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Tele-Rehabilitation:

Demystifying the Use of Technology to Deliver Physical Therapy

Learning Outcomes

After this course, participants will be able to:

- Describe at least three ways to identify appropriate patients for tele-rehabilitation.
- List at least three functional outcome measures for tele-rehabilitation.
- Outline an effective plan for patient treatment using tele-rehabilitation.
- Identify at least three current barriers to tele-rehabilitation.

Tele-rehabilitation: What are your initial thoughts?

- Have you used tele-rehabilitation? Yes/no
- Do you think tele-rehabilitation is not as effective as face to face visits? Yes/no
- Do patients like tele-rehabilitation? Yes/no
- Do therapists view tele-rehabilitation positively? Yes/no

Case Study

- 71 year old male s/p right upper lobectomy
- PMHx: chronic pain, HTN, coronary arteriosclerosis, COPD
- PLOF: Lives in house with son who is unable to drive due to medical issues, gait without device in community, mowed lawn, 12 stairs to basement used daily, drove self
- Current: Walks with rollator, SOB with walking 5 feet, difficulty speaking, lightheadedness with standing, retropulsion upon initial standing

Case Study

- Lives in area where 2 home agencies would not accept patient (lack of staffing and 1 mile out of coverage area)
- How would you address this patient's needs?

Why Tele-rehab?

- According 2010 Census 19.3% population in rural areas in US
- Population density
  - US cities comprise 62.7% population but comprise 3.5% land area-2013 Census Bureau
- Improve dosing of physical therapy
  - Sherrington meta-analysis (2011)
  - At least 50 hours of balance training starting at 2 hours/wk

What is tele-rehabilitation?

- No two states are the same in how telehealth is defined or regulated.
- Telehealth is often used as a broader term
  - Telepractice is frequently used as it relates to PT, OT, SLP, and behavioral therapy
- APTA definition- “Telehealth, the use of electronic communication to remotely provide health care information and services”

Terms

- Telemedicine-used for physician visits
- Tele-rehabilitation- can be for mental health or physical rehab
- Exer-gaming- patient playing games where system detects movements
- VR-virtual reality-sometimes used for videoconferencing, sometimes for creating an artificial environment

The Expansion of Telehealth

- Illinois added PT to state telehealth act starting 2019
- Iowa and Kentucky adopted laws for private insurance plans to cover telehealth
  - PT in Motion, October 2018

PT Compact

- "Agreement between member states to improve access to physical therapy services for the public by increasing the mobility of eligible physical therapy providers to work in multiple states"
  - www.PTcompact.org
- Member states OR, ND, UT, IA, MO, TX, MS, TN, NH
- Enacted legislation WA,MT, NE, CO, AZ, OK, LA, KY, WV, NC, SC, NJ
- Legislation introduced MI, GA, VA

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Reimbursement

- 37 states have laws for private insurance to reimburse. Two more Rhode Island and Utah have laws pending
  - All for synchronous video visits
  - Few for asynchronous
- States vary with Medicaid coverage for PT
- Parity laws vary state to state
  - Laws stating reimbursement same for tele-rehab as face to face
    - Center for Connected Health Policy

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CONNECT Health Bill

- Creating Opportunities Now for Necessary and Effective Care Technologies (CONNECT)
  - H.R. 2556/S. 1016
  - Ease restrictions on telehealth coverage with Medicare
  - Introduced 2017

http://www.apta.org/PolicyResources/PositionPapers/ConnectForHealth/ accessed February 20, 2019

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History

- Teleconsultations and telehomecare were common by 1940's
- 1960's telemedicine or telehealth transmit vital signs with NASA for astronauts
- 1970's progressed into real medical applications
- 1980's military started using store and forward and videoconferencing-increase access to specialists
- 1990's Federal agencies started telemedicine programs

http://eng.mu.edu/wintersj/rehab/rehab167/mod3/history.htm. Accessed Oct 17, 2016.

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More History

- 1996-Institute of Medicine publishes "Telemedicine: A Guide to Assessing Telecommunications in Health Care"
- 2000-APTA creates document stating telehealth is appropriate model for delivery of PT when provided in manner consistent with standard of care
- 2009-PT & Society Summit-"Patients should receive care whenever they need it"
- 2014-Position statement adopted by APTA HOD
- 2015-FSBPT recommendations

FSBPT Recommendations

- Recognize changing patient and provider expectations
- Untether telehealth from traditional reimbursement expectations
- Deconstruct the traditional physical therapy encounter
- Be open to discovery
- Be mindful of the importance of human and ethical factors
- Redesign care with focus on value
- Be bold and visionary

Principles for Delivering Telerehabilitation

- American Telemedicine Association (Richmond et al., 2017)
- Administrative
- Clinical
- Technical
- Ethical

Therapist Perceptions

- PT/OT/NP students (Randall et al., 2016)
  - Mainly positive attitudes about telehealth
  - Thought it less useful in simulated and clinical settings
  - Perceived interpersonal barriers
    - Speyer et al., (2018) Systematic review looked at allied health care including PT, found telehealth as effective as face-face
- Lawford et al., (2017) found similar results
  - PTs agree offers time savings and privacy advantages
  - Most do not like the lack of physical contact

Therapist Perceptions

- 6 main themes from Australian study (Cottrell, et al., 2017)
  - Barriers to some patients access to therapy are complex and multifaceted
  - TR can improve access to management for musculoskeletal conditions
  - Limitations versus face to face
  - Delivery needs to be flexible
  - Perceived barriers (work space, tech support)
  - Need facilitators for successful implementation

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Patient Perceptions

- Patient Preference
  - Studies have shown majority of patients like telemedicine (Gustke et al., 2004)
- Patient Perspective (Kairy et al., 2013)
  - Study for patients post TKA found 6 main themes
    - Improving access/reduce need transportation
    - Developing strong therapeutic relationship while having personal space
    - Complementing with in-person
    - Tailored HEP
    - Perceived ease of use of equipment
    - Feeling sense of support

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Patient Perceptions

- Hip or knee OA (Rini et al., 2015)
  - Pain COACH App for Pain education
    - 109 participants completed study
    - Showed clinical promise to strengthen the effects and adherence was very high
    - 23% of potential participants declined due to not wanting to use a computer but in the end preference for completing on a computer increased from 50% to 62% among participants
- Patient Perceptions TR (Lawford et al., 2016)
  - 330 people with hip/knee OA completed survey
    - Mostly positive perceptions except concern about lack of physical contact with therapist-recommended education and mixed approach

Patient Perceptions

- Telemedicine using patient-centered communication with physician (Agha et al., 2009)
  - Able to develop rapport as with in-person visit
  - Patient-centered communication with shared decision making
  - Higher satisfaction with telemedicine due to convenience
- Diabetes clinic in Australia (Fatehi et al., 2015)
  - Developed a questionnaire for patient satisfaction
  - No issues building rapport
  - 21% concerned about lack physical contact

Patient Perceptions and chronic pain (Cranen et al., 2011)

- Interviews of patients who had not gone through TR
- Performance expectancy
  - Negative view of quality of feedback, fellow suffer contact and rapport
  - Positive view transition knowledge
- Effort expectancy
  - Positive view equipment use
- Social influence
  - Some associated clinic with professionalism
- Facilitation conditions
  - Negative view of motivation for patient, opportunity out of house
  - Positive view of sensor/tracking for motivation, flexibility

Ways to address perceptions with chronic pain

- Bridge to patient homes to create a group where patients can see and interact with each other while still in their own homes
- Bridge to group sites with therapist is with one group and other groups are linked in
- Patient motivation-digital rewards
- Environment- home v. clinical look

Ways to use tele-rehabilitation

- Synchronous-Videoconferencing
  - Peripherals that can be used
    - Stethoscope
    - Blood Pressure monitor
    - Pulse ox
    - Goniometer
    - Tape measure
- Asynchronous-Store and forward
  - Can be still pictures or video

Ways to use tele-rehab

- Evaluation to discharge
  - Challenging
  - Mental health dx such as agoraphobia, anxiety
- Mix of in person and telehealth visits
  - Most common
- Home safety/wheelchair evaluation
- Supervisory visits for assistants
  - Washington due shortage of PTs (Lee and Billings, 2016)
- Case series on booster visits for chronic LBP (Peterson, 2017)

Ways to use tele-rehabilitation

- Meta-analysis with 23 studies
- Post surgical patients (van Egmond et al., 2018)
  - Orthopedic
  - Cardiac
  - Oncological
- Improved quality of life

Supervisory visits for PTA

- Large contract company in Washington state with many facilities
- Shortage of PTs
- Telehealth for supervisory visits with PTA with patient
- Lee and Billings, 2016

Advantages for Tele-rehab

- Address staffing shortages
- Expand coverage area for home agencies
- Greater access for specialty care/niche care
- Improve dosing of therapy
  - Patients post TKR returning home instead of SNF

Specialty care access

- Case studies from rural Minnesota and American Samoa (2 cases out of 117 TR encounters)
- Ages of all encounters ranged from 9 months-86 yo
- 38 had neurologic dx
- Used to access specialists for patients with local PT present
  - Diamond et al., 2003

Advantages Tele-rehab

- Systematic Review (Kairy, 2009)
- Clinical outcomes similar/better than alternative
- Compliance with home programs high
- Consultation time longer
- Satisfaction higher for patients compared to therapists

Advantages TR

- Emmerson, Harding, and Taylor (2018)
- Systematic review and meta-analysis
- Multimedia improved adherence with home programs
- No difference with patient outcomes
  - Looked at studies with standardized exercises-no individualization for exercises or dosing

Challenges with Tele-rehab

- Ease of use with equipment for patients and therapists
- Connectivity
  - Sound and/or video quality
- Identifying appropriate patients
  - Hearing
  - Vision
  - Cognition

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Summary of advantages and challenges

- Scholten et al., 2019 provided a good summary for TR with polytrauma
- "Telehealth does not eliminate the need for face-to-face clinical care but can enhance delivery, coordination, and access to care"

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Patient rapport

- According to Muller (2015), strong patient rapport can be developed using the telephone
- Used patients with chronic dizziness
  - Person-centered communication
  - Encouragement
  - Approval
  - Reassurance of safety
  - Responsiveness to participant cues
- Flaming (2010)-similar findings tele-mental care
  - Positive outcomes correlated with empathy and respect
  - Talking about clinicians own experience
  - Collaborative problem-solving style

Eliciting Patient Agenda

- Most clinicians do not work to learn patient's perspective (Singh Ospina et al., 2018)
- Specialty care less likely to elicit patient agenda versus primary care
  - 36% of encounters elicited patient agenda
  - When elicited-patient interrupted 70% of encounters with median time of 11 seconds to first interruption
  - Left uninterrupted patient took median time 6 seconds to state concern

Medical Errors and Doctor-Patient Relationship (Kondro, 2010)

- 23% of patients post-discharge adverse event
  - Increasing medical complexity
  - View health care as strictly analytic/mechanistic
  - Greater stress/burnout
- Link between medical errors and doctor-patient relationship

Patient Interview

- 80% of the information needed to clarify symptoms is provided by the patient during the interview. (Goodman and Snyder, 2013)
- Effective communication
  - Caring
  - Compassion
  - Cultural differences
  - Personal differences

Patient-centered interview (Martin, 2003)

- Created for medical students due to gap between asking students questions coming from list and patient perspective
- Medicine lacks a framework for taking a patient-centered approach for history taking
- Framework embeds medical and social history to better conceptualize what, when, where, and how questions should be asked

Part 1-Agenda

- Beginning of interview is to establish agenda-why is the patient being seen-verbal
  - More direct questioning from PT comes after patient explains in own words
  - Information about history present illness, illness experience, why patient seeking treatment, feelings, expectations
  - Summarize
  - Transitional statement to start next section

Part 2-History

- Middle part is continue gathering information both verbally and with physical examination
  - Physical exam-red flags, lifestyle risk factors, review of systems
  - Identification of resources-family/caregivers, work, living situation
  - Put in context of functional life for patient
  - Transitional statement before next part

Part 3-closing

- Final part is patient education-diagnosis, rationale, treatment and management plan
  - Address one issue at a time before moving to next
  - For each issue discuss why an issue, differential diagnosis, exam findings, and treatment with rationale
  - Patient education
  - Referrals
  - Common ground
  - Summarize

Types of Patients Seen

- Musculoskeletal
- Neurological i.e. Parkinson's disease, CVA, ALS, MS
- Amputee
- Spinal cord injuries
- Cardiopulmonary
- TBI
- Chronic Pain
- Pediatrics through Geriatrics

Before First Visit

- Have emergency plan in place
  - Emergency contacts
  - Local police and fire
- Make a test call
  - Ensures able to connect
  - May need to have patient move camera due to lighting
  - Ensures patient able to use equipment
- Make sure have private space to conduct session

Examinations

- Best done in-person to have all tests available
- Identification of tests that are indicated versus those able to perform
- Ability to modify standard tests
- Patient safety
- Patient able to follow instruction for test
- Vital signs do with peripherals
  - Can get EKG

Musculoskeletal Examination

- Use of pen and paper tests
- Measurements
- Palpation
- Goniometry
- Strength
- Special tests

Measurements and Palpation

- Some applications have tape measures for edema, wall-to-occiput distance
- Educating patients to self palpation
  - Describing sensation felt

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Goniometry

- Synchronous visit with computer program, (Good, 2012)
  - Picture taken during visit and loaded into program that had goniometer for shoulder
  - Compared against clinical measurement-differences found not clinically significant
- Smartphone app (Jenny, 2016)
  - Camera base application-found to be precise and possibly more accurate at knee.
- Photo with markers at bony landmarks for knee (Naylor, 2011)
  - Reliable and valid

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Strength testing

- Only MMT test-plantar flexors
- Chair rise tests (30 second, 5x, 10x)
- Hand held muscle testers if in clinic or have tech
  - Data can be stored in software
- Self-applied isometrics

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Special Tests

- Not all special tests are appropriate
- Slump and Yocum are easy to adapt
- Modification of tests
  - Hawkins Kennedy-place arm on shelf at 90 degrees and with elbow flexed at 90 degrees, have patient apply self overpressure into IR

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Evidence for examination by TR

- Cottrell et al. (2018)-high level of agreement between in-person and tele-rehab for patients with chronic musculoskeletal conditions
  - Shoulders
  - Low back
  - Knees
- Evaluation of knee (Richardson et al. 2017)
  - Face to Face versus telerehab
    - self-palpation, self-applied modified special tests, AROM, functional tasks
  - High level of agreement
  - Areas to improve for telerehab were more through questions about mechanism injury and palpation

Shoulder examination

- Assessment and diagnosis of MSK shoulder disorders
  - Steele et al., 2012
- Compared TR and face-to-face
- Educated patients with modified special tests(e.g. Hawkins-Kennedy and Speeds)
- Dx agreement and individual findings was consistent conventional methods

Ankle examination by TR

- Russell, Blumke, Richardson, and Truter (2010)
- Compared face to face with telerehab 15 patients with current ankle pain
  - TR exam consisted of functional movements, tasks, and self applied orthopedic/neuro tests
  - Software allowed to send video for patient education with tests
  - Found agreement with face to face 14/15 patients

Examination Evidence

- Diagnostic accuracy TR for lower limb musculoskeletal disorders (Russell et al., 2010)
- Compared face to face with TR examination
- >/= 79% agreement with primary dx and exact system dx
- Physicians with the same clinical information have shown 22-28% disagreement

Low Back Examination

- Validity of low back assessment with TR compared with face to face
  - Truter, Russell, and Fary, 2014
- Substantial agreement for pain with specific movements, eliciting sxs, and sensitizing SLR (used family or nonclinical to assist)
- Moderate agreement with identifying the worst lumbar spine movement direction, SLR ROM, AROM L-spine
- Poor agreement with postural analysis and reasons limitation L-spine mvmt

Low back with TBC

- Face to face and TR assessments with LBP <90 days
- Modified treatment-based classification into manipulation/mobilization, specific exercise, or stabilization
- Agreement was 68.1%
  - SLR part was only component significantly lower
  - Peterson, Kuntz, Roush, 2018

More exam evidence

- 3 case studies by Turner, 2018
  - Hands-off eval for low back pain, cervical pain, and elbow pain
  - Used McKenzie approach
  - All three returned full function without pain within 3 months
- Not all patients appropriate
  - Patient unable to use technology
  - Connectivity
  - Hands-on needed
  - Neuro assessment-DTRs
  - Strength test limitations

Musculoskeletal Treatment

- Have equipment in place for patient
  - Restorator
  - Ankle weights
  - Elastic bands
  - TENS/biofeedback
  - Blood pressure cuff can be used for feedback with posterior pelvic tilts/vmo quad sets
- Adjusting home programs via email, videos, private site access

Musculoskeletal Evidence

- Musculoskeletal Conditions (Cottrell et al 2016)
  - Systematic review (13 studies were included)
  - Telerehabilitation appeared to be superior when compared to standard practice for improving physical function
  - Viable option for the clinical management of musculoskeletal conditions
  - Comparable but not inferior to standard face to face physiotherapy treatment following total knee arthroplasty

More Evidence

- Musculoskeletal Disorders (Mani et al., 2016)
  - Systematic review with 11 studies included
    - Good validity for pain, edema, ROM, strength, balance, gait and functional outcomes
    - Low validity for lumbar spine posture
    - Moderate validity for special orthopedic tests, neurodynamic test and scar assessment
- Systematic review musculoskeletal conditions (Grona et al., 2017)
  - Moderate quality with positive effect on health outcomes and satisfaction

Knee TR

- RTC for treatment knee OA-both groups log book with exercises and 20 minutes hot pack before session (Azma et al., 2018)
- TR group (3x/week for 6 weeks)
  - Strengthening
  - Endurance
  - Flexibility
  - AROM
- Control received face to face-same freq/duration
  - US, TENS
- TR as effective as face to face

After Orthopedic Surgery

- Systematic review (Pastora-Bernal et al., 2017)
- Strong evidence in favor after total knee and hip arthroplasty
- Limited evidence with upper limb interventions (fewer studies)
- Clinical implications
  - Outcomes comparable not inferior to face-to-face

Example post Orthopedic Surgery

- Shoulder decompression (Pastora-Bernal et al., 2018)
  - 12-week program (5x/wk) for both TR and face-to-face
  - Patients received individualized home program through web-based program
    - Pictures, videos, patient manual with exercise tracking form
  - Non significant trend towards greater improvement in most functional outcomes with TR

TR with Lower Extremity Injury

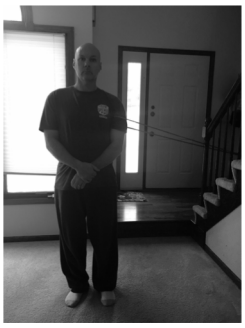
- Control and TR groups treated for 3-months after injury
- TR strapped smartphone with gyroscope, G-sensor, magnetometer, barometer to injured limb
  - ROM
  - Does load injured limb with and without crutches
- Tsvyakh and Hospodarskyy, 2017

Manual Therapy

- Use of devices/tools as needed
  - Baseball/Lacrosse ball
  - Rolling pin
  - Self trigger point release tools
  - Belts/bands
- Reiman et al. (2013)-hip self mobilization
  - Integration of self mobs included 5-8 minutes warmup on bike, static stretches, hip mobs, exercise into new ROM with isometric/isotonic

Self-mobilizations

- Sciatic nerve
- Patients either in lumbar segmental stabilization group (LSS) or LSS + self sciatic mobilization
  - Sciatic nerve tensioner from slump position basically
- Both groups improved with physical function and general health
- LSS + mobilization had greater improvements
  - Jeong et al. (2016)
- Wrist
- Case series using strap while gradually increasing extension and weight bearing with wrist on table
- 5 TX for 1 week
- Incr PROM/AROM extension, force before onset pain and decr pain intensity
  - Choung et al. 2013



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Manual Therapy Tools

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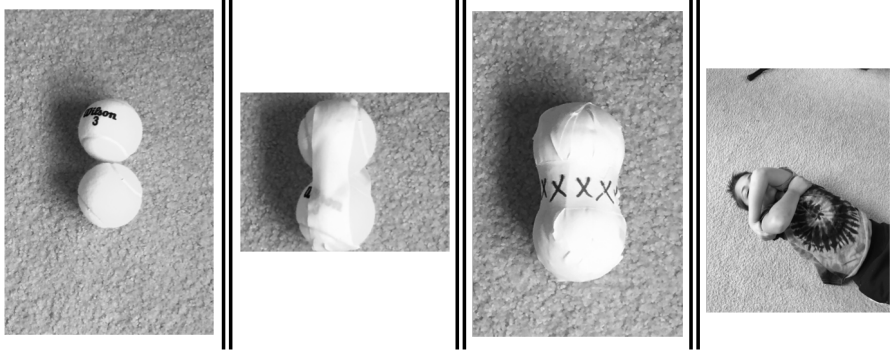
Thoracic self-mobilization (Johnson and Grindstaff (2012)

- Two tennis balls taped together and then fully enclosed with athletic tape, a final strip applied perpendicular to the other tape/between the two balls
- Exercises include: mini crunches and supine arm circles



Thoracic mob pictures

AAOMPT

- "manual physical therapy should be applied by a physical therapist and the effects observed clinically before prescribing a similar treatment for home use."

Acupressure

- Systematic review of self-acupressure (Song et al, 2015).
  - 10 studies-all with positive results for symptom management
- Self-acupressure for knee OA and older adults (Li et al., 2017)
  - RTC with no acupressure, sham acupressure, verum
  - Sham and verum improved WOMAC scores and pain scale

Neurologic Examination

Neurologic Evidence

- Systematic review by Block et al., 2016
  - Telemonitoring physical activity
    - MS
    - Parkinson's
    - Stroke
    - Dementia
    - TBI
  - In Stroke remote measures improved UE function and ambulation
  - Helped predict falls in PD
  - Dementia activity correlated with disease severity

Stroke Evidence

- Systematic review and meta-analysis (Rintala et al., 2019)
  - ADL-similar outcome compared with control/other treatment/usual care
  - UE/LE function- distance PT similar effect to usual care
  - Balance- similar effect
  - Walking-better or similar effect
  - Physical activity- similar effect
  - Participation-similar effect

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Stroke Evidence

- Sarfo et al. (2018)- Systematic review
  - Tele-rehab interventions have equal or better effects on motor, higher cortical, and mood disorders
  - BBS, DGI, 10-meter walk test, Caregiver Strain Index
- Post-stroke (Bernocchi et al., 2016)
  - Mixed method approach with 1-2 home visits, 1-2 phone calls, and 2-8 videoconference sessions
  - Improved in global functional capacity-especially static and dynamic postural balance, UE dexterity paretic side, and physical performance
  - Decreased depression and caregiver strain

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More Stroke

- Scoping review outcomes measures post CVA (Veras et al 2016)
  - 28 studies included
  - 58 different outcome measures used with telerehabilitation/virtual reality
- Study for access and willingness to use post CVA (Sakakibara et al 2016)
  - Technologies used were TV, landline phone, computers
  - Most patients interested to receive assessments (58.4%)
  - Education/HEP (64%)
  - 71% believed quality of care would be less than in-person

Stroke treatments

- Respiratory muscle training after stroke meta-analysis (Menezes et al., 2016)
  - 5x/week for 5 weeks
  - Increased strength in very weak
  - Reduced risk of respiratory complications

Parkinson's disease

- Chen et al., 2018 Systematic review
  - Telehealth effective to improve motor impairment
- Gandolfi et al., 2017
  - Exergames compared with sensory integration balance training
  - 3x/week for 7 weeks
  - Both improved DGI, gait confidence, fall frequency, QOL
  - Cost for exergames was less

Parkinson's treatment ideas

- Active assisted cycling (Ridgel et al., 2012)
  - 5 minute warm-up and cool-down at 40-50 rpm
  - 30 minutes with speed set at 75 rpm, patients asked to pedal at 80-85
- Group adapted tango instruction (Seidler et al., 2017)
  - 10 minute warm-up
  - 20 minute rhythm and partner work
  - 25 minute practice with new step and integration prior steps
  - 2-3 minute cool-down
  - Practice both lead and follow roles

SCI Evidence

- 23 participants for high dose scapular stabilizer and rotator cuff strengthening using telerehabilitation (Van Straaten et al., 2014)
  - Improvements in Wheelchair User's Shoulder Pain Index, DASH, and Shoulder Rating Questionnaire
  - Improved strength with serratus anterior and scapular retractors

More SCI

- RTC (Coulter, 2017)
- 8 weeks 2x/week
- Control: self care Tx: web based PT
- Intervention group increased 6MWT beyond minimal detectable change
- Improved compliance with exercise frequency
- Patients showed satisfaction with telerehab
- After d/c from rehabilitation unit
- Especially for long term health wellness

Multiple Sclerosis

- RCT with store and forward approach
- 2x/week strength 1x/week endurance
- 6 month program, control waited 3 months
- Improvements in strength, lung function, and physical activity (Tallner et al., 2016)

Multiple Sclerosis

- Paul et al., (2018), Subjects used web-based program for individualized home program of exercises and education
  - Videos
  - Text
  - Audio
- Completed online diary-reviewed every 2 weeks
  - Control was given sheet of exercises and paper diary
- 6 month f/u-no significant differences with outcome measures
  - Authors noted dosing was issue-few patients commented in diaries leading to few adjustments

Telerehabilitation Outpatient Neurorehabilitation (Tenforde et al., 2017)

- Can provide access to care team over longer time period after discharge from inpatient
  - Better able to address dynamic aspects of rehab such as community reintegration
  - Able to adjust home programs for disease progression for neurodegenerative diseases
  - Can address specific physiologic parameters to adjust program (e.g. ventilation program for ALS)

TR with Acquired Brain Injury

- Used hybrid synchronous and asynchronous over 2 years for patients with ABI
- 2x/week for 1-2 months 30 minute sessions; 1-2x/week
- VR gaming for UE and cognition
- Improved with UE AROM weak side, shoulder flexion, and Trail Making Test
  - Kizony et al., 2017

BPPV Diagnosis

- Dix-Hallpike has sensitivity estimated at 48-88% (Nguyen-Huynh, 2008)
- Patient Interview with 4 questions has sensitivity of 81% (Imai et al., 2016)
  - Is rotary vertigo a characteristic of your dizziness/vertigo?
  - When you roll over in a supine position, do you experience d/v?
  - Does your d/v last for less than 5 minutes?
  - Have you previously experienced hearing loss in one ear or have experienced hearing loss, tinnitus, or ear fullness with this d/v?
    - 1 point to yes for 1 and 2, 2 points for yes on 3, subtract 1 point for yes on 4
    - Score >2 BPPV

Treatment of BPPV with subjective only

- 91% of patients objective BPPV improved after 1.59 average Semont liberatory maneuvers, 86% of subjective BPPV patients improved after 1.13 average maneuvers
  - Had vertigo with Dix-Hallpike
    - Need to see nystagmus to document positive Dix-Hallpike
  - Haynes et al., 2002
- Non-systematic review 9 studies (including Haynes)
  - Treatment based on history and signs with physical exam
  - 50-97.1% without nystagmus had remission compared to 76-100% with nystagmus
  - Alvarenga, Barbosa, Porto 2011

BPPV Treatment consideration

- Maranhao, Whitney, and Maranhao-Filho (2018)
- 33/221 patients had “Tumarkin-like phenomenon”
  - Sensation of being thrown to the ground
  - Patients remained symptom free 72 hours post Epley and Semont

PC BPPV treatment

- Putting pillow under back with head over the edge
  - Talk patient through the modified Epley maneuver
  - Have caregiver present, if possible, to prevent fall backwards after sitting up
- Half somersault could be used for home program instead (Foster et al., 2012)
- Gans maneuver (Saberi et al., 2017)
  - Less cervical pain
  - Long term efficacy similar with Epley

More PC BPPV treatments

- DizzyFIX
  - Device attaches to bill of hat
  - Efficacy 88% at 1 week (Bromwich et al., 2010)
  - Commercially available
- Semont home exercise

Horizontal canal BPPV treatment

- BBQ roll
- Appiani maneuver

Vestibular Exam and Treatment

- Viirre, 1996-Vestibular telemedicine and rehabilitation: Applications for virtual reality
  - Able to observe nystagmus with video-oculography
  - Needed tech to perform full neuro exam
  - Promise for VOR adaptation due to able to control amount of scene movement with VR

VOR and games

- Wiimote attached to hat, played games to address VOR hypofunction
  - Chen, Hsieh, Wei, Kao (2012)
- Motion sensing mouse attached to head by Velcro
  - Played computer games
  - Progressed from seated, standing, decrease BOS, compliant surface
    - Szturm, Reimer, Hochman (2015)
- aVOR app for iPhone for patient education
- iPod for gaze-stabilization (Huang et al., 2014)
  - iPod in pocket front of hat
  - Able to get objective information on velocity

Vestibular video

Balance and Falls video

Tele-Assessment BBS

- Venkataraman et al. (2017)
- Feasible and reliable to rate BBS via video in clinical setting
- Optimal to have frontal and lateral camera views
- Some loss of information-minimal with slow motion and high-def used

Balance Assessment for TR

- Matjacic, Bohinc, and Cikajlo (2010)
- Patients from NF able stand 1 minute
- Stand in computer-controlled machine with perturbations at waist
- BBS correlated with peak amplitude ML perturbations
- Could be used in homes with modification described in study

Balance treatment ideas

- Foam pad/couch cushion
- Shelf paper with colored tape for BOS
- Reaching in a corner
- Book with half swimming noddle attached for rocker board

Balance and Exer-gaming

- Hall et al., 2012 found WiiFit ski slalom correlated with
  - Gait speed
  - TUG
  - DGI

Exer-gaming video

More balance

- Post stroke program for balance (Llorens et al., 2015)
  - 20 sessions 45-minutes at 3x/week either in clinic or home TR (other 2 days in clinic both groups)
  - Looking at screen placed foot where indicated keeping other foot in center circle
- No difference between groups with BBS, Tinetti POMA, Brunel Balance Assessment
- Decreased cost with TR
- Similar to Clock yourself app

App review

- Standardized review smartphone balance training apps
  - Reyes, Qin, Brown (2018)
  - 5 apps met criteria for inclusion
  - None developed by PT
  - Companies and physicians
  - One company founded by PT
- Standardized review smartphone balance assessment (Moral-Munoz et al., 2018)
  - 5 apps met criteria
  - 3/5 had scientific support
  - Safety concern

Gait

- Portable kits for gait training (Giansanti et al., 2013)
  - Step counter
  - Photo emitter detector
  - Central unit for data
- Rope with distance marked off for gait speed (same used for TUG)
- Study in Japan (Iwatsuki et al., 2004)
  - Hospital recorded gait and was reviewed at university for recommendations for gait training
  - Found no difference between in-person and reviewed recommendations

Cardiopulmonary

Cardiopulmonary Evidence

- Cardiopulmonary Disease (Hwang et al 2015)
  - A systemic review (11 studies)
  - Results: telerehabilitation was no different than other delivery models
  - Appears to have higher adherence rates
- COPD study (Tsai et al., 2017)
  - Low drop out rate and higher compliance with pulmonary rehab
  - Mirrored centere-based programs

COPD

- RTC by Vasilopoulou et al., 2017
- Maintenance pulmonary rehab- usual care, hospital-based, or tele-rehab
  - Hospital-based and TR reduced risk of acute exacerbations
  - Only TR reduced risk of emergency visits

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Cardiopulmonary Treatment ideas for TR

- Inspiratory muscle training for COPD, heart failure
  - Neto et al., 2018
  - Thomas et al., 2010
- Restorator
- Strength training
- Stretches

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Case study

- Evaluation done in-person
  - Dorsiflexion lacked 5 degrees from neutral with knee extension on right and 3 on left
  - MMT plantar flexors 0/5 bilateral
  - Knee extension in sitting right 17#, left 20#
  - Unable to perform single limb stance
  - Deferred 2-minute step test due to SOB with single limb stance
  - Gait with rollator, no heel strike, unable to get swing foot past stance

Case study

- Seen via telerehab 2x/week for 6 weeks with in-person visit every other week
- Issued restorator, elastic bands, inspiratory respiratory muscle trainer
- Mailed/delivered adjustments to home program

Wound care

- Case study by Visco et al., 2001
  - Able to communicate better and more efficiently with health care team
- Le Goff-Pronost et al., 2018
  - Healing time shorter with telemedicine versus traditional follow-up visits.

Chronic Pain

- Cranen et al., 2017
- Patients preferred intermediate telerehabilitation visits for feedback and monitoring along with face to face and exercising outside of the home.

Neuropathy

- Pain-TENS applied to myotome (Dubinsky and Miyasaki, 2010)
- Balance- (Richardson, Sandman, and Vela, 2001)
  - Ankle warm-up in sitting
  - Standing toe/heel raises
  - Standing inversion/eversion
  - Wall slides

Pediatrics

- Clinic used TR for OT for patient education with short video clips
  - Seating and mobility clinic
  - Transition inpatient to outpatient

Cancer

- Remote guided exercise for patients with stable gliomas (Gehring et al., 2018)
- 6-months at 3x/week at 60-85% max heart rate
- Improved cardiorespiratory fitness

Frail

- Timonen et al., 2002
  - Exercise program 10 weeks
  - Knee extension, hip abduction, dynamic balance
- Remotely controlled biking (Jeong and Finkelstein, 2015)
  - 5 speeds for 2 minutes each was target
  - Motor turned on/off at times for passive/active
  - Improved pedaling speed after passive time
  - Benefit for frail elderly, cardiovascular conditions, possibly for pts with dementia

Frail

- Bruns et al., 2018
- Frail elderly planned for colorectal surgery
  - Computer supported strength training/protein recipes
    - Warm-up (dancing/walking)
    - Squats (all exercises 40 seconds, rest 20 seconds)
    - Lunges
    - Arm circles
    - Arm lifting
    - Adapted plank
    - Crunches
    - Digital rewards as motivation
  - Improved SPPB, gait speed, Fried score, QOL improved

Sarcopenia elderly adults

- Videoconferencing 12 week at 3x/week
- 20-40 minute sessions
  - 5 minute warm-up stretch walk in place
  - 20-30 minutes resisted exercise with Borg scale somewhat hard-hard biceps/triceps, front raises, leg raises, leg curls, leg extensions, squats, calf raises
  - Bodyweight weeks 1-4, 1kg d/b 5-8, 2 kg d/b 9-12
- Control group maintain lifestyle
- Increased leg muscle mass, total muscle mass, and chair sit-and-reach length
- Hong, Kim, Kim, and Kong; 2017

Chronic kidney disease (Watson et al., 2018)

- 3x/week for 12 weeks
- 30 minutes at “somewhat hard” intensity
- 20 minutes aerobic
- 10 minutes resisted exercise with leg press and knee extension with weight machine
- Increased strength and walking distance

Incontinence

- Stress incontinence (Sjostrom et al., 2015)
- RCT n=250
- Treatment-pelvic floor strengthening (8 levels), lifestyle adjustments, CBT done asynchronous with email support
- Control-used given same info and trained on own
- Improved QOL greater 2 years post with internet group

Home Safety Evaluations

- Romero et al., (2018)
  - Developed a home safety protocol with asynchronous approach
  - Able to perform home safety assessment before patient leaves hospital/SNF
  - Improve access to home safety assessments
- Renda and Lape, (2018)
  - Home safety assessment and home modifications via TR feasible
  - 2-6 visits performed
  - Looked at self-care, mobility, household, leisure
  - Used tech assist during initial eval to move camera/smartphone around home

Case Study

- 70 year old male Veteran "Bob"
- Primary Diagnosis: Cerebellar ataxia
- Other diagnoses: OA, HLP, HTN, gout, oropharyngeal dysphagia, hypokinetic dysphonia, hypokinetic dysarthria
- Lives on a farm an hour and a half away from the hospital
- Spouse is not in good health and daughter has to bring both of her parents to the hospital every time her dad has an appointment
- Last fell 6 weeks ago before starting Physical Therapy

Case Study continued

- Gait progressively worsening, feels unsteady and has a fear of falling, and has limited his activity
- Ambulates daily outside, but uses cane inconsistently
- Able to transfer independently from chair or bed

Initial Examination

- Activity tolerance: 2-minute step test: 38 steps (norm 95 for age)
- Strength: 30 second chair rise: 9 times (<15 increased risk for falls)
- Vestibular: slow head turns caused diplopia
- Balance: tandem stance 14 seconds
- Gait: 0.6 m/s with cane with inconsistent use, poor quad control

Treatments

- Patient given pedal exerciser, ankle weights, and elastic bands
- Activity tolerance: restorator used as warm-up each session angled 45 degrees
- Therapeutic exercise: strengthening trunk, quads, hip abduction and extensors, stretching plantar flexors/hamstrings, hip abduction/external rotation
- Gait: Cues using single point cane and mechanics

Treatment continued

- Neuro re-education: 4-square, retro gait, braiding, writing ABCs with foot with ankle weight on
- Vestibular: vestibular-ocular reflex x1 and dynamic visual acuity
- Gaze stabilization: 2 targets for saccadic movement

Outcomes

- Seen for total 15 visits
- Activity tolerance: 2-minute step test 63 steps on visit 13 (38 at initial examination)
- Reported diplopia resolved
- Balance: tandem stance 48 seconds, visit 14 (14 at initial examination)
- Strength: 30 second chair rise 14x, visit 11 (9 at initial examination)
- Gait: 0.8 m/s by d/c (0.6 m/s initially)
- Independent with home exercise program

Future

- ER
- Primary care
- Wearable haptic band (Delgado et al., 2017)
  - 8 vibrator motors along wearable band
  - Replace therapist's hands for guiding movement
  - Compared for both arbitrary motion patterns and typical therapy exercises
  - Able to demonstrate efficacy
- Wearable clothing for real-time monitoring of vital signs for chronic patients (Angelidis, 2010)

Case study

- At discharge
  - Single leg stance 10 seconds each leg
  - Gait without device in community 0.8 m/s
  - Knee extension left 56# right 60#
  - Dorsiflexion with knee extension right 2 degrees, left 5 degrees
  - Family/friends and physicians reported improvement in voice quality

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Resources

- www.pubmed.gov
- www.amedeo.com
- American Telemedicine Association SIG www.americantelemed.org
- www.apta.org
- www.fb.com/groups/telehealthpts
- www.telehealthprime.com
- www.telehealthpt.com

CONTINUED

References

- Agha, Z., Schapira, R.M., Laud, P.W., McNutt, G., and Roter, D.L. (2009). *Telemedicine Journal and E-Health, 15*(9), 830-839. doi.org/10.1089/tmj.2009.0030
- Alvarenga, G.A., Barbosa, M.A., and Porto, C.C. (2011). Benign paroxysmal positional vertigo without nystagmus: diagnosis and treatment. *Brazilian Journal of Otorhinolaryngology, 77*(6), 799-804.
- Angelidis, P.A. (2010). Personalised physical exercise regime for chronic patient through a wearable ICT platform. *International Journal Electronic Healthcare, 5*(4), 355-370. doi.org/10.1504/IJEH.2010.036207
- Azma, K., RezaSoltani, Z., Rezaeimoghaddam, F., Dadarkhah, A., and Mohsenolhosseini, S. (2018). Efficacy of tele-rehabilitation compared with office-based physical therapy in patients with knee osteoarthritis: A randomized clinical trial. *Journal of Telemedicine and Telecare, 24*(8), 560-565. doi.org/10.1177/1357633x17723368
- Bernocchi, P., Vanoglio, F., Baratti, D., Morini, R., Rocchi, S., Luisa, A., and Scalvini, S. (2016) Home-based telesurveillance and rehabilitation after stroke: a real-life study. *Topics in Stroke Rehabilitation, 23*(2), 106-15. doi.org/10.1080/10749357.2015.1120453.
- Billings M, Russell T. Federation of State Boards of Physical Therapy. Winter Forum 2015.
- Block, V.A., Pitsch, E., Tahir, P., Cree, B.A., Allen, D.D., and Gelfand, J.M. (2016). Remote physical activity monitoring in neurological disease: A systematic review. *Plos One, 11*(4), e0154335. doi.org/10.1371/journal.pone.0154335
- Bromwich, M., Hughes, B., Raymond, M., Sukerman, S., and Parnes, L. (2010). Efficacy of a new home treatment device for benign paroxysmal positional vertigo. *Archives of Otolarygology-Head & Neck Surgery, 136*(7), 682-685. doi.org/10.1001/archoto.2010.105 130

130

CONTINUED

References

- Bruns, E.R.J., Argillander, T.E., Schuijt, H.J., van Duijvendijk, P., van der Zaag, E.S., Wassenaar, E.B., Gerhards, M.F., Consten, E.C., Buskens, C.J., van Munster, B.C., and Bemelman, W.A. (2018). Fit4SurgeryTV at-home prehabilitation for frail elderly planned for colorectal cancer surgery: a pilot study. *American Journal of Physical Medicine & Rehabilitation*, doi.org/ 10.1097/PHM.0000000000001108
- Center for Connected Health Policy, State Telehealth Laws and Medicaid Program Policies, spring 2018
- Chen, PY, Hsieh, WL, Wei, SH, and Kao, CL. (2012). Interactive wiimote gaze stabilization exercise training system for patients with vestibular hypofunction. *Journal of Neuroengineering and Rehabilitation, 9*(77). doi.org/10.1186/1743-0003-9-77
- Chen, YY., Guan, BS., Li, ZK., Yang, QH., Xu, TJ., Li, HB., and Wu, QY. (2018). Application of telehealth intervention in Parkinson's disease: A systematic review and meta-analysis. *Journal of Telemedicine and Telecare,* doi.org/10.1177/1357633X18792805
- Cottrell, M.A., O'Leary, S.P., Swete-Kelly, P., Elwell, B., Hess, S., Litchfield, M., McCoughlin, I., Tweedy, R., Raymer, M., Hill, A.J. and Russell, T.G. (2018). Agreement between telehealth and in-person assessment of patients with chronic musculoskeletal conditions presenting to an advanced-practice physiotherapy screening clinic. *Musculoskeletal Science and Practice, 38,* 99-105. doi.org/10.1016/j.msksp.2018.09.014
- Cottrell, MA, Galea OA, O'Leary SP, Hill, AJ, Russell, TG. (2017). Real-time telerehabilitation for the treatment of musculoskeletal conditions is effective and comparable to standard practice: A systematic review and meta-analysis. *Clinical Rehabilitation,* 31(5), 625-638. doi:10.1177/0269215516645148.
- Cottrell, M.A., Hill, A.J., O'Leary, S.P., Raymer, M.E., and Russell, T.G. (2017). Service provider perceptions of telerehabilitation as an additional service option within an Australian neurosurgical and orthopaedic physiotherapy screening clinic: A qualitative study. *Musculoskeletal Science and Practice, 32*, 7-16. doi.org/10.1016/j.mskp.2017.07.008
- Coulter, E.H., McLean, A.N., Hasler, J.P., Allan, D.B., McFadyen, A., and Paul, L. (2017). The effectiveness and satisfaction of web-based physiotherapy in people with spinal cord injury: a pilot randomised controlled trial. Spinal Cord 55, 383-389. doi.org/10.1038/sc.2016.125

References

- Cranen, K., Drossaert, C.H.C., Brinkman, E.S., Braakman-Jansen, A.L.M., Ijzerman, M.J., and Vollenbroek-Hutten, M.M.R. (2011). An exploration of chronic pain patients' perceptions of home telerehabilitation services. *Health Expectations, 15*, 339-350. doi.org/10.1111/j.1369-7625.2011.oo668.x
- Cranen, K., Groothuis-Oudshoorn, C.G., Vollenbroek-Hutten, M.M., and IJzerman, M.J. (2017). Toward patient-centered telerehabilitation design: Understanding chronic pain patients' preferences for web-based exercise telerehabilitation using a discrete choice experiment. *Journal of Medical Internet Research, 19*(1), e26. doi.org/10.2196/jmir.5951
- Delgado, A., Alzate, J., Beekhuizen, S., Delgado, H., Donaldson, P., Hall, A., Lago, C., Vidal, K., and Fox, E.J. (2017). Assessment of haptic interaction for home-based physical therapy using wearable devices and depth sensors. *Studies in Health Technology and Informatics,* 220, 33-38.
- Diamond, B.J., Savard, L., Borstad, A., Tkachuk, J., Lauderdale, D., and Conroy, B. (2003). Telerehabilitation consultations for clients with neurologic diagnosis: Cases from rural Minnesota and American Samoa. *NeuroRehabilitation, 18*(2), 93-102.
- Dubinsky, R., and Miyasaki, J. (2010). Assessment: Efficacy of transcutaneous electric nerve stimulation in the treatment of pain in neurologic disorders (an evidence-based review). *Neurology, 74*(1)
- Emmerson, K.B., Harding, K.E., and Taylor, N.F. (2018). Providing exercise instructions using multimedia may improve adherence but not patient outcomes: a systematic review and meta-analysis. *Clinical Rehabilitation,* 1-12. doi.org/10.1177/0269215518819706
- Fatehi, F., Martin-Kahn, M., Smith, A.C., Russell, A.W., and Gray, L.C. (2015). Patient satisfaction with video teleconsultation in a virtual diabetes outreach clinic. *Diabetes Technology and Therapeutics, 17*(1), 43-48. doi.org/10.1089/dia.2014.0159
- Flaming, J. (2010). Establishing rapport in telehealth. *Behavioral Healthcare, 30*(9), 22-24.
- Foster, C.A., Ponnapan, A., Zaccaro, K., and Strong. D. (2012). A comparison of Two Home Exercises for Benign Positional Vertigo: Half Somersault versus Epley Maneuver. *Audiol Neurotol Extra, 2,* 16-23.

References

- Gandolfi, M., Geroin, C., Dimitrova, E., Boldrini, P., Waldner, A., Bonadiman, S.…and Smania, N. (2017). Virtual reality telerehabilitation for postural instability in Parkinson's disease: A multicenter, single-blind, randomized, controlled trial. *Biomed Research International,* 1-11, doi.org/10.1155/2017/7962826
- Gehring, K., Kloek, C.J.J., Aaronson, N.K., Janssen, K.W., Jones, L.W., Sitskoorn, M.M. and Stuiver, M.M. (2018). Feasibility of a home-based exercise intervention with remote guidance for patients with stable grade II and III gliomas: a pilot randomized controlled trial. *Clinical Rehabilitation, 32*(3), 352-366. doi.org/10.1177/0269215517728326
- Giansanti, D., Morelli, S., Maccioni, G., and Grigioni, M. (2013). Portable kit for the assessment of gait parameters in daily telerehabilitation. *Telemedicine Journal and E-Health, 19*(3), 224-232. doi.org10.1089/tmj.2012.0091/
- Good, D.W., Lui, D.F., Leonard, M., Morris, S., and McElwain, J.P. (2012). Skype: a tool for functional assessment in orthopaedic research. *Journal of Telemedicine and Telecare, 18,* 94-98. doi.org/10.1258/jtt.2011.110814
- Goodman, C.C., and Snyder, T.K. (2013). Interviewing as a screening tool. Differential Diagnosis for Physical Therapists- E-Book 5th edition. (Chapter 2). London: W.B. Saunders
- Grona. S.L., Bath, B., Busch, A., Rotter, T., Trask, C., and Harrison, E. (2017). Use of videoconferencing for physical therapy in people with musculoskeletal conditions: A systematic review. *Journal of Telemedicine and Telecare, 0*(0), 1-15. doi.org/10.1177/1357633X17700781
- Gustke, S.S., Balch, D.C., West, V.L., and Rogers, L.O. (2004). Patient Satisfaction with Telemedicine. *Telemedicine Journal, 6*(1), 5-13. doi:10.1089/107830200311806.
- Hall, C.D., Clevenger, C.K., Wolf, R.A., et al. Feasibility of a Low-cost, Interactive Gaming System to Assess Balance in Older Adults. Combined Sections Meeting of the APTA. Chicago, IL, February 8-11, 2012. Phys Ther Abstract. 2128.
- Haynes, D.S., Resser, J.R., Labadie, R.F., Girasole, C.R., Kovach, B.T., Scheker, L.E., and Walker, D.C. (2002). Treatment of benign positional vertigo using the semont maneuver: efficacy in patients presenting without nystagmus. *Laryngoscope, 112*(5), 796-801.

References

- Hong, J., Kim, J., Kim, S.W., and Kong, H.J. (2017). Effects of home-based tele-exercise on sarcopenia among community-dwelling elderly adults: Body composition and functional fitness. *Experimental Gerontology, 87*(Pt A), 33-39. doi.org/10.1016/j.exger.2016.11.002
- Huang, K., Sparto, P.J., Kiesler, S., Siewiorek, D.P., and Smailagic, A. (2014). iPod-based in-home system for monitoring gaze-stabilization exercise compliance of individuals with vestibular hypofunction. *Journal of NeuroEngineering and Rehabilitation, 11*(69), doi.org/10.1186/1743-0003-11-69
- Hwang, R., Bruning, J., Morris, N., Mandrusiak, A., and Russell T. (2015). A systematic review of the effects of telerehabilitation in patients with cardiopulmonary disease. *J Cardiopulm Rehabil Prev*. 35(6), 380-389. doi: 10.1097/HCR.0000000000000121.
- Imai, T., Higashi-Shingai, K., Takimoto, Y., Masumura, C., Hattori, K., and Inohara, H. (2016). New scoring system of an interview for the diagnosis of benign paroxysmal positional vertigo. *Acta Oto-Laryngologica, 136*(3), 283-288. doi.org/10.3109/00016489.2015.1121547
- Iwatsuki, H., Fujita, C., Maeno, R., and Matsuya, A. (2004). Developing of a telerehabilitation system for training physiotherapists in rural areas. *J Telemed Telecare*. 10(suppl 1): S1:51-52.
- Jenny, J., Bureggah, B., and Yann, D. (2016). Measurement of the knee flexion angle with smartphone applications: Which technology is better? *Knee Surgery, Sports Traumatology, Arthroscopy, 24*(9), 2874-2877.
- Jeong, I.C. and Finkelstein, J. (2015). Remotely controlled biking is associated with improved adherence to prescribed cycling speed. *Technology and Health Care, 23,* S543-S549. doi.org/10.3233/THC-150992
- Johnson, K. D., and Grindstaff, T.L. (2012). Thoracic region self-mobilization: A clinical suggestion. *International Journal of Sports Physical Therapy, 7*(2), 252-256.
- Kairy, D., Tousignant, M., Leclerc, N., Cote, A.M., and Levasseur, M. (2013). The patient's perspetive of in-home telerehabilitation physiotherapy services following total knee arthroplasty. *Int J Environ Res Public Health,* 10, 3998-4011. doi:10.3390/ijerph10093998.

References

- Kairy, D., Lehoux, P., Vincent, C., and Visintin, M. (2009). A systematic review of clinical outcomes, clinical process, healthcare utilization and costs associated with telerehabilitation. Disability & Rehabilitation 31(6), 427-448.
- Kizony, R., Weiss, P.L., Harel, S., Feldman, Y., Obuhov, A., Zeilig, G., and Shani, M. (2017). Tele-rehabilitation service delivery journey from prototype to robust in-home use. *Disability and Rehabilitation, 39*(15), 1532-1540. doi.org/10.1080/09638288.2016.1250827
- Kondro, W. (2010). Medical errors increasing because of complexity of care and breakdown in doctor-patient relationship, physician consultant says. *Canadian Medical Association Journal, 182*(13), E645-E646. doi.org/10.1503/cmaj.109-3344
- Lawford, B.J., Bennell, K.L., Kasza, J., and Hinman, R.S. (2017). Physical therapists' perceptions of telephone- and internet video-mediated service models for exercise management of people with osteoarthritis. *Arthritis Care & Research, 70*(3), 398-408. doi.org/10.1002/acr.23260
- Lawford, B.J., Bennell, K.L., and Hinman, R.S. (2016). Consumer perceptions of, and willingness to use, remotely-delivered service models for exercise management of knee and hip osteoarthritis: a cross-sectional survey. *Arthritis Care and Research, 69*(5), 667-676. doi: 10.1002/acr.23122.
- Lee, A.C.W., and Billings, M. (2016) Telehealth implementation in a skilled nursing facility: case report for physical therapist practice in Washington. *Physical Therapy, 96,* 252–259
- Le Goff Pronost, M., Mourgeon, B., Blanchere, J.P., Teot, L., Benateau, H., and Dompmartin, A., (2018). Real-world clinical evaluation and costs of telemedicine for chronic wound management. *International Journal of Technology Assessment in Health Care*, 1-9. doi.org/10.1017/S0266462318000685
- Li, L.W., Harris, R.E., Tsodikov, A., Strauble, L., and Murphy, S.L. (2017). Self-acupressure for older adults with symptomatic knee osteoarthritis: A randomized controlled trial. *Arthritis Care and Research, 0*(0), 1-9. doi.org/10.1002/acr.23262
- Llorens, R., Noe, E., Colomer, C., and Alcaniz, M. (2015). Effectiveness, usability, and cost-benefit of a virtual reality-based telerehabilitation program for balance recovery after stroke: A randomized controlled trial. *Archives of Physical Medicine and Rehabilitation, 96,* 418-425. doi.org/10.1016/j.apmr.2014.10.019

References

- Long, J.T., Kovacs, C.J., Hoobler, A.J., Fritts, E.E.K., Cunningham, B.E., and Caldwell, C.M. (2015). Integrating telehealth experiences in incorporating telehealth tools and principles into a pediatric therapeutic environment. *OT Practice, 20*(7),
- Mani, S., Sharma, S., Omar, B., Paungmali, A., and Joseph, L. (2016). Validity and reliability of internet-based physiotherapy assessment for musculoskeletal disorders: A systematic review. *Journal of Telemedicine and Telecare, 23*(3), 379-391. doi.org/10.1177/1357633X16642369
- Martin, D. (2003). Martin's Map: a conceptual framework for teaching and learning the medical interview using a patient-centred approach. *Medical Education*, 37, 1145-1153. doi:10.1046/j.1365-2923.2003.01719.x
- Maranhao, E.T., Whitney, S.L., and Maranhao-Filho, P. (2018). Tumarkin-like phenomenon as a sign of therapeutic success in benign paroxysmal positional vertigo. *Arquivos De Neuro-Pisquiatria, 76*(8), 534-538. doi.org/10.1590/0004-282X20180073
- Matjacic, Z., Bohinc, K., and Cikajlo, I. (2010). Development of an objective balance assessment method for purposes of telemonitoring and telerehabilitation in elderly population. *Disability and Rehabilitation, 32*(3), 259-266. doi.org/10.3109/09638280902943215
- Menezes, K.KP., Nascimento, L.R., Ada, L., Polese, J.C., Avelino, P.R., and Teixeira-Salmela, L.F. (2016). Respiratory muscle training increases respiratory muscle strength and reduces respiratory complications after stroke: a systematic review. *Journal of Physiotherapy, 62*, 138-144. doi.org/10.2016/j.phys.2016.05.014
- Moral-Munoz, J.A., Esteban-Moreno, B., Herra-Viedma, E., Cobo, M.J., and Perez, I.J. (2018). Smartphone applications to perform body balance assessment: A standardized review. *Journal of Medical Systems, 42*(7), 119. doi.org/10.1007/s10916-018-0970-1

References

- Muller, I., Kirby, S., and Yardley, L. (2015). The therapeutic relationship in telephone-delivered support for people undertaking rehabilitation: a mixed-methods interaction analysis, Disability and Rehabilitation, 37:12, 1060-1065, doi.org/10.3109/09638288.2014.955134
- Naylor, J.M., Ko, V., Gaskin, C., Walker, R., Harris, I.A., and Mittal, R. (2011). Validity and reliability of using photography for measuring knee range of motion: a methodological study. *BMC Musculoskeletal Disorders, 12*(77), 1-10. doi.org/10.1186/1471-2474-12-77
- Neto, M.G., Ferrari, F., Helal, L., Lopes, A.A., Carvalho, V.O., and Stein, R. (2018). The impact of high-intensity inspiratory muscle training on exercise capacity and inspiratory muscle strength in heart failure with reduced ejection fraction: a systematic review and meta-analysis. *Clinical Rehabilitation, 32*(11), 1482-1492.
- Nguyen-Huynh, A.T. (2008). Evidenced-based practice: Management of vertigo. *Otolaryngologic Clinics of North America, 45*(5), 925-940. doi.org/10.1016/j.otc.2012.06.001
- Pastora-Bernal, J.M., Martin-Valero, R., Baron-Lopez, F.J., and Estebanez-Perez, M.J. (2017). Evidence of benefit of telerehabilitation after orthopedic surgery: A systematic review. *Journal of Medical Internet Research, 19*(4), 1-12. doi.org/10.2196/jmir.6836
- Pastora-Bernal, J.M., Martin-Valero, R., Baron-Lopez, F.J., Moyano, N.G., and Estebanez-Perez, M.J. (2018). Telerehabilitation after arthroscopic subacromial decompression is effective and not inferior to standard practice: Preliminary results. *Journal of Telemedicine and Telecare, 24*(6), 428-433. doi.org/10.1177/1357633X17706583
- Paul, L., Renfrew, L., Freeman, J., Murray, H., Weller, B., Mattison, P., McConnacie, A., Heggie, R., Wu, O., and Coulter, E.H. (2018). Web-based physiotherapy for people affected by multiple sclerosis: a single blind, randomized controlled feasibility study. *Clinical Rehabilitation*, 1-12. doi.org/10.1177/0269215518817080 (ahead of print)

References

- Peterson, S., Kuntz, C., Roush, J. (2018). Use of a modified treatment-based classification system for subgrouping patients with low back pain: Agreement between telerehabilitation and face-to-face assessments. *Physiotherapy Theory and Practice,* doi.org/10.1080/09593985.2018.1470210.
- Peterson, S. (2018) Telerehabilitation booster sessions and remote patient monitoring in the management of chronic low back pain: A case series. *Physiotherapy Theory and Practice, 34*(5), 393-402, doi.org/10.1080/09593985.2017.1401190
- Randall, K., Steinheider, B., Isaacson, M., Shortridge, A., Byrd, S., Ciro, C., Ross, H., and Loving, G. (2016). Measuring knowledge, acceptance, and perceptions of telehealth in an interprofessional curriculum for student nurse practitioners, occupational therapists, and physical therapists. *Journal of Interactive Learning Research, 27*(4), 339-353.
- Reiman, M.P. and Matheson, J.W. (2013). Restricted hip mobility: Clinical suggestions for self-mobilization and muscle re-education. International Journal of Sports Physical Therapy, 8(5), 729-740.
- Renda, M. and Lape, J.E. (2018). Feasibility and effectiveness of telehealth occupational therapy home modification interventions. *International Journal of Telerehabilitation, 10*(1), 3-14. doi.org/10.5195/ijt.2018.6244
- Reyes, A., Qin, P., and Brown, C.A. (2018). A standardized review of smartphone applications to promote balance for older adults. *Disability and Rehabilitation, 40*(6), 690-696. doi.org/10.1080/09638288.2016.1250124
- Richardson, B.R., Truter, P., Blumke, R., and Russell, T.G. (2017). Physiotherapy assessment and diagnosis of musculoskeletal disorders of the knee via telerehabilitation. *Journal of Telemedicine and Telecare.* 23(1), 88-95.
- Richardson, J.K., Sandman, D., and Vela, S. (2001). A focused exercise regimen improves clinical measures of balance in patients with peripheral neuropathy. *Archives of Physical Medicine and Rehabilitation, 82*(2), 205-209.
- Richmond, T., Peterson, C., Cason, J., Billings, M., Terrell, E.A., Lee, A.C.W., Towey, M., Parmanto, B., Saptono, A., Cohn, E.R., and Brennan, D. (2017). American telemedicine association's principles for delivering telerehabilitation services. *International Journal of Telerehabilitation, 9*(2), 63-68. doi.org/10.5195/ijt.2017.6232

CONTINUED

References

- Ridgel, A.L., Peacock, C.A., Fickes, E.J., and Kim, CH. (2012). Active-assisted cycling improves tremor and bradykinesia in Parkinson's disease. *Archives of Physical Medicine and Rehabilitation, 93*(11), 2049-2054. doi.org/10.1016/j.apmr.2012.05.015
- Rini, C., Porter, L.S., Somers, T.J., McKee, D.C., DeVellis, R.F., Smith, M., Winkel, G., Ahern, D.K., Goldman, R., Stiller, J.L., Mariani, C., Patterson, C., Jordan, J.M., Caldwell, D.S., and Keefe, F.J. (2015). Automated Internet-based pain coping skills training to manage osteoarthritis pain: a randomized controlled trial. *Pain,*156(5), 837-848. doi.org/10.1097/j.pain.0000000000000121.
- Rintala, A., Paivarinne, V., Hakala, S., Paltamaa, J., Heinonen, A., Karvanen, J., and Sjorgen, T. (2019). Effectiveness of technology-based distance physical rehabilitation interventions for improving physical functioning in stroke: a systematic review and meta-analysis of randomized controlled trials. *Archives of Physical Medicine and Rehabilitation,* doi.org/10.1016/j.apmr.2018.11.007
- Romero, S., Lee, M.J., Simic, I., Levy, C., and Sanford, J. (2018). Development and validation of a remote home safety protocol. *Disabilit and Rehabilitation: Assistive Technology, 13*(2), 166-172. doi.org/10.1080/17483107.2017.1300345
- Russell, T.G., Blumke, R., Richardson, B., and Truter, P. (2010). Telerehabilitation mediated physiotherapy assessment of ankle disorders. *Physiotherapy Research International, 15*(3), 167-175. doi.org/10.1002/pri.471
- Russell, T., Truter, P., Blumke, R., and Richardson, B. (2010). The diagnostic accuracy of telerehabilitation for nonarticular lower-limb musculoskeletal disorders. *Telemedicine and e-Health, 16*(5), 585-594. doi.org/10.1089/tmj.2009.0163
- Saberi, A., Nemati, S., Sabnan, S., Mollahoseini, F., and Kazemnejad, E. (2017). A safe-repositioning maneuver for the management of benign paroxysmal positional vertigo: Gans vs. Epley maneuver; a randomized comparative clinical trial. *European Archives of Oto-Rhino-Laryngology, 274*(8), 2973-2979. doi.org/10.1007/s00405-016-4235-7

CONTINUED

References

- Sakakibara, B., Eng, J.J., Edgar, M.C., Monsees, S., Rhebergen, J., Waring, J., and Van der Star, J. (2016) Feasibility of telerehabilitation in stroke recovery: A survey on access and willingness to use low-cost consumer technologies. *Archives of Physical Medicine Rehabilitation, 97*(12), e10-e11.
- Sarfo, F.S., Ulasavets, U., Opare-Sem, O.K., and Ovbiagele, B. (2018). Tele-rehabilitation after stroke: An updated systematic review of the literature. *Journal of Stroke and Cerebrovascular Diseases, 27*(9), 2306-2318. doi.org/10.1016/j.jstrokecerebrovasdis.2018.05.013
- Scholten, J., Poorman, C., Culver, L., and Webster, J.B. (2019). Department of veterans affairs polytrauma telerehabilitation: Twenty-first century care. *Physical Medicine and Rehabilitation Clinics of North America, 30*(1), 207-215. doi.org 10.1016/j.pmr.2018.08.003/
- Seidler, K.J., Duncan, R.P., McNeely, M.E., Hackney, M.E., and Earhart, G.M. (2017). Feasibility and preliminary efficacy of a telerehabilitation approach to group adapted tango instruction for people with Parkinson disease. *Journal of Telemedicine and Telecare, 23*(8), 740-746. doi.org/10.1177/1357633X16668092
- Sherrington, C., Tiedemann, A., Fairhall, N., Close, J.C., and Lord, S.R. (2011). Exercise to prevent falls in older adults: an updated meta-analysis and best practice recommendations. *New South Wales Public Health Bulletin, 22*(3-4), 78-83. doi.org/10.1071/NB10056
- Singh Ospina, N., Phillips, K.A., Rodriguez-Gutierrez, R., Castaneda-Guarderas, A., Gionfriddo, M.R., Branda, M.E., and Montori, V.M. (2018). Eliciting the patient's agenda-secondary analysis of recorded clinical encounters. *Journal of General Internal Medicine, Jul 2.* doi.org/10.1007/s11606-018-4540-5
- Sjostrom, M., Umefjord, G., Stenlund, H., Carlbring, P., Andersson, G., and Samuelsson, E. (2015). Internet-based treatment of stress urinary incontinence: 1- and 2-year results of a randomized controlled trial with a focus on pelvic floor muscle training. *BJU International, 116*(6), 955-964. doi.org/10.1111/bju.13091

CONTINUED

CONTINUED

References

- Song H.J., Seo, HJ., Lee, H., Son, H., Choi, S.M., and Lee, S. (2015). Effect of self-acupressure for symptom management: A systematic review. *Complemntary Therapies in Medicine, 23*, 68-78. doi.org/10.1016/j.ctim.2014.11.002
- Speyer, R., Denman, D., Wilkes-Gillan, S., Chen, Y.W., Bogaardt, H., Kim, J.H., Heckathorn, D.E., and Cordier, R. (2018). Effects of Telehealth by Allied Health Professionals and Nurses in Rural and Remote Areas: A systematic review and meta-analysis. *Jornal of Rehabilitation Medicine, 50*, 225-235. doi.org/10.2340/16501977-2297
- Steele, L., Lade, H., McKenzie, S., and Russell, T.G. (2012). Assessment and diagnosis of musculoskeletal shoulder disorders over the internet. *International Journal of Telemedicine and Applications, 2012,* 945745. doi.org/10.1155/2012/945745
- Szturm, T., Reimer, K.M., and Hochman, J. (2015). Home -based computer gaming in vestibular rehabilitation of gaze and balance impairment. *Games for Health Journal, 4*(3), doi.org/10.1089/g4h.2014.0093
- Tallner, A., Streber, R., Hentschke, C., Morgott, M., Geidl, W., Maurer, M., and Pfeifer, K. (2016). Internet-supported physical exercise training for persons with multiple sclerosis-A randomized, controlled study. International Journal of Molecular Sciences, 17, 1667-1678. doi.org/10.3390/ijms17101667
- Tenforde, A.S., Hefner, J.E., Kodish-Wachs, J.E., Iaccarino, M.A., and Paganoni, S. (2017). Telehealth in physical medicine and rehabilitation: A narrative review. Clinical Informatics in Physiatry, 9(5), s51-s58. doi.org/10.1016/j.pmrj.2017.02.013
- Thomas, M., Simpson, J., Riley, R., and Grant, E. (2010). The impact of home-based physiotherapy interventions on breathlessness during activities of daily living in severe COPD: A systematic review. *Physiotherapy, 96*(2), 108-119.
- Timonen, L., Rantanen, T., Ryynanen, O.P., Taimela, S., Timonen, T.E., and Sulkava, R. (2002). A randomized controlled trial of rehabilitation after hospitalization in frail older women: Effects on strength, balance, and mobility. *Scandinavian Journal Medical Science and Sports, 12*(3), 186-192.

CONTINUED

References

- Truter, P., Russell, T., and Fary, R. (2014). The validity of physical therapy assessment of low back pain via telerehabilitation in a clinical setting. *Telemedicine Journal and E-Health, 20*(2), 161-167. doi.org/10.1089/tmj.2013.0088
- Tsai, L.L., McNamara, R.J., Moddel, C., Alison, J.A., McKenzie, D.K., and McKeough, Z.J. (2017). Home-based telerehabilitation via real-time videoconferencing improves endurance exercise capacity in patients with COPD: the randomized controlled TeleR study. *Respirology, 22*(4), 699-707. doi: 10.1111/resp.12966.
- Tsvyakh, A.I. and Hospodarskyy, A.J. (2017). Telerehabilitation of patients with injuries of the lower extremities. *Telemedicine and e-Health, 23*(12), 1011-1015. doi.org/10.1089/tmj.2016.0267
- Turner, A. (2018). Case studies in physical therapy: Transitioning a "hands-on" approach into a virtual platform. *International Journal of Telerehabilitation, 10*(1), 37-50. doi.org/10.5195/ijt.2018.6253
- Van Egmond, M.A., van der Schaaf, M., Vredeveld, T., Vollenbroek-Hutten, M.M.R., van Berge Henegouwen, MI., Klinkenbijl, J.H.G., and Engelbert, R.H.H. (2018). Effectiveness of physiotherapy with telerehabilitation in surgical patients: a systematic review and meta-analysis. *Physiotherapy, 104*, 277-298. doi.org/10.1016/j.physio.2018.04.004
- Van Straaten, M.G., Cloud, B.A., Morrow, M.M., Ludewig, P.M., and Zhao, K.D. (2014). Effectiveness of home exercise on pain, function, and strength of manual wheelchair users with spinal cord injury: a high-dose shoulder program with telerehabilitation. *Archives of Physical Medicine and Rehabilitation, 95*(10), 1810-1817.
- Veras, M., Kairy, D., Rogante, M., Giacomozzi, C., and Saraiva, S. (2016). Scoping review of outcome measures used in telerehabilitation and virtual reality for post-stroke 21. doi: 10.1177/1357633X16656235.

CONTINUED

CONTINUED

References

- Vasilopoulou, M., Papaioannou, A.I., Kaltsakas, G., Louvaris, Z., Chynkiamis, N., and Spetsioti, G. et al. (2017). Home-based maintenance tele-rehabilitation reduces the risk for acute exacerbations of COPD, hospitalisations and emergency department visits. *European Respiratory Journal, 49*(5), doi.org/10.1183/13993003.02129-2016
- Venkataraman, K., Morgan, M., Amis, K.A., Landerman, L.R., Koh, G.C., Caves, K., and Hoenig, H. (2017). Tele-assessment of the berg balance scale: Effects of transmission characteristics. *Archives of Physical Medicine and Rehabilitation, 98*(4), 659-664. doi.org/10.1016/j.apmr.2016.10.019
- Viirre, E. (1996). Vestibular telemedicine and rehabilitation. Applications for virtual reality. *Studies in Health Technology and Informatics, 29,* 299-305.
- Visco, D.C., Shalley, T., Wren, S.J., Flynn, J.P., Brem, H., Kerstein, M.D., and Fitzpatrick, J.J. (2001). Use of telehealth for chronic wound care: a case study. *Journal of Wound, Ostomy, & Continence Nursing, 28*(2), 89-95.
- Watson, E.L., Gould, D.W., Wilkinson, T.J., Xenophontos, S., Clarke, A.L., Vogt, B.P., Viana, J.L., and Smith, A.C. (2018). Twelve-week combined resistance and aerobic training confers greater benefits than aerobic training alone in nondialysis CKD. *American Journal of Physiology: Renal Physiology, 314*(6), F1188-F1196. doi.org/10.1152/ajprenal.00012.2018
- http://www.apta.org/Telehealth/ accessed December 5, 2018
- Choung, SD., Kwon, OY., Park, KN., Kim, SH., and Cynn, HS. (2013). Short-term effects of self-mobilization with a strap on pain and range of motion of the wrist joint in patients with dorsal wrist pain when weight bearing through the hand: A case series. *Manual Therapy, 18*, 568-572. doi.org/10.1016/j.math.2013.06.001
- Jeong, UC, Kim, CY, Park, YH, Hwang-Bo, G., and Nam, CW. (2016). The effects of self-mobilization techniques for the sciatic nerves on physical functions and health of low backpain patients with lower limb radiating pain. *Journal of Physical Therapy Science, 28*, 46-50.