Challenges of Trustable AI and Added-Value on Health
B. Séroussi et al. (Eds.)

doi:10.3233/SHTI220619

# The First Introduction of Social Robotics in Rehabilitation Care

Marian HURMUZ[a,b,1], Stephanie JANSEN-KOSTERINK[a,b], Ina FLIERMAN[c], Behrouz FARD[c] and Lex van VELSEN[a,b]
[a] *eHealth department, Roessingh Research and Development, The Netherlands*
[b] *Biomedical Signals and Systems Group, University of Twente, The Netherlands*
[c] *Roessingh Center for Rehabilitation, The Netherlands*

**Abstract.** Can you imagine to receive treatment through a robot? When talking about the future of healthcare, this is the vision many people have. Currently, the predominant role of social robots in care is entertaining patients. However, this does not have an impact on care process itself. In this paper, we focus on defining use cases other than merely keeping patients' company by implementing a Pepper robot in inpatient rehabilitation setting, and expand upon usability testing the use cases. Our findings showed that, to ensure sustainable implementation of social robots in care organizations, we need excessive collaboration with the target population.

**Keywords.** Social robots, rehabilitation care, use cases, usability

## 1. Introduction

"It is 2040, Hannah (an inpatient patient) has an appointment planned today with Robin (a social robot). Robin helps Hannah with treating her chronic pain." When people think about the future of healthcare organisations, it often includes robotics [1]. Looking at their current use with healthcare systems, we see that there is a limited availability of social robots with actual on-site tasks and responsibilities. A well-known example of a social robot is Tessa. Tessa is a small flower pot which can, for instance, remind older adults of appointments, meals, daily activities [2].

However, most social robots in healthcare are currently used for entertaining patients and keeping them company [3]. In this kind of use, the added value of the social robot will not be directly linked to the core activity of the organisation in any meaningful way. Though social robots may provide patients with some entertainment and company, there may be much to be gained by, despite aiming to entertain patients and have social interaction with them, also aiming to relieve the workload of healthcare professionals (HCPs). Rehabilitation care has been recognized as a promising setting for the application of social robots [4]. Within the SCOTTY project, we will study whether rehabilitation care is indeed a promising setting for social robots. We used the co-design method to define use cases in conjunction with the target population. The aim of this paper is to describe the use cases defined for a social robot in inpatient care setting, and to show the first results of the usability testing of its implementation.

[1] Corresponding Author, Marian Hurmuz, eHealth department, Roessingh Research and Development, Roessinghsbleekweg 33b, 7522 AH, Enschede, The Netherlands; E-mail: m.hurmuz@rrd.nl.

## 2. Methods

In the SCOTTY project (DIH-HERO TTE, grant No 825003), we will implement the Pepper robot [5] in a rehabilitation centre. In this paper, we present our methods and results in two parts: the development of the use cases and its usability testing.

### *2.1. Use cases*

For defining the use cases for the Pepper robot, we started with identifying the views of persons admitted for inpatient rehabilitation in Roessingh Center for Rehabilitation (RCR), and HCPs working at RCR about the Pepper robot through questionnaires. With these questionnaires, we identified the attitude towards robots, the intention to use the robot, and the tasks the robot could perform. The results of these questionnaires were analyzed and were the main input for two co-creation sessions to define the use cases. The first session focused on establishing the general functionalities. The second session focused on the roles of Pepper and the use cases. As rehabilitation medicine is a multidisciplinary field, a diverse group participated in the co-creation sessions: nurse, nurse in training, rehabilitation physician, innovation manager and researchers of the SCOTTY project. Finally, after both co-creation sessions, the outcomes were shared with the technical developers within the project to implement the use cases.

### *2.2. Usability study*

After implementing the use cases within the robot, a usability study was conducted among technical experts, nurses (in training) and patients. This study did not require formal medical ethical approval (CMO Arnhem-Nijmegen file number: 2021-12988). The main outcomes were: usability performance metrics (i.e. task completion rate, time and satisfaction) and usability issues. Participants received pre-defined tasks to perform with Pepper. Patients received other tasks than the experts and HCPs. The tasks of experts and HCPs were: (1) Open the Scotty application, (2) Sign in, (3) Synchronize the newest agenda in the calendar, (4) Complete the vital functions questionnaire, and (5) Complete the fluid balance questionnaire. The tasks for the patients were: (1) Complete the USER-P self-report questionnaire, (2) Perform the following physical exercise: ‘hip stretching in prone position’, and (3) Play the solitaire card game for 1 minute.

During the usability tests, the think-aloud procedure was used (i.e. participants were encouraged to share their thoughts). The usability tests were voice- and video-recorded to gather the usability issues. These recordings were transcribed and analyzed. Furthermore, during the tests the researcher took notes of two of the usability performance metrics: task completion and time. After performing each task, participants completed a questionnaire to assess the third performance metric: task satisfaction.

## 3. Results

### *3.1. Use cases*

A total of 13 spinal cord injury patients and 23 HCPs completed the questionnaire. In both groups, more females participated (54% of the patients and 87% of the HCPs), with a mean age of 61.3 (SD=17.8) in the patient group and 38.7 (SD=13.5) in the HCP group. Both groups had a positive attitude towards using robots and a positive intention to use robots. On a scale from 1 (negative) to 5 (positive), patients' attitude was scored with a mean of 3.7 (SD=0.8, range=2–5), and HCPs' attitude with 3.7 (SD=0.6, range=2.3–5). On the same scale, patients' intention was scored with a mean of 3.8 (SD=1.0, range=2–5), and HCPs' intention with 3.6 (SD=0.7, range=2–4.7).

Patients were most positive about completing questionnaires an playing games with the Pepper robot. HCPs were most positive about using the Pepper robot for playing games with patients. Table 1 shows these results.

**Table 1.** Percentages patients and HCPs positive about conducting particular tasks with Pepper robot.

| Tasks Pepper | % patients positive | % HCPs positive |
|---|---|---|
| Completing questionnaires | 85 | 70 |
| Conducting physical exercises | 54 | 74 |
| Playing games | 85 | 92 |

During the two co-creation sessions, the outcomes of the questionnaires were discussed. Based on these sessions and the technical feasibility, the co-creation group (HPCs and lead researchers) formulated four potential roles for the Pepper robot. For each of these roles, different use cases were defined. The roles and final use cases are shown in Table 2.

**Table 2.** Use cases defined for Pepper for four different roles, based on questionnaires and co-creation sessions.

| Nurse's aid | Physical therapist's assistant | Companion | Host |
|---|---|---|---|
| To note and store routine vital signs (e.g. temperature, blood pressure, pulse rate etc.) ( | To remind patients to perform their routine exercises | To play a game with the patient | To provide general information of the health care facility and care process |
| Facilitate self-report routine questionnaires and store outcomes | To show patients their training videos | To read a book with the patient | To perform simple evaluation questionnaires |

## 3.2. Usability study

A total of 12 adults participated in the usability study. Four experts participated, of which three were female and their age range was 20-27. Three nurses participated, all female aging from 19 to 50. Five patients participated (3 males, 2 females) with an age range of 19 to 77 years.

Looking at the different tasks the participants had to complete, the tasks considering completing questionnaires, were difficult to complete for all roles. Furthermore, the experts had trouble with completing the sign in task. All five experts used the wrong sign in card for this. See Table 3 for an overview of the usability metrics.

**Table 3.** Usability metrics of each task divided into the three roles: technical expert, nurse, patient.

| Role | Task | % (rate) task completion | Range task completion time | Range task satisfaction* |
|---|---|---|---|---|
| Technical expert | 1: Open Scotty app | 75 (3/4) | 8 – 10 sec | 3.0 – 6.3 |
| | 2: Sign in | 0 (0/4) | X | 5 – 5.3 |
| | 3: Synchronize agenda | 100 (4/4) | 15 – 21 sec | 5.3 – 6.0 |
| | 4: Vital functions | 50 (2/4) | 179 – 228 sec | 1.3 – 5.7 |

| | | | | |
|---|---|---|---|---|
| | 5: Fluid balance | 75 (3/4) | 147 – 200 sec | 4.3 – 6.0 |
| Nurse | 1: Open Scotty app | 100 (3/3) | 9 – 12 sec | 5 – 6.7 |
| | 2: Sign in | 100 (3/3) | 19 – 69 sec | 4 – 4.7 |
| | 3: Synchronize agenda | 100 (3/3) | 12 – 20 sec | 5.3 – 7.0 |
| | 4: Vital functions | 33.3 (1/3) | 166 sec** | 1.0 – 6.0 |
| | 5: Fluid balance | 66.7 (2/3) | 141 – 163 sec | 1.0 – 6.7 |
| Patient | 1: USER-P | 0 (0/5) | X | 1.0 – 3.3 |
| | 2: Physical exercise | 100 (5/5) | 75 – 248 sec | 3.0 – 7.0 |
| | 3: Solitaire game | 100 (5/5) | 77 – 100 sec | 4.7 – 7.0 |

*Task satisfaction measured on a scale from 1 (not satisfied) to 7 (satisfied)
** N=1, so only one task completion time

Regarding the usability issues, the nurses experienced most issues (N=17), followed by patients (N=15) and experts (N=14). Table 4 shows the number of issues found among the three groups divided into severity categories. We focus only on the critical issues, as these are the ones that have to be solved before implementing the Pepper robot.

**Table 4.** Number of usability issues (divided into three severity categories: minor, serious, critical) per role.

| Usability issues severity | N issues among technical experts | N issues among nurses | N issues among patients | N issues among all roles |
|---|---|---|---|---|
| Minor | 6 | 3 | 6 | 15 |
| Serious | 4 | 10 | 5 | 19 |
| Critical | 4 | 4 | 4 | 12 |
| Total | 14 | 17 | 15 | 53 |

Among the experts and nurses the same critical issues were identified. Regarding the critical issues identified by patients, one issue is shared by nurses and experts. That issue is that when completing questionnaires, it is unclear what kind of answer the Pepper robot is looking for. When users need to sign in (task 2 for experts and nurses), they have trouble finding the right button to open the sign in page. The icon used for that, was not recognized as a sign in button, except for one expert. Furthermore, when wanting to open a questionnaire, the QR code from the patient needs to be scanned. But among both experts and nurses it was unclear which QR code was the patient's. This critical issue was observed in both task 4 and 5. The last critical issue identified by experts and nurses for task 4 and 5, is that it was unclear whether the user had to wait with giving his/her answer to the Pepper robot until its blue lights turn on. This was frustrating for them as they had to repeat themselves multiple times. The three remaining critical issues that were identified only by patients and occurred all in task 1. When opening a questionnaire, they had to scan their QR code, but (1) it was unclear that they had to scan something, and (2) if they knew they had to scan their QR code, they did not know how to scan the code. Finally, when answering the questionnaire, it was unclear whether they had to give the answers out loud, or need to type in the response. This last critical issue did not appear among all patients – bear in mind that not all patients could even open the questionnaire – but among the ones where it did, it took too much time to be able to complete the task.

## 4. Discussion

We defined four roles for the robot, each with use cases. By actively involving the target population, developers can program a robot that better fits the end-users' needs.

After reaching an agreement on the use cases for Pepper within the SCOTTY project, the usability tests showed us that there are some critical issues that need to be solved. Conducting usability tests with social robots is a prerequisite before implementing such a device in a rehabilitation centre. With usability tests, we can assess our preconceived assumptions in practice, eliminate (unforeseen) errors and improve users' satisfaction with the system. When a system has too many errors, it irritates users, and users will discontinue their use [6,7]. The usability issues we encountered in our study will be solved by improving the technology and by educating users before implementation.

In conclusion, we propose that by using co-design for use case development for a social robot involving the target population, and by usability testing the robot among the target population, the implementation of such a robot will experience less difficulties. Of course, it is essential to keep evaluating the robot during the implementation stage and to keep improving the robot to reach sustainable implementation. After months of developing use cases, implementing them in the Pepper robot and testing the robot in the SCOTTY project, we have now arrived to the stage of final improvement and actual implementation in RCR. During this stage, we will continue to monitor the feasibility and added value of our social robot as experienced by HPCs and patients.

## Acknowledgements

We want to thank the team of Bluecompanion for their work with the robot, Lisa Boerrigter and Marleen Nijenhuis for their help with developing use cases, and students from Saxion's Smart Solutions Semester for their help with the usability tests. This study was supported by the SCOTTY project (DIH-HERO technology transfer experiment), funded by EU's Horizon 2020 research and innovation program (No 825003).

## References

[1] Davies N. Can robots handle your healthcare? Eng Technol. 2016 Oct;11(9):58–61.
[2] Vilans. Maatschappelijke Businesscase Dagstructuurrobots. 2020 [accessed 2022 Jan 3]. Available from: https://assets.website-files.com/5f96c0f3619f62286b45df33/600952ce4b478b4b1038f67b_maatschappelijke-businesscase-dagstructuurrobots.pdf.
[3] Aymerich-Franch L, Ferrer I. Socially assistive robots' deployment in healthcare settings: a global perspective. arXiv Prepr. 2021;arXiv:2110.07404.
[4] Wolbring G, Yumakulov S. Social Robots: Views of Staff of a Disability Service Organization. Int J Soc Robot. 2014 Mar;6(3):457–68.
[5] Softbank Robotics. Pepper the humanoid and programmable robot. [accessed 2022 Jan 6]. Available from: https://www.softbankrobotics.com/emea/en/pepper.
[6] Marien S, Legrand D, Ramdoyal R, Nsenga J, Ospina G, et al. A User-Centered design and usability testing of a web-based medication reconciliation application integrated in an eHealth network. Int J Med Inform. 2019 Jun;126:138–46.
[7] Wu D, Moody GD, Zhang J, Lowry PB. Effects of the design of mobile security notifications and mobile app usability on users' security perceptions and continued use intention. Inf Manag. 2020 Jul;57(5):103235.