Exploring Non-Use of New Technology in Emergency Departments

Thomas Schmidt

Center for Health Informatics and Technology, University of Southern Denmark, schmidt@mmmi.sdu.dk

Despite years of research and interdisciplinary collaboration, moving past pure data modeling and validation to early-stage evaluation of artificial intelligence or machine learning systems remains a big challenge. Notwithstanding good intentions, user-driven design, and careful emphasis on acceptability; acceptance of new technology is hard to predict, and non-use of the new system may pose a major evaluation challenge. In this paper, we review non-use of a new patient monitoring system evaluated in a cluster randomized trial and present the preliminary analysis of responses from clinicians using a survey instrument we designed for capturing the reasons for non-use. Results point to the importance of workflow integration, consideration to placement within the existing technology landscape, and providing extensive training and communication of purpose.

CCS CONCEPTS • Human-centered computing – Empirical studies in HCI • Human-centered computing – Field studies • Human-centered computing – HCI Theory, concepts and models

Additional Keywords and Phrases: Patient Monitoring, Clinical Decision Support, Evaluation, Technology Acceptance

1 INTRODUCTION

Artificial Intelligence (AI) initiatives have made multiple forays into clinical environments. Striving to improve efficiency, quality, safety, and other aspects of the daily practices of managing and treating patients, these initiatives have been evaluated across all stages of maturity. However, most AI projects struggle to move past early-stage evaluation. And although the omnipresent challenges of handling clinical data are interesting and relevant, seldom making progress beyond the early phases prevents us from investigating many of the social-technical aspects of AI use in clinical environments, and consequently the fundamental interplay between professionals and AI-driven support systems remain largely unmapped territory.

Broadening our perspective beyond AI, engagement with algorithmic procedures, or information technology in general, is a well-versed research area. As researchers and developers, we naturally design systems expecting them to be used. To increase the likelihood of acceptance and success, the norm is to involve users directly in the design process, and we orient ourselves towards their needs, challenges, and the intended habitat of use [1]. Investigations of use can be performed at multiple levels, but when grounded in medical research practices tend to focus on patient outcomes [2]. Thus, a key part of the evaluation of new technology is considering which variables best capture the deployment of the new system. As well as which factors influence the outcome while minimizing barriers to use and acceptance. Since most AI systems are evaluated at the pilot stage, the novel functionality is seldom being provided as an essential system for clinical cooperative work, but as an addon [3]. Regardless the level of integration, both the physical and symbolic properties of the new technology are important as knowledge generation and learning is dispersed between human and machine [4]. Successful adoption ultimately hinges on acceptance of an added layer of computational complexity whose most frequent selling point is reducing human work but not responsibility. Naturally, this invokes concern amongst many clinicians, and some refrain from accepting and using the new systems. Numerous models have been proposed to explain the observed variations in acceptance and use of technology [5,6]. And while it can be said that to an extent we are all potential future users of a given technology, there is also a need to look at the non-users who never even touch ground with the adoption curve [7]. However, the distinction between use and non-use of technology is not always clear-cut, but rather a contextual and situational matter invoked differently within organizations [8]. This trait makes it difficult to apply the current 'resistance oriented' literature to the field [9]. In complex environments, such as the healthcare sector, a single factor can seldom be pointed out as the root cause of non-adoption, and a wide retrospective analysis is required [4].

This paper presents experiences from a cluster randomized trial of a new patient monitoring dashboard which aggregate and analyze vital signs to provide a better overview of patients' state and trajectory while admitted at Emergency Departments (ED). Despite much preparation, and awareness campaigns during the trial period, we were caught off guard by the widespread non-use of the new system, which necessitated a reconsideration of how to evaluate the socio-technical aspects of the project. Although the patient monitoring system may be classified as AI-light, it nonetheless embodies many of the same aspects as more complex systems. Thus, hopefully, our experiences from the clinical trial, and approach to identify and assess the various non-use causes may inspire further discussion and research on a situation that nobody hopes will materialize in their project.

2 STUDY BACKGROUND

The diverse and unpredictable environments of EDs pose a demanding challenge for any application of algorithmic thinking, manual as well as computerized. For decades, clinical researchers have strived to devise both simple and complex scoring systems that may aid in preventive identification of deterioration in patients[10]. Still, there is no consensus on which scoring system is superior as external validity and transferability of systems are low, and still today calls are made to focus on evaluation and validation of early warning scores [11]. Consequently, automated computerized scoring systems built on various machine learning or artificial intelligence driven approaches have been evaluated, but seldom in actual clinical settings in prospective trials [12].

With this offset, we designed and implemented a new patient monitoring dashboard intended to provide nurses and physicians with a better overview of all admitted patients. Past observations and studies laid the groundwork for identifying the scope and aim of the new system [13]. This was followed by the implementation of a data collection platform that integrated with the ED's patient monitors to register all vital signs from patients. This dataset enabled us to evaluate the traits of patients and utilization of patient monitors, which led to the development of a number of new monitoring metrics [14,15], and a realization that patient trajectories that typically are not a cause for concern, may actually be associated with higher mortality [16]. Based on these findings we designed a new patient monitoring platform in collaboration with physicians and nurses from the ED at Odense University Hospital (OUH), resulting in a prototype that was evaluated with promising results [17]. Consequently, funding was acquired to further develop and evaluate the platform in a larger clinical trial. In coordination with clinical researchers we devised a cluster randomized study design where the new system would be evaluated simultaneously at the ED of OUH and the ED of Hospital of South West Jutland (HSWJ) [ClinicalTrials.org Id: NCT03375658]. Over a 10-month period, the system was evaluated across each department in periods of five weeks where the system was either made available or turned off. Department nurses was hired as project staff to include patients in the study, and to help as ambassadors for the system. Furthermore, information on the evaluation was provided to the staff through employee meetings, flyers, and newsletters. During the clinical trial, we gradually realized that the system was used very little [18], and thus adjusted our evaluation strategy to also focus on this matter.

3 METHODS

Given the known dichotomy in system utilization, two distinct instruments were needed: one for gauging use of the system, another for assessing reasons for non-use. As previously described, there are multiple models available for technology acceptance and use, but less so for gaining a similar understanding of reasons for non-use. Thus, the survey was structured into three sections. First, a common part for demographic variables such as profession, clinical experience, computer proficiency etc. Next, two parallel parts, section 2.a and 2.b, depending on the respondent's history of use: Section 2.a for respondents who had not used the system, and section 2.b for respondents who had. Both sections conclude with an option for comments on the system and overall research project. Design of the survey in section 2.a (non-use) was based on short interviews with clinicians in both departments. These interviews were informal and simply included small talk on the intent of the new system, and whether the participant had used it. If not, we sought to dive deeper into the possible reasons. After two interview rounds with staff from both departments, their comments on use and non-use of the new system were structured into reasons, and a set of survey questions where proposed to explore the reasons. The final list of reasons and survey questions where reviewed with clinical and information technology researchers. Table 1 lists reasons and questions in the survey. Responses to all requestions were captured using a five level Likert scale

Table 1: Overview of responses

Reason	Questions	Shorthand
Workflow	- Using the system is not integrated into my workflow	Not integrated in work
	- None of my colleagues uses the system	Low collegial use
Obligation	- Management has not told me to use the system	Not obligated
Design	- The user interface is to complex	Confusing screen
	- The system appears difficult to use	Hard to use
Resources	- I do not have time to spare for learning to use something new	Lack of time
	- I do have capacity for learning new IT-functions	No capacity for new IT
	- There are so many computer screens I already have to use	Too many screens
Attitude	- I am skeptical towards new systems	IT skeptical
	- I am afraid to make mistakes when use the system	Afraid of breaking
Purpose	- I don't see the point of using the system	Meaningless
	- The system tries to solve an irrelevant problem	Irrelevant problem
Utility	- The system does not provide any new information to me	No new knowledge
Knowledge	- I don't know what the intention of the system is	Diffuse intention
	- Nobody has told me how to use the system	Lack of training

Section 2.b of the survey was a based on an existing Danish translation of the UTAUT survey [19]. After its finalization, the survey was made available to all clinicians across both EDs as paper-based forms. Notification of the survey purpose was given through employee newsletters. To incentivize responses, each survey had a small candy bar attached. In the initial analysis, only the non-use responses will be included to focus on the utility of this instrument.

4 RESULTS

A total of 75 clinicians responded to the survey. The response rate from nurses were ~20%, Assistants somewhat lower. Physician response rate incalculable due to the fluid association between physicians and EDs in Danish hospitals, and very limited number of responses.

Table 2: Overview of responses

	OUH (n=37)	HSWJ (n=38)
Physicians	4	0
Nurses	29	32
Assistants	4	6
<30 years old	13	11
30-39 years old	11	12
40-49 years old	8	7
50-59 years old	5	6
>60 years old	0	2
Female	32	4
Male	5	34
Clinical experience (years)	10.6 (SD=10.1)	10.7 (SD=10.1)
ED experience	4 (SD= 3.4)	4.5 (SD=3.6)
Computer experience (1-10)	8.5 (SD=1.6)	8.2 (SD=1.2)
Computer expertise (1-10)	8.9 (SD=1.3)	8.6 (SD=1.3)
Response section		
Use	8	4
Non-use	29	34

The responses show a right skewed distribution of both experience variables, with a 25% of respondents having the ED as their first place of clinical employment.

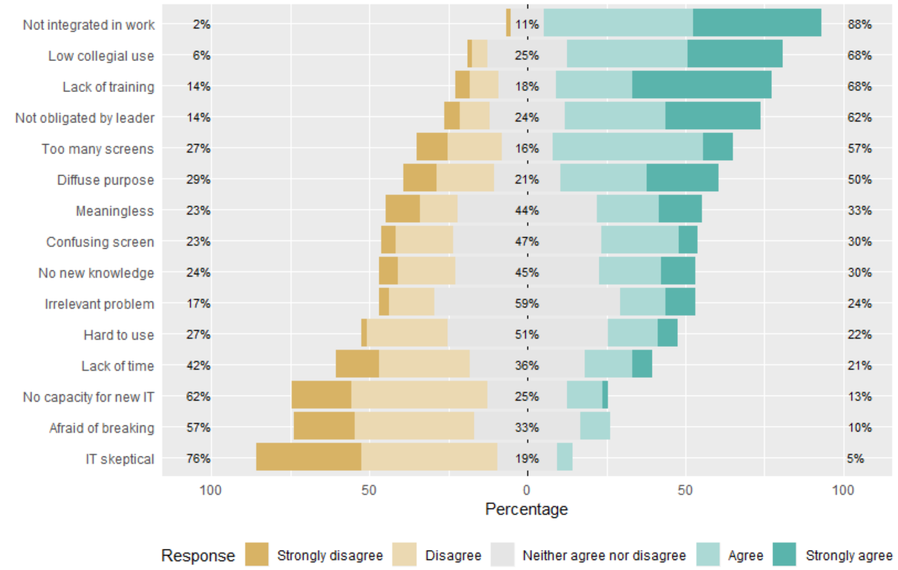

Figure 1: Distribution of non-use responses from both sites

Figure 1 shows the distribution of all responses to the non-use survey part. In the responses with more than 50% agreement (Tier 1), we find that workflow, knowledge, and obligation reasons dominate. At the opposite end, with more than 50% disagreement (Tier 3), we observe that resilience or apprehension seemingly was not influential on non-use. In between (Tier 2), we find responses to reasons that predominantly relate to issues with the actual system. Comparing differences in responses from HSWJ and OUH, we find identical distribution of workflow and knowledge items, close to identical importance of attitude and obligation items. Whereas resources and design items ranked higher at OUH as reasons for non-use, and purpose and utility were more influential at HSWJ.

5 DISCUSSION

Reviewing the list of reasons and the given responses, it is natural to assess the extent to which the different reasons can be modified or mitigated in future projects. Tier 1 items are mainly issues of embedding and integration of technology into clinical work. This is a major challenge for evaluation of AI initiatives conducted outside of partnerships with existing IT providers, as so much clinical work is now being facilitated by IT. Consequently, the effort of designing user interfaces may well be wasted unless attention is paid to the existing information landscape that the new system is intended to complement or supplement. Tier 1 issues require intervention beyond the specific project.

In contrast, Tier 2 items largely address issues of system usability and utility. Acceptance of new systems is higher when the mental models of users, and the information models of systems are aligned [20]. Yet, despite this being a guiding principle during the development of our new system, which manifested in a design that heavily reused the constructs and components of the departments' existing scoring system, we see that workflow integration is even more important. The variation in responses from OUH and HSWJ may relate to the closer involvement of the OUH staff during initial system design and development; although staff turnover meant that the general level of familiarity was low, the presence of senior staff acquainted with the project may explain the lower impact of purpose and utility items on non-use from OUH responses.

In Tier 3, the low ranking of attitude items across respondents is in alignment with the high level of reported computer experience and expertise. Which informs us that clinicians are generally accommodating towards new initiatives. This is encouraging as changing attitudes and comprehension of new IT is probably the most difficult aspect of all.

6 CONCLUSION

We surveyed the clinicians from two Danish EDs evaluating a new patient monitoring dashboard using a mixed instrument to cover both use and non-use. Most respondents had not used the dashboard. The main reasons related to issues with integration into working procedures and protocols. Despite similarities with present technology acceptance models, a specific tool is still needed for situations where no usage of the system has been observed.

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