Trailblazing Healthcare Education: Digital Innovation, Telehealth, and Training

Dr. Nupur Hajela, PT, DPT, Ph.D
Director - Rehab Technologies and Outcomes Research
California State Univ, Fresno CA, USA
Nov 21, 2023 - California Telehealth Resource Center

Educate, Engage, Empower

Speaker Bio and Contact Information

Nupur Hajela, PT, DPT, PhD

- **Assistant Professor, Dept. of Physical Therapy California State Univ Fresno, CA, USA**
- **Director- Rehab Technologies and Outcomes Research , California Sports Science Institute**
- **Co -Director- Gait Balance and Mobility Clinic**
- **Board of Directors of InSPIRE SWADES, nonprofit organization to foster collaboration between India and USA**
- **Vice Chairperson, San Joaquin Valley District. California Physical Therapy Association**

nhajela@csufresno.edu

Telehealth and Digital Innovations

Telerehabilitation/Telehealth/Telehealth PT

World Health Organization, “Telehealth involves the use of telecommunications and virtual technology to deliver health care outside of traditional health-care facilities.”

Telehealth involves remote health care visits delivered through an online/digital platform.

Modes of Telehealth

California Telehealth Resource Center defines telehealth:

“Telehealth is a collection of means or methods for enhancing health care, public health, and health education delivery and support using telecommunications technologies.”

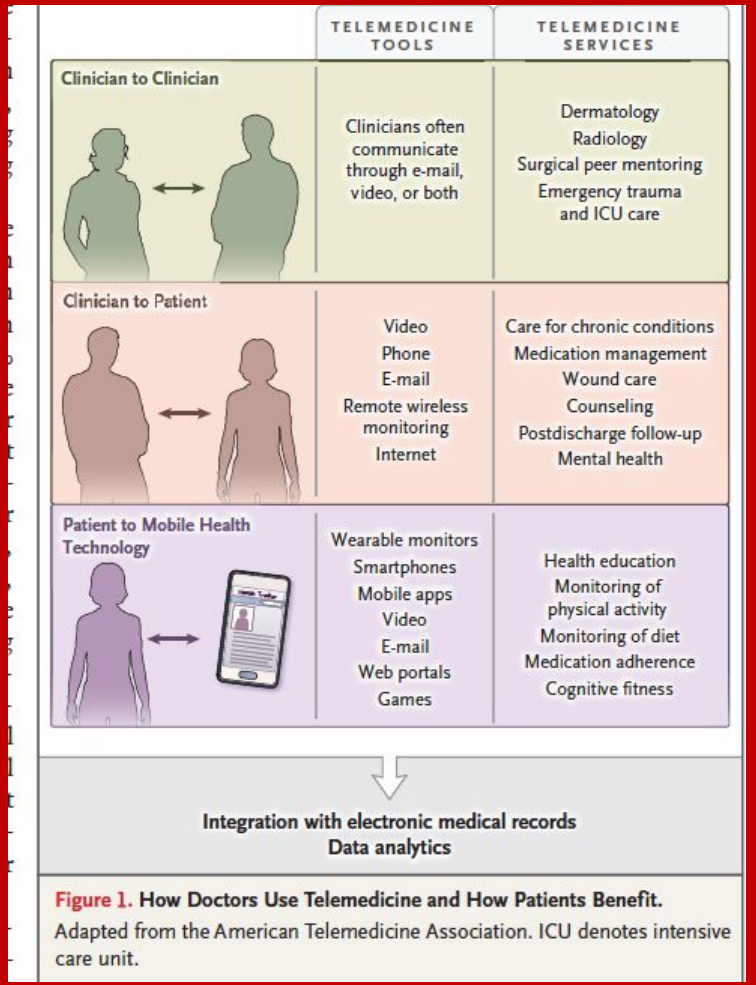


Figure 1. How Doctors Use Telemedicine and How Patients Benefit.
Adapted from the American Telemedicine Association. ICU denotes intensive care unit.

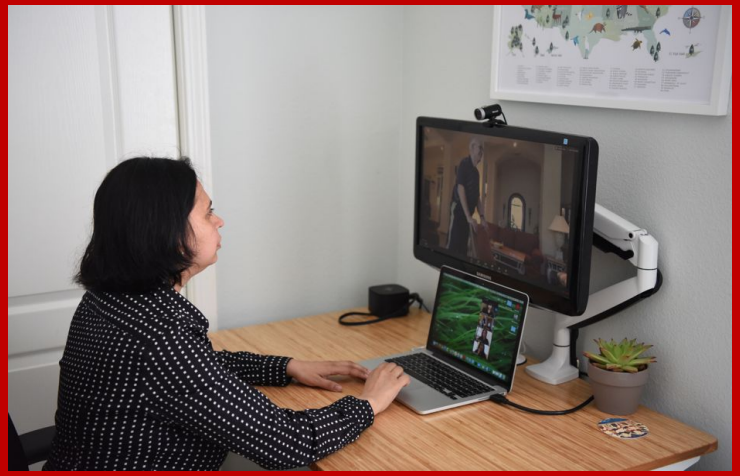
Tukson et al 2017

Introduction: Unleashing the Potential: Telehealth Simulations in Modern Healthcare Education

- How can technology redefine healthcare education methods to better align with the demands of modern healthcare?
- What role do practical skills and real-world experience play in preparing future healthcare professionals?
- How can interprofessional collaboration and inclusivity be integrated into healthcare education?
- Digital Innovation in Healthcare and Healthcare Education

Telehealth Delivery in Healthcare Education

Telehealth Success story: Dept of Physical Therapy



Telehealth - Gait and Balance Mobility Clinic,
California State University, Fresno CA, USA

Telehealth Delivery & Education

Topics in Geriatric Rehabilitation • Volume 000, Number 000, 1-13 • Copyright © 2023 Wolters Kluwer Health, Inc. All rights reserved.
DOI: 10.1097/TGR.0000000000000408

Telehealth Implementation and Teaching Strategies During COVID-19 and Beyond in Gait, Balance, and Mobility Clinic for Community-Dwelling Older Adults

Nupur Hajela, PhD, DPT, PT; Bryan Kwon, DPT, PT, GCS; Katiria Alexandra Penson, DPT, PT; Alan Lee, PhD, DPT, CSW, PT, GCS

TABLE 1 Framework of the Telehealth Gait Balance and Mobility Clinic Set Up for an 8-Week Physical Therapy Program for a Community-Dwelling Older Adult

Number and Type of Session	Telehealth Delivery Plan (8 Wk or 16 Sessions)
Pretelehealth orientation week (2 wk)	Orientation to telehealth for students Mock telehealth practice session (Student and CI)
Session 1	Telehealth (Zoom) setup day SPT with the patient: - SPT helps patient download and get used to the online platform (eg, Zoom) - SPT helps patient get oriented to the camera setup and the ideal place with optimal lightening for the telehealth session - SPT discusses with patients the safe telehealth setup such as the use of a steady chair without wheels and the place next to the wall. Any other equipment that will be needed - SPT discusses equipment and accessories needed (theraband, chair, stool, etc) - SPT takes verbal and written informed consent for telehealth delivery
Session 2 and 3	Telehealth initial evaluation
Session 4-7	Telehealth PT intervention days
Session 8 and 9	Telehealth midterm evaluation (client) Student midterm CPI (student self-evaluation and feedback from CI)
Session 10-15	Telehealth PT intervention days
Session 16	Telehealth discharge evaluation
Posttelehealth (1 wk)	SPT completed discharge note, provide revised HEP to their patient Final CPI (SPT provided self-assessment through CPI and get feedback from their CI) SPT completed reflection assignment SPT participate in discussion board activity

Abbreviations: CI, clinical instructor; CPI, Clinical Performance Instrument; PT, physical therapist; SPT, student physical therapist.

N Hajela et al, 11, 2023
Topics in Geriatrics Rehabilitation

Telehealth Based Balance and Gait Assessment

TABLE 3 Geriatric Client's Clinical and Functional Outcome Measures Collected During Telehealth Physical Therapy

Outcome Measures	Initial Evaluation	Midterm Reevaluation	Final Evaluation at Discharge
Usability questionnaire TUQ	134/147	139/147	136/147
Functional outcome measures TUG Age norm: 7.7 ± 2.3 s for 79 y	12.8 s (*An older adult who takes ≥12 s to complete the TUG is at risk for falling)	11.5 s	8 s
mCTSIB	105/120 *Cond 2 = 15/30 Condition 2: Moderate sway; required use of support surface to stead During condition 2 patient displayed moderate swaying and used 1 hand for support during the last 15 s	120/120 Conditions 2, 3, 4: Minimum sway	120/120
Berg Balance Scale normative value 52-55	45/56	52/56	55/56
4-stage balance tests	Conditions 1, 2, 3: 10 s Condition 4: 0 s Patient unable to perform due to fear of loss of balance	Conditions 1, 2, 3: 10 s Condition 4: 0 s Patient unable to perform due to fear of loss of balance	Conditions 1, 2, 3: 10 s Condition 4: 6 s
Single-leg stance	Patient was not confident trying, score = 0 s	Patient was not confident trying, score = 0 s	6 s bilaterally
Heel standing	Patient was not confident trying, score = 0 s	Patient was not confident trying, score = 0 s	10 s; minimum sway
30-s chair stand (# of stands in 30 s)	6 Patient required the use of his/her arms in order to complete this test. When asked to try and not to use their arms, the patient stated that he/she was not able to do this task without them (*Moderate fall risk; required use of upper extremity for the performance of the test)	8 (No longer requires UE assistance)	9 (No longer requires UE assistance)

Abbreviations: mCTSIB, modified Clinical Test of Sensory Interaction and Balance; TUG, Timed Up and Go; TUQ, Telehealth Usability Questionnaire; UE, upper extremity.

NHajela et al, 2023- Topics in Geriatric Rehab - Telehealth Special Issue

Telehealth Based Physical Therapy

TABLE 4 Example Activities and Progression Used for Exercise Intervention for Geriatric Client Provided via Telehealth

Exercises	Session 2	Session 3-5	Session 5-7	Sessions 7-9	Sessions 10-13	Sessions 14-16
1. Ankle sways 2. Stepping strategy	Ankle sways with wide BOS—no hand support 2 × 5 reps	Ankle sways with narrow BOS—no hand support 3 × 5 reps	Stepping while reaching for objects on front and side 2 × 5 reps	• Big forward rock and reach • Big step and reach 2 × 5 reps		
3. Standing heel raises 4. Standing toe raise	Heel raises 2 × 10 reps	Alternating heel/toes raises 2 × 10 reps	HEP			
5. Toe taps	Forward toe taps on the cup with each leg—no support 2 × 5 reps		Forward toe taps on a stool—no support 2 × 10 reps	Forward and side toe taps on a stool with emphasis on slow and controlled movements 2 × 10 reps		
6. Standing marches	Standing marches—no support 2 × 10 reps	Marches with reciprocal arm and leg movement 2 × 10 reps		HEP		
7. Sit-to-stand transfer	Mini squats—3 fingers used for support 2 × 8 reps	Sit to stand—arms used for support when rising 2 × 5 reps	Sit at the edge of chair→ lean forward with arm straight out→ stand *Utilizing task breakdown 2 × 5 reps	Big sit to stand on the lower surface—no use of arms for support 2 × 10 reps		
8. Standing balance 9. Gait training	Standing on a firm surface with wide and narrow BOS 1 set for 30-s hold each Staggered stance 2 sets of 20-30 s holds each Tandem stance with 3 fingers for support 3 sets of 30 s holds with 3 fingers used for support		Standing on unstable surface 2 set 5-10 s holds "Floor Cleaning"—single leg circles Clockwise 4 reps, counter clockwise 3 reps	Gait training progression added Ambulating with head turns left and right Ambulation with variable speeds 1 set of 2 min Ambulation with unpredictable commands such as "walk fast, slow, stop, turn around" from the student physical therapist	Ambulation with head turns side to side Ambulation while focusing on an object Ambulation carrying grocery bags 2 sets of 15 steps while alternating arms holding bags	
10. Half kneeling					Half kneeling on a stool with maintaining posture for 5 s 1 set of 8 reps each on 1 leg with the use of 1 hand for support Incorporation of UE movement (D1/D2) PNF pattern	

Abbreviations: BOS, base of support; HEP, home exercise program; PNF, proprioceptive neuromuscular facilitation; UE, upper extremity.

NHajela et al, 2023- Topics in Geriatric Rehab - Telehealth Special Issue

Telehealth Delivery & Education - Use of mHealth app platform

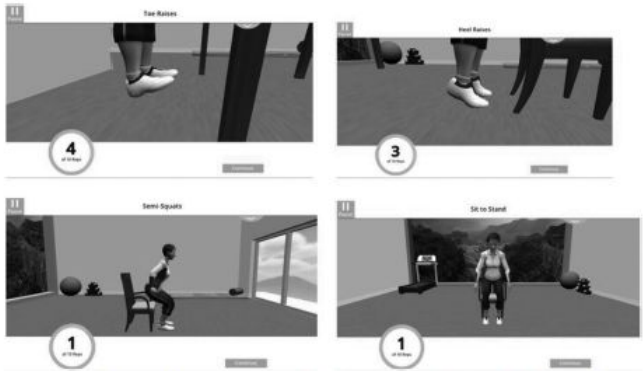


Figure 2. Examples of avatar-guided digital home exercise program provided using Health in Motion App by Blue Marble Health Co. The exercises demonstrated by the avatar are toe raises, heel raises, semisquats, and sit-to-stand for the client to perform at home without student physical therapists. In this client can follow along with the avatar for a guided home exercise program session.

N Hajela et al, 11, 2023
Topics in Geriatrics Rehabilitation

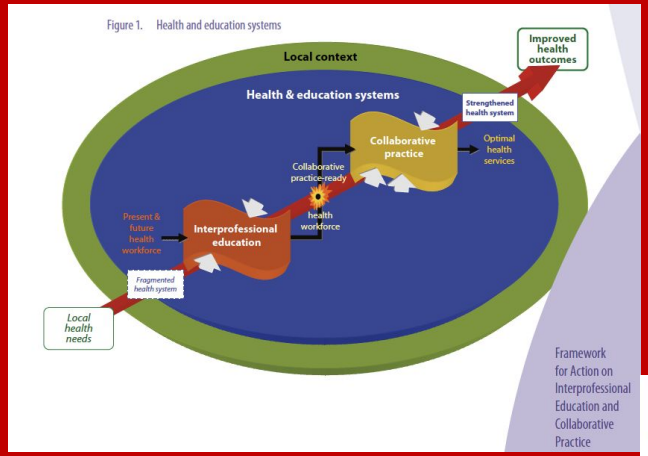
TABLE 2 Virtual Clinical Learning: Examples of Various Activities that were Designed for Students for the Online Clinical Learning Course to Enhance Engagement and Foster Active Learning

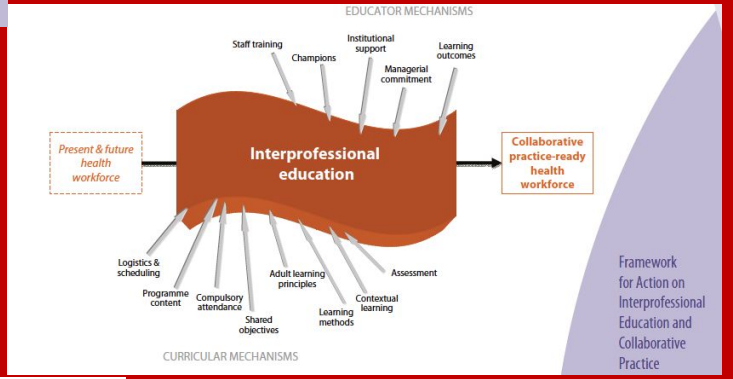
1) Discussion Board Activity
a) What do you think will be the minimum technical requirement to deliver telerehabilitation? With aging adults, how would you bridge the gap to maximize accessibility?
b) What are the potential costs vs benefits of telehealth in physical therapy? Are you in support of telehealth or do you oppose it? Can you provide reasons for your choice?
c) In the state of (X)—what are the current telehealth-related laws and reimbursement policies? How do you see things changing in the near future? If you have to argue—how would you convince the legislators that telehealth sessions should be reimbursed?
d) Which patient populations do you think the patient can benefit most from telerehabilitation? Which patient population will benefit the least? Justify your answers.
2) Peer Observation and Evaluation
Based on observation and interaction with your peer for the last (X) wk of telehealth experience, provide feedback on your peer's professionalism and interactions with the patient and you, as well as his/her organization, performance, and delivery of therapeutic activity in a telehealth setting. Please provide 3 areas that your peer has impressed you and 3 areas that your peer could improve and advance as a student physical therapist.
3) Reflection Assignment
What are your overall thoughts on telehealth as a physical therapy delivery method? Do you think telehealth will be used more frequently in the future? Why or why not? Based on your individual experience shed light on the challenges and opportunities related to telehealth physical therapy. Provide examples from your own therapy sessions.

Telehealth In Interprofessional Education

Interprofessional Education and Collaborative Practice

World Health Organization



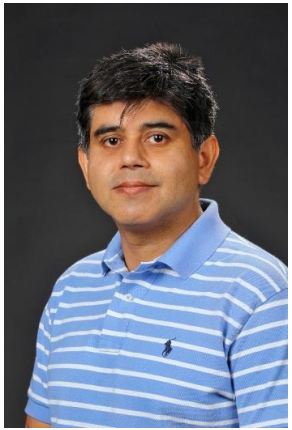


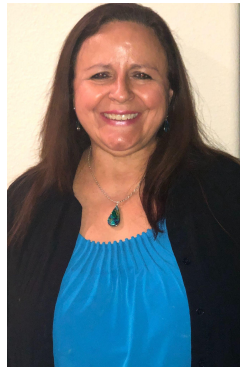
Learning together to work together for better health

World Health Organization (WHO). (2010). Framework for Action on Interprofessional Education & Collaborative Practice. Geneva: World Health Organization.

FRESNO STATE

College of Health and Human Services





PHYSICAL THERAPY

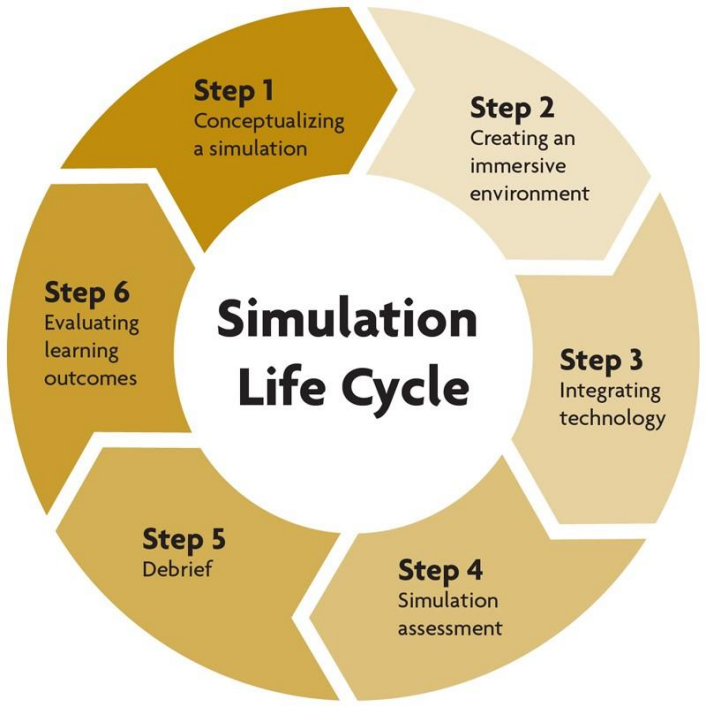
PUBLIC HEALTH

NURSING

SOCIAL WORK

Interprofessional Team working on Telehealth Education and Training for students in Healthcare Profession

Telehealth based Simulated Learning Experience

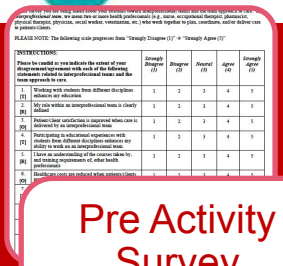


Telehealth Based Simulation Setup

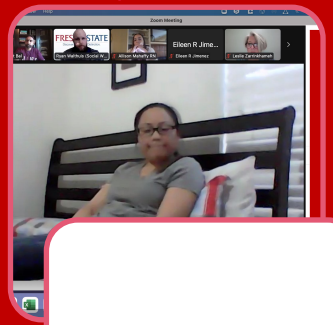
PT
- PT Evaluation- Balance and Gait related for Parkinson's client

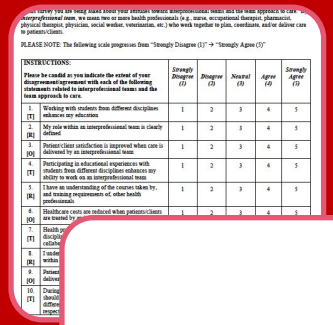
Nursing
- Medical History
- Review of medication

SWE
- Discuss discharge planning
- Financial and social factors



Pre Activity Survey



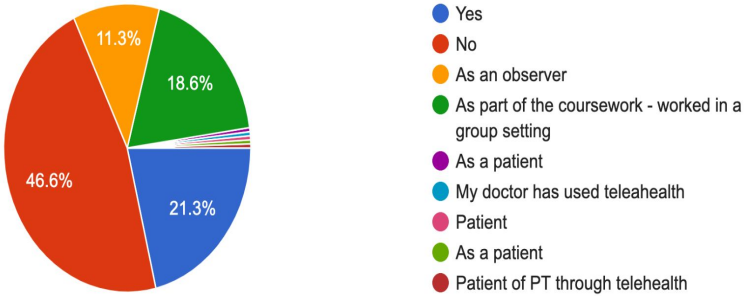


Post Activity Survey

Why we need Interprofessional telehealth Education

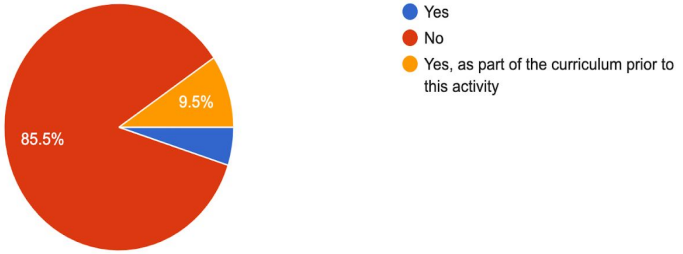
Do you have prior experience conducting a telehealth session

221 responses

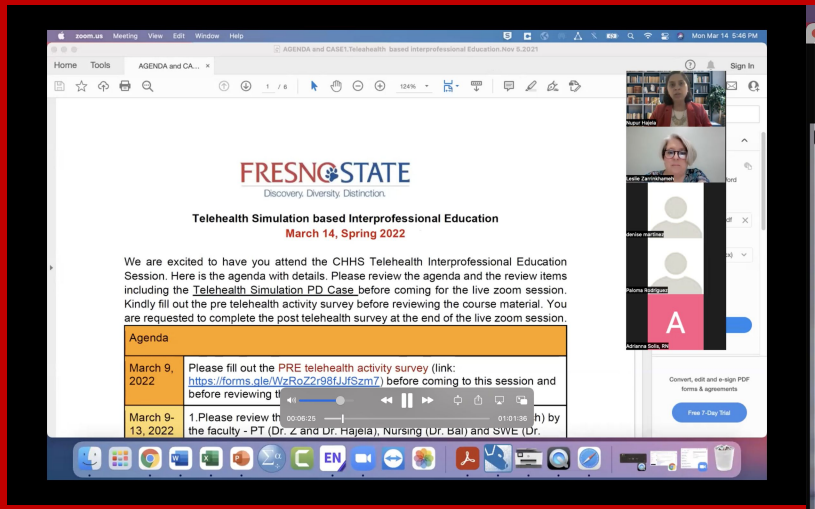


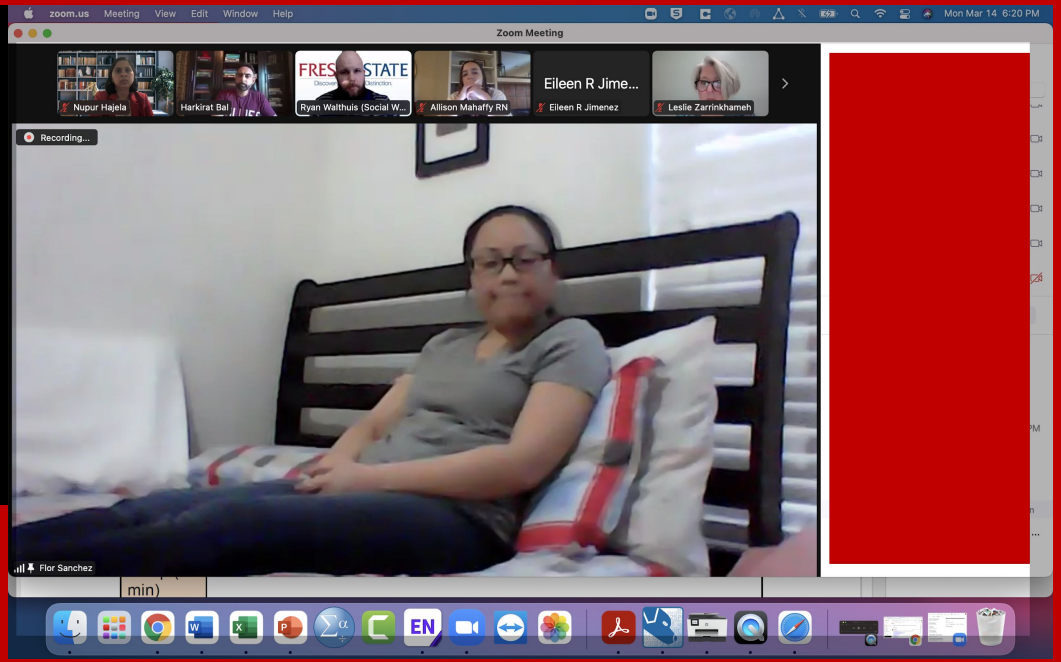
Do you have prior experience conducting a telehealth session with an interprofessional team

221 responses



Telehealth based Simulation





Telehealth based Simulation - Discussion

Telehealth Simulation IPE student discussion

Learning Objectives:

1. **Learn our own role as healthcare professional in discharge planning**
2. **Learn the role of other healthcare professionals in discharge planning**
3. **Learn how to use telehealth for discharge planning meeting**

A. During Telehealth Simulation Observation

IPEC Competency domains:

Competency Domain 1:	**Values/Ethics for Interprofessional Practice**
Competency Domain 2:	**Roles/Responsibilities**
Competency Domain 3:	**Interprofessional Communication**
Competency Domain 4:	**Teams and Teamwork**

Competencies	PT/Nursing/SWE Student	What went well	What would you do differently
Competency 1			
Competency 2			
Competency 3			
Competency 4			

B. Post Telehealth Simulation Discussion

Questions to Discuss in breakout room with students of other health professionals (Faculty and students engage in discussion and fill the table in google doc)

1.What responsibilities do each of you have for the patient involved in discharge planning that we just observed in telehealth simulation? (All students should be able to answer here)

2.Based on your review of the case and telehealth simulation observation, what would be your priority for the treatment and why? (PT, RN students can answer this)

Group/ Breakout room No. 1		
Themes to discuss	Their respective role	Role of other team members
PT		
Nursing		
Social Work Education		

SPICE –R2 Instrument: Student Perceptions of Interprofessional Clinical Education

SPICE-R2 Instrument

Dear Student:

In this survey you are being asked about your attitudes toward interprofessional teams and the team approach to care. By ***interprofessional team***, we mean two or more health professionals (e.g., nurse, occupational therapist, pharmacist, physical therapist, physician, social worker, veterinarian, etc.) who work together to plan, coordinate, and/or deliver care to patients/clients.

PLEASE NOTE: The following scale progresses from "Strongly Disagree (1)" → "Strongly Agree (5)"

INSTRUCTIONS: **Please be candid as you indicate the extent of your disagreement/agreement with each of the following statements related to interprofessional teams and the team approach to care.**		***Strongly Disagree (1)***	***Disagree (2)***	***Neutral (3)***	***Agree (4)***	***Strongly Agree (5)***
1. [T]	Working with students from different disciplines enhances my education	1	2	3	4	5
2. [R]	My role within an interprofessional team is clearly defined	1	2	3	4	5
3. [O]	Patient/client satisfaction is improved when care is delivered by an interprofessional team	1	2	3	4	5
4. [T]	Participating in educational experiences with students from different disciplines enhances my ability to work on an interprofessional team	1	2	3	4	5
5. [R]	I have an understanding of the courses taken by, and training requirements of, other health professionals	1	2	3	4	5
6. [O]	Healthcare costs are reduced when patients/clients are treated by an interprofessional team	1	2	3	4	5
7. [T]	Health professional students from different disciplines should be educated to establish collaborative relationships with one another	1	2	3	4	5
8. [R]	I understand the roles of other health professionals within an interprofessional team	1	2	3	4	5
9. [O]	Patient/client-centeredness increases when care is delivered by an interprofessional team	1	2	3	4	5
10. [T]	During their education, health professional students should be involved in teamwork with students from different disciplines in order to understand their respective roles	1	2	3	4	5

Factors:
T = Interprofessional Teamwork and Team-based Practice
R = Roles/responsibilities for Collaborative Practice
O = Patient Outcomes from Collaborative Practice

SPICE R2 Instrument (Student Perceptions of Interprofessional Clinical Education-Revised Instrument, version 2)

Dear Student:
In this survey you are being asked about your attitudes toward interprofessional teams and the team approach to care. By interprofessional team, we mean two or more health professionals (e.g., physical therapist, physical therapist assistant, nurse, occupational therapist, pharmacist, physician, social worker, veterinarian, etc.) who work together to plan, coordinate, and/or deliver care to patients/clients.
PLEASE NOTE: The following scale progresses from "Strongly Disagree (1), Disagree (2), Neutral(3), Agree (4), Strongly Agree (5)"

INSTRUCTIONS:
Please be candid as you indicate the extent of your disagreement/agreement with each of the following statements related to interprofessional teams and the team approach to care.
Factors:
T = Interprofessional Teamwork and Team-based Practice
R = Roles/responsibilities for Collaborative Practice
O = Patient Outcomes from Collaborative Practice

9. 1[T] . Working with students from different disciplines enhances my education

Mark only one oval.

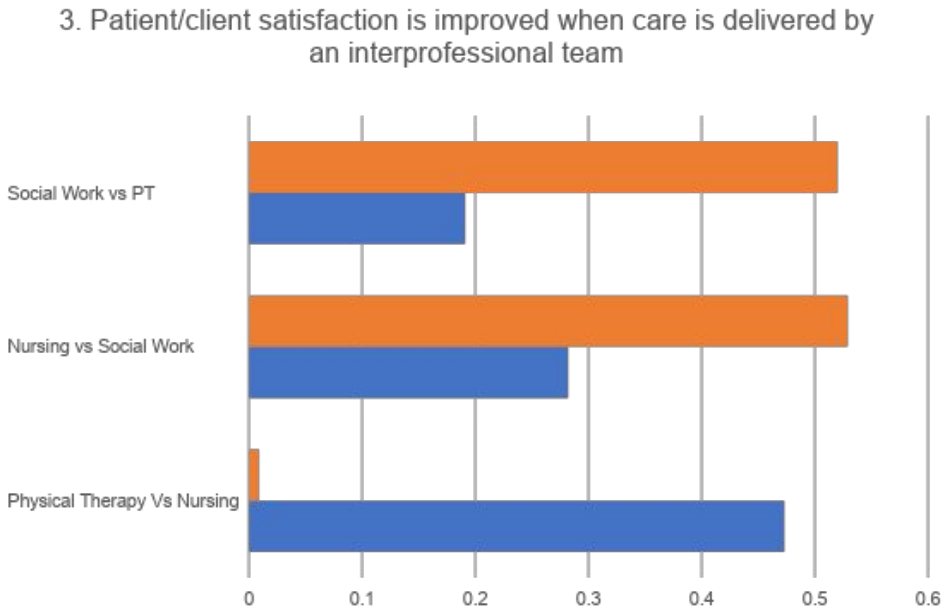
	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

10. 2[R]. My role within an interprofessional team is clearly defined

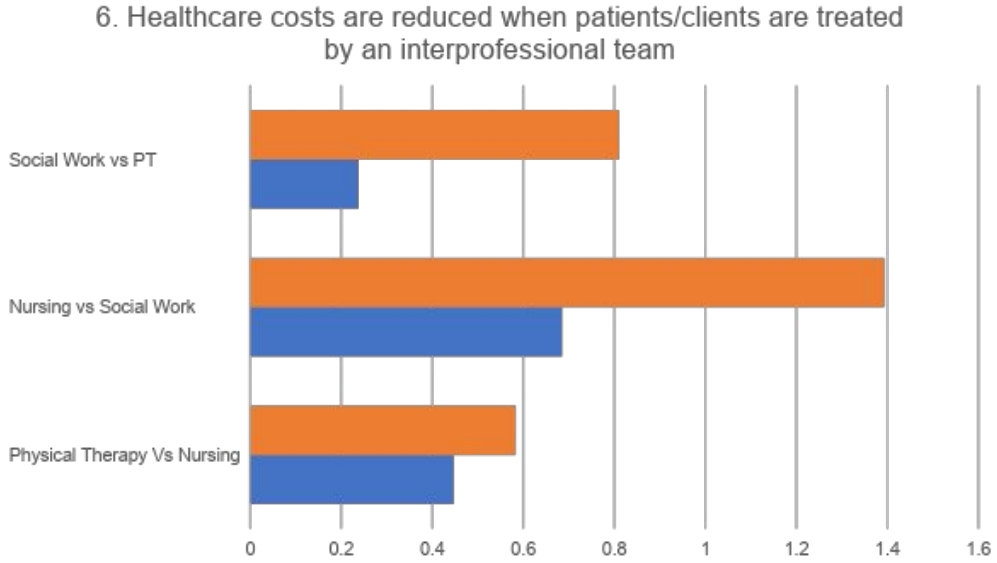
Mark only one oval.

	1	2	3	4	5	
Strongly disagree	◯	◯	◯	◯	◯	Strongly agree

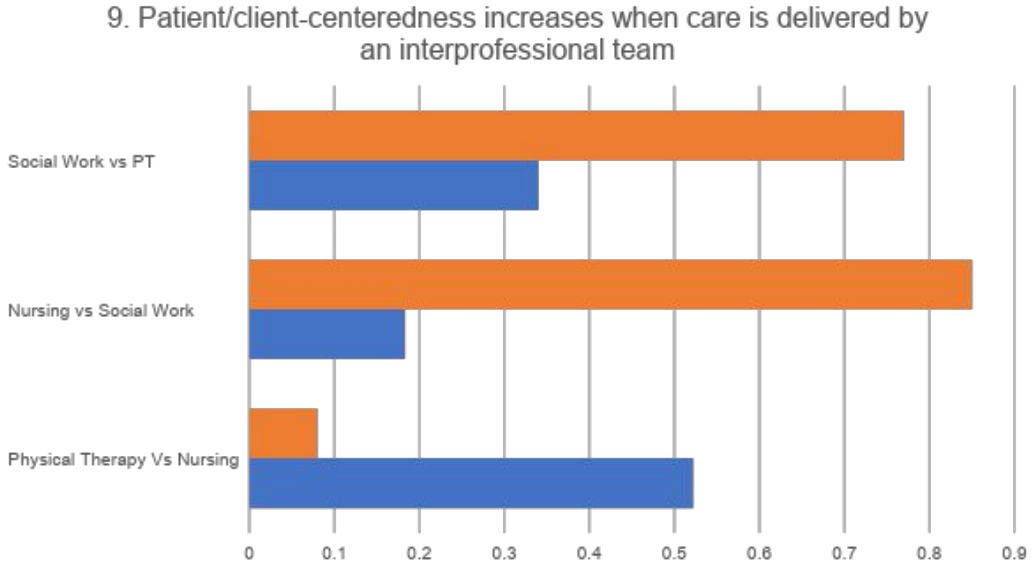
Interprofessional team's impact on Patient/ Client Satisfaction



Interprofessional team's impact on Healthcare Costs



Interprofessional team's perception on Patient/client Centeredness



What was most beneficial – Graduate Student's Perspective

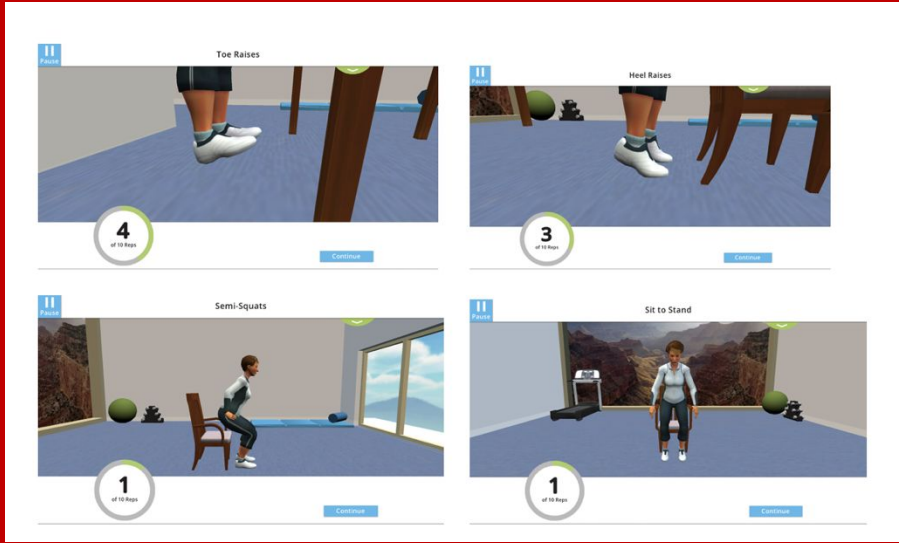
- "to work with students from other disciplines and getting their aspect of health care. We all have something different that we bring to the table and I learned that we work best when we all work together".

- "It was illuminating to see the PTs conduct their assessments and observe their line of questioning."

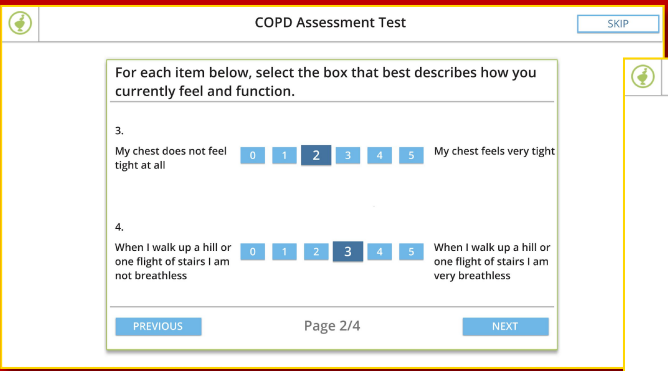
- Understanding the exact roles of other professionals to collaborate together in making goals and plans together.

Telehealth Based Interventions

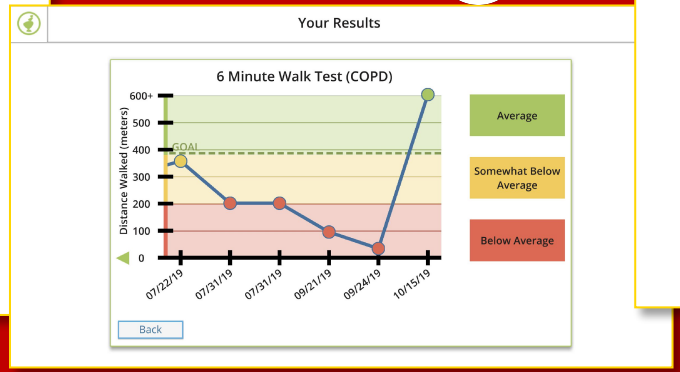
Telehealth Clinic and use of mhealth platform



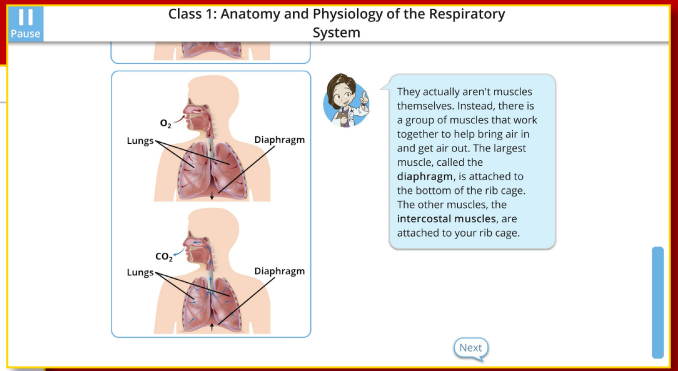
Telehealth - Application of mHealth



Standard Self-Evaluation



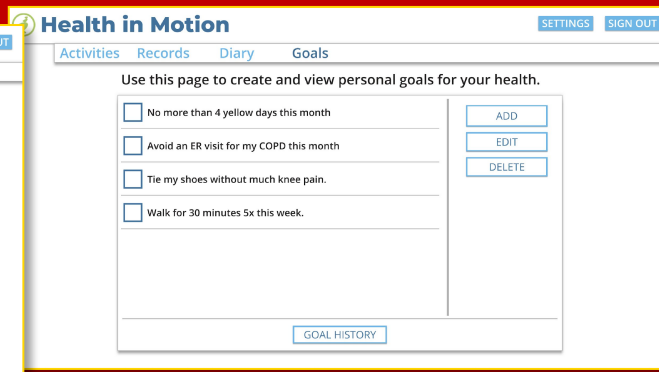
Track Progress



Education Modules

Exercises

Health Diary



Set Goals

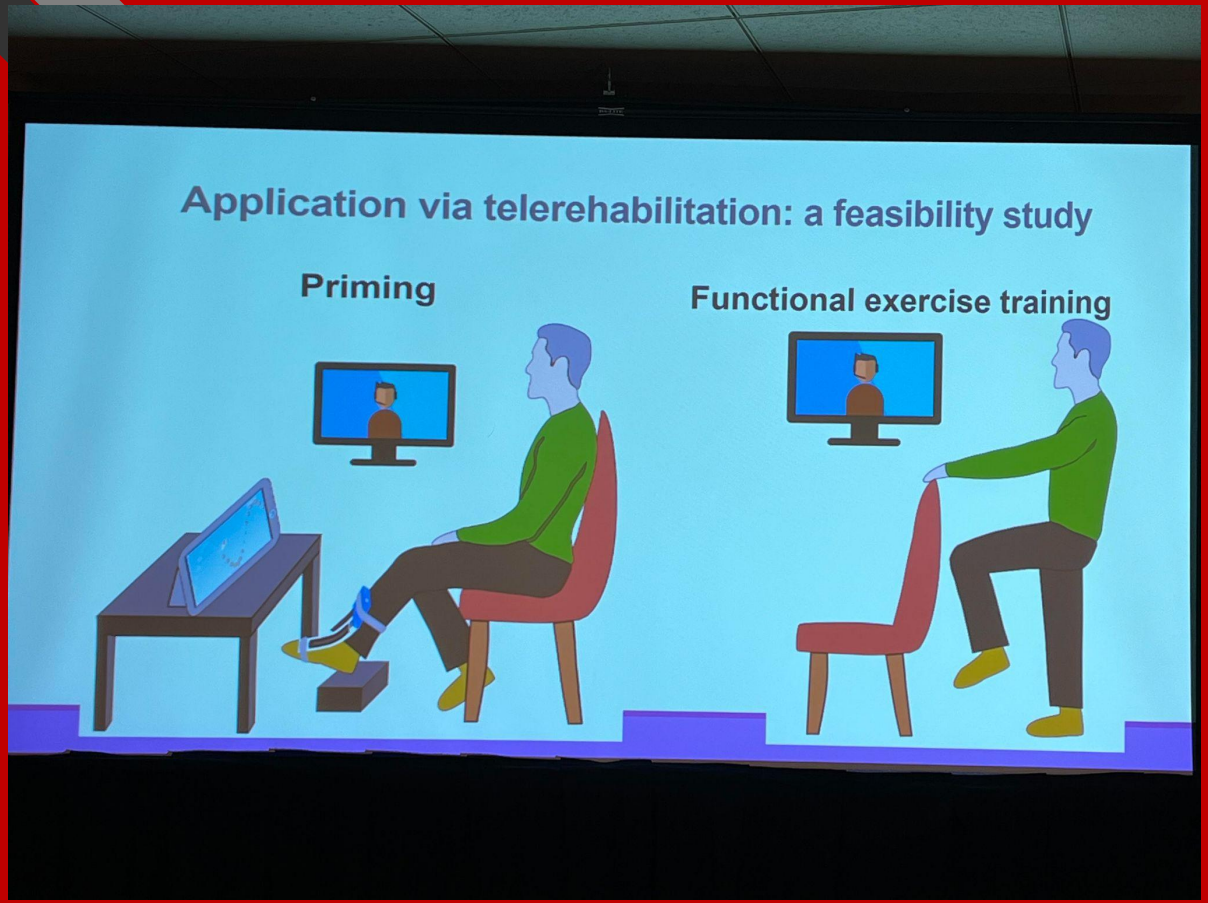
DIG-I -PRIME Games

24

25

Madavan S, 2021

Digi prime Study



Game-based priming facilitates acute priming effect in stroke

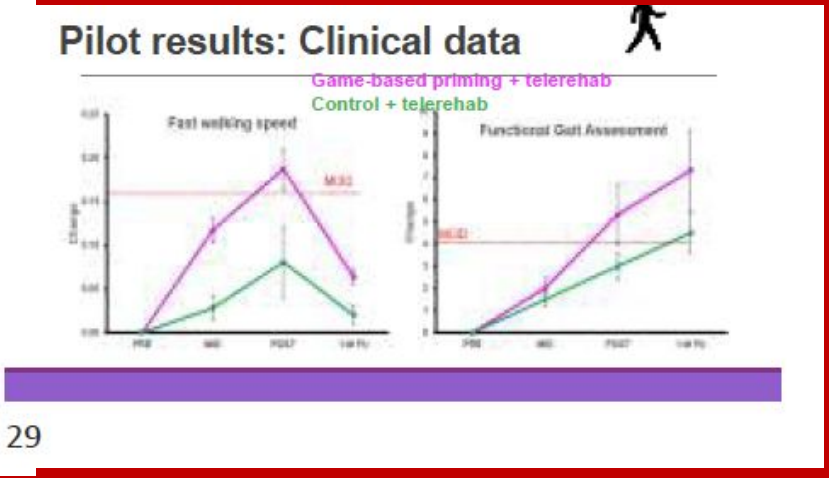
Lim et al. 2020

- Proof-of-concept
- 19 persons with stroke
- Ipsilesional corticomotor excitability increased by 25% after 20 minutes of priming

26

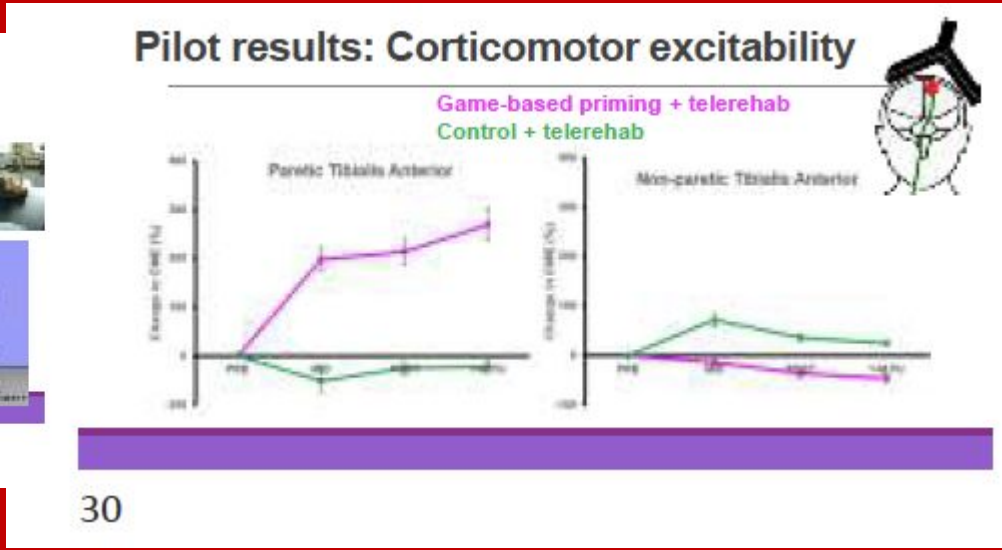
Madhavan S et al, 2021

Remotely supervised exercise intervention



Madavan S, 2021

Corticomotor excitability



Madavan S, 2021

Telehealth in a Hybrid World?

To assess who among are patients are suitable for telehealth.

factors that can help us make that decision:

(1) age of the client

(2) type of disorder or condition

(3) stage of disease -whether it is stable and unstable

(4) support of family and caregivers

(5) patient's motivation level to recover

(6) access to technology and viable internet connection.

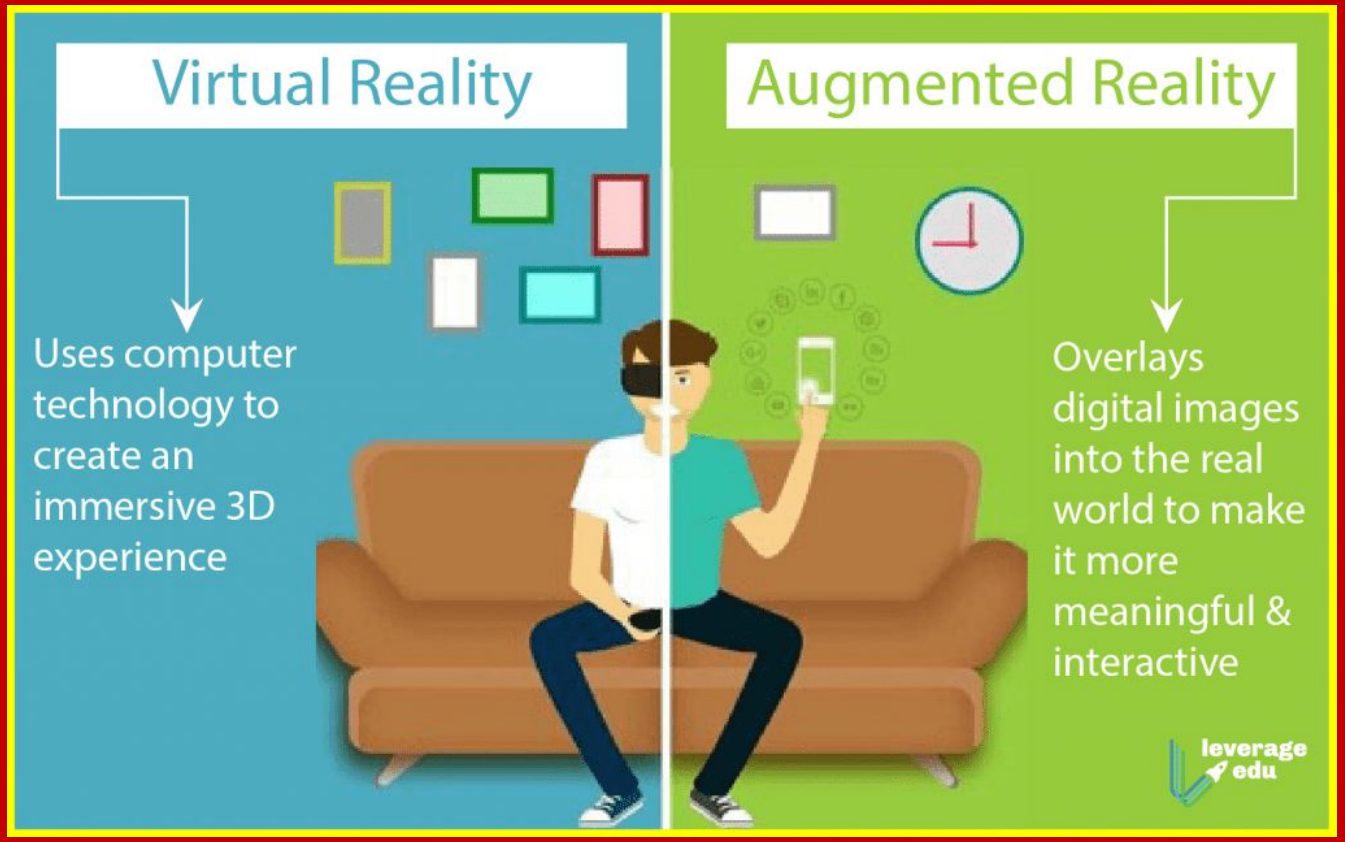
Telerehabilitation - How can it become part of the healthcare ecosystem

- Planning a session
- Role of Telerehabilitation Coordinator
- Role of Physician, PT, PTA, OT, SLP (interprofessional team members)
- Management of Clients - so that they do not deteriorate
- Education of Clients and Clinicians – Use of Webinars
- Home Exercise Program: Using Digital Platform

Digital Innovation - VR and RTM, mHealth Apps

Role of Virtual and Augmented Reality along with AI in Telerehabilitation?

Virtual Reality vs Augmented Reality



Virtual Reality in Telehealth Physical Therapy

Chumbler *et al. Trials* 2010, **11**:74
http://www.trialsjournal.com/content/11/1/74

TRIALS

STUDY PROTOCOL Open Access

Study protocol: home-based telehealth stroke care: a randomized trial for veterans

Neale R Chumbler*[1,2,3,4], Dorian K Rose[5,6], Patricia Griffiths[7,8], Patricia Quigley[9], Nancy McGee-Hernandez[9], Katherine A Carlson[1], Phyllis Vandenberg[10], Miriam C Morey[11,12,13], Jon Sanford[7,14] and Helen Hoenig[10,12,13]

A Swiss startup that invented **MindMaze**, an FDA-approved brain telerehabilitation platform powered by VR and AI, **got $100 million in investments in 2016** and is **currently valued at $1 billion.**

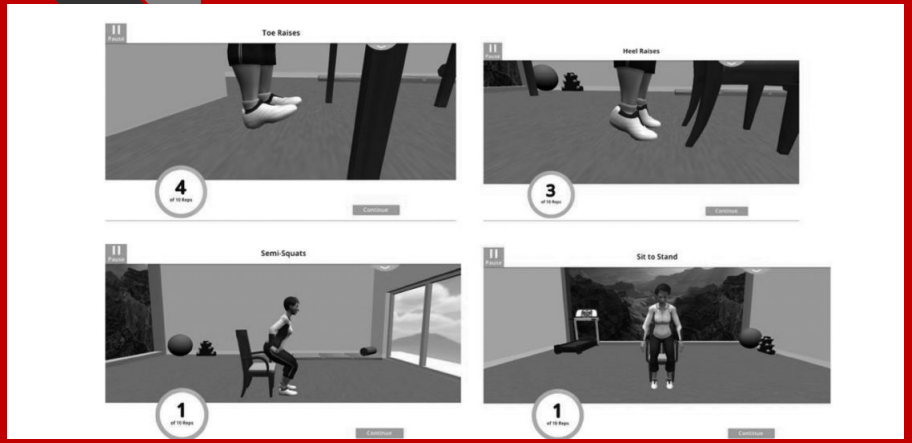
An Austrian startup **Rewellio** that created a VR platform specifically for post-stroke treatment **generated €800K in investments in 2019.** The platform got certified in the US (FDA), Europe (CE), Canada, and Australia.

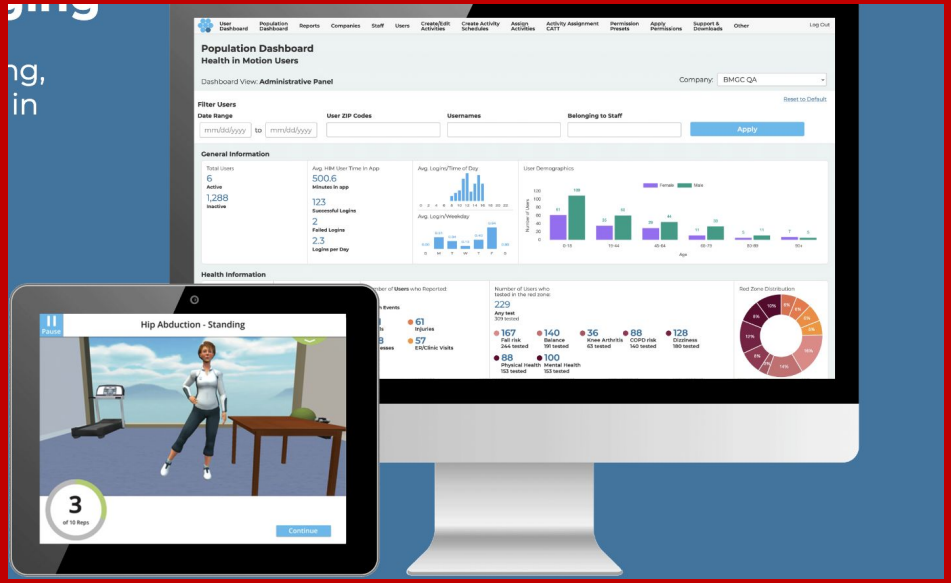
Virtual Reality (VR) for Stroke Rehabilitation in 2021

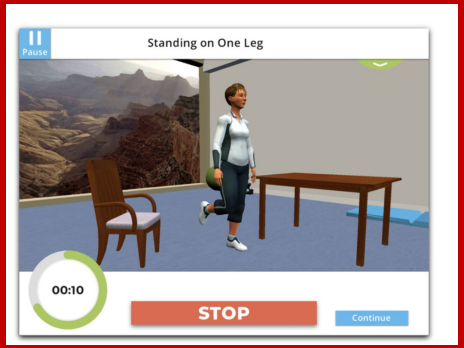
Virtual Reality Based Physical Therapy

NEURO REHAB VR

Health in Motion App- Remote Therapeutic Monitoring







BLUEMARBLE Health

Published study - Digital Fall Risk Assessment in Elderly

International Journal of Physiotherapy and Research,
Int J Physiother Res 2022, Vol 10(5):4369-81. ISSN 2321-1822
DOI: https://dx.doi.org/10.16965/ijpr.2022.158

Original Research Article

Feasibility of a self-reported digital fall risk assessment compared with the traditional functional balance and gait assessments performed during student led balance screening: A pilot study

Nupur Hajela PT, DPT, PhD *[1], Peggy R. Trueblood PT, PhD [2], Sheryl Flynn PT, PhD [3].

[1] California State University, Fresno, USA.

[2] Pacific Northwest University of Health Sciences, USA.

[3] Blue Marble Health, USA.

Fig. 2: Health in Motion Fall Risk Assessment [shown on tablet) and administrative web-portal dashboard [shown on computer).

Fig. 3: Traditional pen and paper-based Balance test - 30 sec chair stand test.

Fig. 1A: 30 Second Sit to Stand Test.

Figure 1B: One Legged Stand Test

BLUEMARBLE Health

OneStep - Remote therapeutic Monitoring

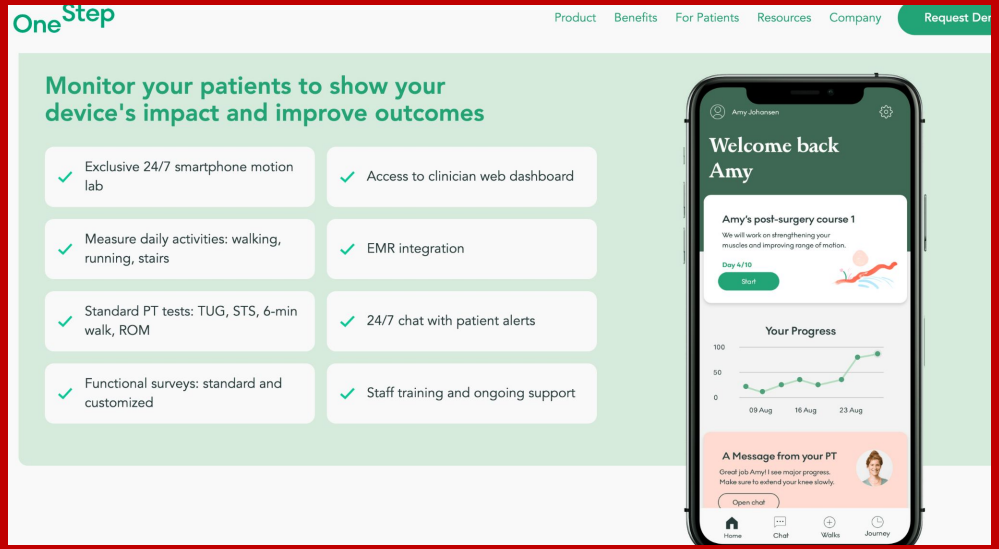
https://www.onestep.co/providers/clinics

Research article | Open access | Published: 14 September 2022

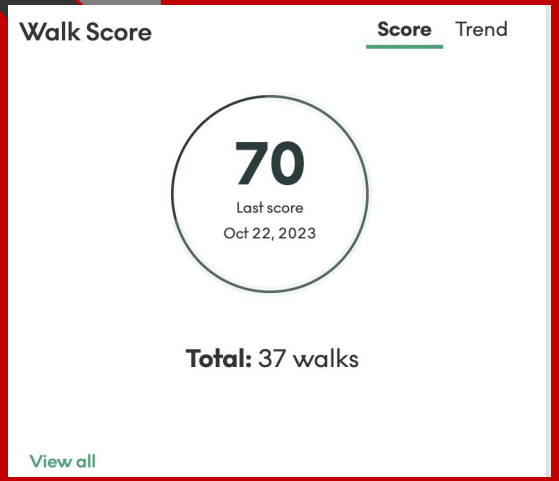
The validity and reliability of the OneStep smartphone application under various gait conditions in healthy adults with feasibility in clinical practice

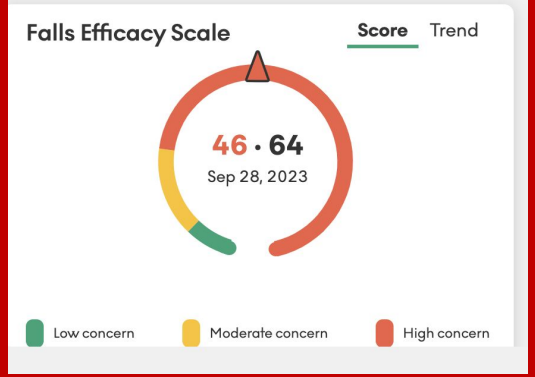
Jesse C. Christensen, Ethan C. Stanley, Evan G. Oro, Hunter B. Carlson, Yuval Y. Naveh, Rotem Shalita & Levi S. Teitz

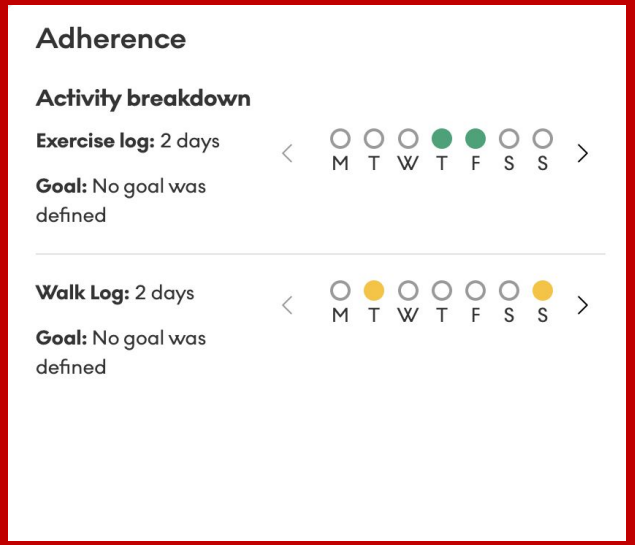
Journal of Orthopaedic Surgery and Research **17**, Article number: 417 (2022) | Cite this article



Case study - Neuro Client - OneStep - Remote therapeutic Monitoring







Gait Parameters - Remote therapeutic Monitoring

	Aug 3, 2023 3:04 PM 00:52 secs 20 steps	Oct 22, 2023 1:37 PM 12:19 min 978 steps
General Parameters		
Walk Score	**39**	**70**
Step Rate	**88**/minute	**113**/minute
Speed	**0.4**m/s	**0.9**m/s
Distance	**34**ft	**1,762**ft
Consistency	**75**	**70**
Temporal Parameters		
Double Support	**41%**	**31%**
Single Support Left	**29%**	**34%**
Single Support Right	**30%**	**35%**
Stance Left	**70%**	**65%**
Stance Right	**71%**	**66%**

Date of birth: Mar 12, 1950 (73)
Sex: Male
Adaptive equipment: Cane
Assigned PT: Nupur Hajela
Last Fall: Aug 14, 2023

FALL RISK

High

Last week: High
Risk level **stable**

Standardized Tests

STS — No Data

TUG — No Data

Patient Reported Outcomes

Fear of Falls — No Data

Gait Analysis

2 walks in the last 7 days.
Compared to 2 walks in the previous 7 days.

Walk Score (score) — 72 (30 – 60)

Speed (km/h) — 1.0 (0 – 0.7)

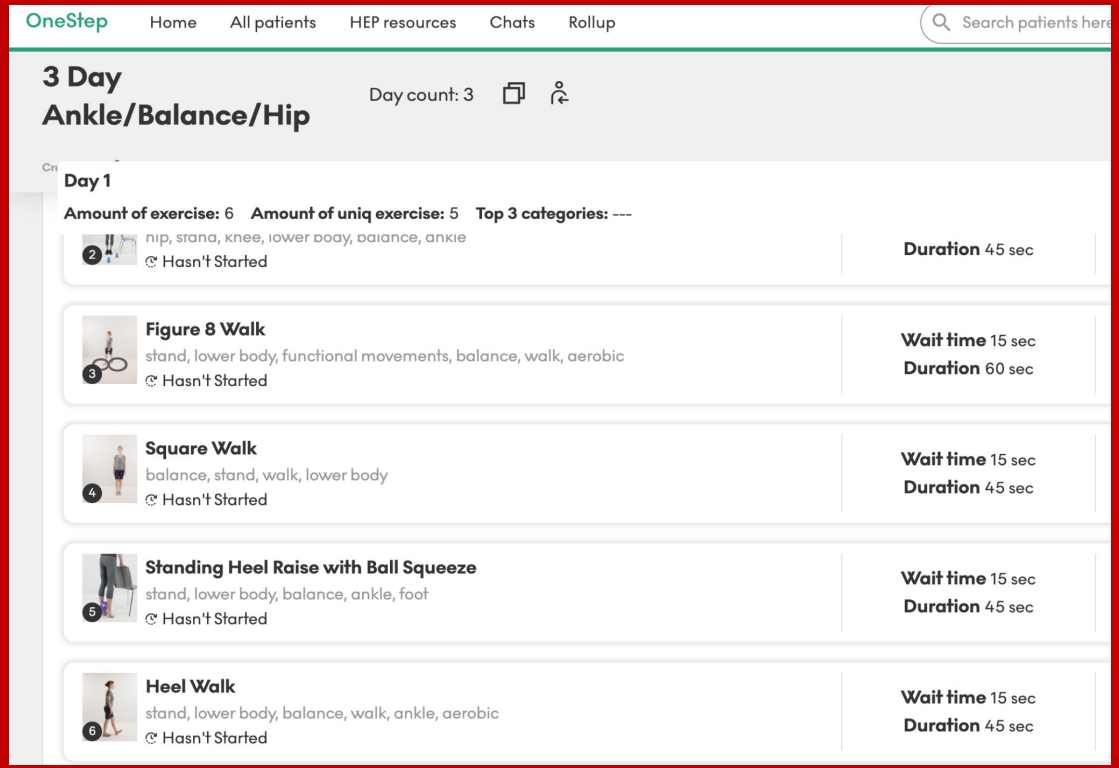
Double Support (%) — 31 (0 – 40)

Stance Asym. (%) — 0.8 (0 – 8)

Step Length Asym. (%) — 9 (0 – 8)

Decline from 5.6 ↘

OneStep App - Video Based Home Exercise Program



Artificial Intelligence (AI) Based Physical Therapy Assessment

The **term AI** encompasses a variety of advanced computing methods — such as **cognitive analysis, machine learning, and natural language processing** — that can be used to accomplish tasks.

Artificial Intelligence (AI) - Paradigm Shift

AI can help us, as humans, improve our intelligence and learn.AI functions at three levels: assisted, augmented, and autonomous.

Still, technology and AI can help us address complex issues. In the medical field, let us not place human intelligence and machine intelligence in separate realms. Instead, we should combine them to make "**Medical Intelligence."**

By thinking of it that way, AI can be a paradigm shift in health care and medicine.

Artificial Intelligence (AI) - Role in PT

Artificial intelligence application versus physical therapist for squat evaluation: a randomized controlled trial

Alessandro Luna[1], Lorenzo Casertano[2], Jean Timmerberg[1,3], Margaret O'Neil[1], Jason Machowsky[4], Cheng-Shiun Leu[5], Jianghui Lin[5], Zhiqian Fang[5,6], William Douglas[2] & Sunil Agrawal[7]✉

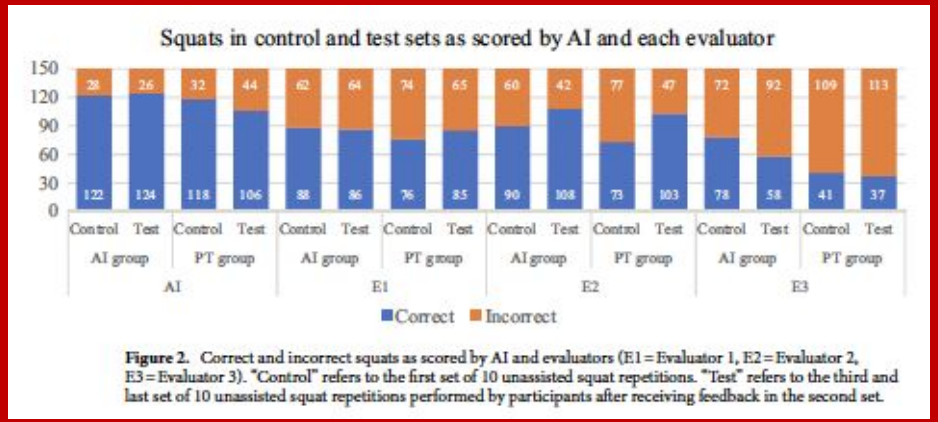


Figure 2. Correct and incorrect squats as scored by AI and evaluators (E1 = Evaluator 1, E2 = Evaluator 2, E3 = Evaluator 3). "Control" refers to the first set of 10 unassisted squat repetitions. "Test" refers to the third and last set of 10 unassisted squat repetitions performed by participants after receiving feedback in the second set.

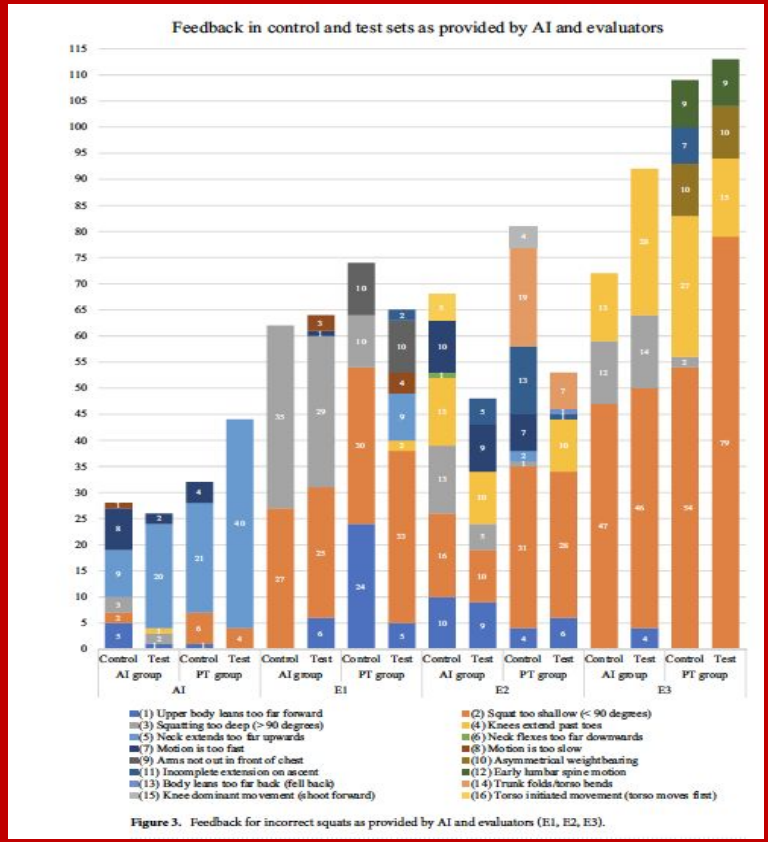
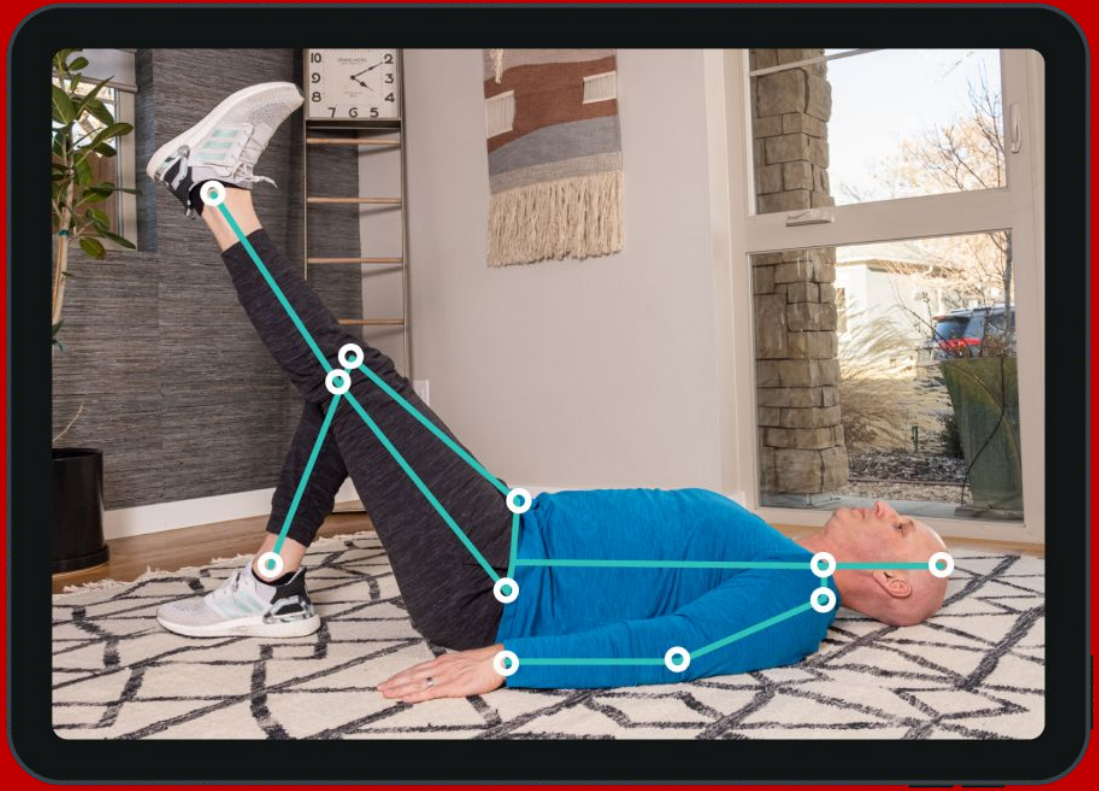


Figure 3. Feedback for incorrect squats as provided by AI and evaluators (E1, E2, E3).

Data Driven Insights- Healthcare

Data Driven - Physical Therapy - Track Movement



Summary: Healthcare and Training the Providers

- **Practical Immersion:** Telehealth simulations offer realistic practice for clinical skills and decision-making, boosting student confidence and competence.

- **Collaborative Training:** Simulations foster interprofessional teamwork, replicating real healthcare dynamics and improving communication among future healthcare leaders.

- **Inclusive Access**: Remote simulations break down geographical barriers, ensuring diverse learners can access quality healthcare education and contribute to the evolving field.

Let’s Stay Connected

nhajela@csufresno.edu