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Author(s): Hyvämäki, Piia; Sneck, Sami; Meriläinen, Merja; Pikkarainen, Minna; Kääriäinen, Maria, Jansson, Miia

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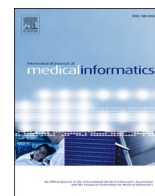
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Interorganizational health information exchange-related patient safety incidents: A descriptive register-based qualitative study

Piia Hyvämäki^{a,b,*}, Sami Sneck^c, Merja Meriläinen^{c,d}, Minna Pikkarainen^e,
Maria Kääriäinen^{a,f}, Miia Jansson^{g,h}

^a Research Unit of Health Sciences and Technology, University of Oulu, Finland

^b Oulu University of Applied Sciences, Oulu, Finland

^c Oulu University Hospital, Nursing Administration, Oulu, Finland

^d Medical Research Center Oulu, MRC

^e Department for Rehabilitation Science and Health Technology & Department of Product Design Oslomet, Oslo Metropolitan University, Finland

^f The Finnish Centre for Evidence-Based Health Care: A Joanna Briggs Institute Excellence Group, Helsinki, Finland

^g Research Unit of Health Sciences and Technology, University of Oulu, Oulu, Finland

^h RMIT University, Australia

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ABSTRACT

Purpose: The current literature related to patient safety of interorganizational health information is fragmented. This study aims to identify interorganizational health information exchange-related patient safety incidents occurring in the emergency department, emergency medical services, and home care. The research also aimed to describe the causes and consequences of these incidents.

Methods: A total of sixty (n = 60) interorganizational health information exchange-related patient safety incident free text reports were analyzed. The reports were reported in the emergency department, emergency medical services, or home care between January 2016 and December 2019 in one hospital district in Finland.

Results: The identified interorganizational health information exchange-related incidents were grouped under two main categories: “Inadequate documentation”; and “Inadequate use of information”. The causes of these incidents were grouped under the two main categories “Factors related to the healthcare professional “ and “Organizational factors”, while the consequences of these incidents fell under the two main categories “Adverse events” and “Additional actions to prevent, avoid, and correct adverse events”.

Conclusion: This study shows that the inadequate documentation and use of information is mainly caused by factors related to the healthcare professional and organization, including technical problems. These incidents cause adverse events and additional actions to prevent, avoid, and correct the events. The sociotechnical perspective, including factors related to health care professionals, organization, and technology, should be emphasized in patient safety development of inter-organizational health information exchange and it will be the focus of our future research. Continuous research and development work is needed because the processes and information systems used in health care are constantly evolving.

1. Introduction

Efficient and accurate **Health information exchange (HIE)**, defined as “the electronic movement of health-related information among organizations according to nationally recognized standards” [1], reduces treatment delays and improves patient safety by improving documentation, care coordination, and the quality of care [2–4]. HIE also supports patient

safety during interorganizational care transitions [5]. However, the continuously evolving practices in health information technology (HIT) may undermine patient safety due to the involvement of human factors [5–8].

Electronic health record (EHR)-related patient safety incidents are predominantly caused by *input* issues (e.g., insufficient medication documentation, incorrect or outdated patient information) [8,9–11,12].

* Corresponding author.

E-mail addresses: Piia.hyvamaki@oamk.fi (P. Hyvämäki), sami.sneck@ppshp.fi (S. Sneck), merja.merilainen@ppshp.fi (M. Meriläinen), minna.pikkarainen@oslomet.no (M. Pikkarainen), maria.kaariainen@oulu.fi (M. Kääriäinen), miia.jansson@oulu.fi (M. Jansson).

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In addition, issues with *transfer* (e.g., system interface issues); *output* (e.g., data retrieval errors); and *general functional* and *technical* issues (e.g., integration problems) affect the overall quality and safety of HIT and HIE [2,7,12–14]. HIE-related patient safety issues have complex socio-technical explanations [9,15,16]; this is especially relevant in fully digitalized hospitals [9]. In previous studies socio-technical factors, both from patient safety and quality perspective are classified in various ways. However, in all classifications technical, personal, and social factors are considered as equally important [17–22]. Socio-technical factors are emphasized particularly in interorganizational HIE due to the several differences in care processes, culture, and information management systems [5,23,24].

Deficiencies in HIE processes and information systems compromise interorganizational care paths and patient safety [5,10,25–30]. HIE-related patient safety incidents impact care delivery, cause near miss events, and can lead to patient harm. When considering clinical processes, medication [31,32] and care practices suffer the most. Problems with user interfaces and transferring records between systems contribute to errors that impact HIE and may affect several patients at the same time. [7,10].

The current literature concerning interorganizational HIE-related patient safety is fragmented and recent studies have applied predominantly quantitative approaches [9,10,28,33]. Therefore, we used inductive content analysis with the objective of revealing new themes of this complex phenomenon [9,34,35]. HIE-related patient safety incidents were also described in terms of causes and consequences. Ongoing research is needed to cope with the challenges arising from constantly evolving technological solutions [8,36].

2. Methods

2.1. Aim and research question

The aim of the study was to identify interorganizational HIE-related patient safety incidents at the emergency department (ED), emergency medical services (EMS), or home care (HC). HIE-related patient safety incidents were also described in terms of causes and consequences. The research was guided by the following questions: 1) What kinds of interorganizational HIE-related patient safety incidents occur in the ED, EMS and HC?; 2) What are the causes of the interorganizational HIE-related patient safety incidents that occur in the ED, EMS and HC?; and 3) What are the consequences of the interorganizational HIE-related patient safety incidents that occur in the ED, EMS and HC?

2.2. Design and setting

This descriptive register-based qualitative study is based on interorganizational HIE-related safety incident reports from one hospital district in Finland; covering the ED, EMS and HC during the years 2016–2019.

2.3. Data collection

All Finnish healthcare organizations must maintain and utilize a patient safety incident reporting system [37]. The Finnish patient safety incident reporting system, HaiPro, was implemented in 2007. The reports in HaiPro are anonymous, voluntary, and confidential.[38].

The HaiPro reporting system has 14 incident categories (Table 1). The reporter can complete the incident report using free text to describe the type, context, and circumstances of the incident. Free text fields may contain information that belongs to more than one classification. The incident reports are processed by the head of the unit. The report is classified into the system and the decision of possible actions is made. [39] The free text fields of the HaiPro reporting system were reviewed to identify the incidents that are related to interorganizational HIE. All reports concerning interorganizational HIE were included. The results

Table 1

HaiPro patient safety incident system categories⁴¹ (Translated from Finnish).

Category	
1	Related to medication or IV fluid care, blood transfusion, or contrast agent
2	Related to information flow and/or information management
3	Diagnosis-related
4	Surgical procedure-related
5	Invasive procedure-related
6	Related to other treatment or follow-up
7	Laboratory or imaging-related
8	Related to a device or device use
9	Hygiene-related
10	Accident/Injury
11	Emergency medical services-related
12	Violence
13	Deviation in radiation therapy
14	Other

were systematically reported according to the Consolidated Criteria for Reporting Qualitative Research criteria [40] where applicable (Appendix 1).

2.4. Ethics

The ethics committee was not required to review this register study [41]. The study was granted a research permit by one hospital district in Finland (license 288/2019). The data of HIE-related incidents were reported voluntarily and anonymously. The corresponding author ensured that data was anonymous prior to the analysis. Good scientific practice was followed throughout the research process [41].

2.5. Analysis

The qualitative data were analyzed using inductive content analysis to answer the research questions (Appendix 2). The analysis included 3 phases: *data reduction*; *data grouping*; and *the formation of concepts* [34]. The first author read through the raw data several times to obtain a full understanding of the content and include only the reports that were related to HIE. Next, the data were transferred to NVivo 12 software (Alfasoft, Göteborg, Sweden). The initial impressions were searched from free text according to the research questions. The initial coding of the data was conducted by the corresponding author and discussed with an author holding a PhD. Then, the data were transferred into Excel (Microsoft Corporation, Redmond, WA) tables based on which research question they corresponded to. Re-coding was performed to ensure the reliability of analysis, and initial impressions were also re-checked. Some of the reports had expressions which corresponded to more than one category (e.g., several factors may have contributed to an incident); therefore, data from one report may be present in more than one category. In the third phase, codes were grouped into subcategories which were named by content, after which similar subcategories were grouped together as generic categories. Generic categories were grouped into main categories (Fig. 1) following unanimous agreement by three researchers (PH, MMJ, and SS).

3. Results

A total of sixty (n = 60) interorganizational HIE-related patient safety reports, filed between January 2016 and December 2019, were analyzed from the patient safety incident reporting database (Appendix 2.).

3.1. Interorganizational HIE-related patient safety incidents

The analysis that corresponded to the first research question yielded two main categories related to interorganizational HIE-related incidents in the ED, EMS, and HC, namely, (1) “**Inadequate documentation**”

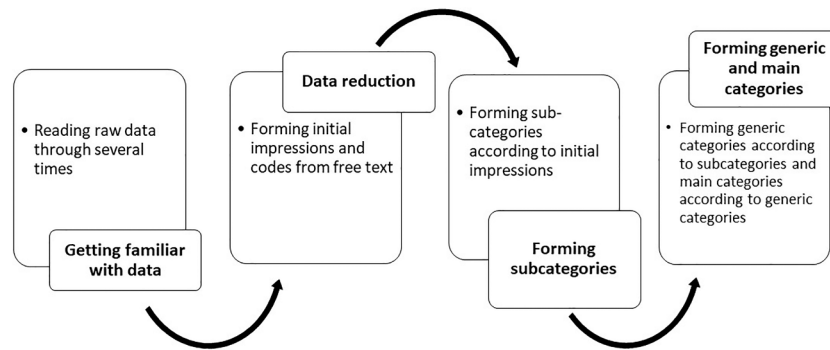


Fig. 1. Description of the analytical process.

(which includes two generic categories— “inadequate orders” and “Inadequate patient information documentation”), and (2) “**Inadequate use of information**” (which includes two generic categories— “Inadequate HIE” and “HIE-related problems in care coordination”) (Table 2).

Table 2

The analyzed interorganizational health information exchange-related incidents that had occurred in the emergency department, emergency medical services, and home care.

Examples of initial impressions	Subcategory	Generic category	Main category
RD166 Dosing and administration instructions for medication were incorrectly documented	Inadequate medication orders	Inadequate orders	Inadequate documentation
RD130 Duplicate examination order	Inadequate examination orders		
RD102 No follow-up documentation available for the patient	Missing care documentation	Inadequate patient information documentation	
RD100 Mixed old and new information in the care instructions	Contradictions in documentation		
RD157 EMS did not provide all of the necessary information about the patient	Deficiencies in content of HIE	Inadequate HIE	Inadequate use of information
RD162 Patient data were not transferred to the information system in a timely manner	Deficiencies in HIE timeliness		
RD180 The patient’s papers were read hours after arrival	Deficiencies in reading patient information		
RD160 The patient was registered into the wrong unit	The deficiencies in care coordination in the receiving organization.	HIE-related problems in care coordination	
RD135 Discharge without contact with relatives or follow-up care	The deficiencies in care coordination between organizations		

3.1.1. Inadequate documentation

The content of the analyzed reports revealed that inadequate documentation plays a significant role in HIE-related incidents; this aspect was related to the inadequate orders (e.g., inadequate medication orders) and inadequate patient information, as documented by clinicians. For example, prescriptions include outdated medication information: “*In the ED, the physician documented that the sending organization did not include a medication list for the patient, so the medication list was printed from the EDs information system. However, the patient had an up-to-date medication list, which was not consistent with the list from the ED*” (RD138).

3.1.2. Inadequate use of information

The inadequate use of information describes HIE-related incidents in which all relevant information is not transferred or include HIE-related problems in care coordination. The information may only be partially transferred, as shown in the following quotation: “*As a nurse, I did not get all of the background information about the patient, such as the fact that the patient has a tendency to escape from home and that this is one of the reasons why he was admitted to the ED*” (RD132). It’s also possible that the receiving organization doesn’t receive any information about the incoming patient.

3.2. Causes for interorganizational HIE-related incidents

The analysis that corresponded to the second research question identified two main categories related to the causes of interorganizational HIE-related incidents in the ED, EMS and HC, namely, (1) “**Factors related to the healthcare professional**” (which includes two generic categories — “variation in documentation practices” and “Insufficient interorganizational information exchange”), and (2) “**Organizational factors**” (which includes two generic categories — “working conditions” and “technical and usability challenges in information systems”) (Table 3).

3.2.1. Factors related to the healthcare professional

Factors related to the healthcare professional were found to be the most frequent cause of the HIE-related patient safety incidents and related to variation in documentation practices and insufficient information transfer. Invalid patient information entries cause safety incidents and, often, documentations are ignored, for example: “*Patient received 250 mg of Aspirin in an ambulance, and it was routinely prescribed again by a doctor on call*” (RD150). Patient transitions pose a significant risk to patient safety; information about the patient transfer was not reported to the receiving organization and information was incompletely transferred: “*The patient asked for his papers when he returned home and was told that the papers would come in the mail. The patient had no information on further treatment and therefore had been without an antibiotic for the weekend. Home care was not aware of the patient transfer.*” (RD173).

Table 3
Causes for interorganizational health information exchange-related incidents in the emergency department, emergency medical team, and home care.

Examples of initial impressions	Subcategory	Generic category	Main category
RD156 Need for control time reported in the wrong place in the system	Invalid patient information entry	Variation in documentation practices	Factors related to the healthcare professional
RD134 The registration status was not changed as treatment progressed	Incomplete patient data entry		
RD150 The patient record was not read before the medication order was documented	Insufficient use of patient documentation		
RD113 Pre-information about an acute patient was not delivered	Insufficient oral or written information of patient transition	Insufficient interorganizational information exchange	
RD162 Too little information about the patient because the oral report was hasty	Insufficient oral or written information during patient transition		
RD160 Suicidal patient was registered without triage due to duplication of work tasks	Overlapping tasks	Working conditions	Organizational factors
RD134 An incoming patient was registered as a consultation, not as a patient, due to hurry at the ward	Hurry		
RD171 Information about the patient's resuscitation was not carried forward because the treatment unit was full	Congestion		
RD125 Patient information systems differ in medication information because the information does not transfer from one system to another	Integration issues of information systems	Technical and usability challenges in information systems	
RD144 Patient was registered to the wrong place	Functional issues of information systems		

Table 3 (continued)

Examples of initial impressions	Subcategory	Generic category	Main category
due to system malfunction			
RD1304 ECG could not be sent to ED	RD141 The patient's allergy was ignored because it is considered too cumbersome to check the system for risk information		
Usability issues of information systems			

3.2.2. Organizational factors

Working conditions and technical and usability challenges in information systems are organizational factors that affect patient safety. Hurrying, congestion, and overlapping tasks are a risk to safety. Moreover, the integration, functionality, and usability of information systems can pose a risk to patient safety, as shown by the following quotation: “Reviewing risk information from information systems is perceived as being too difficult, but its importance is understood” (RD141).

3.3. Consequences of interorganizational HIE-related incidents

The analysis corresponding to the third research question revealed two main categories that described the consequences of interorganizational HIE-related incidents in the ED, EMS, and HC, namely, (1) “Adverse event” (which includes two generic categories — “Patient harm or near miss” and “Delays in care”), and (2) “Additional actions to prevent, avoid, and correct adverse events” (which includes two generic categories — “Actions to prevent, avoid, and correct adverse drug events” and “actions to ensure continuity of care”) (Table 4).

3.3.1. Adverse event

An adverse event is a common consequence of an HIE-related incident. Some patients suffered harm or even death: “I had time to look at the patient late at night and that's when I noticed that the patient was suffering from very severe chest pain. After a chest X-ray, the patient was transferred to the responsibility area of surgical care. Under further examination, the patient drifted into ventricular fibrillation and died after unsuccessful resuscitation. The first EKG from the EMS wasn't available” (RD167). Worth noting is that most of the reports showed that the consequences of incidents were near misses and delays in care.

3.3.2. Additional actions to prevent, avoid, and correct adverse events

HIE-related incidents require additional actions to prevent, avoid, and correct adverse events, which may include checking and correcting medication documentation, and actions to ensure the continuity of care. The following was stated by RN: “Overall, the patient was transferred from the EMS to ER after 25 min and after a search for multiple nurses” (RD161).

4. Discussion

The results of this study demonstrated that **inadequate documentation** plays a significant role in HIE-related incidents. Clinicians' orders and general patient care documentation were found to be inadequate and compromised patient safety. Previous studies have also revealed an inadequate quality of documentation [2,8]. Our result is also consistent with Magrapiš [12] classification, in which data input is classified as one type of EHR-related patient safety incident. The identified barriers of documentation have been related to technological (e.g., deficient system

Table 4

The consequences of interorganizational health information exchange-related incidents in the emergency department, emergency medical team, and home care.

Examples of initial impressions	Subcategory	Generic category	Main category
RD160 The patient died	Severe harm to the patient	Patient harm or near miss	Adverse events
RD140 Extra radiation dose for the patient	Radiological examination error		
RD141 The patient received a drug which had a contraindication based on the risk information, and developed skin symptoms	Medication error		
RD143 Possible unnecessary transport to the ED	Care assessment error		
RD134 Care was delayed by hours	Patient care is delayed in receiving organization	Delays in care	
RD122 Delay in I.V. antibiotics	Delayed medication care in receiving organization		
RD102 Patient waited for three hours for a transition	Delayed patient transfer		
RD153 Medication list needed updating	Additional work to correct medication documentation	Actions to prevent, avoid, and correct adverse drug events	Additional actions to prevent, avoid, and correct adverse events
RD138 Phone calls to confirm right medication prescription	Additional work to ensure correct medication orders		
RD161 Searching for clinicians to care for the patient	Actions to get the necessary care team in place	Actions to ensure continuity of care	
RD121 Contact and accident information clarification work	Actions to get updates to patient information system during patient transition		

usability), organizational (e.g., documenting routines), social (e.g., documentation as a value) and individual (e.g., lack of competence) factors [5,42] which are in line with our results.

This study also revealed that **inadequate use of information** (e.g., problems with the timeliness of the information) impacts the prevalence of incidents. The results agreed with study by Palojoki et al. [9] that patient information may be ignored completely or assessed with a delay. Some of the identified incidents were related to information retrieval caused by technical problems. The reports also showed that the information was – in some cases – used partially, while oral and written communication was not used appropriately to support HIE. Accordingly, HIE should be considered as a socio-technical entity where information is a value that is relevant contextually to health care professionals [17,21]. It is also important to involve staff in the design of HIE systems and processes to meet end-users needs and the reality of healthcare [19,21]. HIE processes need to be further developed to improve care coordination and patient follow-up [2–4,30].

This study highlights the importance of human factors, with this aspect **the factors related to the healthcare professional** found to be the main cause of several HIE-related incidents. These factors are mainly

associated with **documentation practices and insufficient interorganizational information transfer**. Certain data entries were incomplete or invalid, while in other instances the provided patient information was ignored. Information transfer suffers also from the insufficient transfer of oral or written information. The consistent and structured content of the EHR and user education to HIE is essential [18,19,21,43]. HIE-related errors have complex sociotechnical features, and human-machine interactions can significantly influence HIE-related errors in fully digitalized hospitals [7,9,21,22]. Clinical decision support systems, based on artificial intelligence or machine learning, is promising tool for improving safety of HIE [44–46].

Working conditions (e.g., overlapping tasks) and the technical functionality and usability of information systems are significant organizational factors affecting patient safety. The importance of organizational factors is emphasized in work that includes more than one organizations. Moreover, it has been well established that a lack of resources causes or contributes adverse events [47], while usability and functionality issues associated with HIE compromise interorganizational care to amplify the effects of human error [5,7,9,36]. Health information is complex and sensitive and healthcare environments are unique. Thus, HIE development requires more customized approach. [17,19] Healthcare professionals cognitive and physical stressors as well as workflow and context should be considered in interorganizational HIE [21] and related education [5].

At the organization level, the implementation of certain technologies and close collaboration with developers should be carefully considered and resourced [8,10,48]. HIE-related patient safety incidents are associated with complex interactions between information systems, health care professionals and health care organizations [5,9] and therefore organizational and usability issues must be considered with the same precision as technical challenges for the implementation to be successful [21].

HIE-related incidents which are caused by care coordination between organizations need to be considered carefully; this is because adequate HIE reduces treatment delays, improves patient safety, and increases the quality-of-care process [2–4,30]. There is a need for regional strategic development of HIE [19] and organizations should emphasize shared professionalization in collaboration [49].

HIE-related patient safety incidents affect care delivery, correspond to near miss events, and can lead to actual patient harm [11,47]. Our study supports the claim that **adverse events** are common consequence of HIE-related incidents in interorganizational transitions. Even serious harm was apparent in our limited dataset but most of the consequences seemed to be delays in care and near misses. Interruptions and delays in care are commonly caused by EHR-related problems. Issues with user interfaces and transferring records between information systems generate errors that are unique to HIE and may affect many patients at once [7,31].

Our study also revealed that interorganizational HIE-related incidents require **additional actions to prevent, avoid, and correct adverse events**. These actions were particularly significant in preventing medication errors and ensuring the continuity of care. Magrabi et al. [7] stated that IT problems causes disruptions in care delivery and clinicians use excessive time solving problems caused by dysfunctional HIE.

In future, natural language processing should be applied into EHR to generate more meaningful information from free text reports. Overall, incident reporting systems and AI-enabled tools should be developed further (e.g., studying multi-class problems and contributory factor) to monitor patient safety incidents at real-time in order to predict and prevent them [50–52].

5. Limitations

This study has several limitations. The study covers the processes of one specific care path in one hospital district. However, the adequacy of

the data is shown by the fact that no new content emerged at the end of the analysis in terms of research problems, and the results complement the perspective of previous studies. The challenges of interorganizational HIE are serious and not all of them are reported. Therefore, the data is not representative of all errors caused by HIE-related issues. The results of a qualitative study cannot be generalized, but content analysis enabled us to gain a deeper understanding of the complexity of the phenomenon.

The material included reports from three different types of organizations that are likely to have different patient safety cultures. Thus, one of the organizations may have contributed more to the evidence base presented in this research than the other two organizations. Moreover, the analyzed free text reports are reported by clinicians and vary in style and quality; as such, they may contain a lot of information but still be missing some essential points. In addition, the free text reports made it challenging to determine whether a report concerned the cause of an incident or a contributing factor; therefore, this classification is not specified in the results.

For the healthcare professionals it is challenging to differentiate errors caused by non-HIE factors (e.g., local resources and infrastructures) from HIE-related factors. The lack of awareness of HIE-related patient safety issues, the concept of “HIE-related” is unclear and a reluctance to be aware of the impact of one’s actions on a patient safety incident may affect the reliability of the data. As we stated earlier, interorganizational HIE is a very complex socio-technical phenomenon in which different factors (e.g., documentation) may be mired in complex processes, only some of which are understood or acknowledged. Although voluntary incident reporting is a valuable tool for identifying patient safety issues in health care, these systems have limitations which should be addressed in future research [53–55].

6. Conclusion

This study shows that the inadequate documentation and use of information is mainly caused by factors related to the healthcare professional and organization, including technical problems. These incidents cause adverse events and additional actions to prevent, avoid, and correct the events. The sociotechnical perspective, including factors

Appendix

Appendix 2. Analysis of HaiPro- data according to the research questions.

RQ1. The analyzed interorganizational health information exchange-related incidents that had occurred in the emergency department, emergency medical services, and home care.

Initial impressions	Subcategory	Generic category	Main category
RD166 Dosing and administration instructions for medication were incorrectly documented	Inadequate medication orders	Inadequate orders	Inadequate documentation
RD164 Names of medications were incorrectly documented			
RD1301 Dosage instructions were missing			
RD137 Dosage instructions were missing			
RD154 The amount of the drug and the route of administration were not mentioned			
RD166 Prescriptions documented in the wrong place in the system			
RD153 The referral contained numerous prescriptions that the patient is not using			

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related to health care professionals, organization, and technology, should be emphasized in patient safety development of interorganizational HIE and it will be the focus of our future research. Continuous research and development work is needed because the processes and information systems used in health care are constantly evolving.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Summary points.

What was already known on the topic?

- HIE-related patient safety incidents are predominantly caused by insufficient information.
HIE-related patient safety incidents are seldom researched from the interorganizational perspective using qualitative methods
Hie related patient safety incidents have complex socio-technical explanations

What this study added to our knowledge?

- The patient safety incidents in interorganizational HIE are consistent with general HIE related patient safety incidents.
Interorganizational HIE-related patient safety incidents have major impact on Health care professional’s workload, particularly to ensure the continuity of care. The socio-technical aspect is highly relevant in developing patient safety in interorganizational HIE. In future research, patient safety incident reporting systems and AI-enabled tools should be developed to monitor patient safety incidents at real-time in order to predict and prevent them.

(continued)

Initial impressions	Subcategory	Generic category	Main category
RD138 The medication orders contained outdated medication information			
RD100 Medication orders included both outdated and new orders			
RD163 An outdated medication list from the information system was used			
RD150 Double prescription on the care path			
RD142 Prescribed the same drug as had been prescribed for home care			
RD124 Different medication ordered for same disease in separate information system			
RD139 The patient had an incomplete medication list with errors			
RD125 Different medication ordered for same disease in separate information system			
RD130 Duplicate examination order	Inadequate examination orders		
RD181 The same examination was done in two organizations			
RD140 X-ray done twice			
RD165 Emergency consultation orders could not be found in the patient records			
RD102 No follow-up documentation available for the patient	Missing care documentation	Inadequate patient information documentation	
RD121 The patient's contact information and accident information had not been updated			
RD156 No follow-up instructions were documented			
RD151 Referral to home care was not done			
RD146 Medication administration was not documented			
RD173 Patient had no written care instructions after discharge			
RD112 A care report with medication orders could not be found			
RD100 Mixed old and new information in the care instructions	Contradictions in documentation		
RD101 The referral contained information that conflicts with the ECG print-out			
RD1302 Patient arrived with another patient's ECG			
RD110 Patient's ID was incorrect in the patient record			
RD132 Information about the patient's tendency to escape did not reach the nurse	Deficiencies in content of HIE	Inadequate HIE	Inadequate use of information
RD182 All of the data for the patient were not transferred			
RD157 EMS did not provide all of the necessary information about the patient			
RD167 Information about the need for urgent care was not transferred			
RD171 Information about the life-threatening condition was not passed on after the transfer			
RD143 Failed to send ECG			
RD133 ECG was not transferred from first aid to emergency care			
RD1303 ECG could not be sent			
RD162 Patient data were not transferred to the information system in a timely manner	Deficiencies in HIE timeliness		

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Initial impressions	Subcategory	Generic category	Main category
RD136 No care instructions were displayed in the information system			
RD136 Medication changes did not transfer to another information system in a timely manner			
RD184 Patient data cannot be read in time			
RD158 The ECG from one unit could not be viewed at another units because the system was not up-to-date			
RD134 The patient did not get registered at the unit on time			
RD113 Information about the patient's arrival did not reach the department in time			
RD120 The result of the study was not transferred in time			
RD123 The dictation of the doctor was delayed			
RD180 The patient's papers were read hours after arrival	Deficiencies in reading patient information		
RD161 Patient data sent in advance were read with a delay			
RD170 Delays in the viewing of test results			
RD161 Delays in access to patient data			
RD131 Risk information was not read			
RD141 Not notified of risk information			
RD160 The patient was registered into the wrong unit	The deficiencies in care coordination in the receiving organization.	HIE-related problems in care coordination	
RD144 Registration in the registration system logs in to the wrong place of care			
RD145 The registration system guided the patient to the wrong place			
RD134 Patient status did not change as treatment progresses			
RD152 Information about the patient's follow-up care was not passed on	The deficiencies in care coordination between organizations		
RD135 Discharge without contact with relatives or follow-up care			
RD111 Discharged without notice to home care			
RD173 Information about discharge was not passed on to home care			
RD126 The patient transfer was not reported to the receiving unit			
RD122 Invalid follow-up information between systems			
RD183 No patient arrival information was documented			
RD172 Documentation about patient arrival was not documented			

RQ2. Causes for interorganizational health information exchange-related incidents in the emergency department, emergency medical team, and home care.

Initial impressions	Subcategory	Generic category	Main category
RD100 Old and new information mixed in the data	Invalid patient information entry	Variation in documentation practices	Human factors
RD156 Need for control time reported in the wrong place in the system			
RD153 Confusing referral with incorrect medication information			
RD166 Medication orders documented incorrectly			
RD166 Medication orders documented in the wrong place in information system			
RD1301D Dosing instructions were missing from the documentation			
RD164 The names of medications were incorrectly documented			

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Initial impressions	Subcategory	Generic category	Main category
RD101 The referral contained information that conflicts with the ECG printout			
RD142 Duplicate orders in medication list			
RD1302 Patient arrived with another patient's ECG			
RD110 Incorrect ID makes it difficult to order examinations			
RD121 Contact information had not been updated			
RD134 The registration status was not changed as treatment progressed	Incomplete patient data entry		
RD183 Information about the patient's arrival had not been documented			
RD172 Patient arrival was not documented			
RD102 No follow-up entries have been made for the patient			
RD154 Incomplete documentation due to indifference			
RD121 Accident information had not been updated			
RD165 Patient matters were handled by several organizations and the relevant information was not recorded in the information system			
RD151 Referral to home care was incomplete			
RD170 The research results were not announced			
RD130 Patient had double radiological examination due to lack of patient involvement			
RD150 Patient received medication twice and was informed about it afterwards			
RD150 The patient record was not read before the medication order was documented	Insufficient use of patient documentation		
RD163 The on-paper medication list that came with the patient went unnoticed			
RD171 The EMS patient report was not read			
RD153 The on-paper medication list that came with the patient went unnoticed			
RD102 The examination order was documented in the system but not ordered			
RD152 Information about patient transfer was not exchanged	Insufficient oral or written information of patient transition	Insufficient interorganizational information exchange	
RD126 Information about patient transfer was not exchanged			
RD135 Discharge of the patient without contacting relatives or HC			
RD111 Discharge of the patient without contacting HC			
RD122 Lack of information during patient transition			
RD173 HC assumed that patient was at the hospital. Information about discharge was not exchanged			
RD162 Pre-information about an acute patient was not delivered			
RD113 Pre-information about an acute patient was not delivered			
RD151 Information about discharge was not exchanged			
RD126 Pre-information about an acute patient was not delivered			
RD162 Too little information about the patient because the oral report was hasty	Insufficient oral or written information during patient transition		
RD132 The nurse taking care of patient did not hear the oral report			
RD136 No care instructions on paper for the arriving patient, and electronic information exchange was delayed			
RD112 The patient did not have a referral with her/him, so information about orders was not available			

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Initial impressions	Subcategory	Generic category	Main category
RD173 Patient did not receive care instructions when he/she was discharged			
RD182 The information was incompletely transferred via several providers. Patient only had a medication list with him/her			
RD157 Ambulance patients did not have all the necessary information with them			
RD123 The dictation of the doctor was delayed due to a new / duplicate task	Overlapping tasks	Working conditions	Organizational factors
RD146 The medication administrated during shift change was not documented			
RD180 The patient's papers were read hours after arrival as the required professional was not available			
RD180 The patient's papers were read hours after arrival due to multiple phone calls during arrival			
RD161 Patient data sent in advance were read with a delay due to the nurses' report			
RD160 Suicidal patient was registered without triage due to duplication of work tasks			
RD134 An incoming patient was registered as a consultation, not as a patient, due to hurry at the ward	Hurry		
RD152 Information about a follow-up at a polyclinic was not delivered due to hurry at the ward			
RD171 Information about the patient's life-threatening condition was not moved forward, apparently due to urgency			
RD132 Knowledge of the patient's memory problems and tendency to escape was not transferred further because of a busy shift			
RD120 The research result did not move forward in time due to a busy shift			
RD131 Risk information was ignored due to urgency			
RD162 There was no time to read the patient's information due to urgency			
RD171 Information about the patient's resuscitation was not carried forward because the treatment unit was full	Congestion		
RD167 Information about the need for urgent care was not transferred due to the number of patients			
RD180 The patient's papers were read hours after arrival due to the large number of patients			
RD181 The same radiological examination was done in two organizations because the department was congested			
RD184 Text processing was slow due to congestion			
RD136 The information system does not support data transfer due to slow text processing			
RD163 The current medication list was not consistent with information from the ED	Integration issues of information systems	Technical and usability challenges in information systems	
RD139 Inconsistencies in medications between information systems			
RD153 The up-to-date paper medication list provided with the patient was not looked at, rather information in the departments information system was used			
RD138 Outdated medication list in the information system			
RD125 Patient information systems differ in medication information because the information does not transfer from one system to another			
RD124 Medication information for the same disease differs between information systems			
RD122 The patient was incorrectly transferred follow-up care due to problems with information system interoperability			

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Initial impressions	Subcategory	Generic category	Main category
RD130 The patient was x-rayed twice for the same reason because examinations performed elsewhere cannot be seen in the information system			
RD143 ECG could not be sent due to the interoperability problems			
RD133 ECG could not be sent due to the integration problems			
RD144 Patient was registered to the wrong place due to system malfunction	Functional issues of information systems		
RD145 Registration system guided the patient to the wrong unit			
RD170 Examination result was not on any clinician's task list			
RD140 Radiological results and physicians dictations were sent to the archive and not to the attending physician			
RD1303 ECG could not be sent			
RD1304 ECG could not be sent to ED			
RD161 When the shift changes, it takes time to log in to the computers again	Usability issues of information systems		
RD141 The patient's allergy was ignored because it is considered too cumbersome to check the system for risk information			
RD167 The information system did not emphasize the urgency of the patient, so the urgency went unnoticed			
RD158 The ECG cannot be viewed in a timely manner because it was impossible for the recipient to view it at a different location			
RD134 The patient did not register as a patient due to the use of a duplicate information system			

RQ3. The consequences of interorganizational health information exchange-related incidents in the emergency department, emergency medical team, and home care.

Initial impressions	Subcategory	Generic category	Main category
RD160 The patient died	Severe harm to the patient	Patient harm or near miss	Adverse events
RD170 The patient had a stroke			
RD180 The patient had a seizure			
RD140 Extra radiation dose for the patient	Radiological examination error		
RD181 Double radiation dose for the patient			
RD130 A small extra radiation dose to the patient			
RD131 Allergic reaction to medication	Medication error		
RD141 The patient received a drug which had a contraindication based on the risk information, and developed skin symptoms			
RD 100 Administration error			
RD150 Patient received Aspirin twice			
RD142 Two NSAIDs on a patient's medication list			
RD160 Suicidal patient enrolled without triage	Care assessment error		
RD171 The patient was left without proper treatment			
RD101 Appropriate treatment was not received			
RD182 The previous level of consciousness was ignored			
RD132 The patient escaped when knowledge of the tendency to escape did not progress			
RD143 Possible unnecessary transport to the ED			

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Initial impressions	Subcategory	Generic category	Main category
RD133 Uncertainty about the need to transport the patient from home			
RD134 Care was delayed by hours	Patient care is delayed in receiving organization	Delays in care	
RD183 Patient had to wait for care			
RD172 Patient waited for hours			
RD171 Correct treatment was delayed			
RD151 Wound care was delayed			
RD120 Unnecessary waiting			
RD121 Treatment delay			
RD144 Treatment delay			
RD145 Treatment delay			
RD161 Treatment of a patient in poor condition was delayed			
RD110 Delay in ordering tests and examinations			
RD162 Unnecessary waiting for the patient			
RD135 HC did not visit the patient in time			
RD152 Delay in care			
RD153 Delay in morning medication administration	Delayed medication care in receiving organization		
RD122 Delay in I.V. antibiotics			
RD173 Delay in antibiotic administration			
RD136 Patient received antibiotic hours too late			
RD111 Uncertainty if the patient received medication during the weekend			
RD161 Delayed registration as acute patient	Delayed patient transfer		
RD184 Patient transition delayed			
RD123 Unnecessarily long waiting time during patient transition			
RD102 Patient waited for three hours for a transition			
RD110 Transfer as ED patient delayed			
RD162 Transfer to information system delayed			
RD135 Transfer as HC patient delayed			
RD152 Clarifications to antibiotic documentation	Additional work to correct medication documentation	Actions to prevent, avoid, and correct adverse drug events	Additional actions to prevent, avoid, and correct adverse events
RD163 The drug list was printed and not notified			
RD112 Clarification to medication instructions			
RD153 Medication list needed updating			
RD164 The medication list had to be checked			
RD165 Medication orders needed clarification			
RD137 Phone calls to clarify medication orders			
RD146 Calls to clarify medication documentation			
RD138 Double prescription of medication needed correction			
RD139 Errors in medication list required calls and clarifications			

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Initial impressions	Subcategory	Generic category	Main category
RD100 Several clinicians needed to clarify care instructions			
RD136 Calls to clarify medication orders	Additional work to ensure correct medication orders		
RD138 Phone calls to confirm right medication prescription			
RD154 Calls to clarify unclear orders			
RD1301 Call to clarify antibiotic strength			
RD142 Clarifying medication order error			
RD124 Additional work to clarify unclear order			
RD166 Medication orders corrected			
RD125 Rework to clarify medication orders			
RD161 Searching for clinicians to care for the patient	Actions to get the necessary care team in place	Actions to ensure continuity of care	
RD113 Care coordination challenging due to the lack of personnel			
RD126 Additional information system work	Actions to get updates to patient information system during patient transition		
RD121 Contact and accident information clarification work			
RD156 Additional work for booking time for patient examinations			

References

- [1] Department of Health & Human Services. Report to the Office of the National Coordinator for Health Information Technology on Defining Key Health Information Technology Terms. Washington, DC: US Department of Health and Human Services; 2008. 310038.pdf (apache.org) (retrieved 5th of April 2022).
- [2] A. Cheung, F.H. van Velden, V. Lagerburg, N. Minderman, The organizational and clinical impact of integrating bedside equipment to an information system: a systematic literature review of patient data management systems (PDMS), *Int. J. Med. Inf.* 84 (3) (2015 Mar) 155–165, <https://doi.org/10.1016/j.ijmedinf.2014.12.002>. Epub 2015 Jan 3 PMID: 25601332.
- [3] R. Vuokko, P. Mäkelä-Bengs, H. Hyppönen, M. Lindqvist, P. Doupi, Impacts of structuring the electronic health record: results of a systematic literature review from the perspective of secondary use of patient data, *Int. J. Med. Inf.* 97 (2017) 293–303, <https://doi.org/10.1016/j.ijmedinf.2016.10.004>. Epub 2016 Oct 4 PMID: 27919387.
- [4] B. McCarthy, S. Fitzgerald, M. O'Shea, C. Condon, G. Hartnett-Collins, M. Clancy, A. Sheehy, S. Denieffe, M. Bergin, E. Savage, Electronic nursing documentation interventions to promote or improve patient safety and quality care: A systematic review, *J. Nurs. Manag.* 27 (3) (2019) 491–501, <https://doi.org/10.1111/jonm.12727>. Epub 2018 Dec 17 PMID: 30387215.
- [5] P. Hyvämäki, M. Kääriäinen, A.M. Tuomikoski, M. Pikkarainen, M. Jansson, Registered Nurses' and Medical Doctors' Experiences of Patient Safety in Health Information Exchange During Interorganizational Care Transitions: A Qualitative Review, *J. Patient Saf.* 18 (3) (2022 Apr 1) 210–224, <https://doi.org/10.1097/PTS.0000000000000892>. PMID: 34419989.
- [6] Harrison MI, Koppel R, Bar-Lev S. Unintended consequences of information technologies in health care—an interactive sociotechnical analysis. *J Am Med Inform Assoc.* 2007 Sep-Oct;14(5):542-9. doi: 10.1197/jamia.M2384. Epub 2007 Jun 28. PMID: 17600093; PMCID: PMC1975796.
- [7] F. Magrabi, S.T. Liaw, D. Arachi, W. Runciman, E. Coiera, M.R. Kidd, Identifying patient safety problems associated with information technology in general practice: an analysis of incident reports, *BMJ Qual. Saf.* 25 (11) (2016 Nov) 870–880, <https://doi.org/10.1136/bmjqs-2015-004323>. Epub 2015 Nov 5 PMID: 26543068.
- [8] S. Palojoki, K. Saranto, E. Reponen, N. Skants, A. Vakkuri, R. Vuokko, Classification of electronic health record-related patient safety incidents: development and validation study, *JMIR Med. Inform.* 9 (8) (2021 Aug 31) e30470.
- [9] S. Palojoki, M. Mäkelä, L. Lehtonen, K. Saranto, An analysis of electronic health record-related patient safety incidents. *Health Inform. J.* 2017:134–145. doi: 10.1177/1460458216631072.
- [10] U.M. Kinnunen, E. Kivekäs, S. Palojoki, K. Saranto, Register-based research of adverse events revealing incomplete records threatening patient safety, *Stud. Health Technol. Inform.* 16 (270) (2020 Jun) 771–775, <https://doi.org/10.3233/SHTI200265>. PMID: 32570487.
- [11] Jylhä V, Bates DW, Saranto K. Critical factors in the information management process: the analysis of hospital-based patient safety incident reports. *Finnish J EHealth and EWelfare.* 2016;8:164–176. <https://journal.fi/finjehew/article/view/60195>.
- [12] Magrabi F, Ong MS, Runciman W, Coiera E. An analysis of computer-related patient safety incidents to inform the development of a classification. *J Am Med Inform Assoc.* 2010 Nov-Dec;17(6):663-70. doi: 10.1136/jamia.2009.002444. PMID: 20962128; PMCID: PMC3000751.
- [13] N. Wang, P. Yu, D. Hailey, The quality of paper-based versus electronic nursing care plan in Australian aged care homes: a documentation audit study, *Int. J. Med. Inf.* 84 (8) (2015 Aug) 561–569, <https://doi.org/10.1016/j.ijmedinf.2015.04.004>. Epub 2015 May 8 PMID: 26004340.
- [14] M.M. Islam, T.N. Poly, Y.J. Li, Recent advancement of clinical information systems: opportunities and challenges, *Yearb. Med. Inform.* 27 (1) (2018) 83–90, <https://doi.org/10.1055/s-0038-1667075>. Epub 2018 Aug 29. PMID: 30157510; PMCID: PMC6115226.
- [15] E.M. Borycki, A.W. Kushniruk, Towards an integrative cognitive-socio-technical approach in health informatics: analyzing technology-induced error involving health information systems to improve patient safety, *Open Med. Inform. J.* 15 (4) (2010 Sep) 181–187, <https://doi.org/10.2174/1874431101004010181>. PMID: 21594010; PMCID: PMC3097067.
- [16] D.F. Sittig, H. Singh, Defining health information technology-related errors: new developments since to err is human, *Arch. Intern. Med.* 171 (14) (2011 Jul 25) 1281–1284, <https://doi.org/10.1001/archinternmed.2011.327>. PMID: 21788544; PMCID: PMC3677061.
- [17] M.C. Wong, K.C. Yee, C. Nøhr, Socio-technical considerations for the use of blockchain technology in healthcare. *Stud Health Technol Inform.* 2018;247:636-640. PMID: 29678038. <https://ebooks.iospress.nl/publication/48869> (retrieved 22nd of October 2022).
- [18] S. Thew, G. Leeming, J. Ainsworth, Addressing the socio-technical challenges of health information exchange adoption: DataWell in greater Manchester. *Stud Health Technol Inform.* 2018;247:790-794. PMID: 29678069. <https://ebooks.iospress.nl/publication/48900> (retrieved 22nd of October 2022).
- [19] T. Shah, L. Wilson, N. Booth, O. Butters, J. McDonald, K. Common, M. Martin, M. Minion, P. Burton, M. Murtagh, Information-sharing in health and social care: Lessons from a socio-technical initiative, *Publ. Money Manage.* 39 (5) (2019 Apr) 359–363, <https://doi.org/10.1080/09540962.2019.1583891>.
- [20] D.B. Wesley, L. Schubel, C.J. Hsiao, S. Burn, J. Howe, K. Kellogg, A. Lincoln, B. Kim, R. Ratwani, A socio-technical systems approach to the use of health IT for patient reported outcomes: Patient and healthcare provider perspectives, *J. Biomed. Inform.* 100S (2019), 100048, <https://doi.org/10.1016/j.yjbinx.2019.100048>. Epub 2019 Sep 24 PMID: 34384570.
- [21] Z. Zhang, J. Brazil, M. Ozkaynak, K. Desanto, Evaluative research of technologies for prehospital communication and coordination: a systematic review, *J. Med. Syst.* 44 (5) (2020 Apr 3) 100, <https://doi.org/10.1007/s10916-020-01556-z>. PMID: 32246206.
- [22] N.H. Benning, P. Knaup, Hospital information systems, *Stud. Health Technol. Inform.* 25 (274) (2020 Sep) 159–173, <https://doi.org/10.3233/SHTI200675>. PMID: 32990672.

- [23] E. Manias, M. Gerdtz, A. Williams, M. Dooley, Complexities of medicines safety: communicating about managing medicines at transition points of care across emergency departments and medical wards, *J. Clin. Nurs.* 24 (1–2) (2015 Jan) 69–80, <https://doi.org/10.1111/jocn.12685>. Epub 2014 Sep 11 PMID: 25209739.
- [24] M. Karam, I. Brault, T. Van Durme, J. Macq, Comparing interprofessional and interorganizational collaboration in healthcare: A systematic review of the qualitative research, *Int. J. Nurs. Stud.* 79 (2018 Mar) 70–83, <https://doi.org/10.1016/j.ijnurstu.2017.11.002>. Epub 2017 Nov 11 PMID: 29202313.
- [25] Vermeir P, Vandijck D, Degroote S, Peleman R, Verhaeghe R, Mortier E, Hallaert G, Van Daele S, Buylaert W, Vogelaers D. Communication in healthcare: a narrative review of the literature and practical recommendations. *Int J Clin Pract.* 2015 Nov; 69(11):1257-67. doi: 10.1111/ijcp.12686. Epub 2015 Jul 6. PMID: 26147310; PMCID: PMC4758389.
- [26] C. Kessler, M.C. Williams, J.N. Moustoukas, C. Pappas, Transitions of care for the geriatric patient in the emergency department, *Clin. Geriatr. Med.* 29 (1) (2013 Feb) 49–69, <https://doi.org/10.1016/j.cger.2012.10.005>. PMID: 23177600.
- [27] World Health Organization, Human Factors: Technical Series on Safer Primary Care, World Health Organization, Geneva, Switzerland, 2016 retrieved 3rd of May 2022.
- [28] J.L. Howe, K.T. Adams, A.Z. Hettlinger, R.M. Ratwani, Electronic health record usability issues and potential contribution to patient harm, *J. Am. Med. Assoc.* 319 (12) (2018 Mar 27) 1276–1278, <https://doi.org/10.1001/jama.2018.29584833>; PMCID: PMC5885839.
- [29] P. Sockolow, R. Hellesø, M. Ekstedt, Digitalization of Patient Information Process from Hospital to Community (Home) Care Nurses: International Perspectives. *Stud Health Technol Inform.* 2018;250:227-229. PMID: 29857442. <https://ebooks.iopress.nl/publication/49138> (retrieved 3rd of May 2022).
- [30] K. Adane, M. Gizachew, S. Kendie, The role of medical data in efficient patient care delivery: a review, *Risk Manage. Healthc. Pol.* 24 (12) (2019 Apr) 67–73, <https://doi.org/10.2147/RMHP.S179259>. PMID: 31114410; PMCID: PMC6486797.
- [31] M.O. Kim, E. Coiera, F. Magrabi, Problems with health information technology and their effects on care delivery and patient outcomes: a systematic review, *J. Am. Med. Inform. Assoc.* 24 (2) (2017 Mar 1) 246–250, <https://doi.org/10.1093/jamia/ocw154>. PMID: 28011595; PMCID: PMC7651955.
- [32] V. Jylhä, D.W. Bates, K. Saranto, Critical factors in the information management process: the analysis of hospital-based patient safety incident reports, retrieved 28th of April 2022, *Finnish Journal of EHealth and EWellfare* 8 (4) (2016) 164–176, <https://journal.fi/finjehew/article/view/60195>.
- [33] M. Härkänen, K. Vehviläinen-Julkunen, Onko lääkkeiden antaminen potilaille vaarallista? Analyysi Suomessa vuosina 2007–2017 raportoiduista vaaratapahtumista, *Hoitotiede* 33 (2021) 197–208.
- [34] H. Kyngäs, Qualitative Research and Content Analysis, in: H. Kyngäs, K. Mikkonen, E. Kääriäinen (Eds.), *The Application of Content Analysis in Nursing Science Research*, Springer, Cham, 2020, https://doi.org/10.1007/978-3-030-30199-6_1.
- [35] S. Elo, H. Kyngäs, The qualitative content analysis process, *J. Adv. Nurs.* 62 (1) (2008 Apr) 107–115, <https://doi.org/10.1111/j.1365-2648.2007.04569.x>. PMID: 18352969.
- [36] J. Kaipio, T. Lääveri, H. Hyppönen, S. Vainiomäki, J. Reponen, A. Kushniruk, E. Borycki, J. Vänskä, Usability problems do not heal by themselves: National survey on physicians' experiences with EHRs in Finland, *Int. J. Med. Inf.* 97 (2017 Jan) 266–281, <https://doi.org/10.1016/j.ijmedinf.2016.10.010>. Epub 2016 Oct 17 PMID: 27919385.
- [37] Finlex Health Care Act 30 December 2010/1326. Finlex is an online database of up-to-date legislative and other judicial information of Finland owned by Finland's Ministry of Justice, <https://www.finlex.fi/en/laki/kaannokset/2010/20101326> (retrieved 1st of March 2022).
- [38] Awanic oy 2016. Reporting System for Safety Incidents in Health Care Organizations. HaiPro.. <https://awanic.fi/haipro/eng/> (retrieved 24th January 2022).
- [39] M. Kuusisto, S. Sneck, P. Sova, M. Härkänen, Lääkehoidon vaaratilanteet – mitä voimme oppia HaiPro-ilmoituksista?, retrieved 30th of March 2022, SIC! Lääketietoa Fimeasta 1–2 (2019) 21–23, https://sic.fimea.fi/arkisto/2019/1-2_2019/riskilaakkeet-onko-niita-/laakehoidon-vaaratilanteet-mita-voimme-oppia-haipro-ilmoituksista-.
- [40] A. Tong, P. Sainsbury, J. Craig, Consolidated criteria for reporting qualitative research (COREQ): a 32-item checklist for interviews and focus groups, *Int. J. Qual. Health Care* 19 (6) (2007 Dec) 349–357, <https://doi.org/10.1093/intqhc/mzm042>. Epub 2007 Sep 14 PMID: 17872937.
- [41] Finnish National Board on Research Integrity TENK guidelines 2019. The ethical principles of research with human participants and ethical review in the human sciences in Finland. Finnish National Board on Research Integrity TENK publications 3. https://tenk.fi/sites/default/files/2021-01/Ethical_review_in_human_sciences_2020.pdf (retrieved 4th of May 2022).
- [42] Bjerkan, J., Valderaune, V., Olsen, R. M. Patient Safety Through Nursing Documentation: Barriers Identified by Healthcare Professionals and Students. *Frontiers in Computer Science.* 2021. <https://doi.org/10.3389/fcomp.2021.624555> <https://www.frontiersin.org/articles/10.3389/fcomp.2021.624555/full> (retrieved 20th of October 2022).
- [43] D.F. Sittig, A. Wright, E. Coiera, F. Magrabi, R. Ratwani, D.W. Bates, H. Singh, Current challenges in health information technology-related patient safety. *Health Informatics J.* 26(1) (2020) 181–189. doi: 10.1177/1460458218814893. Epub 2018 Dec 11. PMID: 30537881; PMCID: PMC7510167.
- [44] K.H. Bowles, S.J. Ratcliffe, J.H. Holmes, S. Keim, S. Potashnik, E. Flores, D. Humbrecht, C.R. Whitehouse, M.D. Naylor, Using a decision support algorithm for referrals to post-acute care, *J. Am. Med. Dir. Assoc.* 2019 Apr;20(4):408-413. doi: 10.1016/j.jamda.2018.08.016. Epub 2018 Nov 8. PMID: 30414821; PMCID: PMC6541013. *J Am Med Inform Assoc.* 2021 Nov; 28(11): 2502–2513.
- [45] S. Akbar, D. Lyell, F. Magrabi, Automation in nursing decision support systems: a systematic review of effects on decision making, care delivery, and patient outcomes, *J. Am. Med. Inform. Assoc.* 28 (11) (2021 Oct 12) 2502–2513, <https://doi.org/10.1093/jamia/ocab123>.
- [46] A. Hamilton, A. Strauss, D. Martinez, J. Hinson, S. Levin, G. Lin, E. Klein, Machine learning and artificial intelligence: Applications in healthcare epidemiology, *Antimicrobial Stewardship & Healthcare Epidemiology* 1 (1) (2021 Oct) E28, <https://doi.org/10.1017/ash.2021.192>.
- [47] R. Lawton, S. Carruthers, P. Gardner, J. Wright, R.R. McEachan, Identifying the latent failures underpinning medication administration errors: an exploratory study. *Health Serv. Res.* 2012 Aug;47(4):1437-59. doi: 10.1111/j.1475-6773.2012.01390.x. Epub 2012 Feb 29. PMID: 22375850; PMCID: PMC3401393.
- [48] K. Saranto, U.-M. Kinnunen, S. Koponen, M. Kyytsönen, H. Hyppönen, T. Vehko, Nurses' competences in information management as well as experiences in health and social care information system support for daily practice. *Finnish J. EHealth EWelfare* 12(3) (2020) 212–228. <https://doi.org/10.23996/fjhw.95711> (retrieved 3rd of April 2022).
- [49] M. Engel, A. van der Ark, R. Tamerus, A. van der Heide, Quality of collaboration and information handovers in palliative care: a survey study of the perspectives of nurses in the Southwest Region of the Netherlands, *Eur. J. Pub. Health* 30 (4) (2020 Aug 1) 720–727, <https://doi.org/10.1093/eurpub/ckaa046>. PMID: 32221585; PMCID: PMC7445043.
- [50] I.J.B. Young, S. Luz, N. Lone, A systematic review of natural language processing for classification tasks in the field of incident reporting and adverse event analysis, *Int. J. Med. Inf.* 132 (2019 Dec), 103971, <https://doi.org/10.1016/j.ijmedinf.2019.103971>. Epub 2019 Oct 5 PMID: 31630063.
- [51] H.P. Evans, A. Anastasiou, A. Edwards, P. Hibbert, M. Makeham, S. Luz, A. Sheikh, L. Donaldson, A. Carson-Stevens, Automated classification of primary care patient safety incident report content and severity using supervised machine learning (ML) approaches, *Health Informatics J.* 26 (4) (2020 Dec) 3123–3139, <https://doi.org/10.1177/1460458219833102>. Epub 2019 Mar 7 PMID: 30843.
- [52] M. Härkänen, K. Haatainen, K. Vehviläinen-Julkunen, M. Miettinen, Artificial intelligence for identifying the prevention of medication incidents causing serious or moderate harm: an analysis using incident reporters' views, *Int. J. Environ. Res. Public Health* 18 (17) (2021 Nov) 9206, <https://doi.org/10.3390/ijerph18179206>.
- [53] A.M. Howell, E.M. Burns, L. Hull, E. Mayer, N. Sevdalis, A. Darzi, International recommendations for national patient safety incident reporting systems: an expert Delphi consensus-building process, *BMJ Qual. Saf.* 26 (2) (2017 Feb) 150–163, <https://doi.org/10.1136/bmjqs-2015-004456>. Epub 2016 Feb 22 PMID: 26902254.
- [54] I. Mitchell, A. Schuster, K. Smith, P. Pronovost, A. Wu, Patient safety incident reporting: a qualitative study of thoughts and perceptions of experts 15 years after 'To Err is Human', *BMJ Qual. Saf.* 2016 Feb;25(2):92-9. doi: 10.1136/bmjqs-2015-004405. Epub 2015 Jul 27. PMID: 26217037 (I. Mitchell, A. Schuster, K. Smith, P. Pronovost, A. Wu, Patient safety incident reporting: a qualitative study of thoughts and perceptions of experts 15 years after 'To err is human'. *BMJ Quality and Safety* 25(2) (2016) 92–99. DOI: 10.1136/bmjqs-2015-004405).
- [55] M. Liukka, M. Huupli, H. Turunen, Problems with incident reporting: Reports lead rarely to recommendations, *J. Clin. Nurs.* 28 (9–10) (2019 May) 1607–1613, <https://doi.org/10.1111/jocn.14765>. Epub 2019 Jan 17 PMID: 30589957.