AIMS Medical Science

AIMS Medical Science, 5(4): 337–347.
DOI: 10.3934/medsci.2018.4.337
Received date: 22 June 2018
Accepted date: 19 September 2018
Published date: 16 October 2018

http://www.aimspress.com/journal/medicalScience

Research article

Predicting interest to use mobile-device telerehabilitation (mRehab) by baby-boomers with stroke

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Abstract: *Context and purpose:* Demand for stroke rehabilitation services are reaching unprecedented levels due to an overall population aging, driven by the aging of the baby-boomer generation. Delivery of rehabilitation via mobile-device technologies may provide advantages towards meeting the increasing demands on the rehabilitation system by providing individuals with rehabilitation services in their homes and communities. The aim of this paper is to gain an understanding of the interest of current baby-boomers with stroke to use mobile-device technology to receive rehabilitation services such as education, assessments and exercise programs (mRehab). *Methods:* People living in the community with stroke born between 1946 and 1964 (i.e., baby-boomer generation) who participated in a larger telerehabilitation survey were included in this study. Regression modeling was used to evaluate personal, health/disability and technological predictors of interest to use mobile-devices for telerehabilitation. *Results and significance:* Fifty people with stroke, mean age 62.7 (4.4) years, 58% male, 54.2% with moderate or moderately severe disability were included; 86% had access to a mobile phone or tablet. Regression analysis resulted in statistically significant personal (education, β = 0.29 [95% CI = 0.05 to 1.11], population of residence, β = 0.30 [95% CI = 0.07 to 0.69]), health (comorbid conditions, β = 0.30 [95% CI = 0.02 to 0.20]) technology (ownership, β = 0.26 [95% CI = 0.01 to 0.86] and attitude towards telerehabilitation, β = 0.25 [95% CI = 0.01 to 0.79]) predictors of interest to use mobile-devices for telerehabilitation (R^2 = 33.1%).

This study identifies personal, health and technological factors which predict interest of baby-boomers with stroke with ongoing and complex health needs to use mRehab. Health professionals can use this information as they integrate mRehab into their practice and inform future development of mRehab solutions.

Keywords: rehabilitation; internet

Abbreviations: FCI: Functional Comorbidity Index; mHealth: mobile health; mRehab: mobile rehabilitation (telerehabilitation delivered using mobile-devices); mRS: modified Rankin Score

1. Introduction

Stroke is a common occurrence worldwide and is associated with older age [1]. One in four men and one in five women over 45 experience a stroke if they live to be 84 years old [2]. The baby-boomer generation (people born between 1946 and 1964) represent a growing demographic within the stroke population due to their aging. Additionally, high rates of survival in high socioeconomic countries (i.e., 74% at one year [3]) will add to these numbers over the next few decades. With over 65 million baby-boomers in the United States of America, the magnitude of this issue is concerning [4]. Without the development and investigation of novel health and rehabilitation service delivery alternatives for people living with stroke, the demand for health services, particularly rehabilitation, will eventually exceed supply, resulting in unmet health needs and significant economic and social burden.

Telerehabilitation is a novel solution proposed to meet the demands on the rehabilitation system and is typically delivered using computers and teleconferencing technologies located at hospital or rehabilitation settings in urban city centers to deliver services to patients in rural and remote areas. The use of these technologies to deliver stroke rehabilitation services from a distance increases accessibility of specialized stroke services to underserved groups and communities [5] and has been shown to improve both health and rehabilitation outcomes, along with patient and provider experiences without substantial cost increases [6].

Recent advances in technology such as widespread wireless internet access, combined with development and use of mobile-devices (e.g., smartphones, tablets) to access the internet, is broadening the potential of telerehabilitation, as it has already done for telehealth [5]. The use of mobile-devices for the delivery of health services (i.e., mHealth) is defined as “medical and public health practice supported by mobile-devices” [7]. mHealth use is common in older adults with nearly 30 million adults in the United States using mHealth for health related activities with positive results [8]. Examples of mHealth use include communication with health professionals [6], assessment purposes [9] and education and the delivery of medical interventions [10].

Despite this growing body of research, the use of mobile-devices for the delivery of rehabilitation services (i.e., mRehab) is less often applied in practice. In fact the majority of people with chronic health conditions requiring rehabilitation have limited awareness of mRehab related solutions. Only around 16% of people with stroke are aware of the capacity of mobile-devices to assist with their rehabilitation, despite the fact that 93% of people living with stroke in the United States of America report ownership of a mobile device [11].

Familiarity with and access to mobile-devices are issues that will influence the usability of mRehab [12], as will personal and health or disability related factors. For example higher education status has been linked to interest in receiving health related information via text in younger people [13]. For people with chronic diseases like stroke health related factors such as concurrent co-existing other chronic diseases may also impact the perceived usefulness of technology to assist with the delivery of rehabilitation services, however this is currently unknown.

An understanding of the factors that impact interest to use mobile-device technology to receive rehabilitation by people with stroke will inform the development of targeted mRehab programs and increase their relevance and usefulness. While our team has identified that people with stroke have shown interest in receiving rehabilitation services remotely, the specific personal, health or disability, and technology factors that impact interest has not been explored [14], particularly among the baby boom generation.

The objectives of this study were to: 1) describe the use of mobile-devices by baby-boomers who have had a stroke; and 2) identify personal, health or disability, and technology related factors that predict the interest of baby-boomers with stroke to receive mRehab.

2. Materials and methods

Study design and participants: Participant data (obtained from a larger cross-sectional survey [14]) aimed to describe the access to low cost consumer technologies (mobile and non-mobile) and willingness to use those technologies to receive stroke rehabilitation services. Between March and April 2015, 102 participants were recruited using a convenience sampling strategy. Individuals from a rehabilitation hospital's research database were contacted by the research team and provided study information. The research team also presented the study to stroke recovery groups (in both urban and rural settings) and requested stroke advocacy and community groups to send study information to their membership. While participants were enrolled in the larger study if they had a stroke, were at least 19 years of age, lived in the community, and were able to understand English and provide informed consent, we only included those participants in the present study if they were a baby-boomer (i.e., born between 1946–1964, ages 54–72).

3. Measures

Mobile communication technology variables: A study specific survey collected data on our dependent variable of interest as well as other technology related variables. The survey was developed by the research team and inquired about access to rehabilitation services following stroke, use of communication technologies, and perspectives of telerehabilitation. Details of the survey are reported elsewhere [14].

Dependent variable: Interest to receive telerehabilitation for assessments, exercise programs, and education services was assessed using six-items in the survey as shown in Appendix 1. Participants were asked their level of interest to receive each of the three services, using two types of mobile devices: (i) mobile-phone; (ii) tablet. Response options ranged from 1 (not interested) to 3 (very interested). Mean scores were derived with higher scores indicating greater interest.

We also inquired about access to mobile communication technologies (e.g. mobile-devices, cell phone or tablet) that people have access to (yes/no), frequency of use (never/once per month/once per week/daily), and confidence with using the mobile technology (not confident/somewhat confident/very confident). We also assessed attitude towards telerehabilitation using 10 items (e.g., how much do you agree or disagree about the use of technology to receive rehabilitation, lead to more independence, confident in ability to manage progress, enhance current care). Response options for each of the 10 items ranged from one to four (strongly disagree, disagree, agree, strongly agree), with higher scores indicating a more positive attitude towards telerehabilitation, as shown in Appendix 2.

We inquired about access to rehabilitation services following stroke (e.g., type of rehabilitation, location and distance to travel to receive rehabilitation) and difficulties with access (no difficulty, some difficulty or a lot of difficulty).

Personal factor variables: Participants completed a demographic and stroke information form comprised of questions related to age, sex, ethnicity, marital status, employment status, education, income and population setting. Questions also asked about the number of strokes, type of stroke, and difficulties with accessing and receiving rehabilitation (no difficulty/some difficulty/a lot of difficulty).

Health/disability factor variables: The modified Rankin Scale (mRS) was used to describe the sample's stroke severity [15]. The mRS is a reliable and valid scale that measures the level of post-stroke functional independence [16]. mRS levels range from zero (no symptoms) to five (severe disability requiring constant care).

The Functional Comorbidity Index (FCI) was used to estimate the number of comorbid conditions participants had [17]. The FCI asked participants if a health professional had told them that they have a specific condition (e.g. heart disease, diabetes, arthritis). Eighteen conditions are asked and participants responded "yes" or "no". Total scores ranged from 0 to 18 self-reported comorbid conditions. Higher scores indicated more comorbid conditions. Research shows FCI measurements are associated with levels of physical function[17].

Research protocol: After providing written informed consent, participants completed the questionnaires by phone, online, in-person or by mail. All participants received a $10 gift card. Approval for this study was obtained from the university's research ethics board, and the local health authority.

Data analysis: In this secondary analyses of data descriptive statistics were used to characterize the sample and their responses to the survey items. Continuous variables were expressed as means and standard deviations, and categorical variables as frequency counts and percentages.

Regression modeling: We used hierarchical linear multivariable regression modeling to identify personal, health/disability, and technology-related predictors of interest to receive mRehab. Personal factor variables were entered first into the model (Model 1), followed by the health/disability factor variables (Model 2), and then the technology-related variables (Model 3). The order of variable entry is consistent with other multivariable research examining proximal factors first, followed by the examination of increasing modifiable and distal factors, while controlling for the less modifiable proximal factors [18,19]. Regression modeling: Using G*power [20] we determined that 50 participants along with five predictor variables would have 80% power to detect a statistically significant R^2 increase (from 0) of 0.23 (i.e., medium to large effect) at an alpha of 0.05.

The number of independent variables modeled was based on the final sample size and determined using the one variable for every 10 participant ratio [21]. To reduce the number of candidate independent variables we only included those categorical variables with a statistically significant ($p \leq 0.05$) mean difference in the dependent variable, determined using independent sample t-tests or one-way ANOVAs, as well as continuous variables with at least a fair association (i.e. $r \geq 0.25$) [22] with the dependent variable. If no variable met the entry criteria in a particular domain or if there were fewer variables than the maximum allowed, the variables with the largest correlations or mean differences were selected for entry. All data were analyzed using SPSS (Version 23.0) [23].

4. Results

Fifty participants met the inclusion criteria in this secondary data analysis. Twenty-seven people completed the survey online (16 in-person, 6 mailed in their responses, and 1 person completed the survey over the phone). The mean age of the sample was 62.7 (SD = 4.4), 29 (58%) were male, 44 (90%) had at least a high school education, 32 (64%) were from a larger city center, and 21 (55%) reported having at least one comorbid condition to stroke. Sample characteristics are further detailed in Table 1.

Table 1. Sample characteristics (n=50)

	Mean (SD) or Frequency (%)
Age (years)	62.7 (4.4)
Time since stroke (years)	9.0 (6.6)
Male	29 (58.0%)
Caucasian	38 (76.0%)
High school education	44 (89.8%)
Married	32 (64.0%)
Retired	19 (38.0%)
Household income:	
<30,000CAD	13 (30.6%)
30,000 to 49,000CAD	12 (24.4%)
50,000 to 69,000CAD	7 (14.2%)
>70,000CAD	3 (6.1%)
Prefer not to answer	12 (24.5%)
Larger city center (>1 million people)	32 (64.0%)
Type of stroke	
Ischemic	19 (39.6%)
Hemorrhagic	17 (35.4%)
Unknown	12 (25.0%)
>1 stroke	18 (36.7%)
Multimorbidity	21 (54.7%)
FCI	2.0 (1.7)
Stroke severity (mRS)	
No symptoms	1 (2.1%)
No significant disability	7 (14.6%)
Slight disability	12 (25.0%)
Moderate disability	11 (22.9%)
Moderately severe disability	15 (31.3%)
Severe disability	2 (4.2%)
Interest to receive telerehabilitation	1.7 (0.6)
Attitude towards telerehabilitation	2.7 (0.4)

mRS = modified Rankin score.

The most common type of rehabilitation that the participants had already received in a traditional way was physical therapy (98%), followed by occupational therapy (86%), and speech language therapy (72%). Twenty-six (52%) respondents reported having some or a lot of difficulty getting enough rehabilitation, and 22 (44%) reported difficulties having their questions answered. When asked about difficulties attending health/rehabilitation appointments, 22 (44%) reported difficulties attending appointments due to their health, 26 (52%) experienced difficulties due to travel, and 20 (40%) had difficulties due to costs of travel to appointments.

Overall, 42 (84%) of respondents reported having a mobile device (i.e., cellphone or tablet). Of the 36 (72%) people who owned a cellphone, 26 (72%) used it on a daily basis, 6 (17%) used it on a weekly basis. Thirty-four (94%) were either somewhat or very confident with using cellphones. Of the 28 (56%) people who owned a tablet, 15 (54%) used it on a daily basis, 9 (32%) used it weekly. Twenty-six (89%) were somewhat or very confident with using tablets. The mean scores for interest to receive telerehabilitation using mobile-devices for assessments, exercise programs, and education.

Based on our modeling criteria we included two personal factor variables (high school education: Yes or no and larger city of residence: Yes or no), one health/disability variable (number of comorbid conditions), and two technology variables (ownership of a mobile-device: Yes or no, and attitude towards telerehabilitation). We used the Statistical Analyses and Methods in the Published Literature Guidelines to guide the reporting of our results [24].

In Model 1 the R^2 change after adding the two personal factor variables was 17.1% and statistically significant (F2, 44 = 4.55, p = 0.02). The adjusted R^2 was 13.4%. Having at least a high school education was a statistically significant predictor of interest to use mobile-devices for telerehabilitation, but the size of population setting was not. Table 2 presents the regression results for all models.

In Model 2, the R^2 change after adding the number of comorbidities variables was 9.7% and statistically significant (F1, 43 = 5.69, p = 0.02). The number of comorbid conditions variable and both personal factor variables were statistically significant predictors of the dependent variable. The overall adjusted R^2 was 21.7%.

In Model 3 the R^2 change after adding the two technology-related variables was 13.5% and statistically significant (F2, 41 = 4.65, p = 0.02). Both the device ownership and attitude towards telerehabilitation variables were statistically significant predictors, as were the other personal and health/disability variables. Overall the number of comorbidities was the strongest and most precise predictor of telerehabilitation interest, followed by size of population setting, high school education, device ownership and attitude towards telerehabilitation. The overall adjusted R^2 was 33.1%.

Table 2. Hierarchical regression modeling to identify predictors of interest to use mobile technologies to receive rehabilitation assessments, therapy, or education.

	Model 1 equation				Model 2 equation				Model 3 equation			
	b	SE	β	95% CI	b	SE	β	95% CI	b	SE	β	95% CI
Constant	0.93	0.28		0.36 to 1.50	0.56	0.31		−0.07 to 1.18	−0.69	0.59		−1.87 to 0.50
Personal												
High school education	0.65	0.28	0.32	0.10 to 1.21*	0.79	0.27	0.39	0.25 to 1.34*	0.58	0.26	0.29	0.05 to 1.11*
Larger population	0.31	0.18	0.25	−0.04 to 0.67	0.35	0.17	0.27	0.01 to 0.69*	0.38	0.16	0.30	0.07 to 0.69*
Health/disability												
Comorbidities					0.11	0.05	0.32	0.02 to 0.21*	0.11	0.05	0.30	0.02 to 0.20*
Technology												
Device ownership									0.43	0.21	0.26	0.01 to 0.86*
Attitude									0.40	0.19	0.25	0.01 to 0.79*
adj R^2	0.13				0.22				0.33			

* = $p \leq 0.05$; b = unstandardized coefficients; SE = standard error; β = standardized coefficients; CI = confidence interval; adj = adjusted; n = 50.

5. Discussion

In this research we observed personal factors (education and population of residence), health (number of comorbid health conditions) and technology (ownership and attitudes towards telerehabilitation) variables to significantly predict the dependent variable, interest to use mobile-devices to receive rehabilitation, and account for 33% of the variance. The baby-boomer participants in this study had a high level of access to mobile devices and used them regularly. While 84% seems a high rate of access to these devices, it is in line with other studies that have shown access by people with stroke of 93% [11]. Usage by participants in our study to use mobile-devices was generally high, with daily or weekly use described by most participants. This sets an important context for access to services provided by these devices.

We observed use mobile-devices for rehabilitation was most influenced by personal factor variables combined were observed to be the most influential (13%), followed by technology variables (11%) then by health (9%). The number of comorbid conditions was the strongest independent predictor, accounting for 9% of the variance alone. The reason for this may be practical in that people with multiple diagnosed health needs inherently require more interactions with health professionals. Thus to reduce the burden of navigating the health system that requires patients with multimorbidity to make multiple visits with different health professionals, these individuals may view the use of technology as a more efficient method to deliver and receive health services, especially if the services may be accessed in their own homes/communities. Using mRehab to communicate with health professionals when multiple health professionals are involved in care management may also be a reason that people with multimorbidity are more interested to use mobile rehabilitation solutions. For people with multiple chronic conditions increased communication with rehabilitation professionals has the capacity to encourage people to be more active in shared decision making [25].

Previous research of mRehab among people living with stroke was not able to identify personal factors that indicate interest to use this technology [11]. Our study identified two; having higher education and living in a larger population center. Our study suggests that people in larger populations see benefits in having access to health services and connection with clinicians in ways that are more flexible. This adds to previous literature describing the delivery of health and rehabilitation services via technology as a solution to address the needs of people in rural communities. This may be due to issues around transportation, including costs and difficulties reported in attending health professional appointments. For people after stroke the loss of a license to drive is reported to affect 70% of people [26] and negatively influences participation in many aspects of life, including attending health appointments. It may also reflect a societal change or a characteristic of the baby-boomer group who are more likely to want accessible personalized health care more conveniently. People after stroke often have complex rehabilitation needs that would benefit from an individualized program, and the ability of mRehab solutions to personalize care may be perceived as beneficial.

People who owned mobile-devices were more interested to use them to receive rehabilitation than people who did not own a mobile-device. While this seems intuitive, it is an attribute of the baby-boomer age group that they are very competent with technology [27]. This finding can be explained by the potential that baby-boomers see in the use of mobile technologies to receive health services, as “attitude” was also a significant predictor of interest to receive telerehabilitation. That is, people who had better attitudes about the use of mobile-devices to receive rehabilitation were also more interested to receive telerehabilitation. Increasing ownership of technology and developing programs to improve attitudes of using technology for rehabilitation services are simple solutions that may prove beneficial towards the acceptability and use of mRehab programs, which in turn may reduce demand on the existing rehabilitation system. It may be that education and training around the use of new technology that uses mobile devices can overcome hesitation and improve attitudes to use of this medium for health service delivery.

Limitations: Our study may have had a sampling bias in that individuals who had access and familiarity with technological devices may have been more likely to participate in the study. As well, due to our sample of convenience, the results may not accurately represent the population as a whole. Furthermore, due to our online advertising of the study and community groups sending study information to their membership, we are unable to determine an exact response rate. Finally, the cross-sectional nature of this study limits our ability to make causal inferences.

6. Conclusion

Baby-boomers with stroke have a high level of access to and are interested to use mobile-device technologies to receive rehabilitation services. People with stroke and other comorbid conditions show a higher interest to use mRehab than those without comorbid conditions. Access and attitude to technology add to the factors which impact interest to use mRehab. Rehabilitation professionals may use this information in their service delivery models to improve personalized care and communication with their clients to address the anticipated growing need. Technology developers may also use this information to meet the multiple health needs of people with stroke when developing technological solutions for the provision of rehabilitation services such as education, assessments and interventions.

Conflict of interest

All authors declare no conflicts of interest in this paper.

Funding

Professor Janice Eng is in receipt of funding from the Canadian Institutes of Health Research (FDN 143340) and is supported by the Canada Research Chair Program.

Dr. Brodie Sakakibara is supported by CIHR and MSFHR Postdoctoral Fellowships.

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