***Critically Appraised Topic Template***

**Title:** Home Exercise Programs Using Motion Sensing Input Devices are Comparable to Traditional Home Exercise Programs for Improving Functional UE Motor Deficits in Chronic Stroke Survivors.

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**CLINICAL SCENARIO**

**Condition/Problem:**

The medical condition experienced by our patient is a left middle cerebral artery cerebral vascular accident. The middle cerebral artery is the largest cerebral artery and supplies most of the outer portions of the brain (Middle Cerebral Artery Stroke, 2017). Blood vessels can rupture due to longstanding hypertension, which places a lot of pressure on the arterial walls. Blood vessels can be blocked in two different ways. An embolism can occur which is when a blood clot is formed in once place in the body, but then travels to an artery in the brain. A thrombosis is when a blood clot is formed on a blood vessel wall in the brain. This blockage or rupturing of one of the arteries may then cause cerebral hemisphere dysfunction. If the brain is cut off from oxygen and blood for a sufficient period, brain tissue will die (Stroke, 2017).

Residual problems associated with the condition include hemiparesis of the face, arm, and leg, sensory loss of the face, arm, and leg, ataxia, speech impairments (including Wernicke's aphasia and Broca's aphasia), and gaze preference (Effects of Stroke, 2017). Approximately 80% of stroke patients experience motor impairments post stroke (Adie, pg. 174, 2017).

**Incidence:**

Strokes are the fifth leading cause of death in the U.S, and nearly 130,000 people die from stroke each year. Nearly 800,000 people have a stroke in the U.S. every year. Of the strokes that occur, 87% are classified as ischemic (Impact of Stroke, 2017). Currently there are more than seven million Americans who are stroke survivors (Life After Stroke, 2017). Of these stroke survivors, more than half of them sixty-five years and older experience decreased mobility (Stroke, 2017).

**Impact of the Problem on Occupational Performance:**

Individuals presenting with post-stroke motor deficits may experience occupational performance problems related to ADLs, leisure, motor skills, cognition, and mental health (American Occupational Therapy Association, 2016). ADL deficits include UE/LE dressing, grooming, bathing, and toileting activities. Hemiparesis, resulting from a stroke, causes difficulty with bilateral activities, stabilizing, reaching/grasping (Levin et al., 2009), and functional mobility, all of which contribute to the preceding problems of occupational performance. For many stroke survivors, these deficits continue to impact occupational performance 6-12 months after the stroke, as they enter the chronic phase of their recovery process (Page, Gater, & Bachy-Rita, 2004). A stroke-survivor with a higher functional dependence level due to these motor deficits is also more likely to face psychosocial issues such as depression, anxiety, and decreased quality of life (Raju, Sarma, & Pandian, 2010). Occupational therapists address these concerns by focusing on remedial approaches, modification of the environment, adaptation, prevention, and role reintegration (American Occupational Therapy Association, 2016).

**Intervention:**

The general purpose of the motion sensing input device (Nintendo Wii, Xbox Kinect, etc.) in patients post stroke is to improve visual motor coordination, strength, and hand dexterity. The intervention, when implemented as a home program, involves the therapist installing the device and teaching the participant how to use it. Participants are then given the choice of a variety of games (bowling, tennis, golf, baseball, etc.) to play (Adie et al., 2017). The game requires the use of a wireless controller that interacts with the player through a motion detection system and avatar technology. The controllers use embedded acceleration sensors which are responsive to changes in direction, speed, and hand movements. There is also an infrared light sensor placed by the television which is used to capture and reproduce movement from the controller onto the screen. The feedback provided by the TV screen, as well as the opportunity to observe their own movements in real time, generates positive reinforcement which then facilitates training and task improvement (Saposnik et al., 2010).

Per the Adie et. al article, the intervention schedule includes a 6 month data collection period. The control group engages in warm-up exercises for 15 minutes followed by participant-tailored arm exercises (based on the graded repetitive arm supplementary program) for 45 minutes per day. The intervention group engages in warm-up exercises for 15 minutes followed by the Wii game intervention 45 minutes per day. All participants also continue their usual rehab therapy as initiated by their local stroke team (2017).

**OT Theoretical Basis:**

The contemporary motor learning frame of reference best supports the intervention. This frame of reference recognizes that motor learning is a set of processes associated with practice or experience, which leads to relatively permanent changes in the capabilities of responding (Mathiowetz & Haugen, 1994). The basic tenants of the intervention are that the gaming systems are relatively cheap and available to clients. They can also be used as an additional method of motivation to the participant. The increasing motivation and goal directedness of the exercise through the use of the game in the home environment encourages the client to do the movements as many times as possible. The participant is therefore trying to recover skill through practice, which is goal directed. The massed practice that comes from playing the game promotes movement factor restoration of the affected limb which is a major premise of the contemporary motor learning theory.

**Science Behind the Intervention:**

This intervention will encourage “relevant function” and prevent compensatory habits from affecting recovery (Adie et al., 2017). Recent research along with the UK National Stroke Guidelines have recommended 45 minutes of daily therapy during stroke recovery. The exercises and the changes of the brain are still not fully understood, but arm exercises may influence cerebral plasticity in stroke survivors and possibly promote new neuronal connections (Masiero, S., & Carraro, E. 2008). Motion sensing input devices, like the Wii, encourage gross motor movement which can lead to "permanent change". This idea falls under the contemporary motor learning theory as it suggest changes in the brain after stroke.

Intervention protocols for the motion sensing device involve promoting movement of the affected limb in a purposeful and functional motion. This treatment involves movement of the affected arm for one hour a day for 14 consecutive days of Wii training in hopes of improving arm function (Adie et al., 2017). Participating in a home therapy program using Wii with an additional intervention such as traditional OT, will increase the duration of usage of the affected limb. This will allow massed practice which will promote restorative movement patterns of the affected limb. There is also a theory that states when using motion sensor games, brain re-organization will result (Masiero & Carraro, 2008).

The overall big picture of adding a motion sensor program for home therapy is to increase practice and participation of the affected limb.

**Why this intervention is appropriate for OT:**

Motion sensing input devices when used in occupational therapy are typically used as purposeful activities. Purposeful activities are activities that allow the client to develop or enhance occupational performance (Purposeful Activities, 1983). Purposeful activities are utilized in occupational therapy to:

- 1) develop or maintain strength, endurance, range of motion, or coordination
- 2) utilize voluntary movement in a goal directed task, or
- 3) provide regular exercise and practice use of affected parts
- (Purposeful Activities, 1983).

Motion sensing input devices are typically used in conjunction with games that have specific goals, such as Nintendo Wii bowling. The objective of the game is to knock down the pins to earn points, with the client being required to use their arm in a swinging motion (Adie et al., 2017). The client is participating in a purposeful activity that provides reinforcement and performance feedback with the intention of increasing strength in the arm to increase performance in an occupation that is specific to the client.

**FOCUSED CLINICAL QUESTION:**

Is motion sensing input device treatment an effective home exercise program for increasing UE motor function in patients post-stroke?

**SEARCH SUMMARY:**

Stroke Rehab or CVA
X-box Kinect or Nintendo Wii
UE motor deficits
Home-based interventions or community-based interventions
Virtual Reality

**TABLE 1: SEARCH STRATEGY**

| Search Terms | Inclusion and Exclusion Criteria |
|---|---|
| Stroke Rehab or CVA or cerebrovascular accident<br>X-box Kinect or Nintendo Wii<br>UE motor deficits<br>Home-based interventions or community-based interventions<br>Virtual Reality | Inclusion:<br>Post Stroke<br>Home-based interventions<br>Community-based interventions<br>Weakness in UE<br>Virtual Reality<br><br>Exclusion:<br>Inpatient populations<br>Acute populations<br>Articles dated beyond 10 years |

**CLINICAL BOTTOM LINE:**
Home exercise programs using motion sensing input devices are comparable to traditional home exercise programs for improving functional UE motor deficits in chronic stroke survivors.

**Limitation of this CAT:** This critically appraised paper (or topic) has been reviewed by occupational therapy graduate students and the course instructor.

**TABLE 2: SUMMARY OF STUDY DESIGNS OF ARTICLES RETRIEVED**

| Level | Study Design/ Methodology of Articles Retrieved | Total Number Located | Citation (Name, Year) |
|---|---|---|---|
| 1a | Systematic Reviews or Meta-analysis of Randomized Control Trials | 3 | Cheok, G., Tan, D., Low, A., & Hewitt, J. (2015).<br><br>Pietrzak, E., Cotea, C., & Pullman, S. (2014).<br><br>Thomson, K., Pollok, A., Bugge, C., & Brady, M. (2014). |
| 1b | Individualized Randomized Control Trials | 5 | Adie, K., et al. (2017).<br><br>Bower, K. J., Louie, J., Landesrocha, Y., Seedy, P., Gorelik, A., & Bernhardt, J. (2015).<br><br>McNulty, P. A., Thompson-Butel, A. G., Faux, S. G., Lin, G., Katrak, P. H., Harris, L. R., & Shriner, C. T. (2015). |

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| | | | Park, D., Lee, D., Lee, K., & Lee, G. (2017).<br><br>Saposnik, G., Teasell, R., Mamdani, M., Hall, J., McIlroy, W., Cheung, D., & ... Bayley, M. (2010). |
| 2a | Systematic reviews of cohort studies | | |
| 2b | Individualized cohort studies and low quality RCT's (PEDro ≤4) | | |
| 3a | Systematic review of case-control studies | | |
| 3b | Case-control studies and non-randomized controlled trials (quasi experimental or clinical trials) | 1 | Mouawad, M. R., Doust, C. G., Max, M. D., & McNulty, P. A. (2011). |
| 4 | Case-series and poor quality cohort and case-control studies | 4 | Hijmans, J. M., Hale, L. A., Satherley, J. A., McMillan, N. J., & King, M. J. (2011).<br><br>Paquin, K., Ali, S., Carr, K., Crawley, J., McGowan, C., & Horton, S. (2015).<br><br>Trinh, T., Shiner, C. T., Thompson-Butel, A. G., & McNulty, P. A. (2017).<br><br>Tsekleves, E., Paraskevopoulos, I. T., Warland, A., & Kilbride, C. (2016) |
| 5 | Expert Opinion | | |

**STUDIES INCLUDED**:

| | **Study 1: Adie, Schofield, Berrow, Wingham, Humfryes, Prtichard, James, & Allison** | **Study 2: Mouawad, Doust, Max, & McNulty** | **Study 3: Paquin, Ali, Carr, Crawley, McGowan, & Horton** |
|---|---|---|---|
| **Design** | RCT: Pre-Post Design | Non-randomized control trail: Pre-Post Design | Poor quality case series: Pre-Post Design |
| **Level of Evidence** | Level Ia | Level IIIb | Level IV |
| **Rigor Score** | Blinded assessor | PEDro-P Scale Non-Randomized Control Score: 5 | *Limited follow-up<br>*No blinding<br>*Small sample size |

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| **Population** | Control: n=108<br>Intervention: n=101<br>Chronic post-stroke patients | Control: n=5 Healthy control subjects<br><br>Intervention: n=7 Chronic post-stroke patients<br><br>Total: n=12 | Chronic post-stroke patients: n=10 |
| **Intervention Investigated** | Nintendo Wii based movement therapy for UE motor recovery | Intervention Group: Chronic post stroke patients (Nintendo Wii based movement training & therapy) | Commercial gaming as an intervention for fine motor recovery in chronic stroke patients. |
| **Comparison Intervention** | Home exercise program (Tailored arm exercises) | Comparison Group: Healthy individuals (Nintendo Wii based movement training & therapy) | Pre-post comparison of the commercial gaming intervention on fine motor recovery. |
| **Dependent Variables** | UE Motor function, Occupational Performance, and Quality of life | UE Motor function, UE PROM, UE AROM, Client's perception of quality of movement | Fine motor skills, perceived quality of life (perceived ability to complete ADLs) |
| **Outcome Measures** | Primary: Action Research Arm Test (ARAT)<br>• Interrater Reliability: 0.995<br>• Intrarater Reliability: 0.989<br>• Criterion Validity: Excellent correlation between ARAT and arm motor score of the Fugl-Meyer (r = 0.94, p<0.01)<br>• Content Validity: The ARAT is a modified version of the UEFT.<br>• (Shirley Ryan Ability Lab)<br><br>Secondary: Canadian Occupational Performance Measure | Primary: Wolf Motor Function Test (WMFT)<br>• Interrater Reliability: 0.99<br>• Criterion validity: 0.88<br>• Content validity: No studies have reported this.<br>• (Shirley Ryan Ability Lab)<br><br>Secondary: Fugl-Meyer Assessment (FMA), Box & Block Test, PROM, AROM, Modified Ashworth Scale, Berg Balance Scale, Quality of Movement Scale of the Motor Activity Log (MAL-QOM) | Box and Block Test<br>• Test-retest reliability: .93-.98<br>• MDC: 5.5 blocks per minute<br>• (Shirley Ryan Ability Lab)<br><br>Jebson Hand Function Test (JHFT), Nine Hole Peg Test (NHPT), Stroke Impact Scale (SIS) |

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| | (COPM), Stroke Impact Scale, Modified Rankin Scale, EQ-5D 3L. | | |
| **Results** | The results indicated significant improvement for both interventions from pre-test to post-test. Furthermore, there was no significant differences between the two interventions. Both home exercise and motion sensing input were shown to be effective and significant. | Results indicate that scores for the timed WMFT tasks, FMA, both active and passive range-of-motion, and the weight-lifting task in the WMfT were significantly improved ($p<0.05$), but maximum handgrip strength did not increase. | Results indicated that significant improvements occurred between pre-testing and post-testing on all four standardized measures, suggesting that commercial gaming may be a viable resource for UE rehabilitation in chronic stroke. |
| **Effect Size** | Within Group Control Cohen's *d* (6 weeks): 0.50<br>Within Group Intervention Cohen's *d* (6 weeks): 0.42<br>Within Group Control Cohen's *d* (6 months): 0.54<br>Within Group Intervention Cohen's *d* (6 months): 0.56 | Wilcoxon Signed Rank-Test differences are significant at $p < 0.05$ | Pre-testing to post testing (M=31, SD 5.27), (M=36, SD 6.77) |
| **Conclusion** | Results from the study showed significant improvement on all outcome measures for both intervention and control. Pre-testing and post-testing at six weeks and six months showed significant improvement from baseline. Aside from the additional expenses for the Nintendo Wii, both interventions could be completed by the participants safely in their home. | Results from the study indicated that improvements in Wii skills were generalized to the functional tasks tested by the WMFT and FMA that were not due to practice during the two weeks of therapy. This indicates that Wii based movement therapy is a relatively affordable option for post intervention patients to use at home to see improvements in | Results illustrated an increase in fine motor ability as well as an increase in the participants' perceived ability to complete ADLs. These results showcase the rehabilitative possibilities that are available to chronic stroke survivors; however, community-level care and support are necessary for these possibilities to be realized. Future action in commercial gaming and stroke recovery may benefit from integration |

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| | | functional performance of desired occupations. | of commercial gaming into community-level care as a rehabilitation tool, and education on the benefits of outpatient and in-home use. |

**SYNTHESIS SECTION:**

**PICO Question:**
In chronic post-stroke adults with UE motor deficits, does the use of a motion sensing input device (Nintendo Wii, Xbox Kinect) used as a home-program increase the functional recovery of UE motor skills compared to a traditional home program within 6 months?

**Overall Conclusions:**
**Terms:**
Functional UE Motor Deficits: upper extremity weakness post-CVA that does not allow for optimal occupational performance.
Motion Sensing Input Device: device that works by sensing the electrical signature of forearm contractions.
Chronic CVA: participants who were 6 months post-CVA at the time of the study.

**Point in recovery post-CVA:**
On average, participants experienced a CVA 57.3 days prior to the study (Adie,et al., 2017), 38.6 months prior to the study (Paquin et al., 2015), and 15.3 months prior to the study (Mouawad et al., 2011).

**Treatments used in Combination with Motion Sensing Input Device for Home Program:**
In Adie et al., (2017), both the control and intervention groups continued to receive their rehabilitation as usual. In Mouawad et al., (2011), no treatment was used in combination with motion sensing input device. In Paquin et al., (2015), participants completed their motion sensing input device program immediately before or after their existing exercise program. This exercise program included a station-based circuit that included exercise designed for gross motor UE training, LE training, and balance.

**Outcome Measures:**
In Adie et al., (2017), the following outcome measures were used: Action Research Arm Test (ARAT), Canadian Occupational Performance Measure (COPM), Stroke Impact Scale, Modified Rankin Scale, and EQ-5D 3L. In Mouawad et al., (2011) the following outcome measures were used: Wolf Motor Function Test (WMFT), Fugl-Meyer Assessment (FMA), Box & Block Test, PROM, AROM, Modified Ashworth Scale, Berg Balance Scale, and Quality of Movement Scale of the Motor Activity Log (MAL-QOM). In Paquin et al., (2015), the following outcome measures were used: Jebson Hand Function Test (JHFT), Box and Block Test (BBT), Nine Hole Peg Test (NHPT), and Stroke Impact Scale (SIS).

**Results: Similarities**

All three studies measured upper extremity motor function of chronic post-stroke patients receiving motion-sensing input device (Wii, Xbox Kinect, etc.) treatment. Each study found significant improvement in the intervention from pre-post test. Each of the three studies also considered the use of the motion sensing device treatment as part of a home program or community based treatment intervention.

**Results: Differences**

All three studies differed with respect to intervention dosage, schedule, setting, and protocols. For all intervention groups, the studies varied in intervention time ranging from a minimum of 240 to a maximum of 840 minutes.

**Boundaries:**

There was a total of 226 participants ages 24-90. Participants were post-CVA and demonstrated weakness in one upper extremity. The amount of time post-CVA ranged from 1-86 months. On average, participants experienced a CVA 57.3 days prior to the study (Adie, et al., 2017), 38.6 months prior to the study (Paquin et al., 2015), and 15.3 months prior to the study (Mouawad et al., 2011). Adie et al., instructed both groups (Wii group: intervention or tailored arm exercises: control) to complete up to 45 minutes daily for six weeks. Mouawad et al., instructed participants to complete Wii games for over 14 days with 1 hour of supervised training in the laboratory on 10 consecutive weekdays augmented by home practice that increased from 30-180 minutes per day. Paquin et al., instructed participants to complete 15 minute sessions twice a week for 8 weeks total. Each study had different inclusion criteria related to motor function in the upper extremity post-CVA as well as cognitive competence.

**Implications for Practice:**

- The results of these studies support the use of motion sensing input devices in a home-based exercise program for individuals in the chronic phase of post-stroke recovery to improve functional UE motor deficits.
- At this phase of the recovery, post-stroke individuals are likely finishing up outpatient sessions covered by insurance; however, they may still be looking for options to continue and maintain functional motor recovery.
- Motion sensing input device home-programs provide an alternative option to traditional home programs in order to address motivational and compliance considerations for some clients. Further studies should address motivation and compliance associated with motion sensing input device home-programs.
- Considerations for personal preferences, attitudes about technology, financial resources, availability of technology, ability to safely use technology, motivation, and support should influence recommendations on an individual client basis.

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