

## Intended and Unintended Consequences of Implementing a Nursing App

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**Abstract - The paper addresses socio-technical consequences from implementing a nursing app in a North Norwegian health trust. We used the NASSS-CAT (Non-adoption or abandonment of technology by individuals and difficulties achieving Scale-up, spread and sustainability) framework for evaluating the app implementation. The paper is relevant to the Nurse team application track, presenting nurses experience with adoption and use of a nursing app for monitoring progression or deterioration through measuring vital signs. In this paper, the focus is on emerging downstream values for both the healthcare workers and the organization, since these factors are well suited to indicate whether the implementation is a success or not. From the analysis, both intended and unintended consequences of the implementation are outlined. The unintended consequences illustrated how extensive repercussions implementing a simple nursing app can have for the workflow of both nurses, doctors and leaders, as well as the communication at different healthcare levels. In addition, implementing an app for clinical practice generated improvement in the digital competence for both healthcare personnel and the organization.**

**Keywords - Intended consequences; unintended consequences; nursing app; implementation; qualitative evaluation.**

### I. INTRODUCTION

Documentation of and actions taken related to patients' vital signs are of fundamental importance for clinical outcomes [1]. The paper is relevant to the Nurse team application track since it presents nurses experience with adoption and use of a nursing app for monitoring progression or deterioration through measuring vital signs.

In most Northern European countries, for instance in Norway and the UK, monitoring patients' clinical status is guided by protocols based on Early Warning Scores (NEWS). NEWS includes vital signs like blood pressure, heart rate, respiration rate and oxygen saturation [1][2]. These are key indicators of a patient's physiological status. Based on the vital parameters, NEWS allows clinicians to produce a score ranging from 0 to 20, where a higher score indicates greater clinical risk. A deterioration in a patient's condition is often detected by abnormalities in vital signs, and failure to detect deterioration at an early stage is associated with worsened patient outcomes and a contributing factor for avoidable deaths [1][3]. Therefore, nurses measure vital signs regularly, especially for acutely unwell patients [2][3]. In general, patients with a low NEWS score are monitored every 6-12 hours, increasing to hourly for patients with a score above 6 [4]. This results in healthcare professionals conducting an extensive number of time-consuming NEWS scores [5][6]. Nurses often report challenges with maintaining essential patient surveillance due to high workload e.g., one study found that around 35% of the vital sign assessments scheduled according to an early warning score-based protocol were delayed or missed.

Today, measuring the vital signs is mainly a paper-based procedure where the score is registered on paper, and the paper forms are scanned into the Electronic Health Record (EHR) system. However, even if NEWS is implemented as part of clinical practice, previous research has shown that transferring the information from one medium to another has been challenging, in addition, nurses often write vital signs onto interim paper notes prior to documenting them in the EHR, resulting in

double registration practices. Transferring information implies not only time delays, but also an increased number of transcription errors, which could lead to inappropriate treatment and affect patient outcome [2]. It is important that the early warning score is evaluated in line with the overall condition of the patient [2], and that nurses communicate vital signs information as fast and efficiently as possible. Removing the barriers to more direct vital sign documentation can reduce these challenges and facilitate more accurate and timely documentation procedures, contributing to safer patient care [1][5]. Understanding today's nursing workflows and their view of clinical and documentation processes can help optimize recording of point-of-care vital signs documentation. Hence, electronic support tools facilitating timelier and safer recording of vital signs at the point-of-care are important to explore [1][2]. However, the mechanisms involved in implementing and using digital tools for NEWS registration is mainly unvisited both in the healthcare practice and the literature.

To that end, the aim of the paper is to present and discuss empirical findings from the implementation of a nursing app. The app is used for registering vital signs and calculating NEWS score at the point-of-care in a Health Trust (HT1) in Norway. In this paper, we outline consequences generated by the implementation. Hence our research question is: *What are the intended and unintended socio technical consequences of implementing a nursing app?*

Our empirical site is HT1 in the North Norwegian health region. Employing 4000 healthcare professionals, HT1 encompasses 4 hospitals and provide services for 136000 patients [7]. In 2020, HT1 implemented an app for registering vital signs and NEWS score at the patient's bedside. The overall aim of the implementation was to improve the nurses' workflow and patient safety, in addition to improving the digital competence of the users as well as the organization. There is a globally shared concern related to health personnel's digital competence, and skills required for adopting new digital services [8].

In the paper a qualitative evaluation approach is used mainly based on semi-structured interviews with different actors involved in the implementation and use of the app. The evaluation is analysed using the NASSS-CAT (Non-adoption or abandonment of technology by individuals and difficulties achieving Scale-up, spread and sustainability) framework designed by Trisha Greenhalg et al [9].

The rest of the paper is structured as follows: Section II describes the empirical project and the background for the implementation. Section III present our qualitative evaluation approach including the data collection and the NASSS-CAT framework focusing on the category value proposition to discuss the socio technical consequences of the implementation. In Section IV, the results of the study are presented, including the intended and unintended

consequences of implementing the nursing app. In section V, the success of the app implementation is discussed, including the importance of digital maturity. Section VI outlines the conclusion and the implications from the study.

## II. BACKGROUND

HT1 had priorly implemented a procedure for registering NEWS on all patients both in somatic and psychiatric care. This implied that the nurses had to observe and measure the patient's vital signs at the bedside and write the results of the measures on a paper note. Back in the ward office, they transferred the vital signs into a paper form and calculated the NEWS for each patient. The nurses then plotted every single score into the patients' paper-based Medical Charting Schema (MCS). Hence, calculating NEWS implied double and triple registration of vital signs. The procedure of registering NEWS was conducted every morning before the medical doctor's ward round, and the doctors had to go to the ward and search for the paper form to find updated NEWS scores for each patient. If a patient's condition was severe or worsened during the shift, NEWS was recorded more frequently to monitor the patient's situation closely. In addition, the nurses had to manually coordinate the work with NEWS score. This included checking with each other before conducting a NEWS score, to avoid measuring the vital signs twice because another nurse already had the results on a note in her pocket. Accordingly, it was a time-consuming process for the nurses, with an extensive risk of errors due to the complex transmissions of the data.

One of the health trusts in the North Norwegian health region (HT1), had for years been looking for a digital tool to improve the workflow and procedure of registering vital signs and calculating NEWS, in addition to an overall aim of removing paper forms and increasing data accessibility for both nurses and doctors. This required an app that was sufficiently user friendly and intuitive to use in a busy clinical setting. In addition, it was necessary that the app could be integrated with the existing IT infrastructure and automatically transfer data to the EHR system. It was important to find a solution that did not delay the work with complicated processes for logging in and registration of vital signs. The digital solution had to be more efficient than the existing paper-based routines to be of value for the organization.

HT1 was introduced for several vendors of digital NEWS score tools without finding anyone fit to fulfil their requirements. However, in 2019 HT1 was presented for a nursing app by a Finnish vendor, which had implemented their solution in several Finnish and Swedish hospitals as well as nursing homes. The Finnish vendor also had established a business collaboration with the EHR vendor in the North Norwegian health region. The app had the potential to integrate with several type of

standards to exchange data with and reuse the data from the EHR system. However, at HT1 the EHR system was not able to receive or reuse standardized data elements, so the solution was to generate PDF files to be exported from the app to the EHR. There is a plan to include structured data in the EHR further on, then the app will be integrated more seamless with the system.

In short, HT1 found the app to comply with their needs, and came to an agreement with the Finnish Vendor and the hospital’s EHR vendor. HT1 started the implementation of the app as a pilot project in an internal medicine department in March 2020. The pilot project was a success, and scaling of the implementation followed a snowballing effect where both medical, surgical, and mental health wards subsequently implemented the app. In autumn 2021, 26 wards at HT1 used the app, pertaining over 1000 users.

### III. METHOD

The paper is based on a qualitative inductive evaluation study conducted in close collaboration with HT1.

#### A. Data Collection

In the study, 22 semi-structured interviews were conducted with healthcare personnel and other actors involved in the implementation and use of the app (see Table I)

TABLE I. OVERVIEW OF THE DATA COLLECTION

Data source	Nr
Interviews:	
Healthcare personnel	26
Managers at different levels of HT1	6
The EHR vendor	3
The app vendor	4
Regional implementation program	1
Regional ICT	2
Total	22
Observations:	
Observation at the pilot department at HT1	3 hours
Participation in meetings, workshops, and discussions.	20 hours

The data collection started a year after the initial implementation process and were conducted between June and October 2021. Most of the interviews with healthcare personnel were focus group interviews to avoid taking up too much of their time. With the other actors a mix of focus groups and single person interviews were done. The interviews lasted between 20 and 60 minutes. All interviews, except from one, were done on a distance, using Microsoft Teams for communication. All interviews were recorded with a separate voice recorder and transcribed verbatim.

#### B. The NASSS-CAT Framework

For evaluating the empirical implementation process, the NASSS-CAT framework was used as the basis for the

interview guides and the analysis. Separate interview guides were designed for nurses, doctors, leaders, and IT/vendors to allow for domain-specific probing [9]. The NASSS-CAT framework is set to guide and evaluate the success or failure of technology deployments in organizations, as well as assessing complexity related to the implementation process [9][10]. Using the framework can help to predict and change directions during an implementation process to stimulate the success of an intervention [10][11]. The framework includes seven domains identified through systematic literature reviews and refined through empirical case studies of technology implementations [10][11][12].

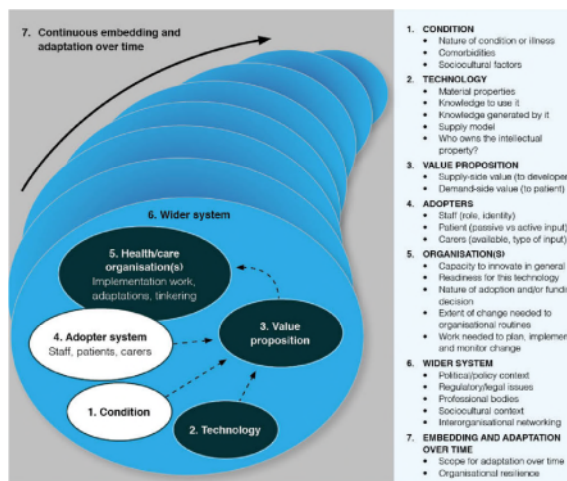


Figure 1. The NASSS-CAT framework

The seven domains are: I) the illness/condition, II) the technology, III) the value proposition, IV) the adopter system, V) the organizations, VI) the wider context, VII) embedding and adaptation over time (see figure 1). The NASSS-CAT framework is set to guide and evaluate the success or failure of technology deployments in organizations, as well as assessing complexity related to the implementation process [9][10]. Using the framework can help to predict and change directions during an implementation process to stimulate the success of an intervention [10][11]. The framework includes seven domains identified through systematic literature reviews and refined through empirical case studies of technology implementations [10][11][12].

By definition, the value proposition category addresses the actual value of an innovation and for whom it generates value. It questions whether a technology is worth developing in the first place and includes both the upstream values that follows the supply side logic of financial markets and investments decisions, including whether there is a straightforward and uncontested business case for generating revenue for the developer. It also addresses the downstream values that follow the demand-side logic of health technology appraisal, reimbursement, and whether there is strong and

uncontested evidence that the technology is desirable for patients, effective, safe and cost-effective [12]. In accordance with the research question, which gives direction for the analysis of data we focus on the downstream values to answer our research question by addressing the values for the users and the organization. Further descriptions of the domains can be found in Greenhalgh et al. (2020) [12]. The value category therefore includes the consequences of the implementation, both intended and unintended ones.

C. Analysis

The first step of the analysis was systematic reading and thematically coding of the interviews in line with the NASS-CAT framework’s seven domains. During this process, the content of the different domains was discussed and how they should be separate, since some of the findings related to more than one domain. For this paper, data representing consequences for the healthcare personnel and actors involved was of particular interest and thematically categorized in the “value proposition”. However, consequences can also be understood as a secondary value or repercussions of the implementation and have a link to other domains as well. For this study, we divided the values proposition into 1) expected values (consequences) traced back to the HT1 list of outcomes, and 2) unexpected values (consequence) including the different repercussions. Both the expected and unexpected values were divided into categories represented by the different informants.

The next step was to produce narrative summaries for both the expected and unexpected values for all the groups of informants. During the analysis, there were three meetings with representatives from HT1 discussing both the definitions of NASS-CAT domains, the division of the value proposition, and the narrative summaries. The final step of the analysis was to merge the narrative summaries into overall themes to give insight into expected and unintended socio-technical values of implementing an app to support healthcare personnel’s point-of-care registrations of vital signs.

TABLE II. OVERVIEW OF OVERALL THEMES

A. The expected values of implementing the nursing app
B. Digitalising more paper-based processes
C. Improving the workpractice for doctors
D. Providing better overview for leaders, increased use of patient whiteboards
E. Improved communication between professions and organizations

The themes are presented in Table II and elaborated on in the results part.

IV. RESULTS

The focus of the paper is to outline intended and unintended consequences for the nurses by evaluating the implementation of an app for registering vital signs and NEWS score at the point-of-care. The aim is to generate an understanding of the repercussions the implementation generated both for healthcare personnel and the organization. In the results part the overall themes that emerged from the analysis are presented.

A. Intended Consequences of Implementing the Nursing App

When deciding to implement the nursing app (illustrated in Figure 2), the management and the IT department defined some overall goals for the implementation.

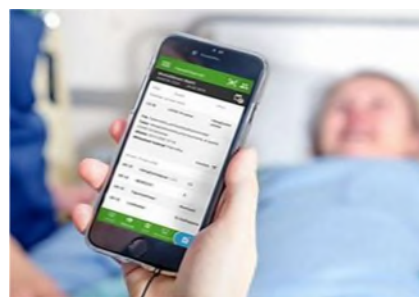


Figure 2. Illustration of the nursing app

These included improving the nurses’ workflow and patient safety real-time registration, the possibility to share and reuse information electronically between different systems simultaneously, decision support for nurses, reducing paper-based processes and scanning of forms into the EHR. In addition, outlining and improving the digital competence for healthcare personnel by using mobile phones for clinical registration was important. There is a globally shared concern related to health personnel’s digital competence, and skills are required in adopting new digital services [8].

When deploying the app, the IT department introduced it and demonstrated the use. The nurses instantly found it user-friendly, intuitive to learn and easy to use, due to the similarity between the app’s interface and the existing paper form. The nurses particularly liked that the app automatically calculated the NEWS score at the point-of-care after filling in the vital signs. In addition, the app provided point-of-care decision support by suggesting which actions to take in accordance with the patient’s updated NEWS score. Compared to before the implementation, the app provided the nurses an overview of all the patients’ NEWS scores in the ward. Now, the nurses could check in the app, at the-point-of-care, if someone else had measured the vital signs recently, and check the patients previous score, instead of



having to run around coordinating the work with each other. This vastly improved organizing v the workflow.

Due to the integration between the app and the existing IT infrastructure, the vital signs and NEWS Score were automatically transferred to the EHR system and the electronic patient whiteboards (Electronic whiteboards used in ward offices for coordination and overview of patients' conditions) at the wards, eliminating the need for double registration

Overall, the nurses found the app very useful, one of them stated: *"The Medanets app has only generated benefits for us. If a patient becomes ill, we can check the previous status on the phone, without having to search for the paper form. In addition, we don't have to double register or calculate NEWS anymore."*

Even if the app implementation fulfilled the intended consequences, some challenges were detected. First, for some nurses it was challenging to start using the mobile phone as a tool for registering vital signs. They needed extensive training in using the mobile phone as a clinical tool, before including the app in their daily practices. Some were concerned to make errors, or not be able to log onto the app. Second, some nurses reported that they experienced a barrier in using the mobile phone in front of patients. They described it as uncomfortable to use the mobile phone at the patient's bedside and worried that the patient found it impersonal and that it would hamper the communication with patients. They also worried that the focus on the digital work tool could risk lowering the focus on assessing the patient as a unique person. One of them said: *"There is a risk that especially young unexperienced nurses focus more on the digital results than the overall patient status."* Consequently, some nurses still noted the vital signs on paper and registered them in the app after leaving the patient room.

Another challenge was the mobile network at HT1. For instance, the Wi-Fi signal at parts of the hospital was very poor, especially at some of the wards. This resulted in instability in exporting data to the EHR and the electronic patient whiteboards. It was important to test and improve the mobile network in line with clinicians using the phone as a work tool. Still, it was possible to register data offline in the app and exporting it whenever the WI-FI signal was back on. Sometimes, it was trouble with the mobile phones which made it impossible to log into the app. Occasionally, this led to going back to use the paper forms.

None of the nurses reported that using the app made them save time on measuring and filling in the vital signs at the point-of-care. However, in addition to the intended consequences summarised which the management and the IT department had defined as goals for the implementation the app generated several unintended consequences as well these are outlined in the following sub-sections.

### B. Digitalising More Paper-based Processes

From using the app for digital registration of vital signs, the nurses increasingly started to see the potential of digitalizing other paper-based processes as well to improve their workflow. In most wards, nurses reported that it was easy to propose new parameters or forms to integrate with the app. Healthcare personnel suggested improvements to their department leaders, which brought them further to the IT department. The IT department discussed the ideas and brought the doable ones to the app vendor.

The first new forms suggested by the nurses were the risk assessment forms related to the national "patient safety campaign" calculating risk for falling, bedsores, and nutrition screening. In addition, other parameters like weight, height, and pain were included in the app. There was also an ongoing work on designing digital admission and submission forms for the app. Every time a new parameter or form was digitalized and included in the app, it increased the awareness amongst the nurse resulting in more systematic follow-up.

In the somatic department measuring vital parameters and calculating the NEWS score were well established routines. However, in some of the psychiatric and substance abuse wards they had just started using the NEWS procedure. Using the app became a means to increase awareness and more systematic registrations of NEWS. The implementation of the app also brought forth suggestions of other paper forms they found appropriate to digitalize, e.g., the violence measurement, symptoms and detoxication checklists. However, some of our informants outlined the importance of not digitalizing all forms. One of the doctors said: *"I don't feel the need to use such app for the scores we use in the IR, it would just generate a lot of clicking and extra time use for us."* This illustrates that not all work processes will be improved by digitalization.

During the first year of using the app, the IT department outlined that 100-150 changes were made to the app. They emphasized the importance of the app being flexible and adjustable in line with the general development of nurses' work practices.

### C. Improving the Workpractice for Doctors

The nursing app was not used directly by the doctors. However, it had an extensive impact on their workflow since the vital signs and NEWS scores were for the first time automatically exported from the app to the EHR system. The doctors could log in to the EHR and view results for patients assigned to them, which was of great importance when it came to following-up the patients with unstable medical conditions. The instant update in the EHR were also included in an overview of previous scores at different time intervals. Before the app was implemented the doctors had to walk to the ward and search for the medical chart in the ward office to get an

overview of all the patients' NEWS scores. If they wanted to look at trends over time, they had to look through a pile of forms and compare the values manually. When they were busy and did not have time to search for the chart, they sometimes assessed the patient based on the approximate value based on their memory. One doctor stated that *"it improves the patient safety to be able to always have the updated NEWS value at hand."*

Before the morning rounds, the doctors had a meeting to assess all their patients and discuss further treatment. The quality of these meetings was improved from having updated NEWS scores at hand. Also following-up patients with unexpected NEWS values were much easier. Now they could look at the patients NEWS overview to assess if the current score was normal for this particular patient or if it was necessary to take further action. This was an asset to prioritising the right patients to focus on, resulting in more efficient patient treatment.

In addition, when the doctors were on call, they did "medical supervision" on patients at other wards. Now they were able to check the NEWS scores on these patients beforehand, enabling a more accurate assessment of patients they did not have the overall responsibility for and did not know so well. One doctor said: *"This is 2021 and it is natural that the information can be registered and read digitally, the world is moving forward, and we are all happy about that."* The managers at HT1 outlined that they did not expect the implementation of the app to have such extensive impact on the doctors' workflow.

#### D. Providing Better Overview for Leaders – Increased use of the Patient Whiteboards.

Besides being automatically exported to the EHR, the NEWS scores from the app were exported to the electronic patient whiteboards that all departments at the hospitals had in their ward offices (illustrated in Figure 3).



Figure 3. The patient whiteboard

The patient whiteboards presented the NEWS score as well as the values from the parameters in the "patient safety campaign" for each patient. One of the leaders said that they had not used the patient whiteboard actively for a while due to limited usefulness. However, after NEWS and vital parameters were included and systematically updated, they used it much more. The NEWS score for

each patient came up with a colour code related to severity, and a countdown for when the patient needed the next score done.

Now the department leader could use the patient whiteboard to get an overview of the status of all their patients to plan the workday for the staff. If one nursing group had many patients with high NEWS scores demanding extra follow-up. Then, the leader could re-arrange the personnel in the different groups and transfer extra personnel for the group with patients that needed closely monitoring for that day. The leaders could use the patient whiteboard also to find out if some of the NEWS scores or other scores were not done or delayed and remind the nurses to do them. One department leader said: *"To have the NEWS score at the patient whiteboards improves our workday. We gather around the patient whiteboard every morning to plan the day and follow-up on scores that have not been conducted in time."* Some of the leaders expressed that it was challenging to get the nurses to use the patient whiteboards systematically since they already used the nursing app and the EHR system. However, these are important overview tools since everybody can access the same information whether it is the medical director, IT department, nurses, or doctors. The psychiatric and substance related department leaders stated that they did not use the patient whiteboards more after implementing the nursing app, since they did not have that many NEWS scores to conduct. The other parameters at the whiteboard were too oriented on somatic care to be of significant value for them.

#### E. Improved Communication Between Professions and Organizations

Improved communication was another important unintended consequence from using the nursing app. Since all vital parameters were registered at the patient's bedside, and the NEWS score automatically calculated, it was much easier to use the actual score in communications at different healthcare levels.

The communication between nurses and doctors improved from using the app because the nurses could use an updated NEWS score as an argument for following-up a patient, instead of using unspecific terms like "the patient looked a bit shabby, sickly, limp, pale." They felt more confident using the NEWS score when the app had calculated it automatically at the patient's bedside, than when they had to do it themselves. It was both more efficient and more accurate. One of the doctors said: *"it is much better to use objective parameters like NEWS score as the starting point for discussing the patient."* However, the doctors and nurses underlined that it is most important to look at the patient as a whole and not be blinded by the NEWS score. For some patients NEWS 8 might be normal and for some NEWS 0 could be dangerous. This depends on the total clinical picture and the dialogue between doctors and nurses for each patient.

Still, the main rule was to call the doctor when NEWS was above 5 to discuss the overall risk for the patient. One doctor said: *“Now we have the NEWS score instantly and can communicate using the same language.”* This was assuring especially for unexperienced nurses and health workers that before may have observed that something was wrong with the patient without being able to confirm it, but now the changing NEWS score made it easier to explain the shift in the patient status. After NEWS was adopted, at first the doctors received a lot of extra calls related to the patient status, however now a year later the nurses used the app more as a supplement to the overall clinical assessment

In one of the psychiatric wards, they stated that using the app resulted in more systematic registration of NEWS, which in turn led to improved communication with the somatic department, in terms of increased focus on somatic deterioration in their patients. One nurse from the psychiatric department said: *“we have a common language now, when we talk about a NEWS score, the somatic doctors understands that this is something they have to follow-up on.”*

Another communication improved was between the central hospital and the smaller district hospitals. One department leader at the district hospital said that earlier they had to argue a lot to get the patients transferred to the central hospital when their condition worsened. Now they could use a NEWS score value, e.g. of 9 or 10 and an overview of the patient’s trends as an description of clinical deterioration and an argument for transferring a patient to the central hospital.

Consequently, the nurses found that using the NEWS score procedure systematically contributed to improve the quality of a patient’s treatment and care in the different steps of the healthcare chain.

V. DISCUSSION

In the result section we presented the intended and unintended consequences that emerged from the implementation of the nursing app for registering NEWS in a hospital encompassing both somatic and mental health departments (see Table III).

TABLE III. AN OVERVIEW OF EXPECTED AND UNINTENDED VALUES FROM IMPLEMENTING THE NURSING APP.

Overview of consequences		
Intended consequences	Unintended consequences	Challenges
Intuitive and easy to use	Better overview for leaders through the patient whiteboard	Difficult to use for nurses with low digital competence
No double registration	Better communication at different healthcare levels	Impersonal to use the phone at patient bedside
Improved workflow related to overview of NEWS	Increased digital focus – suggestions for more digital forms	Some still registered on paper first

Automatic calculation of score	Improved workflow for doctors	Less focus on overall assessment
Instant export of NEWS to EHR and patient whiteboard		Problems with the phones and the network
Less paper-based work		Not very time saving

The intended consequences were in line with the overall aim of implementing the app in clinical practices. The study demonstrates that the implementation of the app was interpreted as a success by the nurses despite that some worry that using technology at the patient bedside shifts the focus from the patient to, in this case, the phone. Healthcare personnel experienced it as useful and intuitive. The app improved their workflow and to the end, it improved the treatment and care of patients also. The app fulfilled the expectations of fast and efficient communication of vital signs that increase accurate and timely documentation of vital signs, which in turn leading to safe patient treatment and care. In addition, the app gave the nurses clinical decision support at the point-of-care that improved their clinical confidence and improved the communication about the patient’s situations with the doctors [1][2][5].

Defining an implementation of a digital solution for healthcare a success is in itself a very rare and important finding. Often such implementation demands for comprehensive training before using the solution, and resource-intensive adaptation of both technology and workflow to make the technology work optimally. In addition, technology often demands for workarounds and fulfils only parts of healthcare organizations’ requirements. To solve several requirements for a heterogeneous group of different healthcare personnel, the system implemented is often a large, complex digital solution, like an EHR system, which takes time to adapt to clinical practice.

However, this app is the opposite, it is a simple app designed to solve a clearly defined work task for one specific group of healthcare personnel. The digital form in the app is identical to the paper-based form, hence the workflow of measuring the vital signs is the same, only the registration process has changed. As a result, the nurses stated that they did not find it time saving to use the app for registration of vital signs. This is in line with previous studies, for example Dall’Ora et al. [2] argues that there is no evidence that nurses save time when using electronic vital signs recording. Our study did not measure time related to using the app for recording and calculating NEWS score. However, this study identifies other values generated by the app. It increases the quality and security of the work processes by offering decision support based on NEWS values, automatically calculating the score, instantly exporting the results to the EHR, and erasing the double registration and the risk of

misunderstanding bad handwriting. The app also improves the work processes surrounding the actual registration. This includes the collaboration amongst nurses, the need for less resources to scan the paper forms and the possibility of reusing NEWS to the EHR and the patient electronic whiteboards. The managers at HT1 were aware of the risk of not making measuring vital parameters more efficient, however, the surrounding values were extensive enough for the process to be defined as successful.

One of the challenges of implementing new technology reflects the diversity of digital competence among nurses [8]. The management at HT1 saw the implementation of the app as a possibility to get an overview of the digital competence amongst their workers. and how they experienced using handheld devices at the point-point-of care. Kaihlanen, et al. [8] outlines the overall concern related to nurses' digital competence since nurse's informatics competence affects the quality of healthcare [8].

It is important to raise the digital competence of the nurses without compromising the clinical assessment. More and more of the digital solutions implemented in healthcare includes digital solutions for registering data. The EHR vendor for instance has worked for years to develop mobile solutions for accessing the EHR and registering data. Other vendors also want to transfer functionality to mobile solutions, and there is a wave of apps entering the healthcare. However, using all kinds of digital solutions, replacing the overall assessment is impossible, the experienced nurses said that this was important to remember in a busy workday. To enable more digital solutions for healthcare personnel it was important for the management to get an overview of the capacity for the mobile network at the health trust. Within the group of

Still, increasing the digital competence of the users and expanding the use of digital solutions demands for an up-to-date mobile infrastructure to make sure that the phones always are available at all locations. If using the phone is too cumbersome, in terms of e.g., no network, out of battery, or delays related to logging in, there is a risk that the nurses will stop using the mobile solution and go back to their old paper-based routines. In this case, the importance of the nursing app to be more efficient and easier to use than paper was outlined as a precondition to use it in the first place. However, the regional IT department ran the IT network, and scaling up the mobile use to clinical use for an entire health trust was new for them and required some improvement and optimizing of their mobile infrastructure.

The implementation of the app implied unintended consequences. These are of particular interest to discuss for understanding the socio technical consequences the implementation of the app brought about. First, the app generated new practises and workflows both for leaders

and doctors, who did not fuse the app, but who were influenced by receiving data from the app in other systems. Both groups report that improved overview and patient safety were important values generated by the app. In relation to the increased use of the patient electronic whiteboards, the results underscore the importance of engaged and digitally mature leaders. In departments with such leaders, the patient electronic whiteboards went from being a rather passive and random used work tool, to an important means for coordinating work practice and resource allocation at the ward.

Existing research points out a lack in standardized clinical processes for measuring vital signs, and inadequate description of the vital signs' observation methods used [2]. HT1 had standardized the process of measuring vital signs by using the NEWS Score years before implementing the app. However, this study also showed how a systematically and standardized procedure for measuring and registration of vital signs and NEWS Score improved the communication between different healthcare professions, healthcare specialities, and the hospital's clinical departments. A standardized language for communication (NEWS), generated more confidence amongst the nurses when reporting the results to the doctors. In addition, the doctors could evaluate the patient not just by the status today, but also the overview from several days resulting in improved patient safety.

## VI. CONCLUSION AND FUTURE WORK

Implementing the nursing app at HT 1 was an overall success both for healthcare personnel and the organization, due to the instant usefulness for nurses as well as the repercussions including positive consequences for doctors, leaders and the improved communication across healthcare.

To define healthcare technology implementations as a success, analysis framework like NASSS-CAT is very useful for to make it clearer what are the intended and the unintended consequences, and how are they fulfilled in the process. Using the framework, revealed that the app generated several intended and unintended consequences that were important to exploit further to understand the repercussions this simple app implementation generated.

Lessons learned from the study:

- The app did not generate extensive time saving for nurses, however other important consequences made the implementation a success.
- Implementing a simple app can generate several unintended values with just as much benefit for the users and the organization as the intended ones. It is important that the organization can rapidly adjust to, and embrace, the unintended values.
- Implementing such simple app and increasing the digital competence and digital interaction between the systems in their IT ecosystem, made the



organization and the healthcare personnel better prepared for forthcoming more complex digital solution and the possibility for exploiting the digital possibilities for optimizing healthcare increased extensively.

When implementing digital solutions in healthcare it can be difficult to measure cause/effect values related to time saving and reduced costs during the implementation process. However, conducting evaluation research generates an increased long-term learning effect for organizations as well as for knowledge production.

Future work will include the relation between the app and the EHR system in related to how large EHR system can keep up with the fast-evolving apps and the interrelation between those different technologies in the IT infrastructure. This will demand for an extensive understanding of the IT infrastructure and the organization at HT1. It is also important to not include too much functionality in the app, to avoid for it to become too complex.

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