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Case Report

Otago Exercise Program Delivery using Digital Practice: A Prospective Case Report

Cheryl J. Hardy-Gostin, Kelly J. Negley, Jade J. Bender-Burnett

College of Health and Education, Department of Physical Therapy, Marymount University, Arlington, Virginia, USA

Abstract

Activity restrictions during the COVID-19 pandemic left many older adults without access to community-based falls prevention programs. Despite a lack of evidence to support the digital delivery of exercise and rehabilitation, these services were quickly implemented during the pandemic in an effort to prevent the transmission of COVID-19, yet support a continuity of care. Our report describes the novel practice and digital delivery of a condensed Otago Exercise Program, a well-documented falls prevention program, to an 83-year-old female with high falls risk. After four weeks of the Otago Exercise Program via digital delivery, the patient in our case had notable improvement in her scores on the Timed Up and Go, Five Times Sit to Stand, 30-Second Chair Stand Test and One Leg Stance tests. Our findings necessitate the additional exploration of the digital delivery of exercise for future community-based falls prevention programs and provide an alternate method of delivery for falls prevention for practitioners to consider.

Keywords: Balance, Exercise, Falls, Otago, Telehealth

Introduction

Falls are a leading cause of injury in adults aged 65 and older and a global public health crisis[1]. The COVID-19 pandemic is expected to compound the rising statistics of falls in older adults. Disproportionately affected by the COVID-19 pandemic in terms of morbidity and mortality, older adults have also experienced a decline in activity levels[2]. Lack of physical activity and exercise hastens functional decline and increases fall risk. For older adults participating in community-based classes prior to the COVID-19 pandemic, many of these in-person exercise classes were suspended to mitigate risk of disease transmission. Long-term effects of physical inactivity exacerbated by the pandemic remain to be seen, however, healthcare providers can help minimize functional decline in older adults by promoting evidence-based fall prevention programs[2-3].

The Otago Exercise Program (OEP) was initially developed in New Zealand in the late 1990's and dissemination in the United States began in 2013[4]. The OEP is a multicomponent, evidence-based program that has been well documented to reduce falls and mortality in community-dwelling older adults[3,5,6]. Robertson et al. report that the OEP reduced falls and fall-related injuries by 35% in high-risk older adults[3]. The positive effects of the OEP are most pronounced for older adults over 80 years of age, and in adults who have fallen in the past year[3,5]. Lower fall rates are also documented for community-dwelling older adults who performed the OEP for 12 months[5,6].

Despite the evidence in support of the OEP, widespread implementation has not materialized. Experimentation with delivery models has occurred in an effort to expand the reach to as many older adults as possible[7]. In addition to improving physical function and reducing fall risk[7], video supported, group-based, and DVD delivered versions of the OEP have the potential to reach a greater number of older adults at less cost than home visits with a physical therapist[8]. A feasibility study published in 2016 reported that while fall risk was

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Corresponding author: *Cheryl J. Hardy-Gostin, 11517 Hudson Lane, Gig Harbor, WA 98332, USA*

E-mail: *cherylhardygostin@gmail.com*

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Test	Pre-Intervention	Post-Intervention	Change	MDC
Timed Up & Go	12.19 sec	11.50 sec	0.69 sec	1.8[25]
30-Second Chair Stand Test	8 reps	12 reps	4 reps	2.96[27]
Four-Stage Balance Test	Completed Stages 1-2	Completed Stages 1-4	2 Stages	Not available
Five Time Sit to Stand Test	17.19 sec	13.6 sec	3.59 sec	*2.5[19]
One-Leg Stand	R: 3 sec L: 3 sec	R: 13.28 sec L: 12.94 sec	R: 10.28 sec L: 9.94 sec	24.1[28]

*Abbreviations: sec=seconds, reps=repetitions, R=right, L=left. * Indicates MDC for older adults with hip osteoarthritis.*

Table 1. Changes in Outcome Measures with published MDC values.

reduced in a video based (interactive DVD) delivery model of OEP, there was notable loss to follow-up with limited internal validity which ultimately limited the feasibility of DVD based OEP[9]. A small pilot study investigating the digital delivery of a group OEP found improvements in performance-based measures for both the digital and in-person groups. The sample size was not large enough to establish efficacy of the digital OEP program; however, participants reported satisfaction with both delivery models[10]. Although each delivery model has limitations, choices are important in order to improve participation in and accessibility to evidence-based fall prevention programs.

Digital delivery of physical therapy services exponentially expanded at the onset of the COVID-19 pandemic; however, there is limited research to support the effectiveness of digital delivery of OEP at the individual level with real-time clinician monitoring and interaction. In an effort to maintain continuity of care during the early days of the pandemic, we transitioned to digital delivery of the OEP. The purpose of this case report is to describe our process for the digital delivery of a condensed OEP and assess the impact of this delivery model on falls-related outcome measures in a community-dwelling older adult.

Case presentation

The patient was an 83-year-old female with past medical history significant for cerebrovascular accident and left total knee arthroplasty. The patient lived independently at home and was a prior participant of a community-based fall prevention program. She had no history of falls but reported unsteadiness with fatigue. The patient was referred to physical therapy for balance assessment. Written informed consent was obtained from the patient to document the outcome of this case.

The patient was assessed at the initial virtual visit using the standard OEP outcome measures which include the Timed Up and Go (TUG), 30-Second Chair Stand, and 4-Stage Balance[11]. These tests are not yet validated for digital practice; however, they are supported for use with traditional OEP assessment[11]. All functional tests were assessed using standardized instructions provided within the CDC publication (CDC Guide), "Tools to Implement the Otago Exercise Program: A program to Reduce Falls"[11]. The optimal set up of the room and the angle of the laptop cameras for both the participant and the therapist were determined at the assessment and at each session. The therapist began timing each functional assessment once the instructed movement was initiated, observing the patient over digital format via Zoom (San Jose, CA). To ensure safety during the session, the participant was instructed to stand near a large desk for upper extremity support as needed and to discontinue any activity that challenged her to a point where she was at risk for loss of balance.

Widely used as a screening assessment of mobility and balance in older adults, the TUG is easy to administer and does not demonstrate floor or ceiling effects in older adults[12]. Test-retest reliability has been reported as moderate to high in older adults[13-15]. The TUG has also been determined to have high sensitivity (0.87) and specificity (0.87) for predicting falls in high risk older adults[13]. Bischoff et al. determined that community dwelling females in the age range of 65-85 years should be able to complete the TUG in 12 seconds or less[16]. The OEP uses the cut-off value of ≥12 seconds on the TUG as indicative of being at risk for falls[11]. The patient in this case report initially scored 12.19 seconds on the TUG (Table 1).

Additionally, the Five Time Sit to Stand Test (FTSST)[17-19] and One-Leg Stance (OLS)[22] were completed to provide a more comprehensive assessment of the patient's balance impairment and fall risk. The 30-Second Chair Stand Test and FTSTT have traditionally been used as functional assessment measures of lower extremity strength[17–20]; however, times on the FTSTT have more recently correlated with static balance[17], dynamic balance[19], and scores on the Activities-specific Balance Confidence Scale[18]. The FTSTT has excellent test-retest reliability[17], whereas, the 30-Second Chair Stand Test eliminates potential floor effects[19]. The patient in this case initially completed 8 repetitions on the 30-Second Chair Stand Test and 17.19 seconds on the FTSTT (Table 1).

The 4-Stage Balance Test is designed to evaluate static balance over a progressively narrower base of support[21]. The patient was only able to complete stages 1 and 2 initially on

Visit Number	Week 1	Week 2	Week 3	Week 4	Week 5
Warm Up	Yes	Yes	Yes	Yes	Yes
Strengthening Exercises					
Front Knee	2 x 10, 5 lb.	2 x 10, 5 lb.	2 x 10, 5 lb.	2 x 10, 5 lb.	2 x 10, 5 lb.
Back Knee	2 x 10, 0 lb.	2 x 10, 2.5 lb.	2 x 10, 2.5 lb.	2 x 10, 2.5 lb.	2 x 10, 3 lb.
Side Hip	2 x 10, 0 lb.	2 x 10, 2.5 lb.	2 x 10, 2.5 lb.	2 x 10, 2.5 lb.	2 x 10, 3 lb.
Calf Raises	2 x 10	2 x 10	2 x 10	2 x 10	2 x 10
Toe Raises	2 x 10	2 x 10	2 x 10	2 x 10	2 x 10
Knee Bends	2 x 10	2 x 10	3 x 10	3 x 10	3 x 10
Sit To Stand	2 x 10	2 x 10	2 x 10	2 x 10	2 x 10
Balance Exercises					
Backwards Walk	2x10 ft	3x10 ft	4x10 ft	4x10 ft	4x10 ft
Walk and Turn	3 reps	3 reps	2 reps	3 reps	2 reps
Heel Toe Stand	10 sec x 2	10 sec x 2	10 sec x 2	10 sec x 2	10 sec x 2
Heel Toe Walk	2x10 ft	3x10 ft	4x10 ft	4x10 ft	4x10 ft
Heel Toe Walk Backwards	2 x 10 ft	2 x 10 ft	4 x 10 ft	4 x 10 ft	4 x 10 ft
One Leg Stand	10 sec x 2	10 sec x 2	10 sec x 2	10 sec x 2	10 sec x 2
Heel Walking	4 x 10 ft	4 x 10 ft	4 x 10 ft	4 x 10 ft	4 x 10 ft
Toe Walking	2 x 10 ft	2 x 10 ft	4 x 10 ft	4 x 10 ft	4 x 10 ft
Stair Walking	NA	NA	NA	NA	NA
Self-Report of HEP					
Walking	0 min	0 min	30 min 1 time/week	25 min 2 times/week	23 min 3 times/week
Number of Times OEP Performed as HEP	2	2	2	2	2

Abbreviations: reps=repetitions, R=right, L=left, ft=feet, lb.=pounds, sec=seconds, NA=not applicable, min=minute, HEP=Home Exercise Program, OEP=Otago Exercise Program.

Table 2. OEP Performance Record & Self-Reported Weekly Home Program: Sets x Reps.

the 4-Stage Balance test. One leg stance (OLS) was recorded independently as Vellas et al. reported subjects who were unable to balance on one leg for 5 seconds had a relative risk (RR) of 2.13 for sustaining an injurious fall[22]. Similarly, Muir et al. determined that the adjusted RR for increased risk of any fall was 1.58 if subjects were unable to maintain OLS for 10 seconds or longer[23]. Springer et al. determined the normative value for OLS was 10.6 seconds in females, 80-99 years of age[24]. The OEP also uses a cut-off of 10 seconds for tandem stand and one leg stand[11]. The patient in this case report initially held 3 seconds for each side during OLS assessment, which is below the age matched normative score and indicative of increased falls risk[22-24].

Five digital OEP sessions were supervised over the course of four weeks by the treating physical therapist using Zoom (San Jose, CA). Additionally, the patient performed the OEP program independently at home twice weekly, completing a total of three OEP sessions each week. Each OEP session began with five flexibility exercises followed by strengthening exercises and balance activities; the patient completed a walking program up to 30 minutes, at least twice a week, as recommended in the CDC Guide[11]. Exercise progressions by week are recorded in Table 2. The CDC Guide recommends that patients 80 and older start with two to four-pound weights, progressing the resistance once the patient can complete 2 sets of 10 repetitions[11]. During the initial Zoom (San Jose, CA) session, the patient completed the front knee strengthening exercise for 2 sets of 10 repetitions with 5 pounds. As a precaution, additional strengthening exercises were performed without added resistance until the second visit. The patient did not report any adverse effects; therefore, resistance was increased for side hip and back knee strengthening as the patient was able to complete 2 sets of 10 repetitions with 2.5 pounds. The level of upper

extremity support varied depending on the task to ensure the patient's balance was challenged without risking a fall. In order to effectively monitor the patient's performance and ensure the program was progressed appropriately to maintain the needed challenge level, the treating therapist adjusted the OEP schedule to include weekly visits rather than providing four visits over the first eight weeks as indicated in the CDC Guide[11].

The patient's scores improved in all five functional assessments as indicated in Table 1. The patient's TUG scores improved from 12.19 to 11.50 seconds. Scores for the 30-second Chair Stand Test improved from 8 to 12 repetitions. The patient was able to complete Stages 1, 2, 3, and 4 on the Four-Stage Balance Test after OEP completion. FTSST improved from 17.19 to 13.60 seconds. Times for OLS increased from 3 seconds on each leg to 13.28 and 12.94 seconds on the right and left lower extremities, respectively. Additionally, the participant reported subjective improvements associated with standing balance confidence.

Discussion

In addition to addressing the needs of patients directly affected by the COVID-19 pandemic, healthcare providers must also address the resulting effects of inactivity on older adults. The purpose of this case report was to investigate the feasibility of the digital delivery of the OEP for a community-dwelling older adult and to describe the set-up and the protocol that was used.

Clinical improvement resulting from the OEP was evaluated based on pre-established Minimal Detectable Change (MDC) values for each of the identified outcome measures. Based on the identified MDC of 1.8[12], the change in this patient's TUG score was not statistically significant[25], however, previous authors have noted greatest improvements in TUG times occur in participants who scored higher than normal limits at baseline[26]. This patient's four repetition increase on the 30-Second Chair Stand Test was statistically significant based on an MDC of 2.96 repetitions[27]. FTSST improved 3.59 seconds which was also statistically significant based on the MDC value of 2.5 seconds[19]. With a MDC of 24.1 seconds, Goldberg et al. determined OLS is not likely to be sensitive for detecting change in balance for older adults[28], however, this participant was at risk for an injurious fall based on her initial OLS time of 3 seconds. After four weeks of the OEP, OLS time increased to 13.28 and 12.94 seconds on the right and left leg, respectively, suggesting a decreased risk for injurious falls[22].

The case report had some limitations. The shortened time frame of the plan of care for this patient, with outcomes reported after only four weeks of performing the OEP, make it difficult to generalize the data. While most OEP results have been reported after a full year of participation, this patient was unable to commit to OEP for more than four weeks which may not be a sufficient time frame to equate changes in outcome measures with reduced fall risk. Although MDC values were exceeded on the 30-Second Chair Stand Test and FTSST, these changes in functional outcomes may have been due to practice or therapeutic alliance. Other authors have also attributed positive changes in performance-based measures to the connections a patient develops with the instructor[13]. Additionally, there is a lack of research on the reliability of outcome measures used in digital practice. The reliability of timing functional tests over a digital platform is unknown. It is possible recorded times were affected by the digital set-up. Future research investigating the reliability of performing functional tests in digital practice is needed. Another limitation of this study was that the treating therapist also performed the pre- and post-intervention assessment of outcome measures. The therapist and patient were not blinded in this case report; therefore, the potential existed for scores on functional assessments to be affected.

Large scale studies should be performed to validate these results with participants of various ages and functional levels, as there are challenges unique to the digital delivery of fall prevention programs. Technical aspects of Zoom (San Jose, CA) conferencing presented a challenge as the patient had difficulty joining Zoom meetings from her laptop. This patient was high functioning, educated, and technologically savvy; however, a user-friendly telehealth platform may improve participation. Observing the patient over Zoom (San Jose, CA) made it challenging for the therapist to view the alignment of the lower extremities during the exercises. Although no adverse effects occurred during this study, feedback from the therapist regarding proper alignment and technique prevents injuries and maximizes effect. Digital set-up limited the therapist's view of the patient and increased treatment time due to the need to frequently adjust camera angles. Future studies should include different video platforms that may address this issue.

In a larger group, many older adults may not be safe performing balance exercises without assistance; therefore, family members or caregivers would need to be present to minimize fall risk. Cognitive assessments and the Activities-Specific Balance Confidence Scale would provide valuable insight into the selection of appropriate patients and necessary safety measures for future studies. Finding adjustable ankle weights was also a challenge as several brands were tested, but all were difficult for this patient to manage. It would be beneficial to recommend a set of known high quality weights that can be donned and adjusted easily.

With ongoing concern about the risk of COVID-19 transmission in this vulnerable population, and the continued public health crisis surrounding falls, alternate methods of fall prevention programs need to be identified. Older adults need a safe and sustainable way to participate in evidence-based fall prevention programs. Our paper uniquely describes the methods that were utilized for implementing digital delivery of the OEP for a single subject, rather than within a group. We also describe our swift changes to maintain continuity of care in response to the COVID-19 pandemic. In conclusion, the

digital delivery of OEP appears to be a feasible opportunity to expand access to fall prevention programs to older adults; however, further research is necessary to determine the efficacy and safety in a larger sample of older adults.

Authors' contributions

CJHG designed the case report and collected the data with guidance from KJN. CJHG, KJN, and JJBB analyzed and interpreted the data, and drafted the manuscript. KJN and JJBB provided content and technological expertise. All authors approved the final version. CJHG is the guarantor.

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