Learning Objectives

At the conclusion of this activity, the participant will be able to:

1. Understand the concepts, history and evolution of technology in rehabilitation research and practice.
2. Recognize practical barriers to translating technology into rehabilitation practice.
3. Identify how traditional and contemporary technology-based treatment approaches can be integrated into everyday rehabilitation practice.
4. Integrate a conceptual practice model to provide support for incorporating technology into rehabilitation practice through specific clinical scenarios.
5. Identify prospective technologies that may be explored for potential use in rehabilitation.

Concepts, History & Evolution of Technology in Rehabilitation

- What Fifty Said – Robert Frost

- When I was young my teachers were the old.
- I gave up fire for form till I was cold.
- I suffered like a metal being cast.
- I went to school to age to learn the past.

- Now I am old my teachers are the young.
- What can't be molded must be cracked and sprung.
- I strain at lessons fit to start a suture.
- I go to school to youth to learn the future.

Technology Definitions

- Systematic treatment of an art or craft.
- Applying knowledge to the practical aims of human life, changing and manipulating the human environment and simplifying tasks to increase productivity.
- Enables us to complete tasks previously thought impossible

- (Technology, 2013a & Technology, 2013b)

Technology Concepts

- Rehabilitation Technology
  - Application of technology to meet the needs of people with disabilities.
    - Assistive technology devices
    - Therapeutic use of technology

Technology Concepts

- Assistive Technology Devices:
  - Any item, piece of equipment, or product system, whether acquired commercially off the shelf, modified, or customized, that is used to increase, maintain, or improve functional capabilities of individuals with disabilities, usually used as the “end” of an intervention

Technology Concepts

- Therapeutic Use of Technology
  - Use of therapeutic and everyday technologies as the "means" of an intervention. Remedial approach with graded activity focused on improving performance skills and client factors to build capacity to complete client directed goals.
    - Therapeutic Technology:
      - Devices developed specifically for a rehabilitation task
    - Everyday Technologies:
      - Technologies engineered to enhance what we do in our daily occupations, from self-care, leisure, and productivity.
      - Computer and mobile "smart" electronic devices with/without switches and peripherals

Technology Concepts

- Virtual Reality (VR)
  - Immersive vs. non-immersive
  - Augmented Reality
- Wearable Technologies
  - Exoskeletons, robotics, sensor-embedded and electroconductive textiles, biologic & movement/activity monitors
    - Accelerometers, force sensors, inertial measurement devices, GPS systems, smart phones/tablets
    - Difficulty managing big data into meaningful measures.

Technology Concepts

- Brain-machine interface (Brain-computer interface)
  - BCIs enable translation of electrophysiological signals acquired from the brain into control commands for therapeutic technologies facilitating direct brain control
  - Applied as neuroprostheses or as novel therapies to restore or improve motor function.
- Knobology:
  - Focusing on function of technology and protocols with less concern for clinical reasoning

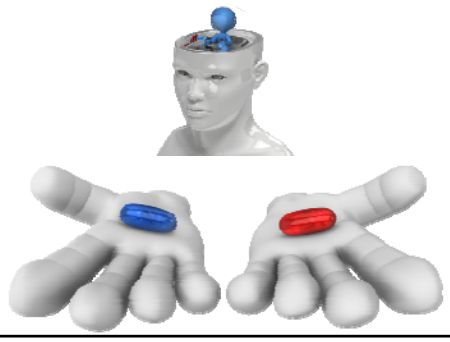
History and Evolution

- Cairo toe; 1295 to 664 B.C
- 1st wheelchairs; late 1500's early 1600's
- 1st non-locking below-knee prosthesis in 1696.
- 1st aluminum prosthesis 1912
- Use of arts & crafts, orthotics, exercise equipment, physical agent modalities, aluminum prosthesis & motorized wheelchair early 1900's

History and Evolution

- VR conceptualized in Sci-Fi story (Pygmalion's Spectacles) by Stanley G. Weinbaum 1935
- Myoelectric arm in 1950's
- 1st motion tracking, 3D head mounted display VR 1961
- Functional electrical stimulation, balanced forearm orthosis, & computerized upper limb exoskeleton in 1960's
- Robotic ambulators 1970's
- VR in rehabilitation and computer assisted therapy 1990's

Survey of Technology-based Evidence in Rehabilitation



Transcranial Direct Stimulation tDCS

- Very low to moderate quality evidence is available on the effectiveness of tDCS versus control (sham/any other intervention) for improving ADL performance after stroke
- Evidence is suggestive of a small beneficial effect on upper extremity impairment, but is not statistically significant
- tDCS are of uncertain benefit and not currently recommended after stroke

Transcranial Magnetic Stimulation rTMS

- Evidence suggests rTMS therapy in patients with Parkinson disease results in mild-to-moderate motor improvements
- rTMS combined with upper-limb training does not have a superior effect than upper-limb training alone on motor function and spasticity after stroke.
- rTMS may be considered to ameliorate neglect symptoms after stroke.

Brain-Computer Interface

- BCIs are promising as either neuroprostheses or as rehabilitative tools, but have not been shown to improve functional or neurological outcomes.

Robotic-Assisted Gait Training

- Robotic-gait training combined with PT is more likely to facilitate independent walking but not gait velocity than with gait training alone after stroke.
- Patients within the first 3 months after stroke and those who are unable to walk benefit the most.
- More studies in robotic assisted gait training are needed to clarify the optimal device type, training protocols, and patient selection to maximize benefits.

Upper Limb Robotic-Assisted Therapy

- Robotic therapy is reasonable to consider to deliver more intensive practice for individuals with moderate to severe upper limb paresis.
- Low to very low evidence available for upper limb robotic-assisted therapy after stroke
  - most recovery limited to shoulder and elbow
- Limited interpretation of benefit for improvement in strength, arm/hand function and ADL to to inconsistent variations between trials in:
  - intensity, duration, and amount of training
  - type of treatment
  - participant characteristics and outcome measure

Robotics Considerations

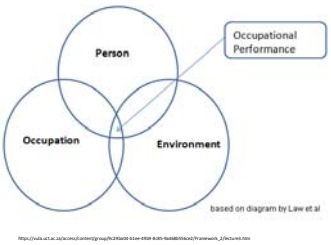
- Evidence that ADL is improved by robotics is needed to justify the clinical cost and facilitate translation to practice.
- Truly functional outcome measures are needed
  - FIM is not representative of UE function during ADL

Virtual Reality VR

- AHA Stroke Rehabilitation Guidelines
- It is reasonable to provide repeated VR, mental imagery, and neck vibration combined with prism adaptation to improve neglect symptoms after stroke.
- VR is reasonable to consider as a method for delivering upper extremity movement practice.
- The use of VR environments to improve visual-spatial/perceptual functioning may be considered.

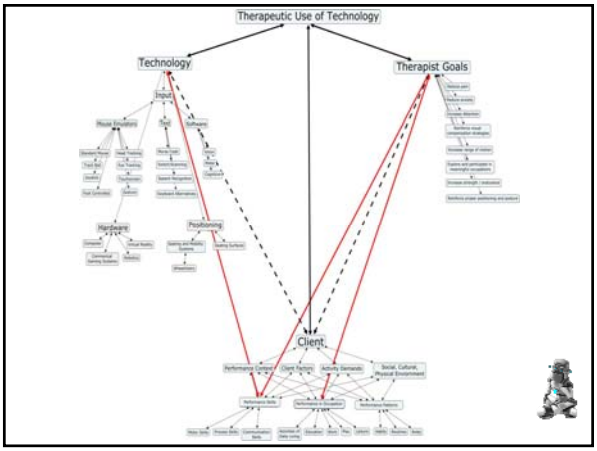
Conceptual Models for using Everyday Technologies

Person-Environment-Occupation Model of Occupational Performance



TUT and the PEO

- Person: person's capabilities
- Environment: equipment you have access to that you can adjust continuously
- Occupation: person's inner drive to complete a specific task
- Everyday Technology
  - Computers, tablets, other electronic devices with switches, touch screens, etc.
  - Game/task on the electronic device that is **motivating** for the person to do
  - Therapist actively engaged in changing the environment to get the needed output by the person (i.e. strength, range, endurance)



OT Process (AOTA, 2014)

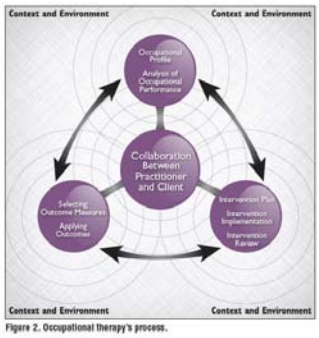


Figure 2. Occupational therapy's process.

American Occupational Therapy Association (2014).Occupational therapy practice framework: Domain and process (3rd ed.).American Journal of Occupational Therapy, 68(Suppl. 1), S1-S48 http://dx.doi.org/10.5014/ajot.2014.682006

EDT Thinking Framework

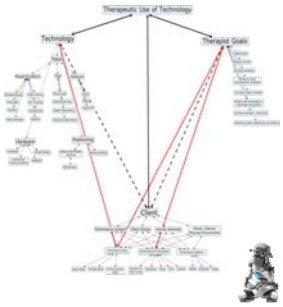
1. Person tells therapist what he/she wants to be able to do: O
2. Therapist assesses the person to determine what the person needs to be able to do in order to complete the task: P
3. Therapist uses electronic devices & peripherals (EDT) to remediate the underlying skills to be able to meet the demands of the task: E
4. Therapist continually evaluates and adjusts the EDT to create the "just right challenge" using games/tasks the person is motivated to do and changing the challenge to remediate the needed underlying skill

Skills Needed for Everyday Technology

- Knobology: (Procedural Reasoning)
  - Know your equipment
  - How it works
  - All the various ways it can be used and adjusted
- Know who your client is and what is important to them—goals, abilities, occupational profile for interests (Narrative Reasoning)
- Focus on the person to continually adjust and adapt the equipment to help the client meet the goal (Conditional Reasoning)
- Be creative in how you use and adapt the equipment to best meet your client's occupational goals (Pragmatic Reasoning)

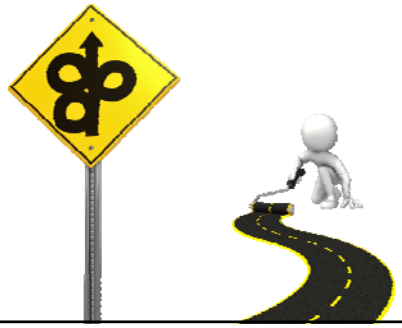
Considerations for the Therapeutic Use of Technology

- Client Dynamics
  - client goals
  - client abilities
  - treatment activities/technology choices
- Practitioner Dynamics
  - session goals
  - client dynamics/technology considerations
- Technology
  - client/practitioner dynamics
  - hardware
  - positioning
  - inputs



Linking Therapy
to
Computer Activity

Case Study: Navigating the TUT Framework Using Clinical Reasoning



Nurse Nancy

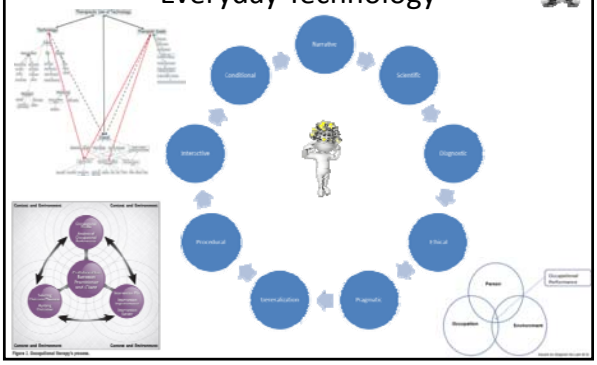
Technology Assessments

- Focus on correct fit—avoiding abandonment
  - MPT: Matching Person to Technology (Scherer)
  - QUEST: Quebec User Evaluation of Satisfaction with Assistive Technology
- Focus on improved function:
  - COPM: Canadian Occupational Performance Measure
    - Performance
    - Satisfaction
  - ICF: International Classification of Function (World Health Organization)
  - FIM: Functional Independence Measure

EDT Outcome Assessment

- No specific tool
- Assess as you would with any other therapeutic modality
  - Change in strength, range, endurance, capability, etc.
  - Person's engagement in the activity
  - Person's ability to complete the chosen occupation

The Complexity of Clinically Reasoning Everyday Technology

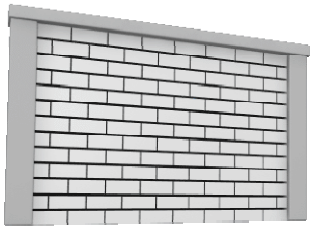


Barriers to Integrating Technology

Barriers to Integrating Technology

- Lack of awareness or access to evidence; Conflicting or limited evidence
- Dogmatic treatment
- Lack of knowledge and education
- Organizational pragmatics:
  - Limited or lack of organizational support, resources, structure or space
  - Leads to limited availability/access to clinicians and consequently to patients
- Limited technology development and testing in clinical settings
- Technology transfer delays

Facilitating Technology Into Practice



Facilitating Technology Into Practice

- Consumer demand
- Development of clinical practice guidelines for therapeutic technology
- Pragmatic clinical research of technology
- Pragmatic organizational support structures and mechanisms that reduce barriers and foster technology transfer
- Business models that allow for the profitable implementation of the technology.

Facilitating Technology Into Practice

- Organizational technology champions
- Consistent education and competency development
- Connect technology with contextual relevance to patient selected goals.
- Flexibility that allows clinical reasoning opportunities to use therapeutic designed activities as well as commercial activities.

Prospective View of the Therapeutic Use of Technology in Rehabilitation

- Improved ability to provide access to technology
- Need for increased interdisciplinary clinic-based research including increased acute rehabilitation
- Need for increased hand-based technology research
  - Increased naturalistic training
- Need to functionally connect technology outcomes
- Open accessed vs. commercialized technology
  - DIY technology and the "Maker" community
- Mobile and wearable technology for remote and community-based rehabilitation/telerehabilitation
  - Movement and activity monitors, biofeedback, VR and AR, wearable/mobile exoskeletons and robotics, E-textiles
- Incorporating and re-developing everyday technologies for therapeutic uses.

Participant discussion

- What barriers have you experienced that limit the translation of various therapeutic technologies into clinical practice?
- How do we overcome these barriers?
- What emerging or imagined therapeutic technologies do you conceptualize or envision for the future of rehabilitation?

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