

Engineering Pressure Injury Prevention in Combat Casualty Evacuation



Shannon S. Layton, DNP, MSW, RN, LICSW-S, NEA-BC, CNL, CNE, CWCN¹
 Patricia Patrician, PhD, RN, FAAN,¹ and Kath M. Bogie, D.Phil, FAIMBE²

(1) University of Alabama at Birmingham School of Nursing, University of Alabama at Birmingham School of Engineering, (2) Louis Stokes Cleveland VA Medical Center

BACKGROUND

Prolonged evacuation times in modern warfare exposes injured personnel to **life-threatening complications** which current transport technologies are not optimized to manage. Routine turning may not be prioritized increasing the risk for further harm to casualties via **pressure injury**

- Pressure injury risk, already high in previous conflicts, remains a serious concern.
- Major traumatic injuries can lead to hypothermia, shock, and impaired circulation, highlighting the critical need for effective thermoregulation during transport.
- **Existing solutions:** Thin foam “orange mats” for pressure injury reduction and mortuary bags for warmth are not optimized for prolonged transportation.
- To address these critical gaps, current evacuation equipment must be reevaluated and upgraded to accommodate current battle plans.

ALIGNMENT WITH PRIORITIES

This improvement research aligns with the Department of Veterans Affairs (VA) and Department of Defense (DOD) high priority for expectant casualty care.

AIMS / GOALS

- Identify gaps in casualty evacuation equipment to maintain soft tissue viability and thermoregulation during prolonged transport
- Develop a prototype technology for preventing pressure injuries during prolonged transport.

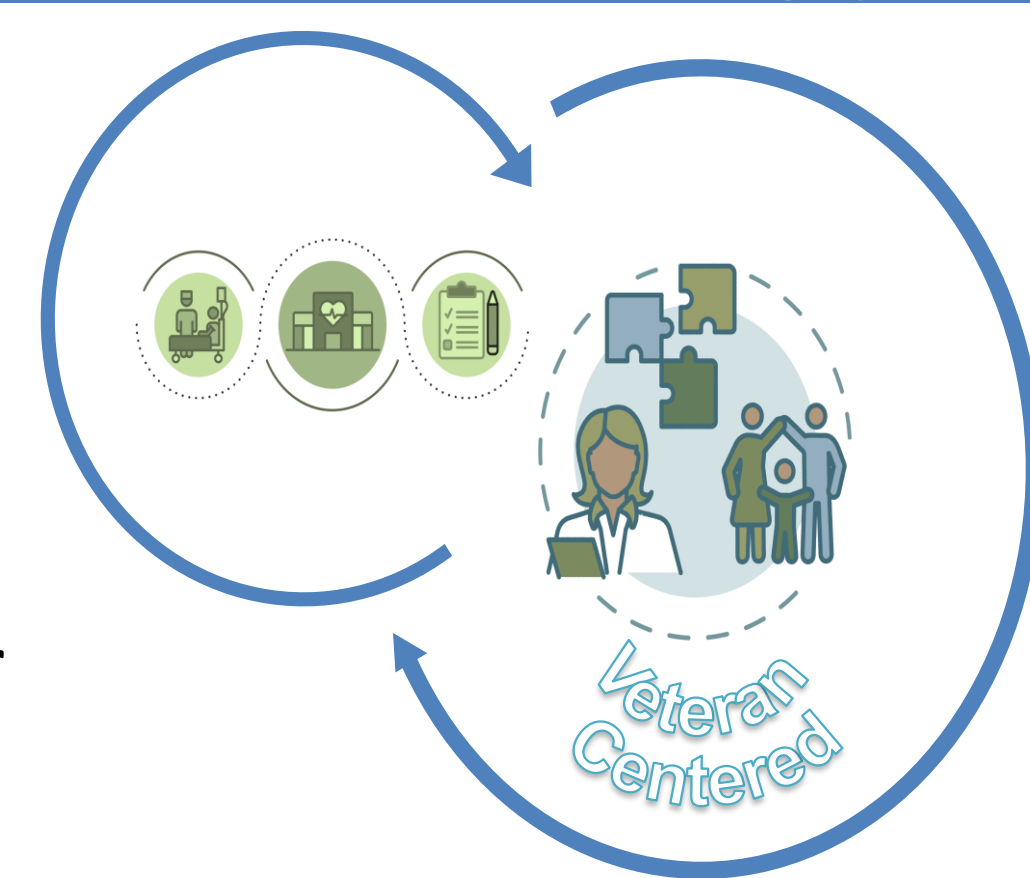
METHODS / INTERVENTIONS

The Design Thinking process was used to develop a Transitional Readiness Level (TRL) 3 prototype, currently named **Battle Nest**, to meet identified gaps.

Interprofessional team: healthcare, military, and biomedical engineering

Phase 2 - Embed sensors for remote:

- Temperature
- Respiration
- Casualty re-triage assist



Empathize

Define

Ideate

Prototype

Test

This process is iterative allowing each step to be revisited in any order

RESULTS



Battle Nest is a low-cost three-part system for use in austere environments (*patent pending*).

1) Reusable Base

- Alternating Pressure Air Mattress
 - Existing and sized to litter
- Pump: Needed Adaptation
 - Dual electric/battery
 - Lightweight < 2.5 Kg



2) Thermoregulating single use mattress cover

- Quick access clip and eyelet latching

3) Thermoregulating single use patient cover

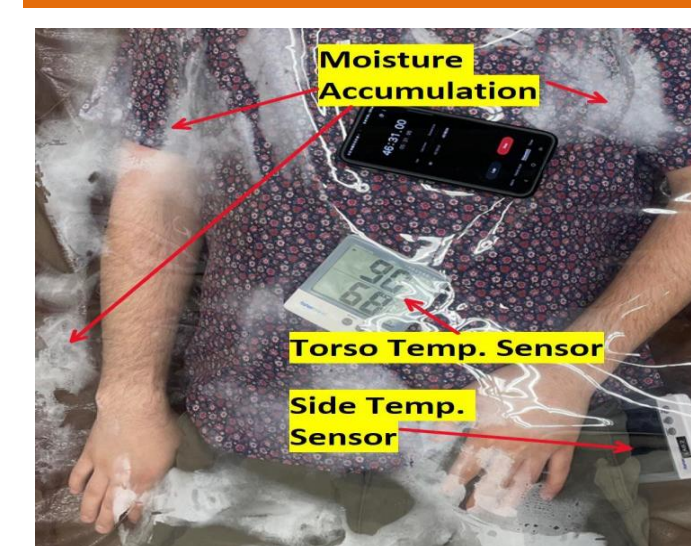
- Clear cover enables quick visual assessment without removing the cover
- Semi vapor permeable for moisture control



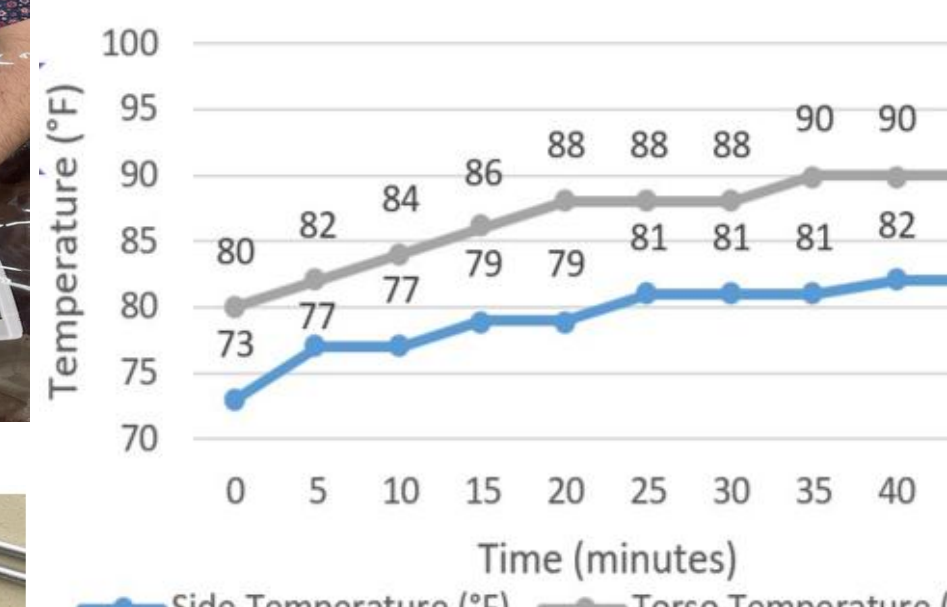
Litter

Litter and insulate mattress pad

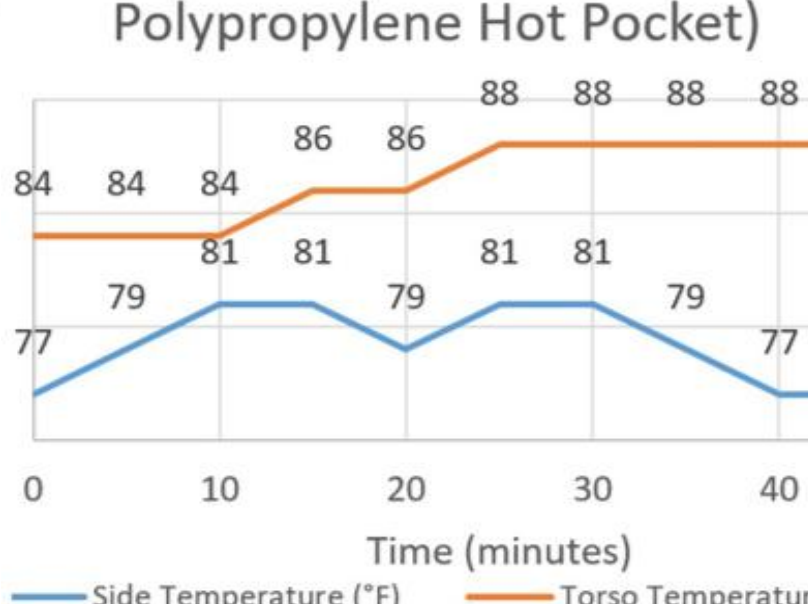
Thermoregulation improved with stable temperatures at the torso (10F above baseline) and side (9F above baseline).



Temperature vs Time (0.02" PVC)



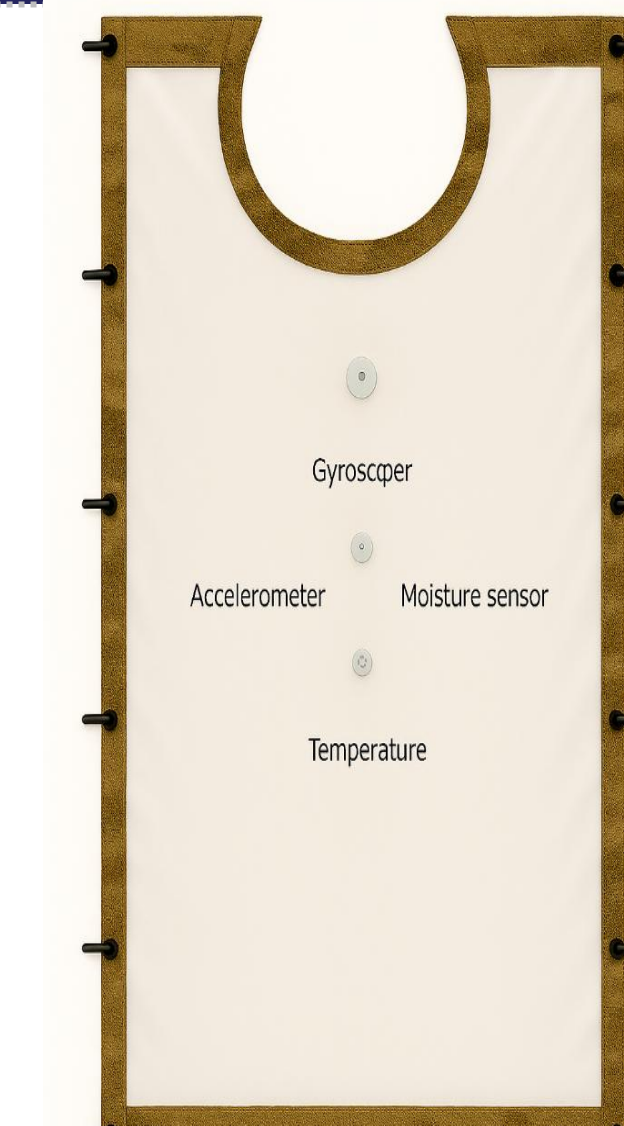
Temperature vs Time (Woven Polypropylene Hot Pocket)



NEED SPECIFICATION	DESIGN CONSTRAINT
Mass Producible	Standardizable subsystems
Can hold weight of service member	Withstands 400lbs with no material fatigue
Pressure reducing	No high body pressure points (> 31mmHg)
Thermoinsular add-on/topper	Maintain ambient temp over 80F
Cost effective	<\$100 price point
Skin moisture = or < talon litter	Conductance measure of moisture < standard
Built-in transport securement	2-point securement minimum

CONCLUSIONS

- Modern changes in warfare are limiting the feasibility of evacuating large numbers of casualties
- Battlefield nursing has adapted to the use of telemedicine however pressure injury prevention has not been adapted.
- Further testing of bacteriostatic polymers, verification and validation of thermal testing using ISO 8301 & 9920 standards, and integration of additional sensor technology is needed.



IMPACT

Integrated sensors for wireless monitoring of health

- **Battle Nest technology fills a critical gap allowing for interface pressure offloading and quick access visual assessment.**
- **Battle Nest provides thermoregulation of casualties during prolonged transportation without use of critical staffing resources.**
- **Avoiding the use of opaque mortuary bags to transport living casualties could further increase morale of injured personnel.**

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