

# Care for those who care for us: Prevention of Musculoskeletal Disorders (MSD) among Paramedics

*PARAMEDICS CONNECTING THROUGH APPLIED RESEARCH*  
*May 28, 2021*

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# | SPEAKER

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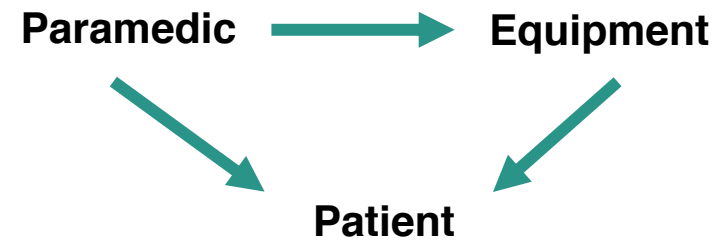
# | AGENDA

- MSD among paramedics
- State of research in ergonomic design of ambulance
- Incorporating ergonomic principles into the design of ambulance
- The new Canadian standard on ergonomic design of ambulance
- Future directions

# Paramedic Tasks



Driver/paramedic → Ambulance

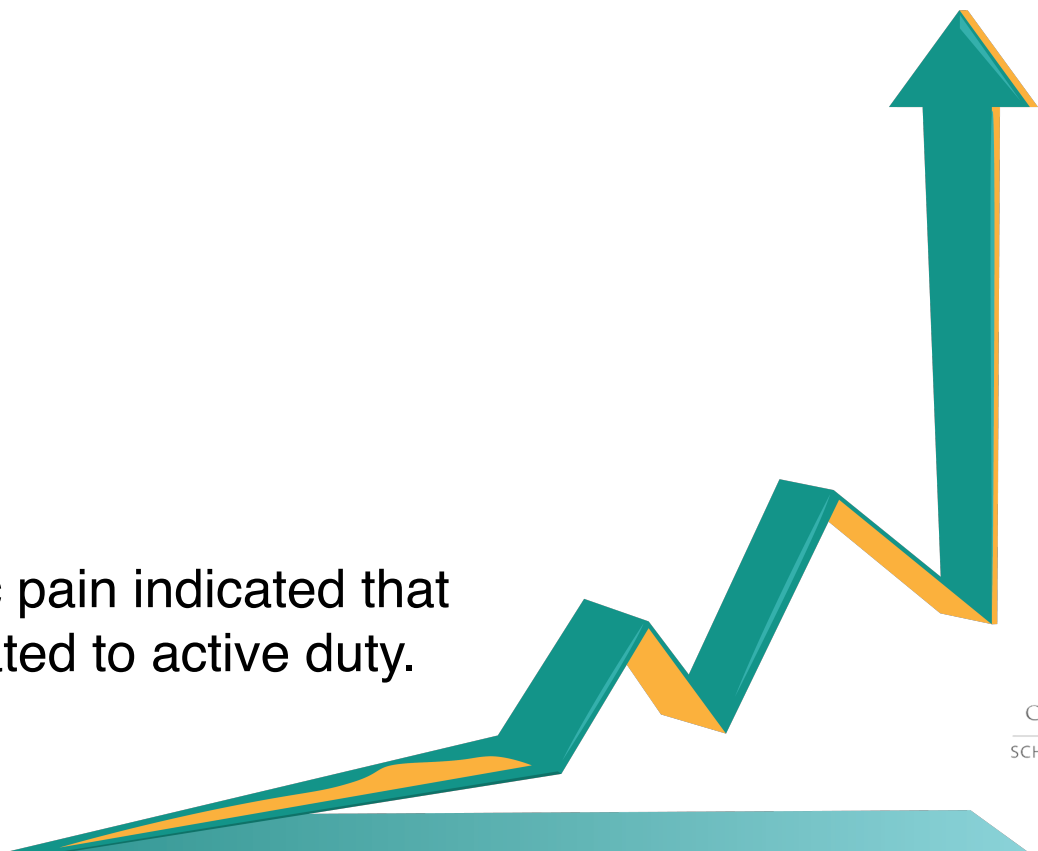




## MSD among Canadian Paramedics

- Over 30,000 paramedics in Canada
- 44.1% of paramedics reported chronic pain in a Canada-wide survey
  - Lower back: 28.9%
  - Shoulder: 21.5%
  - Neck: 18.1%
  - Leg: 15.0%
  - Arm: 12.5%
  - Foot: 12.2%
  - Hand: 12.0%
- Over 50% of paramedics reporting chronic pain indicated that the pain was associated with an injury related to active duty.

(Carleton et al, 2017)



# MSD among Canadian Paramedics



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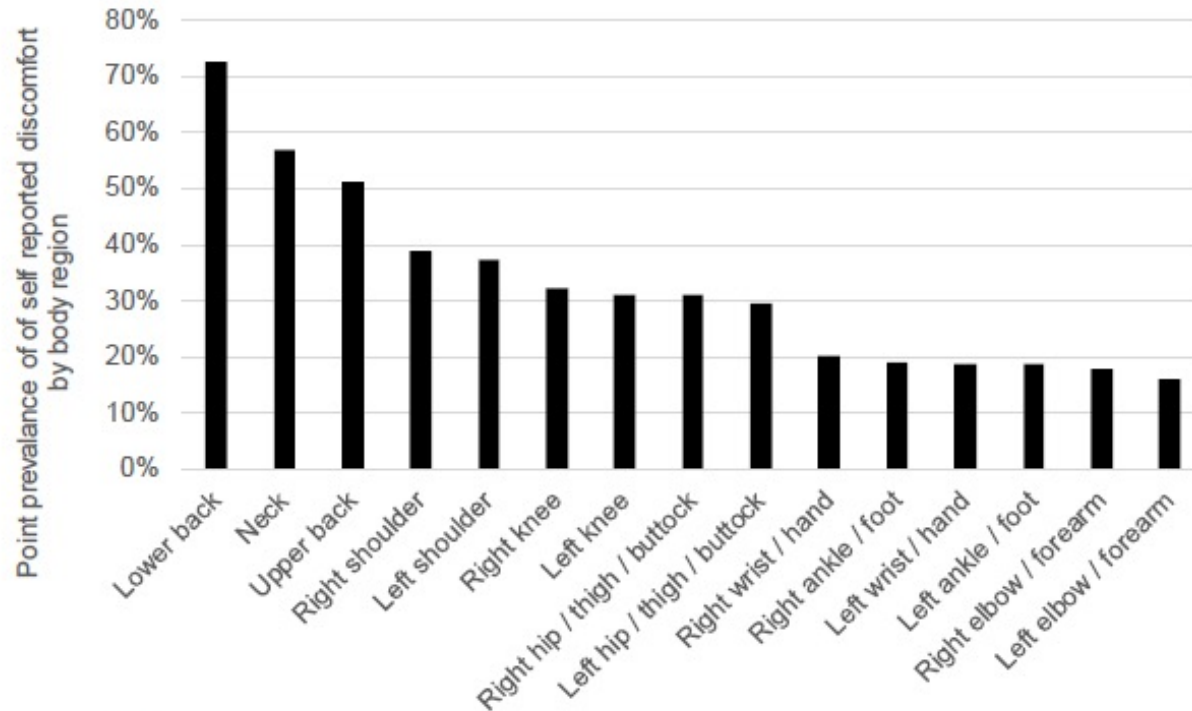
DRDC | RDDC  
technologysciencetechnologie

## Canadian paramedic health and wellness project

*Workforce profile and health and wellness trends*

Steven L. Fischer, PhD, RKin, CCPE  
Renée S. MacPhee, PhD  
University of Waterloo

**A**



## | Source of Injuries

- Physically demanding tasks
  - Transferring patients from bed to stretcher
  - Lifting and carrying patients on stretchers, stairchairs or backboards
- Prolonged sedentary time to sudden high physical demands  
(Coffey et al., 2016)
- Body motions were the most common source of injury
  - 90% attributed to lifting, carrying, or transferring a patient and/or equipment  
(Reichard et al. 2017)

**Design is modifiable.**

## | Source of Injuries

### Traditional Layout:

- Cot positioned in the center of the patient compartment
- Rear-facing airway attendant seat at the head of the cot
- Side-facing squad bench on the curbside wall
- CPR seat and cabinets on the roadside wall



# Canadian Standard for Paramedic Ground Emergency Response Vehicles and Equipment

**Project Summary:** Establish a Canadian Standard for Paramedic Ground Emergency Response Vehicles and Equipment.

**Objective(s):** Develop and promote a Canadian Standard that identifies the minimum human factors/ergonomics design and usage requirements for vehicles and equipment with consideration to paramedic and patient safety and infection control. Objectives include:

- Support manufacturers in designing and the procurement of emergency response vehicles and/or equipment in accordance with evidence-based practices;
- Direct paramedics in the safe and responsible usage of vehicles and/or equipment;
- Protect the health, safety & wellbeing of paramedics, and
- Protect public safety by improving patient safety and improving the capacity of emergency responders.

## Partnership:

- Center of research expertise for the prevention musculoskeletal disorders (CRE-MSD)
- CSA Group (Canadian Standards Association)
- Paramedic Association of Canada (PAC)
- Paramedic Chiefs of Canada (PCC)
- County of Frontenac
- Dessercom Inc.

**Start-End:** 01/2017 to 03/2021

## Research team:

- CO-PIs: Amin Yazdani, Steven Fischer
- Project Manager: Bronson Du

**Outcome(s):** This study will generate valuable information to facilitate future policy development and allow service providers to understand current methods in developing national standards.

**Deliverable(s):** The following deliverables signify completion of objectives:

- Environmental Scan, Literature Review and Needs Assessment Technical Reports
- Standards Development publication in both official languages
- Knowledge Transfer by way of a communications plan

## Impact(s):

Public Safety and Security actors and communities have access to timely, relevant and credible information and advice. This feeds Canada's Safety and Security systems that are evidence-based, interconnected and resilient.



# Research to inform Design



Prehospital Emergency Care

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## Existing Science on Human Factors and Ergonomics in the Design of Ambulances and EMS Equipment

Bronson Du, Michelle Boileau, Kayla Wierts, Sue Hignett, Steven Fischer & Amin Yazdani

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## Exploring the need for and application of human factors and ergonomics in ambulance design: Overcoming the barriers with technical standards

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### ARTICLE INFO

#### Keywords:

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### ABSTRACT

Ergonomic risk factors, such as excessive physical effort, awkward postures or repetitive movements, were the leading causes of injuries amongst EMS workers in the United States, of which 90% were attributed to lifting, carrying, or transferring a patient and/or equipment. Although the essential tasks of patient handling, transport, and care cannot be eliminated, the design of ambulances and associated equipment is modifiable. Our aims were to identify the extent of Human Factors and Ergonomic (HFE) considerations in existing ambulance design standards/regulations, and describe how HFE and the standards/regulations were applied in the EMS system. Through an extensive environmental scan of jurisdictionally relevant standards/regulations and key informant interviews, our findings demonstrated that existing standards/regulations had limited considerations for HFE. As a result, HFE principles continue to be considered reactively through retrofit rather than proactively in upstream design. We recommend that performance-based HFE requirements be integrated directly into ambulance design standards.





## | State of Research



### General Design (n=10)

- Compromising ambulance and equipment designs contributed to the high rates of injury
- 8 articles mentioned the need to develop better design standards



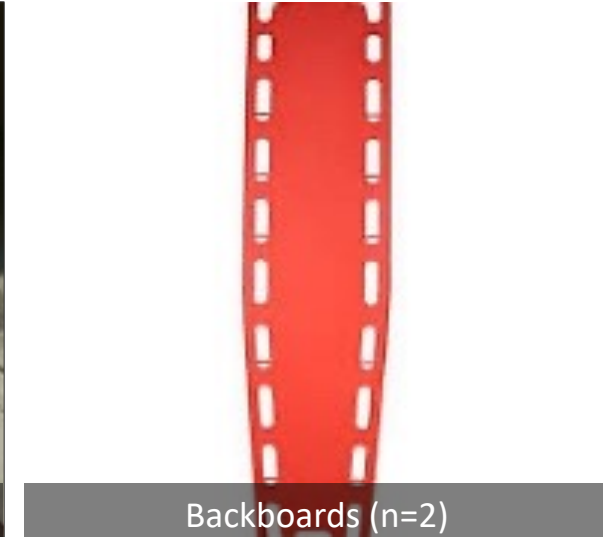
# State of Research

## Patient Handling (n=20)

- Some effective interventions



Cots (n=9)



Backboards (n=2)



Loading systems (n=2)



Stair chairs (n=4)

other patient handling accessories (n=8)

# State of Research

## Patient Transport (n=18)

- Providing patient care during transport was unavoidable
- Holistic approach recommended to ensure that all components worked synergistically



Restraints (n=5)



Crashworthiness (n=3)



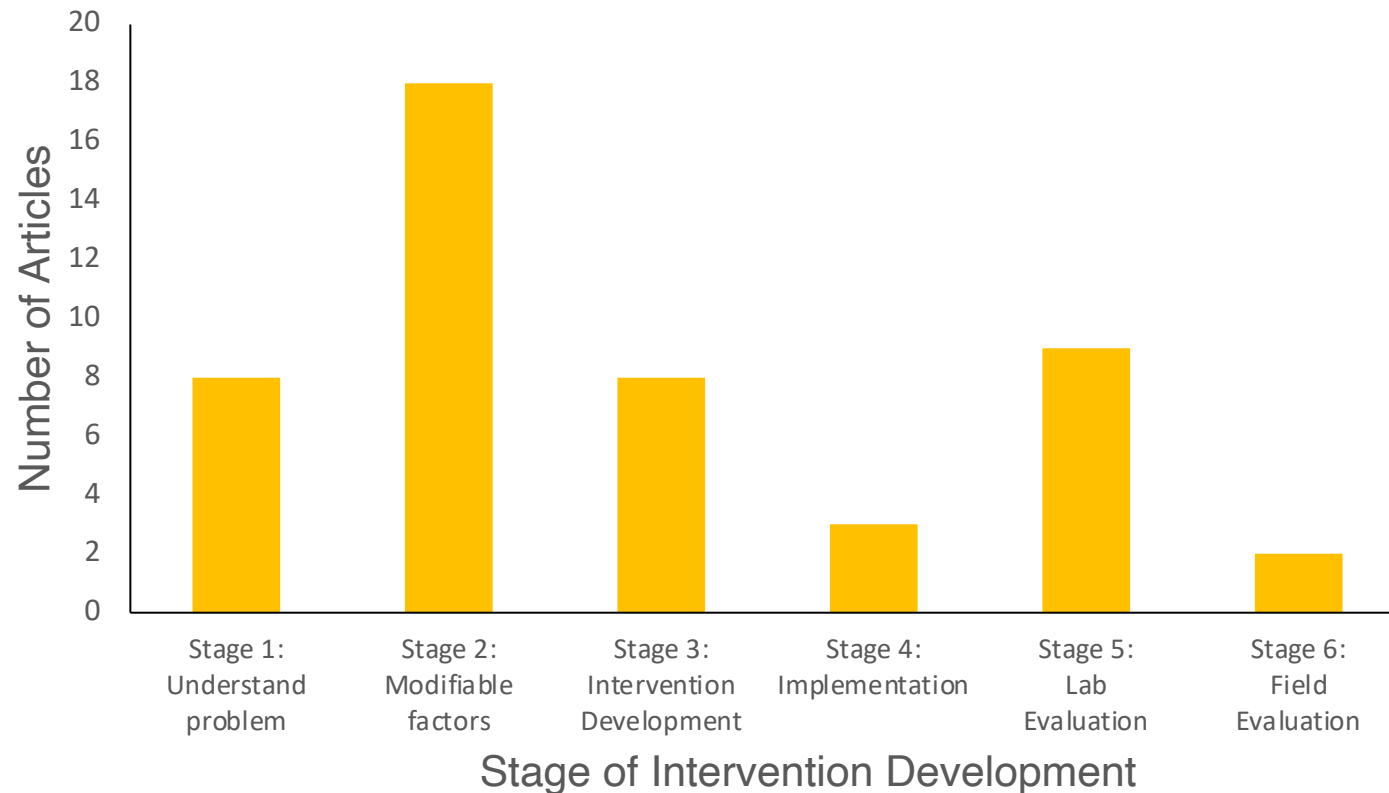
Workspace and layout (n=6)



Storage (n=4)

# State of Research

State of research based on  
**6 Steps to Quality Intervention Development (6SQuID)**





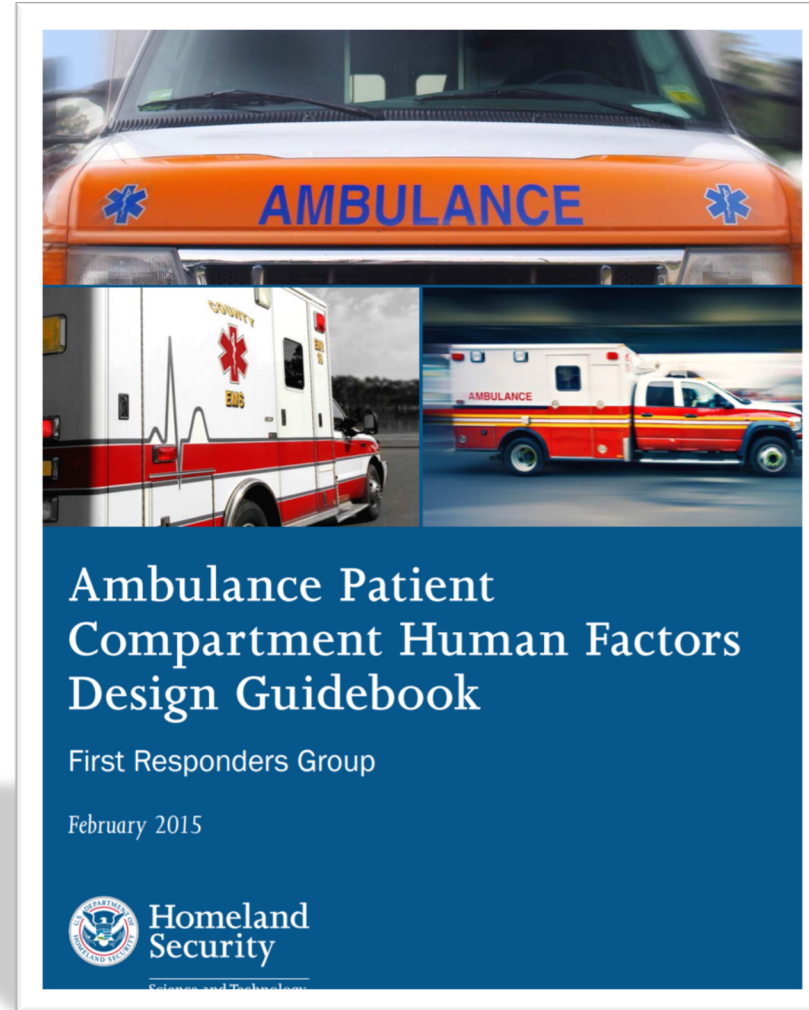


# Existing Resources

Province/ Territory	Standard	Date
BC	WorkSafeBC OHS Guidelines Part 3, First Aid Supplementary Materials - Emergency Vehicles and Equipment	Accessed 2017
AB	Ambulance Vehicle Standards Code	2010
SK	The Ambulance Regulations	2009
MB	Land Emergency Medical Response System Regulation	2015
ON	Ontario Provincial Land Ambulance & Emergency Response Vehicle Standard v4.1	2010
QB	BNQ 1013-110: Ambulances – Vehicles Specifications 2 <sup>nd</sup> edition	2014
NL	Consolidated Newfoundland and Labrador Regulations 965/96 - Motor Carrier Regulations under the Motor Carrier Act (O.C. 95-611)	2006
NB	New Brunswick Provincial Land Ambulance Conversion Specifications	2017
NS	Commission on Accreditation of Ambulance Services, Ground Vehicle standard for Ambulances.	2015
PE	Ambulance Services Act General Regulations	2013
YT	N/A	N/A
NT	N/A	N/A
NU	N/A	N/A

# | Existing Resources

- Design Considerations
  - Seating and restraints
  - Cots
  - Storages
  - Ingress and egress
- Location Considerations



# Existing Resources

Number of standards that considered the **DESIGN** of each component

	DESIGN CONSIDERATION	BC	AB	SK	MB	ON	QB	NL	NB	NS	PE	Σ
Seat & Restraints	Seating		X			X	X	X	X	X	X	7
	Restraint system		X	X		X			X	X	X	6
	Equip each position with restraints		X	X		X	X		X	X		6
	Headroom	X				X			X	X	X	5
	Bolsters		X			X			X			3
	Design seating for cleaning						X		X			2
	Transport of children		X									1
Cots	Retention system		X		X	X	X	X	X	X	X	8
	Cot design		X	X	X	X	X	X			X	6
	Restraints	X			X	X		X				4
	Loading					X						1
Storage	Adequate storage space		X	X		X	X	X	X	X	X	8
	Equipment retention		X	X		X	X	X	X	X	X	8
	Trash and sharps		X		X	X	X		X	X	X	7
	Storage cabinets, doors, and drawers		X	X		X	X		X	X		6
	Labeling and identification					X	X		X	X		4
	Consistency and organization									X		1
	Personal belonging						X					1
Ingress/Egress	Emergency egress		X	X		X	X	X	X	X	X	8
	Doors		X	X		X	X	X	X	X	X	8
	Steps		X			X	X	X	X	X	X	7
	Windows		X			X	X	X	X		X	6
	Handholds/handrails		X			X	X		X	X		5
	Ingress/egress of occupants and equipment		X	X						X		3





# Existing Resources

Number of standards that considered the **LOCATION** of each component

Location Consideration	BC	AB	SK	MB	ON	QB	NL	NB	NS	PE	Σ
Doors		X	X		X	X	X	X	X	X	8
Seats		X	X		X	X	X	X	X	X	8
Lighting		X	X		X	X	X			X	7
Main cot		X			X	X		X	X	X	6
Cabinetry		X	X			X	X			X	5
Action wall		X			X	X		X	X		5
Grab handles		X			X	X		X	X		5
Iv holders			X			X	X	X	X		5
Oxygen outlets		X			X	X		X	X		5
Side door step		X			X	X		X	X		5
Rear step bumper		X			X	X		X	X		5
Suction systems					X	X		X	X		4
Spare tire					X	X	X	X			4
Bolsters		X			X			X			3
Sharps container						X		X	X		3
Fire extinguisher					X	X		X			3
Other patient handling equipment						X		X			2
Incubator receptacles					X			X			2
Restraint net		X									1
Fuses and breakers								X			1
Radio mounting					X						1
Clocks								X			1



# | Existing Resources

- Standards have not been used as a tool to communicate ergonomics
- Many existing standards provided general minimum requirements, but lacked a meaningful and testable criteria for functionality
  - No guidance to assess functionality of the patient compartment as a whole



## | Key Outcomes

- Ergonomics has not been championed by the existing standards or key stakeholders
  - Onus for considering ergonomics was shifted to ambulance purchasers and manufacturers
- Many ambulance services did not sufficiently communicate their ergonomic needs in the request for proposals
  - Other factors such as type/size of ambulance, serviceability, fleet compatibility, payload, fuel efficiency, and costs were prioritized

# Development of a National Standard

## CSA Technical Committee:

Chair: Pierre Poirier (PAC)

Vice Chairs: Amin Yazdani (CISWP) & Gale Chevalier (County of Frontenac)

TC members: 40 members (30 voting members and 10 non-voting members)

CSA Project Manager: Ron Meyers



# CSA D500: 20

## Scope:

- This Standard specifies requirements to facilitate the **application of ergonomics into ambulance design** and describes a user-centered design (UCD) process for establishing additional ergonomic requirements, as necessary.
- The objective of applying ergonomics is to **optimize overall system performance** by ensuring human performance and safety requirements are balanced with engineering and design requirements.



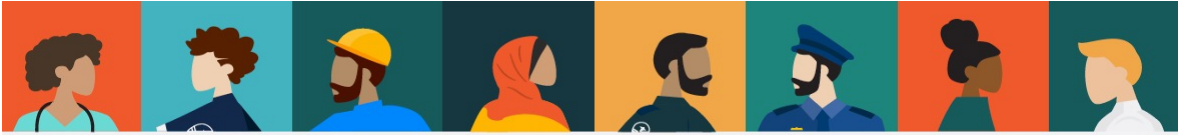
**CSA D500:20**  
National Standard of Canada

**Ergonomic design for ambulances and related equipment**







<https://www.youtube.com/watch?v=yII2LtPPOkA>





## The 10 Steps to Apply Ergonomic UCD In Ambulance Design




 **1. Identify target population:** paramedics, patients, fleet staff, and any other populations affected by the design.


 **2. Identify target population relevant characteristics** (e.g., body size, visual abilities, literacy, skills, knowledge).

 **3. Accommodate the full range of physical dimensions** using anthropometric database of the target population.


 **4. Use task analysis methods** to identify and describe the demands, goals, and intended outcomes of each task.


 **5. Identify Physical (vibration), emotional (stress) organizational (workplace practices), social (attitudes and culture), and legal characteristics** (specific requirements imposed by the authority having jurisdiction) that influence the design.

 **6. Apply ergonomic design consideration and requirements**

 **7. Ensure additional requirements are considered** to address human performance and health, safety, wellbeing and comfort of end of users

 **8. Create design concepts** that are reviewed by paramedics, managers and designers

 **9. Evaluate early-stage design concepts** against human factor and ergonomics criteria

 **10. Develop physical mock-ups and props** to evaluate later stage design concepts.

# User Centred Design:

## The Design of Ambulances and Related Equipment

### How Does It Work?

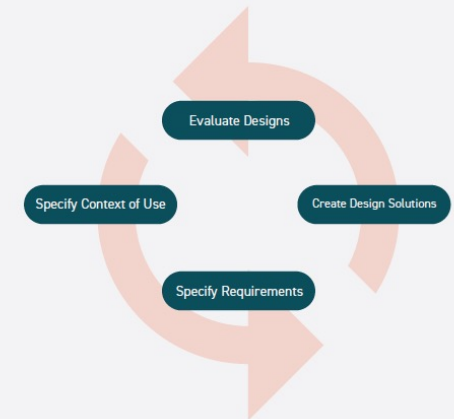
- define and understand the context of use;
- specify user requirements;
- create design solutions; and
- evaluate designs against requirements.

### What is User Centred Design (UCD)?

An approach to designing the environment for users, or to develop products, systems, layouts, and other items that aim to design the environment for users. It seeks to apply information from users who are affected by the process.

### Who Should Use It?

A multidisciplinary team of paramedics, managers, and design engineers.





# CSA D500: 20

## Key Requirements:

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- Application of Ergonomics in Design
- General Patient Compartment and Driver Cabin Ergonomic Design
- Ergonomic Design – Patient Compartment
- Workplace Layout, Placement and Accessibility
- Driver Cabin Requirements

## Annexes:

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- Ergonomic Quality Control Checklist
- Task analysis methods to support user-centred design (UCD)
- Infection prevention and control (IPC) practices in ambulance design
- EMT Anthropometrics



# CSA D500: 20

## General Patient Compartment and Driver Cabin Ergonomic Design

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- Seating Requirements
  - Primary attendant seat
  - Airway attendant seat
- Storage Units
  - General
  - Pressure vessels
  - Stretcher retention
  - IV holder
  - Sharp containers
  - Stair chair
- Steps
  - Rear step design
  - Side step design
- Ingress and Egress
- Doors
  - Door Latches, Hinges, and Hardware
  - Door locks
  - Door Dimensions
  - Door-Activated Switches
  - Handholds
  - Emergency Egress
- Windows
- Labelling and Identification
- Lighting

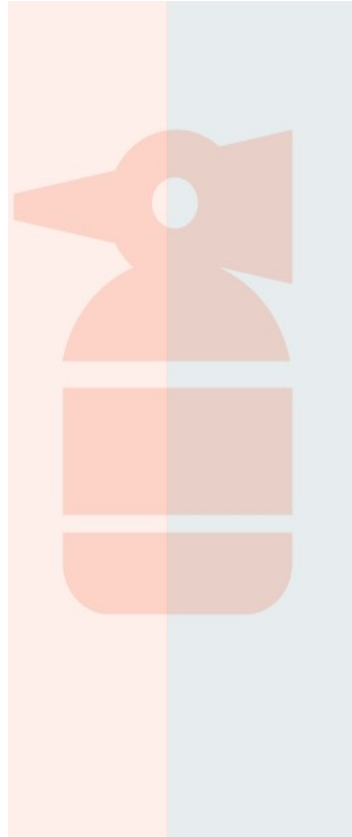


# CSA D500: 20

## Workplace Layout, Placement, and Accessibility

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- Patient Compartment seating layout
- Waste and Sharps Disposal Layout
- Stretcher clearance
- IV Holder
- Action Wall
- Suction System
- Incubator Receptacles
- Radio Mounting Space
- Fire Extinguisher



# Acknowledgement



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University of Waterloo



**Bronson Du, MSc.**  
Research Scientist,  
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- **Co-op students**

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- Kayla Wierds
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