Human Factors Contributions to Healthcare in Canada and Around the World - Everything you wanted to know but didn’t

Kathy Momtahan, RN, PhD
Current Lead for the Canadian Human Factors in Healthcare Network

SHIFTtosafety.com
Audibility and identification of auditory alarms in the operating room and intensive care unit.

Momtahan K¹, Hétu R, Tansley B.

The audibility and the identification of 23 auditory alarms in the intensive care unit (ICU) and 26 auditory alarms in the operating rooms (ORs) of a 214-bed Canadian teaching hospital were investigated. Digital tape recordings of the alarms were made and analysed using masked-threshold software developed at the Université de Montréal. The digital recordings were also presented to the hospital personnel responsible for monitoring these alarms on an individual basis in order to determine how many of the alarms they would be able to identify when they heard them. Several of the alarms in both areas of the hospital could mask other alarms in the same area, and many of the alarms in the operating rooms could be masked by the sound of a surgical saw or a surgical drill. The staff in the OR (anaesthetists, anaesthesia residents, and OR technologists) were able to identify a mean of between 10 and 15 of the 26 alarms found in their operating theatres. The ICU nurses were able to identify a mean of between 9 and 14 of the 23 alarms found in their ICU. Alarm importance was positively correlated with the frequency of alarm identification in the case of the OR, rho = 0.411, but was not significantly correlated in the case of the ICU, rho = 0.155. This study demonstrates the poor design of auditory warning signals in hospitals and the need for standardization of alarms on medical equipment.

Poor alarm design and management has led to a new area of research ... Alarm Fatigue!
‘Human Factors’ Definition

Ergonomics (or human factors) is the scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theory, principles, data, and other methods to design in order to optimize human well-being and overall system performance.

- International Ergonomics Association (IEA)

The Human Factors and Ergonomics Society (HFES) is the North American affiliate of the IEA
There are many depictions in the literature describing ‘Human Factors’. This is mine ....

The Environment (e.g. hospital)
- Organizational Structure
- Works Systems
- Business Processes
- Work-related Stressors

Human
- Cognitive Processes
- Perceptual Processes
- Physiology
- Motor Processes
- Affective Processes
- Capabilities & Limitations
- Training
- Teamwork

Technology
- Computer-based Systems
- Devices (e.g. infusion pumps)
- Networks
- Technology Design

Shift to Safety
Your source for patient safety
What do HCPs already know about Human Factors?

- Most healthcare professionals (HCPs) by now have heard of Human Factors Engineering / Psychology in the context of patient safety, human error, the Swiss Cheese Model, the design of medical technologies, the design and use of electronic health records, usability testing etc.

- The CPSI and the WHO have modules on Human Factors

- Now that many clinicians already know the basics of Human Factors (HF), what else is there to know?

- This introduction is meant to celebrate past successes, with an emphasis on Canadian contributions to the science of HF and to provide an overview of Human Factors applied in clinical practice today as well as ongoing research
Why we will always need to be vigilant about Human Factors in healthcare

- The human condition is relatively stable *(although amazing!)*
- But healthcare technologies continue to grow at a fast pace

Remember what it was like when . . .

- You had to go to the library to look something up?
- You spent time counting drips on an intravenous infusion?
- Being ‘social’ meant going out somewhere?
- You hadn’t even thought about working with a robot?
“At my own hospital, in 2013 we gave a teenager a 39-fold overdose of a common antibiotic. The initial glitch was innocent enough: A doctor failed to recognize that a screen was set on “milligrams per kilogram” rather than just “milligrams.” But the jaw-dropping part of the error involved alerts that were ignored by both physician and pharmacist. The error caused a grand mal seizure that sent the boy to the I.C.U. and nearly killed him.

How could they do such a thing? It’s because providers receive tens of thousands of such alerts each month, a vast majority of them false alarms. In one month, the electronic monitors in our five intensive care units, which track things like heart rate and oxygen level, produced more than 2.5 million alerts. It’s little wonder that health care providers have grown numb to them.”

Introducing the Canadian Human Factors in Healthcare Network

A group of us have formed a network to provide current information on human factors activities in healthcare.

Purpose:
To provide human factors expertise to healthcare organizations through consultation, knowledge transfer and exchange activities, and the promotion of partnerships between healthcare organizations, industry, and academic institutions to promote the delivery of safer, more effective care to patients.

Members include:
- HF engineers and psychologists, information technology experts, designers, and clinicians who are involved in patient safety with a human factors focus
- Many of the network members have worked on projects together, have supervised graduate students together, and otherwise educate students in various faculties regarding human factors
Our HF Network Information is now online!

http://www.patientsafetyinstitute.ca/en/toolsResources/Human-Factors-Network/Pages/default.aspx

http://www.patientsafetyinstitute.ca/fr/toolsResources/Human-Factors-Network/Pages/default.aspx
Other than our current HF Network members, here are a few Canadian Patient Safety champions whose work has a HF focus

- **Pat Croskerry, MD, PhD**
  - Clinical decision-making
  - Cognitive errors
  - Lead for the ‘Halifax’ series of patient safety conferences

- **Kaveh Shojania, MD**
  - Medical error
  - Patient safety leader and educator

- **Ed Etchells, MD, MSc, FRCPC**
  - Medical errors
  - Patient safety leader and educator
And Around the World …

Here are a list of resources outside of Canada:

United States
https://psnet.ahrq.gov/, includes https://psnet.ahrq.gov/webmm
http://www.hopkinsmedicine.org/armstrong_institute

• United Kingdom
http://chfg.org
https://www.england.nhs.uk
http://www.nottingham.ac.uk/research/groups/human-factors-research-group/

• Australia
http://www.ahhfg.org/

There are many other Human Factors resources in Canada and around the world, both public and private. The list above is only a sample.
Defibrillator Design and Usability May be Impeding Timely Defibrillation

Dr. M. Reeson, Dr. K. Kyeremanteng, Dr. G. D’Egidio
University of Ottawa
Division of General Medicine & Division of Critical Care
March 7th, 2017
Disclosure

• All funding was provided in conjunction between the University of Ottawa Department of Medicine Patient Quality and Safety research grant and The Ottawa Hospital division of Critical Care.
Delayed Defibrillation

• Between **75,000 – 150,000** patients suffer in-hospital cardiac arrest secondary to ventricular tachyarrhythmia with attempted cardio-pulmonary resuscitation each year in the United States.

• The only rhythm-specific therapy proven to increase survival to hospital discharge is **timely defibrillation**.

• Guidelines published by the **American Heart Association** recommend the defibrillation of an in-hospital cardiac arrest secondary to ventricular arrhythmia occur **within 2 minutes** of recognition of the arrest.
Delayed Defibrillation

- Patients who experience delayed defibrillation:
  - Less likely to survive to hospital discharge (22.2% when defibrillation was delayed versus 39.3% when defibrillation was not delayed).

- Even amongst those who survive:
  - Lower likelihood of having no major disabilities in neurologic status (odds ratio, 0.74).
  - Lower likelihood of having no major disabilities in functional status (odds ratio, 0.74).
Delayed Defibrillation

- National Registry of Cardiopulmonary Resuscitation:
  - Delayed defibrillation occurs in more than 30% of this patient population.
  - Average time to defibrillation was approximately 1 minute.

- Average time to defibrillation at The Ottawa Hospital (TOH):
  - 8 minutes in a critical care setting (ICU, CCU, PACU, ED).
  - 11 minutes on a medical ward.
Delayed Defibrillation

- Limited data is available regarding the **system-related factors** and the **patient-related factors** that are associated with a higher probability of delayed defibrillation.
Hypothesis

• We hypothesize that flaws in defibrillator design contribute to a delay in timely defibrillation.

• We aim to identify such flaws via high fidelity usability testing in a simulated hospital environment.
Usability Testing

• A technique in which users interact with a product under controlled conditions and behavioral data is collected.
This information is then applied to better understand:

- Human performance capabilities.
- Human performance limitations.
- How product design can be modified to meet these needs.

Thought to be an essential component of safety engineering in other fields, usability testing has been reported to be underutilized in the health care system.
Methods - Design

• Qualitative and quantitative prospective usability study evaluating the use of a manual-mode defibrillator in a simulated hospital environment.

• Study protocol was approved by the Ottawa Health Science Research Network Board.
Methods - Setting

- TOH is an academic quaternary care regional referral center with over 1,100 inpatient beds.
- Operated in conjunction with the University of Ottawa and TOH, the uOSSC is the largest medical simulation center in Canada.
- Simulation was conducted in a high-fidelity clinical exam room.
- Tasks were performed using a full size Human Patient Simulator.
Methods - Participants

- **Twenty-two** internal medicine resident’s post graduate year (PGY) 1-3.
- All participants were certified in **Advanced Cardiovascular Life Support (ACLS)** and had completed ACLS certification training within the preceding 12 months.
- Senior residents (PGY2 – PGY3) are **cardiac arrest team leaders** at our institution while junior residents (PGY1) are member of the cardiac arrest team.
Methods - Intervention

- Participants were asked to perform two simulated tasks typical of in-hospital cardiac arrest care:
  - **DEFFIBRILLATION** - “Attach the defibrillator device to the patient, perform a rhythm check, confirm the presence of ventricular fibrillation, and then deliver 1 defibrillation.”
  - **SYNCHRONIZED CARDIOVERSION** - “Attach the defibrillator device to the patient, perform a rhythm check, confirm the presence of an unstable atrial tachyarrhythmia, and then deliver 2 synchronized cardioversions.”
Outcomes

• Primary Outcome(s) -
  i. Time to defibrillation.
  ii. Proportion of participants able to deliver a defibrillation within 2 minutes.

• Secondary Outcome(s) -
  i. Objective observer evaluations.
  ii. Participants perceived usability of the manual-mode defibrillator.
  iii. Thematically coded qualitative participant feedback on usability.
Results

Time to defibrillation:

- Average time to defibrillation was \textbf{4 minutes 21 seconds ± 138 seconds}.
- Average time to defibrillation for \textbf{senior trainees} was similar to that of the group as a whole at \textbf{3 minutes 56 seconds ± 138 seconds}.
- Only \textbf{9.1\%} of participants were able to perform a simulated defibrillation within 2 minutes.
- Average time to synchronized cardioversion was \textbf{1 minute 55 seconds ± 59 seconds}.
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Results

• Qualitative participant feedback was analyzed and grouped according to theme:
  o Negative participant feedback focused predominantly upon the process of attaching the hands-free defibrillator pads to the defibrillator.
  o All 22 participants commented upon at least one aspect of this core function in the post-exposure questionnaire.
  o Descriptors of the process included “unintuitive”, “inconvenient”, and “awkward”.
Discussion

- Participants in our study are educated predominantly senior trainees with a high degree of familiarity with the Philips HeartStart XL defibrillator and ACLS protocol.

- Despite this, the average time to defibrillation was greater than two-times that which is recommended by the American Heart Association.

- Based on these results, it appears likely that delay in defibrillation are at least partially resultant of poor defibrillator design and lack of usability.

- Even the most expert of users may make continue to make errors when confronted with a device that is illogical and poorly designed.
Discussion

• Expert observer evaluation and qualitative participant feedback were largely congruent in regards to which aspects of defibrillator design do not suit the end-user.
  
  o Inability to **attach the hands-free defibrillator pads** to the defibrillator.
  
  o Inability to **select an appropriate display**.
Hands-free Defibrillator Pads
Cable Locking Mechanism
Default Display

- The Philips HeartStart XL defibrillator has the capability to display information from multiple inputs including ECG leads, hands-free defibrillator pads, and hand-held defibrillator paddles.
- The default display is that of ECG lead II.
- When using either the hands-free defibrillator pads or hand-held paddles the input must be changed manually to that of the desired component.
Discussion

• Modification of future defibrillator design may result in more timely defibrillation.
  
  o Engineering hands-free defibrillator pads as a single component.
  
  o Modifying the default display.
  
  o Re-locating the cable locking mechanism to a more accessible location.
Validity

• Largely dependent upon obtaining behavioral data from actual users of the device in the environment for which it is intended to be used.

  o Attempted to replicate many of the environmental factors typical of a hospital environment through high-fidelity simulation.

  o Physicians are responsible for defibrillator use during cardiopulmonary resuscitation at most large tertiary care centers. As such, we elected to evaluate physician usability of the manual-mode defibrillator which had not been studied previously.
Validity

- It remains somewhat unclear as to why so many of our participants were unable to compete a simulated defibrillation within 2 minutes.
  - Intuitively, we would have expected defibrillation to occur more rapidly in a simulated environment.
  - Role for improved training and education as the time to synchronized cardioversion was significantly less than that of defibrillation likely as a result of learning and recency.
  - Given the relatively low incidence of cardiac arrest it is impractical to train users frequently enough to maintain such proficiency.
Discussion

• Our study has several limitations:
  
  o Single center trial with a relatively modest number of participants.
  
  o Generalizability of our results to other defibrillator models is uncertain (given the discrepancy between real-world and simulated time to defibrillation at our institution relative to that of The National Registry of Cardiopulmonary Resuscitation).
Discussion

Our study has several limitations:

- Participants were recruited on a voluntary basis raising the possibility of selection bias.
- The definition of “difficulty” completing a specific function used in our study has not been externally validated. Nonetheless, we think it is reasonable that a delay greater than one-half of the total time allocated for a task is significant.
Summary

• Most participants in our study were unable to perform a simulated defibrillation within 2 minutes.

• This delay in defibrillation was likely at least partially resultant of poor defibrillator design and lack of usability.

• Expert observation and qualitative participant feedback were largely congruent in terms of which aspects of defibrillator design do not suit the end-user.

• Modification of future defibrillator design may result in more timely defibrillation and subsequently improved outcomes for patients.
References


