Seeking evidence to support usability principles for medication-related CDS functions

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Introduction
Computerized Clinical Decision Supports functions

- **Benefits, for instance**
  - Improve patients’ outcomes [Gary, 2005]
  - Improve prescribing practices [Kawamoto, 2005] [Schedlbauer, 2009]
  - Reduce Adverse Drug Events [Ammenwerth, 2008]

- **However, difficult to implement and accept** [Ash, 2004] due to:
  - Technological issues
  - Parameterization issues
  - Socio-technical issues
  - Usability issues
Usability design principles and CDS functions

- Usability design principles are necessary to help manufacturers develop “usable CDS”
  - General & CDS-specific usability design principles
  - International expert consensus sometimes based on literature

- Lack of scientific evidence to support the principles

- Scientific evidence for usability is needed!
Purpose of this study

- Scientific evidence requires knowing the cause-consequence chain between facts to be able to predict their appearance
  - Randomized Clinical Trials (RCT) to show evidence

- In usability, no RCT: mainly qualitative studies
  - Simple lists of usability flaws: no scientific evidence
  - Capitalization of qualitative scientific data through a framework describing the relations between usability causes and consequences

- Systematic review of the literature supported by a usability framework

- Find usability evidence for CDS usability design principles
Background: usability framework
The “usability framework”

**Usability principles**: usability design principles based, for instance, on physiological and psychological knowledge e.g. Display measurement units for data entry (prompting) [Scapin & Bastien]
The Usability Framework

**Usability flaw**: a violation of a usability principle described from the system’s design perspective. 

E.g. in a dosage calculation support, no measurement units are displayed next to the weight entry field.
Usage problem: A description of what is experienced by the user.

*E.g.* The user does not know what kind of data is expected (e.g. pounds or kilograms?).
The Usability Framework

Outcome: manifestation of the consequences of the flaw from a work system point of view
  e.g. the user entered kg instead of lb, the dosage calculated is inappropriate and a wrong dosage may be prepared

- **Usability principles**
  - General / specific

- **Violations in design**

- **Usability flaws**
  - in the IT system

- **IT System in use**

- **Usage problems**
  - Experienced by users

- **Healthcare work system**

- **Outcomes**

- **Severity of the usage problem**
- **Characteristics of the context of use**
- **Resilience capacity of the organization**
Systematic review method
Queries definition

- Supported by terminology and query experts
- In PubMed, Scopus and Ergonomics Abstracts
- Last update: 25th June 2013
Inclusion criteria

- **Facts** (not opinions) on usability flaws are reported

Usability principles
  - General / specific

Violations in design

Usability flaws in the IT system

IT System in use

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Outcomes

Expert evaluation and cognitive walkthrough Questionnaire and interviews/focus groups

Simulations, user testing (incl. think aloud) and post-implementation surveillance

Socio-technical approach

Impact evaluation with qualitative description
Inclusion criteria

- English/French speaking original publications in peer-reviewed journals and conference proceedings

- To improve the homogeneity, focus on:
  - Alerting/reminders systems in software
  - Supporting the management of e-prescriptions
  - By physicians, pharmacists and nurses.
  - Used in hospital or GP in the internal medicine field
**Study flow**

1 reviewer

2 reviewers: $K=0.66$

2 reviewers: $K=0.69$

3 reviewers: *Fleiss’ K*.95

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1 reviewer

2 reviewers: $K=0.66$

2 reviewers: $K=0.69$

3 reviewers: *Fleiss’ K*.95
Data extraction

- Extraction grid impacted by the usability framework
- Definitions used to extract semantic units about
  - Usability flaws
  - Usage problems (if available)
  - Outcomes (if available)
- Complementary data
  - Description of the evaluated system
Data analysis

- Categorization by two HF experts together

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<th>Usability Flaws</th>
<th>Usability principles General / specific</th>
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<th>Categorization according to</th>
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<td>Usability heuristics/ergonomics</td>
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<td>criteria [Scapin &amp; Bastien, 1997]</td>
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<td>Description of the cognitive</td>
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Preliminary results
Overall results

Usability principles

General / specific

Violations in design

Usability flaws in the IT system

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Healthcare work system

Outcomes

196 items

143 items

51 items

28 complete cause-consequence chains
Overall results: usability flaws

2/3 CDS-specific usability flaws

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General / specific

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Outcomes

Compatibility, 130

Guidance, 25

Workload, 23

Significance of codes, 8

Consistency, 6

Explicit control, 2

Error management, 1

Adaptability, 1

1/3 general usability flaws
Overall results: usability flaws

CDS-specific usability flaws

Results of the decision making: 9
Tasks and control distribution: 7
Speed of reasoning: 2

Cognitive demands for the decision making process: 51

Information missing (evidence, severity, actions to take, issue etc.)
Alert too early/late

Same alerts reoccurring during the same order

Usability principles
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Outcomes

Compatibility: 130

With expertise/habits, guidelines, knowledge

Alert's compatibility: 17

Transparency: 20

Overalerting: 24

Tasks and control distribution: 7
Speed of reasoning: 2

Usability problems
Experienced by users

Outcomes

Used data

Healthcare work system

IT System in use

Usability flaws in the IT system

Violations in design

Usability principles
General / specific

Compatibility: 130

With expertise/habits, guidelines, knowledge

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Alert too early/late

Same alerts reoccurring during the same order
Overall results: usage problems

- Usage problems main categories:
  - Emotional reactions
  - Alert fatigue/Desensibilisation
  - Alert ignored
  - Missed alert/information
Overall results: outcomes

- Outcomes main categories:
  - Change in responsibilities
  - Inter-personal strain
  - Activity oriented towards the system instead of the patient
  - Slowing down the prescription process
  - Patient safety
Discussion: the usability framework

- Innovative framework describing the cause-consequence chain of usability flaws
  - Supporting seeking scientific usability evidence

- Advantageous for a systematic review
  - Support the paper selection process
  - Help design the extraction grid
Discussion: evidence for CDS usability design principles?

- Despite reporting biases, cause-consequence relations exist in the CDS literature
  - To establish other relations: inferences based on retrieved data (under progress)

- Generalization process engaged to define corresponding CDS-usability design principles
  - Scientific usability evidence for each principle

- Flaws identified seem in agreement with usability design principles
  - [Horsky, 2012, 2013] [Phansalkar, 2010]

- Using the framework = to go a step further
  - Able to predict the severity of the consequences of the infraction to the usability design principles
Conclusion

- Scientific evidence is necessary for usability!
- A framework has been designed to seek this evidence through informed systematic review
  - Applicable and useful for CDS functions usability

- It should be applied to other kinds of systems and data to extend the scientific evidence for usability and to improve
  - Health Informatics community usability knowledge
  - Medical systems design
  - Ultimately, medical system efficiency and patient safety
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Thank You Questions?
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