRIDGE: NON-INVASIVE TECHNOLOGY AS AN OPERATIONAL MULTIPLIER

FORWARD
AUSTERE
ENVIRONMENT

**BOTTLENECK:
LACK OF CT SCANNER**

GUIDED
LIFE-SAVING
SURGERY

Infrascanner + Quantitative
Pupillometry



BRIDGING THE DIAGNOSTIC GAP: Deploying non-invasive ICP and hematoma detection to guide life-saving forward neurosurgery when traditional imaging is impossible.



Infrascanner + Pupillometry



NOTE: Non-invasive measures of intracranial injury are an emerging technologies that may be utilized to improve localization of injury or superficial hematoma.

Non-invasive Measurement Resources

1. Quantitative pupillometry: This is a small hand-held device that initiates a miotic pupillary response, records the speed of the response, and supplies a normative pupillary index (NPI).^{1,2}
 - As intracranial pressure increases, the NPI decreases.
 - Asymmetric injury can result in asymmetric NPI and can aide with determining the hemisphere injured.
2. Near—infrared spectroscopy and ultrasound measurement of optic nerve sheath diameter are other technologies with ongoing investigations to determine efficacy for diagnosing intracranial hypertension or hemorrhage.³



TIME IS BRAIN BUT ONLY IF YOU CAN **ACT.**

Forward neurosurgical care in combat reduces mortality in severe penetrating TBI and ASDH.

Lessons from Ukraine — Real-world evidence from 2,554 cases of modern combat neurosurgery.

JOINT TRAUMA SYSTEM CLINICAL PRACTICE GUIDELINE (JTS CPG)



Emergency Life-Saving Cranial Procedures by Non-Neurosurgeons in Deployed Setting

This CPG applies to military non-neurosurgeons in a forward deployed location with surgical capability (Role 2 surgical teams that meet capability requirements) outside of the United States. Based on the Committee on Surgical Combat Casualty Care Position Statement: [Neurosurgical Capability for Deployed Operations](#).

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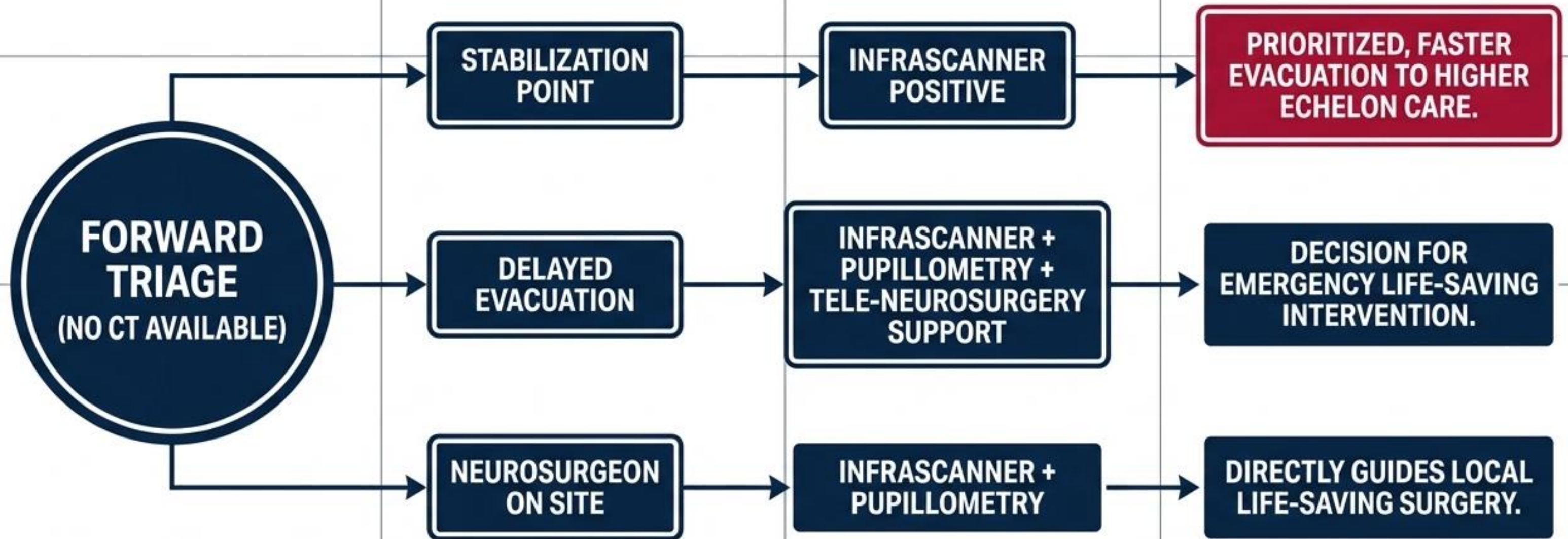
Publication Date: 10 June 2025

Supersedes: 23 Apr 2018

SUMMARY OF CHANGES

1. Updated literature reference list to reflect current evidence for the following:
 - Superior patient outcomes when neurosurgeons are directly deployed to combat area of responsibility.
 - Committee of Surgical Combat Casualty Care position statement reinforcing optimal patient management requires the deployed neurosurgeon for management of severe Traumatic Brain Injury (TBI).
 - Superior patient outcomes with ultra-early surgical intervention for severe TBI.
2. Added two new 'synchronous' neurosurgical support tele-capabilities, including Advanced Virtual Support for Operational Forces and Navy Medicine Readiness and Training Command San Diego on-call neurosurgeon.
3. Provided a streamlined algorithm for clinical indications supporting cranial surgical intervention.
4. Provided clarifying radiographic information and CPG reference ([Catastrophic Non-Survivable Brain Injury](#)) for when NOT to perform a cranial procedure.
5. Expanded procedural check-list for both penetrating and non-penetrating cranial injury.

THE FORWARD NEUROSURGICAL ACTION ALGORITHM



**THE TAKEAWAY: INFRASCANNER
ENABLES ACTION WHERE CT IS ABSENT.**

Study and analysis of your own treatment results

Our Ukraine/US Penetrating TBI Research Team (main investigators)



Prof. Andrii Sirko, MD., PhD
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Our publications on pTBI in leading world journals



Reeltime Surgery



BJS, 2025, znae324

<https://doi.org/10.1093/bjs/znae324>

Reeltime Surgery

Penetrating traumatic brain injury: a video case presentation

Jeffrey M. Breton^{1,*}, Stefan T. Prvulovic², Rocco A. Armonda¹, Yuri Cherednychenko³ and Andrii Sirko⁴

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CLINICAL ARTICLE

Surgical Treatment of Penetrating Wounds After Resuscitation study: a new classification system for penetrating injuries to the posterior fossa

Andrii Sirko, MD, PhD,¹ Jeffrey I. Traylor, MD,² William H. Hicks, BS,² Ghazal Yadav, BS,³ Rocco A. Armonda, MD,⁴ and Alex B. Valadka, MD²

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CLINICAL ARTICLE

Early multimodal neurointerventional and neurosurgical management of penetrating craniocerebral injuries: wartime experience from Ukraine

Andrii Sirko, MD, PhD,¹ Yuri Cherednychenko, MD,² Ehsan Dowlati, MD,^{3,4} and Rocco A. Armonda, MD³

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CLINICAL ARTICLE

Wartime penetrating traumatic brain injury of the anterior skull base involving the paranasal sinuses: a single-center, first-year experience from Dnipro, Ukraine

Andrii Sirko, MD, PhD,¹ Connor Berlin, MD,² Siny Tsang, PhD,³ Bhiken I. Naik, MBCh, MSCR,³ and Rocco Armonda, MD⁴

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CLINICAL ARTICLE

Wartime penetrating sellar/parasellar injuries: a novel classification and management based on trajectory

Andrii Sirko, MD, PhD,¹ Vadym Perepelytsia, PhD,² Ehsan Dowlati, MD,^{3,4} and Rocco Armonda, MD^{4,5}

MILITARY MEDICINE, 00, 0/0:1, 2020

Mortality and Functional Outcome Predictors in Combat-Related Penetrating Brain Injury Treatment in a Specialty Civilian Medical Facility

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The Ukraine War: Traumatic Brain Injury in a Front-Line Hospital

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Contents lists available at ScienceDirect

Trauma Case Reports

journal homepage: www.elsevier.com/locate/tcr



Case Report

Successful surgical treatment of a patient with combined gunshot shrapnel injuries in the heart and brain complicated by middle cerebral artery pseudoaneurysm



biomimetics



Article

Early Challenges in the Implementation of Automated CranialRebuild Freeware for Generation of Patient-Specific Cranial Implant Using Additive Manufacturing: A Pilot Project in Review

Oleksandr Strelko¹, Manish Raj Aryal², Abigail Zack³, Yara Alfawares³, Roland Remenyi⁴, Ian Kristopher Bayan⁵, Yumi L. Briones⁴, Yaroslav Holovenko⁶, Maksym Maksymenko⁶, Andrii Sirko⁷, Sam Anand² and Jonathan A. Forbes^{8,*}

JOURNAL OF NEUROSURGERY: Case Lessons

J Neurosurg Case Lessons 9(13): CASE24875, 2025
DOI: 10.3171/CASE24875

Microscopic endonasal transsphenoidal approach for repair of sellar defect from penetrating trauma during wartime: illustrative case

Andrii Sirko, MD, PhD,¹ Isabelle Pelcher, BA,² Ehsan Dowlati, MD,^{3,3} Rostislav Maliy, MD,¹ and Rocco A. Armonda, MD^{3,4}

JOURNAL OF NEUROSURGERY: Case Lessons

J Neurosurg Case Lessons 10(22): CASE25577, 2025
DOI: 10.3171/CASE25577

Operative management of a nail wound projectile to the skull base with unusual trajectory: illustrative case

Andrii Sirko, MD, PhD,¹ Sebastian Leon, MS,² Mykyta Hulidin, MD,¹ Bohdan Sirko, MD,¹ Ehsan Dowlati, MD,^{3,4} and Rocco A. Armonda, MD^{3,4}

JOURNAL OF NEUROSURGERY: Case Lessons

J Neurosurg Case Lessons 8(2): CASE24128, 2024
DOI: 10.3171/CASE24128

Wartime penetrating skull base trauma with unpredictable internal fragment ricochet and migration: illustrative case

Andrii Sirko, MD,¹ Alex Valadka, MD,² Rocco Armonda, MD,³ Anthony J. Dragun, BS,² and Yuri Cherednychenko, MD⁴

JOURNAL OF NEUROSURGERY: Case Lessons

J Neurosurg Case Lessons 11(1): CASE25563, 2026
DOI: 10.3171/CASE25563

Posterior fossa penetrating traumatic brain injury from military blast: illustrative case

Jeffrey M. Breton, MD,¹ Stefan T. Prvulovic, BS,² Cameron J. Sabet, MS, MBA, MA,² Bohdan Sirko, MD,³ Rostyslav Maliy, MD,³ Vadym Perepelytsia, MD, PhD,¹ Rocco A. Armonda, MD,¹ and Andrii Sirko, MD, PhD¹

Thank you

dreamstime