Advances in Informatics, Management and Technology in Healthcare
J. Mantas et al. (Eds.)

doi:10.3233/SHTI220758

Chances and Risks of Using Robotic Assistance Systems in Early Neurological Rehabilitation: A Qualitative Analysis

Ann-Kathrin WAIBEL[a,1], Felix HOLL[a,b], Walter SWOBODA[a] and Marina FOTTELER[a,c]
[a] *DigiHealth Institute, Neu-Ulm University of Applied Sciences, Neu-Ulm, Germany*
[b] *Institute for Medical Information Processing, Biometry, and Epidemiology, Ludwig Maximilian University of Munich, Munich, Germany*
[c] *Institute for Geriatric Research, Ulm University, Ulm, Germany*

Abstract. Robotic assistance systems offer new therapeutic perspectives for patient mobilization. This work aims to investigate the chances and risks of robotic assistance systems in early neurological rehabilitation. Nine professionals working in physiotherapy and nursing were interviewed on their opinion on robotic assistance systems. The experts were recruited in three different clinics, one of which has already established robot-assisted rehabilitation. 171 individual codes were extracted from the interviews. Based on the professionals' statements and the literature, the most significant added value of robotic assistance systems is seen in the expected relief of employees. The study results and the literature confirm the potential of robotic systems for early neurological rehabilitation.

Keywords. Robotics, neurological rehabilitation, early mobilization, gait trainer

1. Introduction

In Germany, around 250,000 patients are treated for stroke and consequential neurological damage every year. Immediately after the acute treatment, stroke patients' enter early neurological rehabilitation, also called phase B rehabilitation [1]. Early neurological rehabilitation has been proven to minimize lasting damage and increase patients chances for a rapid recovery [2, 3]. Patients in this stage require intensive monitoring as they are often still unconscious, ventilated, and motor and cognitively impaired [4]. A basic therapeutic approach is to mobilize the patient's lower limbs to shorten the time to first standing [5, 6]. These tasks can impose a physical burden on the staff, as the patient usually cannot participate fully [7]. The complex field of neurological motor rehabilitation where frequent repetition of movements is key is ideal for implementing robotic assistance systems. Similarly, to innovations in other areas of health care, the use of robotics in care and therapy can be challenging due to a lack of acceptance. For this and other reasons, the possibilities of robotics are only partially exhausted at this point [8]. Our study uses a qualitative approach to investigate the

[1] Corresponding Author, Ann-Kathrin Waibel, DigiHealth Institute, Neu-Ulm University of Applied Sciences, 89231 Neu-Ulm, Germany; E-mail: ann-kathrin.waibel@hnu.de.

chances and risks associated with using a robotic gait trainer used in early neurological rehabilitation. Under professional observation, the gait trainer allows mobilization of the lower extremities and gradual verticalization with individual settings. Hypothesis one (H1) states that using a robotic assistance system contributes to a reduction of the workload of therapeutic and nursing staff. Hypothesis two (H2) states that the chances of using robotic assistance systems outweigh the risks.

2. Methods

Existing evidence was reviewed and an interview guide with five questions was created. In a pretest, three sample interviews were conducted with nurses to check the length and quality. The interview guide consists of an opening question on the use of robotics in the workplace, followed by two questions focusing on robotics' potential impact, opportunities, and risks. Two additional open-ended questions were asked at the end for further insights. Interview participants were recruited from three hospitals A, B, and C. At hospital A, the neuro center is one of the core departments. Clinic B is currently establishing a critical patient center for early neurological mobilization and plans to purchase a robotic gait trainer. Clinic C, located in a more rural area in southern Germany, is a specialized facility for severe and complex neurological conditions and already works with different robotic systems. As early neurological rehabilitation is an interdisciplinary field, experts from therapy and nursing were interviewed. Interviews were conducted face-to-face or via telephone in January and February 2020. Interviewees were informed about the study and introduced to the topic at the beginning. Written consent was obtained from each participant. The interviews were conducted in German.

Interviews were recorded transcribed with the software 'F4Transcript'. Interview data were analyzed with the software MAXQDA using qualitative content analysis [9]. Two persons independently translated the selected quotes from German into English, and discrepancies, if noted, were discussed. If necessary, a third person was consulted.

3. Results

Nine interviews, eight face-to-face and one via telephone, with three nurses, nursing assistants, and physiotherapists, respectively, were conducted. Five of the respondents were female, and four male. Using a search grid, 171 codes were subdivided into categories. Statements on robotics and quotes on general digitization in healthcare were also considered. The statements were divided into three main categories: therapy/nursing, social/ethics, and economy. Most of the statements related to the therapy/nursing category with 68 mentions, 61 statements were assigned to the social/ethical aspects, and 42 statements pertaining to economic effects. In the first category, respondents acknowledged the potential of the devices for an improvement of patient care. While experts currently lack expertise in using the devices (n=18), 16 statements indicated that a positive effect of the therapy for patients can be expected. The experts also stated that a gait trainer cannot completely replace conventional treatment (n=12). Social/ethical comments focused on a reduction of workload but also patient contact. The experts expected a physical relief for the employees (n=21), but also anticipated a lack of contact with the patient when using the robotic system (n=16).

Table 1. Category system including the number of codes per category (total and percentage)

category	subcategories	Statements (n(%))
Therapy/nursing		68 (39.8 %)
	lack expertise of the staff	18 (10.5 %)
	supportive therapy	16 (9.4 %)
	inadequate therapy	12 (7 %)
	therapeutic area	10 (5.8 %)
	Supervision by nursing assistants	8 (4.7 %)
	incorrect use	4 (2.3 %)
Social/ethical		61 (35.7 %)
	Work relief	21 (12.3 %)
	lack of patient contact	16 (9.4 %)
	Ethical/social aspects	13 (7.6 %)
	Employee acceptance	9 (5.2 %)
	Filling staffing gaps	2 (1.2 %)
Economics		42 (24.6%)
	Process Prolongation	13 (7.6 %)
	Progress	11 (6.4 %)
	increased technical effort	7 (4.1 %)
	Cost increase	6 (3.5 %)
	increased efficiency	3 (1.8 %)
	marketing	2 (1.2 %)
Total		**171 (100 %)**

The experts expected an increased technical effort, such as assembly and disassembly, as well as maintenance (n=7). While nurses were quite open and optimistic about the topic, there were more skeptical statements from therapists that do not work with robotics yet. The therapist from clinic C who works with the gait trainer daily, was convinced of the therapeutic potential of the gait trainer and recommended its use.

4. Discussion

The expert interviews suggest that robotics in early neurological rehabilitation can improve therapy quality if used correctly and as a supportive measure in addition to conventional therapy. The experts rated robotics as a chance to relieve physical work and stress, as shown by the high proportion (12,3 %) of statements on work relief. Using the robotic system gives nurses and therapists more time to monitor rehabilitation progress and talk with the patients [10]. It is also possible to monitor multiple patients simultaneously during one session. Thus, staff can use their expertise and time more efficiently and increase the overall effectiveness and efficiency of the rehabilitation program [7, 11]. H1 could be confirmed based on the results from this analysis.

Robotic gait training has the potential to improve therapy outcomes for patients. Ng et al. (2008) confirmed that robotics could significantly increase patients' walking ability compared to purely manual physical therapy treatments [12]. The experts agreed that the supportive use of robotics provides more effective treatment. None of the experts expected deterioration in the quality of therapy when using robotic assistance compared with manual treatment—considering risks such as incorrect use and lack of staff expertise. It is striking that those therapists who are not yet familiar with the robotic system have a rather negative attitude towards the device. H2 can thus be considered valid based on this analysis. In summary, robotic gait training systems offer several benefits to patients. Kumar et al. (2020) suggest that robotic therapy is as effective as conventional therapy [13]. It is not clear whether a robot used in neurological early

rehabilitation should be considered more of a nursing or therapeutic application (or possibly both). It is also worth mentioning that all therapy experts agree that the therapist's hands work more sensitively and individually than a robotic device. Many patients in neurological rehabilitation are highly dependent on interaction and touch, including emotional and social aspects of rehabilitation therapy. The risk of losing patient contact in the long run, may explain therapists' skepticism and even rejection of these systems. Literature and experts agree that robotic systems should complement manual therapy but not completely replace it [2, 11].

5. Conclusion

Digitization, especially robotics, triggers mixed feelings among the stakeholders, including therapists, nurses, and nursing assistants. The use of robotic gait trainers seems more relevant for the therapeutic field than for nursing. Therapists have sufficient expertise to use the system competently. Individualized treatment adapted to the patient's needs can improve therapy outcomes for phase B patients.

References

[1] Stahmeyer JT, Stubenrauch S, Geyer S, Weissenborn K, Eberhard S. The Frequency and Timing of Recurrent Stroke. Dtsch Arztebl International. 2019;116:711–7. doi:10.3238/arztebl.2019.0711.

[2] Tipping CJ, Harrold M, Holland A, Romero L, Nisbet T, Hodgson CL. The effects of active mobilisation and rehabilitation in ICU on mortality and function: a systematic review. Intensive Care Medicine. 2017;43:171–83. doi:10.1007/s00134-016-4612-0.

[3] Hodgson CL, Capell E, Tipping CJ. Early Mobilization of Patients in Intensive Care: Organization, Communication and Safety Factors that Influence Translation into Clinical Practice. Critical Care. 2018;22:77. doi:10.1186/s13054-018-1998-9.

[4] Pohl M, Bertram M, Bucka C, Hartwich M, Jöbges M, Ketter G, et al. Rehabilitationsverlauf von Patienten in der neurologisch-neurochirurgischen Frührehabilitation. Der Nervenarzt. 2016-04-18;87:634–44.

[5] Bernhardt J, Thuy MN, Collier JM, Legg LA. Very early versus delayed mobilisation after stroke. Cochrane Database Syst Rev. 2009:CD006187. doi:10.1002/14651858.CD006187.pub2.

[6] Chandrasekaran S, Ariaretnam SK, Tsung J, Dickison D. Early mobilization after total knee replacement reduces the incidence of deep venous thrombosis. ANZ J Surg. 2009;79:526–9. doi:10.1111/j.1445-2197.2009.04982.x.

[7] Gandolfi M, Geroin C, Tomelleri C, Maddalena I, Kirilova Dimitrova E, Picelli A, et al. Feasibility and safety of early lower limb robot-assisted training in sub-acute stroke patients: a pilot study. Eur J Phys Rehabil Med. 2017;53:870–82. doi:10.23736/S1973-9087.17.04468-9.

[8] van Velthoven MH, Cordon C, Challagalla G. Digitization of healthcare organizations: The digital health landscape and information theory. Int J Med Inform. 2019;124:49–57. doi:10.1016/j.ijmedinf.2019.01.007.

[9] Mayring P. Qualitative Content Analysis: Theoretical Background and Procedures.

[10] Masiero S, Poli P, Rosati G, Zanotto D, Iosa M, Paolucci S, Morone G. The value of robotic systems in stroke rehabilitation; 2014.

[11] Zheng Q-X, Ge L, Wang CC, Ma Q-S, Liao Y-T, Huang P-P, et al. Robot-assisted therapy for balance function rehabilitation after stroke: A systematic review and meta-analysis; 2019.

[12] Ng MFW, Tong RKY, Li LSW. A pilot study of randomized clinical controlled trial of gait training in subacute stroke patients with partial body-weight support electromechanical gait trainer and functional electrical stimulation: six-month follow-up. Stroke. 2008;39:154–60. doi:10.1161/STROKEAHA.107.495705.

[13] Kumar S, Yadav R, Aafreen. Comparison between Erigo tilt-table exercise and conventional physiotherapy exercises in acute stroke patients: a randomized trial. Arch Physiother. 2020;10:3. doi:10.1186/s40945-020-0075-2.