Building a Virtual Medical Environment for Online Rehabilitation: The e-KINE Pilot Application

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Abstract. The digital transformation of healthcare (eHealth) has been a longstanding priority on the European Union's agenda. However, the COVID-19 pandemic has demonstrably underscored the critical importance of eHealth solutions. This paper presents a response to this urgency by outlining approaches and solutions for online rehabilitation developed within the Erasmus+ joint project " Development of digital skills for online rehabilitation therapies/e-KINE" with the close collaboration and efforts of hospitals and higher education institutions from Turkey, Bulgaria, and Romania.

Keywords: eHealth, Digital Health and Care, Online Rehabilitation, Online Clinic.

1 Introduction

Digital health and care, *i.e.* eHealth, refers to tools and services that use information and communication technologies (ICTs) to improve the prevention, diagnosis, treatment, monitoring, and management of health-related issues and to monitor and manage lifestyle habits that impact health.

Within the domain of eHealth, telerehabilitation has emerged as a field with a wide range of applications across various pathologies. It encompasses the delivery of diverse rehabilitation services through ICTs. The primary areas of telerehabilitation intervention include musculoskeletal, respiratory, cardiovascular, neurological, and geriatric rehabilitation, with ongoing exploration into additional fields. A growing body of evidence suggests that telerehabilitation can be as effective as traditional care in improving activities of daily living, motor function, independence and quality of life for adult populations affected by stroke, cerebral palsy, spinal cord/brain injuries, Parkinson's disease (Thirumalai et al., 2018b), multiple sclerosis (Thirumalai et al., 2018a), and dementia and depression among older adults (Dove et al., 2020). Furthermore, telerehabilitation has shown promise in enhancing geriatric rehabilitation outcomes, including physical activity, balance (Kraaijkamp, et al., 2021), and even cognitive frailty (Scheibe, et al., 2021). Additionally, a growing body of research supports the feasibility

of telehealth interventions in home-based palliative care for various chronic and terminal illnesses, such as cancer, dementia, chronic lung disease, and heart disease (Lundereng, et al., 2021). Although there are still limitations to the use of telerehabilitation, there are many studies that underline its advantages compared to classical face-to-face approaches. Highlighting the knowledge gap in telerehabilitation, Seçer and Tosun (2022) reported that most physical therapy professionals and rehabilitation students surveyed lacked awareness due to the absence of a relevant curriculum (Secer & Tosun, 2022). This underscores the critical need for healthcare professionals to acquire both theoretical and practical knowledge in telerehabilitation. This translates to the development of new core competencies, particularly digital skills for navigating the online rehabilitation environment. Correspondingly, a pressing need exists for Higher Education Institutions and Vocational Training providers to develop and integrate educational programs focused on online rehabilitation practices.

In response to the identified need for digital upskilling in online rehabilitation, in 2021 was launched the Erasmus+ project "Development of digital skills for online rehabilitation therapies/ e-KINE"). This project aims to generate, disseminate, and apply knowledge related to online rehabilitation in diverse contexts, specifically addressing vocational training needs at the tertiary level for kinesitherapists, physiotherapists, occupational therapists, and physical medicine & rehabilitation residents/fellows. The e-KINE project (e-KINE Project, 2020-2023), a collaboration between hospitals and Higher Education Institutions from Turkey, Bulgaria, and Romania, focuses on developing telerehabilitation services. It proposes a virtual medical environment as a potential solution to supplement traditional rehabilitation with online modalities. e-KINE virtual environment encompasses an e-learning platform (optimized for mobile access), social media channels and a virtual clinic and functions as a pilot application of the e-KINE course, integrating periods of work-based learning and opportunities to apply knowledge in practical workplace situations.

2 e-KINE Methodology and Outputs

The e-KINE project employs a target-group-specific methodology to deliver its outputs. For medical professionals, the focus is on online patient rehabilitation management. This includes online evaluation (posture, range of motion), protocol selection and adaptation from a dedicated online database, patient-centred adjustments, and process follow-up.

A training curriculum was developed to equip the involved target group representatives with knowledge and skills to build and manage their online rehabilitation space. This includes exposure to e-health approaches (benefits and limitations), selecting the most suitable option, and acquiring basic online rehabilitation unit development skills (patient database management, communication with patients and colleagues, data protection, legal considerations, payment methods, and business promotion).To achieve these goals, based on the curriculum was created an e-course titled "Contemporary Applications of IT for Online Rehabilitation Services" hosted on the e-KINE collaborative platform. The fundamental technologies behind the proposed solution are open-source

and consist of PHP, MySQL database, Apache web server, Moodle, etc. The proposed technology infrastructure is developed to accessibility compliance standards.

The e-KINE online training, informed by modern technology and pedagogical innovations, equips trainees with knowledge of various telemedicine tools, with a dedicated section on online rehabilitation tools and real-life case studies. Additionally, a database of rehabilitation and prophylaxis protocols with corresponding videos across various pathologies was developed. The pilot work-based learning approach allows trainees to apply their knowledge in simulated workplace situations. Under supervision, trainees conduct online patient consultations, assess conditions, select, or adapt protocols, and follow up on the process. The e-KINE project established standalone online rehabilitation clinics for Romania, Bulgaria, and Turkey that are hosted on Facebook. These clinics integrate various tools to facilitate online services, communication, and information sharing among users. They employ synchronous image-based telerehabilitation via video conferencing tools, enabling real-time physical therapy consultations with two-way audio and video transmission. A database of adaptable online rehabilitation protocols and corresponding videos for various pathologies is embedded within the virtual space. This allows therapists to conduct consultations, assessments, and treatment interventions through video conferencing, fostering interactive sessions.
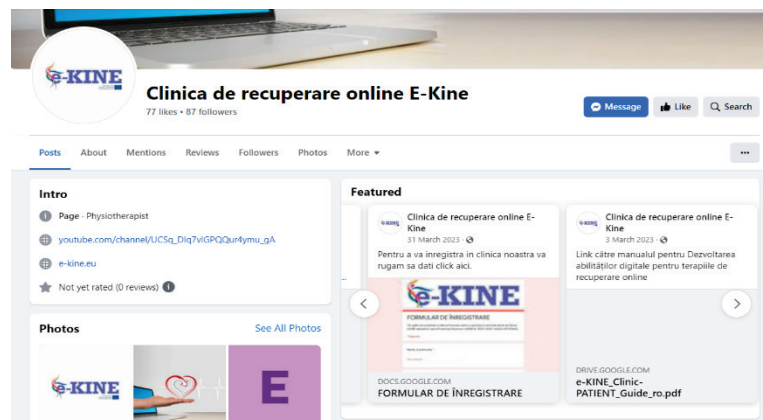

Fig. 1. Online rehabilitation clinic (Romania).

National privacy and security regulations were a primary concern. Partners collaborated to map and analyze key legal concepts in each participating country, informing the development of the clinic's functionalities. Accessible across different operating systems, the clinic offers features like appointment scheduling, measurement tools, and patient communication channels. Chat history is preserved, including discussions, recommendations, and documents exchanged during consultations. Following patient assessment, a pre-set rehabilitation/prophylaxis protocol from the database is recommended based on diagnosis. This database includes 83 standard rehabilitation protocols for rehabilitation in different pathological conditions and 22 prophylaxis protocols, all adapted for online delivery. Each protocol is accompanied by corresponding videos hosted on a

private YouTube channel to ensure adherence to ethical and deontological principles (Fig. 1).
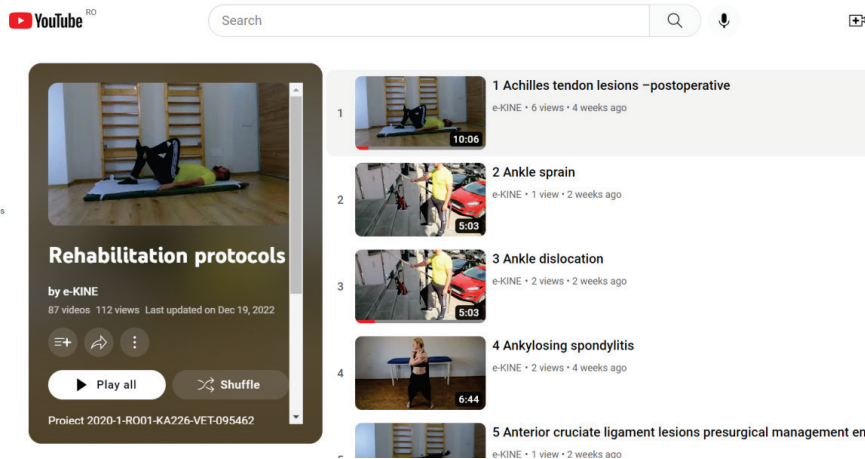

Fig. 2. Rehabilitation protocols on YouTube.

Prophylaxis videos, intended for a wider audience, are publicly available on YouTube (Fig. 2).
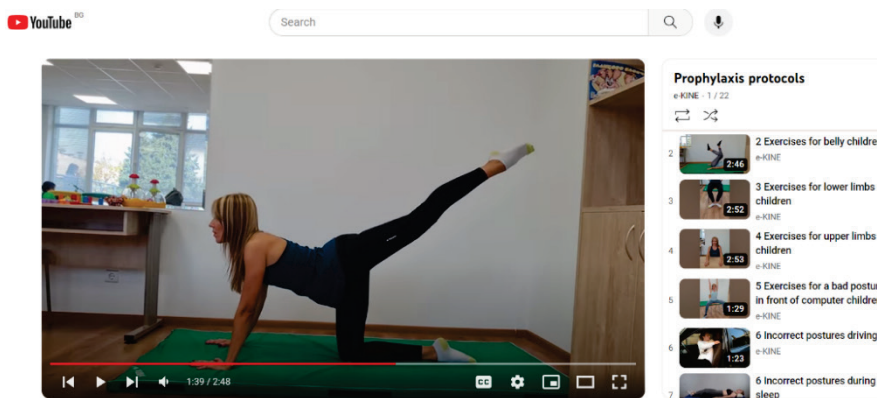

Fig. 3. Prophylaxis videos on YouTube.

Patient-centered adjustments are incorporated, and therapists can provide real-time instructions and high-quality video clips for exercise demonstrations. Periodic reassessments monitor progress and allow for program adjustments. Patient information is readily available on Facebook profiles. To ensure informed participation, patients receive instructions on accessing consultations and rehabilitation services. An online privacy statement and informed consent form are mandatory before consultations. An Ethics Advisory Board provides ongoing oversight and governance. The e-KINE project introduces a virtual medical environment enabling healthcare professionals to conduct

online physiotherapy sessions, replicating core aspects of traditional in-person rehabilitation. Effective patient-therapist communication is paramount for successful online sessions. This is facilitated through features like appointment scheduling, real-time video calls, instant messaging, and access to chat history. Additionally, patients can upload medical documents and complete pre-therapy questionnaires to provide background information. Individualized kinesiotherapy programs within e-KINE follow a structured approach. Each program begins with a comprehensive assessment phase followed by a guided rehabilitation session with real-time therapist monitoring. The assessment process involves the following three key steps:

1. Diagnosis Confirmation: Patients are required to submit a confirmed diagnosis from their physician, along with any relevant medical documents, before commencing the program.

2. Online Condition Assessment: To establish an appropriate rehabilitation plan, the therapist conducts a thorough online assessment of the patient's condition. This includes a review of medical history, discussion of symptoms, and online physical assessments (e.g., observing range of motion through simple movement requests).

3. Exercise Selection: Based on the confirmed diagnosis and assessment findings, the therapist selects targeted exercises from a comprehensive protocols database.

Following the assessment, the patient receives a written rehabilitation protocol tailored to their specific pathology and a corresponding video demonstration. A crucial aspect of the e-KINE approach is the flexibility to adapt protocols to individual needs and home environments. Therapists can select protocols from the virtual environment, make necessary adaptations and send them via email or WhatsApp. The patient-centred customization ensures program personalization, allowing users to focus on their specific condition. During the first session, patients perform the prescribed exercises on camera while the therapist observes, provides feedback, and offers support in real time. This biofeedback loop is crucial for promoting patient autonomy and adherence to the treatment plan. Finally, the e-KINE program emphasizes ongoing monitoring. Therapists conduct monthly reassessments of patients' functional mobility status to track progress compared to the initial evaluation.

3   Conclusions

More than 500 physical therapy professionals and rehabilitation students were involved in the piloting stage of the project and 87% of them declared that due to the e-KINE training, they have improved their telerehabilitation skills. 92,3% of the interviewed patients consider e-KINE protocols as useful while 95% consider that the use of e-KINE protocols will decrease the number of visits to the physio/kinesitherapist. 96,7 of all interviewed stakeholders rated the e-KINE approaches as "good" and "very good" and expressed a desire to use the project results within their organisations. These results give us reason to conclude that the e-KINE approach to online rehabilitation services represents a modern healthcare problem-solving idea for the training and professional development of physiotherapists in telerehabilitation.

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