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Usability of a Patient Portal and Patient-Perceived Errors in Electronic Health Records: A Survey Study

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Abstract

Patient portals provide access to electronic health records (EHRs) for better engaging patients in healthcare services. Patient portals' usability is important as it directly impacts patients' experience and acceptance of the portals. Thus, evaluating patient portal usability could help improve the healthcare service quality and patients' experience. Meanwhile, errors are commonly perceived in EHRs, could lead to further serious problems, and might also negatively influence patients' evaluation of patient portal usability. However, errors in EHRs have rarely been examined.

We aimed to evaluate the subjective usability of a national patient portal, patient-perceived errors in their EHRs, and how their perceptions might be associated with patients' assessment of patient portal usability.

Data were collected from 4719 users of the Finnish national patient portal My Kanta via a three-week online survey in Jan and Feb 2021. Respondents were asked to rate the usability of the patient portal in Likert-scale scores and the average ratings were converted to the System Usability Scale scores for comparison. They were also asked about perceptions of errors and omissions in the records and to rate the seriousness of the most important ones. The average usability scores were then compared and tested.

The overall My Kanta usability was evaluated by patients as good (System Usability Scale score: mean 74.3, SD 14.0). Of all these participants, 1664 (35.3%) reported perceiving at least one error in the electronic health records and 200 (14.0%) described the error(s) as very serious. The average usability rating from patients who have perceived errors in EHRs was tested statistically significantly lower than those who haven't.

In conclusion, the usability of My Kanta patient portal was acceptable, but could still be improved. Errors have been perceived in EHRs on My Kanta, could negatively impact users' assessment of the patient portal usability, and should be reduced for improving user safety and experience.

Keywords patient portals; EHR; electronic health record; usability; patient access; error; national survey

Contents

Preface

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Otaniemi, 24 July 2022

Yuhui Xu

1 Introduction

1.1 Motivation

As senior populations are increasing globally, there is a rising interest in eHealth solutions to gradually substitute traditional healthcare forms and limited human resources (Cabieses et al., 2013; Edwards et al., 2014; Hesse et al., 2010). eHealth refers to organizing and delivering health services through the Internet and related information technologies (Pagliari et al., 2005). It is proposed in studies that eHealth may improve healthcare efficiency and quality, and thereby decreasing financial costs (Eysenbach, 2001; Schade et al., 2006; Thakkar & Davis, 2006). Also, eHealth could encourage novel relationship between patients and healthcare providers as patients are allowed to be engaged in making decisions and therefore the information asymmetry decreases (Eysenbach, 2001; Sadan, 2002).

As a form of eHealth, patient portals are Internet-based platforms that allow patients to access their electronic health records (EHRs) and communicate with their healthcare providers (Osborn et al., 2013; *Patient Portal*, n.d.). Evidence shows that patient portals have improved the quality of healthcare services (Grant et al., 2008; Zhou et al., 2010). Patients can, for example, fill in online registration forms, make appointments, renew prescriptions, pay medical bills, examine test results, and message their provider. With these benefits, patient portals are considered as a revolutionary technology that may facilitate self-management of diseases and patient-centered healthcare (Detmer et al., 2008).

My Kanta is a nationwide patient portal of Finland, allowing patients to access their online health records (*My Kanta Pages*, 2021). After over 10 years of development since 2010, My Kanta now provides functions varying from accessing e-prescriptions and COVID certificates to saving a living will and organ donation testament (*My Kanta Pages*, n.d.; Sääskilahti, Ojanen, et al., 2021). According to statistics from Kanta Services (2021), there were over 3.8 million users of My Kanta in 2021, which increased by 39% compared to the previous year.

One of the premises of fully involving patients into novel Internet-based patient-centered healthcare services might be that users accept patient portals and are willing to use them. A study of user acceptance of computers conducted by Davis (1989) illustrated significant correlations between both perceived usefulness and perceived ease of use to current and future system usage. These two factors were proposed as determinants of user acceptance of information technology (Davis, 1989). Based on this, Holden & Karsh (2010)

proposed The Unified Theory of Acceptance and Use of Technology (UTAUT), which could apply to patient portals (Hoogenbosch et al., 2018).

One key factor of user acceptance to an online digital system is usability. Usability as a key concept in human-computer interaction (HCI) owns multiple definitions and images. Considering the quality of using systems in various contexts, usability has been defined earlier by Shackel (1991) as "the capability to be used by humans easily and effectively" and later as "the effectiveness, efficiency, and satisfaction for specified users to achieve goals" in the ISO 9241-11 standard (ISO, 2018). From the perspective of users' subjective experience towards systems or products, usability could be seen as perceived usability (Lewis et al., 2015; Sauro & Lewis, 2016). It is proved that perceived ease of use and usefulness affect users performance and their willingness of use (Venkatesh et al., 2003). The measurement of usability aims at improving the usability of products or systems and helping the users reach their objectives more effectively (Rosenbaum, 1989). This research will examine the perceived usability of My Kanta patient portal for improving its user acceptance.

In many countries, one of the key features of patient portals is allowing patients to access their online electronic health records (EHRs) (Essén et al., 2018). EHRs are patient-centered clinical information systems that collect, store, and present electronic information gathered during healthcare services (Cowie et al., 2017). It is globally recognized that patient engagement in health promotion is critical for improving quality and reducing cost of healthcare services (Pagliari et al., 2007), and EHRs may empower patients to play a more active role in self-care (Hassol et al., 2004).

As patients and their families increasingly access their EHRs, they may perceive errors and mistakes inside (Lam et al., 2021). In fact, errors are indeed commonly noticed in EHRs as inaccurate, inadequate and missing information (Graber et al., 2017). Healthcare providers may unintentionally import inaccurate medication lists, input wrong examination results, or copy and paste old health records inappropriately (Bell et al., 2020; Sheehy et al., 2014; Siegler & Adelman, 2009). As EHRs are often highly referred to in healthcare decision-making processes, such mistakes could lead to further serious problems, such as medication misuse, incorrect diagnoses and treatment, and so forth (Graber et al., 2017; Koppel et al., 2005; J. M. Walker et al., 2008). In addition, patients' reports have potential for improving safety of individuals and organizations (Giardina et al., 2018). However, few studies have examined patient-identified errors in their medical notes and how these may contribute to improvement of strategies on patient engagement and safety (Bell et al., 2020). Thus, this study also aims at investigating perceived errors and omissions in EHRs reported from users of My Kanta patient portal.

Perceived usability is not merely about user performance such as task completion times and error rates (Nielsen & Levy, 1994). Apart from user performance, various factors might also affect perceived usability of a system, including perceived aesthetics (Tractinsky et al., 2000) and joy of use (Jordan, 1998). In the case of My Kanta as the Finnish national patient portal, perceiving errors in EHRs is an important part of patient experience, as it reflects the system's reliability and safety and might influence users' satisfaction and hence perceived usability of the platform. Due to the concerns, the relationship between errors reported in EHRs and perceived usability of My Kanta patient portal will also be explored in this study.

Regarding My Kanta patient portal, Kujala et al. (2022) measured its usability through a nation-wide survey, which could be described as good. Sääskilahti et al. (2021) also examined pharmacy customers' experiences of My Kanta and mentioned user-reported incorrect information in the services, such as information recorded incorrectly and difficulty correcting erroneous information. However, the evaluated usability might change as there might be more users of My Kanta due to the severer COVID pandemic in Finland starting from December 2021. In addition, the relationship between reported errors in EHRs and perceived usability of My Kanta hasn't been looked into in depth.

This study focuses on perceived usability and existence and importance of errors and omissions in EHRs of My Kanta from a national viewpoint covering a considerable proportion of users that accessed My Kanta services during this research. Moreover, we also intended to explore how patients' perceived errors in EHRs would relate to their perceived usability of the whole portal.

1.2 Problem Statement

The objective of this study is to assess the perceived usability of My Kanta patient portal, the frequency of patient-perceived errors and omissions in EHRs, and patients' potentially different evaluations of My Kanta usability after noticing errors or omissions in their EHRs. The three research questions of the study were presented as follows:

RQ1: How do the users evaluate usability of My Kanta?
RQ2: Did the users perceive errors and omissions in EHRs? How serious were they?
RQ3: Did the users evaluate usability of My Kanta differently if they perceived errors or omissions in EHRs?

1.3 Structure of the Thesis

This thesis was structured as follows. Chapter 1. In Chapter 2, key concepts of the research topic (i.e., usability, patient portal, errors/omissions in EHRs) and the related studies were introduced along with two hypotheses made accordingly. Next, research materials and methods were covered in Chapter 3 in detail, including description of the examined patient portal, research approaches, the survey, and the quantitative analysis process. Chapter 4 consisted of the results of this empirical study, as well as the population description of the involved participants. Finally, research questions were answered and discussed from aspects of reliability, limitations, implications, and suggestions in Chapter 5.

2 Literature background and hypotheses

In this chapter, we will discuss key concepts used in the study. Patient portals and EHRs will be introduced in the first section, followed by the usability concept, its measurement, and patient portal usability. Lastly, we will look into patient-perceived errors and omissions in EHRs and how they have been related to patient portal usability and satisfaction.

2.1 Patient portals

Patient portals are Internet-based platforms that provide eHealth services and allow patients to access their electronic medical information and interact with their healthcare providers (Osborn et al., 2013). The government of United States defined it as "a secure online website that gives patients convenient 24-hour access to personal health information from anywhere with an Internet connection" (HealthIT.gov, 2017).

On patient portals, patients' personal medical data were managed by healthcare organizations, and patients could access their information such as doctor visits, discharge summaries, and medications from various types of portals (HealthIT.gov, 2017). Most patient portals provide patients with various usable and robust functionalities. For example, patients could receive, save, and share their digital prescriptions and health data (Ross et al., 2006; Sääskilahti, Ahonen, et al., 2021; Turvey et al., 2012); self-check for potential health problems (Kujala & Hörhammer, 2022); or even recod living wills and organ donation testaments (Sääskilahti, Ahonen, et al., 2021).

By allowing patients' access to health information and use multiple functions, patient portals were found having the potential to improve the relationship between patients and their healthcare providers, and to enhance patients' awareness to their health condition (Carini et al., 2021). For example, diabetic patients who had been using a patient portal were investigated having better performances in self-care activities (Osborn et al., 2010). Furthermore, accessing to health information could contribute to sustaining patients' use of the patient portals themselves (Ross et al., 2006).

According to Irizarry et al. (2015), patients' characteristics such as age, education level, and health literacy, could have significant impact on their interest and ability of using patient portals. Meanwhile, a favorable patient poratl usability could also contribute to patients' engagement (Irizarry et al., 2015). By identifying specific patient groups and contexts, patients could be better engaged through a patient portal in the future (Irizarry et al., 2015).

This applies to the present study on My Kanta patient portal as it involves examining usability evaluations in specific patient characteristics.

2.2 EHRs

In general, EHRs represent eletronic data gathered in processes of delivering healthcare services (Denaxas & Morley, 2015). The data could involve demographic and vital statistics, medical and pharmacy claims, and patient-oriented data (Cowie et al., 2017). Research have been conducted in multiple countries in the world for developing national health information platforms, including Australia, Canada, England, Finland, and the United States (Hayrinen et al., 2008). A number of terms have been commonly used worldwidely to describe various types of EHRs, such as electronic patient record (EPR; Cheung et al., 2001; Mikkelsen & Aasly, 2001), computerized patient record (CPR; Aronsky & Haug, 2000; Ho et al., 1999), and patient accessible electronic health record (PAEHR; Wiljer et al., 2008; Moll et al., 2018). The common users of EHR systems are physician, nurse, patient, and so on (Hayrinen et al., 2008).

EHRs may empower patients to be more engaged in self-care (Hassol et al., 2004), and allowing patients to access EHRs may improve health condition and satisfaction with the received healthcare services (Wiljer et al., 2008). Although benefits have been identified, many questions remain unsolved in practices for the implementation of EHRs. Factors that facilitate EHR adoption were investigated as efficiency, organization size, and improved healthcare quality (Kruse et al., 2016). Meanwhile, barriers of EHR adoption were identified as cost, time-consuming, user-perceived lack of usefulness, and so on (Kruse et al., 2016). Specifically, lack of usefulness may increase profession burdon, influence patients' experience negatively, and even lead to patient harm with other factors (Ratwani, Savage, Will, Fong, et al., 2018). Research projects have been carried out recently on examining usability of EHR systems with various methods, including expert walkthrough (Howe et al., 2018), interviews (Ratwani et al., 2015), and quantitative survey (Melnick et al., 2020).

2.3 Usability

Usability is one of the key concepts in human-computer interaction (HCI). Earlier in the 90s, Shackel (1991) defined usability as "the capability to be used by humans easily and effectively". The International Organization of Standard later defined usability in Standard ISO 9241 (ISO, 1998) in the following way:

"Software is usable when it allows the user to execute his task effectively, efficiently and with satisfaction in the specified context of use".

According to the ISO standard, usability consists of three components: effectiveness, efficiency, and satisfaction (ISO, 1998). They refer to 1) how well the users achieved their goals using the system, 2) what resources were utilized to achieve their goals, and 3) how the users feel about the use of the system (Abran et al., 2003). This definition is recommended by the majority of professionals on usability, though the security aspects considered to be significant haven't been covered in it (Abran et al., 2003). Notably, by integrating various definitions, Shackel (2009) developed an operationalised definition of usability consisting of criteria in effectiveness, learnability, flexibility, and attitude.

Rather than one established concept of usability, Hertzum (2010) illustrated multiple images of usability in his study, including universal usability, situational usability, perceived usability, hedonic usability, organizational usability, and cultural usability (Table 1). The study aimed at providing in-depth understanding of the usability concept and supplementing the work that only adopted a single image of usability (Hertzum, 2010).

Table 1: Six images of usability and their explanation (Hertzum, 2010).

Images of usability	Explanation of the image
Universal usability	Usability entails embracing the challenge of making systems for everybody to use.
Situational usability	Usability is equivalent to the quality-in-use of a system in a specified situation with its users, tasks, and wider context of use.
Perceived usability	Usability concerns the user's subjective experience of a system based on his or her interaction with it.
Hedonic usability	Usability is about joy of use rather than ease of use, task accomplishment, and freedom of discomfort.
Organizational usability	Usability implies groups of people collaborating in an organizational setting.
Cultural usability	Usability takes on different meanings depending on the users' cultural background.

2.3.1 Measuring perceived usability

To assess perceived usability, standardized questionnaires are commonly developed and applied apart from usability testing. Two of the most popular ones could be the Computer System Usability Questionnaire (CSUQ; Lewis, 1995) and the System Usability Scale (SUS; Brooke, 1996).

CSUQ, also known as Post-Study System Usability Questionnaire (PSSUQ), was developed by Lewis (1995) to measure user satisfaction with usability of computer systems by responding to 16 questions. Similarly, originally created by John Brooke (1996), SUS was a simple, ten-item Likert scale with five response options from "Strongly agree" to "Strongly disagree", providing a quick and reliable tool for assessing subjective usability of a wide variety of products such as websites and software. In fact, SUS has been studied as the most frequently used metric in measuring the usability of telemedicine systems (Klaassen et al., 2016). Although there was a small but significant difference between CSUQ and SUS means after converting CSUQ scores into a 0-100 scale to match the SUS scale, these two questionnaires were still considered similar in practice measuring perceived usability (Lewis, 2018).

Another commonly used tool was the Usability Metric for User Experience (UMUX). UMUX was a four-item Likert scale for assessing an application's subjective perceived usability (Finstad, 2010). Using UMUX when measuring usability could produce results similar to those from SUS, and it was based on the ISO 9241-11 usability definition (Finstad, 2010). Additionally, Lewis et al. (2013) developed UMUX-LITE based on UMUX. It consisted of two items "This system's capabilities meet my requirements" and "This system is easy to use" and was tested to be a promising alternative to SUS (Lewis et al., 2013).

The SUS score could also be converted from UMUX items (Lewis et al., 2013), and could serve as a benchmark when describing perceived usability of a digital product. Bangor et al. (2008) proposed adding an adjective rating to an SUS score for better interpretation. According to the study, digital products which could be considered having a passable usability level have SUS scores above 70, and better digital products could score in the high 70s to upper 80s (Bangor et al., 2008).

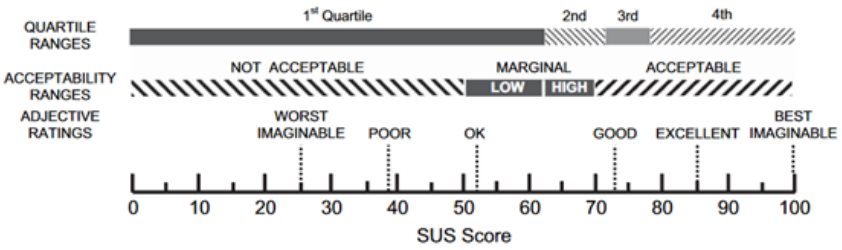

Figure 1: A comparison of mean SUS scores (Bangor et al., 2008).

In this study, we used 3 items from UMUX concerning usefulness, ease of use, and frustration to assess patients' perceived usability of My Kanta patient portal. The outcome was an SUS score converted from UMUX means by applying a regression formula (Lewis et al., 2013).

2.3.2 Patient portal usability

Usability is important for a patient portal as it directly impacts patients' acceptance of it (Irizarry et al., 2015). More specifically, usability impacts the ease of navigation, accuracy of information input, and comprehending perceived information (Irizarry et al., 2015). Furthermore, concerning EHR as a key feature of a patient portal, usability has been confirmed as one of the most important factors hindering patients' adoption (Farzandipour et al., 2018).

One of the widely applied methods for testing patient portal usability is heuristic evaluation, a method of testing draft prototypes by examining the interface according to usability principles (Nielsen & Molich, 1990). It has been commonly utilized for examining objective patient portal usability (Irizarry et al., 2015). Researchers also used "think-aloud" method to test a series of prototypes in scenarios with intended participants to gain in-depth understanding for redesigning the interface and workflows (Irizarry et al., 2015). Moreover, questionnaires were also widely used in a large number of studies to assess patient portal subjective usability and satisfaction to evaluate the overall adoption and acceptance (Irizarry et al., 2015). For example, in a recent study, Martinez et al. (2021) used SUS in assessing the usability of the patient portal My Diabetes Care (MDC). Kujala et al. (2018) empirically evaluated the impact of usability on health professionals' support for a patient portal using UMUX.

2.4 Errors and omissions in EHRs

EHR could prevent medical errors from happening, but at the same time it could also produce errors (Kruse et al., 2016). In fact, errors exist commonly in EHRs as inaccurate, inadequate and missing information (Graber et al., 2017; Koppel, 2012). The most common types of errors in EHRs were identified as mistakes in diagnoses, medical history, medications, physical examination, test results, notes on the wrong patient, and sidedness (Bell et al., 2020).

Patients reported inaccuracies in health records in many of the previous studies, while the situations varied. In a study of an online survey involving over 30000 participants in the United States, about 20% of the patients who read their EHRs reported perceiving a mistake, and two fifths among whom considered the mistake as serious (Bell et al., 2020). Likewise, about 25% of the patients and their family perceived at least one inaccuracy in their ambulatory visit notes in 3 healthcare centers in the United States, and more than half of these specific participants considered the inaccuracies as important or very important (Bourgeois et al., 2019). Freise et al. (2021) also found that

12.4% of the participants noticed error(s) in contact information, appointment details, and results and measurements in their medical records in an online survey of patients' use of a patient-controlled EHR portal in North-West London. By conducting focus group discussions, Papoutsi et al. (2015) found a proportion of participants perceiving errors in health records in UK. Earlier in Finland, errors have also been noticed in EHRs in My Kanta patient portal (Eriksson-Backa et al., 2021). In addition, patients could also perceive errors when reading their paper medical records (Mossaed et al., 2015).

Previous studies have explored the potential of sharing health records with patients for patient safety improvement purposes. Concerning paper medical records, Ross & Lin's (2003) literature review indicated that patient safety could potentially be improved by patients perceiving and identifying errors in their medical notes when they were provided with access to read them. Systematic review of EHRs from patient and family may produce substantial findings (Kim et al., 2017; Ratwani, Savage, Will, Arnold, et al., 2018), and the recognized errors in EHRs may contribute to improvement in healthcare safety (Bourgeois et al., 2019). Moreover, identifying and reporting perceived errors in EHRs may help engage patients in healthcare processes, improve EHR accuracy, and strengthen the safety partnership between patients and their healthcare providers (Lam et al., 2021).

The steady rise in unexpected errors in EHRs has led to negative experiences of reading EHRs to some patients. A number of studies on similar topics could indicate negative impact of perceiving errors and omissions in EHRs on patients' evaluating the patient portal usability indirectly and be worth referring to as follows. According to a qualitative study conducted by Rexhepi et al. (2018), 13 of 15 patients who consulted their online health records became upset when they perceived errors in their medical records. Meanwhile, the consequences of hospital error in ambulatory care were found including negative impacts on patients' psychological wellbeing and social function (Lipczak et al., 2015). From physicians' perspective, the reported practice satisfaction decreased and they were more likely to be dissatisfied due to perceiving new EHR-related errors (Love et al., 2012). Notably, in a study with similar hypotheses on clinicians' usage of and satisfaction with electronic medical records and their related factors, Shin et al. (2021) accepted one of the hypotheses that the perceived EMR-related errors would have a significant influence on perceived ease of use via structural equation modeling. To improve patients' experience, Bell et al. (2020) suggested paying more attention to patients' perceived important errors, though professionals believed some of those reports were not errors.

Based on the previous studies, we state the following hypotheses:

H1. Patients who perceive errors or omissions in EHRs have a lower assessment of usability of the patient portal.

H2. Patients who perceive more serious errors or omissions in EHRs have a lower assessment of usability of the patient portal.

3 Research material and methods

This chapter introduced research methods used in the study. The description of My Kanta patient portal, research approaches, survey, data collection, and quantitative analysis will be covered.

3.1 Description of My Kanta

Patient portals can be characterized and compared using TOPCOP taxonomy (Taxonomy of Patient Portals based on Characteristics of Patient Engagement) (Glöggler & Ammenwerth, 2021a). Initially, it consisted of 7 aspects that covered 20 dimensions of a patient portal, which was later revised by Glöggler and Ammenwerth (2021b) into 25 dimensions by applying a modified Delphi approach. According to the revised version of TOPCOP taxonomy (Glöggler & Ammenwerth, 2021b), the seven aspects were listed as follows: (1) portal design, (2)management, (3) communication, (4) instruction, (5) self-management, (6) self-determination, and (7) data management.

Väyrynen (2021) described My Kanta patient portal by identifying its characteristics in 25 dimensions based on TOPCOP taxonomy. In Väyrynen's study (2021), My Kanta was pictured as a web-accessible generic patient portal which allowed renewing prescriptions and accessing medication summaries but was unable to book appointments, receive instructions, and communicate with health care providers. Notably, regarding the data management aspect, My Kanta was identified as limited that the patients had only shared control of their record access and could only review their health data (Väyrynen, 2021). The results and discussions of the present study were based on these distinguished characteristics of My Kanta.

3.2 Research approach

A quantitative approach was selected for this research, as quantitative data were required to measure patient-perceived usability of My Kanta and errors and omissions in EHRs, and their relationship in a large scale. Qualitative approaches such as semi-structured interviews had been concerned but later excluded due to limited sample size and researcher’s nonproficiency in native language. Regarding measuring usability, usability testing which could have provided a detailed and valuable understanding of a service (Dumas et al., 1999) was also rejected for similar reasons.

Collecting quantitative data by conducting a survey was feasible as it is suitable for large-scale investigation and could reach as many as people in a

short time. Survey has been widely adopted as one of the research approaches in large-scale studies on eHealth services (Kainiemi et al., 2022; Moll et al., 2018; Sääskilahti et al., 2021; J. Walker et al., 2019). Meanwhile, interviews and conversations were excluded from choices as they difficult to carry out and could only cover a limited number of people. This study was based on the survey conducted as a part of NORDeHEALTH project which aimed at identifying challenges and chances in digitalization of health services and providing concrete guidelines and suggestions for further development of Personal eHealth Services (PeHS) in Nordic countries (NORDeHEALTH, n.d.).

3.3 Survey

The survey was designed by research groups from different Nordic countries according to the research proposal of the NORDeHEALTH project. In the questionnaire, various themes of questions were first suggested by different research groups and then discussed together for deciding their meanings and the expected observations in considerable detail.

In Finland, the survey was designed and implemented by Aalto University in cooperation with Kela (the Social Insurance Institution of Finland). The survey questions were iteratively reviewed by the My Kanta product owners as representatives from Kela for identifying issues and proposing suggestions from the perspective of My Kanta. The Nordic country representatives also checked and approved the survey. The survey questions were tested between Oct 2021 and Jan 2022 with 4 volunteering participants who were later rewarded with eBook gift cards. Near before launching the survey, a short marketing video along with a brief introduction was posted on social media platforms (i.e. Kanta Facebook page, LinkedIn) for reaching more My Kanta users.

The online questionnaire was developed using Webropol (version 3.0). The survey was open to response from Jan 24 to Feb 14 in 2022. The starting page of the online questionnaire showed up after users logged out of My Kanta, ensuring the respondents to be actual users of the patient portal. The users who agreed to join were then directed to Webropol to answer the questions anonymously.

The questionnaire consisted of 42 structured, Likert-scale and free-text questions. The main themes of the questions were as follows: (1) subjective experiences of My Kanta, (2) patients' experiences of accessing and reading their EHRs, (3) health condition, received care and records of care, (4) multidisciplinary teams, (5) security and privacy, (6) usefulness evaluation of currently unavailable functions, and (7) all respondents' basic background

information. Questions about background information (i.e., age, region, gender, education, health profession, employment condition) were all structured.

This thesis reports the results of 7 selected questions on patient portal usability and errors and omissions in EHRs from the first and second parts of the questionnaire. Regarding patient portal usability, participants were asked to evaluate their experience of My Kanta in three Likert-scale questions. The questions were assessing the following statements respectively: "The system meets my needs.", "Using this system is a frustrating experience." and "The system is easy to use." All of their responses ranged from 1 ("Strongly disagree") to 7 ("Strongly agree") with an extra option 8 ("I don't know"). The questions were based on a usability-measuring two-item questionnaire UMUX-LITE which was validated to be reliable as a promising alternative to the SUS (Lewis et al., 2013).

Two structured questions concerned the patient-perceived errors and omissions in EHRs on My Kanta, asking "Have you ever found anything in your record you thought was wrong?" and "Have you ever found anything in your record you thought was missing?" The response options were both "yes", "no", and "don't know / don't remember".

The perceived importance of errors was queried with a 4-point Likert-scale question "If YES, how important was the worst mistake for you?" with response options "not at all important", "somewhat important", "very important", and "I am not sure". Similarly, a question concerned the perceived seriousness of omissions, asking "If YES, how serious was the most important missing information for you?" with response options "not at all serious", "somewhat serious", "very serious", and "I am not sure".

3.4 Data analysis

Before analysis, the data file was exported from Webropol. The dataset was first checked for respondents under the age of 15, whose responses were later excluded from data analyses due to ethical concerns (*Guidelines for Ethical Review in Human Sciences*, n.d.).

The data was analyzed using the statistical software SPSS (version 28.0; IBM Corp). The descriptive analyses included frequencies, percentages, means, modes, and medians. In the analyses, the data of two age groups (15-17, 18-19) were merged into one age group (15-19) for better interpretation of the results. The respondent's age was placed into 1 of the 9 groups (15-19, 20-24, 25-34, 35-44, 45-54, 55-64, 65-74, 75-84, and 85 years old or older). The collected data of the 7-point Likert-scale question "Please evaluate your

experience of My Kanta: Using this system is a frustrating experience." was reversed (i.e., resetting 1 into 7, 2 into 6, and the like) for unifying the scale directions and calculating the average usability. Observations with valid ratings in all three usability questions were selected as the source of calculating the average usability. Additionally, the average usability has been rounded for keeping the datatype as ordinal. The option "I'm not sure" was excluded from the data analysis of RQ3.

The statistical analysis methods in the present study were selected mainly referring to the objective of the study, distribution and type of the data, and whether the observations were paired or unpaired (Mishra et al., 2019). For investigating how My Kanta usability was associated with perceiving errors and omissions, we compared the usability means and tested the statistical significance of difference using Mann-Whitney U Test (McKnight & Najab, 2010). The reasons for using Mann-Whitney U Test were that 1) the goal was to compare the means between two independent samples (participants who perceived or not perceived errors/omissions in their EHRs), 2) the distribution of the average usability was tested non-normal according to the result of Shapiro-Wilk normality test and the datatype of average usability was ordinal, and 3) the groups that selected different options in the questions of errors and omissions in EHRs were unpaired. For studying the association between My Kanta usability and the seriousness of perceived errors and omissions, we used the same method of comparing means but Kruskal-Wallis H Test instead for testing the significance of difference among three or more independent samples (Kruskal & Wallis, 1952). Additionally, Kruskal-Wallis H Test was also used in analyzing differences between means in independent groups of perceiving errors/omissions or not for usability with My Kanta. Statistical significance was determined as $p<.05$ in this study.

4 Results

In this chapter we present the results of the study. We discuss basic characteristics of participants, descriptive analytics, the perceived usability of My Kanta, the reported errors and omissions in EHR, and their relationship.

4.1 Participants

A total of 4719 responses to the survey were collected, apart from which 2 responses from users under 15 years old were removed due to related laws. During the time when the survey was open for answers, there were 1 262 708 individual users accessed My Kanta patient portal. Therefore, the response rate was about 0.4%.

The majority (72.5%) of the participants were female (Table 2). It can be easily noticed that more than half of the respondents were over 55 years old, and they were concentrated between 55 and 74 years old (58.4%). The majority of the participants (85.8%) received and completed their education higher than elementary school, in which one fourth (25.8%) gained their diploma in upper secondary education and 21.9% in higher vocational education. Notably, the percentage of participants that graduated with university degrees (38.1%) was higher than that from a survey study of My Kanta users conducted by Sääskilahti et al. (2021). Most respondents (76%) hadn't received any health education. Over half (55.5%) of the respondents were retired when answering the questionnaire, which supports the result of age distribution. Approximately half of the rest participants (24.1%) were working as full-time employees. The majority of the participants (77.2%) have accessed their EHRs over 10 times, in which 27.3% have even accessed more than 20 times.

4.2 Perceived usability of My Kanta

The results of assessing 3 usability statements were shown in Table 3. Notably, the scale direction of the second item was opposite to the others and was presented in the results without being reversed.

Table 2: Characteristics of the study respondents (N = 4719).

Characteristic	n (%)
Gender	
Female	3422 (72.5)
Male	1224 (25.9)
Other	62 (1.3)
Age in years	
15-19	24 (0.5)
20-24	62 (1.3)
25-34	224 (4.7)
35-44	361 (7.6)
45-54	595 (12.6)
55-64	1160 (24.6)
65-74	1596 (33.8)
75-84	620 (13.1)
85 years old or older	52 (1.1)
Education	
No formal education	19 (0.4)
Elementary school	474 (10.0)
12 years school	1217 (25.8)
Vocational diploma	1033 (21.9)
Bachelor	826 (17.5)
Master	886 (18.8)
Research	83 (1.8)
Health education	
Yes	1026 (21.7)
No	3586 (76.0)
Employment	
Full time	1139 (24.1)
Part time	279 (5.9)
Student	137 (2.9)
Retired	2621 (55.5)
Unemployed	214 (4.5)
Not able to work	160 (3.4)
None of the above	145 (3.1)
Access frequency	
This is my first time	49 (1.0)
2 to 9 times	94 (2.0)
10 to 20 times	2354 (49.9)
More than 20 times	1287 (27.3)
Other	916 (19.4)

Table 3: Mean and standard deviation values of the answers to UMUX items from a seven-point Likert scale.

UMUX items	**Mean**	**SD**
My Kanta meets my needs.	5.72	1.370
Using My Kanta is a frustrating experience.	2.33	1.785
My Kanta is easy to use.	5.77	1.532

Table 4: Statistics of the 7-point average perceived usability ratings and the converted SUS score.

	Mean	SD	Median
Average usability	5.45	1.329	6.00
SUS	74.3	14.0	77.1

The perceived usability of My Kanta was calculated by first averaging the Likert-scale scores and then converting to SUS scores for better interpretation. Compared to Likert-scale scores, SUS scores describe usability of a system on a scale from 0 to 100. For My Kanta, the usability mean value was calculated as 5.45 (s=1.329) and then the mean SUS score was converted to as 74.3 (s=14.0) (Table 4).

On the 7-point Likert scale, 90.7% (4016/4426) of the participants had rated the average usability of My Kanta within a range of 4-7 (Table 5). Average usability ratings differed significantly across most of the participant groups except for whether received health education (P=.625). Participants who received higher educations tended to have lower average usability ratings, and participants who have accessed their EHRs over 10 times evaluated My Kanta usability better than those under 10 times.

4.3 Errors and omissions in EHRs

In total, 1664 of 4719 participants (35.3%) perceived at least an error and 1398 of 4719 participants (29.6%) noticed missing information in their EHRs. Aging participants were slightly less likely to notice errors and omissions in EHRs, and participants with higher degrees tended to perceive errors and missing information more easily. The associations between participant characteristics and perceiving error(s) and omission(s) were given in Table 6.

Among 1428 patients who perceived at least an error in EHRs and responded to the seriousness questions, 200 (14.0%) described the error(s) as very serious, 651 (45.6%) were somewhat serious, and 577 (40.4%) were not at all serious (Table 7). Meanwhile, 119 (10.5%) of 1128 responded participants considered the information omission as very serious, along with 491 (43.5%) as somewhat serious and 518 (45.9%) as not serious at all. With their scales from 1 to 3, the mean level of error importance was calculated as 1.74 and for omission seriousness the number was 1.65, which could be both considered overall “slightly important/serious”.

Table 5: Participants' average 7-point Likert-scale usability rating with My Kanta patient portal (N=4426).

Participant group	Average usability rating, n (%)							*P* value
	1	2	3	4	5	6	7	
All participants	49 (1.1)	95 (2.1)	266 (6.0)	566 (12.8)	831 (18.8)	1684 (38.0)	935 (21.1)	N/A
Gender								<.001
Female	34 (1.1)	64 (2.0)	204 (6.3)	439 (13.7)	619 (19.2)	1179 (36.7)	677 (21.1)	
Male	13 (1.1)	25 (2.2)	57 (5.0)	110 (9.6)	194 (17.0)	490 (42.9)	252 (22.1)	
Other	2 (3.4)	5 (8.5)	3 (5.1)	16 (27.1)	15 (25.4)	14 (23.7)	4 (6.8)	
Age in years								<.001
15-19	N/A	N/A	1 (4.5)	4 (18.2)	5 (22.7)	9 (40.9)	3 (13.6)	
20-24	1 (1.7)	2 (3.4)	3 (5.1)	5 (8.5)	16 (27.1)	27 (45.8)	5 (8.5)	
25-34	1 (0.5)	7 (3.2)	12 (5.5)	24 (11.0)	51 (23.4)	90 (41.3)	33 (15.1)	
35-44	5 (1.4)	9 (2.5)	22 (6.2)	60 (17.0)	85 (24.1)	135 (38.2)	37 (10.5)	
45-54	7 (1.2)	21 (3.6)	41 (7.1)	87 (15.0)	130 (22.4)	208 (35.8)	87 (15.0)	
55-64	16 (1.4)	24 (2.2)	54 (4.8)	134 (12.0)	193 (17.3)	442 (39.6)	252 (22.6)	
65-74	15 (1.0)	26 (1.8)	99 (6.7)	182 (12.3)	249 (16.8)	553 (37.3)	358 (24.2)	
75-84	4 (0.8)	5 (0.9)	31 (5.8)	65 (12.2)	90 (16.9)	193 (36.2)	145 (27.2)	
85 years old or older	N/A	1 (2.4)	1 (2.4)	3 (7.1)	8 (19.0)	15 (35.7)	14 (33.3)	
Education								<.001
No formal education	1 (6.3)	1 (6.3)	N/A	2 (12.5)	5 (31.3)	3 (18.8)	4 (25.0)	
Elementary school	3 (0.7)	5 (1.2)	29 (6.9)	37 (8.9)	69 (16.5)	135 (32.3)	140 (33.5)	
12 years school	14 (1.2)	19 (1.2)	56 (4.9)	123 (10.8)	204 (17.8)	446 (39.0)	282 (24.7)	
Vocational diploma	5 (0.5)	15 (1.5)	67 (6.9)	121 (12.5)	146 (15.1)	407 (42.0)	209 (21.5)	
Bachelor	6 (0.8)	24 (3.0)	43 (5.4)	107 (13.4)	170 (21.3)	316 (39.6)	131 (16.4)	
Master	15 (1.8)	21 (2.5)	59 (7.0)	140 (16.5)	189 (22.3)	298 (35.2)	124 (14.7)	
Research	2 (2.6)	6 (7.7)	3 (3.8)	13 (16.7)	17 (21.8)	29 (37.2)	8 (10.3)	
Health education								.625
Yes	10 (1.0)	27 (2.8)	53 (5.4)	132 (13.6)	187 (19.2)	356 (36.6)	209 (21.5)	
No	38 (1.1)	67 (2.0)	207 (6.2)	419 (12.5)	625 (18.6)	1290 (38.5)	706 (21.1)	
Employment								<.001
Full time	13 (1.2)	26 (2.3)	48 (4.3)	159 (14.3)	229 (20.5)	454 (40.7)	186 (16.7)	
Part time	1 (0.4)	7 (2.6)	13 (4.8)	31 (11.4)	49 (18.0)	118 (43.4)	53 (19.5)	
Student	1 (0.8)	1 (0.8)	8 (6.1)	18 (13.6)	33 (25.0)	50 (37.9)	21 (15.9)	
Retired	24 (1.0)	39 (1.6)	155 (6.5)	284 (11.9)	409 (17.1)	888 (37.1)	597 (24.9)	
Unemployed	5 (2.4)	7 (3.4)	17 (8.3)	20 (9.7)	41 (19.9)	76 (36.9)	40 (19.4)	
Not able to work	4 (2.6)	10 (6.5)	10 (6.5)	22 (14.3)	38 (24.7)	56 (36.4)	14 (9.1)	
None of the above	1 (0.8)	3 (2.3)	12 (9.1)	25 (18.9)	31 (23.5)	38 (28.8)	22 (16.7)	
Access frequency								.011
This is my first time	N/A	2 (4.4)	5 (11.1)	6 (13.3)	8 (17.8)	13 (28.9)	11 (24.4)	
2 to 9 times	N/A	5 (6.3)	10 (12.5)	9 (11.3)	18 (22.5)	23 (28.7)	15 (18.8)	
10 to 20 times	22 (1.0)	45 (2.0)	132 (6.0)	292 (13.3)	398 (18.1)	849 (38.5)	465 (21.1)	
More than 20 times	12 (1.0)	24 (2.0)	69 (5.6)	134 (10.9)	226 (18.5)	486 (39.7)	273 (22.3)	
Other	15 (1.7)	19 (2.2)	50 (5.8)	124 (14.4)	178 (20.7)	306 (35.5)	169 (19.6)	

Table 6: Characteristics of participants and whether they reported perceiving an error or an omission.

Participant groups	Perceived an error in EHRs, n (%)			Perceived an omission in EHRs, n (%)		
	Yes	No	Don't know	Yes	No	Don't know
All participants	1664 (35.3)	2211 (46.9)	747 (15.8)	1398 (29.6)	2013 (42.7)	1189 (25.2)
Gender						
Female	1299 (38.7)	1513 (45.1)	544 (16.2)	1022 (30.6)	1415 (42.3)	905 (27.1)
Male	323 (27.1)	683 (57.2)	188 (15.7)	337 (28.4)	585 (49.3)	264 (22.3)
Other	36 (59.0)	13 (21.3)	12 (19.7)	36 (59.0)	9 (14.8)	16 (26.2)
Age in years						
15-19	4 (16.7)	11 (45.8)	9 (37.5)	9 (37.5)	6 (25.0)	9 (37.5)
20-24	26 (41.9)	20 (32.3)	16 (25.8)	23 (37.1)	22 (35.5)	17 (27.4)
25-34	95 (42.6)	84 (37.7)	44 (19.7)	76 (34.2)	83 (37.4)	63 (28.4)
35-44	151 (42.7)	151 (42.7)	52 (14.7)	110 (31.1)	143 (40.4)	101 (28.5)
45-54	222 (38.1)	272 (46.7)	88 (15.1)	197 (33.8)	234 (40.2)	151 (25.9)
55-64	444 (39.0)	515 (45.3)	179 (15.7)	356 (31.4)	486 (42.9)	290 (25.6)
65-74	521 (33.3)	806 (51.6)	236 (15.1)	459 (29.5)	735 (47.2)	364 (23.4)
75-84	182 (30.0)	322 (53.1)	102 (16.8)	150 (25.2)	279 (46.8)	167 (28.0)
85 or older	12 (25.5)	21 (44.7)	14 (29.8)	12 (25.0)	18 (37.5)	18 (37.5)
Education						
No formal education	6 (35.3)	9 (52.9)	2 (11.8)	3 (17.6)	7 (41.2)	7 (41.2)
Elementary school	120 (25.6)	263 (56.1)	86 (18.3)	100 (21.9)	247 (54.0)	110 (24.1)
12 years school	399 (33.3)	582 (48.5)	218 (18.2)	320 (26.8)	542 (45.5)	330 (27.7)
Vocational diploma	360 (35.5)	485 (47.8)	169 (16.7)	304 (30.1)	434 (42.9)	273 (27.0)
Bachelor	328 (40.8)	360 (44.8)	116 (14.4)	274 (34.2)	330 (41.1)	198 (24.7)
Master	354 (41.0)	403 (46.7)	106 (12.3)	303 (35.2)	355 (41.2)	204 (23.7)
Research	32 (40.0)	39 (48.8)	9 (11.2)	24 (29.6)	35 (43.2)	22 (27.2)
Health education						
Yes	437 (43.5)	428 (42.6)	139 (13.8)	328 (32.8)	432 (43.2)	239 (23.9)
No	1188 (33.8)	1736 (49.4)	590 (16.8)	1032 (29.5)	1538 (44.0)	927 (26.5)
Employment						
Full time	364 (32.4)	590 (52.5)	170 (15.1)	289 (25.8)	536 (47.9)	295 (26.3)
Part time	92 (33.8)	128 (47.1)	52 (19.1)	80 (29.4)	124 (45.6)	68 (25.0)
Student	58 (43.3)	45 (33.6)	31 (23.1)	44 (32.8)	50 (37.3)	40 (29.9)
Retired	897 (35.0)	1275 (49.8)	389 (15.2)	755 (29.7)	1157 (45.5)	632 (24.8)
Unemployed	75 (36.1)	87 (41.8)	46 (22.1)	79 (38.2)	62 (30.0)	66 (31.9)
Not able to work	94 (59.1)	39 (24.5)	26 (16.4)	88 (55.3)	33 (20.8)	38 (23.9)
None of the above	70 (50.0)	42 (30.0)	28 (20.0)	52 (37.1)	46 (32.9)	42 (30.0)
Access frequency						
This is my first time	0 (0.0)	0 (0.0)	1 (100.0)	1 (100.0)	0 (0.0)	0 (0.0)
2 to 9 times	14 (15.2)	52 (56.5)	26 (28.3)	14 (15.2)	43 (46.7)	35 (38.0)
10 to 20 times	638 (27.2)	1293 (55.2)	411 (17.6)	556 (23.9)	1155 (49.7)	611 (26.3)
More than 20 times	504 (39.4)	583 (45.7)	190 (14.9)	412 (32.4)	529 (41.6)	332 (26.1)
Other	508 (55.8)	283 (31.1)	119 (13.1)	415 (45.5)	286 (31.4)	211 (23.1)

Table 7: Participants' overall ratings and statistics of perceived error importance and omission seriousness (1 = Not serious at all; 2 = Somewhat serious; 3 = Very serious).

	Rating			Statistics		
	1, n (%)	2, n (%)	3, n (%)	Mean	Mode	SD
Error importance	577 (40.4)	651 (45.6)	200 (14.0)	1.74	2	.689
Omission seriousness	518 (45.9)	491 (43.5)	119 (10.5)	1.65	1	.663

4.4 Perceived usability and errors and omissions in EHRs

4.4.1 Usability and errors/omissions

As shown in Table 8, The overall average My Kanta usability ratings were 5.08 (n = 1576) from participants who perceived errors in EHRs and 5.76 (n = 2077) from those who haven't perceived any errors in their records. Meanwhile, for omissions in EHRs, the two average ratings were 4.94 (n = 1321; have perceived omissions) and 5.80 (n = 1896; haven't perceived omissions). Both of these two comparisons presented statistically significantly lower usability ratings after perceiving errors or omissions, and the significance was confirmed widely among participant groups with a large sample size.

The score difference between "have perceived" and "haven't perceived" were around 0.7 in all participants groups and characteristics, which didn't differ dramatically among groups. Aging participants tended to rate My Kanta usability slightly higher than younger user groups when they found error(s) or omission(s) in EHRs. Participants who received higher education produced lower My Kanta usability ratings regardless of whether perceiving error(s) or omission(s).

To interpret the score differences in a meaningful way, the 7-point Likert-scale UMUX scores were converted into SUS scores (0-100). By applying the regression equation proposed by Lewis et al. (2013), the converted SUS scores from all participants who have perceived error(s) in EHRs were calculated as 70.7 (s = 15.1) and 77.4 (s = 12.5) from those who haven't found any errors. According to the adjective rating scale created by Bangor et al. (2008), 70.7 was slightly lower than "Good" (SUS=71.4) and 77.4 was somewhere between "Good" and "Excellent" (SUS=85.5). Similarly, the SUS scores from those who have found information missing in EHRs was 69.3 (s = 15.2) and 77.7 (s = 12.8) for those who haven't. The adjective rating for them were also "Good" and "Between good and excellent".

Table 8: Participants' average rating of My Kanta usability when perceiving errors and omissions in their EHRs or not, with the significance test results using Mann-Whitney U test.

Participant group	Perceived errors in EHRs			Perceived omissions in EHRs		
	Yes, mean (n)	No, mean (n)	P value	Yes, mean (n)	No, mean (n)	P value
All participants	5.08 (1576)	5.76 (2077)	<.001	4.94 (1321)	5.80 (1896)	<.001
Gender						
Female	5.09 (1237)	5.75 (1419)	<.001	4.93 (966)	5.78 (1331)	<.001
Male	5.12 (299)	5.81 (643)	<.001	5.03 (317)	5.88 (553)	<.001
Other	4.32 (34)	5.15 (13)	.162	4.40 (35)	5.56 (9)	.058
Age in years						
15-19	5.50 (4)	5.55 (11)	.945	5.00 (8)	6.00 (6)	.120
20-24	4.88 (24)	5.84 (19)	.014	4.95 (22)	5.73 (22)	.090
25-34	5.05 (94)	5.74 (82)	<.001	5.04 (75)	5.70 (81)	<.001
35-44	4.69 (150)	5.59 (147)	<.001	4.65 (110)	5.53 (138)	<.001
45-54	4.79 (217)	5.58 (265)	<.001	4.60 (194)	5.60 (226)	<.001
55-64	5.19 (429)	5.82 (497)	<.001	5.03 (344)	5.81 (467)	<.001
65-74	5.15 (482)	5.79 (758)	<.001	5.01 (421)	5.85 (695)	<.001
75-84	5.30 (158)	5.85 (276)	<.001	5.15 (133)	6.00 (239)	<.001
85 years old or older	5.64 (11)	6.12 (16)	.273	5.25 (8)	6.19 (16)	.029
Education						
No formal education	4.60 (5)	5.25 (8)	.651	4.50 (2)	5.33 (6)	.302
Elementary school	5.33 (107)	5.91 (234)	<.001	5.13 (87)	5.96 (222)	<.001
12 years school	5.27 (380)	5.87 (551)	<.001	5.06 (306)	5.91 (511)	<.001
Vocational diploma	5.16 (340)	5.86 (455)	<.001	5.12 (283)	5.88 (410)	<.001
Bachelor	5.06 (317)	5.64 (346)	<.001	4.87 (263)	5.71 (321)	<.001
Master	4.80 (337)	5.56 (387)	<.001	4.72 (293)	5.57 (338)	<.001
Research	4.29 (31)	5.57 (35)	.002	4.29 (24)	5.33 (33)	.012
Health education						
Yes	5.16 (419)	5.71 (403)	<.001	4.95 (315)	5.72 (412)	<.001
No	5.06 (1120)	5.77 (1628)	<.001	4.93 (969)	5.83 (1443)	<.001
Employment						
Full time	5.07 (359)	5.64 (574)	<.001	4.90 (285)	5.64 (521)	<.001
Part time	5.16 (91)	5.81 (125)	<.001	5.16 (79)	5.77 (120)	<.001
Student	5.05 (57)	5.91 (43)	<.001	4.86 (42)	5.85 (48)	<.001
Retired	5.19 (829)	5.83 (1168)	<.001	5.03 (693)	5.90 (1068)	<.001
Unemployed	4.69 (71)	5.84 (85)	<.001	4.81 (77)	5.97 (61)	<.001
Not able to work	4.65 (91)	5.36 (39)	.002	4.65 (85)	5.22 (32)	.015
None of the above	4.91 (65)	5.55 (38)	.016	4.49 (49)	5.67 (43)	<.001
Access frequency						
2 to 9 times	4.42 (12)	5.58 (48)	.025	3.54 (13)	5.57 (40)	<.001
10 to 20 times	5.04 (599)	5.73 (1213)	<.001	4.88 (519)	5.78 (1090)	<.001
More than 20 times	5.16 (484)	5.84 (554)	<.001	5.01 (392)	5.89 (505)	<.001
Other	5.07 (481)	5.82 (262)	<.001	5.00 (396)	5.77 (261)	<.001

4.4.2 Usability and error/omission seriousness

The mean value of My Kanta usability ratings were 5.40 (n = 549) from participants who considered their perceived errors in EHRs not important at all, 5.01 (n = 622) from those who assumed them as somewhat important and 4.31 (n = 188) from those who found them very important, as shown in Table 9. Meanwhile, for omissions perceived in their EHRs, the numbers were 5.33 (n = 489), 4.76 (n = 467) and 4.19 (n = 115), respectively. The scores illustrated a clear trend of decreasing along with the increases of seriousness levels for both perceived errors and omissions. According to Bangor (2009), the converted SUS scores indicated their corresponding adjective ratings as "Good" (Not at all serious), "Almost good" (Somewhat serious) and "Between ok and good" (Very serious). All the scoring differences in Table x were tested as statistically significant ($p < .001$).

Table 9: Participants' average ratings of My Kanta usability (in Likert-scale and SUS) when perceiving different levels of seriousness of errors and omissions in their EHRs, with the significance test results using Kruskal-Wallis H Test.

		Importance of perceived error(s)/omission(s)			*P* value
		Not at all important	Somewhat important	Very important	
Error importance	Likert scale	5.40 (n=549)	5.01 (n=622)	4.31 (n=188)	<.001
	SUS	74.2 (s=12.6)	70.2 (s=15.0)	62.0 (s=19.5)	<.001
Omission seriousness	Likert scale	5.33 (n=489)	4.76 (n=467)	4.19 (n=115)	<.001
	SUS	73.3 (s=12.8)	67.8 (s=15.7)	59.9 (s=19.1)	<.001

With regard to the proposed hypotheses in this study, the overall average usability scores from participants who have found errors or omissions in their EHRs were tested significantly lower than the scores from those who haven't. Also, the average usability ratings became significantly lower when participants considered the perceived errors or omissions more serious. Therefore, it was not impossible to reject hypotheses H1 and H2. In conclusion, patient portal usability seems to be conditioned by perceiving errors/omissions and their seriousness levels.

5 Discussion

This chapter will answer the research questions based on the results and the reviewed literature. Reliability and limitations of this study was also included. Lastly, implications and suggestions for further research and practice will be discussed.

5.1 Answers to the research questions

5.1.1 The usability of My Kanta

The user-perceived usability of My Kanta patient portal was examined to be acceptable (5.45, SD = 1.329) and could be described as "good" according to Bangor (2009). The converted SUS score of My Kanta usability (74.3, SD = 14.0) was slightly higher than the result from the previous year's study of My Kanta (72.7, SD = 15.9) (Kujala et al., 2022), but slightly lower than that of Journalen (79.81, SD = 14.25) in Sweden in 2016 (Hägglund & Scandurra, 2021).

5.1.2 Patients' perceiving errors and omissions in EHRs

Errors and omissions have been perceived by patients in EHRs on My Kanta. The rates were 35.3% for patients who perceived at least one error and 29.6% for those who found at least one information missing in their EHRs. Among those who perceived error(s) and omission(s), 14.0% and 10.5% of patients considered them as very serious, respectively, but nearly half of both those patients found them as not serious at all. Younger patients were slightly more likely to notice errors and omissions in EHRs than elder patients, and patients with higher degrees tended to perceive errors and missing information more frequently. Compared to previous results, the rates of perceiving errors in EHRs and their seriousness were both higher than the reported rate of perceiving mistakes (21.1%) and cases considered very seriousness (9.9%) in open notes in United States in 2020 (Bell et al., 2020). While the exact numbers were different, the result of this study could still support the conclusions from previous studies that errors and omissions are commonly perceived in EHRs.

5.1.3 Errors and omissions in EHRs and My Kanta usability

The two hypotheses cannot be rejected. The average usability ratings were statistically significantly different between patients who have and haven't perceived errors or omissions in EHRs. The former group have produced lower My Kanta usability evaluations. Meanwhile, the similar trend shows on

seriousness of errors and omissions in EHRs that patients who perceived more serious errors or omissions in their EHRs rated significantly lower My Kanta usability. Though the difference were considered statistically significant, the converted SUS scores were described with close adjective ratings, which representing a relatively small significance realistically. The results indicated that in the case of EHRs, perceptions of errors might also impact patients' satisfaction. It also support the result from Shin et al. (2021) that the perceptions of EMR-related errors would impact perceived ease of use significantly.

5.2 Implications and suggestions for further research

In this study, the patient-perceived usability of My Kanta patient portal was evaluated as good in a certain period. By comparing it to previous results, researchers could see how usability of My Kanta changes and whether potential trend exists, in order to propose concrete suggestions for further maintainence and improvement.

Along with aging, the portion of participants who have noticed errors and omissions in EHRs decreased, while their average usability rating increased. Meanwhile, participants with higher degrees tended to perceive errors and missing information more easily. These may suggest further research on error types that might be easier to perceive by patients with younger age and higher received education, and how those types of error might impact patients' experience of accessing the patient portal.

As some errors or omissions might result from usability-related issues (e.g., wrong system input from healthcare providers due to mis-clicking or unclear instructions), usability testing could be conducted to identified detailed misoperations from especially healthcare professions. In this case, healthcare professions could be trained with better improved system instructions for reducing wrong operations.

Patients reported perceptions of errors and omissions in EHRs as very serious or important, suggesting that a feedback channel for those findings might be helpful for improving patients' safety and experience without negative impact for the relationships between patients and healthcare providers (Bell et al., 2017).

The study highlighted the negative impact from perceptions of errors or omissions towards patient portal usability evaluation, indicating importance of patient safety and portal quality. The result on one hand might affect patients' willingness of recommenation of the patient poratl, while on the other hand it could also indicate a potential path of improving patient portal usability by reducing patients' chances of finding mistakes and missing information in EHRs. It is suggested identifying types and causes of the perceived errors and omissions combining with qualitative data to explore design space of future patient portal improvement.

5.3 Reliability and limitations

The survey response rate was low at 0.4%, indicating a relatively unsatisfied representation of the whole user group. Compared to the response rate (0.7%) from a previous study of My Kanta, this number was even lower (Kujala et al., 2022). In Sweden, this number was 0.61% in a similar survey study towards Journalen in 2016 (Hägglund & Scandurra, 2021). Possible cause could be that a number of potential participants might have been unintentionally excluded as they might not have logged out and noticed the survey entrance after using My Kanta services. Moreover, a possibly larger percentage of users might access My Kanta only for the COVID-19 certificate and not be motivated enough to answer the questionnaire during the survey open period when the number of COVID-19 cases grew rapidly in Finland. As the response rate were calculated by dividing the number of responses by the number of My Kanta users during the survey open period, the response rate could therefore be lower than expected.

Patient portal usability was mainly evaluated in this study by averaging the scores of UMUX items asking patients of their agreement on the statements of perceived ease of use, frustrating experience, and perceived usefulness. It is possible that some participants might have rated the scores simply as satisfaction during their use of the patient portal service, as patients might not be able to clearly identify the sources of their potential negative experiences. This could lead to unreal usability evaluation as those patient-portal-unrelated negative experiences could be reflected on or expressed through lower ratings.

Notably, some patient-reported errors might not necessarily be errors, though they could still impact patients' experience. For example, they could be disagreements between healthcare providers and patients (Bell et al., 2020). Meanwhile, some errors might not result from usability-related issues but simply be caused by bad habits of healthcare providers such as frequent copying and pasting (Sheehy et al., 2014). This may indicate that the lower usability ratings from those who perceived usability-unrelated errors/omissions might have distorted the average usability rating to a certain extent.

In the data analyses, a certain proportion of responses were excluded from calculations due to invalid or missing data. The qualitative text data were not used in this study, while it could have possibly revealed novel patterns if being involved. Moreover, few studies were found on the association between perceived usability and errors/omissions when reviewing literature, therefore the hypotheses were made by inferring from indirect proofs.

The adjective descriptions of levels of perceived usability and seriousness of errors/omissions were interpreted from mean values of their ratings. However, the Likert-scale intervals might not be equally meaningful even though the scale numbers were equal (Sullivan & Artino, 2013). When converting the Likert-scale scores of usability into SUS scores, the equation used has only involved two items in UMUX-LITE scale (Lewis et al., 2013) and has excluded the second question asking patients' frustrating experience. In this case, the data has not been fully utilized and the calculated SUS score might slightly vary from what patients actually meant.

Strictly speaking, the revealed association between perceptions of errors or omissions and patient portal usability ratings was not solid. This study only investigated the association by comparing mean values from independent groups, while the correlations and specific parameters of the pattern remain uncertain. This is notable as patients' ratings of patient portal usability might be impacted by various factors at the same time, and the direct or indirect cause(s) of lower usability ratings for each participants remain uncertain.

5.4 Conclusion

This research aimed to assess the perceived usability of My Kanta patient portal, the frequency of patient-perceived errors and omissions in EHRs, and patients' different evaluations of My Kanta usability after noticing errors or omissions in their EHRs. Based on quantitative analyses of Likert-scale scores of usability and reported frequencies and seriousness of perceived errors and omissions, it can be concluded that 1) My Kanta usability was evaluated "good" overall, 2) errors and omissions have been perceived in about a third of EHRs but mostly were considered not very serious, 3) patients who perceived errors or omissions in EHRs have a lower assessment of patient portal usability, and it became worse when they were considered more serious. The results indicate that usability was found to be on an acceptable level but could still be improved. Errors and omissions in EHRs existed on My Kanta, might negatively impact users' assessment of the portal usability, and should be reduced in order to improve user safety and experience. This study provided a new insight into how errors and omissions perceived in EHRs would impact patients' evaluation of patient portal usability. It would be better to look into the association between patient portal usability and errors/omissions found in EHRs by conducting correlation and regression analyses. Moreover, identifying the types and causes of errors and omissions in EHRs by combining text data into data analyses would help provide concrete suggestions for further development of the My Kanta patient portal.

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Appendix A

Contents of the Survey

1. Please evaluate My Kanta based on your experience (1 = Totally disagree; 7 = Totally agree)
    1. My Kanta meets my needs.
    2. Using My Kanta is a frustrating experience.
    3. My Kanta is easy to use.

2a. Have you ever found anything in your record you thought was wrong (not counting misspellings or typographical errors)?
    1. Yes
    2. No
    3. Don't know / Don't remember

2b. If YES, how serious was the worst mistake for you?
    1. Not serious at all
    2. Somewhat serious
    3. Very serious
    4. I'm not sure

3a. Have you ever found anything in your record you thought was missing (not counting misspellings or typographical errors)?
    1. Yes
    2. No
    3. Don't know / Don't remember

3b. If YES, how serious was the worst lack of information for you?
    1. Not serious at all
    2. Somewhat serious
    3. Very serious
    4. I'm not sure