Cost Analysis of Home Telerehabilitation for Speech Treatment in People with Parkinson's Disease

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Abstract

Purpose:

Geographical barriers and impaired physical mobility among people with Parkinson's disease (PD) hinders their timely access to speech pathology services. We compared the costs of delivering a speech treatment via in-person consultation versus telerehabilitation.

Methods:

We used data from a noninferiority randomized controlled trial delivering the Lee Silverman Voice Treatment (LSVT LOUD[®]), where patients with dysarthria associated with PD were assigned to either the urban in-person group (n=16) or the urban online group (n=15), supplemented with a non-randomized group (regional online: n=21). We compared costs over a 1-month treatment period from a health system and a patient perspective.

Results:

The mean treatment costs of both urban online (\$1,076) and regional (\$1,206) treatments tended to be slightly higher than urban in-person (\$1,020) from a health system perspective. While from patient's perspective, the mean treatment cost was \$831 in urban in-person group, \$247 in urban online and \$200 in the regional group.

Conclusion:

LSVT LOUD® may be delivered via telerehabilitation at a slightly higher cost than in-person delivery from a health system perspective but is cost-saving from the patient's perspective. Telerehabilitation is an economically beneficial alternative for the delivery of the LSVT LOUD® program in PD patients with speech disorders.

(196 words)

Introduction

Parkinson's disease (PD) is the second most prevalent neurological disorder in Australia ¹. The primary speech disorder, hypokinetic dysarthria, is common in PD and causes a progressive loss of communication in patients, limiting their social interactions and activities of daily living ²⁻⁶. Behavioural therapy is the gold standard care for this speech disorder in PD patients and the Lee Silverman Voice Treatment (LSVT LOUD®) is the most efficacious treatment available ⁷. Despite the compelling evidence for its benefits, the utilization of LSVT LOUD® remains sub-optimal. A recent survey in Australia found that only one-third of the speech-language pathologists (SLPs) offered LSVT LOUD® to their patients ⁸. Further, patients received SLPs services at much later disease stages than ideal and when communication abilities were already being moderately to severely affected ⁸. The reasons for poor utilization of the LSVT LOUD® are multifaceted; however, the intensive treatment schedule (one hour per day, four days per week, for four weeks) and distance/travel difficulties are two of the most frequently cited barriers ^{7, 9, 10}.

To deal with some of these barriers and improve the utilisation of LSVT LOUD® among PD patients, alternative models of care such as home-based telerehabilitation have been proposed and tested. Telerehabilitation is a platform for delivering rehabilitation services at a distance and could help to negate utilization issues by allowing the delivery of care directly into the patient's home¹¹. Evidence indicates that telerehabilitation can be successfully implemented in routine care. For example, a systematic review of sixty-one studies found that 71% of the telerehabilitation services were successful in patients with physical disabilities¹². For speech disorders, the use of telerehabilitation has been found to be non-inferior to in-person rehabilitation programs¹³.

Home-based telerehabilitation may alleviate the distance barrier, deliver patient-centered care, enhance compliance and provide an opportunity for real-time supervision¹¹. However, the economic consequences of implementing and offering home-based telerehabilitation remain unknown. Moreover, the costs of delivering telehealth interventions have substantially changed in the recent years due to technological advancement, affecting both patients (e.g. increased household internet access) and treatment providers (e.g. the move from hardware to software-based platforms). We recently reported that home-based telerehabilitation delivery of the LSVT LOUD® was non-inferior to LSVT LOUD® delivered FTF in terms of speech (acoustic, perceptual) and quality-of-life outcomes⁷. As a follow-up to this study, we undertook an economic evaluation of these interventions to guide the future acceptance of this new delivery model by policymakers. Consequently, the objective of this study was to assess the costs of delivering LSVT LOUD® via home-based telerehabilitation and the in-person delivery of the same program in patients with PD.

Methods

Design

A trial-based cost analysis was conducted from an Australian health system and a patient perspective. We used data collected as part of single-blinded, randomized controlled non-inferiority trial conducted among three groups from a large urban centre and a regional area for patients with hypokinetic dysarthria associated with PD conducted in Queensland, Australia. In brief, one group (n=16), from the urban centre was assigned to in-person delivery of the intervention (hereafter “in-person”), another group (n=15) also from the same urban centre was assigned to online delivery of the intervention (hereafter “urban online”) and a third group (n=21) from a regional area was assigned the same online delivery of the intervention (hereafter “regional”). The intervention was the Lee Silverman Voice Treatment (LSVT LOUD[®]) treatment. The treatment procedure involved two baseline assessments, 16 one-hour sessions of speech treatment, and two post-treatment evaluations.

Following baseline assessments, each participant underwent the LSVT LOUD[®] program delivered by a certified research SLP for 1 hr/day, 4 days/week, for 1 month. Each session consisted of three repetitive drill exercises and functional speech activities. Patients also received daily home practice activities. Patients in the online groups received the LSVT LOUD[®] at home via a telerehabilitation system video-linked with an SLP located at the research institution. Patients in Group 1 received the LSVT LOUD[®] in-person at the research institution. The online evaluation and treatment was conducted using eHAB (Version 2.0), a mobile multimedia telerehabilitation system developed in the Centre for Research in Telerehabilitation at the University of Queensland. Further detail on the overall conduct of the trial and patient demographics has been published elsewhere ⁷. The trial received ethical approval from the University of Queensland, Australia (HREC 2009001863).

Data collection

Costing followed the standard approach used in economic evaluation including identification of the resources used, measurement and valuation¹⁴. The resource utilization was collected during the intervention period by the research team for all three groups. We included the cost of the intervention's technology (computers and software) and the professional services provided by the SLPs. Since the original study was conducted, there has been a technological shift in the telerehabilitation system from a physical and mobile system (eHAB™ Version 2.0) to a software-based platform (eHAB® software). Therefore, the cost of software-based platform of telerehabilitation system was only considered for this analysis. Detailed cost assumptions and resource utilization are provided in Table 1. We excluded the cost of the internet connection and broadband services as approximately 90% of Australian households have internet access¹⁵. The technology used in the in-person group consisted of a suitcase type of device including a laptop (AU\$600) and software (AU\$500) to measure vocal parameters. The cost of device and iPad (AU\$719) used by patients in online groups were annuitized¹⁴ to obtain an equivalent monthly cost for the capital outlay based on an initial purchase price, the usable life of 3 years and the annuity factor corresponds to an interest rate of 5%. For online groups, eHAB software version (AU\$107.60/patient for 16 hours) was costed. One clinician was assumed to treat 5 patients consecutively as the new eHAB software required less time per patient than the old eHAB 2.0 system.

Speech pathologists' labour costs of providing 16 treatment sessions per patient were based on: treatment time (60 minutes/session), data management (20 minutes/session), and preparation time (10 minutes/session). For online groups, we used the actual duration for online sessions observed in the RCT to account for occasional connection dropouts/re-establishing as expected in the real world. We used the average salary of

AU\$58.50 per hour based on the wage rates of Queensland State Department of Health ¹⁶ and added salary on-costs 28% to reflect the actual value of the clinicians' time to the business. The same personnel rates were applied to both in-person and online groups. No travel costs were considered as eHAB software can be simply delivered to patient's personal computer by downloading it directly from the website. For the in-person group, the cost of car travel was calculated as distance multiplied by AU\$0.66 per kilometre, using cents-per-kilometre methods to claim business deductions as per the Australian Tax Office guidelines ¹⁷. In the base-case, patients' time was valued based on self-reported forgone wage and unpaid time was estimated as leisure time foregone. Discounting of costs was not necessary as costs were calculated for one month (program duration). All costs were reported to 2020 US dollar values using the Cochrane recommended web-based tool that enable the conversion of costs across currencies (using purchasing power parities conversion rates) and years (using the gross domestic product deflator index values). The purchasing power parity for 1 AU\$ was 0.70 US\$ in year 2020 ¹⁸.

Data analysis

We performed descriptive statistics due to a small sample size and reported group means, standard deviation and 95% confidence intervals for the means between in-person and Online groups. All analyses were performed using Microsoft Excel.

Results

The characteristics of the participants are shown in Table 2. Of the 52 participants, 36 (69%) were male with a mean age of 71 years (range: 50 to 87). The mean time since diagnosis of PD was 4.8 years (range: 0.5 to 22 years). Among the participants, the severity of dysarthria

was mild (77%), moderate (19%) and severe (4%). As reported in the RCT publication, the baseline characteristics amongst the three groups were similar ⁷.

The estimated mean costs per patient for a month program for the three groups as incurred during the RCT is shown in Table 3. The mean treatment costs of both the urban online (\$1,076) and the regional group (\$1,206) treatments tended to be slightly higher than urban in-person costs from a health system perspective (\$1,020). The majority of the intervention cost accounted for clinician labour (90-95%) in all groups. The impact of location (urban vs. regional) on costs of telerehabilitation was with regional online delivery incurring an extra \$130 in total due to slightly longer online sessions in the regional (mean: 68 minutes) than in the urban group (mean: 61 minutes).

We also assessed the economic benefits to patients in accessing telerehabilitation. From a patient's perspective, the mean treatment cost was \$831 in urban in-person group, \$247 in urban online and \$200 in regional online group. The cost differences were due to the absence of patients traveling in the online option and lower income loss. The mean total distance to travel to the research centre was 438 km for 16 visits which was reduced to zero in the online groups.

We also conducted a one-way sensitivity analysis. If all patients were assumed to be unemployed or retired and assigned costs for lost leisure time instead of wages, there was no difference for the regional group; however, the total cost reduced by \$216 in urban in-person and \$44 in urban online groups. When regional patients were assumed to have to travel to the research centre instead of the nearest public hospital, telerehabilitation would alleviate the burden of distance travelled by 5.4 times increasing the total cost-saved of \$107 (SD: \$6) per visit and \$1,718 (SD: \$91) per program.

Discussion

This paper assessed whether different modes of service delivery (online vs. in-person) and participant location (urban vs. regional) impact costs to the health system and patients. We found that the LSVT LOUD[®] may be home-delivered online at a slightly higher cost from the health system perspective but at a lower cost from a patient perspective. This is potentially achievable without significantly impacting the clinical outcomes (acoustic, perceptual) and quality of life, as shown previously ⁷. The telerehabilitation program was found to be cost-saving for patients consistent with the previous findings ¹⁹. The impact of location (urban vs. regional) on costs was small assuring that telerehabilitation can be delivered to either location at a similar cost even if in-person session was at nearby public hospitals rather than the research centre. Patients living in more remote areas were likely to derive more cost benefits as they required to travel longer than our regional sample. Further, online telerehabilitation would allow non-remote patients to prioritize the work and social responsibilities which often compete with in-person sessions. This would ultimately improve access to SLPs professional services that are in short-supply, especially in regional and remote areas ²⁰.

The LSVT LOUD[®] program is used worldwide and patients' out-of-pocket expenses may vary widely depending on the reimbursement system. Moreover, unit costs and costing methods vary among jurisdictions making it harder to compare cost estimates across studies ²¹. It is for this reason that we presented detailed cost assumptions and a cost breakdown for local adaptations to inform funding decisions in the jurisdiction of interest.

We also recognize some limitations. First, the non-inferiority effect was assessed immediately after the intervention in the RCT. It is not known whether or how frequently a follow-up booster is needed to sustain the intervention effect for each modality, and this could involve additional intervention costs over the long-term. Similarly, our results were based on outcomes at one-month period ⁷, which did not capture long-term effects and costs. Second, we used a cost minimization analysis as telerehabilitation was shown to be non-inferior to the in-person ⁷. There is a view, however, that we should aim to estimate cost-effectiveness nevertheless and quantify uncertainty unless a study has been “specifically designed to show the equivalence of treatments” ²². By combining data on effectiveness and cost, we may have been better able to characterize the uncertainty around the estimates. Third, our results should be taken with caution due to our small sample size and the use of assumed values where no empirical data was available.

For some, a in-person modality is not an option due to the traveling logistics, while others may decline treatment as they “would rather do other things” or would not consider speech treatment until their condition worsens “to the point where you couldn’t hear me” ²³; the observation is relatable as 77% of our study population had a mild dysarthria. We believe that our results will provide insight into barriers to early intervention from patients’ perspective and inform providers’ investment decisions in a climate that increasingly seeks comparative assessments of SLP services ^{24, 25} including the LSVT LOUD[®] program. Future research should consider not only program effectiveness or costs, but also patients’ preferences for program delivery (e.g. home-based, waiting time, ability to see the same practitioner each time) as these would affect service uptake as well as patient adherence to treatment.

Conclusions

Telerehabilitation has been shown to be a solution to the physical mobility and distance-related barriers involved in the delivery of speech treatment to people with PD. This study suggests that LSVT LOUD[®] may be delivered via telerehabilitation at a slightly higher cost than in-person delivery from a health system perspective but at a lower cost from patient perspective. These findings support the use of telerehabilitation as an alternative for the delivery of the LSVT LOUD[®] program for disordered speech in PD.

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Table 1: Cost assumptions (per person per one-month program)

Perspective	Resources	Urban in-person (n=16)	Urban Online (n=15)	Regional Online (n=21)
Heath system	Device cost* (amortized)	Software, Laptop	eHAB license fee, Laptop	eHAB license fee, Laptop
	Photocopy	5 pages x 16	1 page x 16	1 page x 16
	Clinician labor cost	16 sessions	16 sessions	16 sessions
Patient	Device cost* (amortized)	NA	iPad	iPad
	Lost income	Self-reported	Self-reported	Self-reported
	Average travel	438 Kms	NA	NA

PC = personal computer; NA = not applicable

* Device costs were amortized to month. Usable life was estimated as 3 years.

Table 2: Characteristics of the participants

Variable	Urban in-person (n=16)	Urban Online (n=15)	Regional Online (n=21)
Mean age (SD)	72 (10)	72 (8)	69 (9)
Male (%)	10 (63)	11 (73)	15 (71)
Mean time post diagnosis, years	5	4	5
Dysarthria severity ^a	1.3	1.3	1.2
SPL monologue (DB)	70	70	71

SPL = sound pressure level

a1 = mild, 2 = moderate, 3 = severe.

Table 3: Mean cost per patient for one-month program

Perspective	Cost component	Urban in-person (n=16)		Urban Online (n=15)		Regional Online (n=21)	
		Mean	SD	Mean	SD	Mean	SD
Health system	Device cost*, amortized (\$)	25	0	97	0	97	0
	Photocopy (\$)	12	0	2	0	2	0
	Clinicians' labor (\$)	983	0	977	71	1107	167
	Total	1020	0	1076	71	1206	167
Patient	iPad cost*, amortized (\$)	-	-	17	0	17	0
	Lost income	531	467	247	99	200	0
	Travel cost†	300	103	0	0	0	0
	Total	831	570	247	99	200	0

*Costs reported in 2020 US dollar values.

† Patients' time cost reflects self-reported forgone wage calculated as mean national hourly wage rate (A\$32.81). The mean distance to research center in the city: 13.7km (urban); 95km (regional).