

Evaluation of a Context Specific Communication System Based on Smartphones: Nurses' Uses and Experiences

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Abstract

Nurses often have stressful work environments. This paper presents a study that investigates if and how the intelligent phone communication system CallMeSmart, which is designed for use in hospitals, affects and improves the communication and information flow among nurses. We collected the empirical material through a multi-method research approach using both quantitative and qualitative data. The data were from phone logs, six individual face-to-face interviews, a focus group interview and informal discussions. We categorised the empirical data into two main groups. One group was for the benefits the nurses experienced. The nurses liked the dedicated phone system, and they gave many examples of how the system could facilitate communication and information flow in their work practice. The second group was for the negative experiences, and it included problems the nurses experienced while using the technology. The phone log material showed the usage of the system. Our conclusion is that this dedicated phone system has great potential in facilitating hospital communication. However, the condition to realise this potential is that the problems that were registered should be resolved.

Keyword:

Hospital communication systems, context awareness, nursing, e-health, work practice, implementing ICT, smart phones in hospitals, work efficiency.

Introduction

Nurses' work environment has often been defined as stressful. A negative relationship between their stress and job satisfaction has been revealed [1]. Different research has been conducted to identify how the nurses' stress can be reduced, or how the nurses can cope with stress [1, 2]. Workload, leadership/management style, professional conflict and emotional costs of caring have been described as the main sources of distress for nurses [3]. Our study focuses on how new technology, a telephone system, can simplify the communication flow and the nurses' daily work practice.

The nurses, like other health care personnel, need effective communication and information flow to provide high quality care [4-6]. It might, however, be challenging in a clinical setting to gather and redistribute the right information at the right time. Hospital staff need to have easy access to and be able to redistribute data, such as patient status reports, lab test results and so

on. The management of this information is challenging in a hospital setting where time is a scarce resource. Getting the 'whole picture' can require frequent conversations and discussions [7]. In addition, information and communication systems in hospitals have shown to suffer from poor practice and inefficiency caused by insufficient infrastructure. This is especially challenging when the need for information or communication is urgent [7-9]. Today, hospitals often rely on a mobile communication infrastructure with dedicated devices for each role, which may result in each health care provider carrying several mobile devices. Figure 1 shows a picture of all the communication devices that a nurse at a Norwegian hospital carries on every shift to reach and be available to other health care personnel.



Figure 1. All the devices an acute nurse at a Norwegian hospital carries on every shift

Currently, pagers are the most dominant mobile communication device in use, in addition to wired/wireless phones and Personal Digital Assistants (PDA) [10].

Studies have demonstrated that common mobile phones can overcome most of the limitations of pagers, and improve and facilitate the communication in a hospital setting [11]. Ordinary mobile phones can improve the accessibility and communication in healthcare [7, 9, 12]; for example, by offering two-way text and voice services. However, at the same time, as availability and accessibility increase, an overload of information and numerous number of interruptions on key personnel may occur [5, 11].

Today, mobile phones are not widely used in hospitals, even if they have the potential to reduce delays in communication and

improve patients care, as well as reduce the risk of medical errors [9]. In general, only a few staff members carry mobile phones due to the assumptions that a phone is more interruptive than a pager [5, 10].

To solve some of the challenges described above, an intelligent, efficient and context sensitive communication system called CallMeSmart has been developed. This phone system has been fully described elsewhere [13]. CallMeSmart is a mobile phone system designed for use in hospitals. The system aims to improve communication and information flow and to reduce unnecessary interruptions in clinical settings. A first version of the system has been tested by physicians and nurses in a lab setting. The feedback was primarily positive and has been used as input for the further development and improvement of the system, moving from prototype to production [14, 15].

The system supports voice services, text-messaging and paging services in an efficient and non-interruptive manner. It intends to avoid interruptions when health personnel is busy; for example, when nurses are involved in important conversations with patients or relatives. This kind of context information, which affects the workers' availability, is normally extracted automatically from different sensors, calendar information, work schedule and so on. With this device, individual users can change their availability manually. If a user is busy, the call will be forwarded to another professional at the same level and with the same role, and the caller will be given feedback about the health care workers' availability.

Using these phones, the nurses need to carry only one device in total, instead of one device for personal use and one for each professional role they have. The role-based communication also enables other users to contact someone assigned on an 'on-call' duty at a specific department, even if they do not know the name of that person. The system enables acute calls and alarms to be forced through, balancing between availability and interruptions.

However, before introducing a health care sector tailored communication system like the phone system in question as standard hospital equipment, usability, user satisfaction and impact on work practices need to be investigated. As part of this, we have studied nurses' experiences from using the phone system in their daily work.

In a different paper, we have reported on the frequency of use and the nurses' expectations on the system [16].

The following research questions have been investigated:

1. Would the communication system in question designed for use in hospitals affect the nurses' work practice?
2. Would it aim to improve the communication and information flow among nurses?

Materials and Methods

In the following, we present the research setting, how to use the phone system and the methods used in this study.

The Research Setting

Testing took place at the Oncology Department (OD) of the University Hospital of North Norway (UNN).

The OD offers chemotherapy, radiation therapy, hormone therapy, other symptomatic treatment and care and palliative care guided by national guidelines. The ward includes 25 beds and around 120 employees as nurses, nurse assistances and medical doctors. The nurses work in three shifts: day shift including ten nurses, afternoon shifts with five or six nurses and night shifts with three nurses.

The OD ward has 33 rooms in total, including patient rooms (bathrooms included), storage, examination room and many other amenities. These rooms are distributed along two corridors. Furthermore, they have 26 offices, two meeting rooms and one technical room dispersed over two floors in a connected separate building. The nurses also accompany patients to the radiology department and to the patient hotel. This means that nurses can walk long distances and visit many different rooms during a typical working day.

The phone communication at the OD is currently by wired or wireless landline telephones. Staff on call also carry pagers, but the nurses have no mobile devices for efficient information exchange. This situation has led the management at the OD to invest in mobile communication devices and to test the phone system with the aim to save time and improve patient care.

The Phone System

A detailed technical description of the phone system can be found in Solvoll [13]. To log on to the phone system, users can use their ordinary username and password from the hospital information system. Users can make and receive calls in a one-to-one configuration, or in a one-to-many configuration for conference calls. Moreover, messages can be sent in a one-to-one or one-to-many configuration. The phone system may deliver and read the acknowledgement for each message silently. Whenever users are logged on, their messages will be available on the phones through their profile, since the messages are stored on the users' profiles. A user cannot receive or start another call without hanging up on the first one.

Each nurse was provided approximately five minutes introduction and training before they started using the phone system. The inventor of the phone system was at the ward the first two days after the first nurses started using the system for support if needed. The only support asked was to create new accounts for new users.

Methods

This study focuses on the experiences gained from the use of the phone system at the OD at UNN. Fifteen phone devices were in use during the day shift. The study utilised different methods to collect data, both quantitative and qualitative.

The study data has been reviewed in light of the results from the previous sub-study of the evaluation [16]. The previous study focused on nurses' expectations of the system, while this article focuses on nurses' experiences with the system.

Interviews

Qualitative approaches are used to explore and explain experiences and to achieve in-depth understanding of behaviour and

what reasons actors have for their behaviours [17]. Qualitative methods are also appropriate to investigate how the context affects the outcomes [18, 19]. It is critical to understand how systems are used, instead of only how systems are designed and intended to be used since ‘plans and situated action’ may differ [20].

Our approach was as follows. After the nurses on the ward and unions had been informed about the study, we showed up at the OD in periods we had been informed as usually not too hectic to get interviews. There, we asked at the nurses’ station whether the nurses on duty were willing to be interviewed. We completed six individual interviews. Three of these were with participants who had used the phones through the entire trial period, while three were with nurses who had quickly put the phones away. The interviews were semi-structured. The interviewer was the first author of this article. The interviews were recorded and transcribed.

- How do you use the phone system? In which situations and for what purpose?
- Changes the phone the way you perform your daily work; is it improved or does it cause problems or troubles?
- Do you know whether the other nurses use it differently?
- Can you sum up the positive and negative changes that the phones make in your work?
- Can you describe the changes in information and communication flow?

Box 2. Main questions from the interview guide.

Furthermore, a focus group interview was conducted with the senior charge nurse and other nurses. The reason for the focus group was the feedback in the individual interviews about problems with the technology, and that the problems had led some of the nurses to stop using the phone system. At most, eight nurses were present, while some had to leave or they were ‘to and from’ because of work. The first and last author conducted and made notes during the group interview.

We explored the empirical data using a content analysis to break them down into categories relevant to this study [21]. The data were categorised in two main groups. One group included the benefits that the nurses experienced with the system. The other group included the different kinds of problems they experienced. Furthermore, we coded the empirical material in the following categories: savings of time, fewer interruptions and less messages to remember.

The results section presents quotes both from those who used the phone system through the entire period (quotes marked 1, 2 and 6) and from those who did not (quotes marked 3, 4 and 5).

Log Data

Log data on each user has been collected from the introduction of the phone system in December 2016. From these logs, we extracted the usage on every user between January 1st. and February 10th using Structured Query Language (SQL) for querying the log database.

The logs identified the usage of the system, such as how many messages and phone calls were performed at which date and at what time of day.

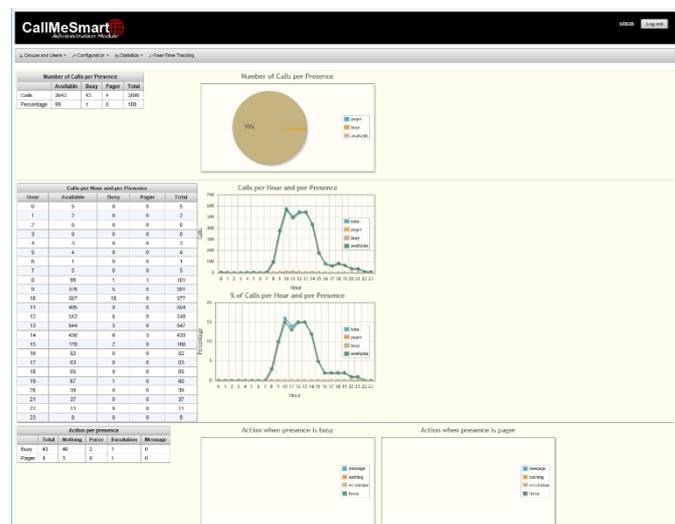


Figure 3. Screen dump from the administrator module of the phone system (Web-based), showing statistics from the usage—calls, messages, availability, missed calls and so on

Ethics

Our project does not cause any risk to patients and does not include any activity that requires approval from the Regional Committees for Medical and Health Research Ethics (REC). (helseforskning.etikkom.no/ikbViewer/page/reglerogrutiner/soknadsplikt/sokerek?p_dim=34998&_ikbLanguageCode=us) Neither is our project subject for notification to Data Protection Official for Research since it does not process personal data (www.nsd.uib.no/personvern/en/index.html).

Results

This section presents the results from the interviews about the nurses’ experiences from their use of the phone system at the OD. Furthermore, it presents data from the phone logs regarding the use of both the message and call service.

The Nurses’ Experiences on Using the Phone System

In this section, we present the benefits and problems that the nurses experienced while using the system. It also presents the nurses’ wishes for improvement.

Benefits

When asked for the most important change that came with the phones, a nurse answered, ‘I saved time because I didn’t have to search for people - to convey messages - or to tell everybody in the group that the meeting starts at 11.15, not at 11.’ (4) The informants emphasised that by using the phone system they can save ample amount of time since they do not have to search for the colleagues that they need to contact.

- You spend a lot unnecessary time searching to find someone, to deliver a simple message, only a number or a blood test result. Or maybe a patient has become suddenly ill, and you need to get the doctor, and so you need give a message to the nurse, that she's got to do something right away. (1)

- With the phones, you can give messages directly to people, just call and you do not have to go and look for them. Especially secretaries who [forward requests] - when patients should take a medical examination, when the home health care calls with questions [...] Every time they need to contact us. Without the phones, we must go to them to get the messages and then go back to our work - and probably have to do something in between. [...]. (2)

- The secretaries could easier reach us - when there was a call from the radiology department or the operating room or anywhere. They could send messages saying that we should fetch/bring back a patient, or to send a message immediately to inform us when a new patients has arrived. (3)

- I need the phone when I have four patients with possible lymphoma! Lymphoma reports progress at full speed ... lots of examinations the first few days, [...] and I need to know their examinations scheduled time and when they will be ready. (4)

One advantage with the phone system reported was that nurses could reach many colleagues at once. One example is that a group leader can easily reach those who made a pre-round and then redistribute messages to many people at once, or send a message to those who are scheduled to perform specific tasks.

With the phone system, nurses can easily receive and give messages and answer inquiries. They can also avoid unnecessary interruptions. They can request assistance without leaving the patient or the task they are about to do. For example, when the nurses were involved with a patient, the phone system made it possible for them to answer a call or to relay a message without leaving the room. Another difference from the pagers is that the phones show who is calling, and this provides the opportunity to assess whether the call is urgent or can wait.

- When I wanted help with a patient, it was helpful for me to find the phone number of one [...] in my group and to ask for assistance. (3)

- When I am with a patient and I have forgotten something, I can just call and say I have forgotten this and that, can you please help me get it. (6)

- For example when the secretaries had sent me a message, [...] I could answer [...]. Then the others knew that I was with a patient and unable to leave the room. (5)

- When using the pagers, you first go to the secretaries [...] or to the landline phone]. I do not use the landline phone otherwise. Then I have to go to one of the offices to find a phone, and then dial the number that and

that. Then I have to wait until those [... I want to contact] arrive. [With the phone system] you don't have to look for people [...] and] you get in touch at once. (6)

- Another thing is that the phones show the name of the person who is calling in the display, allowing you to consider what the call is about. (2)

Using the phone system can make interruptions become less time consuming than using the pagers. The nurses could send messages and inquiries and receive and give responses immediately wherever they are. The nurses expressed that they avoided leaving the room while they were with a patient, and having the phones, they did not have to take off the sterile clothing and leave the room when working sterile. Instead, they could step away from the patient and use the phones to receive and send a message. Thus, they did not have to undress, leave the room, come back, put on sterile clothing once more and continue to help the patient.

- [Then I] had put on the [protection] again, and maybe even had to dispose it, and then go out to get the message. Sometimes I just had to let them call on me for a long time because I prioritized finishing. Now I can just move away from the patient bed and use the phone to let them know that I am busy and so and so. (6)

- Probably also the secretaries experience that the phones make their work easier. (3)

When asked where they used the phone system, one of the nurses replied, 'I could answer "everywhere", but I did not. I answered calls everywhere, but I avoided writing messages when I was in a patient room'. It was not always appropriate to use the phone by the patients' beds.

Searching perceived as unnecessary use of time creates discomfort and frustrations. It also steals energy.

- It offloads not having to search for others. It saves time and the nurses avoid the frustrations that come from experiencing time consuming unnecessary searching. (2)

- The time you spend walking around searching...are time you could have spent on other things. On patients. This cause frustration. It drains energy. (1)

Another source of stress being reduced was to remember to pass on messages. Particularly stressful was when the nurses had forgotten to pass on a message and only remembered when she or he met the person the message was intended for.

- Far fewer paper messages – a relief! (4)

- That is the good thing, that you can deliver the message when it should be delivered, and directly to the person it is intended for. And it does not take that long. When you deliver it directly, then it's less likely to get lost. . Especially if it is a hectic day, [...] and there are four other tasks that pop up, the message can be forgotten until you see the person again. (1)

Several nurses said that they rarely or never used the "busy" button available on the phones.

Problems

What kind of problems did the informants describe?

Sometimes they were not able to get in touch with a specific person even if this person was logged on to the system. Other times they were notified as not available even though they were. In addition, it happened that an English speaking voice answered a call.

Problems that could arise were that only (contact) numbers and not names came up when someone made a call, or the wrong name from the contact list came up when they received or made a call. They also had trouble when they tried to delete messages.

The problems in contacting colleagues made some of the nurses experience the phone system a nuisance. :

- It is only a hassle [...] When you have to take with you [...] the on-call mobile and the pager and the glasses, the pocket gets very full. (5)

- Now I don't take the phone with me. I will not carry it with me if it does not work. (4)

- In addition, sometimes we have to be sterile. So we 'disinfect' a lot. (3)

Moreover, the phones have a smooth surface both on display and the back, and it can easily slip out of the pocket in some situations.

Early in the test phase, a loud alarm went off. One of the nurses stated that: "Just after we had started using the phone system again, a very loud alarm went off [...] and] we were forced to turn the phones off that day." (6) The alarm caused some of the nurses not to use phones.

- *Why did you stop using the phone?* All the alarms that went off for no reason made us tired of it. [...] Before the alarm, we thought it was all fine. (3)

One of the nurses said she did not know if it was just a rumour, but 'there were some who said [...] it does not work anyway.' When some gave up using the phones, this caused those who actually did use the system to face a new problem: Others were offline.

- It has been a fine tool. However, I think we still use it too little. [...] To] few is logged on. (2)

Several mentioned that they would like to access the Physicians' Desk Reference on the phones. They use it several times daily, but the shortcut on the phones does not work.

Will they continue using the phones?

A final question in the individual interviews was whether the informants wanted to continue using the phone system. All responded affirmatively, even those who eventually had stopped using the phones. However, the premise was clear. The system must operate as they were envisioned.

- I really hope we can continue to use the system. That it will work ... work the way it should. (1)

- The system must be improved so we avoid [problems] ... so we can have confidence in it. Nevertheless, if it works, then I would use it. It is a good system! (5)

Improvement opportunities?

New means of electronic communication may require new social ways to communicate. Although the nurses had used the phones, it was not viewed to be okay to make personal phone calls by the patient's bed. One informant referred to yesterday's staff meeting where they argued the need for a cover to the phones that could signal to the patients that the phones are not private phones but work related. Such a phone cover can be an easy and useful innovation. The same applies to a solution that in a hassle-free way prevents the phones from slipping out of the pocket.

They described several requests for the further development and improvement of the phones. One request was to be able to call personnel in other parts of the hospital building in the same way they could call their colleagues in the oncology ward.

- Perhaps, we can use it to call others on the house as well. Instead of searching for other phones, [...] pharmacy, physiotherapist, intensive care nurses and others, it could be very nice to [...] reach them with a short number, like we do here. (6)

Other wishes were to get medicine charts and internet access on the phones.

- It may be even more positive if we get the medicine charts, access the electronic records and the Physicians' Desk Reference on the phones so you do not need to go and look for a computer if there is something you need to look up... Sometimes, we have to find things, and having access to the Internet, I think that would be useful. (2)

It was also emphasised that it would be very helpful if they could track the drug curves.

- We spend a lot of time going around looking for drug curves. Because the nurses need the curves for the medications, to fill pill dispensers, and when patients say they have pain, the nurses must check what they can give. The doctors also needs these curves to look through and see that everything is correct, what you give the patient, maybe add some medicine or take away some medicine. They can also use it to retrieve information. (1)

Phone Logs

We also collected data from the phone logs on the use of both the message and phone service. Figure 3 and 4 show the total usage of the system between January 1st and February 10th. Both figures reveal that the system is used less in the weekends than during the week. We can also see that they use the message service more than the call service.

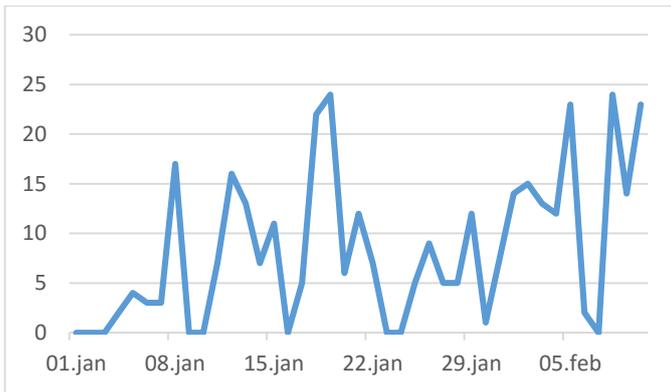


Figure 4. Number of calls between January 1st and February 10th

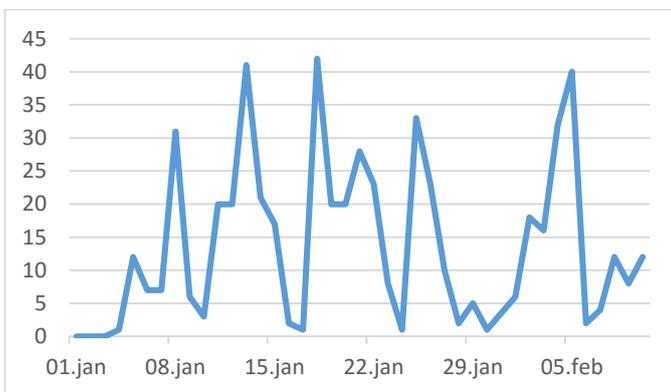


Figure 5. Number of messages between January 1st and February 10th

Discussion

This paper studies whether the phone system in question, which is designed for use in hospitals, affects the nurses' work, practice, and if it improves the communication and information flow between the nurses.

Using the phone system instead of pagers, imply changes at the OD. The nurses are more or less in continuous motion within and partly outside the OD. At the same time, a continuous stream of communication and information is taking place between the nurses and between the nurses and the department secretaries. The secretaries conveys messages and requests for contact from both personnel at the OD and from external bodies.

Without the phones, the nurses must look up the other nurses who they want to contact, and the secretaries must use the pagers to make contact with a nurse. When the secretary uses the pagers to call for a nurse, the nurse has to go to the secretary or has to find a landline phone to learn what the call is about. If the nurse is asked to call someone outside the OD, then it may involve waiting by the landline phone for contact.

Effects on work practice

An earlier study revealed that the nurses expected the phone system to save time because of less searching for others; especially for other nurses in their department, and that it would reduce disruption and interference during their daily work [16].

In our field trial less searching for others was something the nurses highlighted as positive by the phone system. They did not have to search for the other nurses at the department. Neither did they have to walk to the department secretary to receive or to give messages. Interruptions could be less disturbing. This is because using the actual phone system, the nurses could receive answers immediately, and they could receive and send messages, and answer inquiries "there and then", instead of walking to and from to get it done, or wait until they had time if they were busy with a patient.

Less disturbances meant less feeling of stress, and so do avoiding "unnecessary" use of time and energy searching for others or on giving or getting a message. In addition, it is a relief when you can deliver a message "here and now" and not risking forgetting it.

Nurses themselves expect that "time saved on unnecessary searching" will be spend on more useful patient work.

With the phones, the nurses can administer their availability more targeted. They can be reached "here and now", while they can protect themselves from interruptions, in their work practice by using the phones' "busy" button. No use or low use of the "busy" button may be because that the nurses are carrying the norm "being available" and that they have not experienced the buttons potential for less unnecessary bustle combined with accessibility.

Effects on communication and information flow

The nurses' communication at the OD, as in hospital in general, is complex with large numbers of messages and many participants communicating. The phone system in question have a potential to simplify the communication and information flow at the department and make it less energy demanding, by giving the opportunity to communicate 'here and know'. Furthermore, it can simplify the flow because of fewer participants. Finally, the flow can be safer, with less risk for information to disappear or be delayed. However, the potential of the phone system was not taken 'fully out' because of problems that arose during the trial.

What caused the problems?

Certain problem arose in the communication and information flow. Some of the participants gave up when the problems appeared. They became disappointed and insecure. Consequently, they put the phone system away. In turn, those who used the phones could not reach them. Others forgot to install the Physicians' Desk Reference. These factors can be attributed to the human factor. Lack of training can also be a reason, as discussed in Bergmo and colleagues [16].

Other contact problems are interpreted as caused by technical weaknesses in the hospital's wifi-network system, unforeseen difficulties that became visible when the use of the system were moved from the lab setting to the field setting.

Learnings from the logs

The phone logs collected between the 1st of January and the 10th of February show that the nurses use the message service slightly more than the call service. This is probably because a significant amount of the information does not require immediate response. Since the messaging service acknowledges if and when a message has been delivered and read by the recipient, the sender knows if an important message has been received and read. If we compare the usage with our earlier study [16], we experienced in that study a low usage right after implementing the phone system at the department. However, after a couple of weeks, the usage increased, both for the message and call service. The latest logs (Figure 3 and 4) show that the usage and the number of messages and phone calls seem to have stabilised on this level. From Figures 3 and 4, we also see that during the weekends, there are less messages sent and less phone calls. This is because there is less nurses at work, and if we compare the numbers in the log, we see that the usage narrowed down to each user is approximately on the same level during the weekends. From Figures 3 and 4, we can also see some peaks in the usage, which looks like they used the system more in the beginning and in the end of the week, Mondays and Fridays, than during the other weekdays. We cannot claim that this is a pattern, since the figures show that we also have a peak in the middle of the week. We need more data to claim or discharge this idea. However, if this is a pattern, it can be because the department receives new patients in the beginning of the week; therefore, they need more information exchange than during the middle of the week. The same happens when the weekend gets closer; patients leave the department and/or information needs to be forwarded to the personnel on shift during the weekend.

We have also collected data regarding which time of the day they use the system. These data are not presented in this paper due to space limits. However, the logs revealed the same patterns that we presented in our earlier study [16]. The data emphasises that the nurses use the system's calling and messaging services more during the day shift than during the other shifts. There is also a peak in the usage during the beginning of the shift, right after they are done with reports and morning meetings. This is probably due to the patient rounds in the morning and all the following information that needs to be sent between nurses and physicians, such as updating patient records, medication and so on.

Generalisations

Hospital departments are different. We do not know the extent of the communication, and informing generally corresponds to other departments. However, we know that the need for effective communication is undoubtedly huge at hospital departments, generally speaking.

One factor that makes this technology valuable on OD is that the department has only red alert outside patient rooms. There is no green that shows when someone is by the patient. We do not know to what extent this applies to other hospital departments.

Further Work

The problems that the users experienced during this trial period, such as the minor bugs in the system, will be addressed immediately after this trial is over. We see that the system has real potential for solving many of the communication problems or challenges experienced by the nurses during their shifts at the hospital. One of our biggest challenges is that the system is not yet connected to the existing phone system, which means that nurses cannot call from the system's phone to a phone outside of the system. This goes together with the fact that we are still waiting for the vendor of the alarm system (patient alarms) to deliver the connection module that sends the alarms to the phone system. This is ongoing work and will be ready during March this year. Another issue is that the department experienced a theft raid, and several of the phones were stolen. This has also been a frustration for the users since less phones are available for the nurses. An ideal situation would be that all the nurses and the physicians at the department use the phone system, along with the connection to the ordinary phone system and the alarm system. Subsequently, we believe that some of the frustrations from the users will decrease.

Future work in this evaluation is to study the use of the phone system after prolonged use. What are the experiences regarding advantages, problems and time spent? Future research questions will include whether the phone system influences the quality of patient care, safety of information flow and productivity at the hospital ward.

Conclusions

In this paper, we reported a pilot study evaluating the use of a hospital phone system at a hospital department. Our conclusion is that the phone system has great potential to improve the hospital communication and information flow. The condition for releasing this potential is that the problems that were registered are being resolved in a satisfactory manner.

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