Enhancing the Quality of Life and Preserving Independence for Target Needs Populations Through Integration of Assistive Technology Devices


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Abstract

Telehealth Test Bed—Quality of Life Studies is a research study investigating, testing, evaluating, and demonstrating technologies that have the potential to improve the quality of life for target populations, such as warriors in transition, veterans, individuals with physical and mental disabilities, and adults age 65 and older, who may require assistive technology devices to aid in maintaining or improving their quality of life. Thousands of soldiers who fought in Operation Iraqi Freedom and Operation Enduring Freedom have been wounded in action or have sustained injuries from noncombat accidents. Many of these injuries affecting military populations, as well as the general public, have resulted in amputations, traumatic brain injuries, and other physical or mental impairments. Depending on the severity of the injury, assistive technologies may be temporarily needed, or as a long-term solution, to regain and maintain normal daily functions. Saint Francis University’s Center of Excellence for Remote and Medically Under-Served Areas developed an evaluation matrix comparing assistive technologies to identify devices that will improve or maintain the quality of life for these target populations. The integration of telehealth and telerehabilitation applications into patients’ daily lives was examined to help improve home rehabilitation via access to healthcare specialties in rural and medically underserved settings. Researchers identified and tested assistive technology devices to be included in a self-sufficient living environment. The continuation of this research involves recruiting individuals to test and evaluate the functions of these commercially available technologies and to complete data collection surveys and questionnaires. The results are useful in selecting devices that will enhance or extend the quality of life of the target populations.

Key words: technology, military medicine, home health monitoring

Introduction

In the United States today, warriors in transition, veterans, individuals with physical and mental disabilities, and older adults are healthier, living longer, and using technologies to assist in maintaining their independence in society, as well as within their own families. A warrior in transition is a medical hold-over, active-duty medical extension, medical hold, or any other active-duty soldier who requires a medical evaluation board review or has complex medical needs requiring 6 months or more of treatment or rehabilitation.1 It has been estimated that 13.1 million people use assistive technology devices for mobility, communication, and assistance with performing activities of daily living.2 An assistive technology device is defined in the Assistive Technology Act of 1998 as “any item, piece of equipment, or product system, whether acquired commercially, modified, or customized, that is used to increase, maintain, or improve functional capabilities of individuals with disabilities.”3

The U.S. population in 2009 was projected to be 307,006,590 individuals.4 Recent statistics show that there are 9.7 million veterans over the age of 65.5 There are also 54.4 million people currently living with some level of disability6 and an estimated 49.6 million older adults in the United States.7 In 2011, the largest generation in American history, born between 1946 and 1964, the baby boomers, will start to turn 65. By 2050, there will be > 20.5 million people age 85 and above living in the United States, compared with only 2.2 million today.7 To these individuals, “independence” means maintaining private living accommodations, health monitoring, physical and mental regimes, and independently performing activities of daily living.

Providing the delivery of quality and specialized telehealth and telerehabilitation services to a warrior in transition, an older adult, or an individual with a disability can be a demanding process for caregivers. Warriors in transition often face the challenge of grueling rehabilitation and an adaptation to a life that is different from the one they left before their military assignment. The Walter Reed Army Medical Center is 1 of 36 Warrior Transition Units in the United States and has over 2,000 patient visits per month. The types of treatment vary depending on the injury, and the rehabilitation programs can last for up to 1 year. LTC Stephanie Daugherty, Chief of the Occupational Therapy Department at Walter Reed, explains: “The goal is to maximize soldiers’ independence in basic living skills to returning them to their military jobs or transition to civilian life.”8 The injuries that are treated consist of post traumatic stress disorder (PTSD) and poly-trauma, which includes amputation and brain injury. Consider these statistics retrieved in March 2009:

- U.S. troops wounded: - 39,7489
- U.S. troops injured with brain injury: - 27%10
- U.S. troops injured with serious mental health problems: - 33%11

Social isolation, decreased independence, decreased social interaction, and inclement weather can contribute to the decline of an
individual’s physical and mental health and can further compromise the additional services that ensure an individual’s quality of life. Telehealth provides these individuals with access to care in their homes and local communities where possible and appropriate. Increased life expectancy creates a need to explore specialized living environments that promote independence for the target populations without sacrificing comfort.

Recognition of the need to provide accommodations for these individuals, or their caregivers, focuses on the integration of assistive technology devices and practical and successful innovative telehealth applications.

Individuals with disabilities can be monitored by, or receive healthcare through, technologies that enable telemedicine or telehealth applications. The American Telemedicine Association defines telemedicine as the use of medical information exchanged from one site to another via electronic communications to improve patients’ health status. Telehealth is defined as the delivery of health-related services and information via telecommunications technologies and is an expansion of telemedicine. According to Intel Corporation, telehealth is also the use of information and communication technology to deliver health services, expertise, and information over distances. This concept includes Internet or Web-based “e-health” and video-based applications. Telehealth applications can be delivered in real-time (live) or through store-and-forward (record now, view later) mode using a communications network to provide, access, and manage any type of health information or service. Tele-rehabilitation can occur via telephone (including videophone), e-mail (text, graphics, and/or sound), or interactive websites, with robotics or in virtual environments. Tele-rehabilitation, when practiced as a hybrid of synchronous and asynchronous communication, can be augmented by informational web sites, mail/delivery services, and radio/television programming.

Advanced technologies have created new opportunities for the target populations to enhance their living environments and improve their quality of life.

**Materials**

Saint Francis University’s Center of Excellence for Remote and Medically Under-Served Areas (CERMUSA) researchers identified telehealth and telerehabilitation assistive technologies to be evaluated in a comparison study. Areas of focus included technologies for the target populations that were comprised of individuals with disabilities including those with amputations, individuals with traumatic brain injury (TBI), PTSD, and others with speech, sight, hearing, and cognitive disabilities. CERMUSA collaborated with Blueroof Technologies, Inc., located in McKeesport, Pennsylvania. Blueroof develops smart-living facilities that promote self-sufficient, independent living capabilities for the target populations. CERMUSA staff with expertise in telemedicine and telerehabilitation initially tested several technologies for integration into the Blueroof Independence Module (BIM). The BIM, shown in Figure 1, is a 28’×13’6” mobile living environment that has provided CERMUSA with a setting for demonstrating telerehabilitation and telehealth applications that have the potential to enhance or extend the quality of life for the target populations. The BIM exemplified a home adaptable living environment, with assistive devices integrated into the facility, allowing individuals to test and evaluate the devices. These technologies demonstrated additions and modifications that can be added within a living space of targeted populations. The technologies that were integrated into the BIM include the following:

- Biolog Electrocardiogram: measures the electrical activity of the heart and indicates overall rhythm, as well as weaknesses in different parts of the heart muscle
- Pulse Oximetry: a non-invasive method of monitoring the oxygenation of a patient’s hemoglobin
- Spirometry Oximetry: measures lung function, specifically the amount (volume) and/or speed (flow) of air that can be inhaled and exhaled
- Video Gaming for Rehabilitation: activates and motivates eye-hand coordination and increases muscle development and coordination.

**Methods**

Researchers at CERMUSA identified telehealth and telerehabilitation assistive technology devices that could be used by the target populations. The purpose was to perform research on numerous devices that could be used by the study’s target populations. The Internet and the resources of the Institute on Disabilities at Temple University affiliate, Pennsylvania’s Assistive Technology Lending Library, served as research assets. The “Lending Library,” as it is referred to throughout the state of Pennsylvania, is a free public service that loans assistive technology devices to individuals with disabilities. It is available to Pennsylvanians of all ages, with or without disabilities. Research was performed in the eight catalog areas of the library, which maintains an inventory of approximately 3,700 pieces. The categories included the following:

- Communication
- Computer Access
- Control
It was important to know the special needs of the target populations when determining the criteria for the assistive technology devices to be evaluated by CERMUSA staff; they included speech, sight, hearing, and cognitive disabilities. For example, could the device be utilized by individuals with varying special needs such as amputations, TBI, PTSD, or vision/hearing loss? Was the device available to be tested and evaluated, and was it appropriate for the needs of the specific population? It should be noted that staff members viewed many of the items borrowed from Lending Library to be inadequate and inappropriate for individuals over the age of 18. According to Lending Library personnel, it is not uncommon for an individual who has recently acquired a disability to physically or cognitively regress, making fundamental device choices appropriate for their rehabilitation. Many technologies available for testing and evaluation were large, bulky, colorful, and noisy devices that were designed for a much younger audience.

Researchers identified 65 devices to be evaluated from both electronic sources and the Lending Library. As previously mentioned, the areas of focus included technologies for individuals with physical and mental disabilities, including amputees and individuals with TBI and/or PTSD. The devices were selected after extensive examination and review of product literature and ascertaining how the equipment will help the individual. For devices not available within the Lending Library, CERMUSA contacted the assistive technology companies and requested a loan of the selected technologies for evaluation. Most of the companies contacted did not want to lend their devices for evaluation. The majority of companies requested either leasing or purchase of the device. This requirement restricted ability to evaluate greater number of devices with similar attributes and like company devices. The majority of companies requested a loan of the selected technologies for evaluation. Most of the companies contacted did not want to lend their device for evaluation. The majority of companies requested either leasing or purchase of the device. This requirement restricted ability to evaluate greater number of devices with similar attributes and like applications. Of the assistive technology devices researched and evaluated, the following 10 were selected for inclusion into the study:

1. DynaVox V—DynaVox Mayer-Johnson
   Application: Augmentative and alternative communication including Windows XP computer, Internet access, e-mail, and text messaging
2. LifeVest—VivoMetrics, Inc.
   Application: Non-invasive continuous ambulatory monitoring
3. mPower—Dakim, Inc.
   Application: Cognitive learning system and specialized computer games designed to help fight and prevent dementia and Alzheimer’s disease
   Application: Portable 4-inch viewing screen with digital magnification
5. Pen Elite—WizCom Technologies, Inc.
   Application: Collects notes electronically from printed text
6. SmartTalk—Freedom Scientific
   Application: A full-featured talking Windows XP computer
7. SmartView—Humanware
   Application: Compact handheld vision magnifier
8. Turtle 400—Visual Telecommunications Network, Inc.
   Application: A self-contained computer and touch screen monitor supporting commercial-off-the-shelf medical devices for telemedicine
9. Vivo Responder Belt—VivoMetrics, Inc.
   Application: Noninvasive continuous ambulatory monitoring
10. Wii—Nintendo of America, Inc.
   Application: Interactive gaming for rehabilitation using intuitive motion.

**Factors Weight**

- Did the device have a telehealth or telerehabilitation feature? 5
- Was the device easy to use? 4
- Did it meet the need of the individual? 5
Using the evaluation matrix shown in Table 1, the technology and the application for maintaining or improving the quality of life of the target populations were measured. The collection of opinions and results from in-house surveys were obtained from caregivers and people with healthcare backgrounds that are familiar with assistive technology. Their input was valuable in assigning the weight to each factor. No patients of caregivers provided input, because they were not consulted. Through this collaborative method, the gathering of information was collected for each device and was taken into consideration when developing the final factors to design the matrix.

The lack of literature on matrices evaluating assistive technology devices prompted researchers to develop a benchmark range of numbers of >100, assigning each device a number based on its value to the consumer. This number then qualified the final eight technologies for public evaluation (Table 2). Staff ranked the importance of each factor on a scale of 1–10, 10 having the highest weight and 1 the lowest. Each factor was given a numeric weight of 1–5, with 5 having the highest weight and 1 the lowest. Each of the eight factors was then multiplied (×) by the amount of weight assigned in the corresponding column. The total number of each column was added. The total score of >100 was the standard for inclusion in a self-sufficient, independent living environment (W×F = Value Index).

Table 1. Validation Strategy Matrix

<table>
<thead>
<tr>
<th>FACTOR</th>
<th>“TELE” ASPECT</th>
<th>EASE OF USE</th>
<th>MEET NEEDS OF TARGET POPULATION</th>
<th>PORTABILITY</th>
<th>STABILITY</th>
<th>COST-EFFECTIVE</th>
<th>ADAPTABILITY WITH OTHER TECHNOLOGIES</th>
<th>INSURANCE RECOGNIZED</th>
<th>VALUE INDEX</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technology:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. DynaVox V—DynaVox</td>
<td>9</td>
<td>7</td>
<td>5</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>6</td>
<td>6</td>
<td>174</td>
</tr>
<tr>
<td>2. LifeShirt—Vivometrics</td>
<td>7</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>1</td>
<td>126</td>
<td></td>
</tr>
<tr>
<td>3. mPower—Dakim</td>
<td>4</td>
<td>7</td>
<td>4</td>
<td>2</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td>5</td>
<td>114</td>
</tr>
<tr>
<td>4. Nemo Magni—Universal Low Vision Aids, Inc.</td>
<td>0</td>
<td>9</td>
<td>2</td>
<td>8</td>
<td>4</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>104</td>
</tr>
<tr>
<td>5. Pen Elite—WizCom Tech</td>
<td>0</td>
<td>6</td>
<td>2</td>
<td>8</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>89</td>
</tr>
<tr>
<td>6. SmartTalk—Freedom Scientific</td>
<td>8</td>
<td>5</td>
<td>4</td>
<td>8</td>
<td>4</td>
<td>3</td>
<td>6</td>
<td>2</td>
<td>153</td>
</tr>
<tr>
<td>7. SmartView—Humanware</td>
<td>0</td>
<td>7</td>
<td>2</td>
<td>8</td>
<td>4</td>
<td>4</td>
<td>1</td>
<td>2</td>
<td>99</td>
</tr>
<tr>
<td>8. Turtle 400—ViTelNet</td>
<td>8</td>
<td>5</td>
<td>5</td>
<td>2</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>122</td>
</tr>
<tr>
<td>9. VivoResponder Belt—Vivometrics</td>
<td>7</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>2</td>
<td>4</td>
<td>2</td>
<td>106</td>
</tr>
<tr>
<td>10. Wii—Nintendo Weight</td>
<td>8</td>
<td>7</td>
<td>5</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>8</td>
<td>3</td>
<td>166</td>
</tr>
<tr>
<td>Weight</td>
<td>5</td>
<td>4</td>
<td>5</td>
<td>3</td>
<td>4</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

Key: W×F = Value Index, where W is weight and F is factor.

Table 2. Technologies Accepted Against the Evaluation Matrix

<table>
<thead>
<tr>
<th>TECHNOLOGY USE</th>
<th>TECHNOLOGY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Augmentative and alternative communication</td>
<td>DynaVox V—DynaVox</td>
</tr>
<tr>
<td>Respiratory and cardiopulmonary monitoring</td>
<td>LifeShirt—Vivometrics</td>
</tr>
<tr>
<td>Cognitive fitness</td>
<td>mPower—Dakim</td>
</tr>
<tr>
<td>Pocket-sized digital magnifier</td>
<td>Nemo Magni—Universal Aids, Inc.</td>
</tr>
<tr>
<td>Small personal computer for visually impaired</td>
<td>SmartTalk—Freedom Scientific</td>
</tr>
<tr>
<td>Vital Sign monitoring unit</td>
<td>Turtle 400—ViTelNet</td>
</tr>
<tr>
<td>Compact, continuous life-sign monitoring system</td>
<td>VivoResponder Belt—Vivometrics</td>
</tr>
<tr>
<td>Video gaming for cognitive fitness</td>
<td>Wii—Nintendo</td>
</tr>
</tbody>
</table>
At the time of evaluation, five of the selected eight technologies, DynaVox V, Nemo Magi, Smart Talk, Turtle 400, and Wii, were available to the attendees of CERMUSA's Assistive Technology Exposition. Before the exposition, Saint Francis University's IRB had determined this was an exempt study. Two hundred seventy-two surveys were completed by members of the target populations, their caregivers, and those in clinical practices or in an educational setting preparing to enter the clinical practice. The surveys included both technologic and demographic questions. Survey results were then compared against the calculated value index tabulation. This comparison validated the initial matrix evaluation completed by staff members. A sample statistical tabulation of surveys illustrated 94% of individuals believe that the devices were easy to use, n = 256; and 53% thought the devices meet their need, n = 144. Sixty-eight (68%) would pay the cost of the devices, n = 185. For individuals 51 years of age through 64 years of age, 69% would not need assistance to use the devices, n = 187.

The outcomes of these methods of collecting data will be useful in selecting which devices could develop or broaden the quality of life of a special needs population.

**Discussion**

Innovative research is needed to develop the best combination of wellness, special needs education, and technologies that assist or maintain the preferred quality of life for transitioning warriors, older adults, and individuals with disabilities. The number of older adults in the United States is likely to double over the next two decades, and many of those individuals will be retired military personnel. Many soldiers returning from Operation Enduring Freedom and Operation Iraqi Freedom have suffered injuries that have resulted in permanent disabilities, potentially requiring life-long care. This creates an economic and social crisis; America struggles to care for these individuals as they develop, or continue to live with, disabilities. Continued research, evaluation, and integration of qualifying technologies into individual housing and healthcare living environments for these target populations is needed. A loss of independence can be very frustrating for the person experiencing the loss, as well as for their caregiver(s). Fortunately, there are many devices and technologies that can be utilized by both these individuals and their caregivers.

The development of an independent living environment capable of providing a setting that allows the individual to maintain or improve their quality of life can offer alternative living accommodations for warriors in transition, individuals with disabilities, and older adults. Future healthcare technologies should be cost effective, portable, unobtrusive, noninvasive, and sustainable to ensure that the target populations will adapt to them. This study does not satisfy all the requirements necessary to meet every individual’s special need. The objective was to develop an evaluation matrix that demonstrates the correlation between an assistive technology device and the need of the individual. This method will allow the end user of the device to better determine what devices will satisfy their need and the requirements for maintaining or improving their independence.

Over the course of the study, researchers found that there was an abundance of assistive technologies available for the target populations. Several devices were not easily accessible for research evaluation or for consumer testing; many of the companies required either a physician referral or a lease agreement to be executed. Some devices required purchase, and this was not cost effective for these researchers. Age and disability appropriate devices were also difficult to access.

Technology can be vital to a person’s well-being, particularly when new tools facilitate communication, lifelong learning, maintenance of health, and the ability to continue living independently. By using new and innovative technologies to enhance living environments, the quality of life for warriors in transition, older adults, and individuals with disabilities can be maintained or improved.

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**Disclosure Statement**

No competing financial interests exist.

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