Technology induced errors in Electronic Health records

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CONCEPTS

- Health information technology (HIT) related medical errors: many concepts → several definitions.
- Concepts share the idea: HIT errors realize in a complex healthcare environment during the use of HIT (Borycki et al., 2011).
- Terms are e.g., e-iatrogenesis (Weiner et al., 2007), HIT hazards (AHRQ, 2016) and unintended consequences (Ash, 2003; Campbell, 2006)
- The concept of technology-induced error increasingly in the literature.
Errors result from

‘the design and development of technology, the implementation and customization of a technology, and the interplay between the operation of a technology and the new work processes that arise from a use of technology’

Borycki, 2013
Evidence concerning HIT safety is relatively limited and the few existing studies on the subject suggest that HIT contributes to less than 1% of total errors in health care systems.

→ more information needed especially in the hospitals with 100% implementation rate
TECHNOLOGY-INDUCED ERRORS

The lack of HIT-related risk reporting and data describing risks is an obstacle to building and using safer information systems.

Coiera, Aarts and Kulikowski, 2012; Borycki, 2013a and 2013b; Denham et al., 2013; Menon et al., 2014a; Agboola, Bates and Kvedar, 2016; also Jha and Provonost, 2016
HIT ERROR-RELATED FRAMEWORKS

HIT error-related frameworks and models can be divided into three categories:

- **human factors,**
- **software engineering**
- **sociotechnical models and frameworks** (Borycki et al., 2011).
TECHNOLOGY-INDUCED ERRORS

 Today, many researchers share the view that technology-induced errors arise from a number of sources in a sociotechnical environment.
 However, theoretical diversity is needed
THE SOCIOTECHNICAL DIMENSIONS AND EXAMPLES OF SAFETY CONCERNS

- **Examples of error types/concerns**: 1. Computer or network not functioning, 2. Incorrect default for given medication
- **Examples of error types/concerns**: 3. User interface prone to errors, e.g., data entry, 4. Poor training leads to inappropriate use of EHR

1. **Hardware and Software**
2. **Clinical Content**
3. **Human-Computer Interface**
4. **People**
5. **Workflow & Communication**
6. **Internal Organizational Features**
7. **External rules & Regulations**
8. **Measurement & Monitoring**

The Sociotechnical model dimensions and examples of related safety concerns or error types by a dimension, Figure adapted for the study by referencing Singh & Sittig, 2013, Meeks & al., 2014
THREE FINNISH STUDIES ON EHR CLINICAL END USER PERSPECTIVE
# Study objectives, data collection, context, type of the study, methods and data analyses

<table>
<thead>
<tr>
<th>Objective</th>
<th>Data collection and context</th>
<th>Type of the study</th>
<th>Methods and data analyses</th>
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<tr>
<td>I</td>
<td>To analyse EHR related patient safety incident reports in hospital environment with 100% EHR implementation rate. To compare the data with previous research results after the procedure of taxonomy mapping.</td>
<td>Voluntary patient safety incident reporting data (N=23 023) in 23 hospitals of a university hospital district in Finland. Data consist of years 2011-2013, were collected and analysed in 2014.</td>
<td>Retrospective register study</td>
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<td>II</td>
<td>To explore EHR users perceptions on the EHR related high and extreme risk error types in hospital environment with 100% EHR implementation rate.</td>
<td>All health care professionals (N=17 336) possibly using EHR in 23 hospitals of a university hospital district in Finland. Study was conducted and analysed in 2015.</td>
<td>Quantitative, non-experimental cross-sectional questionnaire study</td>
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<td>III</td>
<td>To analyse EHR related medical software users’ reports in the nationwide supervisory (competent authority) database.</td>
<td>National Authority register data of medical software from 2010-2015. Data were collected in September-December 2015. 138 reports were included in the final content analysis and coding in 2016.</td>
<td>Retrospective qualitative register study</td>
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PAPER I
AN ANALYSIS OF ELECTRONIC HEALTH RECORD-RELATED PATIENT SAFETY INCIDENTS.
Palojoki S, Mäkelä M, Lehtonen L, Saranto K.

PAPER II
ELECTRONIC HEALTH RECORD RELATED SAFETY CONCERNS: A CROSS-SECTIONAL SURVEY OF ELECTRONIC HEALTH RECORD USERS.
Palojoki S, Pajunen T, Saranto K, Lehtonen L.

PAPER III
REPORTING OF MEDICAL DEVICE SAFETY INCIDENTS TO REGULATORY AUTHORITIES: AN ANALYSIS AND CLASSIFICATION OF TECHNOLOGY INDUCED ERRORS
Palojoki S, Saranto K, Lehtonen L.

RELATED PAPER:
FIN-TIERA: A TOOL FOR ASSESSING TECHNOLOGY INDUCED ERRORS
Palojoki S, Pajunen T, Lehtonen L, Saranto K.
STUDY I: AIMS

• The aim of this study was to analyse electronic health record (EHR)-related patient safety incidents in the voluntary patient safety incident reporting database in hospitals with 100% EHR implementation.

• We wanted to compare Finnish data to similar international data and discuss the contents with regard to the literature.
STUDY I: METHODS

• The types of EHR-related patient safety incidents at a total of 23 hospitals during a two-year period were analysed: totally around 23 000 reports.

• A procedure of taxonomy mapping between Finnish HaiPro classification and HIT-specific taxonomy*) was performed to allow comparisons (inter-rater reliability tested). Taxonomy*) is more widely used and specifically developed to classify HIT-related incidents.

STUDY I: RESULTS AND DISCUSSION

• A key finding of our study is that human-computer interaction problems were far more commonly reported than in Magrabi’s studies whereas the machine-related problems were reported rarely.

• In our data a total of only 8.5% of the incidents were machine-related problems and 73% were problems in human-computer interaction.
STUDY I: CONCLUSION

- HIT problems emphasizing human-computer interaction and use of EHR confirmed the need to study the phenomenon by applying sociotechnical framework suitable for detecting problems in complex healthcare settings.

- Consequently, the next substudies were performed by using the sociotechnological framework by refining the results of previous studies related to known error types.
STUDY II: AIMS

- Our goal is to study health care professionals’ perceptions of common EHR concerns. The specific objective is to concentrate on severe risk error types and risk factors.

- This study paper aims to answer the following questions: Which of the common EHR error types are associated with perceived high and extreme risk severity ratings among EHR users? Which variables are associated with high and extreme risk severity ratings?
STUDY II: METHODS

• The study was a quantitative, non-experimental descriptive study of Finnish EHR users. A cross-sectional web-based questionnaire study took place over a four-week time period in the beginning of 2015.

• Total of approx. 2700 clinicians answered
STUDY II: THE QUESTIONNAIRE

- Questionnaire development: mixed methods approach in several phases (localization etc)
- The questionnaire consists of eight error types based on Sittig and Singh’s previous research
- Chronbach: All of the dimensions showed good internal reliability, with alpha values ranging from .789 to .888.
- Khi square tests showed good external validity
STUDY II: RESULTS

- The highest proportion, nearly half of the respondents in both gender groups (49%), reported a high-risk level related to extended EHR unavailability.

- A high perceived risk related to incorrect patient identification, system-to-system interface errors, failure to find or use the most recent data, EHR time measurement errors, and open/incomplete orders.

- The lowest overall risk level was associated with selecting an incorrect item from a list of items.
**Figure 2.** Proportion of high risk according to respondents' professions and clinical unit (+95% CIs) in extended EHR unavailability.
STUDY II: RESULTS

- Physicians reported higher risk levels on all of the eight factors, especially those relating to extended EHR unavailability and failures to find the most recent patient data. Registered nursing professionals reported the second highest overall risk scoring, and the highest values were related to extended EHR unavailability and open/incomplete or missing orders.
STUDY II: RESULTS

- Emergency departments (ED), operating rooms (OR), and procedure units were associated with higher perceived risk levels, whereas clinical laboratory and radiology units were related to lower risk scoring.

- Professionals working on general wards reported high-risk scoring on extended EHR unavailability.
STUDY II: DISCUSSION

- EHR unavailability deserves greater interest, as the adoption of EHR systems continues to grow.

- EHR training and skills supporting more efficient use seem to affect how EHR safety issues are controlled.

EHR training is one core solution for meeting EHR safety concerns resulting from the failure to use health IT appropriately or the misuse of health IT.
STUDY III: AIMS

To analyse EHR related medical software users’ reports in the nationwide supervisory (competent authority) database.
STUDY III: METHODS

- A retrospective study of EHR users’ incident reports was conducted for cases submitted to the competent authority database (Valvira) during the period September 2010, through September 2015.

- The database also includes reports of EHR downtime. Downtime does not fall under the reporting criteria of the directive but is instead a borderline issue that may seriously affect patient safety. A decision to include these cases in the analysis was made due to their importance for patient safety.
STUDY III: RESULTS

- Total of 138 valid reports
- Adverse events associated with EHR vulnerabilities clustered around certain error types: The most common error types in the reports were ‘Downtime’ (26.8%) and ‘System-to-system interface errors’ (26.8%).
- These error types caused serious harm and occurred in all types of health care settings.
STUDY III: RESULTS

Table 1. Descriptive statistics (% per n) of error types in EHR user reports.

<table>
<thead>
<tr>
<th>Error type</th>
<th>n</th>
<th>%</th>
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<tbody>
<tr>
<td>EHR Downtime</td>
<td>37</td>
<td>26.8</td>
</tr>
<tr>
<td>System-to-System Interface Errors</td>
<td>37</td>
<td>26.8</td>
</tr>
<tr>
<td>Open, Incomplete or Missing Orders</td>
<td>33</td>
<td>23.9</td>
</tr>
<tr>
<td>Incorrect Identification</td>
<td>14</td>
<td>10.1</td>
</tr>
<tr>
<td>Time Measurement Errors</td>
<td>3</td>
<td>2.2</td>
</tr>
<tr>
<td>Incorrect Item Selected</td>
<td>1</td>
<td>0.7</td>
</tr>
<tr>
<td>Failure to Heed a Computer-Generated Alert</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Failure to Find or Use the Most Recent Patient Data</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Other</td>
<td>13</td>
<td>9.4</td>
</tr>
</tbody>
</table>

EHR: electronic health record.
STUDY III: DISCUSSION

- The problem of underreporting raises questions about the full potential of the present supervisory system.

- Studies (I-II) in a specialised care setting show that, if the supervisory system worked effectively, the number of reports in this nationwide study would be significantly higher.
FINALLY: PRACTICAL IMPLICATIONS

• EHR downtime: Institutions must implement EHR contingency plans. Downtime is proposed to be regulated in a detailed way to enhance wide-scale preparedness.

• Critical care: Emergency Departments, Operating Rooms and Intensive Care Units should have detailed, risk-based implementation and follow-up plans.

• Use of EHRs: Interventions for resilient behaviors to focus on how end-users utilize EHRs → Compulsory and structured training for those using EHRs.

• Classifications: Implement standard classifications for technology-induced errors to facilitate monitoring and use of voluntary incident and oversight data.
FINALLY: STRATEGIC IMPLICATIONS

• Alternative approaches needed respond appropriately to the health IT-related safety risks.

• Need to change our existing patient safety structures and processes to comprehensive HITS measurement. (E.g., Use of clinicians trained in clinical informatics and a multidisciplinary oversight committee to help identify and prioritize risks.)
A CLINICIAN USING EHRs
AT THE HELSINKI UNIVERSITY HOSPITAL EMERGENCY DEPARTMENT