

Resuscitation Reimagined: A Crossover Simulation Study Comparing a Pediatric Emergency Disaster System (PEDS) with the Broselow Bag™ in Simulated Combat Pediatric Casualties

Sara Bibbens, DO¹, Elizabeth Pearce, MA², Patrick O'Meara³, Jonathan Henderson, MD⁴, Sherri Rudinsky MD⁴, Cynthia Shen, DO⁴, Amy F. Hildreth, MD⁴

1. Department of Pediatrics, Uniformed Services University of the Health Sciences 2. Henry M. Jackson Foundation for the Advancement of Military Medicine, Inc.
3. School of Medicine, Uniformed Services University of the Health Sciences 4. Department of Military Emergency Medicine, Uniformed Services University of the Health Sciences

Disclaimer: The opinions and assertions expressed herein are those of the author(s) and do not reflect the official policy or position of the Uniformed Services University, the Henry Jackson Foundation or the Department of War. Mention of trade names, commercial products, or organizations does not imply endorsement by the U.S. Government. The views and conclusions contained herein are those of the author(s) and should not be interpreted as representing the official policies or endorsements, either expressed or implied, of the U.S. Government.

BACKGROUND

- **The Problem:** Pediatric casualties account for up to 10% of humanitarian admissions to deployed military medical facilities, yet providers report low confidence due to a lack of pediatric-specific training and equipment.
- **The Capability Gap:** The standard civilian Broselow Bag™ lacks critical Tactical Combat Casualty Care (TCCC) components (e.g., tourniquets) required in austere, high-stress environments.
- **Objective:** Compare the novel, field-optimized **Pediatric Emergency Disaster System (PEDS)** against the civilian-standard **Broselow Bag™** during simulated mass casualty (MASCAL) events.

METHODS

- **Participants:** N = 110 students.
- Third-year medical and CRNA students were divided into **24 teams** during Operation Gunpowder (USU field exercise).
- **Randomized Crossover:** 2-Sequence Design. Teams randomized to either **Sequence A** (PEDS then Broselow) or **Sequence B** (Broselow Bag™ then PEDS for two 60-minute simulated scenarios. Each team served as its own control.
 - **TCCC case:** Blast-related hemorrhagic shock requiring TCCC resuscitation.
 - **Sepsis Case:** Septic shock and respiratory failure requiring vasoactive/airway support.
- **Data collection:** Evaluated via faculty checklists (dosing accuracy/errors), unweighted NASA-TLX (workload), System Usability Scale (SUS), and a 5-point Confidence Likert Scale.

RESULTS

Usability (SUS): No statistically significant difference ($p = 0.25$). Both systems met average usability benchmarks (PEDS = **71.2**, Broselow = **67.5**).

Workload (NASA-TLX): PEDS showed significantly reduced provider frustration (**9.5 vs. 11.9, $p = .02$**) and improved perceived performance (**14.5 vs 11.6, $p <.001$**).

Clinical Accuracy & Provider Confidence

Clinical Metric	PEDS	Broselow Bag™
TCCC Case: High Confidence	68.4%	36.8%
TCCC Case; TXA Accuracy	100%	50%
TCCC Case: Ketamine Accuracy	100%	71.4%
Sepsis Case: High Confidence	73.7%	51.6%
Sepsis: Antibiotic Dosing Accuracy	100%	54.4%
Sepsis: Epi Drip Rate Accuracy	100%	83.3%

Dosage Variability: Broselow Bag™ users exhibited dangerous clinical variability during the hemorrhage scenario, ranging from 200mg to 1000mg of TXA (Target: 300-520mg) and 4mg to 20mg of ketamine (Target: 4-6mg). PEDS users maintained strict dosing safety paraments.

Support Required: During the sepsis case, more Broselow Bag™ users required additional support from outside parties (e.g. peer resources, telemedicine consultations) to obtain dosing calculations than PEDS bag users (**8 vs 1**).

Funding: This research was supported by the Defense Health Agency (HU00012420112). This effort was awarded through MTEC solicitation MTEC-24-01-MPAI and is funded by Combat Casualty Research Program (CCCRP) in accordance with Congressional direction specified in Sec 736 NDAA 2023 and Sec 721 NDAA 2024.
Conflict of Interest: The authors have no financial interests or relationships to disclose.
Institutional Clearance: This research was reviewed by the Human Research Protections Program Office at the Uniformed Services University. IRB DBS.2026.1081

DISCUSSION

- **Cognitive Relief:** Re-organizing pediatric layouts specifically for tactical environments decreases provider frustration and improves perceived performance during chaotic MASCAL events.
- **Decreasing Errors:** By pre-aligning equipment with TCCC protocols, the PEDS kit minimized dangerous dosing variances for critical frontline medications like Ketamine and TXA.
- **Operational Impact:** Implementing field-optimized resuscitation systems can answer the operational capability gap, providing concrete evidence to reshape pre-deployment training and pediatric equipment requirements for deployed units.



REFERENCES

1. Gurney JM, Graf V, Staudt AM, et al. Characterization of humanitarian trauma care by US military facilities during combat operations in Afghanistan and Iraq. *Ann Surg.* 2022;276(4):732-742. doi:10.1097/SLA.0000000000005592
2. Tovar MA, Lara SW, Rudinsky SL, Bibbens SE. Experientia et progressus: An experiential needs assessment of military health care providers in treating pediatric combat trauma. *Mil Med.* 2025;190(5-6):e1229–e1235. doi:10.1093/milmed/usaf020
3. Matos RI, Jenkins-Woodrum K, Clemons MA. The experience of Critical Care Air Transport teams that transported Afghan refugee children: A qualitative thematic analysis. *Mil Med.* 2026;191(5-6):e900-e910. doi:10.1093/milmed/usaf427
4. Agarwal S, Swanson S, Murphy A, et al. Comparing the utility of a standard pediatric resuscitation cart with a pediatric resuscitation cart based on the Broselow tape: A randomized, controlled, crossover trial involving simulated resuscitation scenarios. *Pediatrics.* 2005;116(3):e326-e333. doi:10.1542/peds.2005-0320