Charlotte Meixner, Silke Kükemück & David Unbehaun (2023): Head-Mounted Display-based Intervention and Education Concepts for Patients Post-Stroke and Relatives in Domestic Care. 9th International Conference on Infrastructures in Healthcare. DOI: 10.48340/ihc2023_pd022

Head-Mounted Display-based Intervention and Education Concepts for Patients Post-Stroke and Relatives in Domestic Care

Charlotte Meixner
TU Clausthal
charlotte.meixner@tu-clausthal.de

Silke Kükemück
Universitätsmedizin Göttingen
silke.kuekemueck@med.uni-goettingen.de

David Unbehaun
TU Clausthal & University of Siegen
David.unbehaun@uni-siegen.de

Abstract. This work presents a demonstration system that was developed as part of an interdisciplinary research project and aims to enhance health literacy and improve functional outcomes for patients post-stroke. The demonstration system consists of three parts: 1) a head-mounted Display and the connection to; 2) the electronic patient data management system and hospital information of the project partner. The system is able to initiate remote treatment and counselling, patient identification, remote mentoring, interactive control, and additional features like clinical assessment and documentation. It facilitates interprofessional information sharing, supports specific workflows (SOP), and enhances communication. The underlying project objectives are anticipated outcomes such as improved health literacy, functional outcomes, self-care abilities, and quality of life of patients and relatives. The study also aims to develop a care concept to prevent rehospitalization, examine the appropriation and acceptance of the system in daily clinical practices, and assess technology opportunities and risks. This work is an inspiration and

orientation for future research, development, and design of AR-based interventions in clinical contexts.

Introduction

Stroke is the leading cause of long-term disabilities, and within one year of experiencing a stroke, approximately 73% of individuals affected by stroke incidents will experience at least one fall (Denissen et al., 2019). Even less severe falls can result in activity limitations, reducing the overall quality of life and triggering concerns about further falls among affected individuals (Denissen et al., 2019). Falls after a stroke can lead to significant health complications, including injuries such as fractures, head injuries, and muscle strains, which can impair the mobility and independence of patients (Belgen et al., 2006). A systematic review and meta-analysis by Denissen et al. (2019) also found that falls in stroke patients were associated with an increased rate of hospital readmissions and poorer functional recovery. Previous falls serve as a predictive factor for future falls in stroke patients (Stolze et al., 2004; Veerbeek et al., 2014). Therefore, it is of great importance to prioritize measures for fall prevention and management from the early stages of the disease and integrate them into the rehabilitation and care of stroke patients. The use of health-related information and communication technology (ICT) such as exergames (Unbehaun, Vaziri, Aal, Li, et al., 2018; Unbehaun, Vaziri, Aal, Wieching, et al., 2018; Unbehaun, Aal, Wieching, et al., 2019; Unbehaun et al., 2020), health applications and wearables (Vaziri, 2018), as well as digital games and training programs (Brown et al., 2022; Raß et al., 2023; Unbehaun, Aal, Carros, et al., 2019; Vaziri et al., 2017) in different domains, shown to improve activity levels and offer valuable potentials. Recently, virtual and augmented realities (VR and AR) are becoming increasingly visible in the field of health-related ICT and Human-Computer-Interaction (HCI) (Janßen et al., 2021; Janßen & Prilla, 2022; Unbehaun et al., 2021). Our work presents a Head-mounted Display-based system to improve the health and care competence of patient/caregiver education and at the same time to minimize the risk of falls in patients with ischemic stroke. For this purpose, assisted reality glasses (AR) are integrated into the care-process by the professional caregivers during the acute stay on the stroke unit, individual care situations are documented and didactically prepared for the patient. In this work, we present an early prototype, illustrating the main features of the system. The overall system will be contextualized, designed, and developed in a participatory design dialogue with all actors and additional stakeholders.

Project Background & Methodological Framework

The methodological framework of the study uses a mixed-methods approach, involving a randomized controlled trial and a practice-oriented oriented research infrastructure within a university medical hospital in Göttingen will be deployed. By introducing a PRAXLABS-Infrastructure we will establish a close symbiosis between the respective field of application and the stakeholder-groups and potential users of the system (Aal et al., 2016; Ahmadi et al., 2018; Müller, 2014; Müller et al., 2015; Ogonowski et al., 2018). This participatory research or development approach enables a flexible development process and ensures the long-term commitment and sustainability of the innovations to be developed in practice via the PRAXLABS-infrastructure. Various qualitative methods of social research with a praxeological focus are applied in the PRAXLABS. An important role is played by ethnographic methods such as participant observation in order to empirically record social practices and possible changes in care processes. Our research approach will use qualitative methods (ethnographies: participant observation, interview methods, biographical methods). Furthermore, concrete practical problems are identified in joint workshops with various stakeholders and experts and addressed in the co-design and technical development process. The insights gained from case studies in the context of qualitative methods will be tested on a broader basis in quantitative studies.

The objective of the randomized controlled trial is to compare the care concepts of the existing therapy with the support provided by the data glasses and gather information on fall prevention during the education process. Patients will be randomly assigned to two groups (1) group 1 will receive the project's care concept, including patient and caregiver education using digital assistive technologies such as the data glasses and (2) group 2 will receive the current standard therapy as outlined in the Stroke Manual.

Technical Infrastructure

The HMD system, designed and developed for the purpose of educating adapted to the needs of patients and caregivers following an ischemic stroke within the framework of care management, consists of a range of interconnected components. The core elements of this technical infrastructure include augmented reality (AR) glasses, and a smartphone, offering diverse multimodal input and output functionalities, such as gesture and voice control.

Various digital, medical, and nursing information will be collected based on different scoring systems. These findings will be compared with clinical parameters routinely obtained during the conventional treatment on the stroke unit.

Additionally, the collected criteria will be documented and presented through questionnaires in the follow-up care.

The usage of the data glasses follows predefined scenarios.

1. ***Baseline assessment:*** The interdisciplinary team analyzes care requirements based on patient and social history. Inclusion/exclusion criteria are verified, and patients and caregivers are informed about the study. Motion analysis using video recordings through data glasses is performed with patient and caregiver consent. The expert standard procedure to prevent falls (from our <anonym> hospital partner) is documented and processed according to data protection requirements. Questionnaires are administered to familiarize participants with the study procedures and data glasses technology.
2. ***Education using data glasses:*** Data glasses are used for patient and caregiver education from day three of the hospital stay. The assigned nursing professional utilizes data glasses to address care needs in the acute setting. Daily live video streams are transmitted to caregivers after obtaining consent. Nursing interventions for fall prevention, as outlined in the fall SOP, are demonstrated using data glasses with virtual presence of caregivers via conference calls.
3. ***Continuous data glasses use:*** Weekly consultations by the nursing professional address individual care needs for caregivers, implementing fall prevention measures through instructional videos created during the acute stay. Quarterly evaluations occur through counseling and surveys. Individual training sessions with data glasses are provided if needed and documented. Workshops during the rehabilitation clinic stay cover care basics and data glasses applications.

Figure 1: Data glasses -RealWear Navigator 520

Integration into Care and Case Management

The system will be used to provide support in various ways in a hospital setting.

Remote treatment: Through data transmission, information about caregiving activities can be shared. Remote assistance can be requested for specific questions or rare caregiving tasks that require specialized knowledge per video or live-chat.

Patient data: Using barcodes or other recognition methods, the glasses can identify patients and document care report by voice message.

Remote mentoring: The glasses can provide step-by-step guidance for specific workflows using text, images, or videos (such as endotracheal suctioning, fall management).

Interactive control: The glasses can display real-time data e.g. from the bed (such as pressure sensors) to show the patient's positioning or repositioning until, for example, pressure ulcers are relieved through changes in positioning (visual monitoring).

Additional functions: Teleconsultation assistance, multiple devices/participants per session, user management and dialogue design, predefined voice commands, camera orientation, support for various languages, shared workspace (photo board, virtual finger, screen sharing, commenting functions

Conclusion and Outlook

The use of data glasses is anticipated to offer numerous advantages for various stakeholders: (1) patients can receive tailored care, minimizing the risk of falls, preventing health issues, and enhancing opportunities for rehabilitation and social integration, thus improving the overall quality of care they receive. (2) Relatives will benefit from an increased flow of information and improved safety measures. (3) The broader society stands to gain from individuals being able to stay at home for longer periods, reducing the burden on family caregivers, improving the quality of care, and alleviating strain on healthcare personnel, that includes positive economic consequences. However, it is essential to consider potential risks, including ethical, legal, and social implications, as well as issues related to privacy, data security, and the evaluation of the impact of these applications.

References

Aal, K., Mouratidis, M., Weibert, A., & Wulf, V. (2016). Challenges of CI Initiatives in a Political Unstable Situation—Case Study of a Computer Club in a Refugee Camp. *Proceedings of the 19th International Conference on Supporting Group Work*, 409–412. https://doi.org/10.1145/2957276.2996281

Ahmadi, M., Weibert, A., Ogonowski, C., Aal, K., Gäckle, K., Marsden, N., & Wulf, V. (2018). Challenges and lessons learned by applying living labs in gender and IT contexts. *Proceedings of the 4th Conference on Gender & IT - GenderIT '18*, 239–249. https://doi.org/10.1145/3196839.3196878

Belgen, B., Beninato, M., Sullivan, P. E., & Narielwalla, K. (2006). The Association of Balance Capacity and Falls Self-Efficacy With History of Falling in Community-Dwelling People With Chronic Stroke. *Archives of Physical Medicine and Rehabilitation*, *87*(4), 554–561. https://doi.org/10.1016/j.apmr.2005.12.027

Brown, G., Hust, J., Büttner, S., & Prilla, M. (2022). The Impact of Varying Resolution and Motion Realism of Avatars in Augmented Reality-Supported, Virtually Co-located Sales Consultations. *Mensch Und Computer 2022*, 255–264. https://doi.org/10.1145/3543758.3543772

Denissen, S., Staring, W., Kunkel, D., Pickering, R. M., Lennon, S., Geurts, A. C., Weerdesteyn, V., & Verheyden, G. S. (2019). Interventions for preventing falls in people after stroke. *Cochrane Database of Systematic Reviews*, *10*.

Janßen, M., Droste, A. V., & Prilla, M. (2021). Designing Augmented Reality Workflows for Care Specific Tasks. *Mensch Und Computer 2021*, 601–604. https://doi.org/10.1145/3473856.3474033

Janßen, M., & Prilla, M. (2022). Investigating the Use of Head Mounted Devices for Remote Cooperation and Guidance during the Treatment of Wounds. *Proceedings of the ACM on Human-Computer Interaction*, *6*(GROUP), 1–27. https://doi.org/10.1145/3492822

Kajastila, R., & Hämäläinen, P. (2014). Augmented climbing: Interacting with projected graphics on a climbing wall. *CHI '14 Extended Abstracts on Human Factors in Computing Systems*, 1279–1284. https://doi.org/10.1145/2559206.2581139

Müller, C. (2014). *Praxisbasiertes Technologiedesign für die alternde Gesellschaft: Zwischen gesellschaftlichen Leitbildern und ihrer Operationalisierung im Design*. BoD – Books on Demand.

Müller, C., Hornung, D., Hamm, T., & Wulf, V. (2015). Practice-based design of a neighborhood portal: Focusing on elderly tenants in a city quarter living lab. In *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems* (pp. 2295–2304).

Ogonowski, C., Jakobi, T., Müller, C., & Hess, J. (2018). *Praxlabs* (Vol. 1). Oxford University Press. https://doi.org/10.1093/oso/9780198733249.003.0011

Raß, E., Unbehaun, D., Wulf, V., Lüssem, J., Eilers, H., Lenz, G., Tandler, J., Afzali, S. N., & Eroglu, B. (2023). Investigating the Potential and Impacts of Social Robots to Engage People with Advanced Dementia and their Caregivers: Early Insights from an Exploratory Ethnographic Study within a Protected Care Environment. *Proceedings of the 16th International Conference on PErvasive Technologies Related to Assistive Environments*, 272–278. https://doi.org/10.1145/3594806.3594826

Stolze, H., Klebe, S., Zechlin, C., Baecker, C., Friege, L., & Deuschl, G. (2004). Falls in frequent neurological diseases. *Journal of Neurology*, *251*(1), 79–84. https://doi.org/10.1007/s00415-004-0276-8

Unbehaun, D., Aal, K., Carros, F., Wieching, R., & Wulf, V. (2019). *Creative and Cognitive Activities in Social Assistive Robots and Older Adults: Results from an Exploratory Field Study with Pepper*. https://doi.org/10.18420/ECSCW2019_P07

Unbehaun, D., Aal, K., Richert, V., & Wulf, V. (2021). *CareFox: An Interactive Learning Application for Care-Students*.

Unbehaun, D., Aal, K., Wieching, R., Wulf, V., Vaziri, D. D., Jahnke, S., & Wulf, B. (2019). Development of an ICT-based Training System for People with Dementia. *Companion Publication of the 2019 on Designing Interactive Systems Conference 2019 Companion - DIS '19 Companion*, 65–68. https://doi.org/10.1145/3301019.3325153

Unbehaun, D., Taugerbeck, S., Aal, K., Vaziri, D. D., Lehmann, J., Tolmie, P., Wieching, R., & Wulf, V. (2020). Notes of memories: Fostering social interaction, activity and reminiscence through an interactive music exergame developed for people with dementia and their caregivers. *Human–Computer Interaction*, 1–34. https://doi.org/10.1080/07370024.2020.1746910

Unbehaun, D., Vaziri, D., Aal, K., Li, Q., Wieching, R., & Wulf, V. (2018). Video-game based Exergames for People with Dementia and Their Caregivers. *Proceedings of the 2018 ACM Conference on Supporting Groupwork - GROUP '18*, 401–405. https://doi.org/10.1145/3148330.3154506

Unbehaun, D., Vaziri, D. D., Aal, K., Wieching, R., Tolmie, P., & Wulf, V. (2018). Exploring the Potential of Exergames to affect the Social and Daily Life of People with Dementia and their Caregivers. *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems - CHI '18*, 1–15. https://doi.org/10.1145/3173574.3173636

Vaziri, D. D. (2018). *Facilitating Daily Life Integration of Technologies for Active and Healthy Aging*. Springer Fachmedien Wiesbaden. https://doi.org/10.1007/978-3-658-22875-0

Vaziri, D. D., Aal, K., Gschwind, Y. J., Delbaere, K., Weibert, A., Annegarn, J., de Rosario, H., Wieching, R., Randall, D., & Wulf, V. (2017). Analysis of effects and usage indicators for a ICT-based fall prevention system in community dwelling older adults. *International Journal of Human-Computer Studies*, *106*, 10–25. https://doi.org/10.1016/j.ijhcs.2017.05.004

Veerbeek, J. M., Van Wegen, E., Van Peppen, R., Van Der Wees, P. J., Hendriks, E., Rietberg, M., & Kwakkel, G. (2014). What Is the Evidence for Physical Therapy Poststroke? A Systematic Review and Meta-Analysis. *PLoS ONE*, *9*(2), e87987. https://doi.org/10.1371/journal.pone.0087987