Rehabilitation for Adults with Traumatic Brain Injury: Where Will We Be Clinically in 2026?

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ABSTRACT

In 10 years, there might be fewer adults who need rehabilitation after traumatic brain injury because of advances in injury prevention and very early treatment. For adults who do need rehabilitation, assessment might include biosensor recordings in their everyday communication contexts, and home practice might be delivered by a robot that can be programmed to mimic target characteristics of human behavior. These advances in science and technology will enhance rehabilitation, but it will always be our responsibility as speech-language pathologists to advocate for our patients and clients and support them in achieving the best possible quality of communication life.

KEYWORDS: Biometrics, bioanalytics, big data rehabilitation, brain injury, robotics future

Learning Outcomes: As a result of this activity, the reader will be able to (1) give an example of a fictional safety foam used in film to prevent traumatic brain injury (TBI) in motor vehicle accidents; (2) describe biometric methods relevant for adults with communication disorders after TBI; (3) identify rehabilitation contexts in which robotics could be helpful to adults with communication disorders after TBI.

It is an honor to contribute to the *Seminars* editorial farewell of my mentor and inspiration, Dr. Audrey Holland. That Audrey would want this last issue to be forward thinking is emblematic of her: she is always thinking years ahead of the rest of us. She also does not like a fuss, so I will go easy on the plaudits and get right to the task.

When I think of the future, I invariably think of the way it is presented in films, so Hollywood movies frame my vision of the future. (It also

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could be subliminal—wishing I could be at the movies instead of working on Saturday.)

DEMOLITION MAN (1993)

There is a scene in the film *Demolition Man* in which Sylvester Stallone (playing John Spartan) has a high-speed motor vehicle crash and the car instantly fills with something called Securefoam. The Securefoam completely immobilizes Spartan and prevents him from sustaining brain or body damage. My dream for 2026 is that Securefoam will be mandatory in cars, on football fields, and anywhere alcohol is consumed. For unpreventable injuries, we will have discovered that progesterone really is an effective neuroprotective agent for people with traumatic brain injury (TBI) (see Schumacher et al for the progesterone clinical trial story).[1] All ambulances will be equipped to administer progesterone at the scene, and patients will have at worst mild impairments in communication. The job of the speech-language pathologist (SLP) will be to coach the person with TBI in metacognitive strategies to address relatively minor challenges in everyday living, which will free up the SLP's time to serve the massive population of adults over age 85, more than 50% of whom will have dementia. Perhaps 10 years is an unrealistic timeline for this vision, so on to plan B.

ED TV (1999)

Readers who are over age 30 might remember the novel concept of video recording someone throughout their day, as was the premise of the film *Ed TV*. Reality television aside, continuous recording of human behavior has made the leap from science fiction to health care, and its transition to rehabilitation is underway. *Bioinformatics*, *biometrics*, *bioanalytics*—these terms all refer to the phenomenon of collecting massive amounts of data to understand human performance. Sensors can be part of wearable devices, like the one that tracks how many steps you take each day, or embedded in your environment, like motion capture systems that provide feedback about your exercise level, motion detectors that detect how often you go outside, audio recording devices that extract prosodic indicators of depression, and video-based face recognition systems. Biometric methods are being used to improve every aspect of health care delivery and utilization.

Take as an example the research by Dr. Misha Pavel and his colleagues at the Consortium on Technology for Proactive Care at Northeastern University. These researchers developed a health coaching platform for seniors in their homes.[2] The platform includes home sensors for temperature, light, and noise; mobile devices for the patient to log food intake; three-dimensional cameras to record the patient's movements around the home; bed sensors that detect movements, heart rate, and respiration during sleep; contact switches for doors; and patient-wearable accelerometers and gyroscopes to track body position in space. Data from these sensors can instantly trigger an ecological momentary assessment about any aspect of the patient's function or a just-in-time adaptive intervention, such as cueing a patient to use a communication strategy or device.

Biometrics have been around for decades—the LENA wearable audio recording system will be familiar to readers—but their use in rehabilitation has been limited by cost, equipment size, and the need for methods to manage enormous amounts of data generated by continuous recording. In the past few years, technology has made quantum leaps in all of these domains, and there are now low-cost, unobtrusive sensors and methods to process big data rapidly, automatically, and in ways that produce intuitively understandable output. A therapist could determine how word finding is related to time of day or environmental distractors, track how much time the patient spends talking to communication partners and the characteristics of that talk, or create a density plot showing the amount of time the patient spends talking in different spaces over a week, to help identify relevant vocabulary for therapy. The possibilities for rehabilitation are endless.

IROBOT (2004)

Hollywood has been fascinated with human–computer communication for decades, immortalized by the 1968 film *2001: A Space Odyssey*, in which the computer develops, for lack of a better term, its (or his) own mind. We are in an era of shrinking health care dollars, short rehabilitation stays, and growing evidence that intensive treatment in the chronic stage may yield less long-term morbidity than using up all insurance funds in the first 90 days after injury. Add in major advances in robotics technology and knowledge about human–computer communication, and it is inevitable that someone would consider using robots in rehabilitation.

My collaborator, Dr. Bilge Mutlu, works to create robots that will help humans. To do this, he conducts fine-grained analyses of human communication behaviors such as gestures,[3] physical distance,[4] and eye gaze,[5] and he uses these data to program robots to be effective partners. I use the term *effective* rather than *naturalistic*, as it turns out that robots that are too natural fall into what is referred to as the *uncanny valley*, a term coined by robotics professor Masahiro Mori in 1970.[6] Mori stated that "climbing toward the goal of making robots appear like a human, our affinity for them increases until we come to a valley."[6(p.98)] Thus, robots cannot be too lifelike or humans will reject them, a particular problem for rehabilitation of communication (versus, say, industrial support). Mori described the human reaction in relation to a prosthetic hand, but the description could apply equally to a communication partner-bot:

> One might say that the prosthetic hand has achieved a degree of resemblance to the human form, perhaps on par with false teeth. However, once we realize that the hand that looked real at first sight is actually artificial, we experience an eerie sensation. For example, we could be startled during a handshake by its limp boneless grip together with its texture and coldness. When this happens, we lose our sense of affinity, and the hand becomes uncanny.[6(p.99)]

As Dr. Mutlu said in a recent webcast,[7] the robots are coming. By 2026, they may be members of the rehabilitation team.

CONCLUSION

Prevention and early treatment of injury, biometrics, robots—all of these may be in our futures, if perhaps not by 2026. Although science and technology will change the landscape of rehabilitation, we as SLPs will ultimately make a difference. The greatest task ahead of us continues to be advocacy for the individuals we serve and our profession as a whole. My sincere hope and wish for 2026 is that rehabilitation of adults with cognitive–communication disorders is less like *The Revenant* (2015)—a painful and often lonely battle—and more like a Pixar film, where differences are celebrated, persistence triumphs, and even the most miserable insurance company representative ultimately shows a heart of gold.

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