Physicians' Experiences of EHR Technical Quality: Results from Four Large Cross-Sectional Surveys in 2010-2021

Tinja LÄÄVERI[a,b,1], Johanna VIITANEN[a], Jarmo REPONEN[c] and Jari RENKO[d]

[a] *Aalto University, Department of Computer Science, Finland*
[b]*Inflammation Center, Helsinki University Hospital, Finland*
[c]*Research Unit of Health Sciences and Technology, University of Oulu, Finland*
[d]*Oy Apotti Ab, Helsinki, Finland*

ORCiD ID: Tinja Lääveri https://orcid.org/0000-0003-4124-6667, Johanna Viitanen https://orcid.org/0000-0002-6659-5022; Jarmo Reponen https://orcid.org/0000-0003-2306-3111; Jari Renko https://orcid.org/0009-0007-7554-3850

Abstract. Unexpected downtime and long response times of electronic health record (EHR) systems not only impact user satisfaction and clinicians' work efficiency but also bring about potential harm for patients. Despite improvements in the performance of EHR systems' architecture, hardware, and networks, technical challenges continue to cause problems. We explored the end-user experiences of EHR technical functionality and quality from four large national cross-sectional surveys conducted among Finnish physicians in 2010–21. The results were analyzed by healthcare sector/specialty groups. In most groups, the experiences of stability and reaction speed became worse in 2010–17, which is readily explained by the implementation of the national patient data repository services, but improvements were seen in 2021, suggesting that EHR vendors have solved at least some of the slowness problems. The proportion of physicians reporting having experienced faulty system function with potential or actualized harm for the patient had decreased in operative and medical specialties and in the private sector but remained stable in other groups. Our findings underline the importance of continuing to develop technical qualities – including the implementations of national integrations.

Keywords. Usability, user experience, physician, electronic health record system, national survey, long-term monitoring, downtime, technical quality, stability

1. Introduction

Technical problems such as instability and slow response times of electronic health record (EHR) systems not only impact user satisfaction, clinical work efficiency, and physician well-being but also bring about potential patient safety hazards [1–7]. Despite this, research into long-term monitoring of physicians' experiences of EHR technical functionality and quality remains scarce.

To achieve optimal technical performance, EHR system architecture needs to overcome the limitations and bottlenecks caused by very large and heterogeneous datasets triggering sequential requests to several databases [8]. Avoiding inadvertent

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[1] Corresponding Author: Tinja Lääveri; E-mail: tinja.laaveri@aalto.fi.

database locks is particularly challenging in massively complex SQL database schemas such as EHRs [9]. In addition, network speeds, hardware capacities, and the nature of integrations impact the stability and responsiveness of EHR systems.

In Finland, EHR system coverage reached almost 100% by 2007 in public healthcare and 2011 in private healthcare [10]. Public sector hospitals provide both inpatient and outpatient specialized care. General practitioners (GPs) mainly work in the public sector. Half of private sector outpatient visits are to occupational healthcare (OH), and most seriously ill patients are treated in the public sector. Most organizations joined the national patient data repository and the prescription center in 2010–17; the specifications, data structures, and integrations required considerable resources from EHR vendors [11].

In this paper, we report physicians' experiences related to the technical quality of their EHRs from four national usability-focused health information system (HIS) surveys conducted in 2010–2021 [9]. The research questions were: 1) How have physicians' experiences on the technical quality of their EHRs evolved in 2010–2021 and 2) Are there differences between specialties/working environments?

2. Methods

National cross-sectional web-based surveys on end-user experiences of HISs were conducted in Finland in 2010, 2014, 2017, and 2021 [12]. We selected three statements about EHR stability, reaction speed, and system errors that were found to correlate with technical qualities in the national usability-focused HIS scale (NuHISS) [13].

There were 3,227 respondents in the 2010 survey, 2,799 in 2014, 3,295 in 2017, and 3,927 in 2021. The groups were formed according to respondents' specialties and working environments: public hospital specialties: (1) operative (n = 742 in 2010; 663 in 2014; 697 in 2017; and 1,093 in 2021), (2) medical (818; 659; 828; 1,047), (3) psychiatric (304; 217; 226; 277), and (4) diagnostic (142; 137; 135; 140); (5) public hospital intensive care units (ICUs) (2010 data not available; 39; 67; 77); (6) public sector GPs (499; 523; 630; 642); (7) private sector OH (239; 171; 209; 183); and (8) other private sector specialties (483; 390; 503; 468). Those with other specialties/specialty unknown/not specialized were not included in the analyses.

Statistical analyses were carried out with SPSS 28 (IBM Corp, Armonk, NY). For the purposes of depicting changes over time (Figure 1), the five-point Likert scale responses "fully agree" and "somewhat agree" were combined into "agree" and "fully disagree" and "somewhat disagree" into "disagree," and a net EHR experience score was calculated by subtracting the proportion of those disagreeing with the statement from those agreeing with it [14]. The Mann–Whitney U test was used to compare the results of the year 2021 between the groups (Figure 2; e.g., operative specialties vs. all others). Statistical significance was determined as $p < 0.05$.

3. Results

The results regarding physicians' experiences on the technical aspects of their EHR systems in 2010–2021 are presented in Figure 1, and the differences between specialty groups for the 2021 survey in Figure 2. While the perceptions of technical stability and response times changed for the worse in 2010–2017, in 2021, the net experience scores

improved. Experiences of faulty system function with potential or realized patient safety hazards became somewhat less frequent during the study period.
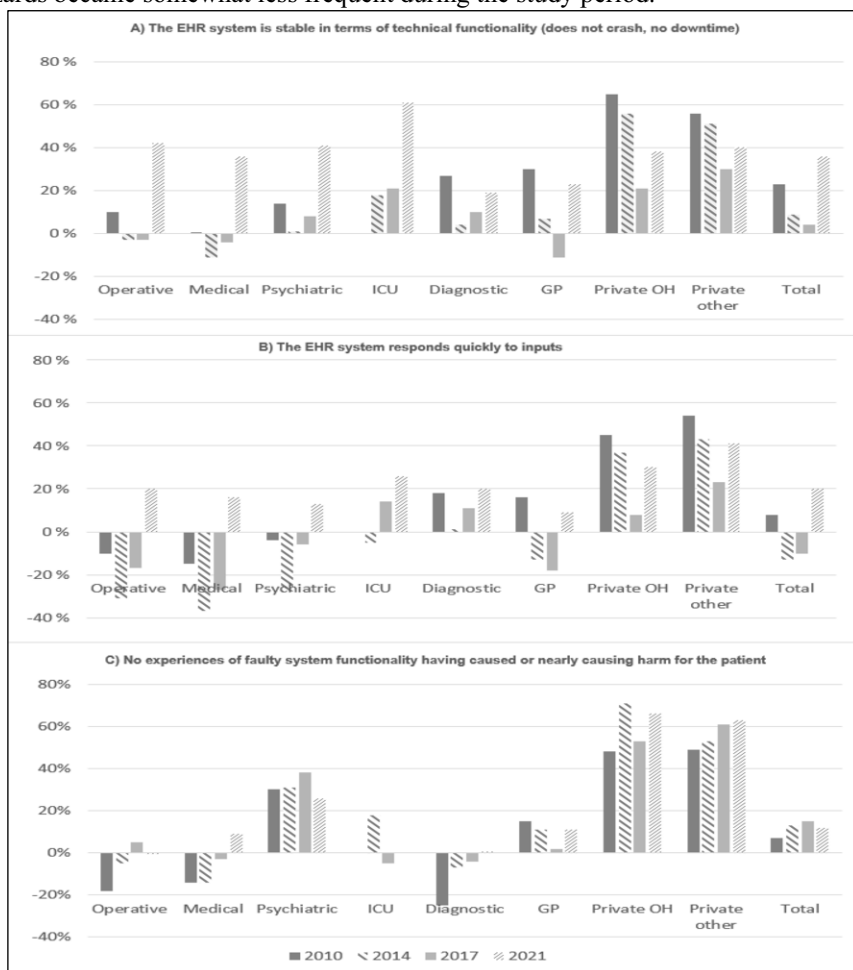

Figure 1. Finnish physicians' net experience scores of EHR technical quality by specialty group between 2010–21. ICU was not included in 2010, and for 2021, the net experience score was 0%.

In 2021, those working in diagnostic specialties were the least content (55% agreed) and ICUs and operative specialties the most content (78 and 66%) with the stability of their EHRs. For response times, the differences between specialties were minimal.. System errors with potential or realized patient harm had been encountered by 12% of those working in the private sector and by 26–46% in other groups.

4. Discussion

Our main finding was that although physicians' experiences of EHR technical quality improved, this development was not linear; particularly among those working in the private sector and GPs, experiences of EHR stability and responsiveness became more negative between 2010 and 2017. This is readily explained by the implementation of the

national patient data repository and prescription center in 2010–17; sending prescriptions and loading documents was slow [15], and it took some years before the EHRs were developed to allow end users to perform other tasks in the meantime. General improvements in EHR infrastructures, network capacities, and hardware performance also explain this development.
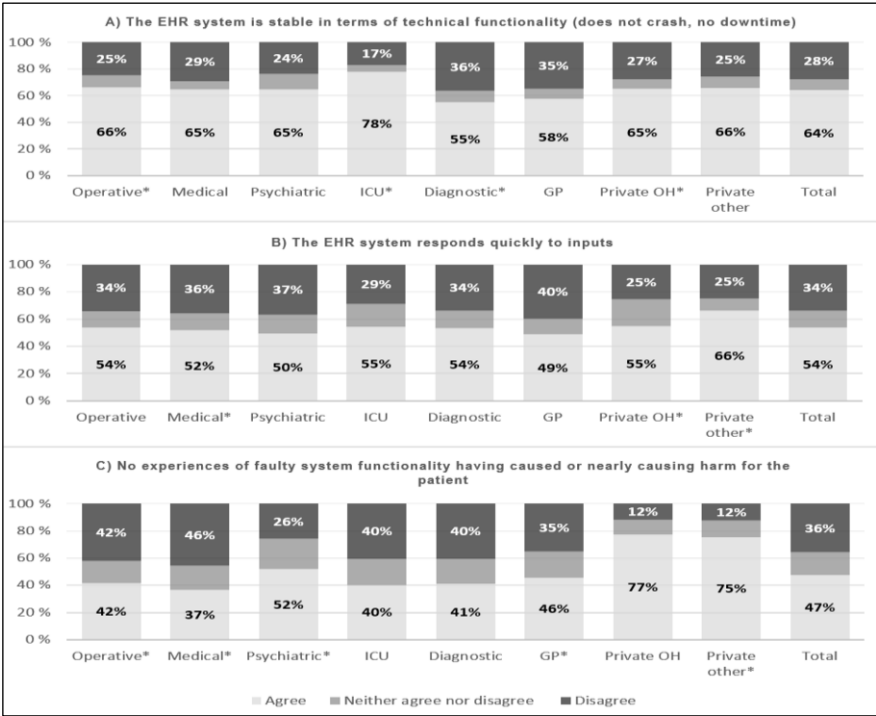

Figure 2. Finnish physicians' experiences of EHR technical quality by specialty group in 2021.
*Differences between groups statistically significant.

The net EHR experience scores did not improve in diagnostic specialties as much as in other hospital specialties. Their work is probably the most heavily impacted by technical issues: if their systems are unavailable, then tasks such as reading images are practically impossible. In addition, the picture archiving and communication system of the largest university hospital was changed a few months before the 2021 survey.

Physicians working in the private sector (private OH and private other groups) were relatively satisfied with the technical qualities. As their patients in Finland typically have fewer problems and are less acutely ill, their work may be less likely to be impacted by downtime or slowness. Although the EHRs appeared stable and fast, the drop in net EHR experience scores in 2017 was particularly steep.

GPs need to access patient information from several sources via national services over a long timespan; instability and slowness impact their work more than in other specialties. Loading documents from national services was still slow in 2021.

Although the experiences of technical stability had become more positive by 2021, the rates of patient harm caused by faulty system function had not decreased to the same extent. In earlier research [1,3,6,7], unexpected downtime explained most of these cases. Possibly more physicians encountered usability-related hazards than before; this may connect to the new EHR implementation in southern Finland in 2018–21 [16].

In 2021, physicians working in ICUs gave especially positive assessments; there was no drop in the net experience scores in the 2017 survey. ICU personnel mostly used ancillary systems that are integrated into the national services via the main EHR.

Although subjective downtime or slow response times might not always correlate with the measured ones, for example, if loading documents from national services is slow, users relying on them are likely to give negative assessments of their EHRs. In addition, end users are usually unable to identify which of the several integrations needed for daily work is not working; thus, they blame the main EHR.

5. Conclusions

Our findings highlight the importance of continuing the development of EHR technical qualities – including the implementations of wide-scale national integrations.

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