


Contemporary Modes of Conveyance:
Research Highlights

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Outline

- Statistics, background
- Studies of modes of conveyance
  - Stair descent devices
  - Cots
- Adapting to change

Number of jobs, EMTs & Paramedics: 241,200
Job Outlook, 2014-2024: +24%
BLS

2014 Incidence rate for EMS and paramedics: 184 per 10,000 FTE, musculoskeletal disorders (MSDs) BLS

2014 Incidence rate for EMS and paramedics: 333 per 10,000 FTE, all injuries and illnesses BLS

The most common events were overexertion (12,146, 56%), falls (2,169, 10%), and transportation-related (1,940, 9%). Maguire & Smith, 2013

2014 number of cases, all injuries and illnesses for EMS and paramedics: 7010 cases BLS

A total of 14,470 cases (67%) involved sprains or strains; back injury was reported in 9,290 of the cases (43%); and the patient was listed as the source of injury in 7,960 (37%) cases. Maguire & Smith, 2013

2014 number of cases, MSDs for EMS and paramedics: 3880 cases BLS

Contributing factors: stairs/steps in private residence; activity involving cot Furber et al., 1997

Modes of conveyance – there is a *statistically significant* difference

- Evidence of reduced physical stress:
  - Less muscle activity = less force required → less muscle fatigue
  - Reduced ground reaction force = less weight supported by paramedic
  - Reduced perceived exertion

- Other important measures include:
  - Time to complete task

Where does it seem that people who need transport are located?

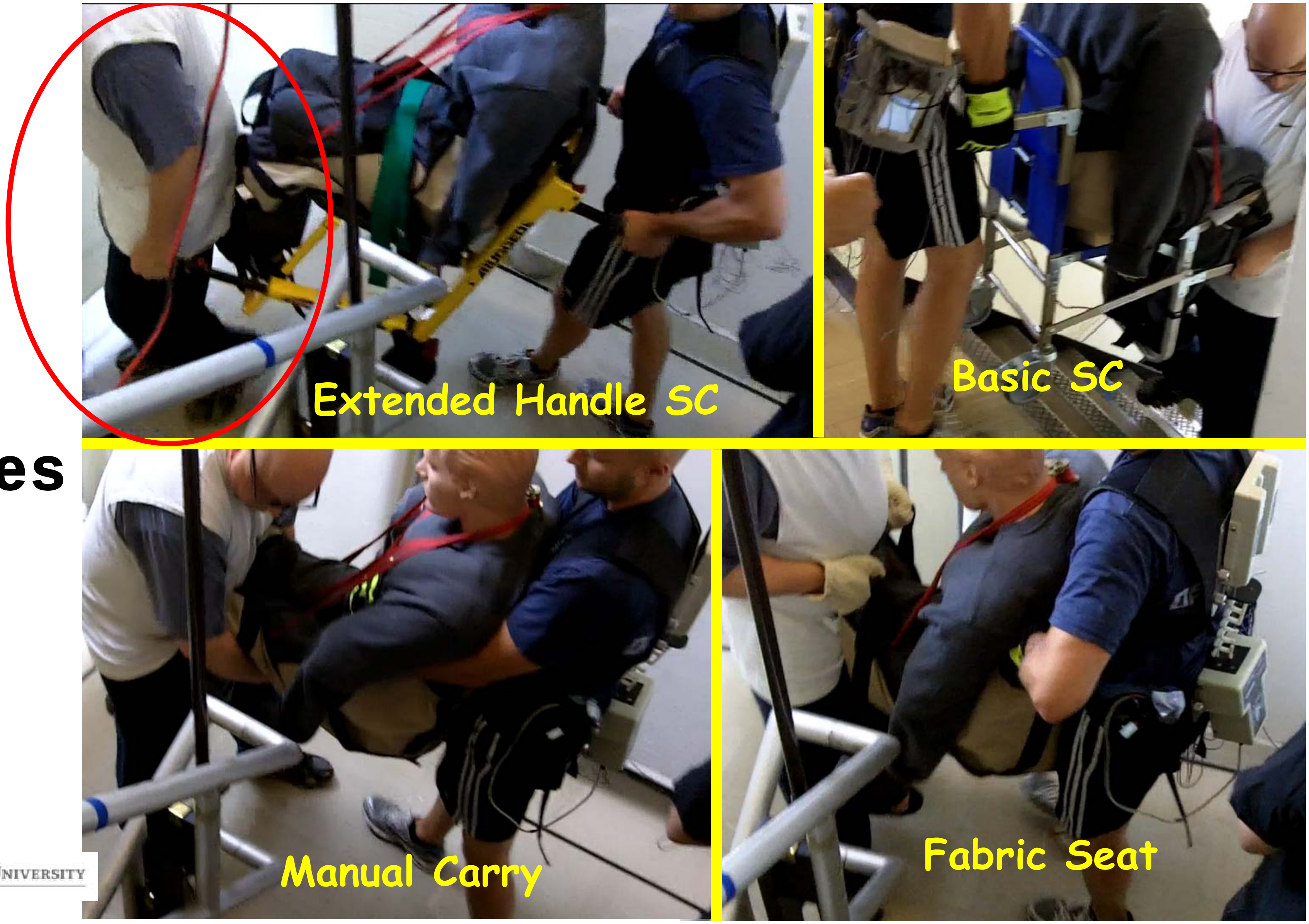
Why can't all homes be single story homes?

Research Study *(FEMA 2009-EMW-FP-01944)*

- Objectives: Evaluate different **stair descent devices** for evacuating individuals when stair descents are required.

- Types of devices: Carried, Track, Sled
- Measure:
  - Physical demands
  - Performance (evacuation speed)
  - Usability
- Task factors:
  - Staircase Width (0.91, 1.12, 1.32 m)
  - Urgency (Urgent, non-urgent)

Hand Carry Devices



Track-Type Devices

Long Track
(Garaventa)

Rear Facing
(Glider)

Narrow
(AOK)

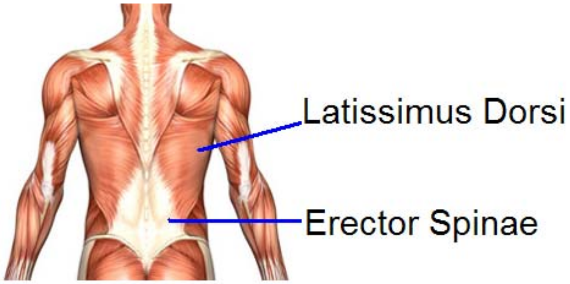
2-Wheeled
(Evac+Chair)

Standard
(Ferno EZ-Glide)

Sled-Type Devices

Research methods

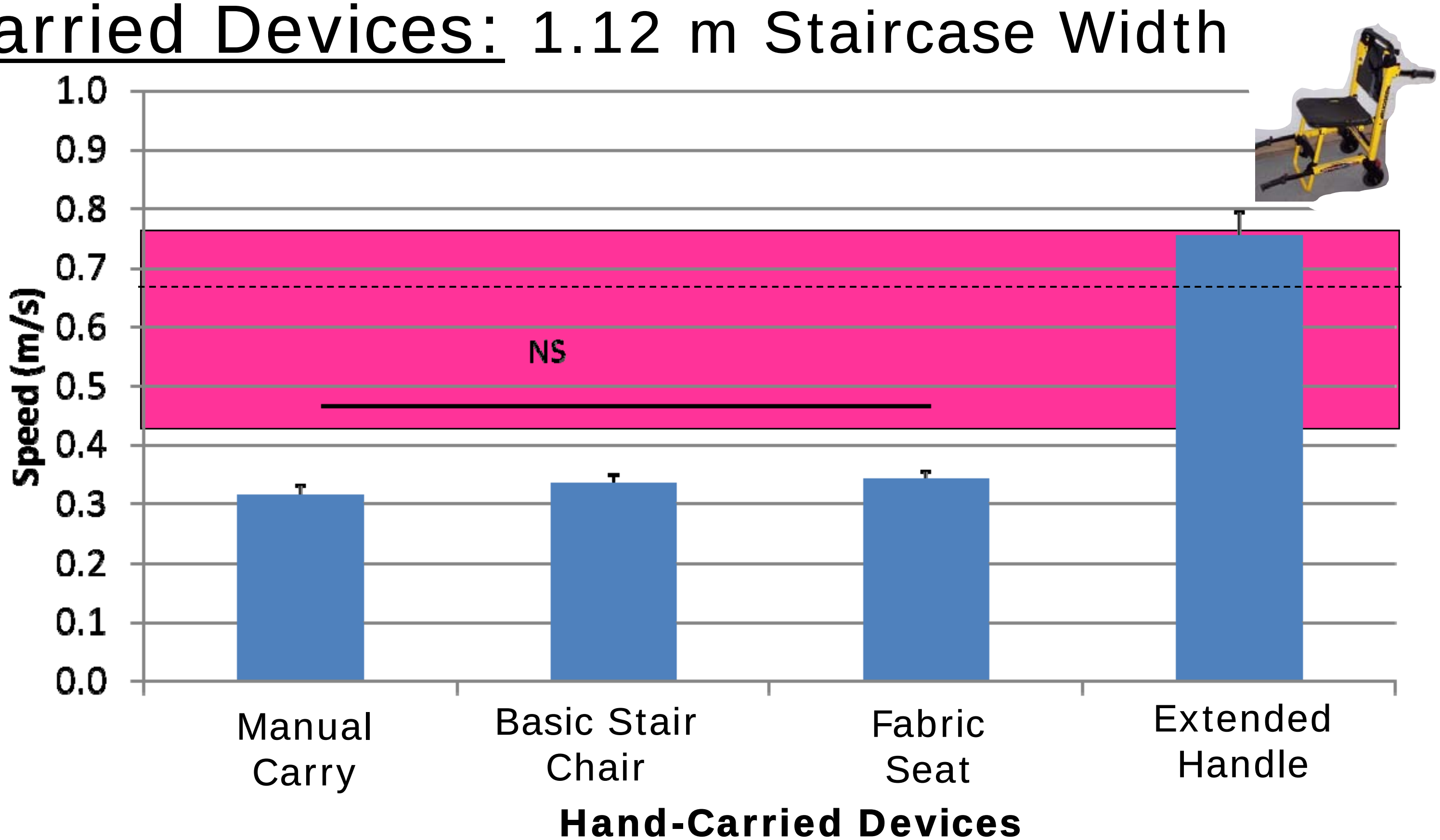
- Study participants: 12 experienced male firefighter-paramedics
- Patient: Rescue Randy (73 kg=160 lbs)
- Measurements:
  - ✓ Duration of evacuation
  - ✓ Electromyography: trunk, shoulder, arms
  - ✓ Heart Rate
  - Perceived exertion ratings
  - Spine motion
  - Usability information via post study interview



Findings

Stair Descent Speed:

Hand-Carried Devices: 1.12 m Staircase Width

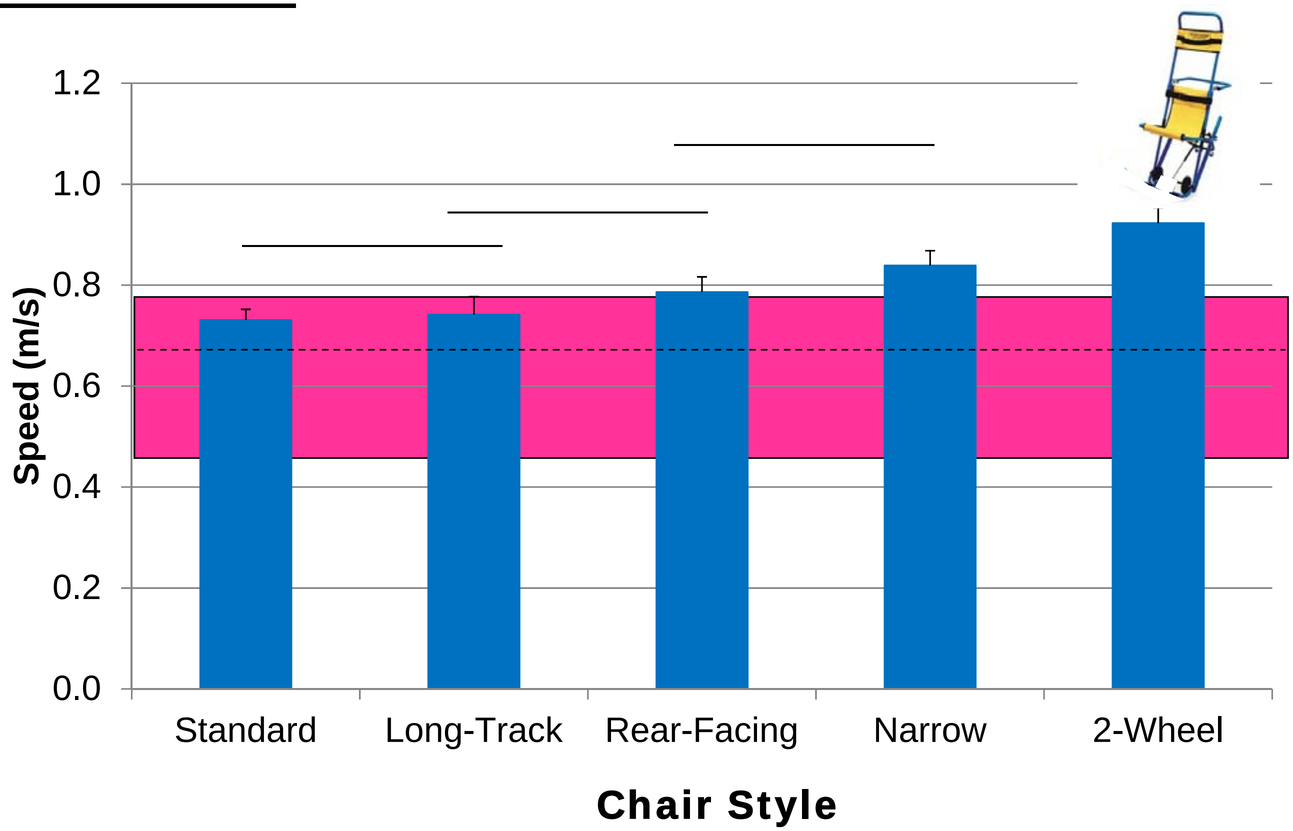


Range based on samples obtained by Peacock, Hoskins, Kuligowski (2012) Safety Science 50, 1655–1664, table 3.

-------- Fruin, J.J. (1971). Pedestrian Planning and Design, All age average, pg 56.

Stair Descent Speed

Track-Type Devices: 1.12 &1.32 m staircase widths



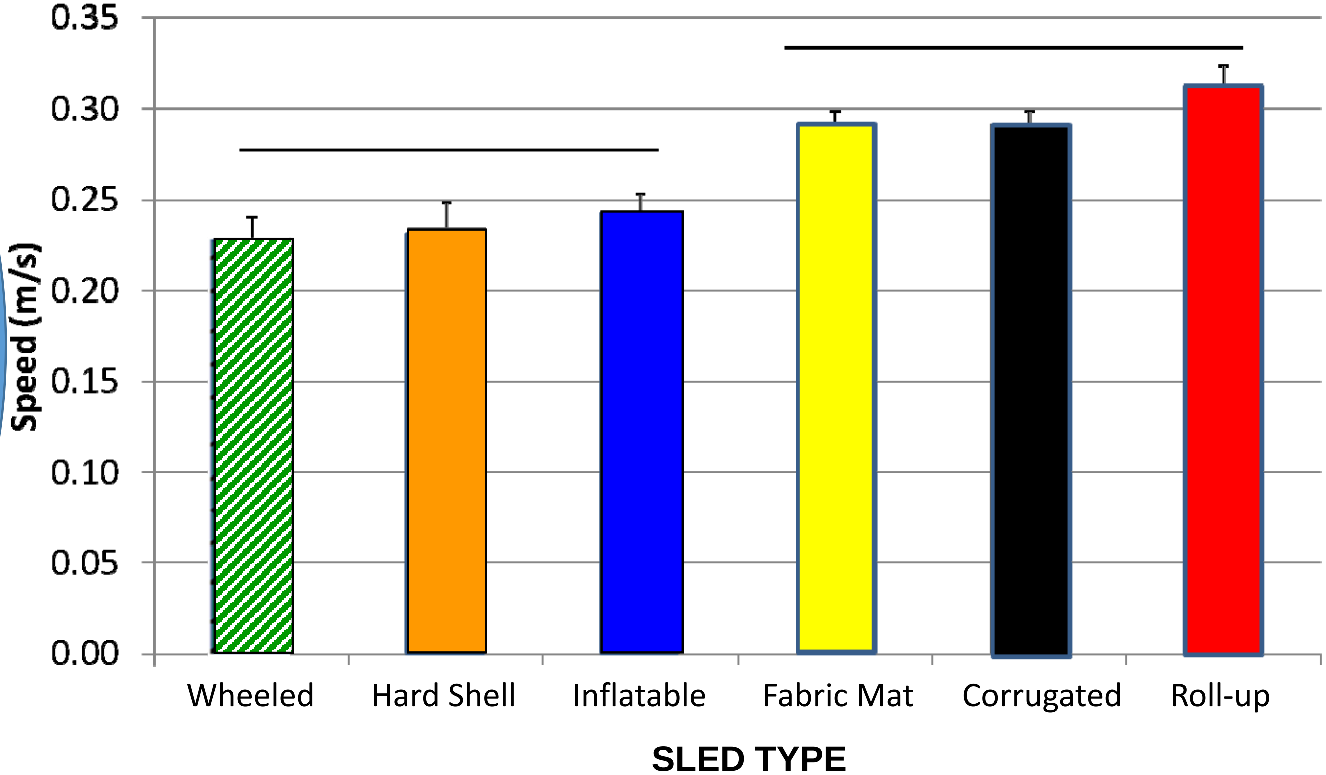
Range based on samples obtained by Peacock, Hoskins, Kuligowski (2012) Safety Science 50 1655–1664, table 3.

-------- Fruin, J.J. (1971). Pedestrian Planning and Design, All age average, pg 56.

Stair Descent Speed:

<u>Sled Devices</u>: 1.12 and 1.32 m Staircase Widths

Slow, compared to track style and extended handle hand-carry device



p values (Width <***0.001*** Device <***0.001*** Device x width = *0.553)*

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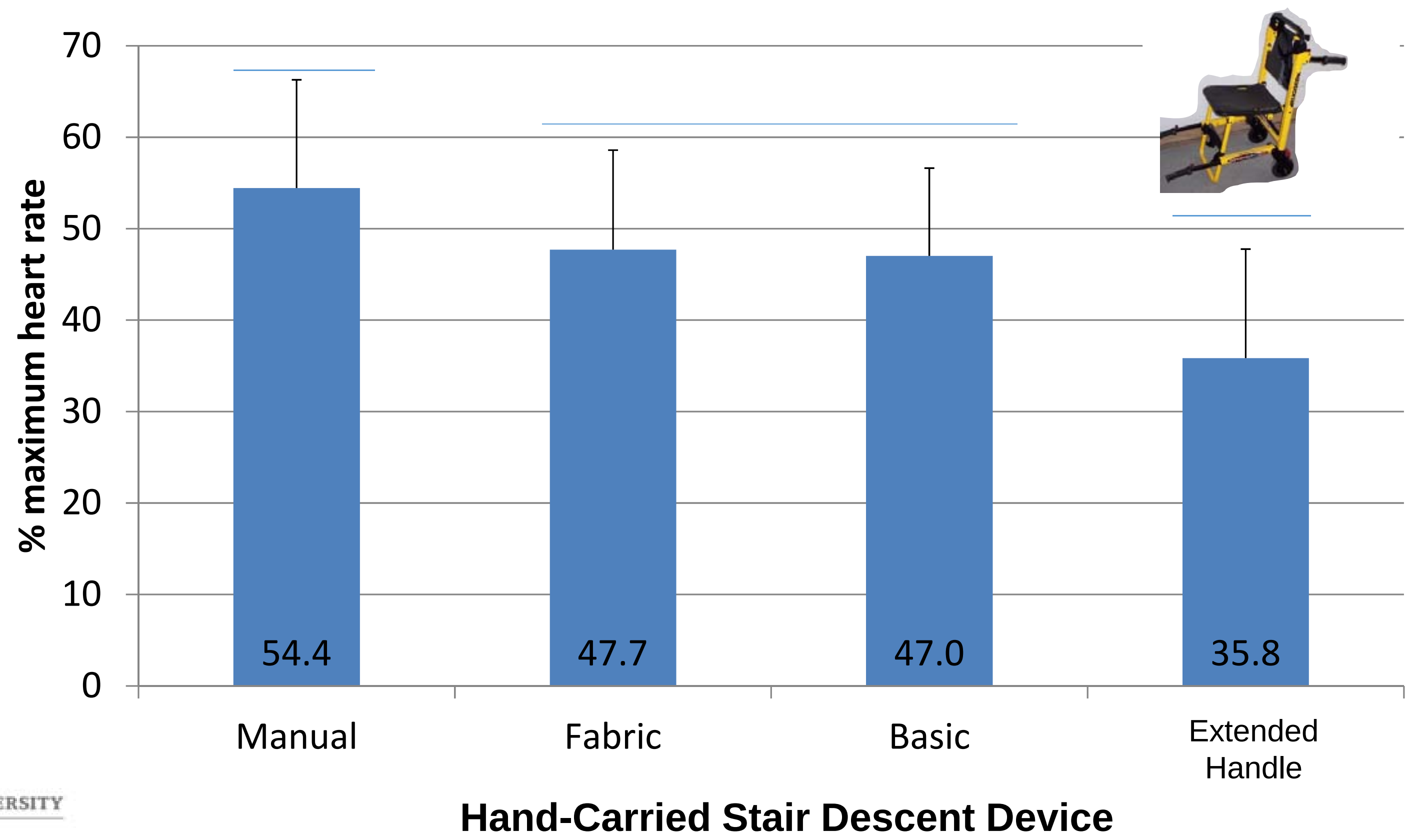
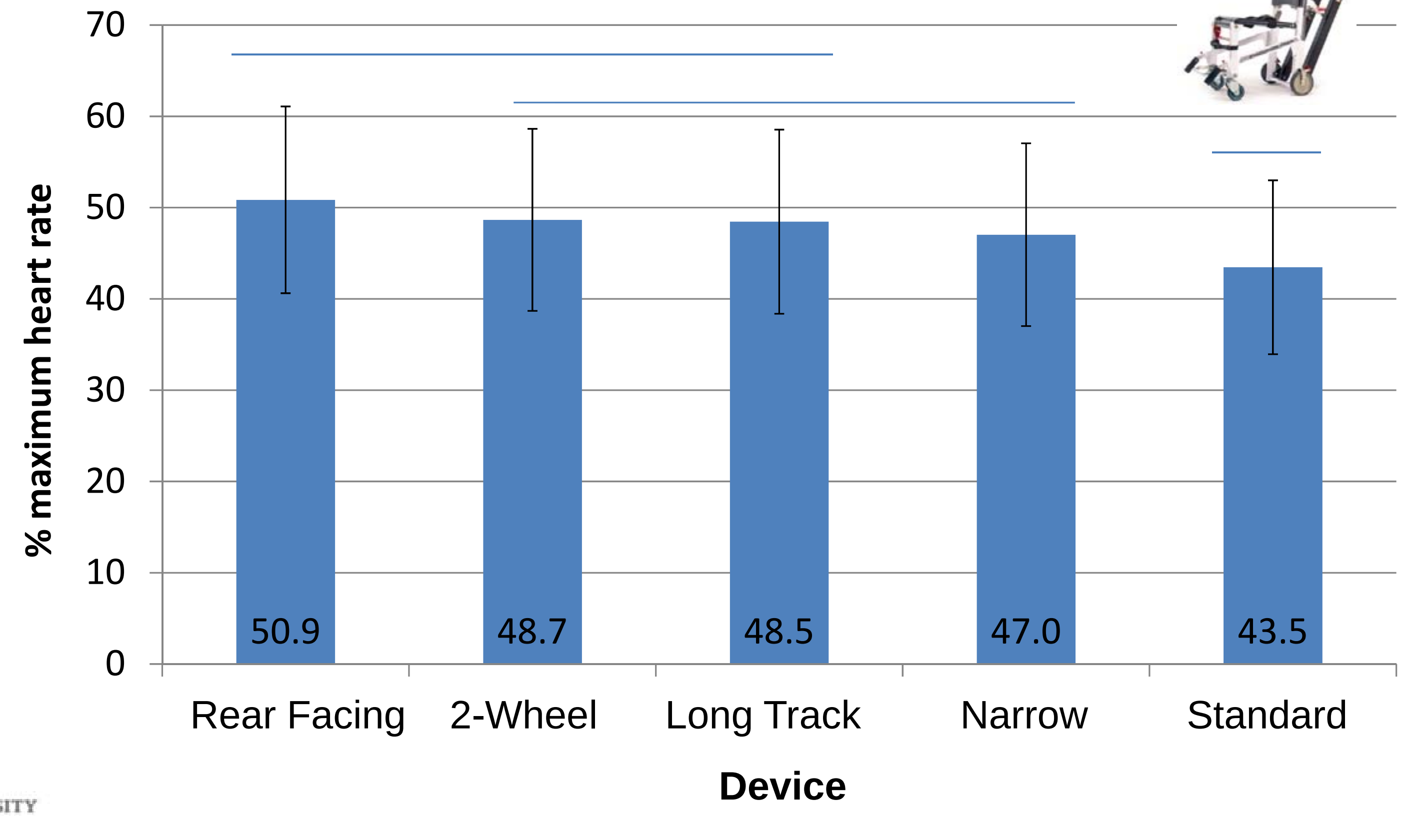
Heart Rate – Percent Max

<u>Hand Carried Devices</u>



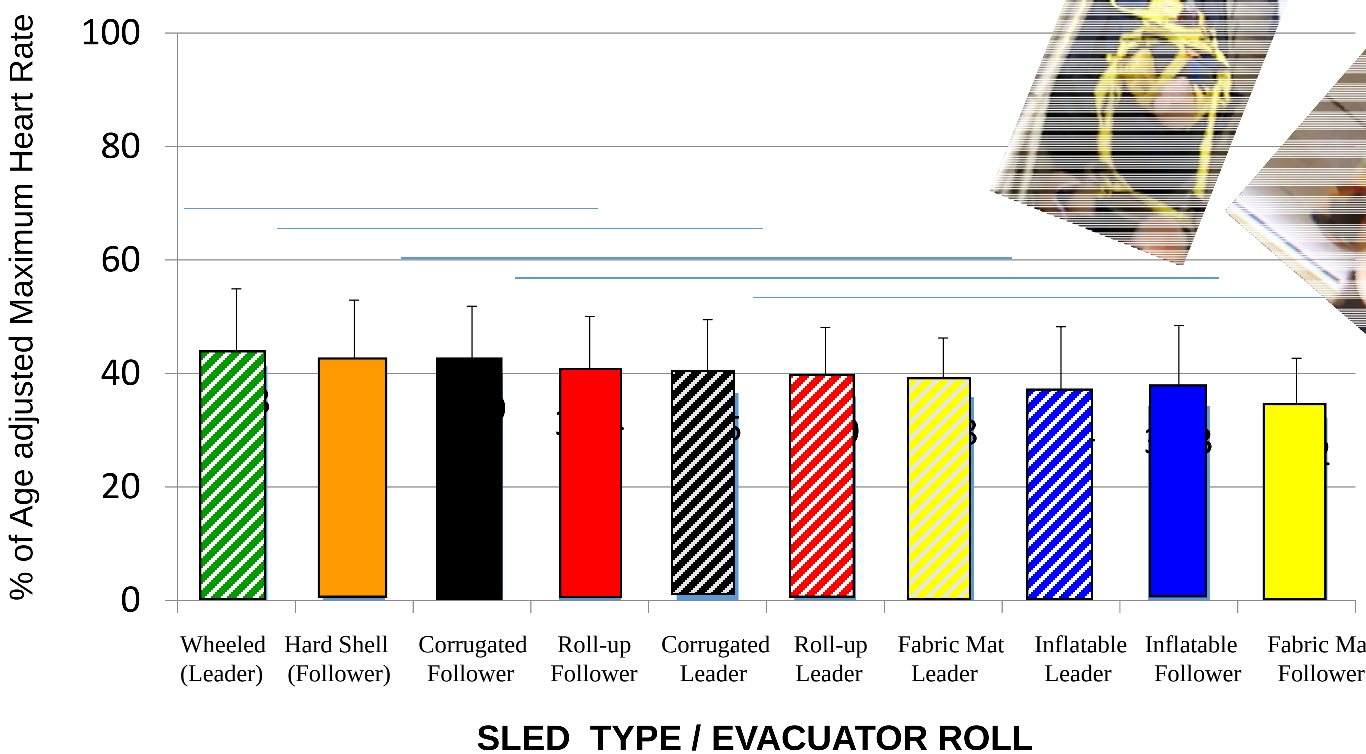
Heart Rate – Percent Max

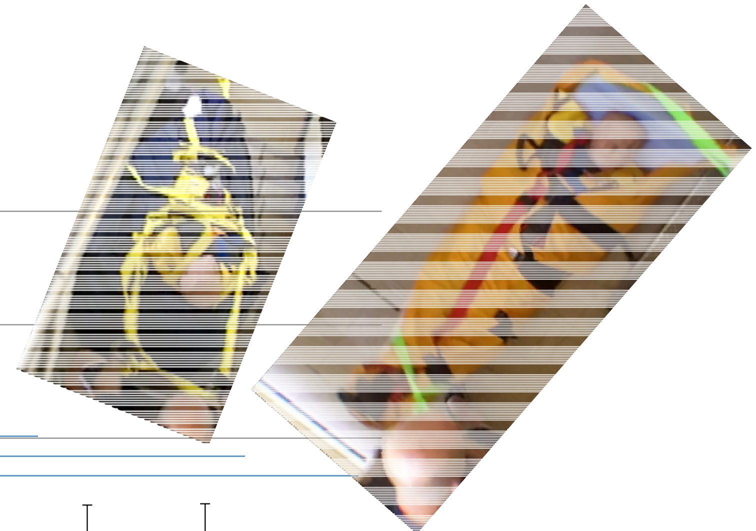
Track-type Devices



Heart Rate – Percent Max

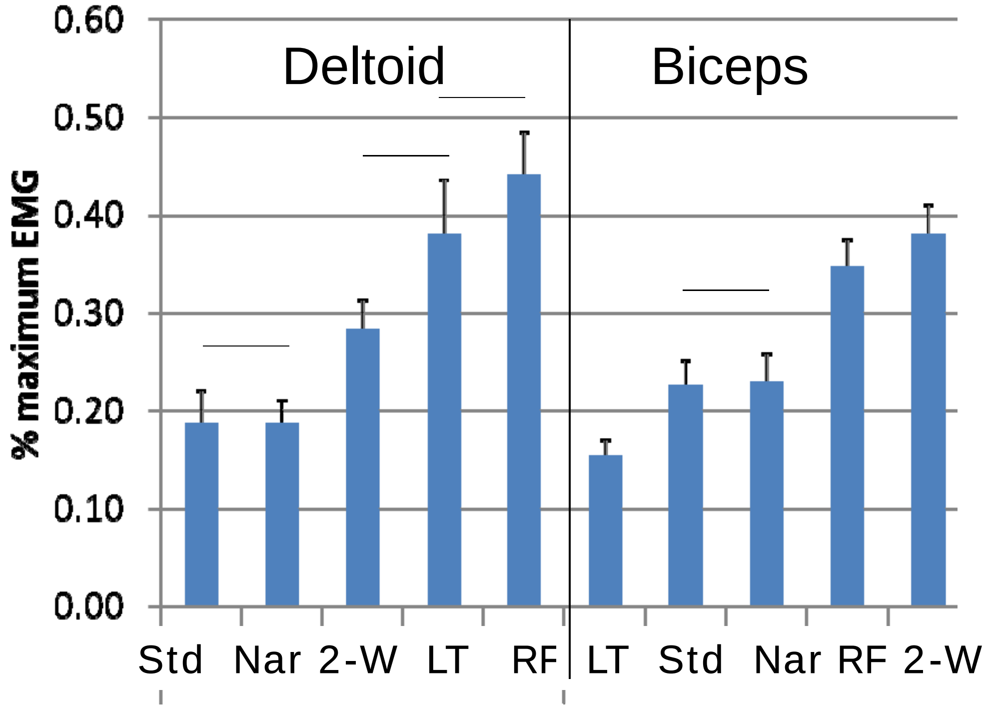
Sled Type Devices





Arm and Shoulder Muscle Activity:

Track Type Devices: Landing, 1.12 and 1.32m



2-W=2-Wheel / **Nar** = Narrow / **Std** = Standard/ **RF** = Rear-Facing / **LT** = Long-Track

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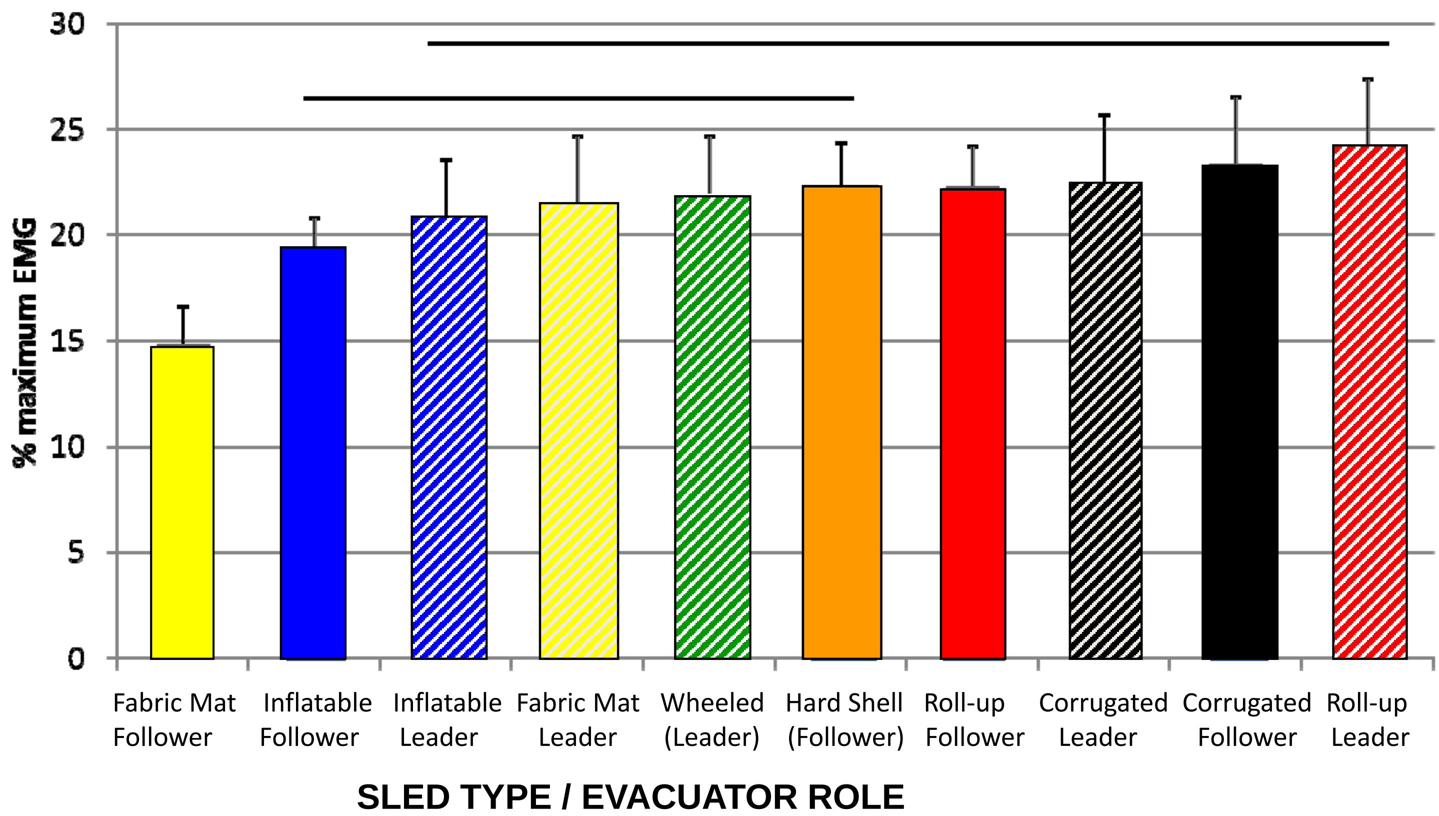
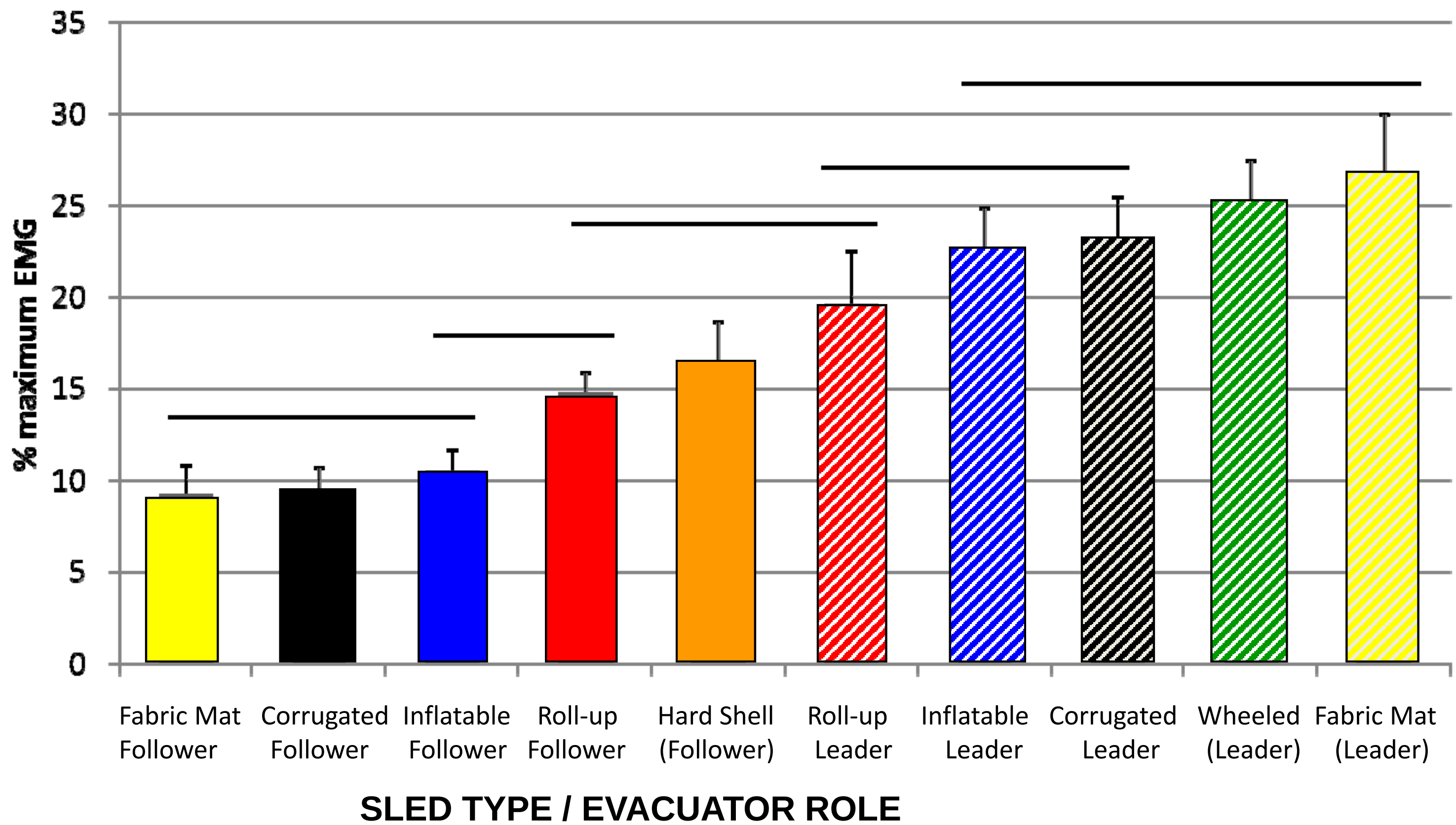
Back (Erector Spinae) Muscle Activity:

Sled Type Devices:



Back (Latissimus Dorsi) Muscle Activity:

Sled Type Devices: Landing



Objective Measures - Analysis Summary

Device	Positives	Negatives
Hand-Carried	Less Expensive	Higher physical demands; Slower – Unless lead person can face forward
Track-type	Reduced back muscle use; Faster	Latissimus use – on stairs, landings
Sled-type	Low muscle demands on stairs.	Transfer in/out; High demands on landing

Conclusions from Stair Descent Device Studies

- Track-type devices – several advantages:
  - Evacuation speed
  - Physical demands
  - Ingress / Egress for occupant
- If a hand-carried device is used, device width and handles should support lead person descending facing forward

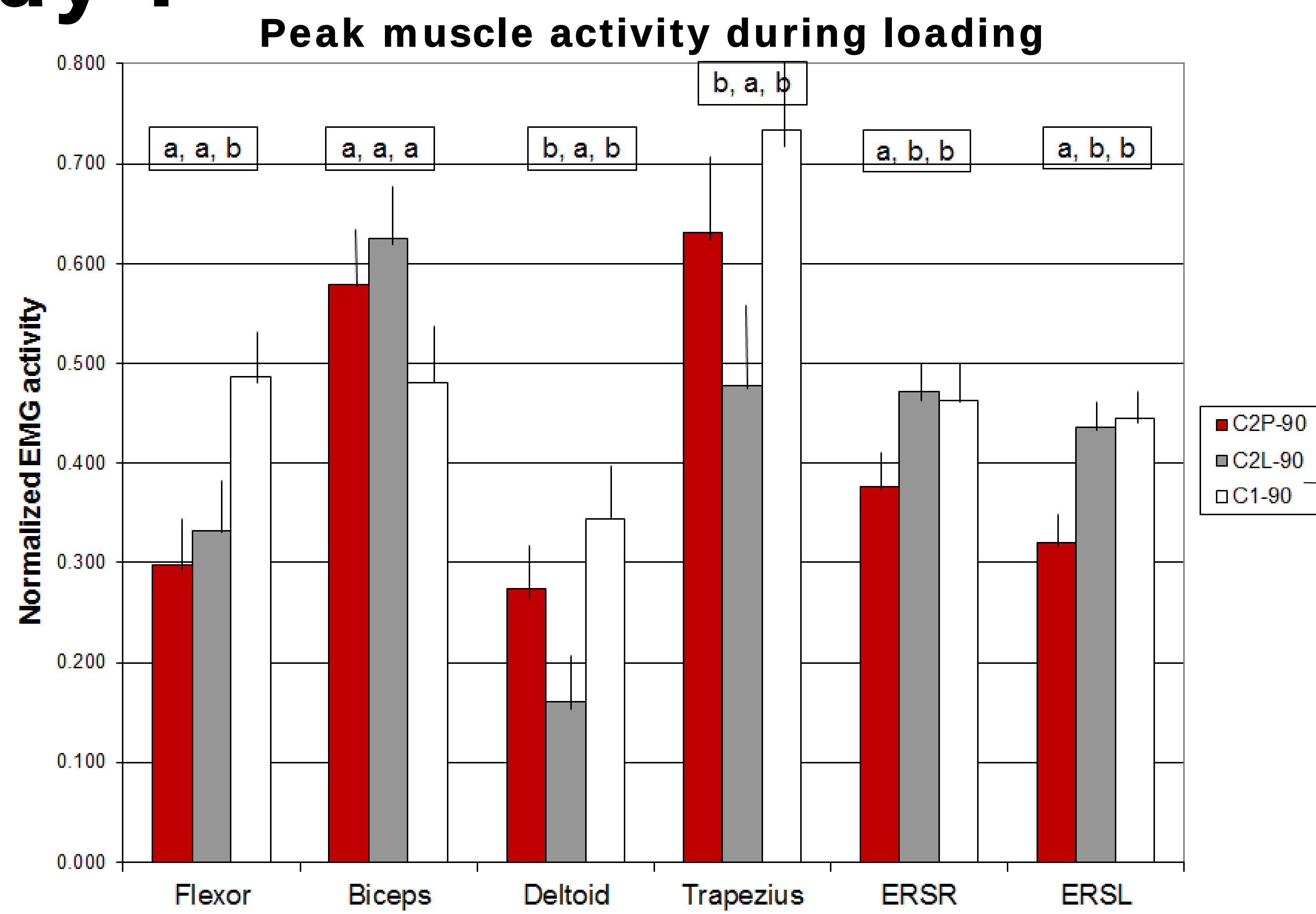
Cot study I – manual cots

- Design characteristics investigated:
  - Leg folding mechanism
  - Handle design options

- Research methods:
  - 15 experienced EMTs & paramedics (4 F)
  - Lab-based study
  - Tasks: load, unload, raise
  - Weight: 23kg for F, 45 kg for M
  - Measurements: muscle activity, joint stress, subject ratings (RPE), task time

Cot study I

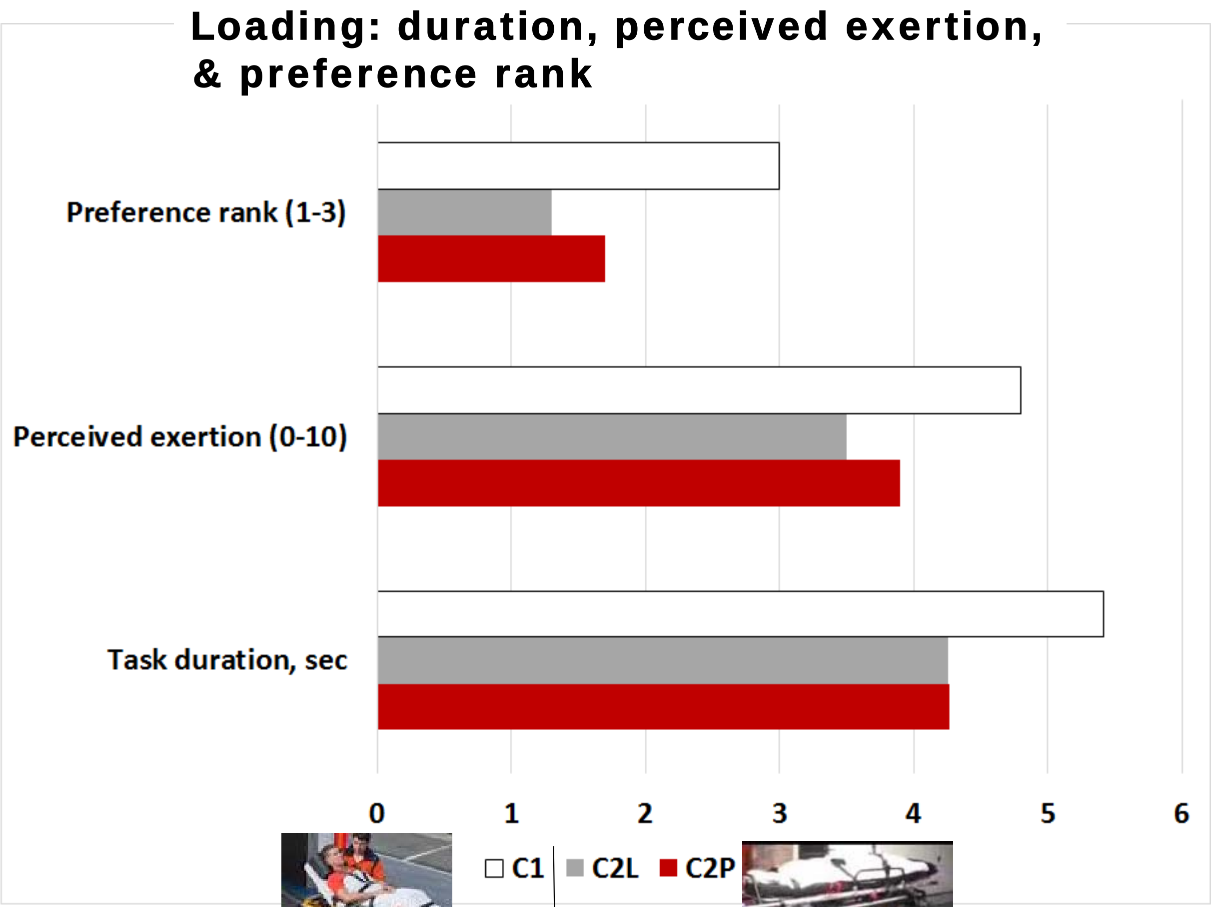
- Findings



Muscles: arm shoulder back

Cot study I

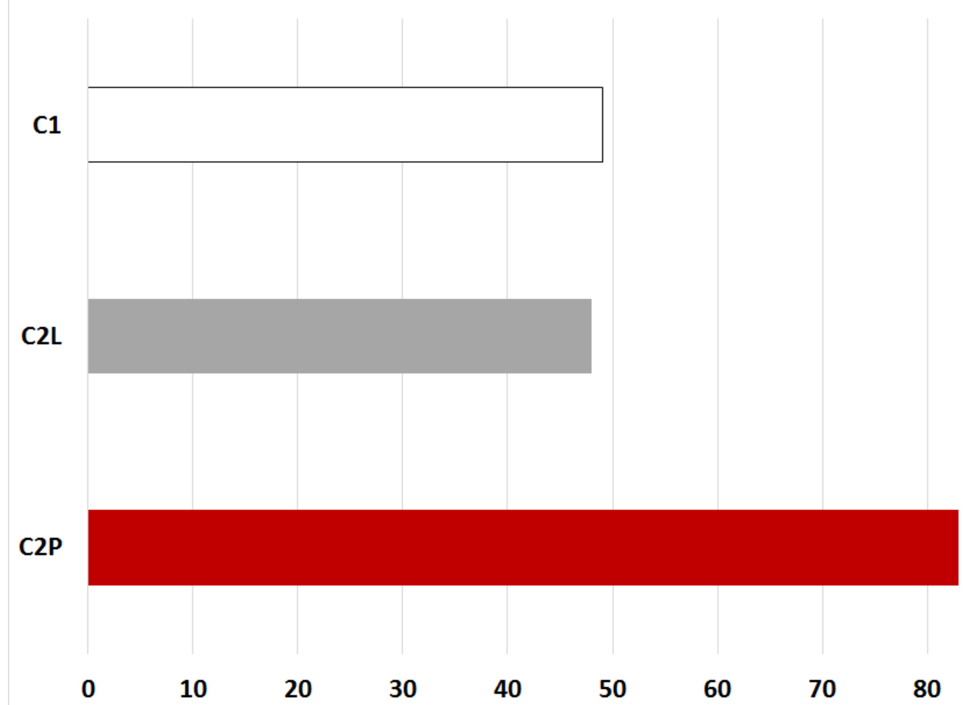
- Findings, cont.



Cot study I

- Findings, cont.

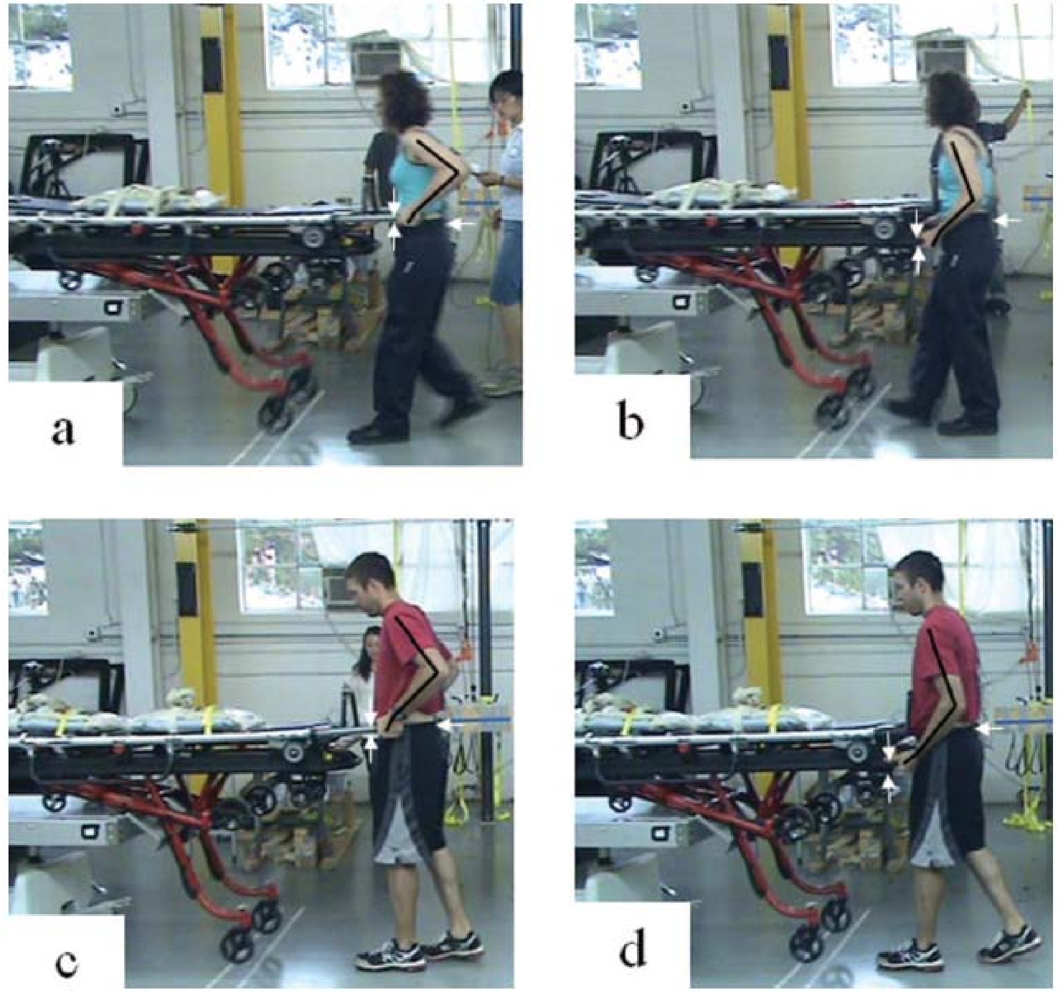
Loading: Percentage of trials where legs support weight of cot



Cot study I

- Unloading: Interaction of subject height and handle design

Pull-out handles | Loop handle



S's ht= 167 cm

S's ht= 190 cm

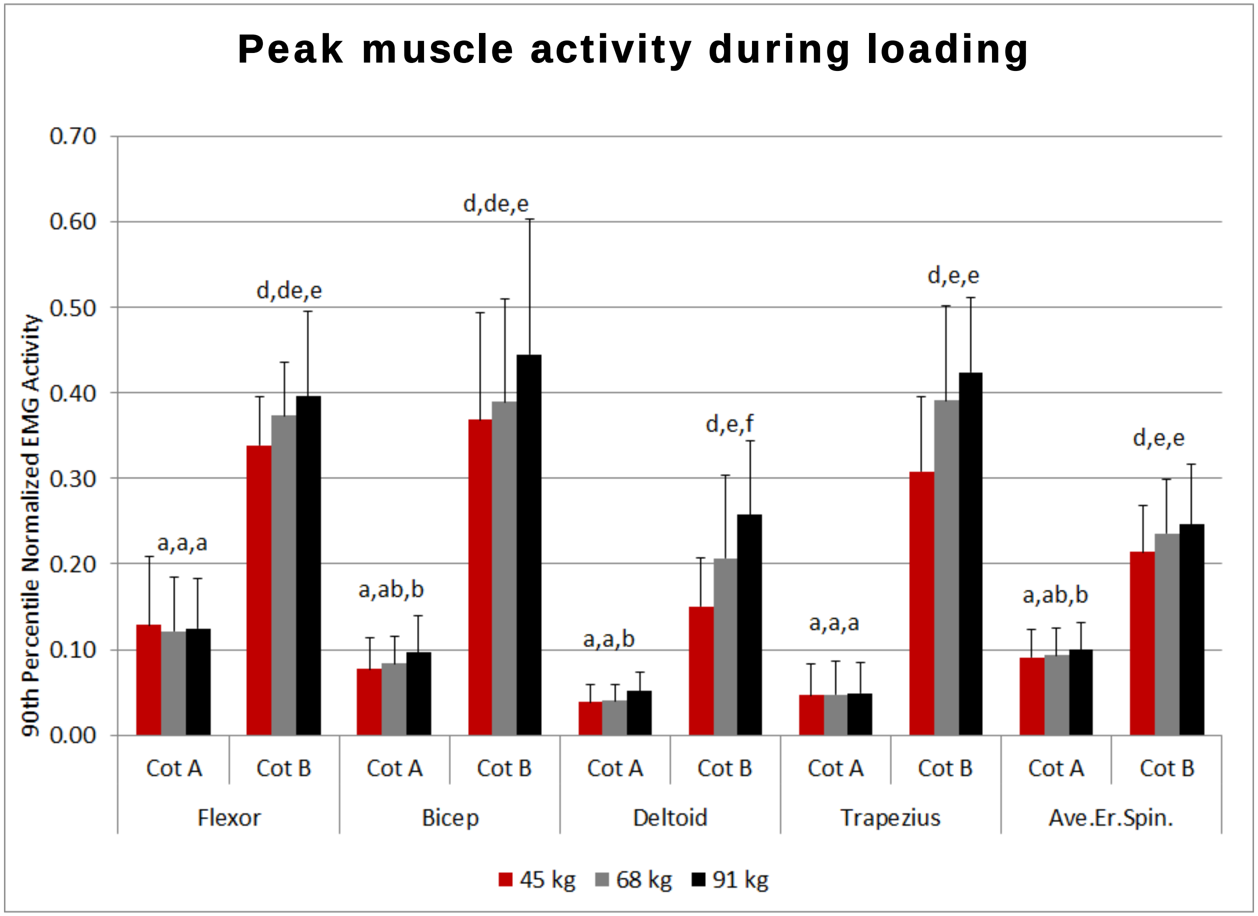
Cot study II – powered cots

- Design characteristics investigated:
  - Leg folding mechanism

- Research methods:
  - 16 experienced male EMTs & paramedics
  - Lab-based study
  - Tasks: load, unload
  - Weight: 45, 68, 91 kg
  - Measurements: muscle activity, ground reaction force, subject ratings (RPE), task time

Cot study II

- Findings



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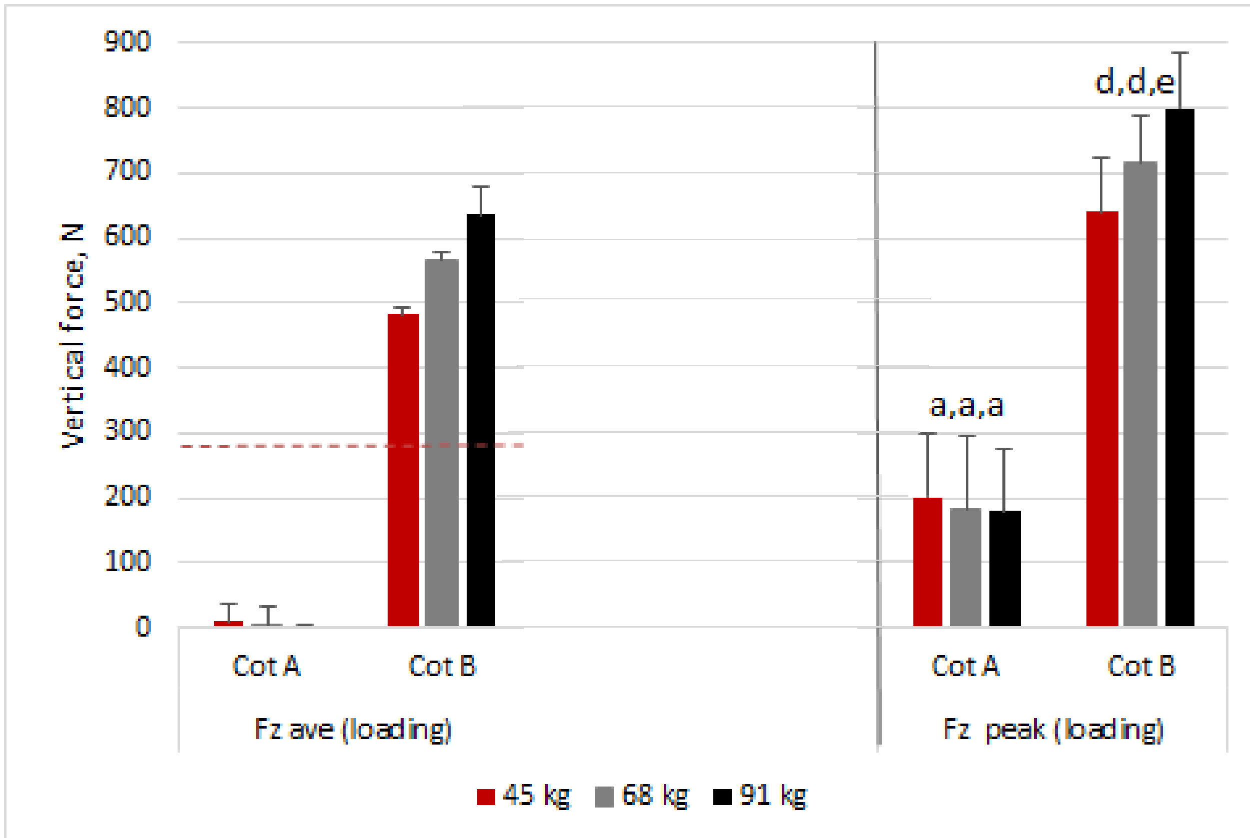
Cot study II

Vertical ground reaction forces, less participant's body weight, represent external holding and peak vertical loads experienced

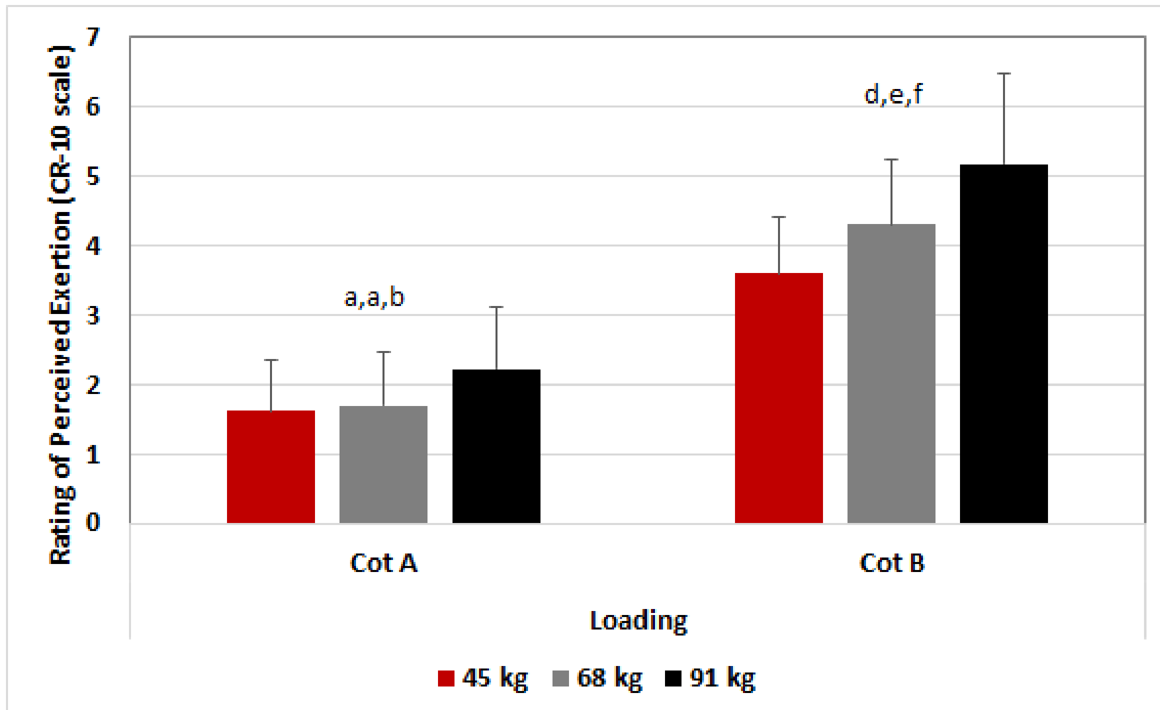
- Findings, cont.



Cot study II

- Findings, cont.

Perceived exertion



Cot study II

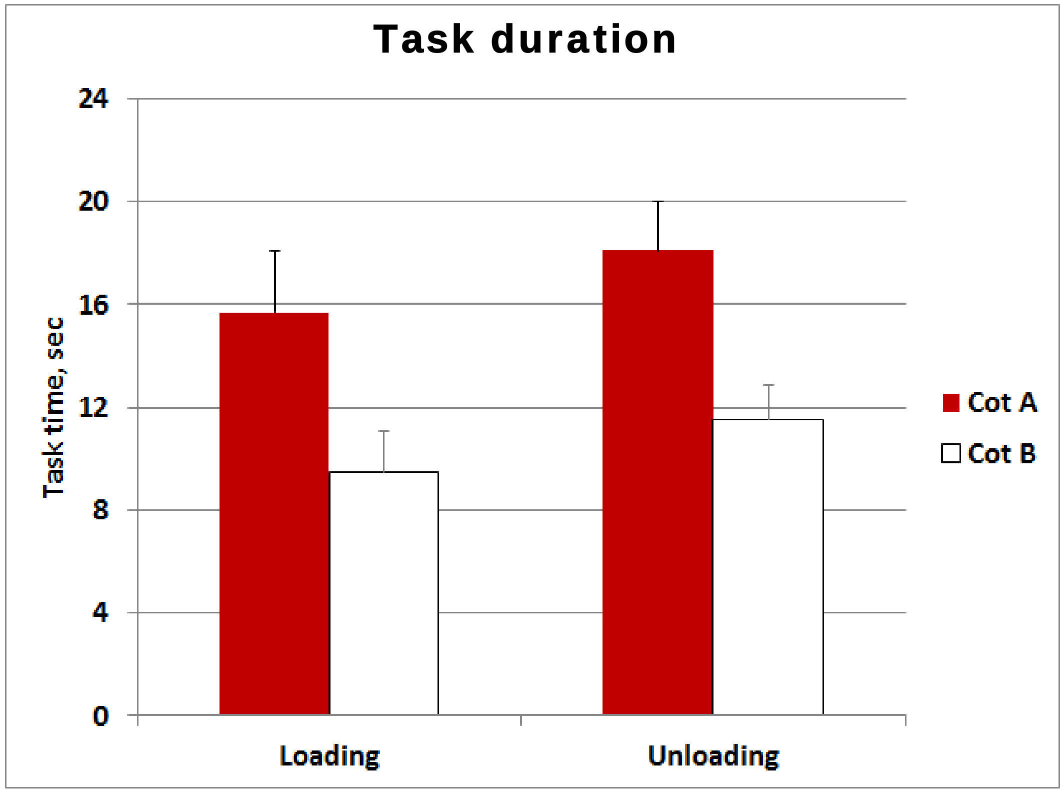
- Findings, cont.

- Perceived task time:

  "I think that the legs of this cot fold and unfold too slowly."

  Cot A – somewhat disagree

  Cot B – somewhat agree - agree



Change

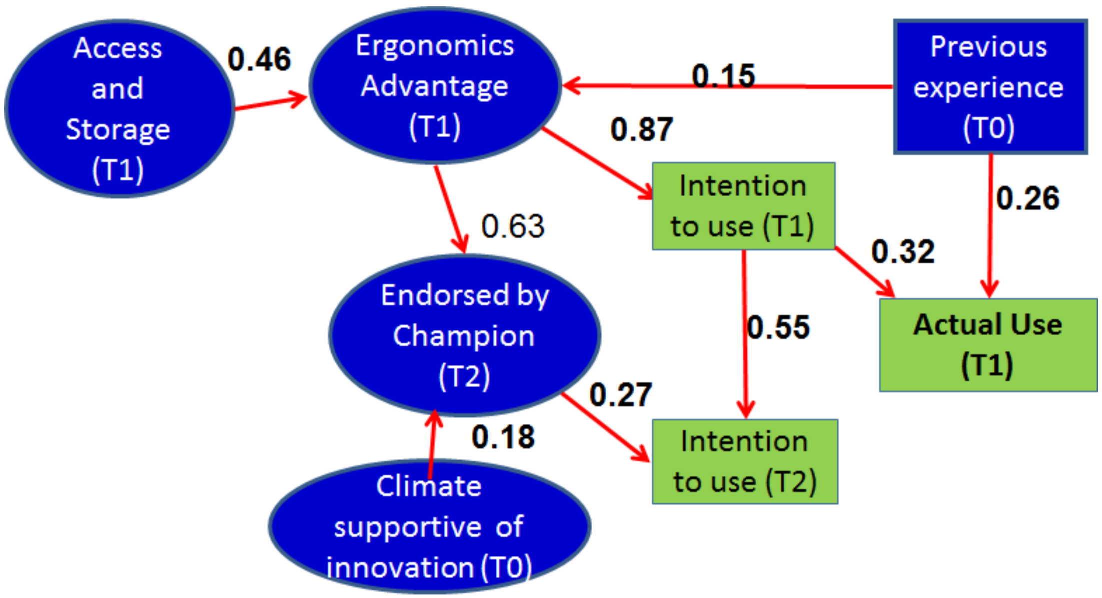
Factors that influence adoption in the early stages of implementation of safety-related changes

8 major themes in successful/unsuccessful implementation:

1. Implementation leadership
2. Effective training
3. Presence of mock-up
4. Active interaction with employee
5. Trialing and flexibility
6. Employee in the loop
7. Employee's perception
8. Reflection, understanding, internalization

Radin Umar, RZ, 2015, Investigation of Factors Influencing the Adoption of Safety-Related Changes during the Early Stages of Implementation: An Exploratory Study, unpublished dissertation, The Ohio State University

Study of factors affecting paramedics' adoption of a tri-fold slide board



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Conclusion

- Engineering controls can reduce physical loads
- Intervention adoption is a process; requires input from users, time to learn, supportive environment, must fit application and constraints, ...

Research Collaborators

- Karen Conrad
- Paul Reichelt
- Glenn Hedman

- Students:
  - Monica Johnson (Weiler)
  - Radin Zaid Radin Umar
  - Peter Le
  - Jay Mehta
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  - Rafael Farfan
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  - SangHyun Park
  - Jing Li
  - Tom Stoughton
  - Xiaojing Wu
  - Benjamin M. Collins
  - Adam Kelly
  - Kyle Hermiller
  - Brittani Brown
  - Kailyn Cage
  - Nicholas Schmidt
  - Christina Lee

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