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Nurses' Perspectives on In-Home Monitoring of Elderlies's Motion Pattern

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Abstract. In-home monitoring systems have been proposed to support aging in place and facilitate home care service. Through a qualitative approach the study explores nurses' existing challenges and perspectives of an in-home monitoring system. Results indicate that nurses base care decisions on multiple, and sometimes, unreliable information sources. However, access to information about elderlies' physical motion could support the care planning process by reducing ambiguity and raising attention. Hence, a simple and affordable system that largely relies on nurses to interpret the sensed data could bring additional value.

Keywords. In-home monitoring, homecare, nurse informatics, qualitative research

1. Introduction

The world population is aging rapidly and the number of people above 65 years of age in Europe continues to rise [1]. Cognitive decline, chronicle age-related diseases, as well as limited hearing, vision, and physical ability are all related to aging, creating a significant demand on healthcare services. To enhance healthcare efficiency and support aging in place, a multitude of ambient assisted living and in-home monitoring technologies have been proposed [2-4]. Most of these solutions have been technology driven, focusing on demonstrating technological capabilities. However, the usefulness and effectiveness of these systems from a caregiver's perspective has received less attention [5].

In collaboration with home care services provided by the city of Kokkola, Finland, the goal of the SmartHome4e project² is to design, deploy, and evaluate an affordable in-home monitoring system. Utilizing low-cost motion sensors, the system is able to monitor elderlies' in-home physical activity, such as the number of bathroom visits, physical motion, time spent in different rooms (e.g. kitchen, bedroom, living room), and the time spent outside. As an initial step of a design science research process [6], this paper reports on a study that aims to explore nurses' existing care provision challenges and whether elementary information about elderlies' motion patterns could support their work. In particular, through a qualitative approach we investigate the question; *how information about an elderly's physical motion can be utilized by nurses?*

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2. Methods

The project adheres to the design science research process model that aims to solve problems through the design of artefacts [7]. Adopting qualitative methods, the study focuses on the two first phases in the design science process, namely; (1) problem identification and motivation, and (2) defining objects of a solution (i.e. what would an artefact accomplish?).

Initially, brainstorming meetings were held with nurses and home care representatives to discuss the idea of an in-home monitoring system. Thereafter, participant observations were carried out to obtain a better understanding of the context of use and nurses' work practices. A researcher shadowed 5 different nurses at work, each occasion lasting about 3 hours. The observations yielded about 15 hours in total.

Based on the gained insight a prototype was developed and used as a vehicle to trigger discussion and reflection of current and future work practices together with nurses [8]. Semi-structured interviews were held with 9 nurses in total. Five of the nurses worked on a home care team that served elderlies living independently in two adjacent apartment buildings. The other four nurses worked on another home care team serving elderlies living in homes distributed throughout the city. During the interviews nurses were presented with the prototype and were asked to reflect on existing work challenges and whether access to information about an elderly's physical motion could support their work. Interviews were transcribed verbatim and analysed together with the observation protocols through a combined inductive-deductive approach [9].

The prototype is designed to be affordable, easy to deploy and maintain, and as little intrusive as possible. Therefore, the system consists of wireless infrared motion sensors (1 per room) and a magnetic sensor attached to the outside door to monitor the elderly's physical motion. The sensed data is sent to a central server for processing and a web application visualises the sensed data to nurses (Figure 1).

The processed data is visualised as daily physical motion information, as well as weekly and monthly views of the physical motion patterns. This provides information such as day/night rhythm, time spent per room, number of bathroom visits, time spent outside of the apartment, etc. The weekly and monthly views provide information about changes in the motion patterns over time.

Day (24h)			Night		
	3 h 30 min	Movement inside		5 h 20 min	In bed
	6 h 50 min	Outside		1 h 20 min	Movement inside
	12 times	Bathroom visits		4 times	Outside door opened

Figure 1. The prototype displaying measured information about an elderly's physical motion.

3. Results

3.1. Challenges with Existing Information Sources

Nurses continuously assess the appropriateness of the care provided and try to detect sudden changes in the elderlies' health. Regardless of any dramatic changes in well-

being, each individual care plan is evaluated twice a year and care needs are estimated together with the elderly. If relevant, whether the elderly should receive care at home or move to a nursing home is also discussed.

Usually, these assessments are based on nurses', relatives', and the elderly's stories about the elderly's well-being. The quest of finding the proper level of care is therefore also complicated by the individuals' motives influencing their story. Through observation and discussion nurses try to develop a thorough picture of the elderly's situation and ability. However, nurse care visits are often short and sometimes infrequent (a few times a month), which makes the task more difficult. A nurse said: 'we struggle to observe that they haven't slept as our visits are so short, at most 30 minutes, and the visits are often in the afternoon, so most of the time we are not aware of that'.

Further, relatives and elderlies tend to want more, or in some cases, less care than what the elderly actually needs. In one example, an elderly couple was withholding information about the husband's frequent falls. The interviewed nurse commented that '...due to fear they didn't want to tell us about the falls. They didn't want to have to receive additional care'. In contrast, nurses also mentioned that they sometimes were confronted with elderlies' asking for more assistance than needed, and even acting incapacitated whenever nurses were around. Nurses stressed that it is important to not provide excessive assistance to maintain the elderly's ability to live independently.

Many of the elderlies also suffer from memory disorders to various degrees, which also make it difficult for nurses to assess the trustworthiness of the information provided. Or as a nurse told: 'we can ask the elderlies, how are you, and then they sometimes answer us almost anything'.

3.2. Raising Attention and Providing Insight

Nurses raised a number of aspects when asked whether access to information about elderlies' physical motion could support their work. Firstly, the information could raise attention to issues of which nurses were unaware, and in this way trigger further investigation. Secondly, the information could help illuminate and clarify already known issues, but where the underlying cause is uncertain. [Table 1](#) summarizes the different aspects brought up during the interviews.

Table 1. Various issues that motion pattern information could raise attention to or further illuminate.

	Issue	Indicator
Raise attention	Urinary tract infection	Increased bathroom visits
	Digestion	Increased or prolonged bathroom visits
	Depression	Staying at home, reduced physical motion
	Wandering behaviour	Leaving home irregularly, motion during night
	Pain	Less movement, moving around in bed
	Memory disorder	Developing an irregular motion pattern
Provide insight	Tiredness and fatigue	Irregular sleeping pattern (circadian rhythm)
	Functional ability	Leaving home, moving around
	Pressure ulcer	Stays for long in a similar position
	Hypnotic drug effect	Movement during night
	Nutrition	Time spent in the kitchen, refrigerator door

Regarding the ability to raise awareness, a central issue nurses brought up was the possibility to identify wandering behaviour early on among elderlies suffering from memory disorders. Nurses told several stories of how their clients had been found outside cold, confused, and unable to find their way back, by passers-by or neighbours. A nurse told: 'last week a resident had left his home and was found outside in the morning. Someone had called the ambulance and he was taken to the hospital as he was very cold'. Nurses stressed the importance of implementing interventions early on to prevent wandering, for example, through night visits, medication, or proposing a move to a nursing home.

Nurses also discussed how a trend of reduced physical motion over a period of time could help them to become aware of important issues. Combined with bed relentlessness it could trig the question whether the elderly is in pain. Particularly, if the elderly's pain is already being managed. However, if the elderly is not leaving his/her home as frequently as before, this might also serve as a sign of depression. A nurse told: 'if he spends most of his time in the bedroom and does not leave the apartment that tells me that something needs to be done'. Further, reduced physical motion could also point to a decreased ability to function, which could be supported through more visits or implementing physiotherapy schemes.

Nurses explained that the appropriate care is specifically tailored to each individual's needs and that in the same manner information about elderlies' physical motion needs to be interpreted based on nurses' experiences, the elderly's health history etc. A nurse mentioned a client that was developing a pressure sore due to sitting still for long periods. Due to that elderly's situation the nurse suggested her client to lay down more often rather than, e.g. a physiotherapy intervention.

It became evident that nurses would not rely solely, or mainly, on information captured through sensors when considering care issues. A nurse told: 'we wouldn't rely completely [on physical motion information], I'd interview, ask, and listen as well of course'. However, nurses thought the sensed information could allow them to catch changes in elderlies' well-being earlier. As a nurse explained: 'for those that we visit less regularly it would be beneficial, those that are still in good shape. If there is a sudden change, we could find out earlier. Parkinson's and Alzheimer's disease have these degradation phases'. Further, the information could also support nurses' work through reducing uncertainty about ambiguous issues. Nurses told that if an elderly is looking more fatigued than usual, discovering an irregular circadian rhythm could help explain the issue. Interventions could be implemented such as activating the elderly in the evenings so that he/she does not go to bed too early.

4. Discussion and Conclusion

There is a great variety among the functional capabilities and health conditions of the elderlies served by the home care service teams included in this study. A central issue for nurses is to provide appropriate and timely care according to each individual's needs. The nature of the information sources used in care planning and assessment complicates nurses' work, which often involves detective work and collaboration, requiring problem-solving skills to identify the appropriate level of care.

The results indicate that even straightforward information about elderlies' physical motion gained through sensors can provide valuable insight to the care planning process. Either by raising awareness to a previously unknown issue or by illuminating

already existing, unsolved issues. Hence, comparing the measured information with existing information sources nurses could develop a more complete picture of the elderly's condition and abilities.

However, the results also demonstrate that the measured physical motion needs to be interpreted individually and that a similar motion pattern might not have the same meaning or implications for all elderlies. Rather, nurses' experience, knowledge, and previous interactions with the elderly and their relatives, is essential in interpreting the measured data correctly.

Despite previous efforts to design technically capable in-home monitoring systems [2], the technology readiness for such systems is still considered low [4]. The cost is also a major obstacle for these systems to become widespread [10]. Complex systems, involving a wide range of sensors, further aggravates the technology's maturity and cost. However, our results indicate that nurses can benefit even from a rather simple and affordable system that provides insights to elderlies' motion patterns.

Block et al. [11] highlights the potential of monitoring physical activity for healthcare purposes. However, the authors also conclude that effort is needed to ensure that the measured data is useful to healthcare workers. We argue that a user-centric approach is instrumental in designing cost-effective monitoring solutions that provide valuable, and good enough, information to nurses' work. Gaining an understanding of the context of use through ethnographically inspired methods and involving nurses early in the project has helped us to focus the development of the monitoring system on issues that are important to nurses' work. Further development and evaluation of the monitoring system and its user interface is considered as future work.

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