Information Overload – A Case Study of Using an Integrated Electronic Health Record System in the Emergency Room

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Abstract. Background: In modern healthcare services, physically distributed and disciplinary specialized healthcare teams must cooperate under pressure and instantly share increasing amounts of patient information. Therefore, Electronic Health Record (EHR) systems are deployed to facilitate data sharing. **Purpose**: We wanted to understand how Emergency Room (ER) teams use EHR systems in their daily practice. ER can be seen as an extreme case for EHR deployment because of extreme time pressure and the need for cross-disciplinary collaboration. **Methods**: We used an interpretative case study approach, investigating an EHR system used in the ER department of a large hospital. We interviewed ER personnel, observed EHR use in real-world ambulatory settings, and consulted various documents to create a deeper understanding of the case. **Results**: EHR systems are increasingly important in ER personnel's practices. At the same time, the information in the EHR system can be perceived as irrelevant and duplicated, which leads to perceived information overload. Moreover, gaining an overview of relevant information under time pressure is difficult, which can lead to stress and frustration. **Conclusion**: EHR systems play an increasingly important role in healthcare services and can sometimes be the only source of information about patients, such as in ER. ER teams must cooperate with multiple healthcare disciplines, often under extreme time and space conditions. Therefore, ER should be used as an important case for EHR design.

Keywords: electronic health record · Helseplattformen · information overload · emergency room · physicians.

1 Introduction

An integrated Electronic Health Record (EHR) is a comprehensive repository of patient information stored by care providers during the care process, including diagnosis and treatment [18, 27]. EHR systems are being integrated across primary and secondary care in many countries [12, 15, 22], promising benefits such

as improved quality of care, efficient management of the healthcare system, and support for research and innovation [2, 20, 28].

However, these benefits can only be achieved if healthcare professionals use integrated EHR systems in their practices [17, 34]. Literature reports mixed outcomes of the healthcare professionals' use of integrated EHR systems [3, 4, 36, 41]. Some studies highlight positive outcomes, such as better collaboration among healthcare professionals [7, 23, 42] and a richer picture of patient's health at the point of care [44]. Comprehensive patient information can also reduce professionals' workload [23, 44].

Conversely, other studies report negative outcomes [8]. Recording and curating patient information in the integrated EHR can increase professionals' workload [23], and incomplete or low-quality information shared in the EHR may result in a lack of trust among care providers [7, 30, 32]. Studies also report usability issues with integrated EHR systems, such as poor information presentation, excessive clicking, and distracting alerts, which may reduce the time physicians spend with their patients and increase medical errors [21, 22, 29].

Information overload, defined as "the problem of having more information than we can process," [9] is a significant problem in healthcare [16, 26], and some studies attribute it to EHR integration [4, 8, 10, 13]. Emerging quantitative studies report that information overload may have adverse consequences such as stress and burnout [1]. However, qualitative studies are needed to unpack the mechanisms behind EHR integration's positive and negative outcomes [1, 17, 40].

To address this gap, we explore Emergency Room (ER) physicians' use of an integrated EHR system to understand better how information overload unfolds. We focused on ER for two reasons: 1) ER is often situated at the boundary between primary and secondary care, and 2) ER is an extreme case of information access where a wide variety of patient information is needed in a relatively short time [11]. Therefore, we ask the research question: **How do ER physicians use an integrated EHR system in their practices?**

This paper reports results from an interpretative case study [43] of an integrated EHR system, Helseplattformen (HP), used in the emergency room (ER) in the municipality of Trondheim in Norway. We looked at both ER practices and the practices of using the EHR system in ambulatory visits under high time pressure. We found that:

1. The HP system seemed to have excessive patient information, leading to time-consuming manual information filtering. Physicians struggled to gain an overview of patient information, which may be caused by information overload.
2. The ER physicians recognized the value of patient information in the HP system for pre-visit preparation. However, they faced additional challenges like complex cases needing immediate help, unavailable information on patient identity, and limited time to make decisions.

Our findings contribute to the ongoing discussion on information overload in the medical informatics literature [37] by presenting how EHR information is used, what value it produces, and how information overload unfolds [17, 40].

2 Background

2.1 EHR use and the practice of healthcare professionals

EHR systems are increasingly being integrated across primary and secondary care to support continuity of care in many countries [12, 15]. Studies report several benefits for healthcare professionals, including improved access to patient information. For example, in the UK, professionals in secondary care could better understand patients' health by accessing primary care EHRs, while primary care workers received fewer inquiries from other providers [44]. A Dutch hospital case study similarly found that shared medical histories may enhance cross-disciplinary collaboration [42], a result echoed in other studies [7, 23].

Research also suggests that integrated EHRs can positively impact patient outcomes, such as reducing unnecessary visits, tests, and drug reactions, especially for patients with comorbidities [3, 30, 32]. One study, for example, found that comprehensive access to patient information reduced emergency department visits and hospitalizations for diabetes patients [35].

However, EHR integration may also have drawbacks for healthcare professionals. It can increase workloads due to the need to maintain comprehensive patient records [8, 23], while low-quality data can lead to frustration and decreased trust in collaboration [7]. Problems like missing or duplicate information have also been reported [30, 32].

Usability issues are a common concern. A US study found that poor EHR interfaces reduced eye contact between physicians and patients during consultations [29]. Other studies have associated EHR usability problems to increased medical errors, frustration, and diminished performance [21, 22].

2.2 EHR use and information overload

Information overload is defined as "the problem of having more information than we can process" [9], and it is often associated with information use in healthcare [16, 26]. Studies report several potential causes of information overload including the amount of information, its complexity, and its practical relevance to the current task [16, 14, 26]. Limited time available for healthcare professionals [4] and failure to use information may exacerbate the problem of information overload [26].

Literature reports several adverse effects of information overload. including stress and reduced performance of healthcare professionals and reduced quality of care [14, 16, 31]. Irrelevant patient information in EHRs may complicate the work of physicians [10].

In summary, the literature reveals mixed outcomes of EHR use among healthcare professionals, with information overload standing out as a notable challenge. Our study builds on these findings.

3 Case Description

In Norway, municipalities are responsible for ER services. The ER in the municipality of Trondheim operates after 15:30 on weekdays and 24/7 on weekends and public holidays. The ER is staffed by physicians with permanent positions and General Practitioners (GPs) who work on shifts. Physicians either work at the ER (called in-house physicians) or in the ambulating physician's car, operated by one physician and one paramedic driving the car. Ambulating physicians provide medical treatments for acute care or trauma outside the ER, including treatment on an accident site, home visits by health personnel, and treatment at the emergency municipal ward.

Patients call the Emergency Medical Communication Centre (EMCC) in case of an emergency, which assigns the task to an ambulating physician if required. Alternatively, the ER call center can also assign tasks originating from the safety patrol, home care services, nursing homes, the prison, or municipal chief medical officer. All tasks appear on a mounted screen in the car. Each task includes a description with known information about the patient, the situation, and the location. The ambulating physician decides which tasks to take based on severity, location, and prioritization of tasks.

Before 2022, patient information was stored in several EHR systems, and communication was done by phone, radio, or paper-based documentation. With the implementation of the integrated EHR system Helseplattformen (HP), the ER has access to real-time information from all units in the healthcare region of Central Norway implementing the HP system.

4 Methods

This paper reports our results from an interpretative case study [43] of the HP system in the ER in Trondheim, Norway [19]. Table 1 presents an overview of the data used in this paper, collected during the spring of 2023. The authors had an initial meeting with the ER coordinator about the study, followed by an observation of the ER to familiarize the first author with the setting. The first author spent 11 hours with two ER physicians observing ten ambulatory visits. The first author took field notes during the initial meeting and the observation sessions. These notes were updated after each session and discussed among the authors to uncover emerging themes. We conducted semi-structured interviews with three physicians to triangulate our observation data [33]. Each interview was held in Norwegian and lasted about 30-40 minutes. The interviews were audio recorded and transcribed. We also used several documents related to the HP system to gain a deeper understanding, including system requirements, project reports, legal documents on emergency care, and newspaper reports about the HP implementation.

Our data generation and analysis approach has been interpretative, spanning several iterations [25]. In the first data analysis phase, we did inductive open coding of the field notes in QSR NVivo v.14 [39]. The first phase helped us

Table 1. Data sources

Data source	Description of participants	Duration	Date
1 Meeting	Meeting with a coordinator at ER	1 hour	12 April 2023
3 Observations	Initial observation of the ER to familiarize the first author with the setting	2 hours	02 May 2023
	Observation of an ER Physician (Phy1) on 3 ambulatory visits	6 hours	03 May 2023
	Observation of an ER Physician (Phy2) on 7 ambulatory visits	5 hours	03 May 2023
3 Semi-structured interviews	ER Physicians (Phy3, Phy4 and Phy5)	30-40 minutes each	May 2023

to refine the research question and prepare the interview guide. In the second phase, we did open coding of the interview transcripts. Finally, we did a thematic analysis of the codes by focusing on patterns of reoccurring concepts and using them to synthesize second-order themes and categories [5].

5 Findings

Table 2 summarizes our findings as the first-order codes from the interview transcripts or field notes from the observation sessions, second-order themes, and third-order categories. We present detailed findings using the same structure in the following subsections. All quotes presented here are translated from Norwegian.

5.1 Information overload

Excessive and irrelevant information

Filtering irrelevant information takes time: During our observations, the physicians expressed that filtering irrelevant information consumed precious time because of the large amounts of information in the system, as the following quote explains: "The challenge is that it can take some time to go through, right, and also, getting it sorted, there is an enormous amount of information in here, so that can occasionally be the problem [...] it takes some time to filter away." **(Phy5)**

Complicated access and time pressure: An ER physician **(Phy3)** reflected that the HP system was not adapted to the situation and the needs of the ER because it was complicated for the physicians to quickly gather patient information, especially in the ambulating car due to the time pressure.

Perception of information overload

The excessive and irrelevant information seemed to result in a lack of trust in the HP system, difficulties finding information, stress, and frustration, culminating

Table 2. Summary of the findings

First order codes	Second order themes	Third order categories
Filtering irrelevant information takes time	Excessive and irrelevant information	Information overload
Complicated access and time pressure		
Lack of trust in the lists	Perception of information overload	
Difficulties in finding information		
Physicians had to work without the needed information		
Stress and frustration		
Documents containing duplicate information	Inability to gain an overview	
Manual filtering because everything was prioritized equally		
Complex cases needing immediate help	Challenges for ambulating ER physicians under high time pressure	Information use by ER physicians
Patient's identity may not be known		
Not enough time to make decisions		
Consult a specialist and ask qualified questions	Preparation before the patient visit	
Background information may improve treatment quality		
Possibility of overlooking important information		
Manual filtering was less effective	Finding relevant information	Usability issues
Search option was difficult to use		
Lack of an option to increase the text size, scrolling issue	Information presentation	
Lack of an option to preview documents		

in a perception of information overload. We describe these results in the following paragraphs.

Lack of trust in the lists: In the HP system, different lists were implemented to give physicians quick access to the most essential information on a patient. Some of these include lists of medicines, allergies, surgical history, and a list referred to as a "problem list," which mainly contains diagnoses. Some physicians used these lists at the start but discontinued using them. They expressed a lack of trust due to adverse experiences, e.g., the lists of medicines and diagnoses did not match, the lists were incomplete or not up to date, or it was difficult to find and use them. Others found the lists helpful but said that they must critically evaluate them each time, as the following quote suggests: "These lists are the most essential for us. And then you have to know they aren't always right, so you can't completely trust them." **(Phy5)**

Difficulties finding information: During our observation, a physician spent several minutes filtering through and looking for information before leaving to see the patient. In one case, much time was spent trying to determine if the patient had any diagnosis, but they could not find anything and concluded that there was no set diagnosis. However, the patient had several contacts with dif-

ferent care institutions, leaving the physician with many documents where such information could be located. While searching, the physician navigated back and forth in other tabs, lists, and between views on the small laptop while struggling to find what they needed. Since there were several possibilities for the location of the sought information, keeping track of the places already searched and more places to search was challenging.

Physicians had to work without the needed information: Since the physicians had limited time available, they had to do their best without the information needed because finding the information took too long:"If you are unable to locate it within a reasonable time, whether it is rooted in user competence, whether it is rooted in where it is located, or whether it is actually not there. Then you do not spend more time because you have to move on." **(Phy4)**

Stress and frustration: The physicians thought they had excessive information, consuming precious time and causing stress and frustration, as the following quote says: "The biggest concern is perhaps that one gets such an information overload, it is impossible to find what we need." **(Phy4)**

Inability to gain an overview

The perception of information overload may have resulted in the inability of the physicians to gain an overview of the patient information in the HP system.

Documents containing duplicate information: While observing in the car, a physician showed that a search for a patient in the HP system returned dozens of documents from the last few months, including several duplicates added by different EHR users. An ambulating physician had to view all these documents individually by clicking and scrolling on a small laptop in a moving car.

Manual filtering because everything was prioritized equally: The EHR had no option to filter the irrelevant information automatically. For instance, it was impossible to show recent notes by nurses that were considered relevant. The list of documents contained information from various EHR users with different roles in healthcare, where everything seemed to be prioritized equally, as the following quote suggests: "We see a lot of information from other professional groups, for example, homecare, which we feel is given the same priority if home homecare was there and served dinner, or if there has been or you have had a visit from the ambulating car." **(Phy4)**

5.2 Information use by ER physicians

In the previous subsection, we presented findings on how information overload may unfold generally in EHR systems. Here, we present findings on how the information use by ER physicians may contribute to information overload due to the particular nature of ER.

Challenges for ambulating ER physicians under high time pressure

Complex cases needing immediate help: Most patient visits by ambulating ER physicians were emergency responses, accidents, or other more complicated

cases. These cases usually involved elderly patients with complex health conditions or situations related to psychiatric conditions. The physician had to make decisions with almost no patient history available to them immediately in the EHR system: "After all, most of it is immediate help in some form, then we have to touch, find a solution, and quality-assure that we are not doing anything wrong, and then we have to move on." **(Phy4)**

Patient's identity may not be known: During our observation, we noted that the patient's identity was not known in advance in some cases. Therefore, the physicians could not search for detailed patient information in the HP system. Instead, they had to rely on the summary information in the task description.

Not enough time to make decisions: The physicians had to make various decisions in an emergency, and searching for patient information was often delegated to save time: "We need to know: Does the patient have heart disease or not? So maybe we have to ask the Emergency Medical Call Center (EMCC) to call someone while we figure something else out. We have to use those resources to get quick answers, and sometimes we don't have answers, and then we have to assume the worst." **(Phy4)**

Since ambulatory physicians had a short time to prepare for the evolving situation, they developed routines to quickly find the information they needed before arriving at the scene. For instance, discharge summaries from the hospital were valuable tools to provide an updated picture in a readable form, given that they are carefully written.

Preparation before the patient visit

We observed how ER physicians prepared themselves for an ambulatory visit using the EHR system and other means.

Consult a specialist and ask qualified questions: Although the ER physicians had access to patient information, they still needed to call other care providers to seek additional information. However, as the following quote suggests, a perceived lack of information in the EHR system prevented them from asking qualified questions:"In those cases where I need to consult with a specialist or someone who is more experienced in the field [..] it may be that I could have asked more qualified questions or have been better prepared if I had access to information [in HP]." **(Phy4)**

Background information may improve treatment quality: Access to information in the EHR system could impact physician decisions and was seen as valuable, as the following quotes suggest: "For example, in the event of a cardiac arrest, you were able to look up the medical record. Then you would have seen that this is someone who has a short life expectancy, perhaps a month left due to severe cancer. So, you would make completely different judgments than you would do for other people." **(Phy5)**

Access to background information could also lead to contact with other healthcare professionals. In one of our observations, the physician found a note in the EHR system from an external specialist after a patient visit and called that specialist to check if the current case of the patient could have any connec-

tion to the note, potentially affecting the choice of treatment and medication to prescribe. The physician reflected that finding and consulting with other healthcare providers involved with the patient could increase the quality of the care given.

Possibility of overlooking important information: We observed that the ER physicians worried about overlooking potentially available information. This meant that they could not use the information available in the EHR system because they could not find it or they did not have enough time: "You're a little curious about the fact that you might be met with [the statement] that, 'yes, but this was available to you. Why haven't you looked at or used it in the assessment?' But you don't always have the chance to do that." **(Phy5)**

5.3 Usability issues

During our observations, we found several usability issues related to finding, filtering, and using relevant information. Because the HP EHR system undergoes continuous optimization, we have not emphasized these usability issues as we expect them to be resolved in future versions of the system. To summarize, some of the main issues were: 1) inefficient manual filtering led to patient information being scattered over many notes in different views, 2) lacking fine-tuning functionality in search required the physicians to manually read all patient information, 3) technical issues such as missing option to increase text size and lack of quick preview options were experienced as frustrating.

6 Discussion

6.1 RQ: How do ER physicians use an integrated EHR system in their practices?

The Helseplattformen (HP) system provided access to integrated EHR from all the units implementing it. However, the HP system appeared to contain excessive and irrelevant patient information without adequate search and filtering options. Sometimes, the physicians had to work without the needed information, which may have caused stress and frustration. The physicians also expressed a lack of trust in the lists implemented in the HP system to provide information access. As a result, the physicians seemed to perceive information overload, which may have made it challenging to get an overview of patient information.

In addition to the general results on information overload for physicians, we found the following results while studying ER physicians' use of information in the integrated EHR system:

1. While the ER physicians recognized the value of patient information in the HP system for pre-visit preparation, additional challenges like complex cases and time pressure appeared to contribute to the information overload.

2. The user interface of the HP system did not seem to be adapted to the needs of ER physicians, especially in the ambulating car setting. We found several usability issues related to information organization and presentation in the HP system.

6.2 Theoretical outlook

Literature reports that sharing patient information among care providers may improve the quality of care [44] and increase the efficiency of care workflows in multidisciplinary settings like ER [2, 23, 28]. The new HP system implements an integrated EHR system for all providers in Central Norway to achieve information-sharing benefits [20]. Our case study's findings support the evidence that timely access to shared patient information may be valuable, especially when handling complex cases such as patients with comorbidities [30, 32]. EHR integrations may reduce the need for communication through phone, fax, or retelling information [23, 30, 44]. However, we found that the HP system does not eliminate the need for calls.

Irrelevant patient information is reported as a negative outcome of earlier EHR integrations [32, 42]. Our study uncovered the consequences of irrelevant information, including time lost while filtering irrelevant information and the worry of overlooking important information. Moreover, the literature reports that balancing too much and too little information is vital for a usable EHR integration [4, 23]. Our results show that access to concise medical history (e.g., a discharge summary) may help an ER physician make quick decisions. While we agree with the literature that an ideal record should provide just what is needed, we argue that what is relevant in one situation might not be relevant in another.

Our results show how physicians' perception of information overload may unfold from difficulties finding the needed information, even working without the required information under time pressure, leading to a lack of trust in system features and stress and frustration. Moreover, we found that information overload may cause difficulties for physicians in getting an overview of patient information. Our results also support the consistent findings in the literature on usability issues of integrated EHR systems [10, 21, 29].

6.3 Implications

Our findings on information overload have practical implications for integrated EHR systems in interdisciplinary settings like ER, with time pressure and the requirement to gain an overview of the relevant information. Since several users contribute to the integrated EHR, the patient information may be standardized to avoid information overload. The issue of redundant information may be handled by regular auditing and cleanup of the EHR systems. Standardization, auditing, and cleanup might potentially be automated using AI tools. Moreover, since usability issues with the integrated EHR systems also contribute to

information overload, user interfaces may be adapted to the user's needs and practices.

Our case study contributes to the broader debate on data and value creation in EHR integration [24]. For instance, we found how information overload may unfold for physicians as a negative outcome of EHR integration instead of the intended positive outcomes of the project [20]. Future research may explore the value of EHR integration for other healthcare professionals. More research is needed to unpack the mechanisms behind the intended and unintended consequences of health IT [6].

6.4 Limitations

Our interpretative case study offers a deeper understanding of information overload for physicians because of EHR use. However, our work may have limitations regarding the generalizability of the findings because of a limited number of interview participants and observation sessions [38]. Moreover, since we selected ER as an extreme case of EHR use, the case selection may have introduced bias in our findings [11]. Also, our findings may suffer from researcher or participant bias because of the nature of the interpretative research [25].

7 Conclusions

We report results from an interpretative case study using an integrated electronic health record (EHR) system in the Emergency Room (ER) in Trondheim, Norway. The findings suggest that excessive and irrelevant patient information may lead to a perception of information overload for physicians trying to get an overview of the information. We also found additional challenges for ER physicians, possibly contributing to the perception of information overload. Moreover, we identified usability issues with the EHR system.

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