USAARL-CNPA-BC--2026-28

UNITED STATES ARMY AEROMEDICAL RESEARCH LABORATORY

Improving MASCAL CASEVAC Efficiency: An Evaluation of Human Performance during Assisted and Unassisted Litter Carriage (Reprint)

Richard T. Oldham, Allison Robinette, Shannon McGovern, and Matthew T. Ballard

Notice

Qualified Requesters

Qualified requesters may obtain copies from the Defense Technical Information Center (DTIC), Fort Belvoir, Virginia 22060. Orders will be expedited if placed through the librarian or other person designated to request documents from DTIC.

Change of Address

Organizations receiving reports from the U.S. Army Aeromedical Research Laboratory on automatic mailing lists should confirm correct address when corresponding about laboratory reports.

Disposition

Destroy this document when it is no longer needed. Do not return it to the originator.

Disclaimer

The views, opinions, and/or findings contained in this report are those of the author(s) and should not be construed as an official Department of the Army position, policy, or decision, unless so designated by other official documentation. Citation of trade names in this report does not constitute an official Department of the Army endorsement or approval of the use of such commercial items.

Human Subject Use

In the conduct of research involving human subjects, the investigator(s) adhered to the policies regarding the protection of human subjects as prescribed by Department of Defense Instruction 3216.02 (Protection of Human Subjects and Adherence to Ethical Standards in DoD-Supported Research) dated 8 November 2011.

IRB Determination and Number

This study, USAARL 2020-09, was approved by the Medical Research and Development Command Institutional Review Board on 12 May 2025.

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE *(DD-MM-YYYY)*	2. REPORT TYPE	3. DATES COVERED *(From - To)*
22-07-2026	Briefing Charts	10/01/2024 - 09/30/2025

4. TITLE AND SUBTITLE

Improving MASCAL CASEVAC Efficiency: An Evaluation of Human Performance during Assisted and Unassisted Litter Carriage (Reprint)

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)

Oldham, R. T.[1], Robinette, A.[1,2], McGovern, S.[1,2], & Ballard, M. T.[1]

5d. PROJECT NUMBER

2020-009

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

U.S. Army Aeromedical Research Laboratory
P.O. Box 620577
Fort Rucker, AL 36362

8. PERFORMING ORGANIZATION REPORT NUMBER

USAARL-CNPA-BC--2026-28

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

U.S. Army Medical Research and Development Command
Combat Casualty Care Research Program
810 Schreider Street
Fort Detrick, MD 21702

10. SPONSOR/MONITOR'S ACRONYM(S)

CCCRP

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT

DISTRIBUTION STATEMENT A. Approved for public release: distribution unlimited.

13. SUPPLEMENTARY NOTES

[1]U.S. Army Aeromedical Research Laboratory; [2]Chenega Services and Federal Solutions, LLC

14. ABSTRACT

Introduction: In a potential conflict with a near-peer enemy, casualty evacuation is expected to be more difficult in mode and scale within large scale combat operations (LSCOs); evacuation teams may be required for litter-based extractions to deliver casualties to aid stations. The number of casualties expected in LSCOs will place high physical demand on the evacuation teams. The objective of this work was to evaluate human performance during litter carriage with and without assistive devices in a simulated mass casualty (MASCAL) scenario.
Methods: Eight, two-person litter teams volunteered to carry a weighted litter on a 50-meter course for 20 minutes per condition: with a shoulder harness (SH), with wrist hooks (WH), and unassisted (UA). Total time and timing of events were collected via custom software. The average casualty evacuation (CASEVAC) time by carry condition, representing the total time to evacuate one casualty, was calculated by averaging the time to pick up, carry, rest (if needed), and drop off the litter for all teams.

15. SUBJECT TERMS

Litter carriage, mass casualty, MASCAL, dismounted litter transport, casualty transport

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			Amanda Hayes, MS
UNCLAS	UNCLAS	UNCLAS	SAR	12	19b. TELEPHONE NUMBER *(Include area code)* 334-255-067

REPORT DOCUMENTATION PAGE (SF298)
(Continuation Sheet)

13. Supplementary Notes (continued)

Oldham, R., Robinette, A., McGovern, S., & Ballard, M. (2026, 3-6 August). *Improving MASCAL CASEVAC efficiency: An evaluation of human performance during assisted and unassisted litter carriage* [Oral presentation]. Military Health System Research Symposium, Kissimmee, FL.

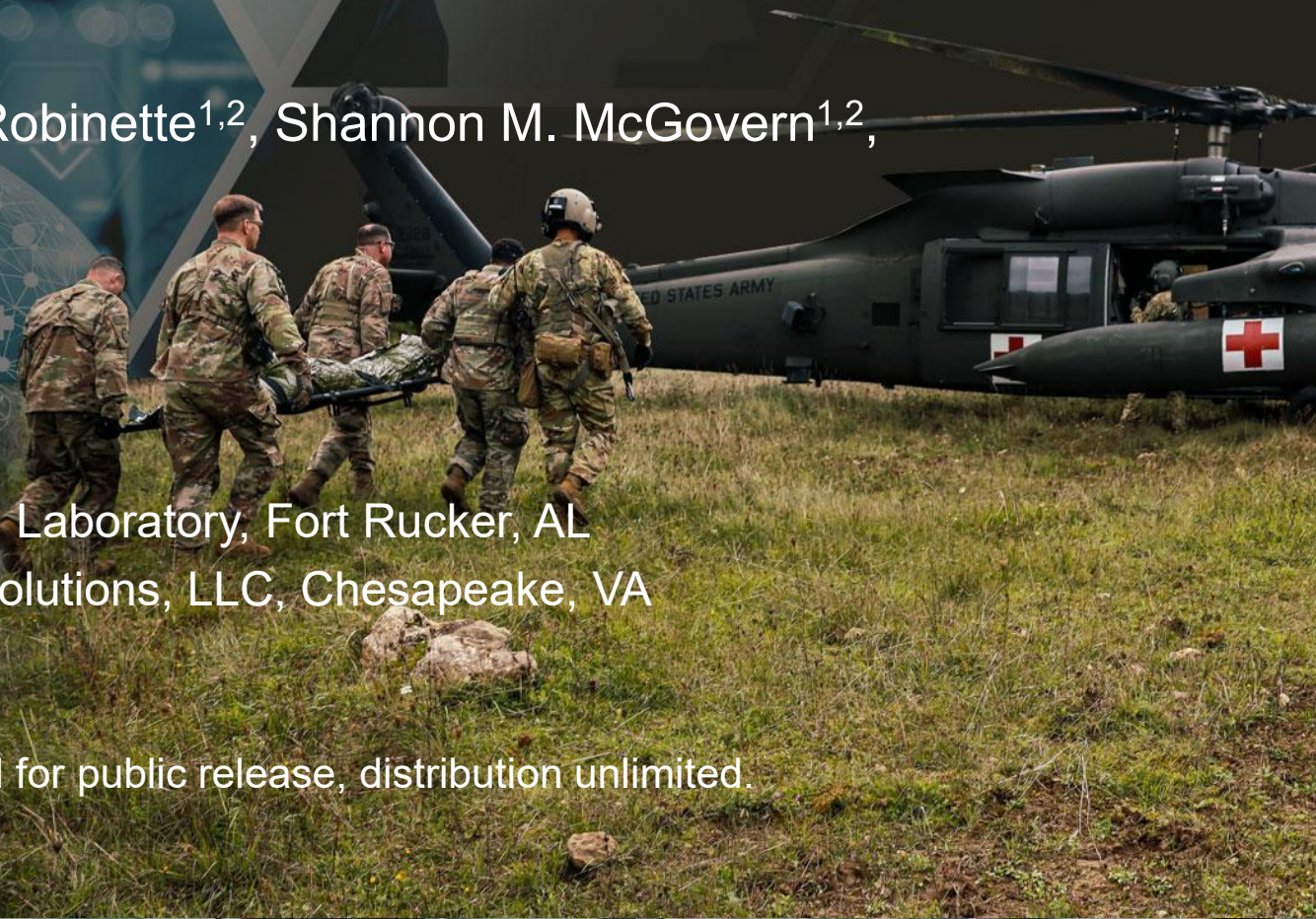
14. Abstract (continued)

Average speeds for all teams by carry condition were calculated from active litter movement including any needed rests, excluding pickup and drop-off times. One-way repeated measures ANOVAs were conducted to identify the effect of carry condition on CASEVAC time and average speed. Pairwise post-hoc analysis, with the Bonferroni correction, was conducted for any statistically significant ($p < 0.05$) findings.
Results: The average CASEVAC times of all carries were 73.30 seconds (s), 61.61 s, and 100.59 s for SH, WH, and UA, respectively. Pairwise post-hoc analysis revealed statistically significant differences between SH and WH, SH and UA, and WH and UA (p-adjusted 0.041, 0.038, and 0.012, respectively). The average speed was 2.59 miles per hour (mph), 2.90 mph, and 2.12 mph for SH, WH, and UA, respectively. Pairwise post-hoc analysis revealed statistically significant differences between SH and WH, SH and UA, and WH and UA (p-adjusted 0.005, 0.048, and 0.005, respectively).
Conclusion: Assisted carry conditions (SH and WH) had lower average CASEVAC times and faster average speeds than unassisted carry (UA). This suggests that assistive devices can improve MASCAL CASEVAC by allowing for less downtime and more casualty movement compared to unassisted carry. Faster evacuations with a two-person litter team are strategically crucial to increasing the survivability of wounded Service Members and those assisting with their evacuation.

Improving MASCAL CASEVAC: An Evaluation of Human Performance during Assisted and Unassisted Litter Carriage

Richard T. Oldham[1], Allison M. Robinette[1,2], Shannon M. McGovern[1,2], Matthew T. Ballard[1]

[1] U.S. Army Aeromedical Research Laboratory, Fort Rucker, AL
[2] Chenega Services and Federal Solutions, LLC, Chesapeake, VA

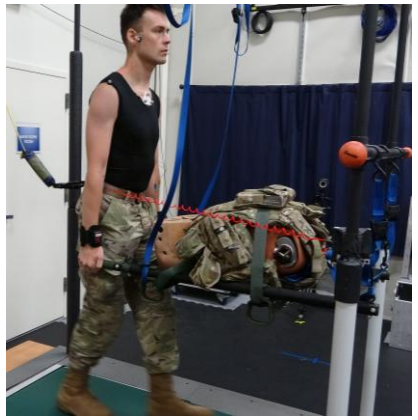


Disclaimer

The views, opinions and/or findings contained in this presentation are those of the author and do not necessarily reflect the views of the Department of Defense and should not be construed as an official DoD/Army position, policy or decision unless so designated by other documentation. No official endorsement should be made. Reference herein to any specific commercial products, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the U.S. Government.

Introduction

- **Dismounted litter carriage is a physically exhausting task**, often requiring Soldiers to stop for rests when conducted for extended periods.
- **Denial of ground vehicle and aircraft operating environments** is anticipated in future large-scale combat operations (LSCO) against near-peer adversaries, **increasing the need and difficulty of dismounted litter carriage**.
- This work builds on previous USAARL **litter carriage assistive device (LCAD)** research[1,2,3,4] to evaluate the **performance effects of LCAD in a simulated mass casualty (MASCAL) scenario**.




Methods

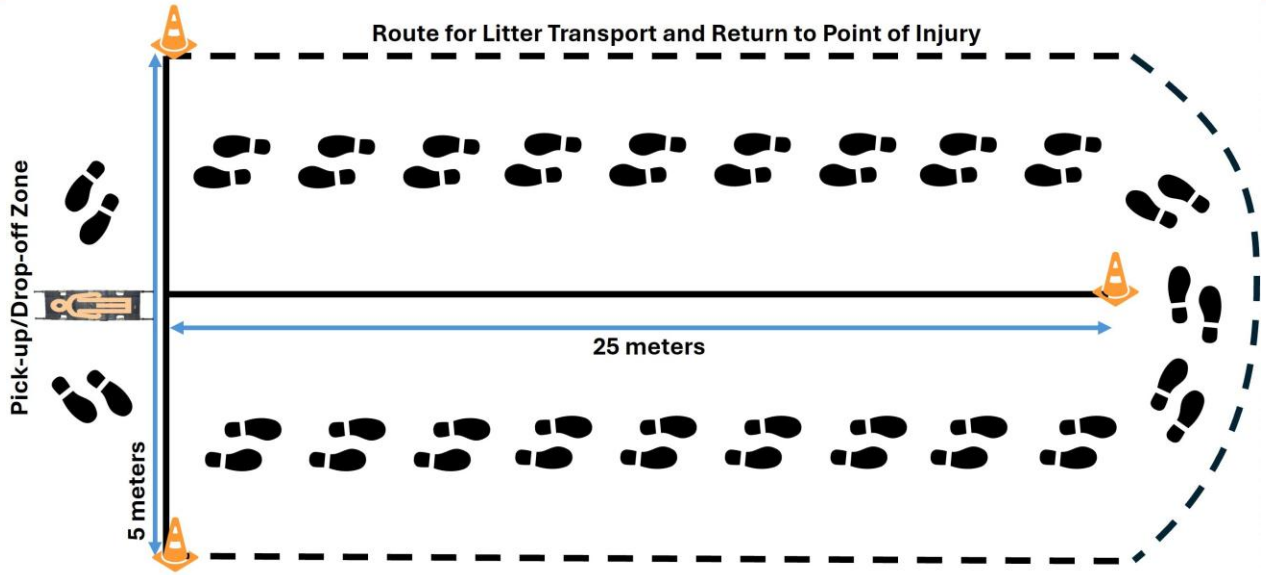
- **Objective:** Evaluate the effects of LCAD use on casualty transport performance during a simulated MASCAL
- IRB-approved protocol to recruit from DEVCOM SC Soldier Research Volunteer cohort (68Ws)
- Eight, 2-person litter teams completed three carry conditions:
  - Unassisted (UA)
  - Wrist Hooks (WH)
  - Shoulder Harness (SH)
- Conditions were counterbalanced to eliminate order effects
- Carry conditions were conducted for 20-minutes with a 20-minute rest period between each condition
- Litters were loaded with a 185-pound manikin, representative of a 50th percentile male

Shoulder Harness (SH)

Wrist Hooks (WH)

Methods

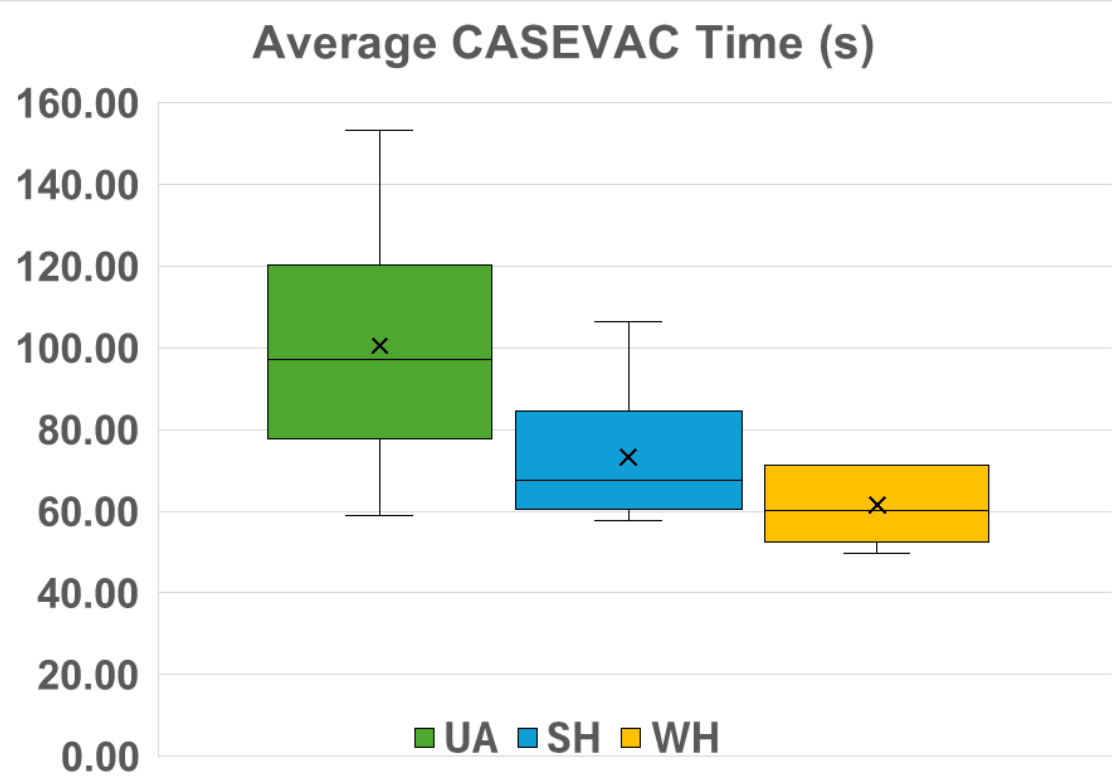
- Simulated MASCAL scenario:
  - 50-meter round-trip course
  - 2-person litter teams (*n* = 8) pickup, carry, drop off, and travel through course again to simulate return to point-of-injury
  - Tasks continued for 20 minutes per carry condition, with teams resting as needed
- **Metric: Average CASEVAC time**
  - Average time to transport a casualty including pickup, carry, rest (if needed), and drop off
- **Metric: Average speed**
  - Calculated from active litter movement (excluding pickup and drop off), including rests



Counterbalanced Test Matrix

Carry Conditions	Litter Carry Teams							
	1	2	3	4	5	6	7	8
1	UA	SH	WH	UA	WH	SH	UA	SH
2	SH	WH	UA	WH	SH	UA	SH	WH
3	WH	UA	SH	SH	UA	WH	WH	UA

Results: Average CASEVAC Time



	CASEVAC Time (s)		
AVG	100.6[a,b]	73.3[a,c]	61.6[b,c]
SD	29.9	16.5	9.0

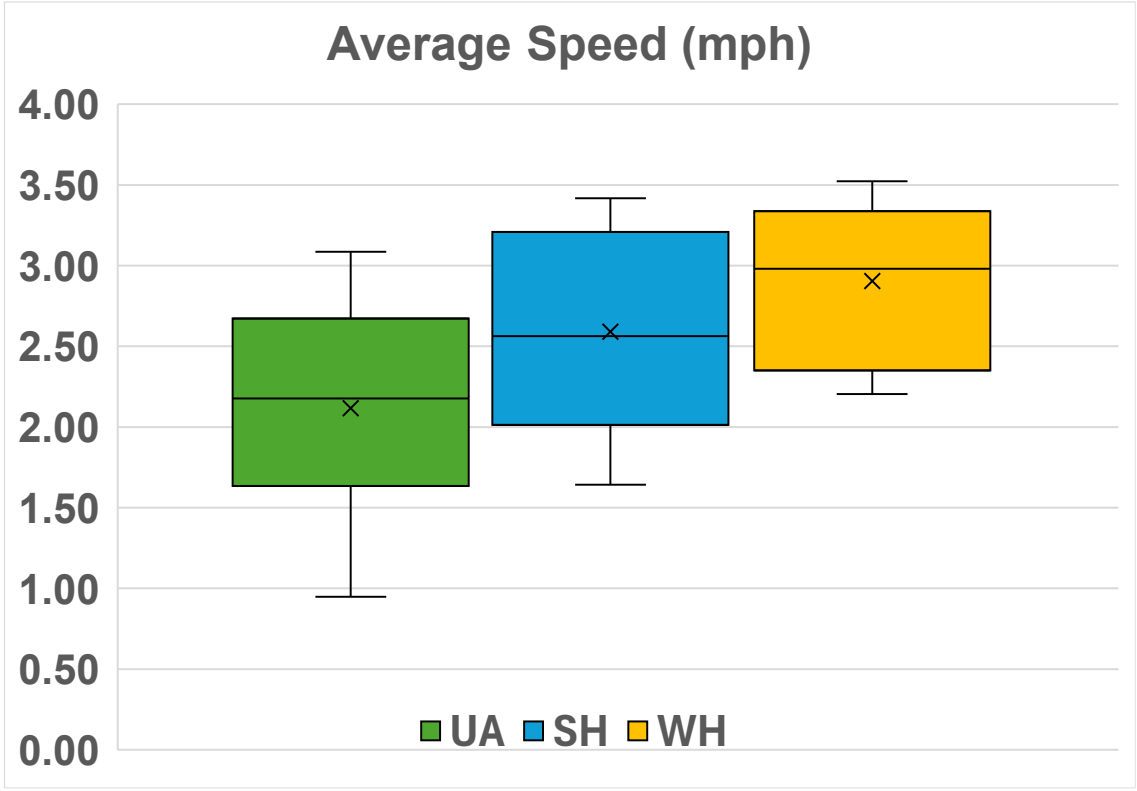
- One-way repeated measures ANOVA with pairwise Bonferroni corrected post-hoc found statistically significant differences[a,b,c] between:
  - [a] UA & SH (p_{adj} = 0.038)
  - [b] UA & WH (p_{adj} = 0.012)
  - [c] SH & WH (p_{adj} = 0.041)
- Both LCADs resulted in shorter average CASEVAC times than UA
- SH ~30% shorter than UA
- WH ~40% shorter than UA

Note: [a,b,c] indicate statistically significant differences

Results: Average Speed

- One-way repeated measures ANOVA with pairwise Bonferroni corrected post-hoc found statistically significant differences[a,b,c] between:
  - [a] UA & SH (p_{adj} = 0.048)
  - [b] UA & WH (p_{adj} = 0.005)
  - [c] SH & WH (p_{adj} = 0.005)
- Both LCAD resulted in faster average speeds than UA
- SH 0.47 mph faster than UA
- WH 0.78 mph faster than UA

Note: [a,b,c] indicate statistically significant differences



	Average Speed (mph)		
AVG	2.12[a,b]	2.59[a,c]	2.90[b,c]
SD	0.69	0.63	0.50

Discussion

- Results from this effort show **LCAD use can increase litter bearer performance** by **lowering the average CASEVAC time** per casualty and **increasing the average carry speed** as compared to unassisted carry (UA) in a MASCAL scenario.
- While **both LCADs showed improvements over unassisted carry**, the WH outperformed SH in both CASEVAC time and speed.
- Prior LCAD research conducted by USAARL showed the SH outperformed WH in prolonged carry scenarios, with both LCADs still outperforming UA.
- Outcomes from USAARL's LCAD research program demonstrate LCADs exhibit worthy performance benefits over UA across various modes of dismounted casualty transport.

Conclusions

- **LCAD use improves dismounted mass casualty transport, providing less downtime and more casualty movement compared to unassisted carry.**
- This study, along with USAARL's previous work[1,2,3,4], exhibits that LCADs can facilitate the dismounted transport of casualties faster, farther, and with fewer people than unassisted carry.
- Given the potential CASEVAC challenges in future operations, non-complex LCADs such as the devices depicted here need to be incorporated into military equipment to improve litter carriage.
- USAARL's future work aims to use knowledge gained from LCAD research in developing a standard methodology for the evaluation of litter carriage exoskeletons, to facilitate the deployment of future LCAD technologies.

References

[1] Ballard, M. T., et al. (2023). *Evaluation of litter carriage performance and post-carry fatigue effects in prolonged combat field care environments (Part 2): Effects of assistive device use during simulated litter transport* (USAARL-TECH-FR--2024-06).

[2] Ballard, M. T., et al. (2025). *Effects of commercial-off-the-shelf assistive devices on long-range field-based litter carriage* (USAARL-TECH-TR--2025-23).

[3] Madison, A. M., et al. (2023, August 14). *Effects of assistive device use on carry distance and grip strength during simulated litter transport* [Oral Presentation]. MHSRS 2023, Kissimmee, FL.

[4] Stewart, A. S, et al. (2024). *Preliminary field evaluation of assistive devices on carry distance and time during two-person litter transport scenarios* (USAARL-CNPA-BC--2024-39).

QUESTIONS?

Matthew Ballard, matthew.t.ballard7.civ@health.mil

Connect With Us

"Military medicine is not just about treating injuries; it's about ensuring the health and readiness of those who serve, so they can accomplish their mission and return home safely."

- MG Paula C. Lodi, Commanding General, USAMRDC

U.S. ARMY AEROMEDICAL RESEARCH LABORATORY

FORT RUCKER, ALABAMA

Optimizing

HUMAN PROTECTION AND PERFORMANCE

since 1962

U.S. ARMY

FCC

MRDC