(Intelligent) Technical Systems in Elderly Care: The Caregivers Perspective

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The market for (intelligent) support systems for nursing of an increasingly aging population has grown rapidly in recent years. Nevertheless, only a few of these systems have found their way into the care of the elderly. An important point, in addition to the lack of refinancing structures in the health care system, is the reservations of those in need of care and those caring for them. With our study, we tried to get an insight into the everyday care work and to better understand the attitudes of caregivers towards the use of technology in elderly care, especially with a focus on artificial intelligence. In our paper, we present the results from a contextual inquiry, interviews, and a workshop for this purpose.

CCS Concepts: • **Social and professional topics** → *Seniors*; • **Human-centered computing** → *Empirical studies in accessibility*; **Field studies**.

Additional Key Words and Phrases: Elderly care, Retirement home, Caregivers, Contextual inquiry, Workshop, Interviews, Artificial intelligence, Field studies, Technology acceptance behavior, User-centered design

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1 INTRODUCTION

A frequently mentioned wish of caregivers is that they would like to spend more time with the residents. However, complex documentation, staff shortages and the number of residents on a station are putting caregivers under enormous time pressure, while the human aspect of the job is fading more and more into the background. Especially the increasing number of residents on a station will become a major problem in the future.

The elderly population is growing rapidly and United Nations forecasts predict that by 2050 one in three Europeans will be aged 60 or over [26]. On the one hand, this will lead to an increasing need for primary care services for older people [6]. On the other hand, there will be fewer young adults to support this aging population. Elderly care is already suffering from high turnover rates, which is leading to declining care quality [13]. It should be noted that this drop in quality is directly linked to the professional burnout of nursing staff due to high workload and stress [9]. In the future, this leads to challenges for the already overburdened care and health system (in Germany): an increasing number of people with chronic illnesses and in need of care, more caring relatives for older family members in need of care and, in addition, a shortage of caregivers and an aging population [22, 24].

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We assume that technology support is able to provide a valuable contribution towards mitigating the mentioned problems. Technology support has the potential to increase the well-being and effectiveness of healthcare and nursing staff [14] as well as improving the quality of care for the elderly [20].The market for intelligent assistance systems for the care sector is growing strongly and steadily, but the use of such technologies is still very limited (in Germany). It is important to find out what leads to the low willingness to use technical, particularly intelligent systems, where concerns about the use of particularly intelligent technologies come from and how the acceptance could be increased among nursing staff and the elderly people cared.

With our study we want to make the work processes and challenges faced by nursing staff in elderly care visible in order to show starting points for the use of intelligent systems. Attitudes, reservations, willingness to support care work through technical, particularly intelligent systems, should be emphasized in order to support the target group in the future with tailored technical solutions. Therefore, we held a workshop on the subject of "care for the future" with employees from a retirement home in Germany. We then took part in a work shift in this nursing home as part of a contextual inquiry and conducted interviews on digitization in care afterwards.

Based on our results, we have developed various communication and working models that are intended to serve as part of a framework to revise an existing intelligent assistance system in a co-creation process with experts and nursing staff.

After presenting related work on the use of technology in caregiving and the technical solutions developed to support it, we describe the workshop, the contextual inquiry, the interviews and the respective results, that we clustered and evaluated it in an affinity diagram [15]. The paper concludes by discussing the results and presenting conclusions based on our findings.

2 RELATED WORK

In our research, we want to show the challenges that the work of caregivers entails and discuss whether and how they want to be supported by (smart) technology in their everyday work. Similar to Huttunen et al. [17], we analyze how care professionals perceive their work processes before ICT systems are implemented to support their work. The results of this study should form the basis for the participatory design of a new type of ICT system for nursing homes, methodically implemented in a human-centered participatory design as in [7, 12, 25].

In order to support older people in their everyday life, it is important from a nursing point of view to recognize and keep an eye on the physical and mental abilities, but also the limitations of older people [19]. The development of context-aware technical healthcare systems is therefore in great demand [4, 5, 14] and is also the focus of our overarching concern, in which such a support system is to be developed in a participatory manner. A context-aware technical assistive system can, for example, automatically track residents' activities, trigger alarms if necessary, serve to simplify communication, be used for process optimization or for documentation [17].

Especially from the point of view of process optimization, it is foreseeable that workflow systems will become a core component of assisted living in the future [8]. Optimizations can, for example, relieve nursing staff and new patient needs can be determined automatically. One of the major perceived burdens is the daily documentation work. In full stationary care in Germany, nurses spend 76.7 hours per year of electronic documentation and 62.7 hours per year of partially electronic or manual documentation for a single person to be cared for [3]. However, the transition from paper-based documentation to electronic patient records also showed that there were major difficulties in locating information and documenting new information. In addition, patients' views were inflexible, requiring long searches. Moreover, some information previously noted by hand did not fit into the formal electronic record [11]. Such difficulties, in particular,

reinforce our goal of making the user interface development process as situationally realistic and user-friendly as possible.

Bravo et al. [2] developed an information retrieval system using mobile phones and NFC technology. Information about a patient's prescription and medical condition is collected by touching a patient's NFC tag with a phone. Reducing the time spent documenting and managing information allows caregivers to focus on patients, which in turn increases the quality of care. Tentori et al. [16] evaluated a mobile and wearable activity monitor that measures patient behavior patterns. Caregivers are informed of relevant information via a mobile phone and a wearable (bracelet). Their findings suggest that such systems can improve healthcare delivery by increasing efficiency, reducing errors, and increasing awareness of patient needs. Sensors can monitor physiological and physical health using a variety of signals [1]. With time-series-based sensor data, differences in values over time can be identified. Intelligent systems can interpret this data from the sensors to assess a patient's health and well-being, make a diagnosis and decide whether further treatment or a care plan is required [19], which needs to inform the caregiver of an emergency. Klakegg et al. [18] developed a healthcare platform that aims to empower caregivers with contextual, non-intrusive, and actionable information about care facility residents on a daily basis. This information is collected through a multitude of IoT sensors strategically installed in an aged care center and accessed via an Android tablet application. The purpose of the application is to provide nurses with a better understanding of the needs of the elderly and ultimately improve the care service.

There are four factors that are significantly related to the abandonment, or conscious rejection, of technical support systems in nursing and healthcare [23]: the non-participation of users in the choice of technology; User friendliness; device performance; and evolving user needs or priorities. Technology-driven interventions need to engage end-users and their long-term needs to educate adoption. A study by Fadel et al. [10] found that while a large proportion of nurses own computers and cell phones with Internet access, just 33 percent use computer-based information systems at work. Although a large proportion of respondents indicated that they would use such technologies even if they had little knowledge of them, at the same time negative views were expressed, such as fear of loss of nursing jobs, feared costs, and increased workload for nurses.

LaRosa et al. [21] state that artificial intelligence and robotics are rapidly gaining ground in healthcare and play a key role in certain medical functions, including diagnosis and clinical treatment. In their paper, they focus on the impact of the technologies on human-human interactions and relationships in healthcare. In particular, they argue that trust plays a central role in healthcare relationships and the adoption of AI in healthcare can potentially have a significant impact on these trust relationships. AI systems in healthcare should be treated as assistive technologies that go beyond the usual functions of medical devices.

Based on previous experience, we argue that we need to focus on better understanding the workflows, the demands, but also the concerns of caregivers in order to derive how technology can support in daily activities. If this basis is in place, a dialogue between developers and caregivers must arise during implementation in order to develop a meaningful and accepted product in a co-creation process.

3 STUDY DESIGN

We split our survey into two separate studies conducted two months apart. First, we conducted a workshop entitled "Elderly care of the future". This was followed by a field study based on contextual design [15] with subsequent lead interviews. We conducted both studies in German in a nursing home in a medium-sized city in Germany. At the time of the investigation, around 80 residents lived there. We described further information on the nursing home and the on-site processes in Chapter 4.1.

The expert workshop was deliberately designed to be very broad in order to make topics visible that would not be mentioned if the focus was purely on technology and intelligent systems in particular, but which could have great relevance for the acceptance and use of technology. In the interviews after the field accompaniment, we then focused on the use of technology, especially intelligent systems.

3.1 Expert Workshop

As the first part of our investigation, we conducted a two-hour expert workshop "Elderly Care of the Future" at the nursing home. For the recruitment we were supported by the facility management in order to enable a diverse composition of the participants in terms of age, area of application/education and attitudes/experience with technology. The participants were on average 38 years old (min = 31, max = 52) and predominantly female (m = 2, f = 5). One participant also took part in the expert workshop. In terms of technology affinity and professional orientation, the participants were deliberately diverse. Among the participants were trained caregivers who work in different, sometimes several positions at the same time, e.g. as nursing specialist, facility manager, nursing service manager, residential area manager, wound expert, practice guide, quality manager and nursing manager.

The participants answered questions dealing with "care of the future" in two phases of group work. The results were presented in the plenum after each round and the groups were reshuffled. In each group work phase, we asked the participants to first write down their personal views on red (negative), green (positive) and yellow (both/neutral) cards alone on the respective questions. The participants then discussed their answers in small groups. During this discussion, participants were allowed to add, group, annotate answers and comment on their answers. At the end, the groups presented their results to the plenum.

The first group work phase was about recording the current status of the care work. The following questions were asked:

- Which aspects of my work do I enjoy most? Is there something I wouldn't want to be without in the future?
- What are the challenges/problems in the care sector? Where do I see potential for improvement?
- What are the special features of my job, especially in the Ruhr area?

The questions of the second phase focused on the future of the caregivers' profession and the use of technology to support their work. In detail, the following questions had to be answered:

- Utopia: If you could change/improve everything in your job, is there anything you would wish for?
- In which areas do you see potential/opportunities to receive support through technology? And how do you envisage this support?
- Where do you absolutely not want to be supported by technology? What risks/dangers do you see when using technology?

The expert workshop gave a first insight into the profession and allowed us to identify problems/challenges as well as positive aspects of nursing work in resident homes. In addition, the opportunities and risks for the use of technologies to support everyday nursing care were recorded from the perspective of the caring relatives. The results were condensed in an affinity diagram together with the findings from the subsequent contextual inquiry and interviews. The results also served to formulate the guidelines for the interviews.

3.2 Contextual Inquiry

In the second part of our investigation, we accompanied three researchers an eight-hour shift with three caregivers (two female, one male, aged 27 to 36 years, additional positions: practice supervisor, ward manager) on different wards of the aforementioned nursing home. Here we were also supported in recruiting the participants by the head of the facility and a nursing specialist. We could not make any further differentiation in terms of age, previous experience, etc., since we had no influence on the shift plan and the researchers took part in the shifts on the three existing wards of the facility at the same time. This approach allowed us to observe both staff and residents in their interaction and care. In our contextual observations in terms of contextual design [15, 16], we focused on identifying work processes related to activities of daily living (ADLs), basic services, and associated bottlenecks. Researchers were familiar with the background of framework development for XAI.

The caregivers were accompanied in a non-participative procedure, while we noted findings, questions and comments. Questions about activities for better understanding and to clarify ambiguities were allowed. Other questions were noted and asked afterwards.

First, the nurses received a briefing on the field study. The focus of the interview on technology to support their care work was not pointed out in order to avoid possible distortions in the fulfillment of the tasks and answering of questions. After the briefing, there was a short introduction and questions about the background and the motivation of the nursing staff to get to know each other and as an ice-breaker. Then we accompanied the work of the nurses and documented workflows, possible problem areas, interfaces and other observations on processes, thoughts and feelings. Various activities, such as basic care, were observed during the accompaniment. The field support enabled us to perceive challenges and activities from the perspective of the nurse and, for example, to empathize with stress and challenges. In addition, we got an impression of the premises and were able to document, for example, the distances covered, technical equipment, etc. and incorporate them into our working models for the framework mentioned.

3.3 Guided Interviews

In the first section of the subsequent interview, we asked questions that arose during the field support. After that, the we started the guided part to lead the conversation towards attitudes, ideas of and requirements for technical support by intelligent systems. The interviews lasted between 30 and 45 minutes, were recorded and partially transcribed afterwards. The results were clustered in the above mentioned affinity diagram together with the findings from the workshop and the contextual inquiry.

Questions within this interview included:

- For which areas/activities would you like to have more time or support?
- In which ADL-related areas could you imagine support from (smart) technology?
- How do you detect (i.e., without technology) that something is wrong with an elderly person with dementia you are not currently with (e.g., if someone has been restless and awake at night and is therefore tired during the day)?
- How do you share the information about the residents with the next shift, doctors, etc.?

3.4 Data Analysis

To create the affinity diagram, we had several virtual affinity workshops with the researchers involved. We transferred our findings to virtual sticky notes in Miro. Each note was colored, coded and assigned to the different participants (ID)

and data collection methods (W = workshop, I = Interview, C = Contextual Inquiry). The statements were noted in the first-person form as they were uttered by the participants. We clustered the sticky notes in an affinity diagram, created headings and showed dependencies. After clustering, a sorting into four major areas emerged: 1. everyday care, 2. characteristics and skills of caregivers, 3. communication and documentation and 4. technology in care.

4 RESULTS AND DISCUSSION

We have decided to briefly present the results of all four areas mentioned above, as the basic conditions and problems play an important role in the development of suitable (intelligent) systems. We do not consider a pure focus on dealing with technology to be sufficient. In addition, the areas originated from the data and were not created by us. A classification according to the origin of the findings (participants from the workshop, contextual assessment and interviews) can be seen in the affinity diagram, but is not reported here because the findings were clustered, are related and in some cases build on one another for the big picture.

4.1 Care Work

The nursing home in which our investigation took place is a fully inpatient care facility. There are three wards, and residents are not classified by illness or physical condition. There are no departments with specializations, i.e. no palliative care or dementia ward. The proportion of people with dementia is currently 60 percent. Each ward accommodates up to 27 residents, who are cared for by three nurses during the day shift. Two nurses are responsible for all 80 residents during the night shift, three room visits (10 p.m., 1 a.m. and 4 a.m.) are mandatory. Accidents can therefore only be discovered during the rounds or when the resident is still able to press the emergency call button. It turned out that a critical element in the nurses' work is the handover meeting. 15 minutes are scheduled for the shift handover for all 80 residents. It is therefore limited to the essentials and just abnormalities during the night (e.g. falls) get reported to the next shift.

The work in the nursing home is divided into three shifts: early, late and night shifts. The morning shift is generally perceived as the most strenuous shift, since basic care, medication, breakfast and lunch, going to the toilet, employment, etc. are all pending here. Prophylaxis and treatment care are included in the nursing actions. Routines are in place for all caregivers to keep up with the tight schedule, but this is often interrupted by unforeseen events. The caregivers walk long distances, since the rooms are sometimes far apart from the residents they cared for before. The caregivers know the elderly people well and adapt handling and care to their abilities and preferences. This has an impact on communication (e.g. type of language, choice of topic) as well as on the planned time for caring for the respective resident. The elderly get involved in caregiving to encourage resources and maintain skills. The aim is not to perceive the residents as deficient, but to preserve their independence.

Because of the high frequency, individual needs that only become apparent during additional visits (additional need to go to the toilet, help, trying to get out of bed, etc.) cannot always recognized immediately. The nurses noticed emergency situations when they visit the residents' rooms or when the resident presses the emergency button. However, it has become apparent that residents use the emergency call button as a bell when they want a pillow fixed or a new glass of water, even though they are able to take care of themselves. Caregivers also report that they rely on their intuition in their work to determine a resident's well-being or anticipate possible accidents.

The heavy workload is cited as one of the biggest problems and is directly linked to the large number of skilled workers that are lacking. The participants would like more time for the core tasks and the interpersonal and contact with the residents. Due to these difficulties, it is also difficult to get young people enthusiastic about this job, since poor

payment, little free time and shift work are not attractive. It is often emphasized that the older generation of caregivers has a greater problem with change and is not as open as the younger generation. Innovations and changes in care are denied, even if they would actually mean a relief. This is particularly evident in dealing with technical innovations. Older caregivers still often have no computer experience and therefore feel overwhelmed by technical innovations, but also by writing the daily documentation on the computer.

4.2 Communication and Documentation

Caregivers are required by law to keep records of patients' health care issues and plans. These records are used to assess and monitor the quality of care, but require constant data recording. The documentation is associated with a lot of "German bureaucracy" and needs the time that the nurses would like to spend with the residents and caregiving. Therefore, the documentation is often perceived as frustrating and annoying. However, the participants are aware that not only the work with the residents is relevant, but also the legal aspects of care are important and therefore all actions must be documented. Since documentation outweighs the time they spend with residents their care (C), which is essential though, because "What's not documented never happened." (I), a great need for technical support is seen here. Much is still documented on paper and later transferred to the computer. All nurses see great potential to be relieved by technical support and thus to avoid mistakes. They have a lot of ideas regarding the direct transfer of the documentation via the various interfaces and documentation systems, and automatic transfer is also mentioned again and again. Regarding to the mobility of the documentation, reference was repeatedly made to the use of tablets, which were seen as very practical. There is currently one computer per ward in the nursing room that is used by all caregivers for their documentation.

Information about residents is still passed on in personal exchange. Brief conversations about anomalies are often exchanged informally, or in the already mentioned handover talk at shift change. In general, the communication is described as "very analogue". In addition to the personal exchange, there is a care plan on each ward, where e.g. pinboards and shower codes are used to identify who will take care of which residents or has taken care of them. In addition to the ways already mentioned of being informed about abnormalities of the residents, the nurses ask for information from the residents themselves or by observing the residents. Communication with external institutions such as doctors is described as very difficult and time-consuming. "I have to coordinate every little thing with the doctors (e.g. the use of skin cream), but they often cannot be reached by phone for days, so I am not allowed to put cream on" (I).

4.3 Technology to Support Care Work

With regard to the use of technology in care, the participants in our study are very divided. On the one hand, they see the advantages of being able to use technology "technology can complement and enrich the occupational field" (I), on the other hand, they have great reservations and say that technology can only support, but not replace their work. However, the lack of trust in technology is a major challenge. The fear is that "if technology fails and emergencies are not detected" (I), trust in technologies cannot be built at all.

The caregivers stated that they see a relief through the use of technology if it is adapted to their needs. Anything that reduces the workload tends to be welcome. Some of them indicated that they are not worried about being replaced by technology, since human interaction can only be done by humans, and machines cannot form an emotional bond. Although there are reservations and uncertainty (W) about technical support systems, advantages are mentioned above

all, such as "more time for conversations and prophylaxis with residents" (W), but also "more time to take care of my own health" (I). "Already after 5 years on the job I have physical complaints" (I).

They would hope for an improvement with regard to the difficult communication with external interfaces and the transfer of information to the documentation system. The caregivers hope that the technical support will give them more time for communication, necessary prophylaxis and the promotion of resources for the residents, but also to relieve their own health.

The nurses would also appreciate more technical equipment to entertain the residents in order to improve the quality of life. The new generation of residents has grown up with technology and would like to be able to watch Netflix or access a WiFi connection for tablets. Even for residents who are already severely affected by dementia, the caregivers could imagine that robots, for example, could bring relief because they could reach the residents on a different level.

In order to get involved with the support provided by technical systems, the caregivers want to understand the system. In the case of smart systems in particular, it should be explained how the system arrives at the assessment. It is noted, however, that the carers would not blindly trust the recommendation and would prefer to measure again themselves, especially in the initial phase. Confidence would then grow over time when it becomes apparent that the assessments of the technology are also correct. However, there is still concern here regarding the stability of the technology so that there are no failures. It is also noted several times that the decisions can be influenced and that the final decision to act lies with the caregivers themselves and not in the intelligent system. Own control would give a better feeling.

As mentioned earlier, there are also some concerns about tech support and making the job easier. In general, there are reservations about the usability of the technology, especially for older or less tech-savvy caregivers, and there are concerns that there is no time to operate the systems in everyday care. It was also noted that the quality of the work can drop if there is blind trust in the technology. At some point, caregivers may no longer be able to measure blood pressure themselves and only become assistants to the technology. In addition, there is great distrust in the functionality of technical systems. For example, when the technology triggers false alarms even though nothing happened, or when it fails to respond even though, for example, a resident has fallen and the system is faulty and the caregiver does not know this and relies on the system.

A big point mentioned by all participants was that technology should not replace people. The interpersonal contact and the emotional closeness to the residents make up an important part of their work for the interviewees. The use of technology was also seen as difficult for care, because care had to be carried out from person to person. Besides naming positive characteristics for residents with severe dementia changes, it was noted that they would no longer be able to understand what would happen if a machine suddenly cared for them. The technical aspect of care must not get the upper hand. Carers don't want to become technicians and be responsible for maintenance. They want to know what they trained for and that no system can replace their expertise. They want to keep feeling needed.

They also expressed great concerns regarding ethical and data protection aspects. For example, the caregivers perceive sensor-based surveillance as an intrusion into the residents' homes, and the caregivers attach great importance to the privacy of the residents in their rooms. Ultimately, sensors would check every step taken by the resident, which was perceived as an infringement of personal rights. The nurses were also aware of bracelets that were supposed to prevent residents who had changed dementia from leaving their old people's home. They stated that, from their point of view, such monitoring would not be in order.

The caregivers have a variety of ideas regarding the possible uses of technology. So they could imagine an intelligent system that measures the composition of the stool and then says what diseases are present and medications to administer.

In addition, they would find sensors in the ground useful that would tell them if a resident had fallen, for example, so that emergencies can be identified more quickly. If this information were then communicated via a telephone or a pager, that would be very helpful, because you cannot keep an eye on all residents around the clock. "I would like to have the possibility to recognize abnormalities with one look at the system. Otherwise, something like that is only recognized by chance, during a tour, or by intuition." (I).

5 CONCLUSION AND FUTURE WORK

In this article we present our results from qualitative data collection, consisting of a contextual inquiry, interviews and a workshop with nurses of a nursing home in Germany. Our goal was to find out and understand how professional caregivers perceive their work processes without (intelligent) technological support. In addition, we focused on surveying their attitudes towards the use of technology in nursing in general, with a particular focus on artificial intelligence. The study was part of the development of a framework for co-creation of explanations, recommendations for action and the user interface of intelligent systems to support care work.

We were therefore not only able to gain an insight into the reservations about the use of technology and its origin, we were also able to gain an understanding of everyday care and the challenges. Through this combination, we have gained the basis for the development of communication models in order to be able conduct a joint design process with IT experts and caregivers. We recommend to create a better understanding on both sides, so that the development of intelligent support systems is not based on the feasibility of the technology, but on recognizing the need, even if it may not be able to be adequately expressed at the beginning without a deeper understanding of technology. Co-creation of (intelligent) technical systems in nursing should therefore be a continuous design process and not end in a requirements survey and evaluation of a developed product.

Other studies have already shown that work processes in residential homes can be intelligently supported by sensors and automated documentation. However, so that these systems can be developed according to needs and the acceptance of the solutions increases, the target group must be involved continuously in the process. In a professional field where analog notes and pinboards, fax machines and telephones face a single computer per floor, there must be an understanding of the need for change alongside the infrastructure. The same applies to the majority of the older caregivers, who are not used to working with computers, let alone smart systems. The introduction of such forms of smart work support must be accompanied in order to make the advantages of intelligent systems visible in everyday work.

The fear of being replaced and losing the humanity in care leads to many reservations. The missing points of contact with smart systems further support this concern through a lack of trust in the correct functionality. Understanding, a sense of control and trust are the cornerstones in the development and introduction of intelligent systems in care. The explainability of intelligent systems therefore plays a major role here.

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