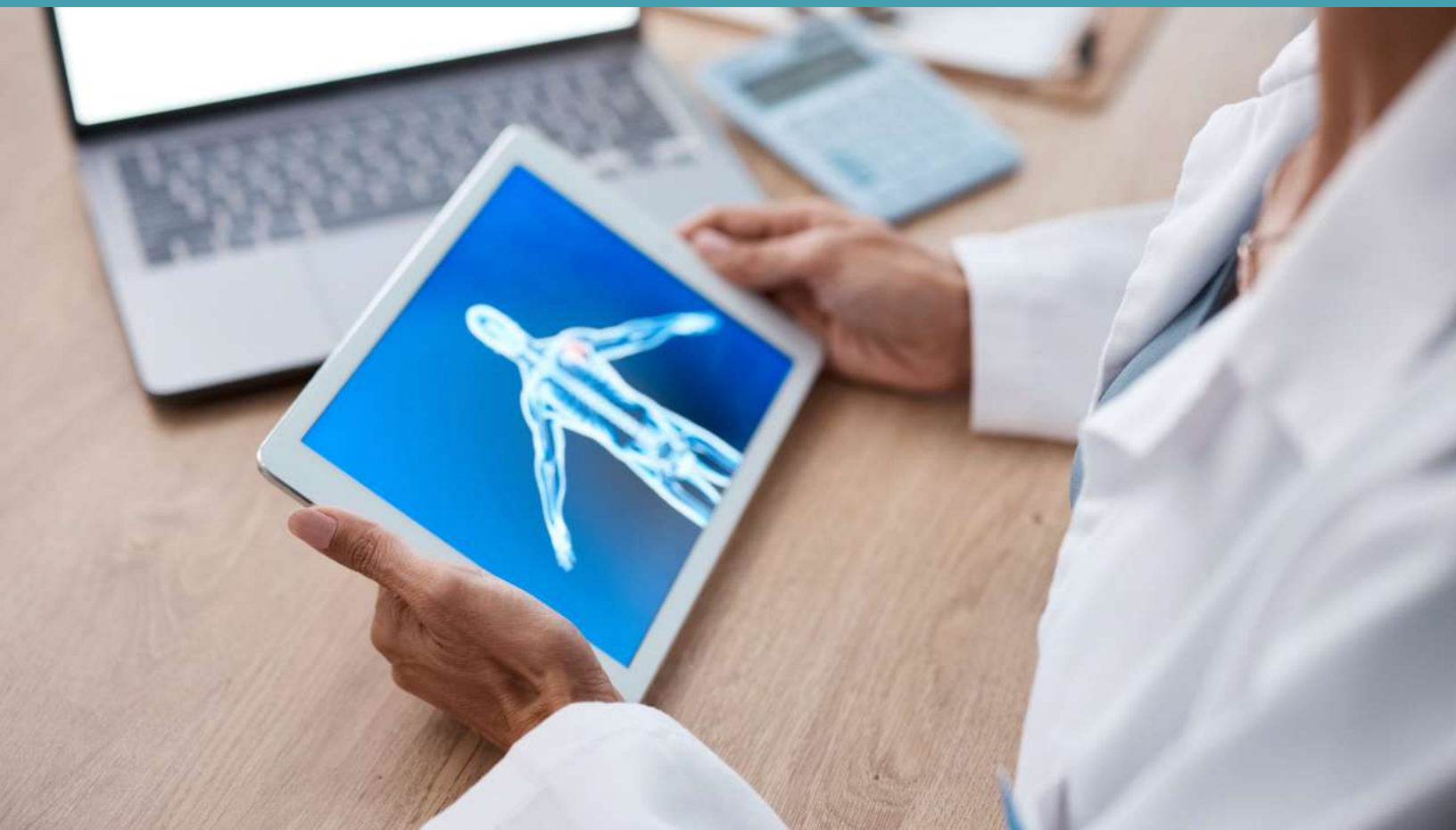
OTMASTERY.com

Technology-Enhanced Interventions



Introduction

The occupational therapy profession must continue to evolve as new trends and technologies emerge. From implementation in intervention to research regarding what has just been released, OTs should strive to stay up to date on technologies and their effect on treatment. This means exploring innovative devices and treatments that can be incorporated into OT sessions as well as having a working knowledge of technologies that may be utilized by other healthcare disciplines.

Technology in the occupational therapy world falls under the category of environmental factors related to service delivery. To this end, the 4th Edition of the Occupational Therapy Practice Framework lists assistive technology as an example of an environmental factor. Therefore, technology is interwoven in the fabric of occupational therapy foundations. Many forms of assistive technology can be used to support skill development, make the environment more accessible for patients with chronic and acute health conditions, facilitate routine and skill maintenance, and help individuals participate in a variety of occupations.

Section 1: Considerations for Technology & Occupation

References: 1, 2, 3, 4

When discussing technology in the realm of occupational therapy, it is important to differentiate between the various ways that technology can be used in the occupational therapy process. In some cases, technology serves as the intervention itself by comprising all of service delivery. One salient example of this is in the realm of assistive devices. A patient who is being treated in the hospital as he recovers from a total hip replacement will likely be trained in the use of a reacher, long-handled shoehorn, sock aid, commode, and possibly even an

abductor pillow. Some individuals may need targeted, hands-on ADL training to gradually build skills in using these devices for the purpose of self-care. However, some patients in this situation may only need an introduction to the devices before being able to demonstrate to their therapist that they can use them effectively and safely. The latter of these instances is an example of technology being the intervention itself, as patients at that functional level may not need OT services beyond that. Technology may also be the OT intervention for digital tools. An OT working in outpatient mental health or pain management may train their clients in the use of an app to assist with symptom and behavior management. This may be all of the help a client needs in that skill area, meaning the app (technology) is the entirety of the intervention in disease management.

Definitions

Technology-enhanced interventions are another way that technology is part of the OT process. This subset of technology in therapy is the focus of this course. Technology-enhanced interventions are those that supplement, support, and enhance more traditional forms of therapy. If we continue to use the above examples, the OT working in either outpatient setting may recommend the app or another digital tool to assist with keeping track of their home program. This may help their compliance and ensure they reap the benefits of the home program, but the client will be asked to do this on their own since it is not a central part of the service delivery process. In the case of the patient recovering from a total hip replacement, the OT may provide range of motion exercises, a strengthening protocol, and ADL retraining as the main focus of their treatment. If the patient is still too weak or fatigued to properly participate in the skill-based portion of their session, the OT may instruct them in the use of one or two devices we mentioned earlier. This will help until they regain their endurance and strength, at which point they will likely no longer need the equipment. In this scenario, the

equipment is a means to an end rather than the basis from which sessions are structured on.

Considerations

In addition to terminology, therapists should be aware of considerations that influence their use of technology within the rehabilitation process both from an adoption and an implementation standpoint. Mitchell et al. (2023) found that six major themes affected a therapist's ability to adopt technology in their work. These included the need for various forms of technology to earn user trust, hidden costs separate from the initial/purchase price, the need for technology to benefit all parties involved (not just therapist and patient), the accessibility of technology in question, simplicity and design allowing for ease of operation, and the participation of multiple parties in the design process – also called co-design. Researchers found that co-design in particular appeared at the center of most technological applications. This study showed all themes were highly related, which emphasizes how many factors are at play with rehabilitation technology.

Some engineers and designers who produce technology for the medical field may feel pressure to 'reinvent the wheel' by creating something so unique and innovative that it cannot be imitated. However, this may lead them to stray away from clinical outcomes. This is one of many reasons clinicians should be involved in the creation of technologies for their field, as it is important to thoroughly understand rehabilitation and properly apply evidence-based practice. Dated studies from various researchers have emphasized this as well as the need for consistency in integration. Pearce et al. (2024) found that many rehabilitation technologies have low utilization rates among clinicians and are often abandoned due to a lack of consistency and low clinical utility. Celian et al. (2024) notes that many esteemed and technologically advanced hospitals had a range of rarely used

rehabilitation technologies, namely measurement devices. However, these researchers found time was not a contributing factor to abandonment, as 85% of devices required 5 minutes or less of set-up time. Point-of-service documentation and other organizational demands may have detracted from more concentrated device use.

These are just some considerations to keep in mind when using technology-enhanced interventions in OT. We will discuss more specific barriers and critiques of these interventions in a different section.

Section 1 Personal Reflection

What are some considerations a therapist should keep in mind when using technology-enhanced interventions in an inpatient setting?

Section 1 Key Words

Co-design - A design approach that strongly emphasizes collaboration between programmers, designers, end users, investors, and more; co-design helps build solutions based on a shared vision

Section 2: Technology-Enhanced Intervention Types

References: 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87

There are many types of technology-enhanced interventions to review in this course. To provide the most up-to-date look into recent developments on the market, we will provide a review of products and devices from the last 10 years.

Artificial Intelligence

We are beginning to see an increase in technology that utilizes artificial intelligence within the rehabilitation field. These technologies traditionally utilize algorithms from a range of patient data (including medical records, wearable devices, and more) in order to customize therapy and offer real-time feedback during sessions – much in the same way a therapist does. In the case of some devices, artificial intelligence is only a portion of the technology used as it may be paired with technologies such as robotics, virtual reality, and more. The following products utilize artificial intelligence:

Korro AI

This company has created several products available worldwide, each of which utilize machine learning to support early intervention addressing a child's emotional, cognitive, psychosocial, and physical skills. Healthcare providers who use Korro AI with children can provide real-time feedback via computer vision. Their services specifically target children who may have little to no access to services. Korro AI is one of the few programs that specifically offers occupational therapy. They also provide a modified version of services to patients and clinics on their waiting list.

Neurofenix

Neurofenix is intended for individuals in need of neurological rehabilitation. They are a group of virtual care providers that use technology to bring specialized care

to a person's home. Neurofenix offers gamified features along with remote monitoring (through remote tracking devices) and messaging with providers for support outside of sessions. This company notes their services are intended to pair well with any other services someone may be participating in, ideally in an outpatient setting. Neurofenix mainly targets individuals who want more frequent, intensive care for better outcomes. Users also have access to a dashboard with analytics so they can see the breakdown of the work they've been doing.

Sword Health

This company offers several product lines that serve as solutions for preventively improving movement, addressing joint pain and pelvic health concerns. More recently, they also have solutions aimed at mental health concerns. Across various product lines, Sword Health aims to provide comprehensive health education resources, prevent the need for unnecessary surgeries, and help individuals at risk of chronic pain avoid its development.

Evidence, Areas for Improvement, & Clinical Considerations

Despite the advances made in the realm of rehabilitation-based artificial intelligence, there remain some barriers to efficacy and large-scale adoption. Research shows the most significant barriers include high costs, a lack of clinician awareness and training in the application of AI within clinical practice, and difficulties with security and data privacy. In addition, many artificial intelligence platforms – including some we just covered – cite high levels of accessibility due to smartphone compatibility. However, some of the most disadvantaged individuals, such as those from low socioeconomic statuses or those living in rural areas with limited cell service, may still struggle with access issues. Other potential concerns include algorithmic biases, data inaccuracies, and an overreliance on this technology by potentially overburdened providers.

Kaelin et al. (2024) brought up that one of the best ways to ensure the ethical use of AI in rehabilitation is by using human-centered principles, which strongly align with occupational therapy's beliefs and values. This also demonstrates strong promise for other areas of rehabilitation, as such a specialty within AI can ensure uses are as evidence-based and effective as possible. Hood (2024) also mentioned the importance of recognizing the role that stakeholders play in OT's involvement and use of AI. While these parties may present barriers to OT using AI, there is also the potential for opportunity in the design and implementation of such technologies.

Augmented Reality

When rehabilitation technology utilizes augmented reality, this creates an environment that is partly digital and partly real-life. Augmented reality (AR) technology integrates sound, text, images, and other forms of content with corresponding real-world information to create a blended experience. Some types of AR operate using smartphones to scan QR codes. QR codes, also known as markers, serve as anchors to directly place digital information on. Markerless AR relies on apps and sensors to understand the environment and the type of content that pairs best with it. Other augmented reality may digitally project an image onto a surface, which users can then interact with independent of its source technology. Lastly, augmented reality can also superimpose some or all of an image with a different view. Augmented reality may be paired with artificial intelligence since the latter can help with functions such as object recognition. However, these two technologies are technically distinct. In the rehabilitation realm, providers may encounter various forms. Therapists may use projection-based AR to engage patients in therapeutic activities addressing fine motor skills (such as keyboarding), cognition (matching or ordering objects), visual skills (spatial organization), and more. Superimposed AR may be helpful when

educating patients about certain injuries or illnesses that might involve visuals of the human body.

Augmented Studio

While not intended for direct patient care, Augmented Studio has used augmented reality to assist with academic learning in physical therapy programs. Augmented Studio uses projection mapping to allow students to see virtual anatomical figures on the human body as it moves. This creates a live canvas through which students can learn from and interact with.

Exer Health

Exer Health's main function is as an artificial intelligence company for the health space, though several of their solutions utilize augmented reality. Exer Health's website details their home exercise program software that monitors specific body movements to ensure proper completion. This company also offers scanning programs that assess gait to monitor and prevent musculoskeletal concerns as well as a hand and upper extremity-based application dedicated to the management of acute and chronic diagnoses affecting these extremities.

Imago Rehabilitation

This company offers care from PTs and OTs with a blend of various technologies in an effort to make their solutions as person-centered as possible. They list AR, robot-assisted therapy, virtual reality, brain-computer interfaces, and gamified therapies (many of which we will discuss in coming sections) as part of their offerings. According to their website, Imago Rehabilitation specializes in neurorehabilitation as well as cardiac and pulmonary rehabilitation.

Immersive Rehabilitation Exercise (IREX)

Created by GestureTek Health, IREX uses augmented reality to engage patients in games that address various upper and lower extremity skills including balance, fine motor skills, stair climbing, and physical exertion. IREX also encourages a variety of major positional adjustments (such as leaning and crouching) to further improve a patient's motor function.

Evidence, Areas for Improvement, & Clinical Considerations

Many of the same concerns that apply to artificial intelligence are present with augmented reality. There are not yet clear regulations or surveillance systems in place, which means that security and privacy may not be as protected as they could be. Due to the newness of some forms of augmented reality, there may be limitations in field of view and image resolution as well as input/output delays, which can all significantly impact the experience for many users. Such delays may even prove dangerous when assessing skills such as balance, especially in high-risk or medically fragile patients who complete sessions remotely in their homes without supervision or assistance. As with any modality, therapists should offer disclaimers and ensure that patients are aware of risks related to overuse, including visual fatigue, neck pain, and disorientation. Therapists should determine what risks, if any, outweigh AR benefits for any given patient.

Overstimulation and distraction are additional clinical considerations for AR immersion. As such, this technology should be used with caution in individuals who have cognitive or sensory processing difficulties. Some steps that can guide proper use include using the evaluation process to determine suitability for this modality, grading the time spent in such environments, and bookending immersive experiences with grounding activities in real-time.

Petrakis et al. (2025) highlighted many of the above areas while noting the major dearth of evidence supporting modalities such as augmented and virtual reality. While research may explore the use of AR on a simplistic level or via case studies, there is still a lack of large-scale studies that are needed to prove a link between AR and enhanced outcomes. These researchers also brought up concerns related to methodology used in the development and implementation of this modality, overall usability, and patient adherence. Providers should also be aware that many AR devices require continual updates, which can place limitations on travelling providers or patients with limited internet connections.

Exoskeletons

Robotic exoskeletons are wearable, motorized devices that provide full-body support to individuals with motor deficits. These devices have a large presence in the rehabilitation field for their ability to assist individuals in regaining abilities such as walking, standing, sitting, transferring, crouching, and lifting. Individuals may also utilize exoskeletons for preventive and maintenance purposes such as assuming proper posture and body mechanics when lifting at work or for the sake of sports and personal fitness.

Ekso Indego

This exoskeleton was developed specifically for individuals with low level spinal cord injuries but can also assist individuals with multiple sclerosis and acquired brain injuries. Ekso Indego Therapy should be used in clinical settings under the supervision of a provider who is trained in the use of this device. Ekso Indego Personal is designed for both indoor and outdoor use by individuals who may or may not be receiving rehabilitation. Ekso Indego notes that the personal version of this device can be donned and doffed without any assistance. The makers state that the design of this device is lightweight and compact enough that it allows

users to remain seated in their wheelchair while placing the device on prior to use. In addition, both devices have a standing function that OTs can use to walk patients through ADLs prior to walking (or in lieu of walking during the earlier stages of rehabilitation).

ReWalk

While this is a personal exoskeleton, this is considered one of the original devices in this category and is intended for use with individuals who have spinal cord injuries. In addition to aiding with gait, the ReWalk Personal Exoskeleton can assist with bladder and bowel function, trunk control, and spasticity management. Many exoskeleton devices utilize app-based controls, but the ReWalk device also comes with crutches that have integrated controls. ReWalk notes they are the only exoskeleton that allows their users to navigate curbs and even stairs, which is unique compared to most rehabilitation-based exoskeletons.

SuitX

While they have industrial applications, SuitX products can also be used in preventive medicine and rehabilitation. SuitX has several product lines, making it suitable for users with various mobility needs. The IX Back Volton offers torso support with added flexibility around the spine, which allows for users to bend and lift while wearing the device. The IX Back Air is a more passive and compact exoskeleton also focused on torso support while lifting. The IX Shoulder Air (worn like a backpack) offers upper body support to both shoulders. SuitX products are app-controlled. This company also offers a more simplistic version of their product to be worn on the neck, designed to prevent cervical strain during overhead tasks.

Evidence, Areas for Improvement, & Clinical Considerations

As with many forms of rehabilitation technology, one of the major barriers to exoskeleton use is their high cost. Large organizations such as teaching hospitals may be able to secure funding for devices used within rehabilitation treatment plans. However, personal exoskeletons are not always covered by insurance and may be unattainable for many patients who are candidates for them. A lack of research supporting their long-term use is one of the chief reasons for minimal (if any) insurance coverage.

Clinical considerations are present in the realm of the time, as the fitting process for personal exoskeleton devices is typically lengthy. In addition, clinicians have voiced concerns over the speed of devices as well as the need for customization to accommodate various levels of physical activity and body weight. There are also concerns over the possibility of pressure injuries in individuals with long wear times who may be at risk for wounds as well as the long-term implications for musculoskeletal health (specifically related to bones). Existing research states the most effective varieties of exoskeletons are paired with brain-computer interfaces and functional electrical stimulation to maximize benefits and address many of the aforementioned limitations. A large systematic review by Chiu et al. (2025) confirmed individuals with spinal cord injury saw greater benefits from actively controlled exoskeletons compared to passively controlled devices. These researchers also confirmed that using such devices in a rehabilitation program encourages neuroplasticity for people with SCI by strengthening weakened bioelectrical signals to promote authentic functional gains.

Gait & Seating Devices

Gait trainers and innovative wheelchair models make up the bulk of the gait and seating device category. Gait trainers are wheeled structures used to assist people

in learning or relearning to walk. Gait trainers are used with individuals who cannot bear the entire weight of their body, as they offer unweighting support through harnesses and straps as well as postural alignment that helps them successfully practice walking. Climbing wheelchairs are a form of wheelchair that allows users to ascend and descend a variety of terrains without the need for a ramp or other environmental modifications.

Hocoma

This organization makes a range of gait-oriented devices that exist in a continuum to suit a range of mobility needs. Erigo Pro offers a combination of cyclical leg loading, gradual verticalization, and leg mobilization, which are all best suited for patients in the early stages of gait training within their rehabilitation. Lokomat is an intensive rehabilitation platform intended to increase strength and range of motion to prepare patients for walking. Users are positioned on a treadmill with unweighting support, which eliminates the need for manual assistance from the therapist. Andago is designed to support people in overground walking, which offers the same unweighting support but with a moveable frame that allows for practice within someone's natural contexts.

LiteGait

LiteGait is the name of both a company and the flagship gait trainer. This company has since developed a range of other gait training products, including adult and pediatric gait trainers for rehabilitation program use, an adult gait trainer for home use, adult and pediatric rehabilitation treadmills, and sit-to-stand/transfer assistance devices. They also created a gamified balance training system for adults and children, which can be used in standing, sitting, or quadruped to accommodate a range of mobility skills.

Path Finder

Marketed as a Parkinson's walking aid, Path Finder is a small, portable aid worn on the shoe to help manage freezing of gait. This device provides visual cues in the form of a colored horizontal laser line to help the brain reinitiate the process of walking. Path Finder is most useful when patients are walking on flat surfaces and can be worn on top of any shoe, as it is size adjustable.

Prelivia

While this is not a traditional gait or seating device, Prelivia addresses one of the most prevalent complications related to prolonged seating (and bed rest): pressure ulcers. By using specialized neurostimulation, Prelivia reduces damage to at-risk tissues by stimulating blood circulation. Not only is it safe for continuous use, but research studies have shown it is the most beneficial when used at that frequency. This device, made by Rehabtronics, was found to take less than 10 minutes for healthcare professionals to use and those who have used it report no barriers to implementation.

Scewo

Scewo Bro is a unique wheelchair that allows users to switch between two large wheels for standard use and integrated tracks to navigate stairs. The Scewo Bro also has seat lifts, two-sided controls, and multiple joystick attachments, which accommodate a range of users. This technology also travels well, as it has a self-driving feature that allows it to enter your vehicle with minimal intervention.

Tango Belt

Tango Belt is a wearable hip protection device designed to lessen complications and injuries resulting from falls. This device releases airbags after sensing a fall, notifies caregivers, and also collects a range of metrics including activity

engagement and balance confidence. Tango Belt is available as a part of remote patient monitoring plans and can also be used for in-home rehabilitation, in assisted living facilities, by value-based care providers, and by single individuals interested in increasing their personal safety.

Evidence, Areas for Improvement, & Clinical Considerations

Research from Thijs et al. (2021) showed that sitting balance training with the assistance of technological methods is a safe, feasible intervention for individuals recovering from stroke. However, the most benefits were seen when this was complemented with a 4-week program consisting of 12 traditional therapy sessions focused on functional balance, gait speed, and trunk control. A systematic review from Lyu et al. (2023) compared the effects of various types of gait training technology on balance. The technologies reviewed included virtual reality gait training, robotic-assisted gait training, body-weight supported treadmills, standard treadmills, overground walking training, and conventional gait training performed without technology. Results showed that standard treadmills and body-weight supported treadmills had the most impact on dynamic balance. Body-weight supported treadmills and virtual reality gait training were found to best improve performance on balance tests. Researchers urged clinicians to more frequently consider body-weight supported treadmills for gait training with stroke patients, as this is not currently accepted practice but can be useful for certain patients.

Other research on the use of gait trainers in rehabilitation is dated, but positive. One dated study showed that adolescents with spastic cerebral palsy who participated in gait trainer-based walking exercises in addition to standard rehabilitation demonstrated significant improvements compared to those who did not receive this modality. Outcomes included improved step length and walking speed. Another dated study looked at the efficacy of body weight support

treadmill training along with visual biofeedback and results were inconclusive when tested with patients who sustained acute stroke.

Gamified Rehabilitation

The concept of gamification involves using core game elements in non-game settings. Rehabilitation is one such setting where gamification has been heavily used in the past decade.

Gamified rehabilitation involves using gaming to enhance activities and exercises as part of traditional therapies. Gamified rehab is considered highly interactive and often contains features such as rewards, scoring, leaderboards, visible progress trackers, and more. Gamification has been proven effective in increasing patient engagement and adherence in various rehabilitation fields. Many products that take advantage of gamification use other technologies such as augmented reality and virtual reality.

GestureFX

This group of products utilizes interactive projection, innovative visual displays, and body-tracking technology to create immersive gaming experiences most commonly used in treating children. However, this (and many other types of gamification) have high applicability to other populations. Many GestureFX products use what they call “The Cube,” which is a portable and compact way to control the program’s functions. This makes these products easy to transport between patient’s homes or within various parts of a hospital or school. Another solution within this product line focuses on creating immersive sensory rooms, which cater to individuals with a range of neurological, neurodevelopmental, or even psychiatric conditions.

Mind Maze Labs

Mind Maze Labs uses gamification along with motion analytics, artificial intelligence, and mixed reality to assist with the rehabilitation of individuals with neurological conditions. They have various products that offer more targeted care for specialized populations, including MindPod for upper limb rehabilitation in post-stroke patients, Intento Pro for severe upper extremity disorders post-stroke, and TOAP Run for individuals with Parkinson's Disease.

Rehabtronics

Rehabtronics also offers several product lines, one of which is an interactive gaming system called ReTouch. This product offers over 20 games that are versatile enough to be completed in seated or standing. Games address physical and cognitive skills including neglect, visual scanning, memory, attention, range of motion, strength, endurance, planning, and problem-solving.

Tovertafel

With the tagline 'purposeful play,' Tovertafel's target audiences are those with dementia (for which they've created a memory care product line) and intellectual disabilities (who can use their ID care line or their inclusive education programs). Their memory care products can be played individually or in large groups, which pairs social interaction with gamification that addresses sensory, cognitive, physical, and social needs. This line is reported to lower emotional tension and restlessness, enhance socialization between an individual and their family, friends, and caregivers, and decrease apathetic behaviors that may serve as barriers to care and functional independence. The games in Tovertafel's ID line are inclusive in that there are no wrong moves, which purportedly boosts confidence, socialization and connection, physical activity, alertness, and independence simultaneously.

Others

In addition to standalone, rehab products such as the ones above, fitness-based companies are also expanding their horizons beyond just general use. For example, FitBit has long been regarded for its utility in basic health tracking. However, they are now adding gamification to their products, which allows for potential use with more clinical populations. Some other companies with similar endeavors include MySugr (a diabetes management app) and Didget (a blood glucose meter that plugs into the Nintendo DS gaming console).

Evidence, Areas for Improvement, & Clinical Considerations

A dated but significant systematic review explored gamification strategies and areas of focus within the health, wellness, and medical spaces. Results showed that applications most often surrounded mental health, physical activity levels, and rehabilitation from chronic diseases, but not necessarily physical rehabilitation. As expected with most technologies (especially those developed and used heavily in the last decade), there are large gaps in evidence supporting the benefits of gamification in healthcare. Research has, however, discovered that most of the major drawbacks in this area include gamification's overt focus on short-term engagement and extrinsic rewards rather than long-term, tangible benefits. This may remain one of the clearest disadvantages associated with this type of technology, especially in the case of gamification devices developed by individuals without any clinical background or used by clinicians who do not have proper training in theoretical foundations and adapted learning. The review also made this clear by pointing out the importance of theoretical bases as well as psychological principles and game mechanics.

In terms of more outcome-focused research, Cheng et al. (2023) found that gamification had various degrees of efficacy when used with individuals who have mental health concerns. Most of these variations stemmed from gender-specific

considerations and differences between gamification design factors, which were found either unaddressed or not addressed thoroughly enough. Khoshnoodifar et al. (2023) looked into how effective gamification was compared to traditional teaching methods when used with high school-aged individuals. Results from this study showed those who engaged with gamification-based learning activities demonstrated greater improvements in their disposition regarding personal learning difficulties, concentration levels, the sense of challenge they experienced from the content, and their perceived experience compared to the control group. However, learning itself did not differ between the two groups. Clinicians can use this information to assist with tailoring therapy sessions to meet the needs of individuals in this age group and pairing these strategies with their own that focus on long-term benefits.

Lastly, research from Ozdamli et al. (2023) showed that gamification strategies served as facilitators for individuals who experienced difficulty executing fitness-based exercises and demonstrated unwillingness toward fitness recommendations and fitness in general. This data gives therapists insight into how they may achieve breakthroughs with clients who struggle with exercises or even the therapy process in general.

Motion Capture Technology & Video Biofeedback

Motion analysis is a core skill that many occupational and physical therapists are taught during the early years of their schooling. While it is important for therapists-in-training to continue learning and growing their skills in this area, motion capture technology is being used in increasing amounts to aid in the evaluation and treatment of a patient's movement. Motion capture technology utilizes cameras and sensors to collect data on range-of-motion measurements, movements patterns, muscle activation, pain sources and pathways, and

movement-based inefficiencies that may be impeding function. This information can be used to help therapists discern the most salient areas to focus a patient's treatment plan on. In addition, such technology can streamline a therapist's ability to track progress and measure goal attainment.

BTS Bioengineering

While they have created products aimed at the sports medicine and engineering industries, BTS Bioengineering offers motion analysis systems for skilled nursing facilities, hospitals, and outpatient clinics. Their products appear to target a wider range of skill areas compared to other motion capture technologies, as they report their products can be used in both motor and cognitive rehabilitation programs. These devices can complement in-person and remote therapy sessions alike. In addition to motion capture cameras, BTS offers wireless surface electromyography (EMG), digital force plates, interactive sensory rooms for children, and even a telerehabilitation platform.

Dari Motion

This company offers human motion analysis catered to the healthcare and sports medicine industries. Dari Motion has taken their work one step further by developing protocols to guide the use of their device with patients recovering from knee and shoulder arthroscopy as well as various joint replacement surgeries. Dari Motion also reports having clinical workflows and insights available that simplify the documentation process for therapists.

Medbridge Motion Capture

They are most well known for their continuing education products for a range of professions, though Medbridge has also ventured into motion capture technology within the healthcare industry. Unlike the wearable products discussed in this

category, the Medbridge app integrates artificial intelligence and motion capture to assist with the evaluation and treatment process for patients. Their design is proprietary in that it encompasses quantitative and qualitative scores as well as those that factor in pain's impact on movement.

QSense Motion

QSense Motion reports their wearable motion sensory technology is suitable for general strengthening as part of physical therapy treatment along with orthopedic and neurological rehab. QSense Motion has developed a portable motion sensing platform, a high-resolution motion analysis device, and a wearable motion sensor unit. This company's rehabilitation-focused products also integrate augmented and virtual reality for a more immersive experience.

Evidence, Areas for Improvement, & Clinical Considerations

There are several less obvious applications for motion capture technology. For example, a systematic review by Salisu et al. (2023) states that motion capture may be used by artificial intelligence models alongside machine learning principles and algorithms to tailor treatment plans to the person, examine client data, avoid diagnostic errors, and allow for earlier diagnosis.

Literature has also discussed the benefits of different models, as this has been explored by researchers. Markerless motion capture technology (such as app-based methods) tends to be far more user-friendly and accessible to the average person and even rehabilitation professionals than wearable counterparts. However, there are barriers to this type of technology. Wade et al. (2022) states its notable lack of precision in calculating joint angles, anatomical midpoints, and other crucial landmarks poses a major challenge to widespread implementation in the healthcare space. Similarly, there are high rates of error in pose estimations, especially since there is no gold-standard for comparison with this type of

technology. However, markerless options can still be useful in some cases. Lam et al. (2023) found that this was the more commonly used option for therapists treating patients with Parkinson's disease. In addition, a scoping review from Pardell et al. (2024) found the mean displacement of joint range of motion was similar between markerless and wearable options, though peak joint angles differed significantly. Disparities were also noted between various parts of the body. Pardell also found upper body range of motion outcomes were comparable but the same could not be said of those related to the lower body.

We've mentioned before that many of the technologies discussed in this course can be (and often are) used in conjunction with one another. Motion analysis is no exception, as Janela et al. (2023) notes this technology used in combination with asynchronous telerehabilitation has the strong potential for scalability and increasing access. Wei et al. (2024) brought up some OT-specific concerns about these tools, specifically that proper integration and accessibility must be considered to align motion capture data with the dynamic nature of daily living tasks.

Robotic Arm and Leg Braces

Similar to traditional braces, robotic braces offer support and stability to individuals with significant limitations in tone, strength, and range-of-motion. However, these devices have powered joints that actually assist users in certain movements. These differ from exoskeletons in that they are chiefly for the extremities and used in the rehabilitation of individuals after injuries. Robotic braces may be used during therapy sessions to assist with neuromuscular reeducation and endurance building, but many individuals may benefit from wearing them on a daily basis to improve their functional independence.

Burt

Produced by Barrett, Burt is a robotic brace that has a zero-gravity mode in addition to a robust resource library that guides patients through therapy games and similar activities. Barrett reports that their set-up time is less than 1 minute in an effort to be one of the more user-friendly robotic technologies. Their website lists multiple applications including vocational rehab, neurorehabilitation, and suitable for use with teletherapy patients.

Loutkar Robotics

This organization has created several robotic braces: Orciti (an ankle orthosis), Orca (a hip orthosis), and Orfe (a femur orthosis). All of their devices have Modular Exomuscular Systems (SEMs), which is their patented technology that assists with various lower limb deficits. It appears Loutkar Robotics makes an attempt to reach people truly in need, as their website notes that patients can try their products at no cost and without any commitments.

Meissa OT

The Meissa OT is a robotic-based upper limb rehabilitation device. Meissa OT has electromyography-based triggers that allow for variable range-of-motion configurations. This device provides electrostimulation that is synchronized with various movement phases and comes with interchangeable tips such as handles, knobs, keys, balls, and screwdrivers. This makes it especially useful to therapists treating individuals with neurological conditions or those being treated in work hardening programs. This same manufacturer also produced Sidra LEG, which focuses on lower limb rehabilitation and Luna EMG that has applications for both upper body and lower body.

MyoPro

This device operates by detecting and strengthening existing electrical impulses to improve the quantity and quality of a person's movements. The MyoPro was designed for conditions such as cerebral palsy, multiple sclerosis, and paralysis resulting from cerebrovascular accidents (CVAs) and brachial plexus injuries.

Evidence, Areas for Improvement, & Clinical Considerations

Bessler et al. (2021) reports the most pressing risks and adverse events related to robotic braces are those related to multi-directional excessive forces on various musculoskeletal levels. These researchers also point out that major gaps in the area of robotics include the dearth of reliable measurement methods and appropriate limit values pertaining to robot-human interactions on the skin and joints. Jee (2025) notes that most robotic braces continue to be high cost and have a substantial lack of customization, making them difficult for many therapists to use properly and equitably. Rahman et al. (2025) echoes that the same high price point applies to wheelchair-mounted robotic arm braces in addition to poor kinematic configurations, a lack of modularity, and limited workspace coverage. There are also dexterity concerns that may lead users to have difficulty operating the arms.

Reicherzer et al. (2024) notes that wearable robotics can be met with varied levels of success when used with older adults due to their perceptions of personal need and utility. A large systematic review performed on individuals using upper limb robotic rehabilitation after sustaining a stroke found this technology produced minimally more upper limb capacity in participants compared to traditional rehabilitation. These gains were not maintained in the long-term and did not carry over to ADL function. Research from Tseng et al. (2024) yielded similar results. They stated robotic technology can be more beneficial than traditional therapy

modalities in some ways, but is majorly lacking in other areas, making it an unreliable replacement for traditional therapy.

Smart Home Technology

There are various smart home technologies, many of which are offered by a company called Barrett's Technology Solutions. Some of the types of smart home technologies include:

- Appliances (coffee makers, dishwashers, garage doors, microwaves, refrigerators, stoves, TVs, toaster ovens, and vacuums are some of the most common types)
- Audio and video controls (speakers, displays, music, information acquisition, and multi-room audio are among the features and devices in this category)
- Home theater, including streaming services
- Lighting control (bulbs, plugs, switches, and motion-sensored lights are available for both indoors and outdoors)
- Networking (these can connect via wifi or ethernet and may be controlled via apps either on the user's phone or their caregiver's phones for remote access)
- Power, temperature, and energy management (including thermostats, air purifiers, and power strips)
- Smart home automation (this includes doorbells, motorized shades, security cameras, locks, and hubs for managing various smart appliances and devices)

Evidence, Areas for Improvement, & Clinical Considerations

Ding et al. (2025) determined what mainstream smart technologies are most suitable for rehabilitation purposes with individuals who have complex physical disabilities and utilize powered wheelchairs. Results showed that nearly 75% of participants moved from needing total or partial assistance with functional tasks to independently completing them. Another 18% moved from needing total or partial assistance with functional tasks to performing them independently or with decreased effort.

Amtz et al. (2023) explored the wide range of smart and other digital technologies that can be used at home for rehabilitation purposes. They discovered that many technology types must be paired together to overcome their individual limitations. Specifically, these researchers suggested that machine learning and artificial intelligence can better help customize smart technologies to a person's health needs. Ghorayeb et al. (2023) states that smart home data visualization is essential for older adults to use this technology. This feature not only deepens the user's understanding, but also its relevance and value to a geriatric population. Visualization can also expand the clinical uses for this technology, which can include improving health awareness and general well-being, socialization and connection, decision-making abilities, cognitive engagement, monitoring of one's health status, and ability to perform daily activities. Ghorayeb et al. (2023) also notes that older adults can serve as excellent co-designers for the development of visualization features in many forms of technology, including smart tech.

A systematic review from Morita et al. (2023) showed that one of the most significant limitations in the use of smart home technologies within rehabilitation is the lack of interdisciplinary collaboration during the recommendation and implementation of such devices. Another major concern is the rate at which these devices are developing and how this often may take precedence over the human-

centered design process. In addition, contradictory definitions of smart technology and smart homes serve as another barrier to clinical implementation, insurance coverage, and research efforts.

Telerehabilitation

Telerehabilitation is defined as the remote completion of therapy interventions using audio and/or video services. Telerehabilitation may utilize general video conferencing software such as Microsoft Teams or Zoom. However, there are a growing number of platforms dedicated solely to the provision of telerehabilitation services. Telerehabilitation may also be provided with the help of wearable technology or mobile applications. There is some variation across telerehabilitation platforms, though synchronous video, asynchronous communication, electronic progress reporting abilities, and patient portals are considered core features for most telerehabilitation services.

The following organizations have created comprehensive programming in the telerehabilitation space, meaning they have referral sources, video conferencing software, and integrated documentation:

- Band Connect (a hybrid therapy platform specializing in orthopedic rehabilitation)
- E-Luma (specializing in school-based services, including OT, SLP, behavior therapy, and mental health)
- E-Therapy (specializing in school-based services, including OT, SLP, PT, and behavior therapy)
- Imago Rehab (specializing in neurological and cardiovascular rehabilitation)

- Kintinu Telerehab (specializing in rehabilitation for needs related to orthopedics, neurology, and limb loss)
- Motus Nova (specializing in neurological rehabilitation)
- Presence Learning (specializing in school-based services, including OT, SLP, and mental health)
- ProCare Therapy (specializing in school-based services, including OT and SLP)
- TalkPath Live (specializing in OT, PT, and SLP for children and adults)
- TinyEYE (specializing in school-based services, including OT, SLP, mental health, and social work)

The following are general platforms that may or may not be HIPAA-compliant and can potentially assist with providing telerehabilitation services:

- Google Meet
- GotoMeeting
- Microsoft Teams
- Updox
- Zoom for Healthcare

In addition, these platforms are HIPPA-complaint and can be utilized by therapists:

- Blink Session
- BlueJay
- Doxy.me
- eVisit

- Health Recovery Solutions
- HelloNote
- Mental Health EHR (formerly TheraNest)
- SimplePractice
- Therabyte
- Thera-LINK
- TheraPlatform
- VSee

Evidence, Areas for Improvement, & Clinical Considerations

Franco et al. (2023) identified several barriers to musculoskeletal-based telerehabilitation, though these apply to telerehabilitation used for any speciality. Barriers included difficulty developing personal relationships with patients, an inability to properly monitor exercise protocols provided and implemented, technological difficulties related to telerehabilitation devices (computers, tablets, phones as well as rehabilitation-specific devices used in conjunction), and variations in Internet access that impact the therapy process.

The 2020s have seen a major boom in the use of telerehabilitation, though research from this time period cites continued difficulties. Namely, Rabanifar et al. (2022) indicates major barriers include a lack of knowledge relating to the use of telerehabilitation equipment and insufficient telerehabilitation infrastructure to support the consistent and safe use of the technology. Dated research lists change management techniques and training improvements as potential solutions, which can still prove beneficial in remedying these problems. Lange-Drenth et al. (2024)

also adds that it is difficult to properly replicate certain aspects of in-person rehabilitation via telerehabilitation, which can impact quality of care.

Gopal et al. (2022) found that a patient's disability status can impact their likelihood to engage with telerehabilitation services. Particularly, patients with multiple sclerosis who scored zero on disability indices were far less likely to participate than patients with tangible disability scores. This presents an opportunity for therapists to properly educate individuals with a range of impairments and functional abilities as to the benefits of telerehabilitation.

Virtual Reality

We discussed augmented reality in rehabilitation earlier, which incorporates virtual elements within real-life contexts. Virtual reality is similar, though it does not incorporate any real-life elements and creates an entirely new environment for the user to receive rehabilitation in. In the rehabilitation space, virtual reality can be used to create an immersive therapeutic environment to provide services in.

Corpus VR

This organization creates virtual reality solutions for various physical injuries, mental health conditions, and neurological disorders. CorpusVR has products that include physical and occupational therapy for corporate wellness programs, home rehabilitation, assisted living facilities, orthopedic and sports medicine clinics, and hospitals.

Immergo Labs

Immergo Labs is a universally available virtual reality therapy environment, meaning it can be accessed using any virtual reality headset and even some

augmented reality glasses. They have patented biomechanical technology that offers full-body tracking along with integrated gamification. Patients have their own embodied avatars and interact with other avatars to enrich their experience.

SafeSpace

Available via a tablet and smartphone compatible app, SafeSpace creates immersive sensory environments for youth with learning disabilities, Autism, developmental delays, neurological conditions, and mental health concerns. With various locations and an easy-to-follow map, users can explore both sensory and emotion spaces at their own pace.

Evidence, Areas for Improvement, & Clinical Considerations

Dated research found that virtual reality device designers must ensure programs take patients through each intervention stage as therapists would do in person. While this research focused on patients with neurological disorders, the point applies to any population that requires specific treatment protocols. Other dated research found barriers to virtual reality use in rehabilitation include difficulty with equipment set-up, participant training, recruitment, and adherence/ monitoring throughout the plan of care along with disparities in the reliability and maintenance needs of equipment.

Lorkowski et al. (2025) states that VR mechanisms and standardization don't appear to keep pace with their popularity and the rate at which technological advances are arising. These researchers also brought up this technology's long-term effects, stating that they aren't as robust as they should be. Naqvi et ak. (2024) notes that virtual reality can be especially impactful when combined with artificial intelligence to make treatment programs even more responsive and adaptive to patient needs. A dated study notes that knowledge translation interventions are needed to facilitate the use of virtual reality (and active video

games) in clinical settings. Knowledge translation can address various virtual reality barriers – including but not limited to skills, knowledge, goal achievement, social influences, beliefs about patient consequences, and beliefs about capabilities – which stands to improve adoption and success rates.

Section 2 Personal Reflection

In what ways can some of the aforementioned technology be combined to create more comprehensive devices for patient care?

Section 2 Key Words

Asynchronous communication - Communication that does not occur in real-time, which is common for messaging services such as texting, chat functions, collaborative work documents, and emails

Human-centered artificial intelligence - A specialty of artificial intelligence that heavily incorporates human values, priorities, beliefs, and overall well-being in the design of their technologies

Section 3: Critiques and Therapist Resources

References: 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100, 101, 102, 103, 104, 105

As we've mentioned in many of the above sections, there are both advantages and areas for future growth related to each type of technology. Across the board, Georgeson et al. (2020) and other large-scale studies on various forms of technology bring up concerns related to security, accuracy, and privacy. These concerns have been connected to issues with adherence, proper use, efficacy, and

overall mistrust between providers and patients, which has a negative impact on the therapeutic process.

There are additional shared concerns regarding a great number of the technologies used in the healthcare space. Akhtar et al. (2022) and other researchers have noticed a lack of consistency in various aspects of the technology, including design, the use of outcome measures, and overall constructs as another significant concern. This not only makes it difficult to weigh the efficacy of healthcare technology, but also prevents researchers from comparing how beneficial a new technology is compared to gold-standard technologies currently in use.

Reviews of technology and related literature show that there are far fewer studies focused on assessing the use of technology with children and adolescents. This may be due to there being fewer technological advances catered to this age group. Borges do Nascimento et al. (2023) found that provider barriers also play a large role in how often and how well technology is used in the therapy disciplines. Their systematic review looked at what barriers healthcare disciplines experienced in the larger field of digital health. Results showed the most common concerns were an increased demand on their workload (further burdening already high productivity standards in many settings), technical difficulties, and mismatch between infrastructure and use in practice. In addition, intrinsic psychological factors prevented some therapists from properly using technology, including but not limited to difficulty or reluctance to learn new skills and slow or poor adaptation to change.

Badr et al. (2024) states that health equity is another potential drawback that should serve as an important consideration for the use of technology in therapies. Cost is a barrier to the use of many technologies both due to variable amounts of insurance coverage for these devices and obstacles preventing patients from

obtaining the same devices they used in therapies within their homes. Therefore, technologies (specifically digital health technologies) can easily increase and magnify inequalities for disadvantaged populations. Therefore, therapists must be judicious about the ways in which they use this technology by taking health distribution and individual characteristics into heavy consideration.

Therapist Resources

Perle et al. (2025) developed one solution to assist with the lack of information and consistency in the realm of healthcare technology. The Intersectional Technology Education and Competency in Healthcare (iTECH) Model was designed to assist with multiprofessional provider education and training to encourage proper use of technology within healthcare. This model aimed to improve outcomes and overall practitioner effectiveness by identifying competencies across six main domains: service type, modality type, primary knowledge, delivery format, setting, and diversity, equity, inclusion, and justice (DEIJ). As we mentioned above, health equity and a lack of proper technological use were main barriers, so this model shows promise in helping therapists with quality implementation.

There are several other resources therapists can explore to effectively use technology in their practice:

- Foundations in Digital Therapy training course through Palo Alto University
- Person Centered Tech offers forms and product reviews for mental health therapists
- The National Academies of Sciences, Engineering, and Medicine hosts workshops and collects publications on new advances in their specialty areas, including technology

- The American Orthotic & Prosthetic Association offers policy updates, publications, and coding/reimbursement guidance for technology pertaining to limb loss
- The University of Washington's DO-IT: Disabilities, Opportunities, Internetworking, and Technology provides programming, webinars, publications, and events for individuals with disabilities. Many of these events address technology and universal design and can serve as great resources for therapists and patients alike.
- The National Coalition for Assistive & Rehab Technology offers a wide range of advocacy resources for patients along with clinical guides for therapists.
- The Administration for Community Living has a section of their website dedicated to grant and funding updates for assistive technology.
- AgrAbility, which aims to cultivate accessible agriculture, has an assistive technology database on their website.
- The American Occupational Therapy Association (AOTA) website has a section for telehealth resources.

Reimbursement

Billing, coding, and reimbursement are additionally important factors to consider related to technology-enhanced interventions. As with any therapy modality, providers must ensure that all tools and treatments provided are medically necessary. As a reminder, the definition of medical necessity is the determination that a medication, service, or procedure has a distinct medical need. Medical necessity states that a given treatment is beneficial for the patient's specific condition(s); required in order to presently enhance well-being, slow disease progression, and/or prevent future medical complications or injury from ensuing;

and has a solid basis of evidence not only according to someone's scope of practice but also in the medical community as a whole.

Medical necessity is important from a reimbursement standpoint to ensure proper utilization of services and cost management. However, it also serves the clinical community the benefit of being able to provide the care each person needs when they need it and where they seek it out. This concept is just as important with technology as it is with other intervention types.

In order to receive reimbursement and properly establish medical necessity, therapists must use the proper CPT (Current Procedural Terminology) and HCPCS (Healthcare Common Procedure Coding System) codes. Some of the following are applicable to the rehabilitation field as they encompass many of the above technologies:

- Assistive technology assessment - 97755
- Orthotic management and training (First encounter) - 97760
- Prosthetic training (First encounter) - 97761
- Orthotic and prosthetic management (Subsequent encounter) - 97763
- Wheelchair management training - 97542
- Biofeedback training, any method - 90901
- Biofeedback training, first 15 minutes - 90912
- Biofeedback training, each additional 15 minutes - 90913

Apart from these codes that govern the use of specific devices, therapists can use many of the same codes as they would for standard interventions. For example, if a therapist is using a robotic-assisted arm to train a patient with unilateral paralysis to self-feed, they would use the CPT code for self-care training, which is

97535. If a therapist is using a gamified rehabilitation device to engage patients in various activities that will prepare them for gait training later, they would use the CPT code for therapeutic activities, which is 97530. Technology-enhanced interventions can be incorporated into nearly any of the below CPT and HCPCS codes already used in therapy sessions:

- 97032: Application of electrical stimulation
- 97113: Aquatic therapy with therapeutic exercises
- 97550: Caregiver training in strategies and techniques to facilitate the patient's functional performance in the home or community
- 97129: Cognitive function training or retraining
- 97537: Community or work reintegration training
- 97024: Diathermy
- 97014: Electrical stimulation, unattended
- 97113: Gait training
- 97552: Group caregiver training in strategies and techniques to facilitate the patient's functional performance in the home or community
- 96156: Health behavior assessment or reassessment
- 96158: Health behavior intervention (individual and face-to-face) (initial 30 minutes)
- 96167: Health behavior intervention (family-based, face-to-face, with the patient present) (initial 30 minutes)
- 96170: Health behavior intervention (family-based, face-to-face, without the patient present) (initial 30 minutes)

- 96164: Health behavior intervention (group with 2+ patients and face-to-face) (initial 30 minutes)
- 97140: Manual therapy techniques
- 98970: Qualified nonphysician healthcare professional online digital evaluation and management service
- 98975: Remote therapeutic monitoring (initial set-up and patient education on use of equipment)
- 98980: Remote therapeutic monitoring treatment management services (provided by a physician or other qualified healthcare professional)
- 97533: Sensory integration techniques
- 97150: Therapeutic procedures in a group setting
- 92606: Therapeutic service(s) for the use of non-speech-generating device (including modification and programming)
- 92526: Treatment of swallowing dysfunction and/or oral function for feeding
- 97545: Work hardening or conditioning (first 2 hours)
- G2251: Brief communication technology-based service by a qualified healthcare professional who cannot report evaluation and management services, provided to an established patient
- G0541: Caregiver training in direct care strategies and techniques to support care for patients with an ongoing condition or illness and to reduce complications (family-based, face-to-face, without the patient present) (initial 30 minutes)

- G0543: Group caregiver training in direct care strategies and techniques to support care for patients with an ongoing condition or illness and to reduce complications (family-based with multiple caregivers, face-to-face, without the patient present) (untimed)
- G0129: Occupational therapy services requiring the skills of a qualified occupational therapist, furnished as a component of a partial hospitalization or intensive outpatient treatment program (45 minutes or more)
- G2250: Remote assessment of recorded video and/or images submitted by an established patient, including interpretation with follow-up with the patient within 24 business hours

Takeaway

Some of the most effective ways to use technology in therapy interventions include assisting with improving independence in disease management, behavior management, and self-care skills. Therapists must ensure that any plan of care incorporates areas that relate back to their scope of practice. In summary, one of the simplest ways to ensure the proper use of technology-enhanced interventions is to maintain a strong focus on being occupation-based and client-centered. This is not only crucial for the integrity of the treatment, but also for reimbursement. Therapists must remember to do their research and ensure that any technology utilized is evidence-based and supportive of best practices in accordance with the field of occupational therapy.

Section 3 Personal Reflection

What resources can therapists use when discussing the possible use of

technology-enhanced interventions with their superiors?

References

1. Mois, G., Lydon, E.A., Mathias, V.F., Jones, S.E., Mudar, R.A., & Rogers, W.A. (2024). Best practices for implementing a technology-based intervention protocol: Participant and researcher considerations. *Archives of Gerontology and Geriatrics*, *122*, 105373. https://doi.org/10.1016/j.archger.2024.105373.

2. Mitchell, J., Shirota, C., & Clanchy, K. (2023). Factors that influence the adoption of rehabilitation technologies: A multi-disciplinary qualitative exploration. *Journal of Neuroengineering and Rehabilitation*, *20*(1), 80. https://doi.org/10.1186/s12984-023-01194-9

3. Pearce, L., Pryor, J., Redhead, J., Sherrington, C., & Hassett, L. (2024). Advanced technology in a real-world rehabilitation setting: Longitudinal observational study on clinician adoption and implementation. *J Med Internet Res*, *26*, e60374. DOI: 10.2196/60374

4. Celian, C., Redd, H., Smaller, K., Ryali, P., Patton, J.L., Reinkensmeyer, D.J., &. Rafferty, M.R. (2025). Use of technology in the rehabilitation setting: Therapy observations, mixed methods analysis, and data visualization. *Archives of Rehabilitation Research and Clinical Translation*, *7*(1), 100425. https://doi.org/10.1016/j.arrct.2024.100425.

5. Eunice Kennedy Shriver National Institute of Child Health and Human Development. (n.d.). What Are Some Types of Rehabilitative Technologies? Retrieved from https://www.nichd.nih.gov/health/topics/rehabtech/conditioninfo/use

6. Korro AI. (n.d.). Occupational Therapy. Retrieved from https://www.korro.ai/ot/home

7. Neurofenix. (n.d.). Neurofenix for Hospitals. Retrieved from https://www.neurofenix.com/hospitals

8. Sword Health. (n.d.). Thrive. Retrieved from https://swordhealth.com/solutions/thrive

9. Kaelin, V. C., Nilsson, I., & Lindgren, H. (2024). Occupational therapy in the space of artificial intelligence: Ethical considerations and human-centered efforts. *Scandinavian Journal of Occupational Therapy*, *31*(1), 2421355. https://doi.org/10.1080/11038128.2024.2421355

10. Hood, T.R. (2024). Artificial Intelligence's Role in Occupational Therapy – The Innovation and Instability. Retrieved from https://www.aota.org/publications/student-articles/career-advice/ai-innovation-instability

11. Alsobhi, M., Sachdev, H. S., Chevidikunnan, M. F., Basuodan, R., K U, D. K., & Khan, F. (2022). Facilitators and barriers of artificial intelligence applications in rehabilitation: A mixed-method approach. *International Journal of Environmental Research and Public Health*, *19*(23), 15919. https://doi.org/10.3390/ijerph192315919

12. Digital Promise. (n.d.). Types of AR. Retrieved from https://digitalpromise.org/initiative/360-story-lab/360-production-guide/investigate/augmented-reality/getting-started-with-ar/types-of-ar/

13. Vetere, F. (n.d.). Augmented Studio. Retrieved from https://www.ngv.vic.gov.au/exhibition_post/augmented-studio/

14. Exer Health. (n.d.). Products. Retrieved from https://www.exer.ai/

15. Imago Rehabilitation. (n.d.). About Cardiovascular Rehab. Retrieved from https://imagorehab.com/cardiovascular-rehab/cardiovascular-rehab-overview/

16. Imago Rehabilitation. (n.d). Devices & Digital Therapy. Retrieved from https://imagorehab.com/neurological-rehab/neuro-devices-digital-therapy/

17. GestureTek Health. (n.d.). IREX. Retrieved from https://gesturetekhealth.com/products/irex

18. Iqbal, A. I., Aamir, A., Hammad, A., Hafsa, H., Basit, A., Oduoye, M. O., Anis, M. W., Ahmed, S., Younus, M. I., & Jabeen, S. (2024). Immersive Technologies in Healthcare: An In-Depth Exploration of Virtual Reality and Augmented Reality in Enhancing Patient Care, Medical Education, and Training Paradigms. *Journal of primary care & community health*, *15*, 21501319241293311. https://doi.org/10.1177/21501319241293311

19. Petrakis, A., Koumakis, L., Kazantzaki, E., & Kondylakis, H. (2025). Transforming healthcare: A comprehensive review of augmented and virtual reality interventions. *Sensors (Basel, Switzerland)*, *25*(12), 3748. https://doi.org/10.3390/s25123748

20. Vinolo Gil, M. J., Gonzalez-Medina, G., Lucena-Anton, D., Perez-Cabezas, V., Ruiz-Molinero, M. D. C., & Martín-Valero, R. (2021). Augmented reality in physical therapy: Systematic review and meta-analysis. *JMIR Serious Games*, *9*(4), e30985. https://doi.org/10.2196/30985

21. Denche-Zamorano, A., Rodriguez-Redondo, Y., Barrios-Fernandez, S., Mendoza-Muñoz, M., Castillo-Paredes, A., Rojo-Ramos, J., Garcia-Gordillo, M. A., & Adsuar, J. C. (2023). Rehabilitation is the main topic in virtual and augmented reality and physical activity research: A bibliometric analysis. *Sensors (Basel, Switzerland)*, *23*(6), 2987. https://doi.org/10.3390/s23062987

22. Yang, Z. Q., Du, D., Wei, X. Y., & Tong, R. K. (2022). Augmented reality for stroke rehabilitation during COVID-19. *Journal of Neuroengineering and Rehabilitation*, *19*(1), 136. https://doi.org/10.1186/s12984-022-01100-9

23. Ekso Bionics. (n.d.). Ekso Indego Therapy. Retrieved from https://eksobionics.com/ekso-indego-therapy/

24. Ekso Bionics. (n.d.). Ekso Indego Personal. Retrieved from https://eksobionics.com/ekso-indego-personal/

25. LifeWard. (n.d.). ReWalk Personal Exoskeleton. Retrieved from https://golifeward.com/products/rewalkpersonal-exoskeleton/

26. SuitX. (n.d.). SuitX Product Range. Retrieved from https://www.suitx.com/en/products

27. Hohl, K., Giffhorn, M., Jackson, S., & Jayaraman, A. (2022). A framework for clinical utilization of robotic exoskeletons in rehabilitation. *Journal of Neuroengineering and Rehabilitation*, *19*(1), 115. https://doi.org/10.1186/s12984-022-01083-7

28. Siviy, C., Baker, L. M., Quinlivan, B. T., Porciuncula, F., Swaminathan, K., Awad, L. N., & Walsh, C. J. (2023). Opportunities and challenges in the development of exoskeletons for locomotor assistance. *Nature Biomedical Engineering*, *7*(4), 456–472. https://doi.org/10.1038/s41551-022-00984-1

29. Chiu, K.A., Taylor, C., Saha, P., Geddes, J., Bishop, T., Bernard, J., & Lui, D. (2025). Actively controlled exoskeletons show improved function and neuroplasticity compared to passive control: A systematic review. *Global Spine J*, *15*(8), 3933-3952. doi: 10.1177/21925682251343529

30. Riccò, M., Ranzieri, S., Vezzosi, L., Balzarini, F., & Bragazzi, N. L. (2022). Wearable Exoskeletons on the workplaces: Knowledge, attitudes and

perspectives of health and safety managers on the implementation of exoskeleton technology in Northern Italy. *Acta Bio-medica: Atenei Parmensis*, *92*(6), e2021310. https://doi.org/10.23750/abm.v92i6.10437

31. Gesturetek Health. (n.d.). Gesture FX Interactive Surfaces. Retrieved from https://gesturetekhealth.com/products/gesture-fx-interactive-surfaces
32. Mind Maze Labs. (n.d.). About Us. Retrieved from https://mindmaze.com/about/
33. Rehabtronics. (n.d.). ReTouch Interactive Gaming System for Upper Limb Exercises. Retrieved from https://rehabtronics.com/product/retouch-for-rehabilitation/
34. Tovertafel. (n.d.). Tover Care. Retrieved from https://www.tover.care/us/
35. MySugr. (n.d.). MySugr. Retrieved from https://www.mysugr.com/en-us
36. News Medical Life Sciences. (n.d.). DIDGET Blood Glucose Meter - Plugs into Nintendo DS, from Bayer. Retrieved from https://www.news-medical.net/DIDGET-Blood-Glucose-Meter-Plugs-into-Nintendo-DS-from-Bayer
37. Cheng, C., & Ebrahimi, O. V. (2023). Gamification: A novel approach to mental health promotion. *Current Psychiatry Reports*, *25*(11), 577–586. https://doi.org/10.1007/s11920-023-01453-5
38. Khoshnoodifar, M., Ashouri, A., & Taheri, M. (2023). Effectiveness of gamification in enhancing learning and attitudes: A study of statistics education for health school students. *Journal of Advances in Medical Education & Professionalism*, *11*(4), 230–239. https://doi.org/10.30476/JAMP.2023.98953.1817

39. Ozdamli, F., & Milrich, F. (2023). Positive and negative impacts of gamification on the fitness industry. *European Journal of Investigation in Health, Psychology and Education*, *13*(8), 1411–1422. https://doi.org/10.3390/ejihpe13080103

40. BTS Bioengineering. (n.d.). Medical. Retrieved from https://www.btsbioengineering.com/sectors/medical/

41. Dari Motion. (n.d.). Dari Healthcare. Retrieved from https://darimotion.com/healthcare/

42. Medbridge. (n.d.). Motion Capture. Retrieved from https://www.medbridge.com/care/motion-capture

43. QSense Motion. (n.d.). Rehabilitation & Clinical Gait Analysis with QSense Wearable Motion Sensors. Retrieved from https://qsense-motion.com/motion-tracking-solutions/rehabilitation-motion-sensors/

44. Wade, L., Needham, L., McGuigan, P., & Bilzon, J. (2022). Applications and limitations of current markerless motion capture methods for clinical gait biomechanics. *PeerJ*, *10*, e12995. https://doi.org/10.7717/peerj.12995

45. Pardell, M., Dolgoy, N. D., Bernard, S., Bayless, K., Hirsche, R., Dennett, L., & Tandon, P. (2024). Movement outcomes acquired via markerless motion capture systems compared with marker-based systems for adult patient populations: A scoping review. *Biomechanics*, *4*(4), 618-632. https://doi.org/10.3390/biomechanics4040044

46. Malik, K., & Dua, A. (2025). Advancing Patient Care With Biofeedback. [Updated 2025 Jan 18]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; Available from: https://www.ncbi.nlm.nih.gov/books/NBK553075/

47. Janela, D., Costa, F., Weiss, B., Areias, A. C., Molinos, M., Scheer, J. K., Lains, J., Bento, V., Cohen, S. P., Correia, F. D., & Yanamadala, V. (2023). Effectiveness of biofeedback-assisted asynchronous telerehabilitation in musculoskeletal care: A systematic review. *Digital Health*, *9*, 20552076231176696. https://doi.org/10.1177/20552076231176696

48. Salisu, S., Ruhaiyem, N. I. R., Eisa, T. A. E., Nasser, M., Saeed, F., & Younis, H. A. (2023). Motion capture technologies for ergonomics: A systematic literature review. *Diagnostics (Basel, Switzerland)*, *13*(15), 2593. https://doi.org/10.3390/diagnostics13152593

49. Hellsten, T., Karlsson, J., Shamsuzzaman, M., & Pulkkis, G. (2021). The potential of computer vision-based marker-less human motion analysis for rehabilitation. *Rehabilitation Process and Outcome*, *10*, 11795727211022330. https://doi.org/10.1177/11795727211022330

50. Lam, W.W.T., Tang, Y.M. & Fong, K.N.K. (2023). A systematic review of the applications of markerless motion capture (MMC) technology for clinical measurement in rehabilitation. *J NeuroEngineering Rehabil*, *20*(57). https://doi.org/10.1186/s12984-023-01186-9

51. Wei, L., & Wang, S. J. (2024). Motion tracking of daily living and physical activities in health care: Systematic review from designers' perspective. *JMIR mHealth and uHealth*, *12*, e46282. https://doi.org/10.2196/46282

52. MyoPro. (n.d.). What is a MyoPro Orthosis? Retrieved from https://myopro.com/what-is-a-myopro-orthosis/

53. Barrett. (n.d.). Burt Research Edition. Retrieved from https://barrett.com/burt-research-edition

54. Loutkar Robotics. (n.d.). Our Devices. Retrieved from https://loutkar-robotics.com/en/ortesis-roboticas/

55. EGZO Tech. (n.d.). Meissa OT. Retrieved from https://www.egzotech.com/en/meissa-ot/

56. Bessler, J., Prange-Lasonder, G.B., Schaake, L., Saenz, J.F., Bidard, C., Fassi, I., Valori, M., Lassen, A.B., & Buurke, J. H. (2021). Safety assessment of rehabilitation robots: A review identifying safety skills and current knowledge gaps. *Frontiers in Robotics and AI*, *8*, 602878. https://doi.org/10.3389/frobt.2021.602878

57. Jee Y. S. (2025). Potential issues of future robot-assisted rehabilitation exercises. *Journal of Exercise Rehabilitation*, *21*(1), 1–2. https://doi.org/10.12965/jer.2448714.357

58. Rahman, M.M., Banik, N., Sunny, M.S.H., Zarif, M.I.I., Bedolla-Martinez, D., Schultz, K., Ahamed, S.I., & Rahman, M.H. (2025). Wheelchair-mounted robotic arms: A systematic review of technical design and activities of daily living outcomes. *Disability and Rehabilitation. Assistive Technology*, *20*(7), 2532–2556. https://doi.org/10.1080/17483107.2025.2547042

59. Reicherzer, L., Scheermesser, M., Kläy, A., Duarte, J. E., & Graf, E. S. (2024). Barriers and facilitators to the use of wearable robots as assistive devices: Qualitative study with older adults and physiotherapists. *JMIR Rehabilitation and Assistive Technologies*, *11*, e52676. https://doi.org/10.2196/52676

60. Boardsworth, K., Rashid, U., Olsen, S., Rodriguez-Ramirez, E., Browne, W., Alder, G., & Signal, N. (2025). Upper limb robotic rehabilitation following stroke: A systematic review and meta-analysis investigating efficacy and the influence of device features and program parameters. *Journal of Neuroengineering and Rehabilitation*, *22*(1), 164. https://doi.org/10.1186/s12984-025-01662-4

61. Tseng, K. C., Wang, L., Hsieh, C., & Wong, A. M. (2024). Portable robots for upper-limb rehabilitation after stroke: A systematic review and meta-analysis. *Annals of Medicine*, *56*(1), 2337735. https://doi.org/10.1080/07853890.2024.2337735

62. Hocoma. (n.d.). Andago. Retrieved from https://www.hocoma.com/us/solutions/andago/

63. Hocoma. (n.d.). Lokomat. Retrieved from https://www.hocoma.com/us/solutions/lokomat/

64. Hocoma. (n.d.). Erigo Pro. Retrieved from https://www.hocoma.com/us/solutions/erigo-2/

65. LiteGait. (n.d.). Products. Retrieved from https://litegait.com/products

66. Walk with Path. (n.d.). Path Finder. Retrieved from https://www.walkwithpath.com/products/path-finder-2-0

67. Rehabtronics. (n.d.). Prelivia. Retrieved from https://rehabtronics.com/product/prelivia-protects/

68. Scewo. (n.d.). Scewo Bro. Retrieved from https://www.scewo.com/en/#info

69. Tango Belt. (n.d.). About Tango. Retrieved from https://www.tangobelt.com/about

70. Thijs, L., Voets, E., Wiskerke, E., Nauwelaerts, T., Arys, Y., Haspeslagh, H., Kool, J., Bischof, P., Bauer, C., Lemmens, R., Baumgartner, D., & Verheyden, G. (2021). Technology-supported sitting balance therapy versus usual care in the chronic stage after stroke: A pilot randomized controlled trial. *Journal of Neuroengineering and Rehabilitation*, *18*(1), 120. https://doi.org/10.1186/s12984-021-00910-7

71. Cao, N., Packel, A., Marcy, E., Sprik, K., Harold, E., Xiao, R., & Esquenazi, A. (2021). Implementing robotic-assisted gait training in acute inpatient stroke rehabilitation: A quality improvement initiative. *The Journal of the International Society of Physical and Rehabilitation Medicine*, *4*(4), 168–173. https://doi.org/10.4103/jisprm-000130

72. Hwang, S., & Song, C. S. (2023). Assistive technology involving postural control and gait performance for adults with stroke: A systematic review and meta-analysis. *Healthcare (Basel, Switzerland)*, *11*(15), 2225. https://doi.org/10.3390/healthcare11152225

73. Lyu, T., Yan, K., Lyu, J., Zhao, X., Wang, R., Zhang, C., Liu, M., Xiong, C., Liu, C., & Wei, Y. (2023). Comparative efficacy of gait training for balance outcomes in patients with stroke: A systematic review and network meta-analysis. *Frontiers in Neurology*, *14*, 1093779. https://doi.org/10.3389/fneur.2023.1093779

74. Arntz, A., Weber, F., Handgraaf, M., Lällä, K., Korniloff, K., Murtonen, K. P., Chichaeva, J., Kidritsch, A., Heller, M., Sakellari, E., Athanasopoulou, C., Lagiou, A., Tzonichaki, I., Salinas-Bueno, I., Martínez-Bueso, P., Velasco-Roldán, O., Schulz, R. J., & Grüneberg, C. (2023). Technologies in home-based digital rehabilitation: Scoping review. *JMIR Rehabilitation and Assistive Technologies*, *10*, e43615. https://doi.org/10.2196/43615

75. Ding, D., Morris, L., Novario, G., Fairman, A., Roehrich, K., Foschi Walko, P., & Boateng, J. (2025). Mainstream smart home technology-based intervention to enhance functional independence in individuals with complex physical disabilities: Single-group pre-post feasibility study. *JMIR Rehabilitation and Assistive Technologies*, *12*, e70855. https://doi.org/10.2196/70855

76. Ghorayeb, A., Comber, R., & Gooberman-Hill, R. (2023). Development of a smart home interface with older adults: Multi-method co-design study. *JMIR Aging*, *6*, e44439. https://doi.org/10.2196/44439

77. Morita, P. P., Sahu, K. S., & Oetomo, A. (2023). Health monitoring using smart home technologies: Scoping review. *JMIR mHealth and uHealth*, *11*, e37347. https://doi.org/10.2196/37347

78. Franco, J. B., Maximino, L. P., Barretti Secchi, L. L., Antonelli, B. C., & Blasca, W. Q. (2023). What are the barriers to telerehabilitation in the treatment of musculoskeletal diseases?. *Portuguese Journal of Public Health*, *42*(1), 33–42. https://doi.org/10.1159/000534762

79. Rabanifar, N., Hoseini, M. A., & Abdi, K. (2022). Exploring barriers to implementing telerehabilitation from experiences of managers, policymakers, and providers of rehabilitation services in Iran: A qualitative study. *Medical Journal of the Islamic Republic of Iran*, *36*, 157. https://doi.org/10.47176/mjiri.36.157

80. Gopal, A., Bonanno, V., Block, V. J., & Bove, R. M. (2022). Accessibility to telerehabilitation services for people with multiple sclerosis: Analysis of barriers and limitations. *International Journal of MS Care*, *24*(6), 260–265. https://doi.org/10.7224/1537-2073.2022-002

81. Lange-Drenth, L., Schulz, H., Suck, I., & Bleich, C. (2024). Barriers, facilitators, and requirements for a telerehabilitation aftercare program for patients after occupational injuries: Semistructured interviews with key stakeholders. *JMIR Formative Research*, *8*, e51865. https://doi.org/10.2196/51865

82. Immergo Labs. (n.d.). Platform. Retrieved from https://www.immergolabs.com/platform

83. SafeSpace. (n.d.). About. Retrieved from https://safespacevr.com/

84. CorpusVR. (n.d.). About. Retrieved from https://corpusvr.com/

85. Lorkowski, J., Raulinajtys-Grzybek, M., & Pokorski, M. (2025). Virtual reality-based rehabilitation therapy. *Physiological Research*, *74*(4), 563–569. https://doi.org/10.33549/physiolres.935590

86. Naqvi, W. M., Naqvi, I. W., Mishra, G. V., & Vardhan, V. D. (2024). The future of telerehabilitation: Embracing virtual reality and augmented reality innovations. *The Pan African Medical Journal*, *47*, 157. https://doi.org/10.11604/pamj.2024.47.157.42956

87. Felnhofer, A., Pfannerstill, F., Gänsler, L., Kothgassner, O. D., Humer, E., Büttner, J., & Probst, T. (2025). Barriers to adopting therapeutic virtual reality: The perspective of clinical psychologists and psychotherapists. *Frontiers in Psychiatry*, *16*, 1549090. https://doi.org/10.3389/fpsyt.2025.1549090

88. Georgeson, A. R., Highlander, A., Loiselle, R., Zachary, C., & Jones, D. J. (2020). Engagement in technology-enhanced interventions for children and adolescents: Current status and recommendations for moving forward. *Clinical Psychology Review*, *78*, 101858. https://doi.org/10.1016/j.cpr.2020.101858

89. Akhtar, N., Khan, N., Qayyum, S., Qureshi, M. I., & Hishan, S. S. (2022). Efficacy and pitfalls of digital technologies in healthcare services: A systematic review of two decades. *Frontiers in Public Health*, *10*, 869793. https://doi.org/10.3389/fpubh.2022.869793

90. Borges do Nascimento, I. J., Abdulazeem, H., Vasanthan, L. T., Martinez, E. Z., Zucoloto, M. L., Østengaard, L., Azzopardi-Muscat, N., Zapata, T., & Novillo-Ortiz, D. (2023). Barriers and facilitators to utilizing digital health

technologies by healthcare professionals. *NPJ Digital Medicine*, *6*(1), 161. https://doi.org/10.1038/s41746-023-00899-4

91. Badr, J., Motulsky, A., & Denis, J. (2024). Digital health technologies and inequalities: A scoping review of potential impacts and policy recommendations. *Health Policy, 146*, 105122. https://doi.org/10.1016/j.healthpol.2024.105122.

92. Perle, J. G., Chandran, D. N., Brezler, E., Coleman, M., Deziel, J., Nahhas, P., McDonald, G., & Jent, J. F. (2025). Technology-enhanced practice competencies: scoping review and novel model development. *Frontiers in Digital Health*, *7*, 1571518. https://doi.org/10.3389/fdgth.2025.1571518

93. Lucas Molitor, W., Feldhacker, D.R., Li, Z., Kuhl, N., & Jewell, V.D. (2025). Occupational therapy telehealth interventions across populations from 2019 to 2022: A systematic review. *Am J Occup Ther, 79*(4), 7904205160. doi: https://doi.org/10.5014/ajot.2025.050939

94. McBridge, S., Alexander, G.L., Baernholdt, M., Vugrin, M., & Epstein, B. (2023). Scoping review: Positive and negative impact of technology on clinicians. *Nursing Outlook*, *71*(2), 101918. 10.1016/j.outlook.2023.101918

95. Hoel, V., von Zweck, C., & Ledgerd, R. (2021). Was a global pandemic needed to adopt the use of telehealth in occupational therapy? *WORK: A Journal of Prevention, Assessment & Rehabilitation*, *68*(1), 13-20. https://doi.org/10.3233/WOR-205268

96. Segal, A., & Doyle, N.W. (2023). Evaluating digital skills & environments in OT: A scoping review of standardized measures. *Am J Occup Ther*, *77*(Supplement_2), 7711500039p1. doi: https://doi.org/10.5014/ajot.2023.77S2-PO39

97. Mendonca, R., Burns, S., Schwartz, J., & Smith, R.O. (2022). Inclusive environments: Home, work, public spaces, technology, and specialty environments within occupational therapy practice. *American Journal of Occupational Therapy, 76*(S3), http://dx.doi.org/10.5014/ajot.2022.76S3001

98. Domínguez-Lucio, S., Compañ-Gabucio, L.M., Torres-Collado, L., & de la Hera, M. G. (2023). Occupational therapy interventions using new technologies in children and adolescents with autism spectrum disorder: A scoping review. *J Autism Dev Disord*, *53*, 332–358. https://doi.org/10.1007/s10803-022-05431-3

99. MetLife. (2023). What Is a Letter of Medical Necessity (LMN) and Who May Need One? Retrieved from https://www.metlife.com/stories/benefits/letter-of-medical-necessity/

100. U.S. Department of Labor - Office of Workers' Compensation Programs. (2022). Letters of Medical Necessity. Retrieved from https://www.dol.gov/sites/dolgov/files/OWCP/energy/regs/compliance/Outreach/Outreach_Presentation/lmn_mba06222022.pdf

101. HealthEquity. (2024). Letter of Medical Necessity. Retrieved from https://help.healthequity.com/en/articles/5749543-letter-of-medical-necessity

102. American Occupational Therapy Association. (2025). 2025 Frequently Used CPT® and HCPCS Codes for Occupational Therapy. Retrieved from https://www.aota.org/-/media/corporate/files/advocacy/federal/coding/2025-frequently-used-ot-cpt-and-hcpcs-codes.pdf

103. Centers for Medicare and Medicaid Services. (2025). Healthcare Common Procedure Coding System (HCPCS). Retrieved from https://www.cms.gov/medicare/coding-billing/healthcare-common-procedure-system

104. Washington State Health Care Authority. (2024). Complex Rehabilitation Technology (CRT) Products & Related Services Billing Guide. Retrieved from https://www.hca.wa.gov/assets/billers-and-providers/Complex-rehab-tech-bg-20240401.pdf

105. Centers for Medicare & Medicaid Services. (2024). List of CPT/HCPCS Codes. Retrieved from https://www.cms.gov/medicare/regulations-guidance/physician-self-referral/list-cpt-hcpcs-codes