Mobile Tablet-based Stroke Rehabilitation: Using mHealth Technology to Improve Access to Early Stroke Rehabilitation

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Abstract—Mobile health (mHealth) technology represents a means through which more stroke survivors could access early stroke rehabilitation. Although rehabilitation is most effective when begun early post-stroke, limited resources (facilities, therapists) prevent survivors from initiating therapy. Furthermore, the coupling of an aging population with advances in acute therapy has led to an increase in the absolute number of individuals suffering from and surviving strokes which in turn has put further strain on already scarce rehabilitation resources. There is an urgency to conduct high-quality research exploring cost-effective and creative mHealth devices for early rehabilitation in the acute setting. Mobile technology allows therapists to prescribe apps based on standard cognitive/physical assessments in the acute setting, remotely monitor patient progress across individual carepaths, and update prescribed therapies based on patient feedback and recovery. Recognition of the growing problem of accessing early stroke rehabilitation, and the possibilities offered by mHealth technology led to the development of the RecoverNow platform for stroke rehabilitation in the acute setting. RecoverNow is a custom built, tablet-based stroke rehabilitation platform that houses a variety of previously existing apps with activities analogous or identical to exercises in speech language and/or occupational therapy. While RecoverNow represents how mobile technology can be utilized to address a growing public health issue, the feasibility, acceptability and efficacy of tablet-based stroke rehabilitation are unknown. Studies with the goal of establishing feasibility of early tablet-based stroke rehabilitation are needed and, if appropriate, a randomized controlled trial to establish efficacy.

Keywords—aphasia, mobile tablet, recovery, stroke.

In the years to come, the stroke community will be tasked with solving an increasingly important problem: how can early stroke rehabilitation be made accessible to a continuously growing population of stroke survivors when resources are already unable to cope with current needs? Globally in 2010, 16.9 million individuals suffered a first ever stroke and there were 33 million stroke survivors representing increases of 68% and 84% respectively since 1990 [1]. Among the growing number of stroke survivors, one-third of survivors experience aphasia [2], up to two-thirds experience cognitive impairments [3], and another third experience post-stroke depression [4]. These life-altering impairments can prevent individuals from returning to work, engaging in preferred regular activities, and in some cases, prevent independent living.

When combined with acute stroke therapy, stroke rehabilitation reduces odds of death, dependency, and institutionalization [5]. Although the optimal time for beginning stroke rehabilitation has not been identified [6], there is considerable evidence showing that better results are obtained when rehabilitation begins early post-stroke and when therapies are performed intensely [7]. However, many patients are not receiving timely rehabilitation. In Canada, the proportion of patients transferred to inpatient rehabilitation is approximately 16%, even though 40% of patients would benefit from inpatient rehabilitation [8]. Among those transferred, only 50% begin rehabilitation within two weeks. These patients spend an average of eight extra days in acute

care between the completion of acute therapy and assessments, and transfer to rehabilitation facilities [9], often due to resource limitations and shortages in rehabilitation spaces [10]. A similar pattern is seen in the United States with 24% of patients being transferred to inpatient rehabilitation after an average of 27 days from stroke onset [11][12]. Patients experience significant down-time during their acute care stay, spending more than 50% of their time resting in bed and only 13% of time engaging in recovery [13]. It is during this down-time where the proposed mHealth strategy to improve access to early stroke rehabilitation could be implemented.

1 The mHealth Strategy

Mobile health technology may be able to provide a solution to increase the availability of early stroke rehabilitation through relatively economically-efficient means. Mobile technology has become ubiquitous and affordable, and if carefully developed in collaboration with health experts and evaluated using robust scientific methodology, this technology can be used to effectively provide therapy. In particular, tablet computers are of interest as they are compact yet large enough to be easily manipulated by stroke survivors. Recently, there have been a number of studies exploring the feasibility and effectiveness of various tablet-based stroke therapies and stakeholder perspectives on their usage [14]-[18]. Although these studies are typically small pilot studies of varying quality, they reflect the growing interest in tablets as a means of providing therapy.

Transforming a tablet into a stroke rehabilitation platform would reduce patient dependence on bedside therapist visits for engagement in rehabilitation activities while in acute care. Instead, a streamlined approach can be taken where a therapist assesses a patient and prescribes a personalized rehabilitation regime directly through the platform. Between therapist assessments, medical tests and other acute care activities, patients could independently engage in their prescribed rehabilitation activities. Their progress could be monitored remotely, and regimes adjusted to reflect their current state – all without a bedside visit. Furthermore, patients would have access to rehabilitation regardless of how they proceeded through the continuum of care; whether they continue to inpatient rehabilitation or directly to the community, as the device is easily portable. How to go about harnessing the power of mHealth technology to provide tablet-based stroke rehabilitation is dependent on close collaboration between software developers and stroke rehabilitation experts.

2 RecoverNow: A Mobile Tablet-Based Platform for Early Stroke Rehabilitation

The need for a cost-efficient means of improving access to early rehabilitation paired with the power and affordability of current mobile technology led to the development of RecoverNow at The Ottawa Hospital. RecoverNow is an Android tablet-based early stroke rehabilitation platform designed for use in the acute care setting.

The platform is a custom Android launcher (home screen) limiting the patient to a list of tailored therapeutic apps that can be swapped in and out by therapists, depending on patient rehabilitation needs (Figure 1). By harnessing tablet technology and currently available apps, patients can begin speech language therapy and occupational therapy while in acute care, and use the device to supplement therapy during inpatient or outpatient rehabilitation. RecoverNow empowers stroke survivors with the ability to control when and how often they choose to engage in rehabilitation, while still receiving guidance from rehabilitation professionals.
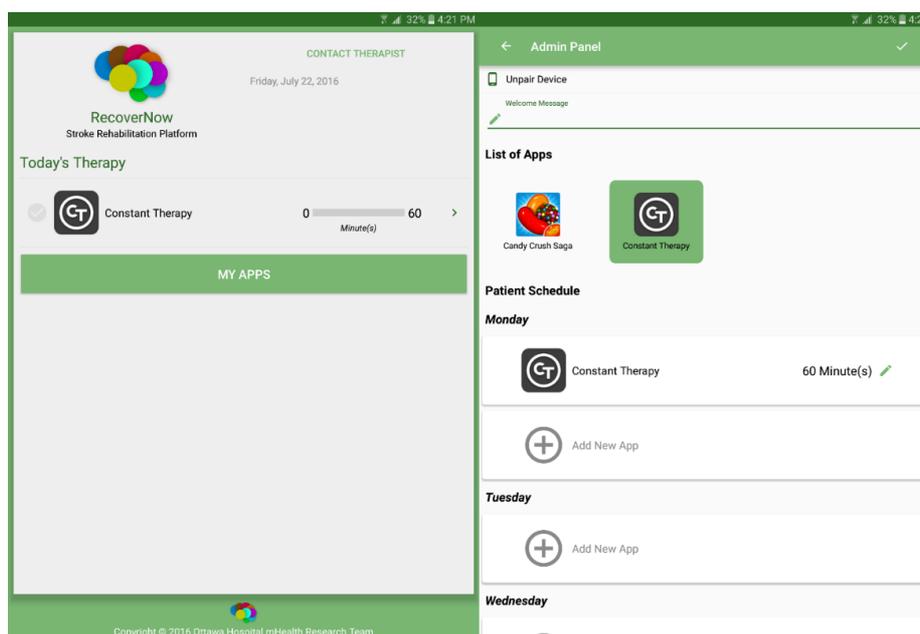

Fig. 1. Tablet screenshot of RecoverNow patient homepage (left) and therapist administration portal (right)

Once patients are admitted to an acute care facility for stroke and have completed the standard of care allied health assessments, early rehabilitation can begin via mobile tablet. Based on the assessments, patients and their therapists can select apps best suited towards their specific deficits and recovery goals. The included apps are selected from pre-existing products in the Google Play Store, that may either be directly therapy-related (ex: Constant Therapy for aphasia and cognition) or simply games that are selected by therapists to help improve certain motor, cognitive, linguistic and/or perceptual processes (ex: Fruit Ninja for cuing, fine motor control and frontal inhibition). Furthermore, a Patient Health Questionnaire (PHQ-9) app allows for quick and easy depression screening. As soon as apps have been selected and app usage goals assigned, the patient is ready to begin tablet-based therapy.

While engaging in therapy between regularly scheduled tests and assessments, patients can use the cellular capabilities of the tablet to keep in contact with their thera-

pist. A messaging system using a pre-defined list of messages can be used to communicate technical difficulties or displeasure with the recommended apps. A desktop administration portal allows therapists to remotely update the apps patients can access on their tablets based on patient feedback or follow-up assessments. The administration portal can also be used to change recommended app usage goals and track the amount of time patients have spent engaging in therapy. Based on app usage data, therapists can identify patients who have difficulty adhering to the prescribed therapeutic regimen, send personal messages of encouragement, or prescribed less challenging apps (Figure 2). All of this information can be transmitted and received in real-time via a cellular connection, thereby avoiding the need to use institutional wireless networks thus alleviating some security concerns.
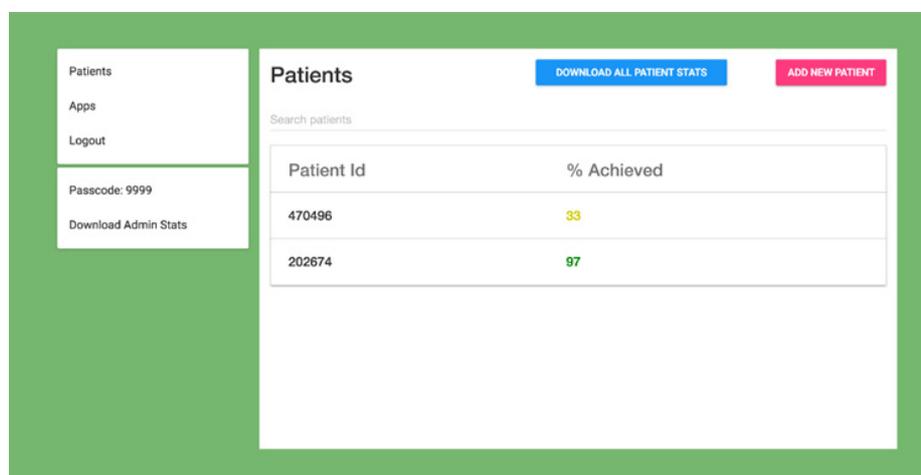

Fig. 2. RecoverNow web administration portal. Patients with app usage achievement below 50% of recommended time are highlighted for easy identification

Therapist-patient communication and regular assessments create a cyclical process where recommended apps continually change based on patient feedback, adherence and recovery progress. This cyclical prescribe-engage-assess process can continue remotely as patients continue to recover (Figure 3). Rehabilitation with the remote guidance of a therapist can similarly continue after discharge, and throughout the transitions of care.

3 Limitation of Tablet-Based Stroke Rehabilitation

Tablet-based stroke rehabilitation platforms like RecoverNow are an economically attractive means of offering early rehabilitation to patients who would otherwise receive little to no immediate therapy while in acute care. However, this solution is limited in that it currently lacks the full comprehensiveness of a typical stroke rehabilitation program. In particular, physiotherapy is difficult to provide without supervi-
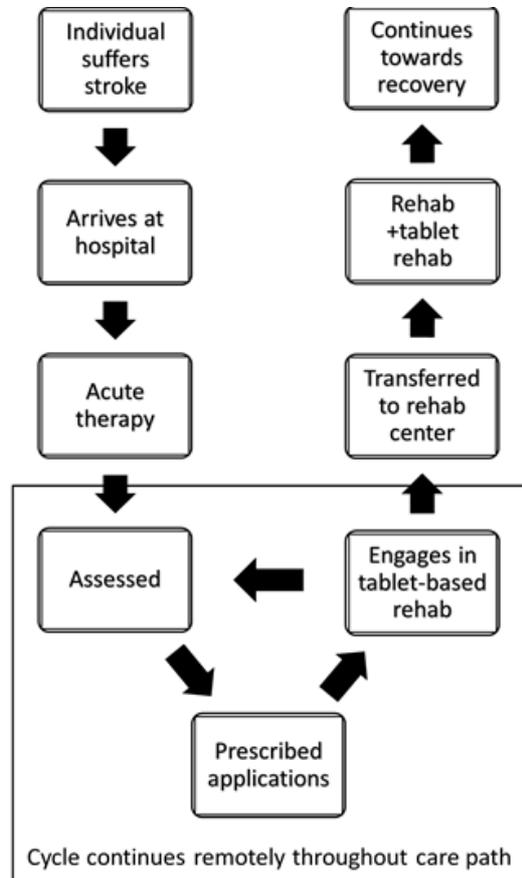
Fig. 3. Use-case scenario of tablet-based rehabilitation in the stroke-care pathway

sion to ensure safety in the early post-stroke setting. There are also limits to which stroke survivors will be able to manipulate tablets in order to participate in therapy. Individuals without a functional upper limb may have limitations using tablet-based therapies, as would individuals with severe comprehension deficits. It is therefore unclear if tablet-based therapies are feasible for patients with more severe strokes.

Even if feasible for patients, the acceptability of tablet-based therapy is unclear. Some patients may have concerns about their anonymity using platforms that capture and transmit detailed participant usage data including apps accessed, the length of the app usage session, and the date and time of each app usage session. Online platforms also carry the risk of security and privacy breaches that may be concerning to some patients due to the collection and storage of the potentially sensitive personal usage data listed above. However, little is known about tablet-based therapy and the communication of this information is crucial as it is needed to evaluate patient adherence with the daily app usage recommended by therapists, and therefore the feasibility of offering tablet-based stroke rehabilitation in the acute setting.

4 Next Steps

There is an urgency to pursue the rigorous development and evaluation of tablet-based strategies for increasing accessibility to early stroke rehabilitation. Both the health system need and mobile technology are present, what remains is to answer questions regarding feasibility, acceptability and efficacy. Although there are some small pilot studies supporting the feasibility of tablet-based therapy for stroke patients [14][16], there appears to be no evidence regarding acute patients. Mobile devices and rehabilitation platforms/apps need to be put into the hands of acute stroke patients in the form of well-designed longitudinal studies in order to establish therapy adherence, barriers to use, and to generate patient feedback that can be integrated into the design of tablet-based therapy platforms and apps. Once deemed feasible and acceptable, a randomized controlled trial would be appropriate to determine if tablet-based therapy in addition to standard stroke rehabilitation results in better functional outcomes when compared to standard care alone.

5 Conclusion

There are currently not enough resources to meet the demand for early stroke rehabilitation and without cost-effective solutions the demand is likely to continue rising above the limited number of available therapists and inpatient rehabilitation beds. It follows that these barriers to early therapy will prevent patients from achieving maximum recovery and increase the number of survivors requiring some form of assisted-living. This public health problem could potentially be addressed using mobile technology, specifically mobile tablet-based stroke rehabilitation. Tablet-based rehabilitation has the potential to empower stroke survivors to take an early active role towards recovery. This promising strategy requires evaluation to establish feasibility and acceptability before attempting to establish efficacy. If successful, more stroke survivors will be able to maximize their recovery potential through easy access to early stroke rehabilitation.

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