

1

Technology for Successful Aging and Disabilities

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Although technology acceptance or rejection is dependent on a combination of several factors, it is not possible to accurately weigh these factors to determine the highest predictor for acceptance or rejection of an assistive technology (AT) device. Optimal use of AT devices depends on a combination of variables, including personal and environmental factors, the device in itself, the service delivery factor, and the social factor. Usability of the devices also depends on the training that the user receives. Inadequacy in training may lead to unfamiliarity with the use of the device, which in turn may result in restricted use or nonuse of the device. Three types of acceptances related to AT can be described as reluctant acceptance, grateful acceptance, and internal acceptance. *Reluctant acceptance* occurs when the individual is accepting the device only as a “necessity” or a medium for completing activities of daily living (ADL). In *grateful acceptance*, the device is viewed as a part of life and considered as one of the “assets.” With this type of acceptance, AT is a medium for overcoming functional deficits occurring as a result of the disability. *Internal acceptance* is the highest category among the levels of acceptance of AT devices, where individuals view the devices as a part of themselves. The AT device in this case is considered by users as a medium for overcoming their physical impairments and a replacement for the impaired part of their bodies [1].

The acceptance or rejection of AT devices in turn is affected by several factors. These factors have a strong common component, namely, the temporal effect. The temporal component influences the usability of a device. The usability, nonusability, or both, of a device, is determined by a dynamic relationship between several variables including

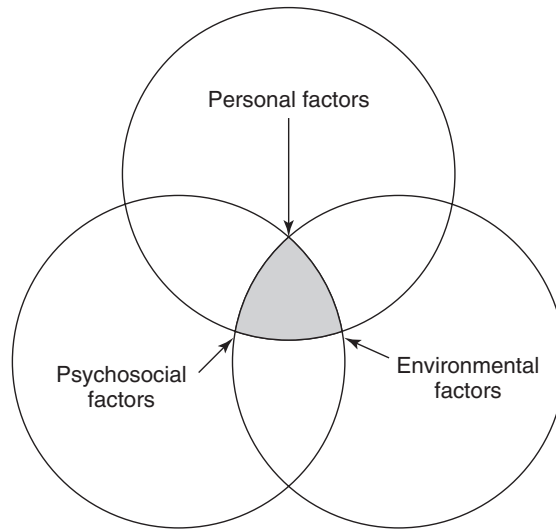


FIGURE 1.1 Interaction between different factors for acceptance of AT devices.

personal, environmental, psychosocial, and economical factors. The interaction between these factors continually changes across the time domain, which directly affects acceptance/rejection of AT device (Fig. 1.1).

Another factor that increases the usability of an AT device is the perception about the advantages and disadvantages of the AT devices. If the (perceived) benefits outweigh the (perceived) disadvantages, then, there are higher chances of that device to be utilized. On the contrary, if the (perceived) disadvantages outweigh the (perceived) benefits of the device, there are higher chances that the device will not be used.

Personal factors, including motivation, cooperation, optimism, good coping skills, and the ability to learn or adapt to new skills, work in a combination for the user [2]. In the older population, all the abovementioned factors diminish gradually. Therefore, acceptance of AT devices can be a challenge in this population, which, in turn, may result in suboptimal use of AT devices for functional independence.

A review article [3] indicated a relationship between (1) the type and degree of impairment and the severity of illness and (2) the use of AT devices. A variation in the number of AT devices used was observed in people with varying disorders within the aging population. The overall trend indicated a positive relationship between the severity of disorders and the number of AT devices used by the older people [3]. The usability of AT devices also depends on environmental accessibility. The presence of environmental barriers can limit acceptance of the devices. For instance, consider an elderly individual, living in a two-story house, who has been prescribed a power wheelchair for functional mobility. There is a ramp to enter the house. The second floor, where the individual spends most of his time during a day, however, is not accessible. In this situation, the use of the power wheelchair inside the house will be limited by the presence of an environmental barrier. Acceptance of AT in older adults is also determined to a large extent by views of society. An example of this is the higher acceptability of home modifications, such as grab bars in the bathroom and a high-rise commode; than that of a mobility device

such as a cane or a walker. The latter are considered to be indicative of a significant disability [4].

1.1 INADEQUATE TRAINING

The Department of Health and Human Services (HHS) mentioned inadequate training of use of AT for elderly population as one of the significant barriers in decreasing usability of the devices [5]. In acute-care settings such as hospitals, the reduced length of stay limits the time availability for occupational/physical therapist to provide adequate education about the use of AT devices during discharge. This results in elderly individuals going home with different types of AT devices, but having limited knowledge regarding the use and maintenance information about these devices. Ineffective follow-up care after discharge from hospitals also results in hesitance to use AT devices at home, causing rejection or abandonment of the devices. Lack of standardization across various settings specialized in prescription of AT, and the variable training time allocated and emphasized across different settings, also leads to inconsistent levels of acceptance. Evidence is pointing at the benefits of providing training of AT in improving effectiveness of use and in prevention of primary and secondary injuries associated with inappropriate use. However, the existing research focuses primarily on effectiveness of training for operating manual wheelchairs. Also, very few studies related to aging and AT mentioned training as an important component for improving acceptance of use of the devices. Chiu and Man [6] indicated greater improvement in the functional independence, higher satisfaction with the AT devices as well as a higher usage of AT devices, among the elderly individuals who received a home based training program after getting discharge from the hospital, as compared to other groups of elderly individuals who did not receive home based training program [6].

Following are some of the guidelines that can be helpful in providing training for older individuals regarding use of AT devices:

1. *Client and Family Involvement.* Along with client involvement in selection and finalizing AT devices, an immediate family member's involvement is also beneficial. This could be effective with elderly people being discharged from hospitals or skilled nursing facilities and returning home, where the device will be used. A smooth transition from hospital to home could be facilitated by involvement of one or more family members.
2. *Follow-Up Care.* Status of elderly people after being discharged from the care setting and receiving the device from a specialized clinic is not monitored effectively. If communication is maintained between providers and consumers, with responses to questions about the use of AT for specific purposes within the home environment, it could provide the encouragement required for continuing the use of AT devices.
3. *Instructions and Training in Context of Use.* Elderly individuals usually receive training in use of AT devices in an environment completely different from the environment where the devices will be used. Transference of skills from one environment to the other sometimes is not very efficient, resulting in increased level of frustration and ultimately to nonuse of the device. On the contrary, if

emphasis is placed from the start on transferring skills and cross-training for all environments, transition of AT use will be more effective.

1.2 TECHNOLOGY REJECTION

Technology abandonment has been a critical issue that has a negative impact on the user's daily living and also on the clinical practice. Because of the intricate nature of the prescription procedure, the cost could accumulate; thus premature rejection of the prescribed AT devices could be an expensive business for the healthcare services. Phillips and Zhao [7] raised this issue for the first time in their descriptive article about factors related to rejection of AT. The study indicated that a change in the needs of people was the most important factor. The easier it was to obtain an AT device, the greater was the likelihood that it would be rejected. The higher was the performance of an AT device, the lower was the rejection rate. If the users' opinions were considered in the AT service delivery process, there were higher rates of device retention.

1.3 IMPROVING MATCH BETWEEN PERSON, ASSISTIVE TECHNOLOGY, AND ENVIRONMENT

Several factors need to be considered prior to prescription of the AT device, with some of the more important ones listed below:

- Inclusion of end users in design, feature selection, and evaluation process of AT devices.
- Sharing information between providers and clients, and taking feedback for determining match between users and AT.
- In the event that client is not satisfied with original loaner equipment, provision for replacement with newer equipment. This process can reduce wastage of human and system resources if a client is not willing to use a particular type of prescribed AT device.
- Consideration of time factor—effective use of AT device could be a time-consuming procedure, which needs to include all factors where an AT device will be used. Also, this process must be adapted by the user in the psychosocial environment where it will be used.

1.4 TECHNOLOGY FITTING

When providing a mobility device, it is essential to conduct a careful and methodical evaluation of a potential mobility user with clinical input from trained professionals. An assistive technology practitioner (ATP) should consider several steps before providing an AT device. The matching person–technology (MPT) assessment process is one means for providing a more personal approach to matching person and technology. The MPT components include the environments in which the person uses the technology, the individual's characteristics and preferences, and the functions and features of the technology.

Characteristics within these three components can each influence technology use either positively or negatively. If there are too many negative influences, the chances of the technology being successfully used are greatly reduced. In fact, the technology itself can appear perfect for a given need, but if the user does not possess the appropriate personal characteristics or does not receive the needed support, that perfect technology may go unused or may be used inappropriately. The steps in a successful MPT assessment are as follows:

1. *Client Evaluation.* The nature and progression of the disease should be well understood and considered. Joint range of motion, especially at the hips and knees, as well as pelvic and spinal alignment, will determine the proper configuration and postural supports of an AT device. Sensory and central processing skills should also be evaluated. The risk for and presence of skin breakdown needs to be considered, for example, for proper seat cushion selection. Each cushion has advantages and disadvantages that need to be carefully considered. Pressure mapping is typically used as part of the routine screening or evaluation procedure to determine whether individuals are at risk of developing pressure sores. Pressure mapping (Fig. 1.2) is often used for relative comparison between different types of cushions and wheelchair setups to assist in the selection of such equipment. They are also useful as biofeedback to the individual regarding weight shift and pressure relief abilities and strategies [8]. Inappropriate seat cushion provision can lead to costly and fatal pressure sores as well as affect the user's postural alignment and ability to transfer in and out of the chair [9]. Features such as tilt-in-space and backward-reclining systems need to be considered for people who cannot physically adjust or reposition to reduce the potential for postural deformities, discomfort, and skin breakdown [10]. When considering manual wheelchair propulsion, an ATP should also consider the stress being applied to the upper extremities, which has been associated with upper-extremity repetitive strain injuries [11]. An external



FIGURE 1.2 Pressure-mapping assessment.



FIGURE 1.3 A SmartWheel.

device called SmartWheel (Fig. 1.3) had been introduced in a clinical setting to measure forces at the wheelchair during wheelchair propulsion. A SmartWheel is an instrument that can be easily attached to most standard manual wheelchairs [12]. *Simulation* is an assessment process in which the AT team observes the dynamic interaction between the client and the AT equipment.

2. *Driving Abilities.* The appropriate mobility device needed, whether a manual wheelchair, a scooter, or a power wheelchair, needs careful evaluation. For example, a power wheelchair—a heavy piece of equipment capable of reaching high speeds—can cause serious damage, injury, and even death in a collision. Therefore, the ATP must carefully assess a candidate's ability to operate the equipment, especially when the candidate has cognitive or perceptual deficits. People with these deficits should not necessarily be prohibited from the use of a power wheelchair; however, they may require training to learn to operate the device.
3. *Environmental Accessibility Evaluation.* A home-and-work assessment is often needed to ensure that the device will be compatible. Few power wheelchairs can be carried upstairs, or through narrow doorways, or made to negotiate tight turns in a hallway or bathroom. A proper assessment involves taking the device to the user's home, surveying the environment for accessibility, and having the potential user get into the device and drive it where needed within the course of a routine day. The home assessment should also involve having the candidate complete specific tasks. This includes transferring to various surfaces, reaching for objects, cooking, pulling up to a table or work surfaces, and completing any other important activity.
4. *Transportation Accessibility Evaluation.* The physical capabilities of the person to manage the device must be considered. For example if a power wheelchair or scooter must be transported, the person who will be conducting the task should have an opportunity to stow the device to verify that the operation is feasible. A consumer who will use an accessible vehicle, such as a van with a lift or ramp,

will need to drive the device into the vehicle, maneuver it into an appropriate position for securement or transfer to another seat, and then exit the vehicle. It is crucial to consider a device that has the appropriate attachment points to ensure optimal safety during transportation [13].

1.4.1 Client Training and Equipment Delivery Model

Equipment delivery must include careful attention to final adjustment and to proper training in the equipment's safe and effective use. Even though the equipment was previously specified in detail, it is important for the ATP to be present during the final fitting to verify that the seating goals and objectives have been achieved. ATP help is important to make prescriptive decisions during the fine-tuning of the adjustable components [14].

During the final fitting, training and delivery of the equipment should be done. The client must be properly trained in the use of the equipment. This training should include instruction in proper sitting, postural adjustment, weight shift, propulsion, chair maneuverability, transfers, soft-tissue protection procedures, vehicular transportation of the equipment, and operation of all components of the equipment [14].

1.4.2 Client Follow-Up

Delivery of the equipment is not the end of the process. Assessment of the effectiveness of the equipment should continue throughout the duration of use. The frequency and extent of the follow-up visits should be determined according to each client's needs [14]. To accomplish a thorough follow-up assessment, the team should review the seating (or equipment) goals and objectives, as well as the prescriptive approaches that were recorded during the client's prior assessment. With that information in mind, the team should screen the client's needs, identifying any changes or additions that would effect a change in the client's equipment. Any changes in the client's abilities or demands on the social or physical environment should be reassessed [14].

1.5 DEVELOPMENT AND TECHNOLOGY TRANSFER

1.5.1 Participatory Action Design (PAD)

The PAD model describes a process of developing products (AT product) in this instance. The process starts with identification of users' needs. There are several ways of doing this: through focus groups, with an open-ended discussion moderated by a person from a design team, getting feedback from users through surveys and questionnaires about specific requirements and possible solutions. All of this information is put together, which will help in identifying various features of conceptual products. These data are also helpful in comparing two options of a product feature, and determine advantages or disadvantages of each. The next step includes development of a mock-up system, where all these features are incorporated together, to have a product design. All the features of the product, are then compared to benchmarks available, ensuring that the designed feature are at par with the industry standard. However, since all this is done on paper or in a computer-aided design (CAD) system, actual performance cannot be measured until the next step. The prototype is built up after this step, and it includes

all the features discussed above. After this, a comparison is made with the standards for the product. Product efficacy is usually determined by doing a durability–reliability testing of the product. Standards, which will be discussed in greater depth in the next section, can be used to determine the level of durability of the developed product. Durability testing typically determines the ability of individual components of a particular device to withstand repeated use by the end user. Following incorporation of the changes as suggested by the efficacy testing, the product is submitted for the Food and Drug Administration (FDA) approval process. The FDA approval process is an extensive procedure, with the main emphasis on ensuring safety to the end users. Unfortunately, with AT devices very few, especially mobility-related, products undergo the FDA approval process. The clinical effectiveness of AT devices could be established in several phases. Typically, four phases of testing are involved to determine clinical effectiveness: (1) conducting a focus group of clinicians, end users, and manufacturers, who provide feedback on benefits and disadvantages of that product; (2) testing the product using an unimpaired population; (3) using case studies, where a small number of (potential) end users are tested on the device, as the outcomes for determining clinical effectiveness could include physical capacity measure and or functional performance measure; and (4) testing a large group of potential end users, for generalization to the entire population who will eventually be using the device. The most intricate step in this entire process is establishing insurance coverage for a particular product. This involves either formulation of a common code for the device and establishing a fee schedule for the device (Fig. 1.4).

PAD is the form of research design that accounts for the needs and opinions of the end users and tries to implement that in designing of a product. Several features of a PAD are

- Consideration of end users as partners right from the beginning of the design process
- Feedback at all stages of development, which can lead to constant modification of the desired product
- Problem breakups in small parts, starting to find solutions for a smaller problem and working the way upward (i.e., bottom–up approach to problem solution)

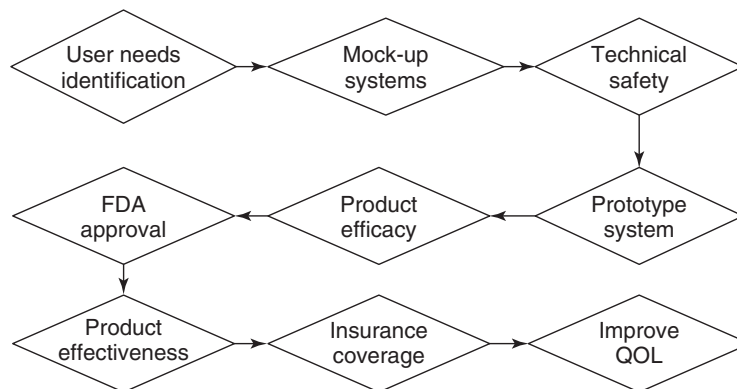


FIGURE 1.4 Participatory action design model (QOL — quality of life).

1.5.2 Quality Assurance

As mentioned above standards are those benchmarks against which a product or a service could be compared. Standards are also useful for determining durability of a product and comparing several products available on the market, so as to prescribe the most durable, reliable, and cost-effective AT device to consumers. Unlike that of the body implant industry, where standards are the crucial prerequisite for FDA approval, AT devices do not mandate meeting a minimal-standards requirement prior to prescription. The scenario is changing, with the wheelchair industry following standards testing for determining quality of their product. In 1979 the American National Standard Institute (ANSI), together with the Rehabilitation Engineering Society of North America (RESNA), formulated testing standards for wheelchairs, commonly known today as *ANSI/RESNA standards*. The standards are applicable to all forms of wheelchairs—manual, power, and scooters—with some differences, which depend on the feature that has to be tested. These standards are developed and continuously refined by the workgroups, who change their parameters according to constant shifts in the manufacturing quality and user requirements. There are several sections of standards for wheelchair performance testing; one of the most critical standards is the durability test. The durability performance test, which is also known as the *fatigue strength test*, determines the average life of a wheelchair under certain testing conditions and generalizes this to the end user's daily use of the wheelchair. The durability test has two separate components: the double-drum test and the curb drop test (Figs. 1.5 and 1.6):

The double-drum test needs to be conducted before the curb drop test. In the former, a 100-kg dummy is placed on a chair, which is set up on two drums, with drive wheels placed on one drum and castors on the other drum. The speed of rear drum is 1 m/s, which is set 5–7% slower than the front drums. The purpose of this test is to simulate the commonly encountered road hazards by a wheelchair user. The standard for this testing indicates a value of 200,000 cycles, which is the minimum requirement for the wheelchairs to pass the test, without any major mechanical failure. The curb drop test

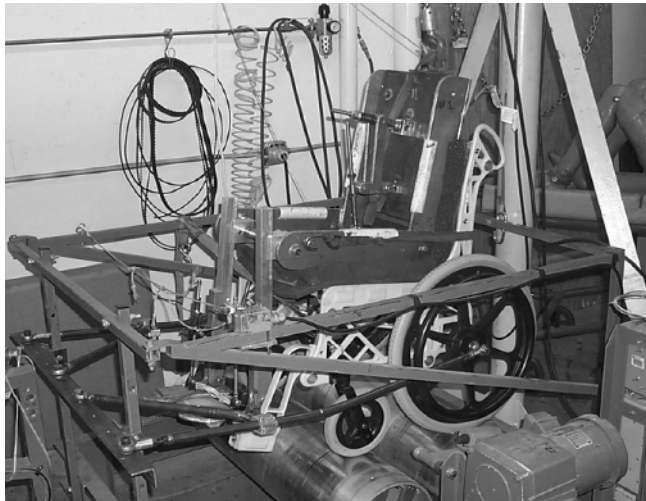


FIGURE 1.5 Double-drum testing.

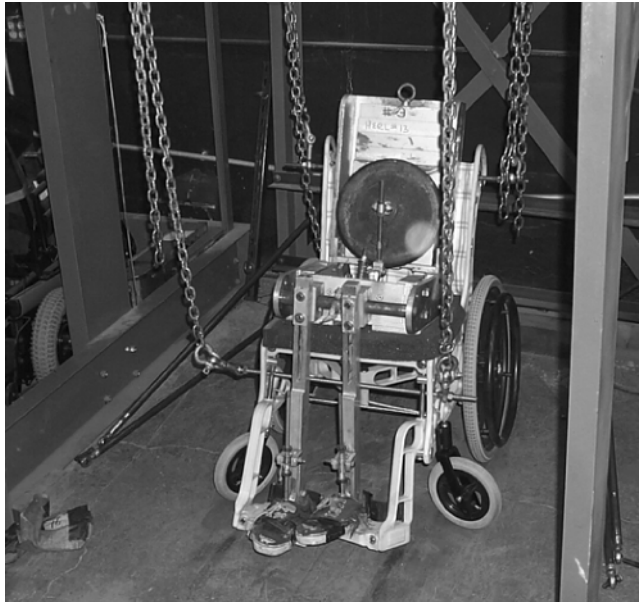


FIGURE 1.6 Curb drop testing.

is designed to simulate traversal over uneven terrains, especially going up and down small curbs. A 100-kg dummy is set on the wheelchair, which is lifted 5 cm above ground level and then dropped. This is repeated until there is any major failure of the system. The ANSI/RESNA standards for this test are 6666 drops. The numbers selected for the fatigue strength test, typically represents a 3–5 years of functioning life for a wheelchair.

These standards could be utilized in several possible ways to improve quality of the AT device itself and deliver services to consumers:

- *Ensuring Safety.* These tests mimic the performance tests conducted in the automobile industry, with a purpose of providing quality products to consumers.
- *Product Comparisons.* The standards could be utilized in comparing the products for providing the best available care to consumers. Pearlman et al. [15] compared product efficiency of three types of power wheelchairs with Medicare codes: K0010 (nonprogrammable), K0011 (programmable), and K0014 (programmable with customized seating). The study found that determination of the cumulative survival level, which was based on the fatigue strength tests using ANSI/RESNA standards, was significantly higher for the K0011 and K0014 chairs than for the K0010 ones. The study suggested prescription of more durable wheelchairs despite higher cost upfront, to have longer life expectancy, which can ultimately ensure greater patient safety [15].
- *Cost Analysis.* Although this could be done in a very crude form, the cost efficiency of a particular product could be determined by comparing the life expectancy of the product and cost.

1.5.3 Total Quality Management (TQM) and Continuous Quality Improvement (CQI)

The commonly used lingo in the management field emphasizes TQM and CQI, for any industry related to providing services. *Total quality management* is defined as a process of constant accomplishment of clients' satisfaction through a continuous improvement (in quality of products and services). *Continuous quality improvement*, on the other hand, is a constantly changing process for adapting to newer demands and needs of the end users and bring changes in the product and/or service delivery in order to establish a TQM. The CQI process is very crucial for maintaining and improving optimal use of AT devices by an end user and also prevents premature abandonment. Several steps are involved in this process (see Fig. 1.7).

Several other recommendations suggested in the literature could be applicable for ensuring TQM and CQI in the AT devices prescription–delivery process:

1. *Client Needs and Values.* The process should be customized according to clients' needs and values. With client as a source of control, the process should account for the clients' needs and requirements. This will enforce creativity for clinicians to provide AT to clients, and bring in new designs and solutions. Clinicians should also have the expertise for anticipating future needs of clients and consider them before making a final choice. For example, in progressive diseases, clients may not be able to foresee their future needs. In this situation, clinicians may need to factor in those aspects.
2. *Communication.* This is key to maintaining quality. The communication should be between client, clinicians, engineers, and manufacturers. In the communication process, there should be sharing of knowledge among the team, which will help the client make decisions and ensure quality. The system should be transparent, allowing sharing of all advantages and hazards associated with a particular product that will help the client make an informed decision. With an aging population, denial of disability could be a potential barrier for acceptance of technology. Open dialogues within the team may help people understand their limitations and make appropriate decisions.

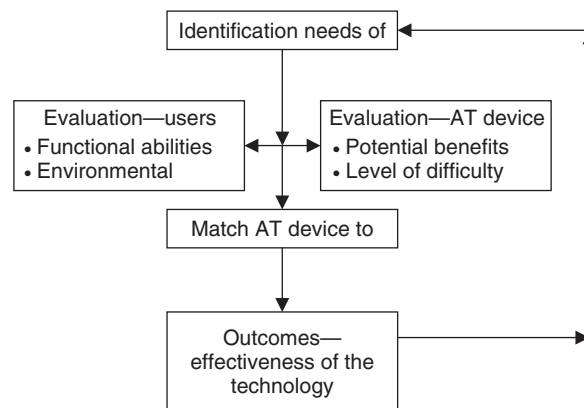


FIGURE 1.7 CQI model for AT device delivery process (adapted from Ref. 12).

3. *Evidence as a Basis for All Decisionmaking Processes.* With vast availability of free information on the Internet, there could be mixed evidence about a particular technology. Clinicians need to act as a filtering mechanism, accepting best available evidence and discarding falsifying statements about a product. Clinicians also need to learn to make best use of available evidence for all decisionmaking processes and also push for new evidence for bringing quality of care up continuously.
4. *Client Safety.* This should be the priority of providing any form of healthcare, including AT devices. Analyses of the entire system should be conducted regularly to prevent occurrence of systematic and/or random errors. Again, clinicians and others involved in the AT delivery process should be accountable for acceptance of mistakes and encourage free discussion of the same for prevention in the long run.

1.6 SERVICE DELIVERY MODELS

There is a basic process for delivery of services to the client, and several steps are involved in this process [2]. The first step is referral and intake. The client or a close relative or friend or a healthcare professional will have identified the need for AT and will contact an ATP to make a referral. The service provider gathers basic information and determines whether there is a match between the type of services he or she provides and the identified needs of the client.

Once the criteria for intake have been met, the evaluation phase begins. A more detailed specification of the client's AT needs is determined. Following a thorough identification of the client's needs, the client sensory, physical, and central processing skills are evaluated. Understanding the disease process and prognosis and the client's current skill level are also identified. These are the gaps between abilities and goals that AT devices are supposed to fill. At this stage, the ATP will review the evidence-based practice literature and will bring her or his own expertise to narrowing the number of devices that will be discussed with the client. Next, advantages and disadvantages of the AT devices will be clearly explained to the client. The client's opinion is essential in the AT selection process [16]. The client knows his or her assets, needs, and limitation and is the best individual to make the final selection. Therefore, technologies that match the needs and skills of the client are identified, and a trial evaluation is performed. At this point, a home evaluation should be performed if there is a need. If the AT is fulfilling the client's goal and his/her environment, the AT should be ordered, and a letter stating the medical necessity should be written. This medical necessity letter should describe the client's current condition, level of function, daily living situation, and equipment features, including advantages and cost benefits of the equipment. The medical necessity letter must justify the importance and benefit of the AT device to purchasing agencies. The ATP should be aware of funding sources available to the client. Although funding is important, the results of the AT evaluation should be based first on the client's need and second on the funding.

When funding is secured, the client proceeds with intervention in the implementation phase. In this phase, the equipment that has been recommended, ordered, modified, and/or set up is delivered to the client. Initial training on the basic operation of the device and ongoing training strategies for using the device are also performed at this stage. After the AT device has been delivered, the AT provider should periodically reevaluate the degree

of integration of the initial device into the user's life. The client should be able to use her/his available skills to achieve the desired goals within the immediate environment with the AT device chosen. It is also important to update the AT device to a more appropriate system when needed by the user if improved products appear in the marketplace.

The AT delivery process is dynamic and requires an interdisciplinary team, where several professionals should be involved. The client, family member(s), and caregivers should be considered team members. Research into consumer dissatisfaction and disuse of AT suggest that device abandonment could be reduced if consumers are actively involved from start to finish in the development process [2]. Therefore, the AT process delivery outcome would be a result of the team, client, and family effort and will impact the client's independence and quality of life.

1.7 CLIENT-CENTERED APPROACH

Assistive technology services are provided via consultation, in which an ATP is called to address the AT needs of a client. Several people may be involved with the client, including family members, teachers, vocational counselors, and therapists. The AT and intervention are more successful when these significant others are identified and involved at the beginning of the process. It is essential that the assessment and intervention be a collaborative process. The role of the ATP is to educate consumers of the choices available, to enable the client to make decisions related to the AT in an informed manner. The challenge for the ATP is to do this without unduly influencing the client's choice. The value of this approach is that the client and the ATP inform each other throughout the process and develop a shared mutual responsibility for the outcome. The ATP should initiate the collaborative process by identifying significant others as a part of the intake referral procedure. The success of the AT system depends on coordination and teamwork among all the individuals involved with the client. In a client-centered approach, the client's input is important to the success of the AT process [2].

1.8 REIMBURSEMENT AND PAYMENT

A commonly used analogy in the US healthcare system is a "pie" with different types of healthcare services competing against each other to get a large "piece of the pie." All services, including AT, are significantly affected by the constant increase in the cost of healthcare. Provision of the AT services is, to a large extent, controlled by the availability of the funding source. As the insurance structure in United States does not support uniformity in terms of coverage of AT from person to person, this could sometimes be a major barrier in providing quality of services to clients. Provision of AT consists of several steps, such as assessment, AT provision, follow-up, and repair and maintenance. The cumulative cost of the entire process could be significant; in most cases insurance companies are the only available option for getting a piece of AT equipment, rather than the person paying individually for the services. As mentioned earlier, because of the high cost of the services, a combination of several types of insurance agencies—public as well as private—is required in order to get a piece of AT. For several years, the requirements for AT funding have also changed drastically. There has been an increase in the need of third-party reimbursement agencies for documentation and evidence. AT practice,

therefore, which was traditionally based on the expertise of an occupational or physical therapist, now requires need for evidence-based practice to support the decisionmaking of a prescribed piece of AT equipment. Impact of evidence-driven AT service reimbursement practice has a significant impact on the following:

- Assessment procedure, which now demands time-related cost-efficiency from clinicians
- Documentation, justifying the need for that particular piece of equipment and its advantages over the other lower-cost options available
- Developing standards for different types of AT that are undergoing constant revision and changes, such as the American National Standard Institute (ANSI)/Rehabilitation Engineering Society of North America (RESNA) standards for wheelchairs, for providing a benchmark of care
- Prescription that accounts for clinical practice guidelines, and the client's needs and preferences, to reduce the possibility of abandonment of the prescribed device
- Service delivery in a timely and cost-effective manner
- Follow-up care, including repair and maintenance of the prescribed device, to improve long-term use and minimize frequent replacement of the entire instrument

1.8.1 Funding Sources

A wide variety of funding options are available for provision of AT services in the United State. The common objective in provision of AT services is based on medical necessity of the client. A common definition of medical necessity, despite the variability in interpretation by different insurance agencies as proposed by Center for Medicare Medicaid Services (CMS), is "Services that are proper and needed for the diagnosis or treatment of medical condition meet the standards of good medical practice and are not mainly for the convenience of [the] health professional" [17].

Funding sources for AT include the following:

1. *Medicare*. Established in 1965, Medicare is the largest payer for AT services throughout the United States. Some of the eligibility criteria for Medicare are (a) age >65 years and receiving monthly Social Security benefits; (b) age <65 years and receiving Social Security Disability Income (SSDI), (c) age <65 years with a diagnosis of amyotrophic lateral sclerosis (ALS), (d) diagnosis of end-stages renal diseases, and (e) age >18 years acquiring disability before age 22 years. AT devices, which are referred to as "durable medical equipment" (DME) by Medicare, are covered by Medicare Part B, and are defined as equipment that is used primarily to serve medical necessity, can withstand repeated use, and is seldom useful to a person in the absence of an injury and illness. AT devices that are funded through Medicare Part B are designed for use by clients in the home environment with the ability of substituting (lost) body functions. Medicare funding generally works in combination with funding by other insurance agencies, with Medicare paying approximately 80% of the cost of the AT device and the insurance company (or clients themselves) covering remaining 20%. A medical justification letter identifying need for that particular piece of AT equipment is an essential prerequisite for Medicare funding.

2. *Medicaid.* Medicaid provides medical coverage for individuals with limited income and individuals with disabilities who meet the income eligibility guidelines. Medicaid is a state-governed program. Therefore, the eligibility criteria differ from one state to the other. Eligibility criteria for Medicaid are (a) a person enrolled in a government benefits program such as Supplemental Security Income (SSI), (b) a person with a significant disability receiving SSDI and meeting income eligibility criteria, (c) the parent of a disabled child (age <21 years) who meets SSDI and income guidelines, and (d) person previously receiving SSI but who is now working. Medicaid pays for AT that is medically necessary, and should be under the fee schedule. If the device does not have a fee schedule or if its cost exceeds the amount of fee schedule, a prior authorization is required. Medicaid is always referred to as the “payer of last resort,” meaning that a person is eligible to apply through Medicaid for AT if other insurance agencies have denied provision of that service.
3. *Office of Vocational Rehabilitation (OVR).* OVR is a federally funded state-governed program that helps individuals with disabilities to resume and retain employment. The goal of provision of AT devices through OVR is to meet the vocational needs of individuals with disabilities. The wide range of AT services funded by OVR includes work evaluation, work training, and job placement, by funding AT devices from mobility aids to workstation modifications.
4. *Veterans Administration (VA).* This is a federally funded program that provides healthcare benefits, including AT, to eligible individuals. Enrollment in the VA system is required prior to determination of benefit eligibility. VA administers several programs for providing AT, ranging from mobility devices to work modifications to transportation system modifications.
5. *Workers’ Compensation.* Workers’ compensation is a state-run insurance program that provides health benefits to those who incurred employment-related injuries and/or diseases. AT includes equipments and home modifications, which a person receives with a physician’s prescription and prior authorization for that device through a service provider, which is typically a private insurance company.
6. *Education.* Education-based programs are governed by local school districts in order to provide appropriate public education to a child with a disability. A child (age <21 years) with a disability is deemed eligible for the special education program [viz., an Individualized Education Program (IEP)] if it is determined that utilization of the AT device is necessary for that child to complete his or her school-related activities both at home and at school.
7. *Private Health Insurance.* Reimbursement of AT services differs significantly among private insurance providers. However, they follow the same guidelines as that of Medicare, and medical necessity is the basis for the justification of AT-related services.

1.8.2 The Funding Procedure for AT Devices

In spite of variation in funding processes for reimbursement of AT-related services, there are some common rules, and the following steps apply in seeking funding for all AT-related services:

1. *Identification of Insurance Source.* Even though the best practice should never be based on the type of insurance that a client has, a thorough evaluation of this resource is essential. Since the objectives of different insurance agencies differ, this understanding can help achieve a fit between the insurance agency's objectives and the client's objectives.
2. *Procedural Coding.* The Center for Medicare and Medicaid Services (CMS) has developed a common procedural coding system (HCPCS) and constantly revised codes for different AT devices and AT-related services. These codes are very critical since they define the specific purpose that an AT [durable medical equipment (DME)] device serves and also indicates specific service utilization. The main purpose of these codes is to enable clinicians to bring uniformity to their billing. Understanding these codes is also crucial for writing a better justification letter, showing a match for a person's need by prescribing a specific AT device.
3. *Justification Letter.* Irrespective of the type of insurance agency involved, a justification letter is the most important component of the AT funding procedure. The purpose of a justification letter is to provide a rationale for providing a particular AT device or ordering AT-related services that can (a) meet medical necessities for that person, (b) compensate for the functional limitation, and (c) be the best and least cost option.
4. *Appeal Process.* This is the process that follows a denial of a requested AT service or piece of equipment. Although the appeal procedure differs for different insurance carriers, it is mediated through a clinician. Several steps are involved in the appeal process, such as identification of reasons for denial and providing reasons supporting the decision. Sometimes a request for personal appeal can be granted, where a clinician can represent the case through an attorney in a courthouse. [12,2,17,18]

1.9 CONSUMER EMPOWERMENT

In more recent decades, society has placed an increasing value on quality of life (QOL) issues and has supported the development of rehabilitative services and products [14]. The United States has experienced the passage of several significant pieces of state and federal legislation and an increase in federal dollars spent for rehabilitative product research and development, as well as a public expectation that federal and state governments should provide financial assistance for those who need seat mobility equipment (or assistive technology) [7]. Some of the landmark legislations are the following:

1. The Rehabilitation Act of 1973, which authorized the expenditure of federal funds for the training persons with mental and physical disabilities for competitive employment. Through this Act, individuals with disabilities could not be excluded from or discriminated against in programs conducted by federal agencies, programs receiving federal financial assistance, federal employment, or employment practices of federal contractors. For the first time in US history, the civil rights of individuals with disabilities were protected by law.
2. There were changes in state residential institutions (during the 1970s and 1980s), with transfer of persons who previously lived in large state facilities to smaller group homes that were often located within residential communities.

3. The Fair Housing Act of 1988 was intended to increase housing opportunities of individuals with disabilities. This legislation allows individuals with disabilities to make modifications of existing buildings, if the modifications are necessary to enable a disabled person to live functionally. It also requires that new multifamily housing with four or more units be designed and built to allow access for individuals with disabilities. Despite new guarantees of civil rights and educational laws, individuals with disabilities did not achieve broad civil rights until the passage of the American with Disabilities Act (ADA).
4. The American with Disabilities Act (ADA) in 1990, a landmark federal antidiscrimination law, ensures equal access to employment opportunities, public accommodations, and state/local services. With this act, Congress identified the full participation, inclusion, and integration of individuals with disabilities into mainstream society as a national goal. Public places, such as government buildings, libraries, restaurants, and universities, must be accessible for people with disabilities. The ADA law applies to private sector as well as state and local government. The ADA titles are listed here:

ADA Title I—Employment. This provision prohibits discrimination in employment. Employers should provide reasonable accommodation to individuals with physical and mental limitations.

ADA Title II PART A—State and Local Government Activities. Requires that state and local governments provide individuals with disabilities equal opportunity to benefit from all of their programs, services, and activities, such as public education, employment, transportation, recreation, healthcare, social services, courts, voting, and public meetings. State and local government are required to follow specific architectural standards in the new construction and alteration of their buildings.

ADA Title II PART B—Public Transportation. Public transportation services, such as buses and public rail transit (subways) must comply with requirements for accessibility. Paratransit services should be provided for individuals who are unable to use the regular transit system independently.

ADA Title III—Public Accommodations. This prohibits provision exclusion, segregation, and unequal treatment of disabled individuals in public places.

ADA Title IV—Telecommunication. This provision ensures address, telephone, and television access for people with hearing and speech disabilities.

In addition to the enactment of legislation, there has been a gradual shift from the medical model to the social model. Increasingly, disability is perceived as a social problem, not a medical problem, as before. The social model does not deny the problem of medical impairment, but identifies disability as matter of participation in society. It is not individual limitations, which are the major cause of disability, but society's failure to provide appropriate services [19]. Another social change that affects the delivery of seating (or assistive technology) services is consumers' growing demand to be informed [14]. Increasingly, they demand to know about the treatment and products that are being recommended, and they demand their right to choose. They want to be active participants in the development of their healthcare plans. Such changes in the role of the consumer in turn modify the role of the AT practitioner from decisionmaker to information resource, guide, and partner. Current trends suggest that therapists should empower clients by

providing them with information and helping them make wise choices. These services acknowledge the importance of the therapeutic interaction between the therapist and the client and highlight the client's active participation in the prescription of the seating (or assistive technology) process [14].

1.10 FUTURE TECHNOLOGY

The use of technology has demonstrated promise in assisting elderly individuals achieve independence [20]. Currently, assistive technology most commonly applied includes mobility (powered wheelchairs), communication, and environmental control. Several researches on technology devices are still in development. Examples of those technologies are (1) smart wheelchairs, (2) smart walkers, (3) wheelchair-mounted robotic arms, and (4) smart houses.

Older adults with cognitive impairment or individuals with poor vision can benefit from a device called the "smart wheelchair" [20]. A smart wheelchair consists of either a standard power wheelchair base to which a computer and a collection of sensors have been added, or a mobile robot base to which a seat has been attached. Users can choose different operation modes (e.g., line follower, door passage, obstacle avoidance, navigation) through one switch according to their individual situations and needs [20]. There are different types of wheelchair navigation systems; smart walkers can assist elderly individuals who have both mobility and visual impairment. The goal of these devices is to provide obstacle avoidance and navigation as well as to prevent falls and provide postural stability among frail elderly [21].

Wheelchair-mounted robotic arm (WMRA) technology has been an area where the use of computer-integrated controls is applied. Currently, a robotic arm can be installed on a fixed workstation [22], mounted on a mobile platform, or attached to a wheelchair [23]. WMRA provides disabled individuals with tools to independently perform activities of daily living (ADL) and vocational support tasks that would otherwise require assistance from others. Typical tasks of robotic manipulation aids include manipulating and moving objects, assistance in eating and drinking, and controlling communication devices and environment control units. Such a manipulation aid is usually controlled by its operator by a joystick, keypad, voice-command, or other input device [24].

Communication devices and environmental control units are common applications of computer integrated technology, which provides more options for individuals who have minimal physical control and increases their level of independence and productivity. A base environment control system has been built to assist people with severe disabilities in controlling their home environments. The concept of a smart house for people with disabilities is becoming popular and exciting [25]. In a smart house, an elderly person or an individual suffering from a physical disability is able to control a device in another part of the house. The smart house can also facilitate communications and enhance both personal and building security. Communication technologies in a smart house keep people with disabilities in touch with careers and loved ones, and also provide the means to reduce the number of journeys to stores or banks. Smart houses can be realized by using a central control bus, which can be implemented by cable, infrared receivers, or radio. The bus connects all sensors and all actuators in the smart house. A computer connected to a bus system with a serial interface is designed to control the bus [25].

As we have shown, elderly individuals can benefit tremendously from assistive devices to perform essential functions in their daily lives. Assistive devices are essential to help people with severe physical limitation to become more independent and to improve their quality of life.

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