Availability Communication: Requirements for an Awareness System to Support Nurses' Handling of Nurse Calls

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Abstract

The recent development of mobile technologies allows nurses to receive different types of requests anywhere. However, the interruptions generated by these devices often presents a challenge for nurses in their daily work in a hospital department. In previous inquires we have investigated nurses' strategies to managing technology-mediated interruptions in the form of nurse calls. This study reports on an effort to co-design a system that supports an important strategy employed by nurses. Through the involvement of domain experts, the study elicits requirements for an awareness system to support nurses' collaborative effort in handling nurse calls.

Keywords:

Awareness; Interruptions; Collaboration; Nurse Calls.

Introduction

Nursing work in a hospital department is characterized by complex cognitive work that involves continuous organisation, prioritisation and decision making [1]. Nurses can have multiple clinical and administrative tasks that simultaneously compete for their attention. To manage these challenges in order to provide high quality care, communication among nurses is fundamental [2, 3].

One important aspect of nurses' work is responding to nurse calls. Nurse call systems provide a means for patients to communicate their need of assistance to a nurse. Regardless of how the nurse calls are communicated to the nurse, they are likely to interrupt an ongoing task. This requires the called nurse to assess her availability for the nurse call and perhaps yet again re-prioritise and re-organise work. Therefore, nurse call systems have often been accused to be a source of interruptions that not always are appreciated, as they often disturb ongoing work [4-6]. Interruptions in these environments are also associated with reduced quality of care [7] and patient safety [8].

The intentions behind a nurse call can vary greatly, from toileting assistance or pain medication to information requests [9]. As most nurse call systems do not provide urgency clues, nurses need to decide, with sometimes limited information, whether they should abort an activity to respond to the nurse call or not. A decision that often is regarded as stressful [4, 6].

To date, limited literature exists that describes nurses' handling of nurse calls. Instead, previous research on nurse call systems investigated aspects such as patient satisfaction [10], reasons behind nurse calls [11], and attempts to limit nurse calls [9, 11]. Through ethnographical fieldwork, we previously investigated nurses' strategies in managing interruptions in the form of nurse calls [6, 12]. As a next step, the aim is to discover how a system could be designed to support these strategies.

Nurses assess their availability towards a nurse call based on a number of contextual factors, including their current activity, the relationship to the calling patient and the patient's condition [6]. A strategy employed by nurses to handle nurse calls is to hand over their patient responsibility in certain situations [12]. However, another important strategy identified in our previous studies is maintaining an awareness of colleagues' activities. The decision of whether to respond to a nurse call is highly influenced by this awareness [6].

Therefore, the main objectives in this study were to (1) co-design a system with end-users that supports nurses in maintaining awareness of colleagues' availability, and (2) to analyse the possible effects the proposed system could have on current work. Based on data from our previous studies, we developed a prototype system. The prototype was used as a trigger for further requirement elicitation and analysis in participatory design workshops [13] to achieve the study objectives.

Background

Awareness

Awareness is a central concept within the field of computer-supported cooperative work (CSCW) that is essential when one aims to support efficient coordination and collaboration among team members [14]. The perhaps most commonly used definition of awareness within CSCW is *"...an understanding of the activities of others, which provides a context for your own activity"* [15]. Schmidt discusses the problem that the notion of awareness is indeed ambiguous and that it needs to be understood as a person's awareness of *something* [16]. One relevant example would be activity awareness that is an essential part of collaboration between medical personnel in a hospital. Here, the awareness of colleagues' activities has direct influence on their own activity [17]. Further, Heath et al. discuss how awareness is achieved and sustained through social interaction that involves participants' sensitive monitoring and displaying of actions and activities [16, 18]. A key aspect is that the monitoring and displaying process can occur simultaneously as its own activity, requiring very little effort [19].

There has been extensive research into how technology could support awareness [14]. Within the healthcare domain, one

example is the AwarePhone approach that seeks to minimize interruptions by mediating context cues about the callee to the caller through the phone's address book [20]. The main focus in their study is how the mediated social awareness can enhance collaboration among health care workers who are not co-located. For example, allowing a nurse to consult a doctor more easily. Our focus, however, is to investigate how such an awareness system could be designed to support the handling of a specific type of interruption, that is nurse calls. Nurse calls differ from information requests in the form of phone calls in that the former is expected to be responded to more or less immediately, while that is not always the case for the latter.

Activity Awareness to Support Nurse Call Handling

A few years ago a new, wireless nurse call system was deployed at a Norwegian university hospital. The system allows patients to issue a nurse call by using a draw-string mounted inside each patient room. The signal is then delivered to nurses on both public displays and on wireless phones carried by the nurses. A call plan allows nurses to configure to which nurse a nurse call should be delivered first. If the primary nurse is not able to respond to the call, it can be forwarded to the next nurse. Nurses usually configure the call plan according to agreed patient responsibility. By doing so nurses' receive nurse calls on the wireless phone from patients they have the primary responsibility for first [12].

Through observations and workshops, we investigated nurses' strategies to handle nurse calls at the hospital where the above system was deployed [6]. The findings report a number of contextual factors that play a role in nurses' decision whether to respond to a nurse call in a busy situation. An important factor, however, is their awareness of colleagues' activities.

Nurses continuously monitor colleagues' activities as well as their own, in order to know who is available. Knowing that someone is available when, for example, situated in a patient room talking to an anxious patient, allows the nurse to remain focused on the task at hand, trusting that a colleague will take care of the call. Similarly, nurses prioritize their own activities based on their awareness of colleagues' activities. For example, if a nurse is aware of that his or her colleagues are busy and unable to respond to nurse calls, the nurse may not undertake an activity that will make him or her unavailable as well. Rather, the nurse chooses to remain available in order to act as a backup in responding to nurse calls for the other nurses [6].

However, it is not always the case that nurses are able to monitor colleagues or display their own activities. Nurses report that sometimes a patient visit can take an unexpected turn. In these cases, when nurses normally have not told anyone about the prolonged stay, it might be that no one is able to respond to nurse calls [6].

Methods

Research Design

To meet the first objective, to co-design a system with domain experts, participatory design workshops were held. To trigger discussion, and to demonstrate to the participants technological possibilities, a prototype was developed [21]. The prototype system allowed nurses to communicate their availability status through the wireless phone, as well as, become aware of colleagues availability when a nurse call was issued.

Mogensen and Trigg discuss how artefacts can be used to foster analysis of both current and future practice in participatory design workshops [13]. Scenarios were designed for the workshop where the prototype was used to address the second objective, to analyse possible effects of the designed technology.

Two workshops were held with nine female student nurses from five different hospital departments. All participants had at least one month of experience working at the hospital and using the wireless nurse call system. The workshops were held in a usability lab furnished as a hospital ward and videotaped to facilitate detailed data analysis afterwards. Each workshop lasted for about three hours. After an initial focus group interview, the workshops also included a role-play session, before allowing participants to reflect on their experience with the prototype in another focus group interview.

The scenarios for the role-play session were based on our previous observational studies of the system at the hospital. The scenarios aimed to replicate tricky situations where the acting nurse had to decide whether or not to abort the current activity in order to respond to a nurse call. Participants were instructed to use the prototype in the scenarios. The methodology applied was also influenced by scenario-based design, often employed in the design of collaborative systems [22], and the use of role-play in the design of mobile systems [23].

Prototype

The prototype was developed using a conceptual user interface design tool. The prototype was deployed on an iPhone and allowed users to interact with the application's different screens and menus. However, as the prototype only implemented the user interface, it was not possible to send messages between the phones. Additionally, the application did not receive nurse calls. Therefore, we configured the phones to display a nurse call before the scenario (Figure 1). Then, during the scenario, one of the researchers would play a sound that indicated that the acting nurse received a nurse call.

Figure 1 - Colleagues' statuses are displayed on the phone when a nurse receives a nurse call

In addition to displaying the room number from where the call was initiated, the prototype also displays the availability status for each colleague in the ward. The nurse can then use this information in deciding whether to reject ("avvis") or accept the nurse call ("ok"). Through the user interface, nurses can set their availability status to: available (green), busy (yellow), or unavailable (red), as illustrated in Figure 2. The idea was that a nurse could use the green indication when not occupied with anything important and is able to respond to nurse calls. Yellow indicates that the nurse is busy, but that the task is not of the highest importance. The red indicator communicates that the nurse is undertaking an important task that the nurse would not like to forsake.

Figure 2 - Nurses can be choose from three different availability statuses

Results

Availability Monitoring

When presented with the prototype, nurses' initial reactions were very positive. A nurse reflected: *"That's clever, then you see whether someone can respond to it or not, or if you have to assess responding to it yourself"*. The nurses explained that in a situation where they are occupied with another task, it relives the decision making process if they know that there are other colleagues who can respond to the call, but also that this enhanced awareness of their colleagues' availability could alter their decision to engage in an activity in order to remain an available resource. A nurse explained: *"if I see that many have set themselves to busy I would have waited, it would have been great to have an overview really"*.

This resonates with nurses' current practice of monitoring their colleagues' activities and availability [6]. The nurses reported trying to keep each other informed about activities they undertake. However, as a nurse stated, it is impossible to know where everyone is all the time. For example, nurses said if they are just bringing something from a different floor they do not tell anyone about it. They also admit that it is more difficult to keep track of colleagues' activities while inside a patient room.

Availability Displaying

Being able to display ones' availability through the system to colleagues in times where it would have otherwise been tricky to do so, was seen as a benefit. According to the nurses, this would allow them a higher degree of focus on the task they are performing. A nurse said: *"It would have been useful to be able to give a notice (.), or to lock ones phone (.), so that when you're in a situation that is difficult to leave (.), that some of your responsibility of responding to nurse calls is taken away if there are others who are able to respond during that time"*.

In the focus group discussions, nurses expressed uncertainty in how to set ones' availability status in different situations. The prototype allowed nurses to set their availability to green, yellow, or red. But, it was far from clear in what situation a nurse's availability would be set, for example, to yellow or red. When discussing how the system should behave when different statuses were set, no nurse wished to make themselves completely unavailable (or unreachable) in any situation. They rather wished to indicate that they are occupied at the moment but not completely block incoming requests. While discussing a scenario where the acting nurse was visiting an anxious patient, a nurse said: *"I would never had set myself as unavailable – that is completely unavailable, no, because if the others are busy with various things that they can't leave, then I'm able to leave a patient who is a bit anxious if I explain myself and ask if I can leave for just two minutes"*. Hence, nurses wished to remain in the "loop" even when occupied to remain aware of what was going on outside. As a nurse told: *"You can't remain an overview [of what is happening] if you're completely unavailable or blocked"*. Especially at night shifts, were there are fewer nurses working, it important that nurses are notified about a nurse call

even while "unavailable". A nurse explained: *"during the night for example (.), it isn't possible (.), then you are usually alone at the bed area (.), perhaps together with an assistance nurse"*.

One concern the nurses voiced was the extra work maintaining their status would require. Although they saw the benefit, they were afraid it would not be used or that they would forget to change their statuses. Therefore, they suggested the status of a nurse should be changed automatically whenever he or she enters and leaves a patient room. Further, it was proposed that there should be a timer, which would remind the nurses to change their availability back to green after some time.

Adaptive Notification Profile

In the deployed system at the hospital, when a nurse call is issued, nurses are notified through wall panels and the wireless phone. The wall panel where a nurse has marked his or her presence displays the room number and makes an alarming sound. The wireless phone also plays a ringtone when a nurse call is received. The wireless phone at the hospital is configured so that nurses are not able to turn the volume of the ring signal below a certain level.

In the focus group discussions it was evident that the nurses did not appreciate the rigid notification scheme. Nurses felt the ringing was too excessive, especially inside a patient room. A nurse said: *"Inside the room it is quite quiet so you don't need to have such a severe sound"*. Similarly, a nurse expressed that *"there is no point in having alarms both on the phone and on the wall"* inside a patient room. Nurses said the many alarms made it more difficult to focus on the patient they were caring for.

Instead nurses propose that the notification should be modified according to their availability status. A vibration, they explain, would be enough to make them aware of a nurse call in situations where they, for example, are busy with another patient. However, if a nurse call is not responded to by anyone after some time, nurses suggested the notification could become more persuasive. Another nurse proposed that the time the calling patient had waited for a response could be displayed together with the notification.

System Interaction and Feedback

After having forwarded a nurse call, nurses explained that the calling patients do their thoughts, making them wonder whether the patient received help or not. As this further takes some of their attention away from their current task, they said that they would wish to receive feedback, after having dismissed a nurse call, as to whether someone else responded. A nurse proposed that the room number displayed on the wall panel could change colour when a nurse confirmed that he or she will respond to the call. Another nurse confirmed: *"Yes, a type of confirmation that tells you that the nurse call you forwarded has been responded to"*.

Further, the nurses proposed that feedback should be provided to the patient that someone is on their way. The current system does not provide any information to the patient about whether a nurse has noticed their request.

During the focus group interview the nurses explained that the phones are badly suited for sterile environments and the phones should not be exposed in these situations. A badly designed user interface, which required too much attention, was also mentioned as a reason why the phones were not used. The nurses felt that interacting with the phones took too

much focus away from, for example, a visited patient. When asked how they would like to be notified about a nurse call, a nurse explained: *"To have a look at the wall-panel is not as disruptive as to pick up and look at the phone"*. Instead nurses preferred to use the wall-mounted displays to learn about a nurse call and to respond to them. It was suggested that colleagues' availability status should be displayed on public displays, to make the information accessible "at-a-glance". A nurse said: *"I think that the proposal made was very good, that the sound is turned off, and that you instead see it on the wall-panel"*.

Expected Effects

One expected effect of the new functionality the nurses discussed was that it would allow them to more fully focus on the patient they are nursing if they knew there were others available to care for a calling patient. The nurses explained that if they are aware a colleague is able to respond to a nurse call, they then do not rush away from the patient as quickly as they would otherwise.

Further, they expected the availability awareness to reduce the wait-time for patients. Although the nurses said the current system works as it is, the proposed functionality would make it more effective. A nurse explained: *"With the new functionality it would probably be more efficient and faster, five minutes for us seems like nothing, but for the patients it probably feels like forever"*. If the nurses know their colleagues are unavailable, there is no need to let the nurse call keep calling to find out whether someone is able to respond.

Similarly, nurses revealed that, even if they are not busy with something, they sometime hesitate to respond to a nurse call from a patient that is not their assigned responsibility. A nurse explains: *"It is best for the patient to be [in] contact with the same nurse as much as possible, so if she isn't busy there is no reason for me to go in there, otherwise you could just enter any room at any time"*. However, if the primary nurse for the patient is not responding and cannot be seen, nurses said they do respond to the call. Providing quick access to information about the primary nurse's availability status could therefore also reduce response times to nurse calls.

Summary of Proposed Functionalies

The following list summarizes the additional functionalities to the proposed awarenss system that were suggested by the nurses during the workshops.

- Nurse calls should not be blocked even if status is set to yellow or red so nurses can remain aware of what is going on in the department
- The notification for nurse calls should be modified according to set availability status and for how long the calling patient has waited
- Status should be set automatically when entering or leaving a patient room
- A timer should remind the nurses to update their status if it has been set to yellow or red
- Allow nurses to interact with wall mounted displays instead of the phone (monitoring and displaying availability)

Discussion

A concern raised during the workshop was the extra work required in maintaining ones' status, which also was men-

tioned as an issue in [20]. While the proposed solution to update the status automatically based on location is appealing, there is reason to be cautious when building context-aware applications [24]. Brown and Randell argue for a defensive use of context that allows users to easily correct the system when it makes an erroneous inference [25]. The system could well infer a nurse's availability based on the location, but make this inference flexible. For example, the system could automatically set the nurses status to busy (yellow) when entering a patient room. At the same time, this selection could be displayed on the wall panel inside the room and allow the nurse to change the status by pressing either a green or red button on the wall panel.

As both monitoring and displaying of co-located colleagues requires barely any effort [18, 19], the difficulty is to achieve the same awareness when designing a system to support spatially distributed team members [14]. Some degree of automatic inference of availability helps at the displayer's side, but it is important to not overload monitor with too much information, as Gross discusses [14]. In their paper, Avrahami et al., demonstrate how people often over- and under-estimate the significance of various cues when estimating the interruptibility of a person. In their study, contextual variables such as whether a person was on the phone, drinking, reading, or socially engaged were included. Similarly, another study found that people use contextual cues to merely find out whether a person is present, rather than assessing whether the person can be interrupted or not [26]. While the cues included in these two studies were more related to typical office work, it does raise the question whether such cues are beneficial when estimating whether a person can be interrupted or not? The main rationale to merely display a colour code is to lessen the effort required by the one monitoring. However, whether such an indication is correctly estimated is not addressed in this study.

With regard to system interaction, the results hint that the nurses do not prefer to pick up the phone when a nurse call is issued. Therefore, one alternative could be to present the number of available nurses along with the nurse call on a wall panel. Further, the availability information could be made easily accessible on a big screen in the hallway. Allowing nurses to change their status on the publicly available screen might also provide advantages over doing so through the wireless phone in form of reduced effort.

Scholars have argued for the need of user-centred design approaches in the development of technological systems within the healthcare domain [27, 28]. Participatory design has previously been used in the design of nursing tools [29], and a similar method was adopted in this study. The approach, which combined artefacts in the form of scenarios and a prototype, was found to stimulate participants to come up with ideas on how to design the system; system features that maybe participants would not have been able to envisage otherwise. The prototype, although an early version, allowed the participating nurses to widen their technological frame of reference [30].

The artefacts also triggered analytical discussions on the expected effects of the proposed awareness system. A short summary of these would include; faster response times to nurse calls, less noise, and allow the nurse to remain more focused on the patient. Both the reduced response time and the notification modification based on status, contributes to less noise in a department. Less noise means that nurses can better focus on their work. Also, knowing that someone else is able to respond to an issued nurse call allows nurses to more fully remain focused on the current task.

A study limitation is that all participants were nurse students with limited experience. However, the initial prototype was designed based on a thorough study of nurses work practices that included both observations and workshops with experienced nurses [6]. Another limitation is the relatively small sample size. Yet, in usability studies, for example, there is no consensus of an optimal number of participants [31]. Some advocate that five is enough, while others suggest around ten participants [32], or even more [31].

Conclusion

Through a particpatory design approach, this study has investigated how an awareness system could be designed to support nurses' handling of nurse calls in a hospital setting. Requirements for a system that is sensitive to and communicates availability information of nurses has been elicted. Further, through co-analysis with domain experts, expected effects of the co-desiged system hints at increased focus on current tasks, reduced noise, and faster response times to nurse calls.

Acknowledgement

References

[1] Ebright PR. The complex work of RNs: Implications for healthy work environments. Online Journal of Issues in Nursing 2010: 15(1).

[2] Miller ET, Deets C, and Miller RV. Nurse call and the work environment: Lessons learned. J Nurs Care Qual 2001: 15(3).

[3] Toussaint PJ, and Coiera E. Supporting communication in health care. Int J Med Inf 2005: 74(10).

[4] Klemets J, and Kristiansen L. Extended communication possibilities for nurses: Taking context into consideration. Stud Health Technol Inform 2013: 194.

[5] Deitrick L, Bokovoy J, Stern G, and Panik A. Dance of the call bells: Using ethnography to evaluate patient satisfaction with quality of care. J Nurs Care Qual 2006: 21(4).

[6] Klemets J, and Evjemo TE. Technology-mediated awareness: Facilitating the handling of (un)wanted interruptions in a hospital setting. Int J Med Inf 2014: 83(9).

[7] McGillis Hall L, Pedersen C, and Fairley L. Losing the moment: Understanding interruptions to nurses' work. J Nurs Adm 2010: 40(4).

[8] Mayo AM, and Duncan D. Nurse perceptions of medication errors: What we need to know for patient safety. J Nurs Care Qual 2004: 19(3).

[9] Torres SM. Rapid-cycle process reduces patient call bell use, improves patient satisfaction, and anticipates patient's needs. J Nurs Adm 2007: 37(11).

[10] Roszell S, Jones CB, and Lynn MR. Call bell requests, call bell response time, and patient satisfaction. J Nurs Care Qual 2009: 24(1).

[11] Meade CM, Bursell AL, and Ketelsen L. Effects of nursing rounds: on patients' call light use, satisfaction, and safety. AJN The American Journal of Nursing 2006: 106(9).

[12] Klemets J, Evjemo TE, and Kristiansen L. Designing for redundancy: Nurses experiences with the wireless nurse call system. Stud Health Technol Inform 2013: 192.

[13] Mogensen P, and Trigg RH. Using Artifacts as Triggers for Participatory Analysis. Proc of PDC'92.

[14] Gross T. Supporting effortless coordination: 25 years of awareness research. Comput Support Coop Work 2013: 22(4-6).

[15] Dourish P, and Bellotti V. Awareness and coordination in shared workspaces. In Proceedings of CSCW'92.

[16] Schmidt K. The problem with 'awareness': Introductory remarks on 'awareness in CSCW'. Comput Support Coop Work 2002: 11(3).

[17] Bardram J, and Hansen T. Context-based workplace awareness. Comput Support Coop Work 2010: 19(2).

[18] Heath C, Svensson MS, Hindmarsh J, Luff P, and vom Lehn D. Configuring awareness. Comput Support Coop Work 2002: 11(3).

[19] Schmidt K. Cooperative Work and Coordinative Practices. Cooperative Work and Coordinative Practices: Springer London, 2011; pp. 3-27.

[20] Bardram JE, and Hansen TR. The AWARE architecture: Supporting context-mediated social awareness in mobile cooperation. In Proceedings of CSCW'04.

[21] Kyng M. Designing for cooperation: cooperating in design. Commun ACM 1991: 34(12).

[22] Bardram J. Scenario-based design of cooperative systems. Group Decis Negot 2000: 9(3).

[23] Svanaes D, and Seland G. Putting the users center stage: Role playing and low-fi prototyping enable end users to design mobile systems. In Proceedings of CHI'04.

[24] Erickson T. Some problems with the notion of context-aware computing. Commun ACM 2002: 45.

[25] Brown B, and Randell R. Building a Context Sensitive Telephone: Some Hopes and Pitfalls for Context Sensitive Computing. Comput Support Coop Work 2004: 13.

[26] Fogarty J, Lai J, and Christensen J. Presence versus availability: the design and evaluation of a context-aware communication client. Int J Hum-Comput St 2004: 61(3).

[27] Ongenae F, Duysburgh P, Verstraete M, Sulmon N, Bleumers L, Jacobs A, et al. User-driven design of a context-aware application: An ambient-intelligent nurse call system. In Proceedings of PervasiveHealth'12.

[28] Moen A, and Mæland Knudsen LM. Nursing Informatics: Decades of Contribution to Health Informatics. Healthcare Informatics Research 2013: 19(2).

[29] Reeder B, Hills RA, Turner AM, and Demiris G. Participatory Design of an Integrated Information System Design to Support Public Health Nurses and Nurse Managers. Public Health Nurs 2014: 31(2).

[30] Orlikowski WJ, and Gash DC. Technological frames: making sense of information technology in organizations. ACM Trans Inf Syst 1994: 12(2).

[31] Schmettow M. Sample size in usability studies. Commun ACM 2012: 55(4).

[32] Hwang W, and Salvendy G. Number of people required for usability evaluation: the 10±2 rule. Commun ACM 2010: 53(5).

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