A Model for Human Factors Design of a Trauma OR at the Foothills Medical Centre

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Presentation Overview

- Simulation-based mock-up evaluation framework
- Interventional Trauma Operating Room
- ITOR evaluations
- Next Steps
Simulation-based mock-up evaluation framework
- Started in Feb 2015
- Printed in Mar 2016
- Document and appendices available from: hqca.ca/humanfactors
Health Quality Council of Alberta

- An independent corporation legislated under the *Health Quality Council of Alberta Act* with a mandate to promote and improve patient safety and health service quality on a province-wide basis.
Introduction

Project lead / principle author
- Jonas Shultz

Project team / contributing authors
- Bev Knudtson
- Jason Laberge
- Mirette Dubé
- Steve Fowler
- Susan Biesbroek
- Trevor Peter
Stakeholders

Contributed knowledge, expertise and feedback to develop and disseminate the framework
Stakeholders

CSA Z8000
Canadian Health Care Facilities

Provides a nationally recognized baseline for the design and construction of hospitals and selected care facilities.
Guidelines in Alberta

Health Facilities Capital Program Manual
Describes responsibilities, accountabilities and processes for the planning and delivery of the Program for Alberta.
Simulation-based mock-up evaluation
Simulation-based mock-up evaluation

- Full scale mock-up

Simple mock-up  Detailed mock-up  Live mock-up
Simulation-based mock-up evaluation
Simulation-based mock-up evaluation

- Data is collected and analyzed
- Recommendations made to:
  - Guide design decisions
  - Optimize the environment
FIGURE 1: The cost-influence curve

MOVING SAFETY UPSTREAM IN THE HEALTHCARE FACILITY DESIGN PROCESS
Cost influence curve adapted from Max Wideman (2001) and Christensen and Manuele (1999)

- Pre Design
- Schematic Design
- Design Development
- Construction Documents
- Bid
- Construction
- Commissioning
- Punch List
- Occupancy

ABILITY TO INFLUENCE FINAL COST
- Low
- High

ABILITY TO INFLUENCE FINAL COST (%) of construction time
- -75%
- -35%
- -7%
- +75%

Safety through proactive design
Need for retrofitting enhancements
Ease of safety implementation
Cost of safety implementation
Ongoing costs of adverse events

Taylor, Hignett, Joseph, 2014

SIMULATION-BASED MOCK-UP EVALUATION
HEALTH QUALITY COUNCIL OF ALBERTA
Simulation-based mock-up evaluation

- Framework goals:
  - Enhance awareness
  - Assist with planning for an evaluation
  - Provide guidance to conduct evaluation
<table>
<thead>
<tr>
<th>Room type</th>
<th>City</th>
<th>Facility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hybrid operating rooms</td>
<td>Calgary</td>
<td>Foothills Medical Centre (cardiovascular)\textsuperscript{32}</td>
</tr>
<tr>
<td></td>
<td>Calgary</td>
<td>Peter Lougheed Centre (vascular)\textsuperscript{33}</td>
</tr>
<tr>
<td></td>
<td>Edmonton</td>
<td>Mazankowski Alberta Heart Institute (cardiac)\textsuperscript{34}</td>
</tr>
<tr>
<td></td>
<td>Calgary</td>
<td>Foothills Medical Centre (interventional trauma)\textsuperscript{11,14,35}</td>
</tr>
<tr>
<td>Intensive care unit patient rooms</td>
<td>Calgary</td>
<td>South Health Campus\textsuperscript{36}</td>
</tr>
<tr>
<td></td>
<td>Calgary</td>
<td>Foothills Medical Centre\textsuperscript{10}</td>
</tr>
<tr>
<td></td>
<td>Calgary</td>
<td>Peter Lougheed Centre\textsuperscript{10}</td>
</tr>
<tr>
<td>Emergency department exam rooms</td>
<td>Calgary</td>
<td>South Health Campus\textsuperscript{37}</td>
</tr>
<tr>
<td>Ambulance patient compartments</td>
<td>Provincial</td>
<td>Emergency Medical Services\textsuperscript{38}</td>
</tr>
<tr>
<td>Acute care unit patient rooms</td>
<td>Calgary</td>
<td>South Health Campus\textsuperscript{39}</td>
</tr>
<tr>
<td>Designated assisted living resident rooms</td>
<td>Provincial</td>
<td>Facility design standards and guidelines\textsuperscript{29}</td>
</tr>
<tr>
<td>Outpatient exam rooms</td>
<td>Calgary</td>
<td>South Health Campus\textsuperscript{40}</td>
</tr>
<tr>
<td>Medical day unit pods</td>
<td>Grande Prairie</td>
<td>Grande Prairie Regional Hospital\textsuperscript{41}</td>
</tr>
<tr>
<td>Systemic prep rooms</td>
<td>Grande Prairie</td>
<td>Grande Prairie Regional Hospital\textsuperscript{41}</td>
</tr>
</tbody>
</table>
Realizing Improved Patient Care through Human-Centered Design in the Operating Room

- $4M, 4 year AHRQ grant
- Design safer, more ergonomic OR
- Multiple simulation-based mock-up evaluations

Joseph, Wingler, Allison, 2016 (available from http://issuu.com/clemsonchfdt/docs/ripchd.or_volume_1/1)
Guiding Principles
GUIDING PRINCIPLE 1

A simulation-based mock-up evaluation should be considered, and if applicable, planned, as part of the pre-design stage for inclusion in the design stage.

Include consideration or requirement to conduct a simulation-based mock-up evaluation
GUIDING PRINCIPLE 1
A simulation-based mock-up evaluation should be considered, and if applicable, planned, as part of the pre-design stage for inclusion in the design stage.

Pre-design

Design

• Schematic design
• Design development
• Construction documents
• Bidding and negotiation

Construction / Commissioning

Conduct simulation-based mock-up evaluation
GUIDING PRINCIPLE 2
The mock-up evaluation should be thoroughly planned to maximize effectiveness.

GUIDING PRINCIPLE 3
Building of the mock-up should align with evaluation timing and objectives.

Scope
- Outlined during predesign
- Should outline
  - Evaluation objectives
  - When to evaluate
  - Costs
  - Time requirements
Evaluation objectives

- Unit configuration
- Room size
- Design or design feature comparisons
- Space requirements for equipment or processes
- Access to the patient and/or equipment
- Patient/family spaces and experiences
- Patient transport routes to and from the room
- Room configuration
- Furniture, fixtures, and equipment placement
- Furniture, fixtures, and equipment usability
- Visibility of patient, monitors, supplies, and/or equipment
- Supply placement
- Adverse events
- Work flows and processes
- Team functioning/performance
When to evaluate

**FIGURE 3:** Design phase(s) most applicable to various evaluation objectives

- Schematic Design
- Design Development
- Construction/Commissioning

- Unit configuration
- Room size
- Comparisons
- Equipment or processes
- Equipment placement
- Equipment usability
- Equipment, and/or equipment supplies, and/or equipment placement
- Process
- Performance
- Processes
- Performance...
Time required

**FIGURE 2:** Approximate time requirements to prepare for and conduct a simulation-based mock-up evaluation

3-6 MONTHS

1 MONTH
- Evaluation planning (page 10)

1-2 MONTHS
- Designing and building a mock-up (page 14)
- Simulation preparation (page 21)

2 DAYS
- Enacting simulation scenarios (page 25)

1 MONTH
- User feedback and analysis (page 26)

1-2 MONTHS
- Video analysis (optional – page 27)

1 DAY OR MORE
- Disseminating findings and recommendations (page 29)
GUIDING PRINCIPLE 4
Roles and responsibilities for those involved in the evaluation should be clearly defined.

APPENDIX 1: LIST OF EVALUATION TASKS

Simulation preparation
- Create simulation scenarios
- Obtain ethics approval and consent
- Recruit participants
- Stage the mock-up with furniture, equipment and supplies
- Train participants
- Set up an observation room

Enacting simulation scenarios
- Provide pre-briefing and scenario-enactment instructions
- Direct the scenario enactments
- Operate the patient simulator
- Take photos and videos

Data collection and analysis
- Debrief with scenario participants and observers for feedback and analysis
- Conduct video analysis
- Develop findings and recommendations
GUIDING PRINCIPLE 5
The simulation scenarios that are created and enacted should test the evaluation objectives.

- Selecting task to develop scenarios
  - Task analysis
  - Functional program
  - Design requirements
  - User focus groups
  - Design team questions / concerns
  - Safety reporting data
Enacting scenarios

- Pre-briefing
  - Evaluation objectives
  - Scenario overview
  - Think-aloud protocol
- Scenario enactment
  - Typically 2-5 scenarios
GUIDING PRINCIPLE 6
Recommendations should be informed by evidence-based data from scenario enactments.

- User feedback
  - Debriefing x 2 (participants & observers)
  - Surveys
- Video analysis
  - Video coding
  - Link analysis
  - Bump analysis
### Video coding

#### SAMPLE DATA ANALYSIS SPREADSHEET ENTRIES

<table>
<thead>
<tr>
<th>CAMERA</th>
<th>ELAPSED TIME</th>
<th>NOTES</th>
<th>CODER</th>
<th>CATEGORY</th>
<th>VIDEO COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>C3: Surgical area</td>
<td>00:08:50</td>
<td>Anesthesiologist asks for the site rite (ultrasound) for the 2nd time</td>
<td>JS</td>
<td>Communication</td>
<td></td>
</tr>
<tr>
<td>C1: Aerial</td>
<td>00:40:48</td>
<td>DI tech moves monitor to bring in C-ARM</td>
<td>JS</td>
<td>Adjustment</td>
<td></td>
</tr>
<tr>
<td>C3: Surgical area</td>
<td>00:41:03</td>
<td>Lines resting on C-arm are pulled when rotating C-arm</td>
<td>SB</td>
<td>Line snag</td>
<td></td>
</tr>
<tr>
<td>C3: Surgical area</td>
<td>00:42:15</td>
<td>Nurse lifts bed drapes to watch lines while moving the C-ARM</td>
<td>JS</td>
<td>Visibility</td>
<td></td>
</tr>
</tbody>
</table>

#### Category Definition

- **Adjustment**: Adjustment made to equipment or monitor.
- **Access**: Equipment needed that is not easily accessible.
- **Beneficial**: Positive design feature noted by participant or evaluator.
- **Bump**: Physical contact between two objects (people and/or equipment) that were not intended to make contact.
- **Communication**: Unsuccessful attempt to communicate (i.e., lack of response, demonstrated confusion, repeated instructions, multiple simultaneous communications, or disruptions due to environmental noise).
- **Congestion**: An object (person or equipment) is in the way.
- **Excessive reach**: Accessing something beyond one’s ‘reach envelope’, which is the length of an extended arm.
- **Line snag**: Unintentionally applying force to a line (IV) being used as part of patient care.
- **Cord/cable snag**: Unintentionally applying force to a cord (for power supply or patient monitoring) being used as part of patient care.
- **Searching**: The location of a supply or equipment is unknown to an individual needing it.
- **Suggestion**: Verbalized comment or room design/equipment observation.
- **Tripping hazard**: Object (people or equipment) required to move over another object, cord, or line.
- **Usability**: Difficulty using a computerized technology, equipment, packaging, or data entry devices.
- **Visibility**: Needing to see something (i.e., patient, monitor, equipment, etc.) that is not in view of the individual needing to see it.
Link analysis

Highlights:
- Motion patterns
- High traffic areas
- Interactions between staff and equipment
- Inefficiencies in staff workflow
- Space usage

Biesbroek, Shultz, Kirkpatrick, Kortbeek, 2012
Bump analysis
Disseminating findings

- Presenting findings
  - Presentation to participants / stakeholders
  - Technical report to design team
  - Consider broad distribution
What is ITO R?

Interventional Trauma Operating Room

An operating theatre specifically designed to control bleeding of patients with severe trauma by combining a traditional operating room and an angiography suite with diagnostic imaging capabilities.
Why?

During an average year in Alberta:

• 1,931 Albertans die from an injury = 5 deaths each day
• 28,809 Albertans are hospitalized = 79 hospital admissions each day
• 429,741 Albertans visit emergency departments = 1,177 Emergency Department visits each day

Uncontrolled bleeding remains a major factor in early mortality after trauma, contributing to 30 to 40% of trauma-related deaths.
Trauma in Calgary
Some History

Remember the uncontrolled bleeding....

Medical advancement:

From surgery to angiography embolization
Who needs the ITOR?
Mock Up Evaluation 2010

Photo used with permission
Commissioning 2013
ITOR Evaluation
56 recommendations

Before / after comparisons to evaluate implemented design changes
ITOR: Design modifications
Mock-up design
(Feb 16, 2010)

Built design
(Nov 28 & 29, 2012)
ITOR: Design modifications

Mock-up design (Feb 16, 2010)

Built design (Nov 28 & 29, 2012)

Biesbroek, Shultz, Kirkpatrick, Kortbeek, 2012

SIMULATION-BASED MOCK-UP EVALUATION

HEALTH QUALITY COUNCIL OF ALBERTA
ITOR: Design modifications

Mock-up design
(Feb 16, 2010)

Built design
(Nov 28 & 29, 2012)

Nursing area bumps:
↓ 44%
(25 vs 14)

Biesbroek, Shultz, Kirkpatrick, Kortbeek, 2012
Mock-up design
(Feb 16, 2010)

Non bold circle,
Bold colour change arrow
Improved space utilization

**Scenario:**
Retro-peritoneal bleed and cardiac arrest

**Mock-up design**
(Feb 16, 2010)

**Built design**
(Nov 28 & 29, 2012)
Next Steps
Framework ROI Project

Medication Room

Simple mock-up

Detailed mock-up

Virtual reality mock-up

South Health Campus
Project Goals

- Develop evidence-based guidelines outlining which mock-up fidelity is most effective
  - cost effectiveness (ROI)
  - outcomes (identified latent conditions, hazards, etc)
Questions?

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