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Electronic Patient Records in Managing Medication Information – A Health Care Professional Perspective

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Abstract

Efficiently managed information is a key resource in clinical practice. Electronic patient records (EPRs) are in focal point in managing patient-specific medication information. In this multi-method-study, we combine qualitative and quantitative data to investigate Finnish physicians' perceptions of EPRs. Physicians consider EPRs important in their clinical practice and use them in managing patients' medication information while addressing a considerable dissatisfaction with quality of the current EPRs. Altogether the findings highlight the need for improving the quality of the systems and increasing the physicians' satisfaction to materialize the benefits from the EPRs

Keywords: electronic patient records, physicians, medication information

1   Introduction

The global trend of health care organizations is to aim at producing health care services more efficiently. Many areas on health care sector are highly information-rich and data-intensive in nature (Hagland, 1998; Reddy & Spence, 2008). Consequently, the collection, transmission, storage, and retrieval of information are essential in majority of activities performed in health care sector. Therefore, efficiently managed information is one of the most important resources in clinical practice. (Moen, 2003.) Information technology (IT) is often seen as a part of the solution in achieving the goal of making the health care sector more competitive (Chiasson, Reddy, Kaplan, & Davidson, 2007).

Availability of information is essential in many sectors but in health care, the consequences of failing to provide professionals with accurate information can be more serious than just financial losses. According to an estimate, more than 1.5 million people are hurt every year by preventable medication errors in the U.S. (Landro 2009.) Consequently, information related to medication is highly essential for health care professionals. The most important part of it is a patient's current medication regimen, and in addition to that, does he/she take them according to the physician's orders. Medication information refers to a patient's current medication regimen, including e.g. medication history, the generic and commercial name of the drug, the dosage, the use indication, and an individual's medication-taking practices. This information also covers a patient's risks information e.g. drug allergies. (Aarnio & Raitoharju, 2008.)

Electronic patient records (EPRs) have an important role in managing patient-specific medication information. EPR refers to a system that *"contains all or most of patient's clinical information from a particular hospital"* (Häyrinen, Saranto, & Nykänen, 2008, p. 295). The medication information presented in the EPRs is critical for securing safe and high quality health care (Xu et al., 2010). However, despite the undoubtedly essential role of the EPR, there are not many studies describing its ability to support prescribing and other medication information related issues (Delpierre et al., 2004; Häyrinen, et al., 2008).

The Finnish health care sector is characterized by universal public health services. Since the market area is fairly small and language unique, it is not the most attracting one for service providers developing EPRs. However, there are several different EPRs in use in the Finnish primary and secondary care, of those six have the highest number of users. Recent studies conducted in Finland, but also internationally (cf. Christensen & Grimsmo, 2008) have revealed the weaknesses of the EPRs and also some problems related to medication information. Despite the increased research interest, the current literature focusing on EPRs in supporting the management of medication information from physicians' perspective is scant.

To full in the aforementioned gap in the literature, we take a deeper look at the electronic management of medication information by exploring physicians' perceived need for medication information, quality of medication information recorded in the EPR, availability of the medication information and finally the benefits achieved from the use of EPR from the physicians' point of view. We take a multi-method approach by first analyzing a series of in-depth interviews and use the findings to develop a survey measuring the physicians' perceptions of EPRs. The research question is stated as follows: *how do Finnish physicians perceive EPRs in management of medication information?*

The paper is organized as follows; after the introduction, a brief review of prior literature on EPRs is given. In chapter 3, the empirical research is reported. First, the analysis of the interview is presented. Based on the findings from the interviews a research model and the research hypotheses are developed, followed by reporting the quantitative data collection and data analysis. In the final chapter, the main findings are presented, followed by the theoretical and practical implications. Finally, the limitations of the study and avenues for further research are discussed.

2 Related research

EPRs have been studied rather extensively. The research is often concerned with EPR adoption among health care professionals (Boonstra & Broekhuis, 2010) or effects of the systems on information quality (Häyrinen, et al., 2008). There is a set of definitions for the often even interchangeably used terms EPR, electronic health record (EHR) and electronic medical records (EMR). According to the definition of Häyrinen, Saranto et al. (2008, p. 293), EHR is *"a repository of patient data in digital form, stored and exchanged securely, and accessible by*

multiple authorized users", whereas EPR refers to patient-specific clinical information from a certain health care organization.

The often expected benefits from using information systems (IS) in health care are for instance improved quality of patient care, access to patient medical information and efficiency, financial savings and decreased number of medical errors, e.g. adverse drug events (Wang et al., 2003; Yamamoto & Khan, 2006). Contrary to the often promoted, the benefits of eHealth technologies related to both cost effectiveness and patient outcomes in fact still remain to be proven (Black et al., 2011). In regard to the assessment of specific information systems, a literature review conducted on EHRs revealed that the most often used criteria for health care IS quality were completeness and accuracy, and ease of use. Added to that, physicians' use of EHRs was the most often studied topic. (Häyrinen, et al., 2008.)

EPRs are used in hospitals as well as in primary care organizations (Häyrinen, et al., 2008). Physicians have a significant role in the assessment of EPRs. In a Norwegian multi-method study conducted among general practitioners, physicians were commonly satisfied using the EPR. However, they still had many needs and other issues that needed to be improved especially related to the functionality. Especially, the availability of the information within the EPR was not self-evident (Christensen & Grimsmo, 2008). A recent study conducted in Finland is in line with this; it was found that the EPRs do not support physicians' clinical work as expected. Furthermore, the poor functionality and usability can even lead to lowered patient safety (Winblad et al., 2010). Furthermore, EPRs have found to be even a complicating factor when it comes to the physicians' work (Vänskä et al., 2010). These studies are in line with earlier ones in regard to patient safety; for instance adverse drug events cannot be prevented even in computerized hospitals (Nebeker, Hoffman, Weir, Bennett, & Hurdle, 2005).

3 Research design

3.1 Qualitative study

To gather information and increase knowledge on how Finnish physicians perceive EPRs in management of medication information, a collection of interview material was arranged. The interviews were conducted in a primary care organization consisting of one main health center and dispersed sub-units within one Finnish municipality. Five physicians with a varying work experience were chosen for the interviews. The interviewed physicians worked mainly in the daytime and treated patients from a fixed area on 15 to 20 -minutes, pre-booked visits. The interviews consisted of semi-structured questions that also allowed new themes to be brought up. Each of them lasted from one to two hours; all the interviews were recorded and transcribed by one of the authors. QSR NVivo 8 was used in the analysis. The interviews uncovered several interesting aspects on the electronic management of medication information of which few appeared repeatedly. These aspects are developed next.

The interviews clearly showed the importance of medication information for clinical work; all the interviewees mentioned needing the information very often, almost with every patient. One of the physicians summed up the comments of the physicians concerning the need of information: *"I want to know the patient's medication information as extensively as possible, well, there is not much about the medication information I wouldn't like to know."* Another one described the meaning of the information as follows: *"In my opinion, this is really an important issue, to know what medication a patient is taking."*

Since medication has an effect on many treatment decisions, the need for medication information is high especially in critical situations. Consequently, there should be an easy access to the information: *"Yeah, on-call. They may bring an unconscious, old, sick, patient...and we start thinking, has he/she been treated somewhere, does he/she have any*

illnesses, and what medication has he/she taken and what's the dosage, it's essential -- this is the most difficult situation, you are extremely busy and you can't reach anyone on Saturday night." However, availability of information is always essential when there is only a limited time for each patient. One of the interviewees described how she would like to acquire the information: *"The faster, the better, of course but we've got 15 minutes per patient and there [on-call] even less."* In other words, there should not be any obstacles hindering the access to information.

Many of the comments were related to the desired characteristics of medication information. Often these characteristics were expressed in negative relation since there were many difficulties in regard to the current quality of medication information. The desired characteristics were described for instance in the following comment: *"...that you don't get the information from anywhere, reliable information. If there was a medication list [in the EPR] that would be updated according to a basic rule you would know that it is complete for sure, there would not be any problems..."* Another physician was suspicious about the information recorded in the EPRs: *"...at least I don't trust that it [medication information] is recorded there accurately enough".* For instance changes in the dosage were not always entered into the EPR properly. Therefore, the information acquired from the EPR was not always relevant enough to support treatment decisions. Added to that, one of the physicians commented: *"of the amount of the information that is currently recorded, I would say that 90% is irrelevant that from a patient's [treatment's] point of view is useless, at least 80%. The essential information should be winnowed out, it should jump out."* Summing up the above presented, the medication information desired should be reliable, up-dated, complete, and relevant.

When it comes to the perceived benefits, the interviewed physicians were not extremely satisfied with EPRs. One of the interviewed commented on the patient safety: *"Well, it has probably enhanced."* Another one also found positive sides of the EPR: *"I must admit that there are some benefits from the ADP (automatic data processing) issues. We have a system that is, however, full of failures,..., but it has been advantageous for real for a couple of times when I'm prescribing a medicine,...,and I have forgot that the patient is taken this [drug],..., I have avoided many mistakes when the computer has alerted me [of possible adverse effects]."* Despite the less enthusiastic opinions, the interviewed would probably not be ready to go back to the time before electronic patient records thus it can be expected that there must be at least some benefits of using it.

3.2   Research hypotheses

Based on the analysis of the data obtained from interviewing the physicians, we identified two key factors, namely availability and information quality. Third, the analysis of the interviews clearly demonstrated the need for obtaining medication information that EPRs designed to fulfill. The fourth factor, perceived benefits encompasses the value of the EPR in managing patients' medication information.

Altogether, we have constructed the research model in a way that EPRs are viewed as task-oriented systems designed to fulfill a core set of needs and hence increase work performance. Consequently, the perceived quality of the IT artifact is viewed to have a positive effect on the physicians' work performance. This line of reasoning has been extensively used in prior technology adoption research. (see e.g. Davis, 1989; Goodhue & Thompson, 1995; Venkatesh, 2000; Venkatesh & Bala, 2008; Venkatesh, Morris, Davis, & Davis, 2003.)

Given the exploratory nature of the present study and the limited literature focusing specifically on the core properties and value of EPRs for user's perspective., the research hypotheses are

drawn based on the findings from the qualitative analysis of the interviews as well as prior IT adoption literature from other contextual settings.

Benbasat & Zmud (2003) have addressed the importance of usage context in understanding the usage decisions. Hence, we used the data from the interviews to operationalize the four key research constructs. The need for medication information from the EPR was operationalized to consist of information about the usage over the counter drugs, patient's medication history, information about the current medication and potential risk factors such as allergies. Increased patient safety, increased work efficiency and enhanced quality of the clinical work were used as the variables measuring the perceived benefits of the EPR.

Altogether the respondents addressed their dissatisfaction with various aspects of the EPRs they are currently using. Given their critical approach toward the EPRs it is plausible to interpret that when the medication information needed extensively the users are more critical towards the system. Hence, the following hypothesis is postulated:

H1: Need for medication information has a negative influence on the perceived benefits of the EPR.

Grounded on the information obtained from the interviews, the information quality and availability of the medication information as well as availability were used to capture of the perceived quality of the EPR. Prior IS research has demonstrated information quality being an important contributor to system utilization and hence, organizational impact (DeLone & McLean, 2003). As a result we put forward the following hypotheses:

H2: Information quality of the medication information obtained from the EPR positively affects the perceived benefits of the EPR.

H3: Availability of the medication information positively affects the perceived benefits of the EPR.

The physicians addressed the importance and need for medication information in their work but at the same time addressed several problems associated with the EPRs. Thus, the more the physicians need information from the EPR makes the problems and shortcomings more prevalent. In consequence, the relationship between need and information quality of the EPR is likely to be negative.

H4: The need for medication information negatively affects the perceived reliability of the information obtained from the EPR.

We assert that the extensive use of the EPR to obtain medication information makes the physicians savvier with the features and functionalities of the EPR suggesting a positive relationship between the needs and availability of the information. In consequence, we propose the following:

H5: The need for medication information positively affects the perceived availability of the medication information.

Based on the information obtained from interviewing the physicians, accessing the information fast and easily were found as key aspects of availability of the medication information in the EPR. Also prior literature offers evidence that systems that are considered ease to use are also perceived more useful (Davis, Bagozzi, & Warshaw, 1989). As a result, the final hypothesis is postulated:

H6: Availability of the medication information positively affects information quality.
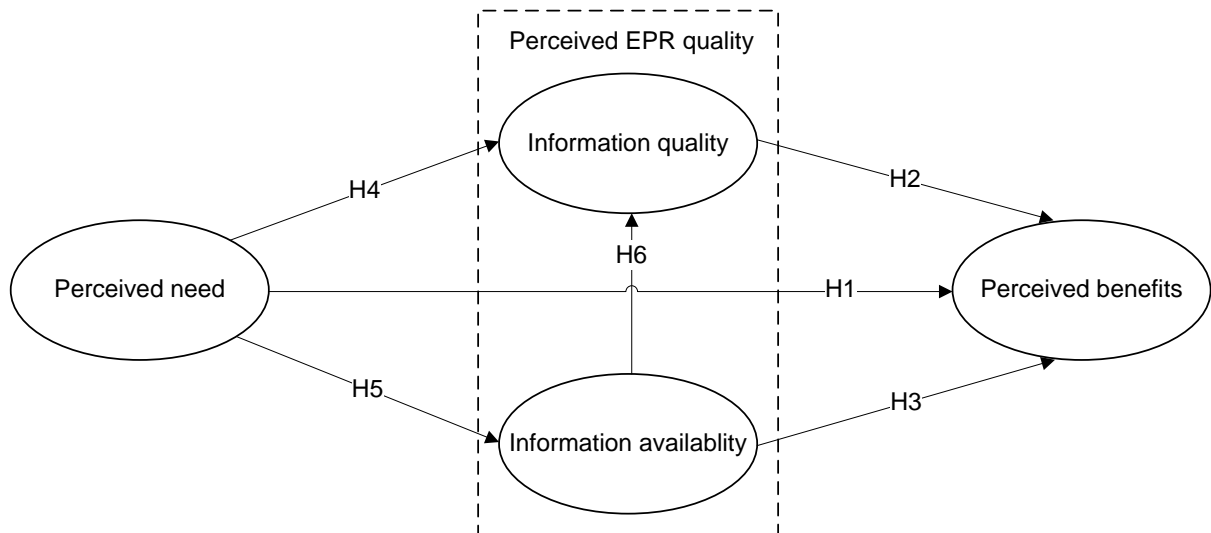
Figure 1 The Research Model

3.3 Data collection

The empirical data to test the research model was collected with an online survey that was administered to 500 physicians belonging to the Finnish medical society Duodecim. The invitation to participate the research was first emailed to two professionally well-known physicians representing the medical society who then forwarded the invitation to their professional networks. The researchers and representatives of the medical society jointly designed a questionnaire that went through many assessment rounds. The survey consisted of 19 multiple choice and short answer questions. Those were mostly 5-point Likert-scale questions anchoring from "Agree not at all" to "Agree completely" and from "With every patient" to "Never". The participation was based on voluntariness and the answers were anonymous, containing background information on their age, gender, professional experience and speciality.

The final sample consisted of 131 Finnish physicians of which 68 were male and 63 female. The respondents were relatively experienced; the median value for the professional experience was 20 years (see Table 1 presenting the characteristics of the respondents).

Parameter	No. of Respondents	No. of physicians	%
Length of career, years	131		
Mean $\pm$ SD		20.0 $\pm$ 12.0	
Sex	131		
Male		68	51.5
Female		63	48.5
Specialty	117		
General practice		28	23.9
Internal medicine		24	20.5
Occupational health care		17	14.5
Psychiatry		9	7.7
Anesthesiology		5	4.3
Gynecology		5	4.3
Surgery		5	4.3
Other		24	20.5

Table 1 Characteristics of the respondents

As can be seen from Table 2 presenting the means, standard deviations and factor loadings for the observed variables, the respondents were not particularly satisfied with their EPRs. This is also in line with the interview results though the interview material consists only of primary care physicians whereas the survey respondents represented both primary and secondary care physicians

	Mean	S.D.	Loading	Loading final	Operationalization
INFOQUAL1	2,725	1,313	0,844	0,821	The medication information acquired from the EPR is reliable.
INFOQUAL2	3,252	1,427	**0,547**		The medication information acquired from the EPR is relevant to my work.
INFOQUAL3	2,542	1,285	0,878	0,916	The medication information acquired from the EPR is up to date.
INFOQUAL4	2,557	1,354	0,875	0,918	The medication information acquired from the EPR is complete.
BENEFIT1	2,725	1,425	0,865	0,864	The medication information acquired from the EPR makes my work more efficient.
BENEFIT2	2,847	1,506	0,860	0,861	The EPR makes the quality of clinical work better.
BENEFIT3	3,153	1,367	0,890	0,890	The EPR enhances patient safety.
AVAIL1	2,824	1,438	0,935	0,934	Medication information can be acquired quickly from the EPR.
AVAIL2	2,527	1,338	0,932	0,934	Medication information can be acquired easily from the EPR.
NEED1	3,787	1,017	0,717	0,737	How often you need information on over the counter drugs.
NEED2	3,258	1,248	**0,575**		How often you need information on the medication information from the past 24 months.
NEED3	2,301	0,920	**0,593**		How often you need information on the medication history older than 24 months.
NEED4	4,250	0,799	0,779	0,787	How often you need information on the diagnosis related to the medication.
NEED5	3,917	1,015	0,739	0,747	How often you need information on the prescriber and the place.
NEED6	4,520	0,780	0,774	0,777	How often you need information on the patient's risk information (e.g. allergies).

Table 2 Descriptive statistics of the observed variables and their operationalizations

The data was analyzed using partial least squares (PLS) with SmartPLS M3 software (Ringle, Wende, & Will, 2005). The PLS method is typically recommended in situations in which there are no stable, well-defined theories to be tested in a confirmatory research setting and when the sample size is small (Haenlein & Kaplan, 2004).

The convergent validity was evaluated based on three criteria: 1) all indicator factor loadings should be significant and exceed 0.7, 2) composite reliabilities should exceed 0.80, and 3) average variance extracted (AVE) by each construct should be greater than the variance due to measurement error (AVE > 0.50) (Fornell & Larcker, 1981). As can be seen from Table 2, altogether 3 items had factor loadings below 0.7 and they were dropped from the measurement. Other factor loadings exceeded 0.7 and were significant at the .01 level. After dropping the three items, all measures met the criteria for convergent validity.

Discriminant validity was investigated by examining whether the square root of AVE for each construct was higher than the squared correlation between it and all other constructs (Fornell & Larcker, 1981). The statistics for convergent and discriminant validity are presented in Table 3 demonstrating that the tests were met.

	C.R.	AVE	BENEFIT	INFO QUALITY	AVAIL	NEED
BENEFIT	0,905	0,760	**0,872**			
INFO QUAL	0,916	0,785	0,680	**0,886**		
AVAIL	0,932	0,872	0,730	0,689	**0,934**	
NEED	0,847	0,581	0,169	0,266	0,180	**0,762**

Table 3 Convergent and discriminant validity (bolded items in the diagonal square roots of AVEs)

Of the hypothesized relationships only three were statistically significant (t>1.98). As a result, hypotheses 1, 4 and 5 not supported. Figure 2 represents the results from the path analysis and Table 3 summarizes the results of the hypothesis.
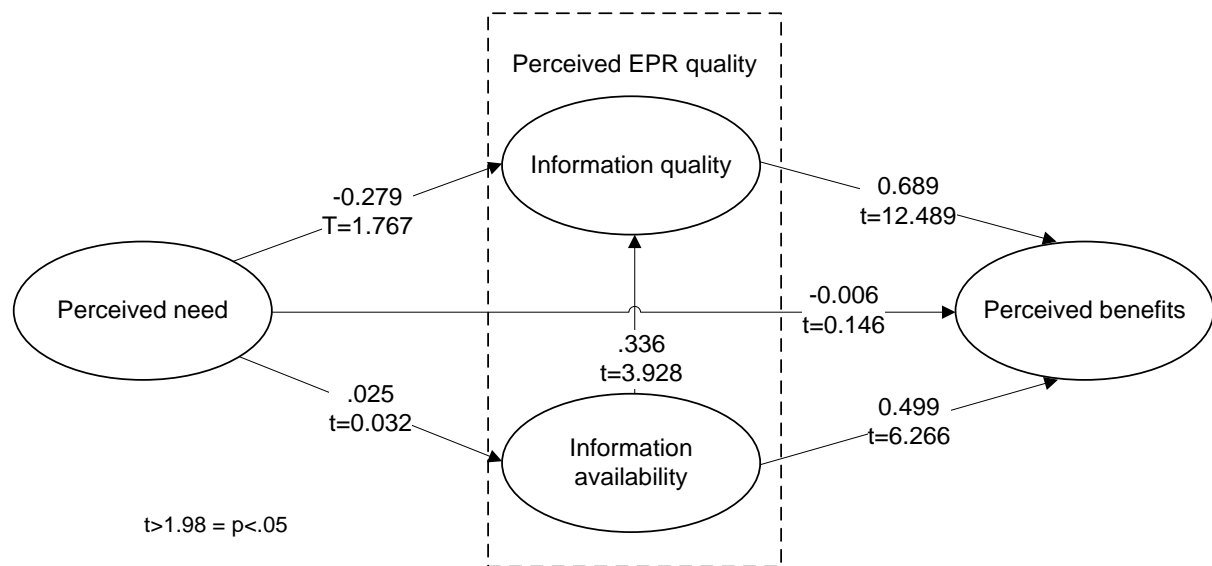

Figure 2 Results from the PLS analysis

Hypothesis	Result
H1: Need for medication information has a negative influence on the perceived benefits of the EPR.	Not supported
H2: Information quality of the medication information obtained from the EPR positively affects the perceived benefits of the EPR.	Supported
H3: Availability of the medication information positively affects the perceived benefits of the EPR.	Supported
H4: The need for medication information negatively affects the perceived reliability of the information obtained from the EPR.	Not supported
H5: The need for medication information positively affects the perceived availability of the medication information.	Not supported
H6: *Availability of the medication information positively affects information quality.*	Supported

Table 4. Results of hypotheses testing

4   Discussion

4.1   Research implications

From a IS adoption perspective the current situation with EPRs in Finland reflects a post-adoption scenario (Jasperson, Carter, & Zmud, 2005) where the system has been adopted in the organization and is actively used. Interestingly, however, at the same time the problems with the system are widely acknowledged. Thus, instead of promoting the system and persuading the user to adopt it the current challenge lies within making the system utilized more effectively to fully materialize the benefits from the system usage (DeLone & McLean, 2003). In this regard the present study underscores the importance of viewing IS adoption as an ongoing and adaptive process towards better utilization of the systems.

The results revealed a negative, albeit not statistically significant relationship between the need for medication information and perceived benefits of the EPR, confirming the findings from the interviews. The findings of the study are in line with prior research addressing the challenges with EPRs (Christensen & Grimsmo, 2008). This reflects that EPRs have not reached a sufficient level of functionality to meet the expectations of the users and that the users' needs to be managed more efficiently to avoid further dissatisfaction.

An interesting aspect from a theoretical perspective is the actual source of the dissatisfaction with current EPRs alongside the issues with the functionality of the EPRs. The adoption of EPRs has caused changes to the work practices but according to a literature review by Uslu & Stausberg (2008), 11 studies out of 20 confirm that time needed for administrative work has reduced. Added to that, costs related to documentation including for instance data acquisition were also reduced. Therefore, it might be reasonable to argue that the challenges related to poor functionality of EPRs manifest themselves for individual users but on organizational level these issues are less visible. In any event, for highly educated and relatively well-paid professionals such as physicians, this may cause frustration and feelings of misuse of resources.

4.2   Practical implications

The most important factor influencing several aspects of EPR use is the limited time. If there was unlimited time for searching and use of information, health care professionals would not face many of the current difficulties. However, since one of the drivers for using IT in health care settings is to produce efficiency, the time required to manage patient-specific medication information should be decreased by doing so. If that does not happen, and furthermore, if even the quality of the information is questionable, what is the point of using IT applications that neither support the clinical work nor produce gains in efficiency?

The results reveal that the patients' medication history is not needed as extensively as the other aspects of medication information investigated here. Given, that the physicians expect the most important information to be available fast, this suggest that the medication history does not include in the most important information appearing on the main screen of the patient's record.

The analysis of the quantitative data demonstrated that the need for obtaining high-quality medication information and at the same time that the current EPRs do not meet the physicians' needs. Because physicians understand the importance of the medication information, and because their organization mandates them to do so, EPRs are used. Added to that, acquiring information from other sources is difficult since in practice paper-based records do not exist anymore. The analysis of the qualitative data however revealed that in addition to the EPR, the patient acts as a source of medication information.

4.3 Limitations & further research

The sample size for the quantitative analysis was small and the respondents not randomly selected. Therefore, the results of the study cannot be generalized in a statistical sense to represent all Finnish physicians. The Finnish as well as the Nordic health care system is characterized by public universal access and physicians being employees of the health care organizations to the service contrary to e.g. the USA where the supply of the health care services is more complex and the physicians work on entrepreneurial basis within the organizations. As a result, the context should be taken account when considering the theoretical generalizability of the findings.

The current study focused on investigating the physicians' perceptions regarding EPRs in managing the medication information. Given that perceptions are ultimately subjective evaluations, further research investigating the "objective" performance of the EPR e.g. the length of downtimes, response times would be highly appropriate. In addition, future research could explicitly examine the gap between selected measures of system performance and the users' evaluations of these measures. Third, critical incident technique could be employed to identify the encounters having the greatest significance in forming users' perceptions of the performance of EPRs.

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