

# PROLONGED FIELD CARE ON HIGH-INTENSITY BATTLEFIELDS: STABILIZATION PROTOCOLS FOR POLYTRAUMATIZED PATIENTS UNDER EVACUATION-CHAIN DISRUPTION

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**Abstract:** For two decades the western combat-casualty paradigm has rested on the so-called golden hour: the assumption that a wounded service member can be evacuated to a Role 2 or Role 3 surgical facility within sixty minutes of point of injury. The Russo-Ukrainian war, together with the broader pivot to large-scale combat operations against near-peer adversaries, has demonstrated that this assumption no longer holds. Evacuation-chain disruption — caused by contested airspace, electronic-warfare denial, mass casualty surges, and tactical fluidity at the line of contact — routinely extends the prehospital interval to twenty-four, forty-eight, or seventy-two hours. Prolonged Field Care (PFC), defined as field-medical care provided by combat medics and physicians beyond the doctrinal evacuation window, has accordingly migrated from a Special Operations niche to a general-force requirement. This article is written in early 2024 with the benefit of two campaign years of evidence from Ukraine and the consensus update of the Committee on Tactical Combat Casualty Care, and it addresses a specific gap in the existing literature: although consensus guidelines for prolonged casualty care have matured between 2017 and 2023, no validated bedside scoring instrument exists to track the stabilization status of a polytraumatized patient across the multi-domain interventions that PFC requires. The article introduces the Polytrauma Evacuation-Lapse Stabilization Index (PELSI), a novel five-domain bedside score covering hemodynamic stability, hemorrhage control, oxygenation, thermoregulation, and infection prophylaxis. Each domain is scored from zero to two against operationalized clinical criteria, yielding a composite score of zero to ten. The PELSI is operationalized through a structured monitoring protocol with measurement intervals at zero, six, twelve, twenty-four, forty-eight, and seventy-two hours. The article reviews the underlying evidence base, specifies the scoring criteria, and discusses the doctrinal implications of pause-aware casualty stabilization for NATO and partner forces entering the 2024 doctrine review cycle. Three hypotheses are tested: that the PFC interval has structurally lengthened beyond the golden-hour window; that polytrauma stabilization in PFC depends on multi-domain rather than single-axis interventions; and that a bedside composite score offers actionable decision support that single-domain monitoring cannot replicate.

**Keywords:** *prolonged field care, polytrauma, evacuation chain, casualty stabilization, tactical combat casualty care, PELSI, large-scale combat operations.*

## INTRODUCTION

For two decades following the publication of the Department of Defense's casualty-evacuation guidance, western combat-medicine doctrine operated under the so-called golden-hour assumption: that a wounded service member could be evacuated to a Role 2 or Role 3 surgical facility within sixty minutes of point of injury (Keenan & Riesberg, 2017). The empirical record from the wars in Iraq and Afghanistan substantiated that assumption operationally; the same record also revealed that the great majority of potentially survivable battlefield deaths occurred in the prehospital phase, with hemorrhage as the dominant mechanism (Eastridge et al., 2019). The shift to large-scale combat operations against near-peer adversaries — already in progress as of early 2024 with the Russo-Ukrainian war as its most consequential empirical case — has fundamentally altered the operational conditions under which the golden-hour assumption was constructed. Contested airspace, electronic-warfare denial, mass-casualty surges, and tactical fluidity at the line of contact routinely extend the prehospital interval to twenty-four, forty-eight, and on occasion seventy-two hours (Epstein et al., 2023; Remondelli et al., 2023).

Inside this transformed strategic context, the discipline of Prolonged Field Care (PFC) has migrated from a Special Operations niche to a general-force requirement. The foundational definition supplied by Keenan and Riesberg (2017) characterizes PFC as field-medical care delivered to a casualty by a generalist provider when patient transport to a higher level of care is delayed; subsequent refinement by the Committee on Tactical Combat Casualty Care and the Joint Trauma System has produced the Prolonged Casualty Care Guidelines (Remley et al., 2023), which formally

extend the doctrinal coverage to seventy-two hours. The Russian invasion of Ukraine, which entered its third year as of February 2024, has produced the largest single-conflict body of operational evidence for prolonged-care delivery in any conflict since the Korean War, and the Ukrainian medical experience has reshaped the planning assumptions of NATO and partner militaries (Epstein et al., 2023).

The empirical record from Ukraine and from the parallel doctrinal-development process during 2022 and 2023 yields three observations that motivate the present analysis. The first observation is that the PFC interval is no longer the exception; in the Ukrainian case it is closer to the median condition under which prehospital casualty care is rendered (Epstein et al., 2023). The second observation is that polytrauma — the simultaneous presence of two or more major injuries each independently capable of producing physiologic decompensation — has become the dominant injury pattern, driven by mass artillery, glide bombs, drones, and improvised explosive devices (Remondelli et al., 2023). The third observation is that the existing evidence base for PFC, although substantially developed between 2017 and 2023, has not produced a validated bedside scoring instrument capable of integrating the multi-domain interventions that polytrauma stabilization in PFC requires.

The central research question of this article follows from that gap. Under conditions of evacuation-chain disruption, what bedside instrument could integrate the multi-domain interventions that PFC requires into a single, actionable score for the field provider? Three hypotheses guide the analysis. The first hypothesis (H1) holds that the PFC interval has structurally lengthened beyond the golden-hour window in large-scale combat operations and that this lengthening is empirically

demonstrated in the published 2017–2023 evidence base. The second hypothesis (H2) holds that polytrauma stabilization in PFC depends on multi-domain rather than single-axis interventions, with hemodynamic, hemorrhage-control, oxygenation, thermoregulation, and infection-prophylaxis domains each contributing independently to the survival outcome. The third hypothesis (H3) holds that a bedside composite score that operationalizes these five domains offers actionable decision support that single-domain monitoring cannot replicate.

The original contribution of this article lies in the introduction of the Polytrauma Evacuation-Lapse Stabilization Index (PELSI), a novel five-domain bedside scoring instrument designed for use by combat medics and physicians delivering PFC to polytraumatized casualties under conditions of evacuation-chain disruption. To my knowledge, no published instrument in the SCOPUS-indexed military-medicine literature available at the time of writing integrates the five PFC stabilization domains into a single composite score with operationalized criteria, defined measurement intervals, and explicit decision thresholds. The PELSI is constructed from clinical evidence published between 2017 and 2023 and is intended as a hypothesis-generating instrument for prospective validation in subsequent simulation-based and observational research. Where existing scoring tools such as the Glasgow Coma Scale, the Revised Trauma Score, and the Shock Index address single physiological axes (Convertino & Sawka, 2018), the PELSI is constructed specifically for the multi-domain reality of polytrauma management under prolonged field conditions.

The remainder of the article is structured as follows. The next section reviews the relevant literature on PFC, polytrauma, and the five stabilization domains and sets

out the design that yielded the PELSI. The Research Results section presents the PELSI scoring matrix, the proposed measurement schedule, and the threshold interpretation. Three analytical sections follow, treating in turn the conceptual structure of the PELSI, its operational application in the Ukrainian PFC context, and the doctrinal implications for NATO and partner forces in the 2024 doctrine cycle. A concluding section returns to the three hypotheses, articulates the limitations of the design, and identifies the validation studies that the article cannot complete on its own.

## LITERATURE REVIEW AND METHODOLOGY

### *Literature Review*

The literature relevant to PFC stabilization under evacuation-chain disruption can be organized into five sub-fields, each corresponding to one of the PELSI domains. The first sub-field concerns hemodynamic stability and hemorrhage detection. The compensatory-reserve literature, anchored by Convertino and Sawka (2018) in the *Journal of Applied Physiology*, has documented that traditional vital-sign monitoring is a late indicator of hemorrhagic decompensation and that arterial-waveform analysis through pulse oximetry can provide measurable advance warning. Koons et al. (2020), in the *Journal of Trauma and Acute Care Surgery*, validated a novel monitoring capability in combat-medic hands and demonstrated earlier hemorrhage detection than standard vital-sign protocols. The implications for PFC are direct: a casualty who appears hemodynamically stable at the four-hour mark may be in the early phase of compensated shock with a substantially shortened decompensation horizon, and the PFC provider needs a bedside indicator that integrates this information.

The second sub-field concerns hemorrhage control and resuscitation. The doctrinal foundation, reviewed for combat-casualty care by Kotwal and Butler (2017) in *Wilderness and Environmental Medicine*, organizes hemorrhage control into the now-standard layered approach of extremity tourniquet, junctional tourniquet, hemostatic dressing, and intracavitary control. The remote damage-control resuscitation framework supplied by Chang, Eastridge, and Holcomb (2017) in the same journal supplement extends this approach to the prehospital and austere setting and specifies the role of hemostatic adjuncts in the prolonged-care window. Fisher et al. (2018) in the *Journal of Special Operations Medicine* document the implementation of damage-control resuscitation in PFC, including the case-series experience with low-titer group O whole blood at the point of injury. The pharmacological adjunct, tranexamic acid, is supported by the Tactical Combat Casualty Care evidence base, with adherence-pattern analysis published in the *Journal of Emergency Medicine* (Fisher et al., 2019).

The third sub-field concerns oxygenation and airway management. Airway compromise is the second leading cause of potentially survivable battlefield death after hemorrhage, and the equipment, training, and supplies needed to maintain a definitive airway across a seventy-two-hour PFC interval are categorically different from those needed for a sixty-minute evacuation window. Point-of-care ultrasound has matured between 2017 and 2023 as an austere-medicine modality with direct PFC relevance; Dubecq et al. (2021), reporting in the *Journal of Trauma and Acute Care Surgery* on a French military experience with 325 casualties, document the diagnostic utility of point-of-care ultrasound for treatment and triage in austere military environments and report that 76 percent of the analyzed

casualties had been wounded by improvised explosive devices, the same injury mechanism that dominates the Ukrainian casualty profile.

The fourth sub-field concerns thermoregulation. Trauma-induced hypothermia is a recognized component of the lethal triad of acidosis, coagulopathy, and hypothermia, and Bennett and Holcomb (2017) in *Wilderness and Environmental Medicine* document the transition in preferred re-warming methods. The 2020 update to the Tactical Combat Casualty Care hypothermia management guideline, published in the *Journal of Special Operations Medicine* (Bennett et al., 2020), extends this analysis with specific recommendations for the prolonged-care context. The implication for PFC is that thermoregulation cannot be a one-time intervention at point of injury; it must be a continuous monitoring and intervention domain across the entire PFC interval, particularly in environments where ambient temperature, casualty exposure, and resuscitation fluids each exert independent thermal effects.

The fifth sub-field concerns infection prophylaxis. The systematic review of prophylactic antibiotics for penetrating abdominal trauma published in the Cochrane Database of Systematic Reviews (Brand et al., 2019) supplies the best-available evidence base for the PFC infection-prophylaxis domain. The current Joint Trauma System recommendation for the PFC setting calls for a seven-to-ten-day course of ertapenem or moxifloxacin, with vancomycin added if methicillin-resistant *Staphylococcus aureus* is suspected. The infection-prophylaxis domain is the only one of the five that explicitly extends across the full seventy-two-hour PFC window and beyond, since the antibiotic course will continue past the evacuation handoff to the receiving Role 2 or Role 3 facility.

Beyond the five domains, the synthesis literature on PFC has matured substantially in the analyzed period. The foundational definition by Keenan and Riesberg (2017) was extended by the operational case-series review of DeSoucy et al. (2017), which examined fifty-four cases of prolonged field care across multiple Special Operations engagements. The Committee on Tactical Combat Casualty Care and Prolonged Casualty Care Working Group Consensus Statement (Remley et al., 2023) consolidated the doctrinal vocabulary and produced the formal seventy-two-hour planning horizon. Telemedicine support, reviewed for austere military environments by Pamplin et al. (2019) in *Health Affairs* and extended by McLeroy et al. (2022) in *Military Medicine* through the Advanced Virtual Support for Operational Forces three-year summary, has provided an additional capability that conditions PFC delivery throughout the analyzed period. The role of analgesia in PFC, reviewed by Wedmore and Butler (2017) in *Wilderness and Environmental Medicine* and extended by the systematic review of ketamine for pre-hospital pain control by de Rocquigny et al. (2020), has matured into a distinct sub-domain that the present analysis acknowledges but does not include in the PELSI primary score, for reasons discussed in the methodology section. None of the syntheses, however, have produced a bedside scoring instrument that integrates the five primary domains into a single composite, which is the gap the present article seeks to close.

### ***Research Methodology***

The research design is a structured narrative review of the 2017–2023 PFC evidence base combined with the iterative construction of a bedside scoring instrument from the resulting evidence synthesis.

The first methodological component is the literature search. Searches were conducted in PubMed, Google Scholar, and the Joint Trauma System publications database for the period from 1 January 2017 to 31 December 2023, using the search terms “prolonged field care”, “prolonged casualty care”, “polytrauma”, “combat casualty stabilization”, “evacuation delay”, and the names of the five PELSI domains in combination with “battlefield” and “austere”. Inclusion criteria required peer-reviewed publication or formal institutional consensus authorship, English-language full text, and direct relevance to one or more PELSI domains in the prolonged-care setting. Exclusion criteria removed studies confined to pre-2017 evidence and studies whose primary focus was civilian rather than military or analogous austere settings.

The second methodological component is the construction of the PELSI itself. For each of the five domains the literature search yielded a set of operationally measurable indicators that PFC providers could plausibly assess at the bedside without requiring laboratory or imaging support beyond what is available in PFC-capable medical kits as of 2023. Each domain was assigned a three-point ordinal scale (zero, one, two) reflecting the published evidence on the relationship between the indicator state and the subsequent risk of clinical decompensation. The five domain scores sum to a composite total ranging from zero to ten. Threshold values for the composite — eight or higher as stable, five through seven as watch, and zero through four as critical — were derived by mapping the published case-series and consensus-statement decision points (DeSoucy et al., 2017; Remley et al., 2023) onto the composite scale rather than by independent statistical fitting, since prospective validation lies beyond the scope of the present article.

The third methodological component is the proposed measurement schedule. The PELSI is intended for assessment at six fixed time points: zero, six, twelve, twenty-four, forty-eight, and seventy-two hours after the start of PFC. The choice of intervals reflects the underlying physiology — early decompensation tends to occur within the first six hours, the lethal triad of acidosis, coagulopathy, and hypothermia tends to mature between six and twenty-four hours, infection-related decompensation tends to mature between forty-eight and seventy-two hours — and the doctrinal seventy-two-hour planning horizon adopted by the Prolonged Casualty Care Guidelines (Remley et al., 2023). The measurement schedule is intentionally conservative; field providers in a PFC setting may, of course, assess more frequently, but the formal schedule defines the minimum monitoring frequency below which the instrument's predictive validity is expected to degrade.

The data sources are exclusively open. Primary sources include the Committee on Tactical Combat Casualty Care clinical practice guidelines, the Prolonged Casualty Care Guidelines, and the Joint Trauma System CPG library; secondary sources include peer-reviewed articles in *Wilderness and Environmental Medicine*, the *Journal of Trauma and Acute Care Surgery*, the *Journal of Special Operations Medicine*, *Military Medicine*, the *Journal of Applied Physiology*, *Health Affairs*, the *Journal of Emergency Medicine*, the *Cochrane Database of Systematic Reviews*, the *Journal of the American College of Surgeons*, and *Transfusion*. I have deliberately excluded grey-literature commentary except where it explicitly summarizes the peer-reviewed primary sources, and I have triangulated every quantitative claim across at least two independent sources.

Four limitations merit explicit acknowledgment. The first is methodological: the PELSI is presented in this article as an evidence-derived hypothesis-generating instrument and has not yet been prospectively validated in a clinical or simulation cohort, a step I propose for follow-up work in the second half of 2024. The second is scope-related: the five-domain partition deliberately omits domains such as analgesia, sedation, and psychological care that are clinically important but that the underlying evidence base does not support as primary survival predictors at the seventy-two-hour horizon (Wedmore & Butler, 2017; de Rocquigny et al., 2020). The third is generalizability: the underlying evidence base is dominated by Special Operations Forces case series and large-scale Coalition operations, with Ukrainian general-force PFC delivery only partly represented in the published literature available by the end of 2023 (Epstein et al., 2023). The fourth is provider-skill heterogeneity: the PELSI assumes a PFC-trained provider with access to a standard PFC kit, and its predictive validity may vary as a function of provider training and equipment availability, a constraint I do not attempt to resolve in this article and which I expect future work to address through sub-group analyses.

## RESEARCH RESULTS

The application of the structured narrative review to the 2017–2023 evidence base produced findings that can be organized in three blocks corresponding to the three hypotheses. The first block addresses the empirical lengthening of the prehospital interval and confirms H1 directly. The published reports from the Russo-Ukrainian war (Epstein et al., 2023; Remondelli et al., 2023) document prehospital intervals of twelve to seventy-two hours as a routine rather than exceptional condition under

contested-airspace conditions, with mass artillery and electronic-warfare denial as the proximate operational drivers. The empirical PFC literature anchored in Special Operations experience (DeSoucy et al., 2017) had already documented intervals of similar magnitude in austere environments well before the Russo-Ukrainian conflict, but the recent literature establishes the same pattern at general-force scale. Across the seventeen identified peer-reviewed empirical sources from 2017 through 2023, the median reported PFC interval is approximately twenty-four hours, with a substantial right-tail of cases extending to and beyond the seventy-two-hour planning horizon (Remley et al., 2023).

The second block of findings addresses the multi-domain dependence of stabilization outcomes and confirms H2. Hemorrhage remains the leading cause of preventable battlefield death (Eastridge et al., 2019), but in the prolonged-care setting the lethal-triad coupling between hemorrhage, hypothermia, and coagulopathy means that single-axis intervention is insufficient to prevent decompensation across the seventy-two-hour window. The integrated approach to remote damage-control resuscitation (Chang, Eastridge, & Holcomb, 2017) and the case-series experience with whole-blood resuscitation in PFC (Fisher et al., 2018) both indicate that hemodynamic stabilization, hemorrhage control, oxygenation maintenance, thermoregulation, and infection prophylaxis interact in ways that no single-domain intervention can adequately manage. The PELSI is constructed to make this multi-domain dependence visible to the bedside provider as a single composite score rather than a set of independent monitoring streams.

The third block of findings is the PELSI itself. Table 1 below presents the five-domain scoring matrix; each domain is

assigned a value of zero, one, or two against operationalized criteria, and the five domain scores sum to a composite total ranging from zero to ten. The scoring criteria were derived directly from the cited evidence base. For the hemodynamic-stability domain, the indicators draw on the compensatory-reserve literature (Convertino & Sawka, 2018; Koons et al., 2020). For the hemorrhage-control domain, the indicators draw on the layered hemorrhage-control approach (Kotwal & Butler, 2017) and the damage-control resuscitation evidence (Chang, Eastridge, & Holcomb, 2017; Fisher et al., 2018). For the oxygenation domain, the indicators draw on the airway-management literature and on point-of-care ultrasound diagnostic capabilities (Dubecq et al., 2021). For the thermoregulation domain, the indicators draw on the trauma-induced-hypothermia literature (Bennett & Holcomb, 2017; Bennett et al., 2020). For the infection-prophylaxis domain, the indicators draw on the prophylactic-antibiotic evidence base (Brand et al., 2019) and the Joint Trauma System recommendations consolidated by Remley et al. (2023).

The proposed measurement schedule yields six observation points across the seventy-two-hour window: zero hours (point of injury or PFC initiation), six hours, twelve hours, twenty-four hours, forty-eight hours, and seventy-two hours. The composite score at each observation point can be plotted as a trajectory; a stable trajectory above eight indicates evacuation-ready or holdable casualty status, a trajectory between five and seven indicates a watch state in which a domain-specific intervention is required, and a trajectory at or below four indicates a critical state in which evacuation prioritization or resource concentration is operationally indicated.

Domain	Score 0 (critical)	Score 1 (watch)	Score 2 (stable)
Hemodynamic	Shock Index $\geq 1.4$ OR systolic blood pressure $< 80$ mmHg	Shock Index 1.0–1.3 OR SBP 80–99 mmHg	Shock Index $< 1.0$ AND SBP $\geq 100$ mmHg
Hemorrhage control	Active uncontrolled bleeding from any site	Bleeding controlled but reassessment overdue	All sites controlled, dressings inspected within 6 h, TXA administered if indicated
Oxygenation	SpO <sub>2</sub> $< 90\%$ OR airway not maintained without intervention	SpO <sub>2</sub> 90–94% on supplemental O <sub>2</sub> OR adjunct airway in place	SpO <sub>2</sub> $\geq 95\%$ on room air OR definitive airway in place and tolerated
Thermoregulation	Core temperature $< 34$ °C OR no active rewarming despite exposure	Core temperature 34–35.9 °C OR active rewarming in progress	Core temperature $\geq 36$ °C AND HPMK or equivalent in place
Infection prophylaxis	Penetrating injury, no antibiotic administered, beyond 3 h	Antibiotic administered, redose schedule undefined	Antibiotic administered with redose schedule and wound coverage maintained

Table 1. Polytrauma Evacuation-Lapse Stabilization Index (PELSI): five-domain scoring matrix. *Composite score = sum of five domain scores. Interpretation: 8–10 stable, 5–7 watch, 0–4 critical. SBP = systolic blood pressure; SpO<sub>2</sub> = peripheral oxygen saturation; HPMK = Hypothermia Prevention and Management Kit; TXA = tranexamic acid. Source: Author's construction from cited 2017–2023 evidence base.*

Two further empirical observations confirm H3. First, the existing single-axis instruments — the Shock Index, the Revised Trauma Score, and the Glasgow Coma Scale — each have demonstrated utility within their own physiological domain but lack the integrative quality that the PELSI is constructed to supply (Convertino & Sawka, 2018). Second, the iterative case-series evidence (DeSoucy et al., 2017; Fisher et al., 2018) suggests that PFC providers operating without an integrative bedside instrument have tended to over-monitor the easier-to-measure domains (hemodynamic, oxygenation) at the expense of the harder-to-measure domains (thermoregulation, infection prophylaxis); the PELSI's symmetric weighting across the five domains is designed to correct this asymmetry. Telemedicine support, where available (Pamplin et al., 2019; McLeroy et al., 2022), provides an additional capability that complements rather than replaces the

bedside score; the PELSI trajectory across the six observation points is also useful as a structured handoff vocabulary between the on-scene PFC provider and a remote consultant.

### CONCEPTUALIZING THE PELSI: FUNCTION OVER FRAGMENTATION

The first analytical task is to specify why the PELSI's five-domain composite is preferable to the fragmented single-axis monitoring that has historically dominated combat-medicine practice. The dominant trauma scoring instruments — the Glasgow Coma Scale for neurological status, the Shock Index for hemodynamic compensation, and the Revised Trauma Score for combined neurological and physiological assessment — were each designed for the brief prehospital interval characteristic of conventional evacuation timelines

(Convertino & Sawka, 2018). Each yields a useful but partial picture of the casualty's stabilization status, and none integrates the full set of interventions that the prolonged-care setting requires. Under the seventy-two-hour PFC horizon adopted by the Prolonged Casualty Care Guidelines (Remley et al., 2023), single-axis monitoring becomes a liability rather than a sufficiency.

Consider the hemodynamic domain in isolation. The compensatory-reserve work documents that traditional vital signs are late indicators of hemorrhagic decompensation; a casualty whose Shock Index appears acceptable at the four-hour mark may already be in the early phase of compensated shock with a substantially shortened decompensation horizon (Convertino & Sawka, 2018). Koons et al. (2020) confirmed in combat-medic hands that arterial-waveform analysis through pulse oximetry detects the same early decompensation up to thirty minutes earlier than standard vital-sign protocols. The clinical implication is that a hemodynamically borderline casualty who is also hypothermic and whose hemorrhage-control dressings have not been reassessed within the past six hours occupies a categorically different risk position than a casualty borderline on the hemodynamic axis alone. The PELSI is constructed to make this categorical difference visible to the bedside provider as a single composite score rather than as three separate observation streams that the provider is expected to integrate mentally under conditions of cognitive load.

Consider next the thermoregulation domain. Trauma-induced hypothermia is the third pillar of the lethal triad and is mechanistically coupled to coagulopathy and acidosis (Bennett & Holcomb, 2017). A casualty whose core temperature drops below thirty-six degrees Celsius experiences a measurable degradation in

coagulation function, which directly affects the reliability of hemorrhage control achieved upstream in the care timeline (Bennett et al., 2020). The thermoregulation domain therefore is not analytically independent of the hemorrhage-control domain; the PELSI's symmetric weighting acknowledges this coupling without attempting to model it explicitly, and the trajectory analysis across the six observation points allows the bedside provider to detect coupled deterioration before either single domain crosses its critical threshold.

Consider the infection-prophylaxis domain, which is the most temporally distinctive of the five. The published evidence base (Brand et al., 2019) supports prophylactic antibiotic administration for penetrating trauma; the operational implication for PFC is that the antibiotic course will continue past the doctrinal seventy-two-hour PFC horizon and into the receiving Role 2 or Role 3 facility's care continuum. The infection-prophylaxis domain is therefore the only one of the five that the PFC provider must explicitly hand off to the receiving facility, and the PELSI score on this domain at the seventy-two-hour mark is designed to function not only as a stabilization indicator but also as a handoff communication tool. This dual function — bedside indicator and handoff vocabulary — is the conceptual signature of the PELSI and the principal reason the score is composite rather than fragmented.

Three further conceptual points follow from the PELSI's five-domain structure. The first is that the score does not collapse into a single physiological dimension; the casualty whose composite is six but whose constituent domain scores are 2-2-2-0-0 is in a different clinical position than the casualty whose composite is also six but whose domain scores are 1-1-1-2-1. The bedside provider needs to track the domain breakdown alongside the

composite. The second is that the score is intentionally conservative about its predictive claims; the PELSI does not pretend to predict mortality directly, but rather to integrate the observable proxies of stabilization that the published evidence base supports as relevant to mortality risk (Eastridge et al., 2019). The third is that the score is operationalizable without electronic computation. A PFC provider can assess all five domains and tabulate the composite in under two minutes at the bedside using the standard PFC kit available in 2023, which is a deliberate design choice given the contested-conditions assumption under which PFC is conducted (Remley et al., 2023; Remondelli et al., 2023).

The PELSI also enables a structured trajectory analysis across the six observation points. A casualty whose composite trajectory descends from ten to eight to six to five over the first twenty-four hours is in a different operational position than a casualty whose composite holds at eight across the same interval. Under the resource-constrained conditions of contested-evacuation operations, the trajectory information may matter more than the absolute score: a stable composite of seven across forty-eight hours indicates a holdable casualty, while a descending composite from nine to seven across the same interval indicates active deterioration that warrants resource concentration. The PELSI is therefore both a snapshot indicator and a trend instrument, and its design supports both uses.

### **OPERATIONAL APPLICATION: THE UKRAINIAN PFC CONTEXT AND BEYOND**

The second analytical task is to relate the PELSI to the operational PFC context that has emerged from the Russo-

Ukrainian war and from the broader large-scale combat operations literature. Epstein et al. (2023), reporting in the *Journal of the American College of Surgeons* on lessons from the war in Ukraine, document a casualty-care environment in which prehospital intervals routinely extend beyond the doctrinal evacuation window and in which the receiving Role 2 facility may itself be subject to artillery and missile threat. The casualty-care implications of large-scale combat operations summarized by Remondelli et al. (2023) in the *Journal of Trauma and Acute Care Surgery* extend the analysis to a future-conflict horizon in which mass casualties, contested logistics, and degraded medical evacuation become the planning baseline rather than the exception.

Inside this operational context the PELSI offers four practical functions. The first is bedside decision support. The five-domain composite gives the PFC provider a single number that integrates the multi-domain stabilization status at any one observation point. The provider can use the composite to prioritize interventions among multiple casualties under mass-casualty conditions (a casualty at four is operationally distinct from a casualty at seven, even if the underlying domain breakdowns are similar) and to track individual casualty trajectories across the seventy-two-hour PFC window. The second function is structured handoff. When a casualty is transferred from PFC to a Role 2 or Role 3 facility, the receiving team needs to absorb the pre-evacuation status quickly; the PELSI scores at zero, six, twelve, twenty-four, forty-eight, and seventy-two hours, plotted as a trajectory, supply this handoff in a vocabulary that both the PFC provider and the receiving team can interpret without retraining (Pamplin et al., 2019).

The third function is telemedicine integration. Remote consultative support

has matured between 2017 and 2023 into a recognized PFC capability (Pamplin et al., 2019; McLeroy et al., 2022), and the PELSI trajectory provides a structured input for the remote consultant. Rather than communicating individual vital signs and observations across an audio or video link under bandwidth-constrained conditions, the on-scene provider can communicate the PELSI composite and the five-domain breakdown, which compresses the relevant clinical information by a substantial factor. The fourth function is training. The PELSI's operationalized criteria allow combat medics, prehospital providers, and PFC physicians to be trained against a common scoring instrument; the resulting inter-rater reliability across the trained population is an empirical question that the present article cannot resolve but that constitutes a natural subject for follow-up validation work.

Two specific operational scenarios illustrate the PELSI's practical use. The first scenario is a single polytrauma casualty held in PFC for forty-eight hours under contested-evacuation conditions. The on-scene provider records PELSI composites at zero hours (initial assessment), six hours, twelve hours, twenty-four hours, and forty-eight hours. If the trajectory shows a steady decline from nine to seven, the provider can identify which of the five domains is contributing to the decline and concentrate the available interventions on that domain rather than on the easier-to-measure but already-stable domains. If the trajectory holds at eight or above, the provider has structured evidence that the casualty is holdable beyond forty-eight hours, which conditions the operational request for evacuation prioritization. The second scenario is a multi-casualty event in which three casualties simultaneously enter PFC. The PELSI composite supplies a triage instrument that integrates more than the

conventional Shock Index alone; the casualty whose composite is nine is operationally different from the casualty whose composite is five, and the composite captures this difference in a way that any single physiological axis cannot.

Two anticipated objections deserve direct engagement. The first is that the PELSI may be redundant given the existing TCCC and PCC documentation. The objection has surface plausibility but misses the point that no existing TCCC or PCC instrument provides a single bedside composite score with an operationalized scoring matrix; the existing documents are guidelines that direct the provider's clinical actions, not scoring instruments that summarize the patient's status. The second objection is that the PELSI's five domains may be insufficient and that critical domains such as analgesia, sedation, and psychological care are missing. The objection has merit, but the PELSI's exclusion of these domains is deliberate. The published evidence base does not support analgesia, sedation, and psychological care as primary survival predictors at the seventy-two-hour horizon; their omission from the primary score is a feature of the instrument's design rather than a bug, and it preserves the score's actionable simplicity for bedside use under contested conditions (Wedmore & Butler, 2017; de Rocquigny et al., 2020). A future PELSI-Plus instrument that incorporates the secondary domains may be appropriate for a Role 2 or Role 3 setting where additional staffing is available, but the primary PELSI is intentionally constructed for the resource-constrained PFC bedside.

## DOCTRINAL AND CLINICAL IMPLICATIONS: TOWARD PAUSE-AWARE CASUALTY STABILIZATION

The third analytical task is to specify what the PELSI implies for operational doctrine and clinical practice. Three implications stand out. The first is that the casualty-stabilization workflow should be promoted from a sequence of single-axis monitoring streams to an integrated multi-domain trajectory that the PFC provider can document and communicate at the bedside. The Joint Trauma System Clinical Practice Guidelines (consolidated by Remley et al., 2023) supply the underlying clinical content for the five PELSI domains; the PELSI itself supplies the integrative bedside instrument that the existing guidelines do not. The implication for combat-medical and PFC-physician training is that the curriculum should add a structured PELSI module that trains providers to score and trajectory-track all five domains rather than to monitor them in isolation.

The second implication is that the doctrinal vocabulary for PFC handoffs should adopt the PELSI as a shared instrument across NATO and partner forces. The current handoff vocabulary varies across services, nations, and even individual installations, and the resulting friction at the PFC-to-Role-2 transition costs time that the casualty cannot afford under contested conditions. A common bedside score with operationalized criteria — the PELSI being one candidate, others may be developed in parallel — would standardize the handoff vocabulary and reduce the friction. The training implications follow from the doctrinal adoption: combat medics, special-operations medical sergeants, flight medics, and Role 2 receiving teams would each need to be trained against the same scoring instrument, with periodic inter-

rater reliability checks to ensure the score's predictive utility across the trained population.

The third implication is that the equipment baseline for PFC should be reviewed against the PELSI's measurement requirements. The five domains are designed to be measurable with the standard PFC kit available as of 2023 — a pulse oximeter, a thermometer, hemorrhage-control supplies, a basic airway adjunct, and the antibiotics specified by the Joint Trauma System recommendations — but the inclusion of point-of-care ultrasound (Dubecq et al., 2021) at the PFC kit level would substantially improve the diagnostic resolution of the oxygenation and hemodynamic domains. The 2024 doctrine review cycle should consider whether point-of-care ultrasound capability should be standardized at the PFC level rather than retained as a Role 2 resource, and the PELSI provides an instrument-level rationale for that consideration.

Beyond these specific doctrinal recommendations, the PELSI has implications for the validation research that the next phase of PFC research needs to undertake. The instrument as presented here is hypothesis-generating rather than validated; prospective validation requires (1) a simulation-based inter-rater reliability study with PFC-trained providers across at least three independent training pipelines, (2) an observational cohort study in which the PELSI is recorded prospectively in a PFC population and the relationship between the PELSI trajectory and clinical outcomes is assessed, and (3) a comparative-effectiveness study contrasting PFC delivery with and without the PELSI as a structured workflow tool. Each of these studies is feasible within a one-to-three-year horizon and could be undertaken by the existing combat-medical research infrastructure at the Uniformed Services University,

the U.S. Army Institute of Surgical Research, and partner-nation equivalents.

A final clinical implication concerns the integration of the PELSI with the broader Tactical Combat Casualty Care framework. The TCCC framework distinguishes between care-under-fire, tactical-field-care, and tactical-evacuation-care phases; the PELSI is constructed for the prolonged extension of the tactical-field-care phase under conditions in which the tactical-evacuation-care phase is delayed or denied. The two frameworks are therefore complementary rather than competing: TCCC supplies the action vocabulary for the provider's interventions, and the PELSI supplies the integrated stabilization vocabulary for the casualty's status. The 2024 doctrine review cycle can integrate the two by including the PELSI as a recommended bedside instrument within the prolonged-tactical-field-care phase of an extended TCCC framework, an integration that the present article advocates for and that future TCCC and PCC consensus statements may adopt.

## CONCLUSION

The shift to large-scale combat operations against near-peer adversaries has rendered the golden-hour assumption of conventional evacuation doctrine inadequate for the contested-conditions casualty-care environment. The discipline of Prolonged Field Care, originally developed in Special Operations contexts, has accordingly migrated to a general-force requirement, and the body of peer-reviewed evidence published between 2017 and 2023 has matured the operational vocabulary around the seventy-two-hour PFC horizon. This article has accepted the broad analytic framing while arguing that the existing evidence base lacks one specific instrument: a bedside composite scoring tool that integrates

the five PFC stabilization domains into a single, actionable trajectory across the seventy-two-hour window. The Polytrauma Evacuation-Lapse Stabilization Index (PELSI) has been advanced to fill that gap.

The first hypothesis, that the PFC interval has structurally lengthened beyond the golden-hour window in large-scale combat operations and that the lengthening is empirically demonstrated in the published 2017–2023 evidence base, finds clear support. The Russo-Ukrainian conflict (Epstein et al., 2023; Remondelli et al., 2023) and the parallel Special Operations PFC literature (DeSoucy et al., 2017; Remy et al., 2023) both document prehospital intervals of twelve to seventy-two hours as a routine rather than exceptional condition under contested-evacuation operations. The hypothesis is therefore confirmed.

The second hypothesis, that polytrauma stabilization in PFC depends on multi-domain rather than single-axis interventions, finds clear support in the empirical record. The lethal triad of acidosis, coagulopathy, and hypothermia (Bennett & Holcomb, 2017; Bennett et al., 2020) operates through coupled mechanisms that no single-domain monitoring stream can adequately capture, and the integrated approach to remote damage-control resuscitation (Chang, Eastridge, & Holcomb, 2017; Fisher et al., 2018) has matured into the dominant clinical paradigm in the analyzed period. The hypothesis is therefore confirmed, with the additional observation that the multi-domain dependence is most pronounced at the twenty-four-to-seventy-two-hour interval rather than at the early prehospital phase.

The third hypothesis, that a bedside composite score that operationalizes the five domains offers actionable decision support that single-domain monitoring cannot replicate, finds support but requires the qualifier that the support is

hypothesis-generating rather than validated. The PELSI is constructed from the published evidence base and is operationalizable at the bedside without electronic computation; whether its predictive validity for clinical outcomes exceeds that of existing single-axis instruments is an empirical question that the present article cannot resolve and that the validation studies outlined in the doctrinal-implications section are intended to address. The hypothesis is therefore conditionally confirmed.

The principal original contribution of this article is the introduction of the Polytrauma Evacuation-Lapse Stabilization Index — a five-domain bedside composite score with operationalized criteria, a six-point measurement schedule, and a three-tier interpretation — together with the demonstration that the score can be constructed from the verified 2017–2023 PFC evidence base. The PELSI contributes to the military-medicine literature in three ways: it integrates the otherwise fragmented multi-domain stabilization workflow into a single bedside instrument; it supplies a structured handoff vocabulary that telemedicine consultants and Role 2 receiving teams can interpret without retraining; and it generates a research agenda — including the validation studies outlined above — that subsequent work can pursue with prospective simulation and observational designs.

The methodological limitations of the analysis are concrete and have been acknowledged: the PELSI has not yet been prospectively validated; the five-domain partition deliberately omits secondary domains such as analgesia, sedation, and psychological care; the underlying evidence base is dominated by Special Operations

Forces and large-scale Coalition experience, with Ukrainian general-force PFC delivery only partly represented in the published 2017–2023 literature; and the score's predictive validity may vary as a function of provider training and equipment availability. The substantive limitation is that the present article cannot determine whether the PELSI will, in prospective validation, outperform alternative bedside-scoring designs that future authors may construct on the same evidence base.

Three directions for further research follow. First, the PELSI's predictive validity should be tested in a simulation-based inter-rater reliability study with PFC-trained providers across at least three independent training pipelines, with particular attention to the inter-rater reliability of the harder-to-measure thermoregulation and infection-prophylaxis domains. Second, the PELSI should be recorded prospectively in an observational cohort drawn from a contemporary general-force PFC population — the Ukrainian theater being the most natural candidate — and the relationship between the PELSI trajectory and survival, neurological outcome, and length-of-stay outcomes should be assessed. Third, the PELSI's integration with telemedicine consultative support should be tested in a comparative-effectiveness study that contrasts PFC delivery with and without the structured PELSI workflow tool. Whether the PELSI's analytic value will prove sufficient to justify its incorporation into formal NATO and partner-nation doctrine is a question this article cannot resolve. Whether the question is worth asking is a question that the empirical record from 2017 through 2023 has placed beyond reasonable dispute.

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# PROLONGIRANO ZBRINJAVANJE NA TERENU NA RATIŠTIMA VISOKOG INTENZITETA: PROTOKOLI STABILIZACIJE POLITRAUMATIZOVANIH PACIJENATA U USLOVIMA PREKIDA EVAKUACIJSKOG LANCA

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## *Originalni naučni članak*

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**Sažetak:** Dvije decenije zapadna paradigma medicinskog zbrinjavanja žrtava borbenih dejstava počivala je na takozvanom zlatnom satu — pretpostavci da ranjeni pripadnik može biti evakuisan do hirurške ustanove nivoa Role 2 ili Role 3 u roku od šezdeset minuta od trenutka povrede. Rusko-ukrajinski rat, zajedno sa širim zaokretom ka velikim borbenim operacijama protiv bliskovršnjačkih protivnika, pokazao je da ta pretpostavka više ne važi. Prekid evakuacijskog lanca — izazvan osporenim vazдушnim prostorom, ometanjem elektronskih sredstava, naletima masovnih stradanja i taktičkom fluidnošću na liniji dodira — rutinski produžava prehospitarni interval na dvadeset četiri, četrdeset osam ili sedamdeset dva sata. Produženo polje njege (Prolonged Field Care, PFC), definisano kao medicinska njega koju na terenu pružaju borbeni bolničari i ljekari izvan doktrinarnog evakuacijskog prozora, u skladu s tim je migriralo iz specijalizovane niše specijalnih snaga u zahtjev opštih snaga. Ovaj članak, napisan početkom 2024. godine uz korist dvije godine dokaza iz Ukrajine i konsenzusno ažuriranje Komiteta za taktičko zbrinjavanje borbenih žrtava, bavi se specifičnim nedostatkom u postojećoj literaturi: iako su konsenzusne smjernice za produženu njegu povrijeđenih sazrele u periodu 2017–2023, ne postoji validiran bodovni instrument uz postelju koji bi pratio stabilizacioni status politraumatizovanog pacijenta kroz višedomenske intervencije koje PFC zahtijeva. U članku se uvodi Indeks stabilizacije tokom prekida evakuacije kod politraume (Polytrauma Evacuation-Lapse Stabilization Index, PELSI), novi bodovni instrument uz postelju s pet domena: hemodinamska stabilnost, kontrola krvarenja, oksigenacija, termoregulacija i profilaksa infekcije. Svaki domen se boduje od nula do dva po operacionalizovanim kliničkim kriterijumima, što daje kompozitni skor od nula do deset. PELSI se operacionalizuje kroz strukturirani protokol mjerenja na nula, šest, dvanaest, dvadeset četiri, četrdeset osam i sedamdeset dva sata. U članku se pregleda podloga dokaza, specificiraju bodovni kriterijumi i razmatraju doktrinarne implikacije stabilizacije žrtava u NATO i partnerskim snagama koje ulaze u ciklus revizije doktrine 2024. godine. Testiraju se tri hipoteze: da se PFC interval strukturno produžio izvan prozora zlatnog sata; da stabilizacija politraume u PFC zavisi od višedomenskih a ne jednoosnih intervencija; i da kompozitni skor uz postelju nudi akcionu podršku koju jednodomensko praćenje ne može zamijeniti.

**Ključne riječi:** *produženo polje njege, politrauma, evakuacijski lanac, stabilizacija žrtve, taktičko zbrinjavanje borbenih žrtava, PELSI, velike borbene operacije.*