A qualitative survey on challenges and use-cases for robotic assistants in nursing care

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Abstract— Nursing care robotics applications address one of the biggest humanitarian challenges of the future. Shortages of nursing staff and a growing need for nursing care due to an aging population require innovative technological solutions. However, a significant effort has to be made to achieve acceptance of such solutions, both from patients and caregivers. In this extended abstract, preliminary results of a qualitative survey of nursing care professionals on challenges and requirements for robotic assistants is presented. Specifically, six assistance scenarios are detailed where care professionals see the most benefit of such assistance. These scenarios serve as a guide for further exploratory development within the German federal Innovation Center of nursing care (Pflegeinnovationszentrum, PIZ).

I. INTRODUCTION

Ensuring care is one of the biggest humanitarian challenges of the future. The use of new technology is a promising way to counteract the otherwise expected shortage of nursing staff and increase of patients requiring care with innovative approaches grounded in robotics and human-technology interaction. In recent years, many innovative technological developments have been promoted in the care context. Their integration into nursing everyday life has so far only been very selective.

As a general problem of engineering-driven solutions, it often turns out that application conditions in nursing were not adequately reflected in the development of technology. As a result, caregivers and patients reject the implementation of innovations in their everyday life. Another possible cause of problems is a lack of technical qualifications in nursing practice that is necessary for the use of innovative technologies. The benefits and challenges of new solutions in the field of human-technology interaction used in nursing care have so far only been studied superficially or sporadically.

This shows that systematic research approaches are needed to adequately include caregivers, care patients and the conditions of use - but also ethical and legal issues - when developing new solutions and implementing them in nursing practice. Context-specific conditions in different supply settings have to be considered.

This is the research and development focus of the project PIZ (Pflegeinnovationszentrum, Innovation Center of nursing care), funded by the Federal Ministry of Education and Research (BMBF). The goal of PIZ is to analyze needs in nursing practice, evaluate available but also research and develop new nursing care technology, as well as developing

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Fig. 1. An ideal scenario: Robots cooperate with the care professional and patient in an intuitive way. This is the vision of the robotics efforts of the German federal nursing care innovation center.

qualification programs while incorporating considerations on ethics and responsibility in the entire process. PIZ is funded within the "Bringing Technology to the Person" initiative [1], which focuses on integrated technology development with priority on use-cases and users. The technology being developed is intended to support and relieve the nursing staff, however, as shown in Fig. 1.

PIZ follows a rigorous participative design and development methodology. As a first step towards useful and accepted robotic assistance systems, promising scenarios for robotic assistance were to be identified. This paper presents the initial results of a qualitative exploratory survey of initial use-cases among care professionals in Germany.

II. RELATED WORK

There are few authors who address an analysis of tasks applicable for robotic assistance systems in nursing care. Some of them consider only general requirements on the robotic system [2]. Others investigate the possible applications of mobile, autonomous service robots [3], [4], [5], [6], [7], [8]. Chen and Kemp [6] investigate the question which activities are often performed by caregivers and how much they enjoy these activities. However, the question whether or not the task is automatable or if caregivers would like the task to be performed by a robot is not addressed.

III. Survey

In order to explore the needs of professional care givers and their impression for useful robotic assistance, a small but diverse group of nurses was interviewed. A total of six nurses participated in the exploratory survey. The participants work in outpatient care (two), outpatient intensive care (one), inpatient intensive care (one), nursing management of a hospital (one) and nursing training (one). This allows anecdotal conclusions, which nevertheless capture a varied pool of expertise and practical circumstances. The interviews were conducted informally and analyzed qualitatively.

IV. Identified Care Activities

Preliminary results of this exploratory survey find that care professionals would like assistance with and would accept robotic assistants in the following activities:

- Re-attachment of a wet nose
- Take care of cables and hoses, as well as correcting their position if necessary
- Handing care utensils
- Picking up personal items that have fallen out of bed and hand them to the patient
- Give the patient the water bottle/glass
- Support in positioning the patient during activities in and around the bed

The activity *Re-attachment of a wet nose* involves putting an artificial nose back on the tracheal cannula for ventilated patients. Artificial noses often fall off by coughing. Replacement is possible with one hand. However, it is important that this is done promptly, as the artificial nose moistens the patient's breathing air. In a setting where multiple patients are under the care of a single caregiver, this may be a problem.

In the activity *Take care of cables and hoses, as well as correcting their position if necessary*, the robotic system should monitor the trajectories of hoses and cables connected to the patient. If they are under too much tension, there is a risk of them tearing off the patient and injuring him or her. Also, the cables and hoses may get tangled if the patient moves. In this case, the robot should intervene and reposition the cables and hoses.

The activity *Picking up personal items that have fallen out of bed and hand them to the patient* involves detecting that a patient has dropped personal belongings such as a pen, their magazine or the like out of their bed and autonomously picking them up again without having to call a nurse.

The *Give the patient the water bottle/glass* activity is very similar to the previous one. Here the patient should be able to have the system serve a glass or bottle of water autonomously, as shown as an example in Fig. 2. The drink may be stored on the bedside table, for example, but not within reach of the patient. This often happens because bedridden patients have limited mobility.

The activity *Support in positioning the patient during activities in and around the bed* requires securing the position of the patient where he or she was placed by the nurse. This could be used for example in a bandaging task, for changing

Fig. 2. Example scenario of a robot serving water.

bedsheets, or inspection of wounds. Usually, a second nurse is required for this activity, but often it is hard to find someone to fill this support role even in a hospital. This use-case seems to be the most promising to tackle first, as it has a large potential impact on both care efficiency and physical relief for the caregiver.

V. Exemplary Use-Case Analysis

As an example for further use-case analysis, we focus on the activity *Support in positioning the patient during activities in and around the bed*. This task would be performed several times a day by the system, since a large number of nursing activities are supported by it. A more thorough use-case analysis of all identified activities will be subject of future work.

One important use-case of this activity is securing the patient lying on the side. This is done frequently by the caregivers to perform cleaning tasks, reapply bandages, or change bedsheets. This use-case is dubbed *Patient lying on the side for activity in bed (on the patient)*.

First, the user scenario is considered, as shown in the Fig. 3. The current regular procedure of the activity is as follows [9]:

1) Patient turns to side or is turned by the nurse to the side
2) Patient stays on the side or is secured by a nurse or positioning aids on the side
3) Nursing staff carries out the task

This use-case as depicted in Fig. 3 offers the main assistance potential in the step *Stabilize patient on the side*. The patient can not usually hold him/herself on the side without help, thus either external positioning aids or manual stabilization by the caregiver is necessary. Positioning aids, such as shaped cushions, usually impair the task which made the repositioning of the patient necessary. Finally, manual stabilization at the very least costs a hand which would be useful in the final task, and is usually quite strenuous.
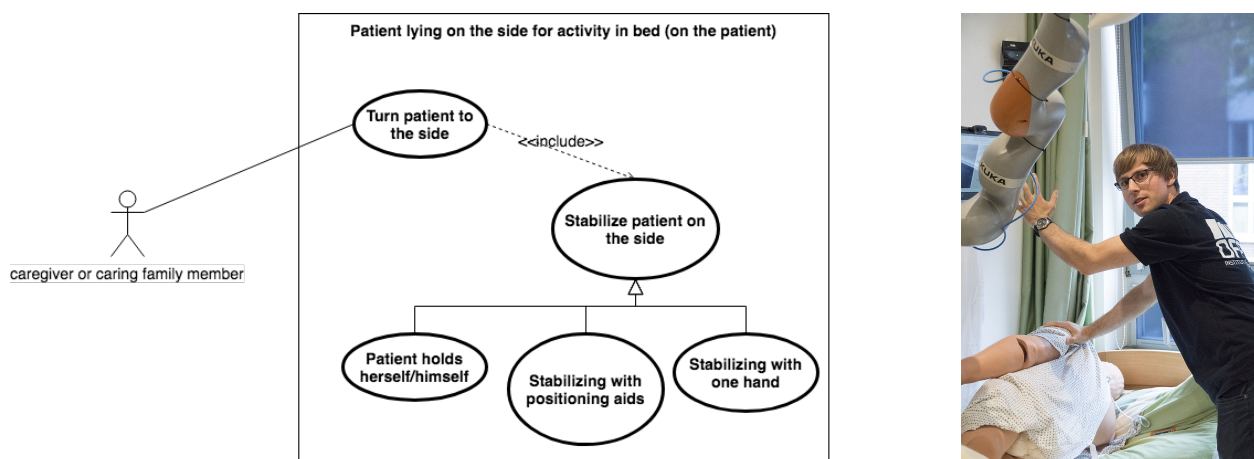
Fig. 3. Left: Example use-case digram for *Patient lying on the side for activity in bed (on the patient)*. Right: First demonstrator for this use-case in the Living Lab IDEAAL for home care at OFFIS.

This scenario requires a robotic assistance system which can exert enough force to stabilize the patient. A simple start command by the caregiver or an action recognition system could trigger the start of the assistance task. The assistance system must be able to recognize the patient posture, identify a suitable stabilizing grasp, and perform the stabilization.

It is important that assistance is provided quickly from the moment the caregiver requests assistance or such intent is recognized. Responses by care professionals indicate that the caregiver must not get the feeling that he or she has to wait for the system. It is important for the patient that the stabilizing grasp of the assistance system is no more unpleasant than it would be by a human being.

Fig. 3 shows an early prototype assistance system for this use-case on the right.

VI. CONCLUSION

Nursing care is a prime application of close human-robot collaboration and will become very important as demand increases. Acceptance by the care professionals and patients is key, so the respective groups need to be involved in designing corresponding robotic assistance systems. This extended abstract presented preliminary findings from an exploratory needs analysis survey among nursing care professionals from varying disciplines. Specifically, six scenarios are identified and detailed, where care professionals see the most impact of robotic assistants. These scenarios serve as a guide for further research and development efforts.

In future work, a more in-depth use-case analysis of the identified scenarios is planned. A demonstrator for a specific use-case in the last mentioned scenario was already realized and will be evaluated by care professionals.

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