Sensor technologies and fall prevention
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CHAPTER 4

User driven innovation for fall prevention technology: Experiences and requirements from the perspective of nursing home staff

Nienke M. Kosse, Kim Brands, Henrietta Dale, Claudine J.C. Lamoth
Abstract

Background
User acceptance is a major determinant whether the use of a sensor system succeeds or not. Therefore, the first step in the development of a new fall prevention sensor system is to gather knowledge about the user requirements. The aim of this study was to examine the attitude of caregivers towards fall prevention technology. More specifically, we assessed the self-reported knowledge of caregivers towards fall prevention, the opinions about institutional fall prevention policy, the experiences with currently used techniques and determined the demands and expectations for new technology to prevent falls.

Methods
Four psychogeriatric wards of a nursing home participated. Qualitative participatory research (semi-structured interviews) was combined with quantitative research (questionnaire) methods to study the attitude towards fall prevention technology. Caregivers from one of the four wards, the intervention ward, were involved in the development of a new sensor system and participated in the semi-structured interviews (n=5). A questionnaire about fall prevention and sensor technologies in health care was distributed to all four wards (n=126).

Results
Caregivers found fall prevention very important. Caregivers were satisfied with the available sensor systems (bed-exit alarm and shoe chip), and the notification that was given when a high (fall) risk situation occurred. However, the current used sensor needs improvement. Requirements for a new fall prevention system proposed were: notification without delay, an automatically activated sensor system and availability for all residents. Moreover, time, education and support by management were considered important factors for the successful implementation of fall prevention systems.

Conclusion
User involvement is crucial to develop and introduce a new technology successfully. Important issues addressed as advantages and disadvantages, and demands create new ideas and optimization opportunities for technology use and development.
Introduction

The health care sector is experiencing a transformation as a result of the introduction of sensor technologies. Sensor technologies are used in all facets of health care, from monitoring vital signs in a hospital setting to facilitating independent living in the community for elderly. One of the upcoming technologies used in intramural care facilities (e.g. hospitals, nursing homes) are fall prevention sensor systems.

In intramural care institutions, both injurious and non-injurious falls are a frequent occurrence resulting in potentially devastating physical, social and financial consequences [1–3]. Psychogeriatric wards are more regularly confronted with fall incidents and consequently with a larger number of injuries compared to patients of other wards [2]. Therefore, fall prevention is an important topic in health care institutions which provide care for old adults.

The use of sensor systems to prevent falls has been introduced as an alternative for physical restraints, because physical restraints may lead to adverse events such as depression, aggression and absence of freedom, but also to a greater risk of fall-related injuries, breathing difficulties and even early death [4,5]. Due to these negative effects of physical restraints, there is a growing interest in the use of fall prevention sensor technologies.

A wide range of sensor technologies (e.g. wearable and non-wearable technologies using infra-red, position or pressure-sensitive sensors) has been developed in the last decade to reduce the number of falls and fall-related injuries in intramural care facilities. Sensors detect a change in position and might provide feedback to the patients in the form of a sound or verbal instruction, and/or alarm the nurses that a patient is getting out of bed or rises from a chair [5–7]. However, despite the fact that there are various sensor systems on the health care market, there is no consistent evidence that the sensor systems reduce falls in intramural care settings [8].

There are different reasons why sensor technologies for fall prevention may not have the desired effect. One of the possible explanations is the use of sensors that detect only a small area (around a chair or bed) and monitor one event (standing up from a chair or moving out of bed). However, elderly people fall not only in those small areas with one event as trigger. Elderly people also trip and slip in bathrooms, living rooms, hallways and gardens [2,9]. Another limitation of the currently used sensors is that they are not adjusted to the individual patient, while we know that there exists no standard patient. The individual characteristics and the severity of patient’s medical condition complicate the effectiveness of the sensor systems [10,11]. New sensor systems need to cover bedrooms, hallways and living rooms, detecting fall risk for every individual patient.

However, technological sophisticated sensors do not offer the full solution. In addition to the capabilities of the sensor system, user acceptance is a major determinant as to whether an intervention succeeds or not [7,12–14]. To date most technological developments aimed at fall prevention are technological driven. For new technologies to
be successful in clinical practise a user-driven perspective, in which users participate in the development process, might ensures that technology is compatible with the needs of the end users [15–17].

The purpose of this study was to assess the attitude of caregivers towards fall prevention, fall prevention technology and policy making. We were interested in learning more about the experiences with the currently used sensor systems from the perspective of the users, as well as the specific requirements and expected effects for a new fall prevention system.

**Methods**

**Setting**
The study was executed at four closed psychogeriatric wards of a nursing home in the Netherlands. One of the wards, the intervention ward, actively participated in the development of a new fall prevention system. On the intervention ward, with 20 psychogeriatric residents with severe behavioural problems, worked 19 nursing assistants and five nutrition assistants on a permanent basis; they were complemented with flex workers. In the present study the term caregivers is used to refer to nursing assistants and nutrition assistants working in nursing homes. The other three wards (non-intervention wards) had place for respectively 30, 31 and 32 psychogeriatric residents. On each ward 34 caregivers worked permanently. Other disciplines involved in the wards were nurses, physiotherapists, occupational therapists, physicians and ICT members.

**Procedures**

*Qualitative research - Interviews*
Qualitative research, semi-structured interviews, with the caregivers from the intervention ward was used to assess in detail their experience with currently used techniques and to specify the requirements for new fall prevention system(s).

Five caregivers from the intervention ward were invited for a semi-structured interview. The interviews were conducted in a closed office and recorded with a digital voice recorder with the caregivers’ consent. The respondents were provided with three topics to guide the depth-interviews. The depth-interviews started with questions about the working of currently used sensor systems and notification functions, followed by questions about the advantages and disadvantages of the systems and finally the requirements for a new fall prevention system were discussed. Follow-up questions were asked to deepen or clarify the answers of the caregivers. The interviews lasted approximately 45 minutes.

*Quantitative research - Questionnaire*
A questionnaire was given to the caregivers of the four psychogeriatric wards to investigate the attitude towards fall prevention and policy making, to assess the experiences of the
currently used sensor systems and examine the requirements and expected effects of a new fall prevention system.

A special questionnaire entitled ‘Caregiving’ was constructed out of two Dutch questionnaires [18,19]. The questions related to fall prevention and/or sensor technologies in health care were selected from the two questionnaires. Some of these selected questions were adapted to the nursing home’s situation. The first questionnaire used was ‘Course in fall prevention for employees in nursing homes’, designed to evaluate the influence of a fall prevention course on the knowledge of the caregivers [18]. The questionnaire asked about the degree of agreement (1 to 9) on statements regarding different aspects of fall prevention [18]. Eight statements were selected for the questionnaire ‘Caregiving’, asking about the attitude towards fall prevention (3 items), and the self-reported knowledge towards fall prevention (2 items) and fall risk factors (3 items).

The second questionnaire used was the ‘Experiences of nurses and nursing assistants with new technologies in healthcare’, designed to discover the ideas of nurses and caregivers concerning new technologies [19]. The questionnaire detects the threats, opportunities and needs that caregivers experience in using these technologies [19]. For the present study the movement and notification functions were included in the questionnaire ‘Caregiving’. The experienced effects of the used technologies and the required and expected effect of a new technology on the quality of care (4 items), amount of work (2 items) and the quality of work (3 items) were questioned. Every item was rated on a 5-point scale ranging from a negative effect (-2 or -1), no effect (0) or a positive effect (1 or 2) [19]. Additionally fourteen possible requirements to introduce a new technology were listed. Per requirement the health care worker had to indicate if it was not needed, desirable or absolutely necessary.

Four questions about the policy making of the organization concerning new technologies and involvement of the caregivers in the decision-making process were changed and added to the questionnaire in the form of a statement. The caregivers were asked how much they agreed with the statements scoring 1 to 9 [18,19].

The final questionnaire ‘Caregiving’ included 16 questions addressing the following items: characteristics of the caregivers, attitude towards fall prevention, the self-reported knowledge towards fall prevention and fall risk factors, the opinions about institutional fall prevention policy and the involvement of the caregivers in policy making, the experiences with currently used techniques, requirements and necessary conditions for using a new fall prevention device, and the effects and expected effects of current and new sensor systems on the quality of care and work.

Since three wards were not actively involved in the development of the new fall prevention system, the questions about the expectations of the new fall prevention device were excluded for those wards. Those three wards were informed about the development of the fall prevention system in a short introduction accompanying the questionnaire.
Data analyses
An inductive method of analysis was applied, in which interview transcripts were read and coded. The codes were grouped into the three pre-developed themes: the current used sensor systems, the advantages and disadvantages of the current used sensor systems and the requirements for a new sensor system.

Data from the questionnaire were analysed with IBM SPSS statistics version 20.0. Descriptive statistics (mean, standard deviation, percentage and range) were calculated for the characteristics of the caregivers on the wards. The data from the questionnaires were analysed with the Mann-Whitney U test to control for differences between the intervention ward and the wards without intervention. A p value of < 0.05 was considered statistically significant. For the items with no significant difference, descriptive statistics are presented for all wards together. The items with a significant difference are presented separately for the intervention ward and the non-intervention wards.

Ethical considerations
The study was approved by the local Ethical Committee of the center of Human Movement Sciences Groningen, University Medical Center Groningen.

Results
Qualitative research - Interviews
Interviews were obtained with five caregivers from the intervention ward, three nursing assistants and two nutrition assistants (mean age 49.4 years, range 36 - 60).

Currently used systems
Three different sensor systems (Table 4.1) were used on the psychogeriatric ward:
- a bell system, residents can ask for help with a button next to their bed, the bedroom or in the bathroom.
- a bed-exit alarm (Optiscan ®) for residents with a high risk of falling. The alarm goes off when the resident gets out of the bed.
- a shoe chip, for residents who are walking away from the ward. When a resident with shoe chip walks through certain doors an alarm is triggered.

Notifications were received on two different pagers, one for the bed-exit alarm and the bell system, and another for the shoe chip. On the small pager screen, the room number of the resident who needs assistance appears or the door number of the door where a resident is walking through. The bell system is rarely used by the residents on the intervention ward; the residents are not able to use the system because of their cognitive problems. Therefore, the bed alarm system and shoe chip alarm were further discussed in the interviews.
The currently used devices are mainly associated with positive effects. As two of the caregivers said in their interview:

‘I could not do without (the bed-exit sensor)’

‘I do not know otherwise, I’ve always worked with this system (bed-exit system) and I don’t know other systems. So for me, this is handy.’

**Advantages and disadvantages**

There are benefits and disadvantages noticed by the caregivers throughout the time the sensor systems were used (Table 4.1). The caregivers were content with the notification function of the sensor systems. The alarm goes when an intervention is needed and it is clear to which room or door they have to go. However there are also some disadvantages about the technologies. The alarm systems are delayed between the event (getting out of bed or walking through the door) and the signal given on the pager:

‘I always start to walk at the first beep, and I walk fast, but the resident is already moving through his room when I arrive. It (the bed-exit alarm) notices too late’.

Another problem is the activation of the bed-exit alarm:

‘For us it is a routine to turn on the bed-exit alarm when we put the residents to bed at night, but staff who is not familiar on the ward can forget to turn the alarm on.’

The bed-exit alarm is not available for all residents. The system is only used for the residents who have a high fall risk at night, and unfortunately it often appears that residents have to fall first before the need for an alarm is considered.

‘It would be nice if all residents were connected to a new fall prevention system. Now the choice to use a bed-exit alarm is often made after a fall incident, so when the steed is stolen, the stable-door is locked.’

Sometimes the sensors give false alarms, for example residents are not walking through a door or a sheet has fallen off the bed and causes an alarm. False alarms can cause desensitization, and this occurs especially in the early morning on the ward. During the shift change, the caregivers do not immediately react to the alarm.
Chapter 4

Requirements for a new fall prevention system

Table 4.1 lists the requirements for a new fall prevention system. The caregivers like to know which resident needs help and where on the ward they have to go. An early alarm must be provided, preferably before the high fall risk situation occurs.

‘I would almost say that if a resident is tossing and turning in his bed it must be registered’

Furthermore, the fall prevention system must be available for all residents on the ward and automatically activated.

‘It is in our routine to activate the alarm at night when we bring the residents to bed, but for people not familiar on the ward or who haven’t the routine to turn on the switch it would be useful to have it (bed-exit sensor) automatically regulated.

The support of all colleagues on the ward is required to make the introduction of a new technology successful:

---

Table 4.1 Interview outcomes: experiences of current used systems and requirements for a new fall prevention system.

<table>
<thead>
<tr>
<th>Current used systems</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bell system for residents asking for help</td>
<td>The notification ‘you know there is something wrong’</td>
<td>The alarm signal is delayed</td>
</tr>
<tr>
<td>Bed-exit alarm (Optiscan ®) for residents with a high risk of falling</td>
<td>Notification by room number or door</td>
<td>The resident causing the alarm is unknown</td>
</tr>
<tr>
<td>Shoe chip for residents who walk away from the ward</td>
<td></td>
<td>False alarms, due to:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>· blankets falling of the bed</td>
</tr>
<tr>
<td></td>
<td></td>
<td>· curtain moved by the wind</td>
</tr>
<tr>
<td></td>
<td></td>
<td>· residents walking through a door under supervision</td>
</tr>
<tr>
<td></td>
<td></td>
<td>· no cause of alarm</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The bed-exit alarm is not automatically activated</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The bed-exit alarm is not available for all residents</td>
</tr>
</tbody>
</table>

Requirements for a new fall prevention system

<table>
<thead>
<tr>
<th>Notification by:</th>
<th>Automatically activated</th>
<th>Available for all residents</th>
</tr>
</thead>
<tbody>
<tr>
<td>· location of the resident</td>
<td></td>
<td>The system needs to be supported by all members</td>
</tr>
<tr>
<td>· name resident</td>
<td></td>
<td>of the team</td>
</tr>
<tr>
<td>Early detection of fall risk</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No delayed notification</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
‘I think it is important that everyone supports and co-operates with the new system. […] If one person thinks the system is nothing for him/her and walks away, the system won’t work of course.’

**Quantitative research - Questionnaire**

The questionnaire was handed out to all 126 caregivers working permanently on the four psychogeriatric wards. Forty-two questionnaires were filled in and returned to the researchers, a total response of 33.3%. The mean (SD) age of the respondents was 41.1 (9.6) years and all the respondents were women. The characteristics of the caregivers for the intervention ward and the non-intervention wards are described in Table 4.2. There was no significant difference between the characteristics of the caregivers on the wards.

**Table 4.2 Characteristics of the caregivers who returned the questionnaire.**

<table>
<thead>
<tr>
<th></th>
<th>Intervention ward</th>
<th>Non-intervention wards</th>
</tr>
</thead>
<tbody>
<tr>
<td>Response (%)</td>
<td>70.8 (n = 17)</td>
<td>24.5 (n = 25)</td>
</tr>
<tr>
<td>Age (mean ± SD)</td>
<td>42.8 ± 9.4 (range 23-59)</td>
<td>39.6 ± 9.8 (range 20-55)</td>
</tr>
<tr>
<td>Gender, female (%)</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Working hours a week (mean ± SD)</td>
<td>20.4 ± 5.6 (range 12-30)</td>
<td>21.0 ± 8.8 (range 0-32)</td>
</tr>
<tr>
<td>Years’ work experience (mean ± SD)</td>
<td>14.5 ± 8.9 (range 0-26)</td>
<td>15.6 ± 9.1 (range 0-32)</td>
</tr>
</tbody>
</table>

**Attitude towards fall prevention and policy making**

The results of the questionnaire are presented in Table 4.3. More than 95% of respondents agreed or agreed strongly that it is important to give attention to fall prevention, 64.3% think falls are preventable in the elderly and 81% of the caregivers are already doing a lot on their ward to prevent the residents from falling. However, the caregivers are not convinced of their knowledge about fall risks and prevention. Only 47.5% say that they know what to do to prevent residents from falling, 73.9% knows the causes of fall incidents and 61.9% can list the fall risk factors on their ward.

The majority (59.5%) of the caregivers on the four wards found the policy with regard to the use of new techniques and technologies of their organization progressive. Nevertheless, the wards disagreed about the policy making and the way caregivers are involved in the decision making process. More than 82% of the caregivers on the intervention ward judged the policy of the organization with respect to the use of new techniques and technologies to prevent falls as good, compared to 50% on the non-intervention wards. The opinion about the involvement of staff in introducing new techniques and technologies differed also between the wards: 70.6% on the intervention ward felt that they were involved in the right way compared to 32% on the non-intervention wards. The largest contrast between the wards was seen in the involvement of staff in decision-making in introducing new
<table>
<thead>
<tr>
<th>Quality of care</th>
<th>Current devices (n = 42)</th>
<th>Requirements of a new device (n = 42)</th>
<th>Expectations of the new device (n = 17)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quality of care given to the patient</td>
<td>0 2.4 97.6 ++</td>
<td>0 7.1 92.9</td>
<td>0 5.9 94.1 ++</td>
</tr>
<tr>
<td>Quality of life of the patient</td>
<td>0 4.8 95.1 ++</td>
<td>0 4.8 95.2</td>
<td>0 5.9 94.1 ++</td>
</tr>
<tr>
<td>Independence of the patient</td>
<td>4.9 31.7 63.4 +</td>
<td>2.4 17.1 80.5</td>
<td>6.2 18.8 75.0 ++</td>
</tr>
<tr>
<td>Safety of the patient</td>
<td>0 0 100 +/-</td>
<td>0 2.4 97.6</td>
<td>0 0 100 ++</td>
</tr>
<tr>
<td><strong>Amount of work</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost of care</td>
<td>20.5 23.1 56.4 +</td>
<td>38.5 33.3 28.2</td>
<td>47.1 17.6 35.3 --</td>
</tr>
<tr>
<td>Number of patients that can be cared for</td>
<td>5.0 27.5 72.5 +</td>
<td>14.6 36.6 48.8</td>
<td>5.9 23.5 70.6 +</td>
</tr>
<tr>
<td><strong>Quality of work</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physical workload</td>
<td>28.6 26.2 45.2 +</td>
<td>*</td>
<td>64.7 0 35.3 -</td>
</tr>
<tr>
<td>Intervention ward (n = 17)</td>
<td>0 17.6 82.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non- intervention wards (n = 25)</td>
<td>0 0 100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>General workload</td>
<td>24.4 24.4 51.2 +</td>
<td>*</td>
<td>47.1 0 52.9 +</td>
</tr>
<tr>
<td>Intervention ward (n = 17)</td>
<td>6.3 31.3 62.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non- intervention wards (n = 25)</td>
<td>0 4.0 96.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Job attractiveness</td>
<td>9.8 34.1 56.1 +</td>
<td>5.0 12.5 82.5</td>
<td>11.8 17.6 70.6 ++</td>
</tr>
</tbody>
</table>

*significant difference (p < 0.05) between the intervention ward and the wards without intervention according to the Mann Whitney test

neg = negative, pos = positive, ++ strong positive, + positive, 0 no effect, - negative effect, -- strong negative effect
techniques and technologies: 81.2% of the caregivers on the intervention wards found that they took part in the decision-making compared to 4% on the non-intervention wards.

Experiences of the current used system
Table 4.3 gives an overview of the opinion of the caregivers concerning the quality of care, amount of work and quality of work. The current used systems have a strong positive effect on the quality of care, quality of life, independence and safety of the residents. The technology has a positive effect on the number of patients that can be cared for and the cost of care. The quality of work is for half of the caregivers positively influenced by the current used sensor systems. Although the other half of the caregivers found that the sensor systems had a negative or no effect on the physical and general work load.

The requirements to introduce the fall prevention system are shown in Table 4.4. Support from all people who are involved on the ward is necessary, including the management team, supervisors, colleagues and other disciplines involved on the ward, the technical department, the residents and their legal representatives. To make the system work, it is important to give good education to the caregivers, give them time to get used to the system and time to practice with the device.

Table 4.4 Requirements to introduce a new system obtained from the questionnaire.

<table>
<thead>
<tr>
<th>Requirements</th>
<th>Extra education in knowledge and skills</th>
</tr>
</thead>
<tbody>
<tr>
<td>Support from:</td>
<td>Self-confidence about working correctly with the device</td>
</tr>
<tr>
<td>· other members in my team</td>
<td>Time and space to get used to the system</td>
</tr>
<tr>
<td>· other disciplines</td>
<td>Good technical support</td>
</tr>
<tr>
<td>· the direct supervisor</td>
<td></td>
</tr>
<tr>
<td>· clients and/or legal representatives</td>
<td></td>
</tr>
<tr>
<td>· the management team</td>
<td></td>
</tr>
</tbody>
</table>

Discussion
In the present study we assessed the attitude of caregivers towards fall prevention, fall prevention technology and policy making. We were interested in the experiences with the currently used sensor systems from the perspective of the users, as well as the specific requirements and expected effects for a new fall prevention system.

Fall incidents are a big problem in nursing homes, especially on psychogeriatric wards. Caregivers working on a psychogeriatric ward in a nursing home strongly agree that fall prevention is necessary and that falls are preventable. However, less than 50% of the caregivers reported that they know what to do to prevent resident from falling. Making caregivers aware of the fall hazards on their ward can reduce fall incidents [20] and generate more user-driven ideas to make a highly effective fall prevention system.
Caregivers were satisfied with the available sensor systems (bed-exit alarm and shoe chip) on the psychogeriatric ward. The sensor systems gives a notification when there is a high (fall) risk situation for the residents and the message on the pager shows clearly were to go. However, there are still improvements needed. The requirements for a new fall prevention system arose from the disadvantages of the current used sensor systems. The caregivers like to be notified earlier about a high fall risk and without delay, with the location and the name of the resident, preferably a system automatically activated and available for all residents. The caregivers expect from a new system that it will increase the quality of care and the quality of life of the residents. These findings highlight the need to increase the fit between users and technology through co-creation. Technological developments need to be driven from the user’s perspective.

The involvement of users does not stop after the design phase of the product, but users have to be involved into the introduction and implementation phases [21]. Users need to start to work with the fall prevention system. However, caregivers can have a negative attitude towards technologies, poor skills and knowledge about what could be done with the available technology, which prevents them from using the technology. Therefore, identifying the barriers keeping caregivers from using new technologies could help to better design the system and to optimize education strategies and programs. When a system is developed and ready to use, caregivers need to learn how to manage the new system. Time and education has to be provided to get used to the fall prevention system and to learn how to work effectively and safely with the system [14,22–24]. Increasing knowledge and experiences with technologies will provide acceptance of using technologies [25,26]. Therefore, it is not only important to involve the caregivers in the development process of a new system but technology development and the use of technologies need to be admitted to the educational programs of students following a health care study. For the caregivers who finished their studies the use of technology must be added into the in-service training they receive. Creating optimal conditions to acceptant a technology and developing user required technologies will increase the successfulness of technology interventions into health care.

The development of a fall prevention system from a user perspective requires the involvement of users themselves [27]. Users know the advantages and disadvantages of the current used technologies and can indicate solutions and optimization opportunities for a new device. Users generate ideas from their wishes, demands and expectations for a new and innovative product. The group investigated caregivers was small and coming from a single nursing home, which makes the results less generalizable. However, this study makes clear that involvement of the users during the development process of a new technology is important. The caregivers involved in the development process were highly motivated and liked to contribute to the fall prevention system. When a health care system is developed the designer has to take into account that health care facilities differ in users’ characteristics, skills and working environment [21]. In this study the user requirements from the intended users of the new technology are examined [19].
Co-creation is recommended, where designers, managers and caregivers listen to the ideas of each other to develop an optimal working system in clinical practice [16,28].

The results of this study showed that user involvement is crucial to get a cooperative attitude from caregivers. Almost three-quarter of the caregivers from the intervention ward filled in the questionnaire compared to a quarter of the caregivers from the wards without intervention. Where the caregivers from the intervention ward felt they were involved in the organizational decision-making process about technology use and the caregivers on the non-intervention wards felt that they were not involved at all. Besides the more cooperative attitude from the caregivers on the intervention ward they were more willing to invest into a new technology when this technology would be introduced on the ward. The caregivers of the intervention ward responded positively and productively to the involvement into the development process [9]. Thus, involving users establishes a positive attitude and the willingness to invest into a new system [22].

Conclusion

Managers, designers and researchers developing and implementing new technologies into health care settings need to be aware of the user’s characteristics, wishes and demands. In the current study, nursing home staff provided information about the experiences of current used technology and the requirements and expectations for a new fall prevention system. Users addressed issues and ideas strongly related to the daily use of technologies, like the occurrence of false and delayed alarms and the wish for an automatically activated fall prevention system available for all residents. Additionally, optimal conditions, including support and education, have to be created to develop and implement a new sensor system with success.

User involvement appeared crucial to motivate caregivers to take part in research and create the willingness to invest into a new technology. The knowledge of users is essential in the development and introduction of new technologies. The next step is to monitor and evaluate the development, introduction and implementation of the new fall prevention system continually. The view of caregivers may change over time and the impact of the system may change wishes and demands.

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