eRehabilitation after stroke: the interplay between the effectiveness, the implementation and the context

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General introduction

GENERAL INTRODUCTION

Definition, consequences and epidemiology of stroke

Stroke, or cerebrovascular accident, is a medical condition in which the blood flow to the brain is interrupted. Stroke can be either ischemic, when a clot in a blood vessel blocks the blood flow to the brain (80% of the cases), or haemorrhagic, when a blood vessel in the brain ruptures (20% of the cases). As a consequence, brain areas are deprived of oxygen and nutrients, causing damage to the brain tissue [1]. Abilities controlled by these areas can be lost or impaired. Survivors commonly experience disabilities in motor function, speech and/or cognition [2,3] and may have lifelong restrictions in daily activities and participation in society [4].

Stroke is the second leading cause of death in the world [5], with 1 in 6 people worldwide suffering from stroke in their lifetime. In the Netherlands in 2018, the incidence of stroke was estimated to be 40,000 (20,2000 men and 19,800 women) with a prevalence of 356,400 people living in the community with the consequences of stroke [6]. Worldwide, the absolute number of stroke and the people affected by stroke is expected to increase [7]. This is mainly due to an aging population and to the improved quality of stroke care, especially early thrombolysis, resulting in declining mortality rates [8]. In the Netherlands, the annual prevalence of stroke is expected to increase with 54% between 2015 and 2040 [6].

Medical management & specialized rehabilitation

In the acute phase, stroke patients are treated in a hospital (emergency room, intensive care, medium care, stroke unit and/or neurology ward). In 2018, in the Netherlands, 30% of the people with an ischemic stroke and 11% of those with a haemorrhagic stroke died within 30 days [9]. Hospital stay is generally short, with an average length of stay of 6 days [10], and ends when the patient is medically stable. After hospital discharge, approximately 25-30% of the patients is discharged to a nursing home for geriatric rehabilitation. These are mostly older patients with limited potential for recovery and who are not able to return home (yet). About 60-65% of the patients is discharged to their homes [11], where treatment can be provided by healthcare professionals close to home (primary care) or during outpatient rehabilitation in specialized rehabilitation facilities. The remaining 10% is discharged to specialized rehabilitation facilities for inpatient stroke rehabilitation [12].

Inpatient and outpatient stroke rehabilitation in a specialised rehabilitation facility is offered mostly to patients in the working age with potential for recovery and more complex participation goals [13]. In the Netherlands, about 3,200 stroke patients receive this treatment each year [14]. In 2020, 18 of the 36 members of the overarching organization for medical rehabilitation in The Netherlands (Revalidatie Nederland) deliver specialized stroke rehabilitation [15].

Stroke rehabilitation in specialized rehabilitation facilities includes a comprehensive, multidisciplinary process aiming to restore impaired functions, activities and/or participation restrictions [2]. The multidisciplinary team usually includes a rehabilitation physician, a physical therapist, an occupational therapist, a speech therapist, a psychologist and a social

worker. Depending on local availability, additional professionals such as a recreational therapist or dietician can also be involved. Rehabilitation typically follows a process of assessment, goal setting, therapy and reassessment [2]. For each patient, a tailored rehabilitation plan is defined, depending on the type and severity of the impairments and the patients' personal rehabilitation goals. The length of stroke rehabilitation ranges between 3 and 26 weeks [16]. Multidisciplinary stroke rehabilitation reduces the likelihood of long-term disability and increases independence in daily activities [17,18], and approximately 90% of the patients are able to live independently after stroke rehabilitation [13].

Digital health technology in rehabilitation (eRehabilitation)

Recently, there is an increasing interest in the application of digital health technologies in healthcare in general, including in stroke rehabilitation [19,20]. The use of digital health technologies in rehabilitation is often referred to as eRehabilitation. eRehabilitation can be used for several purposes. First, it may improve quality of care, by the possibility to monitor compliance, progress and health behaviour better [21] and by supporting self-management and self-ownership [21]. Second, it may improve access to care during rehabilitation [21], between inpatient and outpatient rehabilitation [22,23], after rehabilitation [24] and at a distance when face-to-face treatment is impossible [21]. Third, it may increase (cost) effectiveness [25], in the absence or scarcity of resources [26,27]. The use of eRehabilitation may facilitate all phases of the rehabilitation process, i.e. assessment, diagnosis, goal-setting, therapy, and education [28] and may be applied by means of various devices such as a smartphone, laptop or tablet.

Several classifications exist to order eRehabilitation technologies, such as the framework published by Chen and colleagues [29]. Based on that classification, multiple technologies are described which can be part of an eRehabilitation intervention. *Games and exercise programs* are conducted to perform rehabilitation activities by using online exercise programs or by playing games [30,31]. This includes exercise games which are developed for commercial purposes and applied for stroke rehabilitation, or programs specifically developed for therapeutic purposes [32]. Those games and exercise programs are mostly provided as an addition to conventional stroke rehabilitation [22]. *Telecommunication technologies* include the use of digital technologies such as telephone and video conferencing for communication purposes only, to help patients receive medical services from healthcare professionals remotely [33]. *Sensors,* such as smartwatches are devices to measure for instance patients' daily activity[34]. *Virtual reality* devices provide a virtual environment that simulates the physical environment, making exercising more realistic [35].

Barriers and facilitators in the context of eRehabilitation

In order to successfully start using eRehabilitation, the context in which eRehabilitation will be implemented needs to be known. According to the implementation theory of Grol, the use of healthcare innovations is influenced by barriers and facilitators in the context of the setting, in this case the specialized rehabilitation facilities [36]. Barriers and facilitators in the context may be identified at six levels: the Innovation, the Organizational context,

the Individual professional, the Individual patient, the Social context and the Political and economic context. For eRehabilitation after stroke, previous literature identified factors at five levels. Barriers and facilitators at the level of the Intervention included concerns about ease of use [37] and security of data transfer [38]; at the level of the Organisational context insufficient time for the implementation [39] and the lack of integration of eRehabilitation into the existing stroke rehabilitation services [40]; at the level of the Individual patient and Individual healthcare professional lack of technical expertise [28,37] and fear of reduced face-to-face contact [41]; and at the level of the Political and economic context problems with insurance [42].

Although abovementioned barriers and facilitators give some insight into the acceptability and feasibility of eRehabilitation, it remains unknown which barriers and facilitators have the greatest impact on the use of eRehabilitation. These insights are necessary in order to tailor an implementation strategy to factors that influence the use of eRehabilitation the most, making an implementation strategy more effective [41,43].

Effectiveness of eRehabilitation

In the past 10 years, a number of systematic reviews was published on the effectiveness of eRehabilitation after stroke. It was concluded that eRehabilitation in a controlled research environment may result in improved healthcare outcomes, like walking speed, balance and mobility [35], cognition and mood [44] and health-related quality of life [45]. Despite the increasing body of evidence with a growing number of randomised controlled trails (RCT), it is hard to draw conclusions about the effectiveness since interventions and outcome measures varied greatly and few studies were adequately powered [25].

Most studies concerning the effectiveness of stroke eRehabilitation focused on interventions targeting only one domain of stroke rehabilitation, e.g. hand function [25]. However, as most stroke patients face multiple and distinct problems, evaluating different eRehabilitation modalities simultaneously may be useful. As such, eRehabilitation programs can be used for multiple purposes and combining exercise programs (including cognitive, speech and physical exercise programs), communication technologies and sensors like activity tracking. Combining eRehabilitation interventions would greatly increase ease of use [46]. However, evidence on the effectiveness of eRehabilitation interventions combining various digital interventions is scarce. In the recent published systematic review about eRehabilitation for stroke [25,29,35,44,45], only three RCTs are performed combining multiple interventions in one digital environment, i.e. online exercises combined with activity tracking and/or stroke-related education. In this, eRehabilitation was compared with conventional rehabilitation in patients less than one year post stroke. All showed comparable outcomes for conventional rehabilitation and eRehabilitation with respect to motor function and knowledge about stroke [47-49].

As mentioned previously, research concerning the effectiveness of eRehabilitation after stroke is mainly performed in a controlled setting [25,50]. However, the clinical context and the employed implementation strategy may be of great influence on the effectiveness [51]. Moreover, eRehabilitation should be offered and investigated in combination with conventional stroke rehabilitation to achieve its full potential [42]. Pragmatic trials, in which

the effectiveness of eRehabilitation is studied when integrated in the context of a stroke rehabilitation facility, are barely performed but could be a valuable next step in increasing the use of eRehabilitation after stroke [25].

Implementation of eRehabilitation

Worldwide, the translation of recent developments of digital healthcare technologies into the use of eRehabilitation in specialized rehabilitation facilities has been slow [52]. This is remarkable since the potential benefits of eRehabilitation are evident [25], eRehabilitation becomes more and more available [22] and patients and healthcare professionals are very willing to use eRehabilitation [53,54]. Although literature is available concerning the feasibility of eRehabilitation and its implementation, a profound evaluation of what works and why regarding implementation strategies for eRehabilitation has not previously been performed in a clinical setting for stroke rehabilitation. This knowledge can be very important to support future implementation of eRehabilitation and to interpret the results of pragmatic effectiveness studies [25,55].

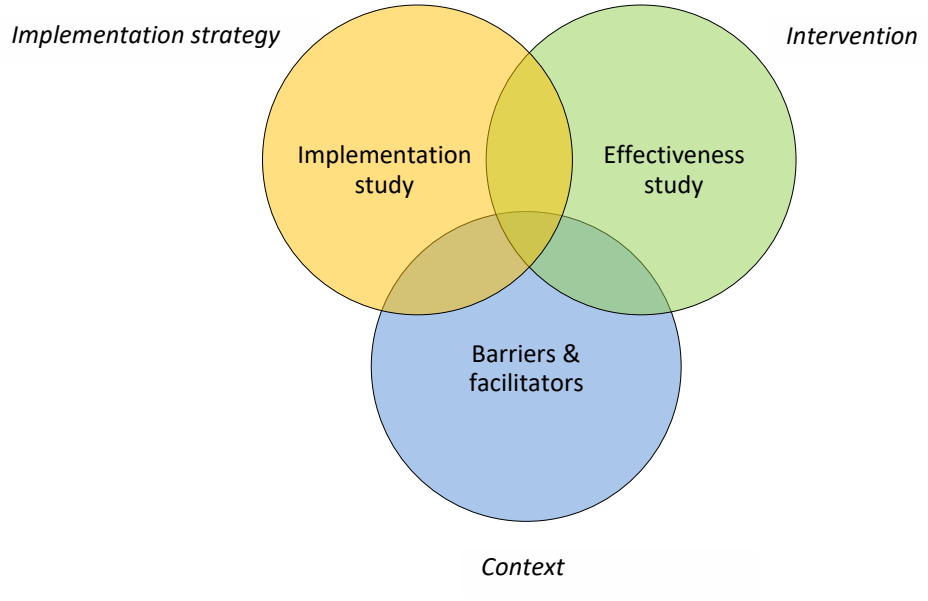

Figure 1. The complex interplay between the barriers and facilitators in the context, the effectiveness and the implementation strategy for the use of eRehabilitation after stroke [51]

The interplay between effectiveness, implementation and context

For successful use of eRehabilitation in specialized rehabilitation, the complex interplay between the intervention, the implementation strategy and the barriers and facilitators in the context is important (Figure 1). An optimal method to investigate this interplay is performing a hybrid implementation and effectiveness study, combined with an exploration of the barriers and facilitators. In such a hybrid implementation and effectiveness study, the eRehabilitation intervention and the implementation strategy are tested simultaneously. A benefit of a hybrid design is that it supports a more rapid translation of evidence into clinical practise and provides a more valid assessment of the clinical effectiveness [56].

Outline of this thesis

The effectiveness of eRehabilitation is not only influenced by the intervention itself, but also by the implementation strategy and the context in which the intervention is implemented. The latter two aspects often vary from one intervention, organisation or country to the other. Since knowledge about these specific areas is scarce, this thesis aims to provide insight in the interplay between the effectiveness, the implementation strategy and the context of eRehabilitation after stroke, as delivered in a specialized rehabilitation facility. To study this interplay, the sub aims of this thesis were:

- Identify the (most important) barriers and facilitators of patients, informal caregivers and healthcare professionals regarding the use of eRehabilitation after stroke (Chapters 2, 3, 4).
- Investigate the effectiveness of a multidisciplinary eRehabilitation intervention embedded in conventional stroke rehabilitation, using a hybrid implementation and effectiveness study design (Chapter 5).
- Investigate what works and why in the implementation of a multidisciplinary eRehabilitation intervention in conventional stroke rehabilitation, using a hybrid implementation and effectiveness study design (Chapter 6).

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