Electronic Health Records User Experiences: a Nationwide Survey From Norwegian Hospitals.

[a] Ove K Lintvedt, [b] Maryam Tayefi, [c] Espen Nordheim, [d] Rune Pedersen, [e] Kristian Malm Nicolaisen, [f] Halvard Lærum, [g] Bente S. Nedrebø, [h] Luis Marco-Ruiz

Norwegian Centre for E-health Research, University Hospital of North Norway, Tromsø, Norway

Department of Architecture Governance, The Norwegian Directorate of eHealth, Oslo, Norway

Research and Knowledge Resources, Sikt, Bergen, Norway

e-mail: [a]ove.lintvedt@ehealthresearch.no, [b]maryam.tayefi@ehealthresearch.no, [c]espen.solbakken.nordheim@ehealthresearch.no, [d]rune.pedersen@ehealthresearch.no, [e]kristian.nicolaisen@ehealthresearch.no, [f]hallvard.laerum@ehelse.no, [g]bente.nedrebo@sikt.no, [h]luis.marco.ruiz@ehealthresearch.no

Abstract—**The adoption of a new Electronic Health Record (EHR) is a disruptive event for hospitals influencing the satisfaction and performance of clinicians. In Norway, the four health regions (South-East, West, Central, and North) have used several EHR systems for decades. This study analyses the satisfaction of clinical users and determines which features of the EHR that should be prioritized to improve clinicians' satisfaction. In addition, findings show a relatively high frequency of interruptions that could affect secure and easy access for the health care professionals to information about the patients. Finally, differences are found within the same EHR regarding clinical user satisfaction, meaning that the context significantly impacts the satisfaction.**

Keywords-Electronic Health Records; Usability; User Satisfaction; Human Factors; Computerized Clinical Decision Support Systems (CCDSS).

I. INTRODUCTION

Digitalization programs in the EU and US have spread the adoption of Electronic Health Records (EHR) [1][2]. EHRs have evolved from electronic journals for note keeping into integrated health information systems that provide a holistic view of most patient clinical information and actively support clinical users in decision making through Computerized Clinical Decision Support Systems. Examples include infobuttons, medication alerts, and computerized medication order entry [3]. While the functionalities of EHRs have been significantly expanded, there are concerns about their actual usefulness and perceived benefit [4]. Some studies point out that the amount of work required by EHR interaction contributes to clinical burnout due to a focus on long-term outcome measures and reimbursement rather than the actual value of daily practice [5]. International research is often focusing on usability, safety, quality, functionality, and satisfaction [6][7][8]. Developing e-health indicators is a relatively new focus in the field. Nordic eHealth Research Network (NeRN) works on standard Nordic e-health indicators [9].

In the last decade, Norway has increased the investments on eHealth initiatives to meet the future need of the healthcare sector. This wave of digitalization is in line with the national white paper 9, ´One citizen – one Health Record´ [10]. This white paper states that: a) secure and easy access

for the health care professionals to information about the patients is required; b) citizens should have access to safe and accessible digital services; and, c) clinical data should be available for monitoring, management, and research.

One of the actions towards addressing these requirements has been the deployment of a newer EHR system in three (North, South-East, and West) out of four health regions. A fact that directly impacts clinicians' daily work.

This change has raised the need to evaluate clinicians' user experience to understand if the investments in new EHRs have improved clinical users' experience. A previous study in 2019 published an initial evaluation with three hospitals from two health regions and a total of 208 wholly answered questionaries [11]. This study targeted the use of the currently implemented EHR systems, focusing on clinical task support and the overall satisfaction with the EHR. Each of these three hospitals had implemented DIPS (Distributed information and patient data system in hospitals) Classic (DIPS, DIPS ASA, Bodø) over the previous years, 2010-2014. However, these three hospitals covered only two main cities in Norway, corresponding to two neighbouring regional health administrations (South-East Norway and West Norway, respectively). This paper expands the former study by including data from University Hospital North Norway (North Norway health region) and St. Olav Hospital (Central Norway health region), which allows us to cover all the four health regions in Norway.

Nurses and doctors were asked to specify functionalities that worked well in their EHRs and functionalities that required further improvement. This extension of the 2019 study attempts to determine if the results from the previous survey also hold for all Health Regions in Norway and elucidate the effect of the latest eHealth developments on clinical users.

This paper is organized as follows: Section II explains the methods used, where questionnaires and statistical methods are explained. Section III presents the survey results, focusing on the three types of satisfaction. Tables and figures illustrate the results. Section IV describes ethical considerations. In section V, general findings of the three types of satisfaction are discussed, and a comparison between national data and data from the study including only two

health regions. Section VI concludes in relation to significant findings from this national survey. In addition, it summarises how the findings can be understood and how suppliers and regional health authorities can make use of the findings.

II. METHODS

In this section we focus on the questionnaire, statistical methods in use, as well as the data collection.

A. Setting

We approached clinical users from the newly implemented EHRs at Haukeland University Hospital (HUH), University Hospital of North Norway (UNN), Trondheim University Hospital (St. Olav), and Oslo University Hospital (OUH). These hospitals belong to the four Regional Health Authorities in Norway, which allows us to cover the whole country. Except for St. Olav, all hospitals had been involved in the transition from their previous system, DocuLive (DocuLive EPR, Siemens Medical Systems Norway, Oslo)., into the new system, DIPS Classic. Specifically, OUH, HUH, and UNN have been implementing the new her since 2010, and St. Olavs has been implementing theirs since 1999.

Before 2006, DocuLive was a system of journal documents mainly used by clinicians for reading and signing clinical documents and laboratory results. The system lacked integration with the patient administrative system. DocuLive added functionality to scan documents into the system, e.g., forms and response reports. At the same time, DIPS Classic was regarded as a complete system with a patient administrative system, patient journal, laboratory system, and an integrated system for psychiatry [12].

The fundamental reasons for changing the system were a lack of necessary functionality and a lack of integration between the journal system and the patient administrative system. In addition, the government took over the ownership of the public hospitals in Norway in 2002 [13]. The regional health trusts promoted the standardisation of health information systems. For example, in the Northern Health Region, where UNN was the only hospital in the health region using DocuLive, switching to DIPS was seen as a common-sense decision.

B. Data collection

A total of 506 clinicians (nurses and physicians) were contacted in 2018. Response rates were 35.0%, 22.0%, and 29.0% for physicians, nurses, and all clinicians, respectively. Surveys from UNN, St. Olav, and HUH were gathered with the following responses: n=87 physicians, n=60 nurses, n=147 in total. We issued ten reminders to the respondents in the period from September to December 2018 and four reminders to their superiors. Some superiors also reminded the respondents in person at a joint meeting. The availability of clinical functionality varied between units and wards in the same units.

Email lists for the employees in the units were collected from the institutions themselves. Respondents were selected using a random number generator [14].

For OUH, surveys were gathered from 2015/2016 (n=152 physicians), and details about data collection, methods, and results are published elsewhere [11].

Regarding inclusion criteria, participants were physicians and nurses who worked full time at any participant hospitals in 2018, and only physicians who worked full time in 2015/16. Respondents who stated that they did not actively work with patients were excluded. A total of 299 individuals, of which 239 (79.9%) were physicians and 60 (20.1%) were nurses, completed the questionnaire (see Table 1). Forty-six worked at Haukeland University Hospital (HUH), 39 worked at University Hospital of North Norway (UNN), and 62 worked at St. Olavs hospital – Trondheim University Hospital (St. Olav), and 152 worked at OUH. Data from OUH was only available for one year (2015/16), but no new questionnaires were filled out for the following years in this hospital. Still, we kept the results from OUH to cover the regional health area. Data were stratified by both time and organization to deal with this limitation. Table I shows the amounts of respondents to questionnaires gathered by hospital and clinical role.

C. Questionnaire

The web-based survey tool Questback (Questback, Oslo, Norway) was used for the online questionnaire. Questback allows users to record their responses anonymously and preserve their privacy remotely. The questionnaire was piloted among nine representatives of the target group. Some content was revised based on feedback from the pilot group. Questions were dynamically designed to ensure that the respondents were only asked about relevant things for their stated place of work and role (physician or nurse). Some questions were sent to both nurses and physicians, while parts of the survey specifically targeted one of the professions. The survey also included several broad questions, which the respondents were allowed to answer freely.

The survey was developed based on past research using a previously validated questionnaire [15][16]. Changes were made as the old questionnaire was too extensive and tailored for physicians only. This new questionnaire is an early effort toward developing clinical user satisfaction and interruptions indicators. The new questionnaire used a 5-point Likert scale ('Completely disagree', 'Partially disagree', 'Neutral', 'Partially agree, 'Completely agree'). Some questions were only rated as agree/disagree. The overview of the questions in the questionnaire can be accessed online [17].

The questionnaire was structured in 3 main sections, all related to various dimensions of satisfaction. The first dimension was satisfaction with the EHR functionalities, which contained 11 items. The second dimension was related to generic aspects of the EHR system, which contained four items. The third dimension was related to overall satisfaction with the EHR system, which contained only one item.

D. Analysis/statistical methods

The main statistical methods used for analysis were frequency (percentage) for discrete variables and mean for continuous variables. The Pearson chi-square test was used for comparison. The level of significance was considered as 0.05.

The statistical software SPSS 25 version was used for the analysis. In the process of cleaning data, we had to address missing values. For EHR functionality satisfaction, there were no missing values. For EHR generic satisfaction and EHR overall satisfaction, missing values were n=48 (15.7%) and n=47 (14.6%), respectively. The easiest way is to remove the incomplete records. In the case of lacking enough sample size, this procedure is not proper to deal with missing values. Several imputation techniques have been suggested in situations where the missingness is completely random (MCAR). MCAR implies no systematic reasons for missingness [18]. Little [19] provided the chi-square test for the MCAR assumption to check that the missingness is completely random. While providing the comparison between health regions/satisfaction profession/satisfaction, we applied the MCAR assumption by Little (Chi-Square=502.988, df=512, p=.604). The results confirmed that the missingness is MCAR. Then, we imputed our missing records with the neither-nor value.

E. Ethics

The Regional Committee for Medical and Health Research Ethics South-East Norway has been consulted. According to national regulations ethics, approval was not required because the study did not involve biomedical research, and all data were anonymized.

III. EASE OF USE

This section will present the baseline data and questionnaire results. Further there will be a presentation of the three types of satisfaction.

A. Baseline data

Table I contains the baseline data by year, location, and participants clinical role. The medical field with the highest number of participants was the aggregation of those treating surgical, woman-related, and cancer conditions, with n=138 (46.0%). The following fields with the highest number of participants were related to neurological, orthopaedics, and rehabilitation conditions n=98 (33.0%), followed by medical, heart/lung, and other conditions with n=35 (12.0%), 21 (7.0%), and 7 (2.0%), respectively.

B. Questionnaire results

There were two questions related to interruptions of the clinical workflow while using the EHR. The first one regarded interruption caused by login requests; results range from 4 to 50 interruptions per day (outliers removed). The mean number of interruptions per day is 17.21. The corresponding number from the 2019 study was 17.15. The second one regarded the number of interruptions due to the EHR hanging or crashing. The mean number of interruptions is 3.08, corresponding to one interruption per week in the scale used. The corresponding numbers from the 2019 study was 2.95, slightly less than once a week. Almost 70% of respondents reported interruptions that ranged between once a year and once a week, 30%

TABLE I. BASELINE DATASET

Health Region (Survey year)	Clinical profession		
	Physician	Nurse	Total
West (2018)	34	12	46 (15.4%)
Central (2018)	31	31	62 (20.7%)
North (2018)	22	17	39 (13.1%)
South-East (2016)	152	0	152 (50.8%)
Total	239 (79.9%)	60 (20.1%)	299 (100.0%)

that interruptions occurred once or more a day. The corresponding numbers from the 2019 study was 72% and 28%, respectively.

C. EHR functionality satisfaction

Table II presents the responses about satisfaction with specific EHR functionalities.

Regarding aggregated EHR function satisfaction for all 11 questions, 47.0% of respondents reported to be satisfied, 35.0% were neither satisfied nor dissatisfied, and 18.0% were not satisfied (see Fig. 1). The corresponding numbers from the 2019 study was 59.0%, 26.0%, and 15.0%, respectively.

If we observe the functionalities in Table II, the one rated with the highest satisfaction was question 1, where 72.0% of respondents were satisfied with the function allowing them to read sample responses from medical biochemistry. The lowest satisfaction was related to question 11, which refers to the overall overview of the patient´s drug treatment, where only 29.0% of the respondents were satisfied. The corresponding numbers from the 2019 study was 84.0% and 33.0%, respectively.

Questions 2 to 5 have the second-highest satisfaction rate, between 55.5% to 69.0%. For these questions, the range of respondents who answered that they were neither satisfied nor dissatisfied was 11.0% to 17.5%. The corresponding numbers from the 2019 study was between 58.0% to 70.0% and 19.0% to 31.0%, for satisfaction and neither-nor, respectively.

TABLE II. EHR FUNCTIONALITY SASISFACTION

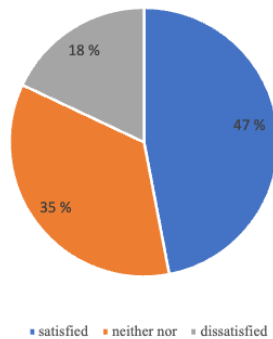| Survey question	EHR Functionality Satisfaction		
	Satisfied	Neither- nor	NotSatisfied
1 Read sample responses from medical biochemistry	72.5%	21.0%	6.5%
2 Compare the treatment and efficacy of a particular patient	69.0%	20.0%	11.0%
3 Overview of the patient´s issues	60.0%	27.0%	13.0%
4 Read the radiology response reports	55.5%	27.0%	17.5%
5 Overview of your outstanding task	55.5%	33.0%	11.5%
6 Communicate with patient about health information	25.5%	51.5%	23.0%
7 Receive specific advice and recommendations for further treatment	33.0%	51.0%	15.0%
8 Prescribe drug treatment	33.0%	44.0%	22.0%
9 Concrete plan for the patient´s assessment, treatment and care	39.5%	33.0%	11.5%
10 Assess the right to priority health care	32.0%	37.0%	31.0%
11 Overall overview of the patient´s drug treatment	29.0%	31.0%	34.0%

Figure 1. EHR functionality satisfaction.

Questions 11, 10, 6, and 8 have the highest dissatisfaction rates, with more than a 20.0% of respondents answering that they were not satisfied. This is the same as for the 2019 study.

Questions 6, 7, and 8 have the highest indifferent rate (nighter satisfied nor dissatisfied). From the 2019 study, questions 11, 9, 6 ans 7 have the highest indifferent rate.

For the aggregated dataset containing all health regions, the differences by clinical role differences were not significant (p<0.603). Nurses (20.4% satisfaction) are less satisfied than physicians (79.6%), which is not significant (p>0.05).

There were no significant differences among health regions (p>0.05). Likewise, the difference between the central region (St. Olav), which used the DocuLive system, and the other three regions, which used DIPS Classic, was not significant (p>0.05).

D. EHR generic satisfaction

Generic EHR satisfaction refers to effectiveness, high quality, worth time and effort, and user-friendliness.

A total of 39.3% of respondents were satisfied, 24.8% of respondents reported that they were neither satisfied nor dissatisfied, and the remaining 35.9% reported being dissatisfied (see Fig. 2). The corresponding numbers from the 2019 study was 40.1%, 23.2%, and 36.7%, respectively.

By clinical role, the difference was significant (p<0.001). Nurses (33.6% satisfaction) are less satisfied than physicians (66.4% satisfaction).

The generic satisfaction between regions West (18.0% satisfaction), Central (25% satisfaction), North (18.8% satisfaction), and South-East (38.3% satisfaction) was significant (p<0.001). However, when comparing the region with DocuLive (Central) with the other three regions using DIPS Classic, no significant differences were found for EHR generic satisfaction (p>0.05).

E. EHR Overall satisfaction

Overall satisfaction was addressed through a single item. A total of 34.7% of respondents were satisfied, 24.4% of respondents reported that they were neither satisfied nor
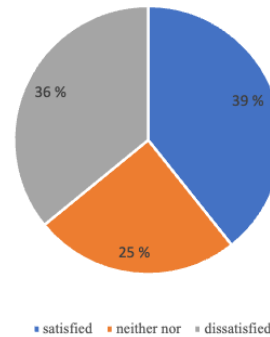

Figure 2. EHR overall satisfaction.

dissatisfied, and the remaining 40.8% reported being dissatisfied (see Fig. 3). The corresponding numbers from the 2019 study for overall satisfaction was 37.5%, 21.5%, and 41.0%, respectively.

The overall satisfaction by clinical role was significant (p<0.001). Nurses (36.3% satisfied) are less satisfied than physicians (63.7% satisfied).

The overall satisfaction by regions West (17.6%), Central (22.0%), North (20.9%), South-East (39.6%) was found to be significant (p<0.05). However, the overall satisfaction for the region with DocuLive (Central) was not significant when compared with the group of the other three regions using DIPS Classic (p> 0.05).

IV. DISCUSSION

The discussion will focus on different types of satisfaction and the more generic findings.

A. EHR functionality satisfaction

Four questions had the lowest score about EHR functionality satisfaction. These were related to the overall overview of patients' drug treatment, the assessment of the proper priority of care, the concrete plan for patient assessment, communication with the patient about health information, and prescriptions of drug treatments. These are the main functionalities that vendors should prioritize when developing new versions of their products.

B. EHR generic satisfaction

Most of the respondents were satisfied with the generic functionality of the EHR. The proportion of respondents being indifferent or dissatisfied adds up to almost 61%. Although this does not indicate a clear need for product replacement, it
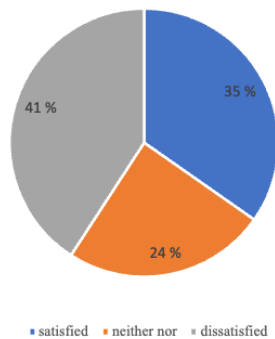
Figure 3.   EHR generic satisfaction.

points out a significant room for improvement in current EHRs' generic satisfaction. Vendors should prioritize understanding why almost 36% of users are dissatisfied. Also, they should understand more about the requirements from users in general to improve satisfaction, so more users are fully satisfied.

C.   EHR overall satisfaction

With regards to overall satisfaction, there is a significant portion of respondents that reported to be overall dissatisfied (40.8%). Interestingly, this level of dissatisfaction is higher than the score found when measuring specific functionality dissatisfaction. This may indicate that, even though users were not dissatisfied with specific functionalities, the integration of functionalities in the system workflow increases overall dissatisfaction. Vendors should consider better integration of their functionality in clinicians' workflow.

D.   Generic findings

Differences in overall satisfaction were significant depending on the clinical role and could be interpreted as differences in the satisfaction of role-specific functionality. Physicians were overall more satisfied than nurses for the three dimensions of satisfaction and could be interpreted as a requirement for improving nurse-specific functionality.

No significant differences were found in the EHR used (DocuLive vs. DIPS classic). However, there were significant differences among regions regarding generic satisfaction and overall satisfaction. We interpret this finding as a difference arising from differences in the deployment context, but there is no evidence of this difference coming from the system itself (DIPS Classic vs. DocuLive).

The high number of interruptions (number of logins a day and EHR hanging or crashing) could directly affect security and easy access for healthcare personnel. The high frequency of interruptions indicates that the first goal from the government stated in the whitepaper "one citizen - one Health Record" (secure and easy access for the health care professionals to information about the patients is required) is still not covered good enough. Missing on this goal will have consequences for both citizens and healthcare professionals. It should provide patients and residents with safer and better

treatment and health professionals a more uncomplicated working day.

E.   Comparison with study including two health regions

The previous study from 2019 [11] included only physicians from two health regions. For this reason, there will be no comparison of regions or professions.

There are no significant differences in the number of interruptions of the clinical workflow while using the EHR.

Aggregated EHR function satisfaction for all 11 questions shows almost the same response for dissatisfaction. More respondents were satisfied in the 2019 study. Both studies report the same function with the highest satisfaction and the same for the function with the lowest satisfaction for the EHR functionalities. The response pattern for the other functionalities is almost similar between the two studies. Our interpretation is that the decrease in satisfaction could be a regional effect as OUH got the new DIPS Classic with new functionality one year before the survey. The new regions had several years of experience with the system when the responded to the survey. The inclusion of nurses could cause one other explanation as they reported less satisfaction in this new study.

Generic EHR satisfaction is almost identical for the two studies. It seems like the inclusion of more hospitals/regions, and other professions do not change this effect. Even though, the EHR functional satisfaction is lower in the new study, the satisfaction regarding effectiveness, perceived quality, and user-friendliness is persistent.

The EHR overall satisfaction was addressed through a single item and persistent on a national level.

V.   CONCLUSION

This study has analysed hospitals from the four health regions in Norway. No differences in generic or overall satisfaction were found when including data for all four health regions in Norway. Data from the study using only two health regions was higher than for the one with all four health regions. No differences in satisfaction were found between the two types of EHRs. Significant differences are found within the same EHR, meaning that the context significantly impacts the satisfaction attributed to the EHR. A substantial portion of users reported not being fully satisfied with their EHR. Nurses were the group less satisfied, and functionalities related to showing the broad overview of patients are where vendors should concentrate their efforts to respond to user requirements and improve their satisfaction.

The EHR vendors and regional health authorities should also be focusing on bridging the gap between the goal for secure and easy access to patient data and the relatively high number of interruptions experienced by the clinical users.

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