Effective Health Care Program

Technical Brief Number XX

Wheeled Mobility (Wheelchair) Service Delivery

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Technical Brief

Number XXX (Provided by AHRQ)

Wheeled Mobility (Wheelchair) Service Delivery

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Preface

The Agency for Healthcare Research and Quality (AHRQ) conducts the Effective Health Care Program as part of its mission to organize knowledge and make it available to inform decisions about health care. As part of the Medicare Prescription Drug, Improvement, and Modernization Act of 2003, Congress directed AHRQ to conduct and support research on the comparative outcomes, clinical effectiveness, and appropriateness of pharmaceuticals, devices, and health care services to meet the needs of Medicare, Medicaid, and the State Children's Health Insurance Program (SCHIP). AHRQ has an established network of Evidence-based Practice Centers (EPCs) that produce Evidence Reports/Technology Assessments, and Comparative Effectiveness Reviews to assist public- and private-sector organizations in their efforts to improve the quality of health care. Technical Briefs are the most recent addition to this body of knowledge.

A Technical Brief provides an overview of key issues related to a clinical intervention or health care service—for example, current indications for the intervention, relevant patient population and subgroups of interest, outcomes measured, and contextual factors that may affect decisions regarding the intervention. Technical Briefs generally focus on interventions for which there are limited published data and too few completed protocol-driven studies to support definitive conclusions. The emphasis, therefore, is on providing an early objective description of the state of science, a potential framework for assessing the applications and implications of the new interventions, a summary of ongoing research, and information on future research needs.

Transparency and stakeholder input are essential to the Effective Health Care Program. Please visit the Web site (www.effectivehealthcare.ahrq.gov) to see draft research questions and reports or to join an e-mail list to learn about new program products and opportunities for input. Comparative Effectiveness review will be updated regularly, while Technical Briefs will serve to inform new research development efforts.

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Contents

A. Abstract 1
Purpose 1
Findings 1
B. Background 1
C. Guiding Questions 2
Question 1. Technology 2
Question 2. Context 3
Question 3. Evidence 3
Question 4. Issues 3
D. Methods 3
Data Collection 4
E. Findings 5
a. Description and Context of Wheeled Mobility Service Delivery 5
b. Evidence Map of Wheeled Mobility Service Delivery 12
F. Summary and Implications 16
Payer Reimbursement 16
Consumer Issues 17
Provider Issues 17
Service Issues 17
Research Issues 18
G. Next Steps 18
H. References 20

Tables

Table 1 Recommended elements of wheeled mobility service delivery 11
Table 2 Summary of studies on wheeled mobility service delivery 15

Figures

Figure 1 Reference flow diagram 14

Appendixes

Appendix A Terminology and Abbreviations
Appendix B Key Informants and Potential Questions
Appendix C Search Strategy
Appendix D Evidence Tables

A. Abstract

Purpose. The purpose of this Technical Brief is to describe the wheeled mobility service delivery process, outline the criteria used by stakeholders in decisionmaking, survey the evidence on service delivery, and identify issues and areas for future research. Information was gathered from discussions with key informants representing various perspectives and searches of the grey and the published literature.

Findings. Recommended steps in the process of wheeled mobility service delivery were identified in textbooks, guidelines, and published literature. At present there is no high quality evidence supporting these recommendations. Overall, there were many elements common to all processes identified. Recommendations to include equipment trials, formal followup, and outcome assessment were less uniform. Twenty-one studies pertaining to wheeled mobility service delivery were identified in the published literature. The majority of studies were observational and were designed as exploratory studies to determine consumer use of and satisfaction with the overall wheeled mobility service delivery process or some aspect of it. Issues related to reimbursement include Medicare regulations regarding use in the home; limited coverage for patient evaluations, training, and followup; and equipment codes that do not adequately distinguish between basic and more complex features. Consumer issues include difficulty identifying or having access to qualified providers and suppliers and having the knowledge and skill to navigate the delivery process. Provider issues include lack of evidence-based guidelines related to wheeled mobility service delivery. Research is needed to support the development of evidence-based guidelines and to assess outcomes related to appropriate wheeled mobility delivery.

B. Background

Wheeled mobility or wheelchair use in the United States is at an all time high and growing. A 2005 survey of noninstitutionalized Americans estimated that approximately 3.3 million people (1.4 percent of the population) 15 years of age and older used a wheelchair or similar device. Of those 3.3 million, approximately 1.8 million were 65 years and older, representing over 5 percent of the elderly population. Among children under 15 years of age, an estimated 83,000 used a wheelchair or similar device, representing 0.2 percent of that population.[1] An earlier survey (1994-1995 data) of noninstitutionalized individuals in the United States estimated that there were 1.6 million (0.6 percent) wheelchair users including 88,000 under age 18 years (0.12 percent) and 897,000 (2.87 percent) 65 years of age and older. Of the total group of wheelchair users, 1.5 million used manual wheelchairs and 155,000 used electric wheelchairs. The leading conditions associated with wheelchair use included stroke, osteoarthritis, multiple sclerosis, absence or loss of lower extremity, paraplegia, orthopedic impairment of lower extremity, heart disease, cerebral palsy, rheumatoid arthritis, and diabetes.[2]

At the same time that the population of mobility impaired individuals is growing, advances have been made in assistive technology. Power wheelchairs are more widely available. Technological advances have greatly enhanced manual wheelchairs. Scooters or power operated vehicles (POV) are commonplace. Advances in wheeled mobility assistive technology offer enhanced functionality. Mobility devices have been shown to increase the activity, participation, and quality of life of individuals with mobility limitations.[3] The degree to which these wheeled

mobility devices contribute to quality of life depends on the appropriateness of the wheeled mobility selected for the patient and their utilization of the device. However, inappropriate mobility devices may result in harms (including overuse or repetitive strain injuries, pressure sores, and accidents), equipment abandonment, and underutilization.

Wheeled mobility service delivery is the process by which mobility impaired individuals are matched to wheeled mobility devices and provided service. The process has been described by providers, patient organizations, and others. The World Health Organization (WHO) identified the following steps: (a) referral and appointment, (b) assessment, (c) prescription (selection), (d) funding and ordering, (e) product preparation, (f) fitting, (g) user training, and (h) followup, maintenance, and repairs.[4] To maximize the benefit of scarce resources, matching patients with mobility limitations with the most appropriate wheeled mobility device, therefore avoiding under- and over-prescribing, is paramount. However, many patients, providers, and payers may not be aware of or fully understand the aspects of wheeled mobility service delivery that likely contribute to attaining the most appropriate match between individual and equipment, features, and services.

Interest in identifying an evidence based assessment tool that could guide decision making regarding coverage for wheelchair types and specific wheelchair features prompted the nomination of this topic. An evidence based tool might provide guidance in areas such as critical components of the assessment and follow-up, selection of appropriate equipment based on patient needs, provider qualifications, and frequency of reassessment.

To address this need, we prepared a Technical Brief to identify and describe the literature and expert opinion regarding the process of wheelchair service delivery. The Brief provides background information for stakeholders interested in developing wheelchair service delivery standards of care, researchers of mobility assistive technology, and patients, providers, and payers of wheeled mobility. It also identifies patient, provider, and payer issues that may impact the service delivery process.

There exists unique terminology and prevalent diseases and conditions related to this topic. A listing of key terms and abbreviations can be found in Appendix A.

C. Guiding Questions

We addressed the following questions to provide stakeholders with an improved understanding of the theoretical underpinnings of and the ways in which wheeled mobility service delivery occurs in practice and to describe the body of research addressing wheeled mobility service delivery and the appropriateness of the match between individual and equipment, features, and services. Consistent with the Technical Brief reporting format, questions pertaining to four topics (technology, context, evidence, and issues) guided the research process.

Question 1. Technology. What criteria (i.e., medical conditions, physical characteristics, functional and/or vocational needs, environmental factors, etc.) do *assessors* and *payers* (including Medicare, Medicaid, Veterans Affairs (VA), and others) take into consideration when determining the appropriateness and medical necessity of a wheelchair type (i.e., manual, power scooter, power chair) and features (i.e., seating, tilt, etc.) for an individual patient?

a. What formal criteria exist?

b. How do the criteria differ across *assessors*?
c. How do the criteria differ across payers?
d. How do the criteria differ for patients of different ages (i.e., 21 years old and younger versus older than 21 years)?

Question 2. Context. Which of the following elements have been studied with regard to facilitating or hindering achievement of an appropriate patient/wheelchair match?

a. Provider type (i.e., occupational therapy, physical therapy, primary care provider, physiatrist).
b. Provider qualifications (i.e., certification, experience performing wheelchair assessments).
c. Setting (i.e., primary care clinic, specialty clinic, school, retail store).
d. Payer (i.e., Medicare, Medicaid, Veterans Affairs, Vocational Rehabilitation, private insurance).
e. Components of patient assessment (i.e., diagnosis versus functional abilities, cognitive abilities, physical abilities).
f. Assessment, prescription, and delivery steps (i.e., access, number of visits covered by insurance, trials and simulations with wheelchair, education and/or training provided to the patient, followup, etc.).

Question 3. Evidence. What studies have reported on wheeled mobility service delivery? Specifically, describe the following elements of the studies:

a. Indication/patient inclusion criteria
b. Study design/size.
c. Elements of service delivery (i.e., patient physical characteristics, environmental factors, needs [functional, vocational], cognitive ability, provider, payer, fitting process [trials], counseling/training/education, followup).
d. Outcomes assessed (i.e., functional ability, utilization of chair, patient satisfaction, quality of life).
e. Adverse events/harms/safety issues (i.e., pressure sores, injuries, need for repairs, need for replacement)

Question 4. Issues. What are the important issues surrounding wheeled mobility service delivery? What are the topic areas, research designs, populations, interventions, comparators, outcome measures, and settings for future research into the most effective and efficient approach to matching patients with appropriate wheeled mobility devices?

D. Methods

The objective of this report is to describe the wheeled mobility service delivery process from various perspectives, to outline the criteria used by various stakeholders in wheeled mobility decisionmaking, and to survey the evidence available on wheeled mobility service delivery.

We identified and utilized a variety of information sources, including key informants, published, peer-reviewed literature, and grey literature.

Data Collection

We included information gleaned from discussions with key informants, targeted searching of the grey literature, and a comprehensive search of the peer-reviewed literature.

Discussions with key informants. We identified several key informants to provide expertise from various perspectives relevant to wheeled mobility service delivery. We included wheeled mobility service delivery providers, third-party payers, consumers, suppliers, and researchers. Key informants initially participated in discussions aimed at developing the guiding questions for the Technical Brief and provided leads to resources in the peer-reviewed and grey literature. These individuals, their perspectives, and affiliations are listed in Appendix B (Table B1). Individual interviews were then conducted via telephone or in person, if logistically feasible, during June and July of 2010. The interviews were designed and conducted to gather information pertaining to the guiding questions. Information requested from each key informant varied based upon their area of expertise and/or perspective with regard to wheeled mobility service delivery. Guiding questions were developed in advance of interviews to ensure that necessary information was solicited in a timely manner. A list of these guiding questions appears in Appendix B: (Table B2).

Grey Literature Search. Grey literature on this topic was important to provide background and context to the topic. It also provided insight into current issues regarding wheeled mobility service delivery. A targeted approach to searching the grey literature was conducted and included bibliographic databases such as ProQuest Digital Dissertations and topic specific databases such as those maintained by the National Rehabilitation Information Center (NARIC) (REHABDATA, NIDRR Project Database, and the NARIC Knowledgebase). Grey literature searching also included searches of related conference abstracts (i.e., International Seating Symposium, RESNA Annual Conference). Payment policies were obtained by searching relevant online databases such as the Medicare Coverage database and through targeted requests for information. Web sites of relevant not-for-profit organizations and government agencies were searched for information and publications. Relevant Web sites may include those published by the RESNA, the Christopher and Dana Reeve Foundation, Paralyzed Veterans of America, the National Coalition of Assistive and Rehabilitation Technology, and others. Quality of Web site information was evaluated to insure that the information provided was authoritative, up to date, had minimal ties to for-profit interests as appropriate, utilized references to scientific information, and provided names and credentials of Web site contributors. Grey literature was utilized primarily in addressing the descriptive guiding questions (Questions 1, 2, and 4).

Published Literature Search. We conducted literature searches in MEDLINE®, CINAHL, and ERIC from the earliest time permitted electronically until July 22, 2010. Searches were limited to studies relevant to humans and published in English. Restricting the research to English language materials was not expected to result in a language bias for this topic and stakeholders.[5] Due to the limitations of the Medical Subject Headings (MeSH terms) and the relatively inconsistent use of terminology in this field, a search strategy with maximum recall potential was used. The search was not limited by study type because published literature of any study type was considered appropriate for addressing the descriptive guiding questions. We also conducted a manual search of references from reports of relevant studies or review articles. The search strategy used with Ovid MEDLINE® and guiding searches of CINAHL and ERIC, including a concept analysis and proposed search terms is described in Appendix C.

Results from the bibliographic database searches were screened for inclusion based on title and abstract, if available. Full text articles were retrieved when warranted by the title and/or abstract. All publication types were included if they related to the guiding questions. Only information related to wheeled mobility service delivery elements and outcomes were abstracted for studies that included more than one intervention. The exclusion criteria below were applied to studies resulting from the bibliographic database searches:

1. Does not address wheeled mobility service delivery and its relationship to wheeled mobility user outcomes (i.e., studies of individuals using wheelchairs and their quality of life without addressing aspects of the service delivery process).
2. Addresses aspect of wheeled mobility not relevant to guiding questions:
   a. Wheeled mobility used outside of routine activities around home and community (i.e., sports chairs, standing chairs, etc.)
   b. Very specific aspect of seating and mobility (i.e., types of seat cushions, joysticks, specific brands of chairs or seating materials, etc.)
   c. Outdated technology
   d. Research and development on equipment not currently widely available
3. Addresses creation, validation, or research on particular outcome measurement instruments.

E. Findings

a. Description and Context of Wheeled Mobility Service Delivery

As described in the background section of this report, wheeled mobility service delivery is the process by which mobility impaired individuals are matched to wheeled mobility devices and provided service. This process has been described by a number of experts from the point of identification of a need for mobility assistive technology to the point of replacement. These sources provide background, education, and guidance to the topic of wheeled mobility service delivery.

Our guiding questions were developed to direct our search of the literature and to focus our discussions with our key informants. Based on the information we gathered about the wheeled mobility service delivery process and how it occurs in practice, we organized our findings for Guiding Question 1 (Technology) under Guidance and our findings for Guiding Question 2 (Context) under Third party payers, Practice, and Wheeled mobility service delivery elements.

Guidance. The "Technology" (Guiding Question 1) being reviewed in this Technical Brief is the wheeled mobility service delivery process. The process has been described or structured into delivery models, in various levels of detail, by providers, organizations representing patients, payers, researchers, and health care agencies. While there are many common elements among these descriptions or models, there are also differences. With the exception of adherence to the steps required to obtain reimbursement, no service delivery process is mandated. Furthermore, no evidence exists to say that one source of guidance is superior to another or which steps are essential in obtaining an appropriate match between an individual and wheeled mobility system. The guidance described below represents individual or consensus expert opinion. Table 1 provides an overview of these sources. More detail is presented in Appendix D.

Once a patient is referred, or self-refers, the patient evaluation takes place. There is overall agreement that identifying the individual's goals and needs, assessing various aspects of their

ability (including physical, cognitive, and functional), and assessing the environment in which they will use the wheeled mobility device are important elements of the patient evaluation. With regard to equipment selection and delivery, equipment trials are not consistently recommended. This may be, in part, because in some settings the equipment is not available and in some reimbursement systems equipment trials are not covered. After the equipment is delivered, there is agreement on the need to train the individual and, if necessary, family members or caregivers on the use of the equipment. A formal followup phase was recommended by many but, perhaps because followup is not reimbursed, was not included in all of the delivery systems. Outcome assessment, one approach to determining the appropriateness of the equipment (e.g., usage, user satisfaction), was less frequently recommended.

The American Medical Association's 1996 "Guidelines for the Use of Assistive Technology: Evaluation, Referral, Prescription" describe the role of the primary care physician in meeting the needs of individuals with disabilities.[6] These guidelines were developed by the Assistive Technology Advisory Panel with input from focus groups of consumers and allied health professionals. The primary care provider may be the person who initially identifies the individual's need for assistive technology. An interdisciplinary team of physicians, therapists, rehabilitation engineers/technologists, durable medical equipment (DME) suppliers, social workers, vocational counselors, and caregivers/family members will likely be needed for more in-depth assessment, prescription, and training. Respect for the individual and caregiver goals, needs, and preferences, continual assessment of the status and goals, monitoring to ensure that the assistive technology (AT) prescribed matches what was delivered, and documentation of goals, intervention provided, and outcomes achieved are elements of the rehabilitation process that also pertain to service delivery.

The Paralyzed Veterans of America prepared a guide to eligibility for wheelchairs within the Veterans Affairs system.[7] The steps to obtaining a wheelchair were also presented (Table 1).

Cooper described an iterative process [8] (Table 1) for AT service delivery where outcomes are assessed and compared to goals. He suggested that the individuals' perspective, objectives, and goals will evolve and should be regularly assessed. Given that inadequate training is a potential factor in predicting equipment abandonment, training for individuals prior to or at delivery and for rehabilitation professionals to keep abreast of new products was also recommended.

In a series of on-line lectures developed to provide an overview of the wheelchair mobility and seating evaluation process, Schmeler and Buning described a nine-step process for service delivery[9] (Table 1). The screening step should focus on the needs and goals of the individual. Fitting, delivery, and training often involve the supplier so selection of the right supplier is critical. Followup is especially important for individuals with progressive conditions.

Minkel outlined five steps for AT service (Table 1).[10] A team approach was recommended with the individual AT user, payer, practitioner (physician, therapist, teacher, and counselor), supplier, and rehabilitation engineer included in the decisionmaking process.

In 2004 the Clinician Task Force of the Coalition to Modernize Medicare Coverage of Mobility Products (CMMCMP)[11] developed recommendations for wheeled mobility device coverage and presented the recommendations to the Centers for Medicare and Medicaid Services (CMS) Interagency Work Group. The goal was to "provide CMS with an objective and consistent process by which medical necessity may be determined and documented." The Task Force addressed all steps in the service delivery process (Table 1) with particular emphasis on patient evaluation. They identified three levels of patient complexity – basic, intermediate, and complex – with a more in-depth evaluation required as complexity increased.

Cook and Polgar addressed AT delivery in their guide for clinicians and individuals. They described six steps[12] (Table 1) and emphasized a collaborative and consumer-centered approach. Identifying needs and goals during the initial evaluation was believed critical as it would provide the basis for assessing the effectiveness of the final outcome, justifying the purchase to payers, and guiding the rest of the evaluation.

Guidelines from the WHO outline eight steps in wheelchair service delivery[13] (Table 1). The overall focus of the guidelines is on provision of manual wheelchairs in "less resourced settings." The individual's physical, environmental, and lifestyle needs should be considered. The Guidelines further described "good practice" for each of the service delivery steps.

The perspective of the clinician was described by Taylor and Furumasu in the Industry Profile on Wheeled Mobility.[14] Their focus was on the seating and mobility evaluation, but they outlined the overall process, as well (Table 1). They emphasized the need to evaluate seating first because postural stability, upper extremity function, and head control are factors in controlling and/or propelling a mobility device. They identified the primary individual needs as comfort, independence, and the ability to be mobile. The role of the supplier was also addressed. The supplier, ideally credentialed by RESNA and certified by the National Registry of Rehabilitation Technology Suppliers (NRRTS), is involved in equipment trials and selection of devices and features. They may also followup with the individual in their home.

Batavia presented a nine-step approach to wheeled mobility service delivery[15] (Table 1). Key steps included early identification of the funding source, as this might limit equipment options, selection of a knowledgeable, reputable supplier (certified, Medicare enrolled, experienced, available in emergency situation, convenient location for service, carry wide variety of products), and training (for individual and family/caregiver).

In addition to the overall process descriptions, providers have contributed suggestions for service delivery focused on specific populations. These include children,[14,16,17] bariatric patients,[18] patients with neurological or musculoskeletal conditions,[19-22] and older adults.[23,24]

Descriptions of the AT or, more specifically, wheeled mobility, service delivery process have also been presented in the published literature. Di Marco et al.[25] reported that, after a literature review identified no published standards of practice for wheelchair prescription, staff occupational therapists developed clinical guidelines for wheelchair selection, a maintenance education package, and a followup plan. Their focus was on three outcomes: abandonment of the wheelchair, satisfaction, and posture and comfort. They identified factors that influenced these outcomes and which should be addressed in the delivery process based on their experience with 128 patients over a 2 year period of implementing the guidelines. These factors, included lack of active involvement of the individual in the prescription process, lack of training of professionals involved in the process, changes in the needs of the individual between prescription and delivery, poor device performance, and unsatisfactory design features and poor fit. Measurement tools, while not validated, were identified for assessment of service delivery from user (satisfaction, comfort, posture, management skills, maintenance knowledge), technology (stability, durability, need for repair/modification), and process (provision of education, followup, waiting time between prescription and delivery) perspectives.

Ripat and Booth interviewed six providers, seven funders, and five individual users to identify the components of ideal AT service delivery.[26] Three themes emerged. First, the user of AT is a unique individual within his or her environment. The user must be the focus of all decisionmaking, and individuals should not be classified on the basis of their diagnosis, age, or the type of equipment they require. As part of the service delivery, it is important to identify the

individual's priorities, their current and future abilities and needs, and the resources available to the individual (financial, human, and environmental). The second theme related to allocation of equipment in a fair and equitable manner. The individuals' "needs" should be identified and their "wants" should be considered. It is important to match the AT to the individual within their context. Finally, given the complexity and rapid development of AT devices and services, AT should be considered to be broader than just a device with a single purpose. The device impacts the individual's safety, health, comfort, socialization, quality of life, and self-esteem. Beyond the cost of the equipment, costs of training and maintaining equipment in the individual's environment should be considered.

The most comprehensive process description was presented by Eggers et al.[27] The focus of the work was on individuals with spinal cord injury being evaluated for a primary replacement chair. In addition to the seven-component model for overall service delivery (Table 1), sub-models were developed for each component. Service delivery may be influenced by individual user factors, provider factors, supplier factors, payer factors, and system factors.

Numerous authoritative and comprehensive descriptions of the wheeled mobility service delivery process exist. These sources can offer education or guidance to providers and other stakeholders. However, conversations with key informants provided little assurance that these models are fully utilized in actual practice.

Third Party Payers. An important element of the "Context" (Guiding Question 2d) in which wheeled mobility service delivery occurs relates to the payer. Although payers do not specify the steps in the delivery process, third party payer coverage policies determine the equipment, features, and services that are reimbursed for enrollees. Medicare is a major source of reimbursement for wheeled mobility. CMS last modified the Medicare National Coverage Determinations Manual in 2005.[28] The current coverage is based on mobility-related activities of daily living (MRADLs) – activities such as toileting, feeding, dressing, grooming, and bathing.

Mobility assistive equipment (MAE) is one aspect of the DME benefit category. DME is defined as equipment that (1) can withstand repeated use, (2) is primarily and customarily used to serve a medical purpose, (3) generally is not useful to an individual in the absence of an illness or injury, and (4) is appropriate for use in the home.[29]

Prescription guidelines were included in the CMS 2005 Decision Memo for Mobility Assistive Equipment.[29] The guidelines were derived from the work of the Interagency Wheelchair Work Group (IWWG), physicians, therapists, researchers, and policy specialists with practical experience with mobility device utilization issues.[30] The group also reviewed the evidence presented in an unpublished technology assessment on the topic. The resulting guidelines identify assessment of the individual's physical, cognitive, and emotional limitations and abilities, their willingness to use MAE on a regular basis, and their typical home environment as important for appropriate prescription. A series of questions, in the form of an algorithm, direct the clinician in identifying the appropriate MAE.

A second element of the review of policies related to MAE was the 2006 final rule on power mobility device regulation and payment.[31] This document specified the responsibilities of physicians and other treating practitioners as well as suppliers. Specifically, the physicians' or other treating practitioners' responsibilities include (1) a face-to-face examination of the individual, (2) a written prescription submitted to a supplier within 45 days of the examination, (3) supporting documentation outlining the need for the power mobility device in the home, submitted to the supplier within 45 days of the examination, and (4) billing and payment for the face-to-face examination and for the work and resources required to compile the supporting

documentation. The supplier, having received the prescription and supporting documentation, must identify the specific type of power mobility device to fill the prescription.

A third phase of the CMS initiative is development and implementation of quality standards for suppliers of DME.[32] The standards pertain to Business Service and General Product-Specific Service and specify supplier qualifications and specific responsibilities related to intake, record keeping, product trials, delivery and set up, and training and instruction.

Another major payer is Medicaid. Each state establishes its own coverage policies but many follow the CMS policy. As with CMS, the focus is not on the wheeled mobility service delivery steps but rather on the qualifications of the prescriber and the documentation of need for a particular device.

A third major payer for wheeled mobility is the VA. Information from the Paralyzed Veterans of America and the Veterans Benefit Department outlines the VA policies.[7] Veterans who meet eligibility for prosthetic service and have a disability that requires the use of a wheelchair may receive a wheelchair and a backup chair. Repairs and replacement chairs (based on whether the chair meets the patient's requirements or the estimated costs of repairing the chair) are also provided.

Third party payers have similar processes for providing wheeled mobility to their enrollees. While policies may be cumbersome and require extensive documentation, they can be challenging for providers and payers alike.

Other elements of the "Context" (Guiding Question 2 a, b, c, e, and f) are addressed in the Practice and Wheeled mobility service delivery elements sections below.

Practice. The actual practice of wheeled mobility service delivery was a topic of discussion with a number of our key informants. In practice, the process of wheeled mobility service delivery begins with the recognition of mobility limitations and action taken to address these limitations. At their own recognition or that of a provider or family member, an individual enters the wheeled mobility service delivery process. Entry to the process may be via a rehabilitation department after an injury or stroke, through a provider referral based on a progressive condition, through a supplier storefront, or through an advertisement.

Once the need is recognized and the individual finds his or her way into the process, an assessment is conducted. Ideally, a PT or an OT specializing in seating and mobility performs the assessment. The assessment process can vary in intensity based upon the complexity of the individual's medical condition and functional needs. Although ideally the assessor is unaware of the patient's funding source and is focused on maximizing the patient's functional ability, consideration must be given to what will be reimbursed. A supplier representative is typically involved in some part of the assessment to assist the therapist in identifying the appropriate equipment. While the individuals and their care teams are knowledgeable about the individuals and their condition and functional status, the supplier has the expertise in the technology that can address the identified functional needs and goals. Once the assessment is complete, a prescription from a physician and a seating and mobility system recommendation in the form of a letter of medical necessity is provided by the supplier to the third party payer.

Occasionally, the supplier will provide loaner equipment so the patient has a chance to try it out before committing to the purchase. Another aspect of the assessment that is only occasionally provided includes a home assessment or a home trial in an effort to design a system that will work well in the individuals' home.

Once the third party payer authorizes payment, the supplier can order the equipment. Seating and mobility systems for complex needs often require parts from several manufacturers. The

supplier assembles the system that he/she designed and ordered and delivers the system to the patient. Ideally, with the therapist present, a fitting and any necessary adjustments or programming are completed at delivery. Based on our conversations with key informants, there is little followup after the delivery. Outcomes are rarely formally assessed.

Wheeled mobility service delivery elements. Theoretically, many elements of the wheeled mobility service delivery process can affect the quality of the match between individual and seating and mobility device.

Access. Identifying high quality providers and suppliers and having access to those providers and suppliers is an important component in achieving high quality wheeled mobility service delivery. Certification for providers and suppliers is one way to identify those with more training in seating and mobility. Asking providers and suppliers about their years of experience, in particular experience with the condition of interest to the individual, is another approach recommended by key informants and others.[15,25,33] In rural areas there are likely fewer qualified providers and suppliers.

Provider type and qualifications. The provider is another element that clearly influences wheeled mobility service delivery. It is generally accepted that that PTs and OTs have the training necessary to perform seating and mobility evaluations. However, from conversations with key informants we have learned that most PT and OT education and licensure programs spend little time providing training on these skills. The providers that we talked to emphasized that their seating and mobility skills were learned and enhanced through continuing education opportunities (e.g., seating workshops, product in-services) and through their work experience. RESNA offers an Assistive Technology Professional (ATP) certification process that requires a professional to pass a written exam on the topic of assistive technology. RESNA recently developed a new certification, Seating and Mobility Specialist (SMS), designed especially for professionals assessing individuals for wheeled mobility. [34]

Setting. Key informants recommended that patients be seen in a hospital seating clinic. The clinic will likely be staffed with PTs, OTs, rehabilitation engineers or technicians, and others.

Steps in the service delivery process. Many of the commonly performed or recommended steps in the service delivery process have obvious links to the quality of matching individual and device and the resulting outcome. Training and patient education have been identified as important factors in reducing accidents,[35] preserving limb function, [36] and increasing use of the wheeled mobility device.[37,38] Involving the individual in the prescription process may reduce the risk that the device will be abandoned.[25,39,40] Active follow-up has been found to reduce accidents[41] and allow for adjustments to improve fit.[25]

The ultimate goal of the process is to obtain a good match between the individual and the device. A good match will reduce nonuse or inappropriate use of seating and mobility equipment and features.[37] As described above, several factors can be expected to influence how well this process works. The next section of this report describes the extent to which these expectations are supported by evidence.

Table 1. Recommended elements of wheeled mobility service delivery

Source	Patient Evaluation			Equipment Selection and Delivery			Post-Delivery		
	Goals	Physical, Cognitive, Functional Ability	Environment	Product Selection	Trial	Delivery and Fitting	Training	Followup	Outcome Assessment
Provider and Patient Resources									
Paralyzed Veterans of America, 1997[7] Wheeled Mobility	√	√	√	√		√	√		
Cooper, 1998[8] AT	√	√	√	√		√	√		√
Schmeler & Buning, 2003[9] Wheeled Mobility	√	√	√	√	√	√	√	√	
Minkel, 2002[10] AT	√	√	√	√	√	√	√		√
Clinician Task Force, 2004[11] Wheeled Mobility	√	√	√	√	√	√	√	√	√
Cook & Polgar, 2008[12] AT	√	√		√		√	√	√	√
World Health Organization, 2008[13] Wheeled Mobility	√	√	√	√		√	√	√	
Taylor & Furumasu, 2009[14] Wheeled Mobility	√	√	√	√	√	√	√	√	
Batavia, 2010[15] Wheeled Mobility	√	√	√	√	√	√	√	√	
Peer Reviewed Resource									
Eggers et al., 2009[27] Wheeled Mobility	√	√	√	√	√	√	√	√	√

AT = assistive technology

b. Evidence Map of Wheeled Mobility Service Delivery

Evidence. Searching the bibliographic databases for studies about the process of wheeled mobility service delivery yielded 2,106 titles (1,761 from MEDLINE®, 303 from CINAHL, and 42 from ERIC). Of these, 15 primary studies qualified for inclusion. Hand searching yielded another six studies for inclusion, for a total of 21 studies. A reference flow diagram appears in Figure 1. An evidence map is presented in Table 2.

Study design/size. Included studies were published from 1986 to June 2010 with the majority of the studies published during the last 3 years. We read each study and highlights are discussed in this text. Study designs for this limited body of research vary widely and include one randomized controlled trial, one quasi-randomized controlled trial, one controlled trial, one case-control study, three retrospective cohort studies, three studies that used a combination of cross-sectional and qualitative study designs, five cross-sectional studies, and six qualitative studies. More recent publications used higher quality study designs with a quasi-randomized trial published in 2005, a randomized controlled trial published in 2007, and a controlled trial published in 2010.

Sample sizes ranged from three to 318 and included individuals of all ages, with most studies focusing on adults and only four studies including children and two that focus on children.

Indication/patient inclusion criteria. Many types of consumers were represented in these studies including individuals with spinal cord injuries, multiple sclerosis, spina bifida, cerebral palsy, rheumatoid arthritis, osteoarthritis and stroke. Ten of these studies included a consumer population with similar diagnoses; three studies addressing individuals with spinal cord injuries, one study addressing individuals with spina bifida, one study addressing individuals with rheumatoid arthritis or osteoarthritis of the knee, one study addressing individuals recovering from stroke, one study of individuals with muscular dystrophy, one study of individuals with amyotrophic lateral sclerosis, one study of individuals with cerebral palsy, and one study of individuals with neuromuscular disorders broadly classified. Often the group of individuals in a particular study experienced mobility limitations related to the same condition, such as spinal cord injuries. However, wheeled mobility service delivery studies also occasionally addressed groups of individuals as wheelchair users for a particular service delivery clinic or geographic area. These studies provided a broader representation of individuals in terms of disease and conditions as may be the case in practice. Most of the included research was conducted on localized practices of wheeled mobility service delivery and took place in the United States, the United Kingdom, Canada, Sweden, Holland, the Netherlands, and Australia.

Elements of service delivery. The study purposes of these studies are primarily exploratory. Batavia and Hammer[42] and Ward et al.[43] set out to identify factors important to individuals when considering wheeled mobility options. McDonald [44] and Telfer et al.[45] assess children's caregivers' and parents' opinions about the wheeled mobility used by their child. Beaumont-White and Ham[46] and Pimentel [47] undertake evaluation goals within a particular service to identify ways to improve wheeled mobility service delivery.

Outcomes assessed. Most of these studies address consumer satisfaction with wheeled mobility and related services in some way. Fourteen address satisfaction with the equipment, while only seven address satisfaction with aspects of wheeled mobility service delivery.

Less than a quarter of the studies we identified involved comparisons. Five studies aimed to study comparisons of one approach to wheeled mobility service delivery to another. Barlow et al.[48] and Schein et al.[49] compared in-person assessments with those done via telerehabilitation. These were both completed relatively recently, possibly indicating a trend towards more research

on this topic. The other three comparison studies compare different treatment approaches, either different types of treatment or different approaches to assessment. Hoenig et al.[50] compared an intervention including a multifactorial team approached to service delivery to usual care where a physical or occupational therapy assistant, PT, or OT provided a standard wheelchair at discharge. Hoenig et al.[51] compared the provision of a motorized scooter to adults with OA or RA of the knee to usual care. While the purpose is not to make a comparison, Dicianno, et al.[52] do compare outcomes between patients having assessments performed at specialized AT clinics versus those that did not.

Samuelsson et al.[53] analyzed outcomes in response to a seating clinic visit concerning a particular problem the individual was experiencing related to their wheelchair. Kittel et al.[40] explored individuals' reasons for abandoning their equipment.

Table 2 summarizes the elements of wheeled mobility service delivery and the outcomes addressed in the included studies. While 11 studies examined some aspect of the wheeled mobility service delivery process overall, other studies address particular elements of the process. Several authors explore opinions and views of consumers and others aim to identify aspects of service delivery important to outcomes. Elements of service delivery studied included access, setting, provider, patient education, device selection, device delivery, wheelchair user training followup, and maintenance and repairs. The outcomes analyzed in these studies include mobility, device usage, goal achievement, and satisfaction with the device and service provided.

Adverse events, harms, safety issues. Many studies mentioned adverse events with respect to service delivery. These events most frequently included issue with difficulty getting equipment serviced and repaired.

Figure 1: Reference flow diagram

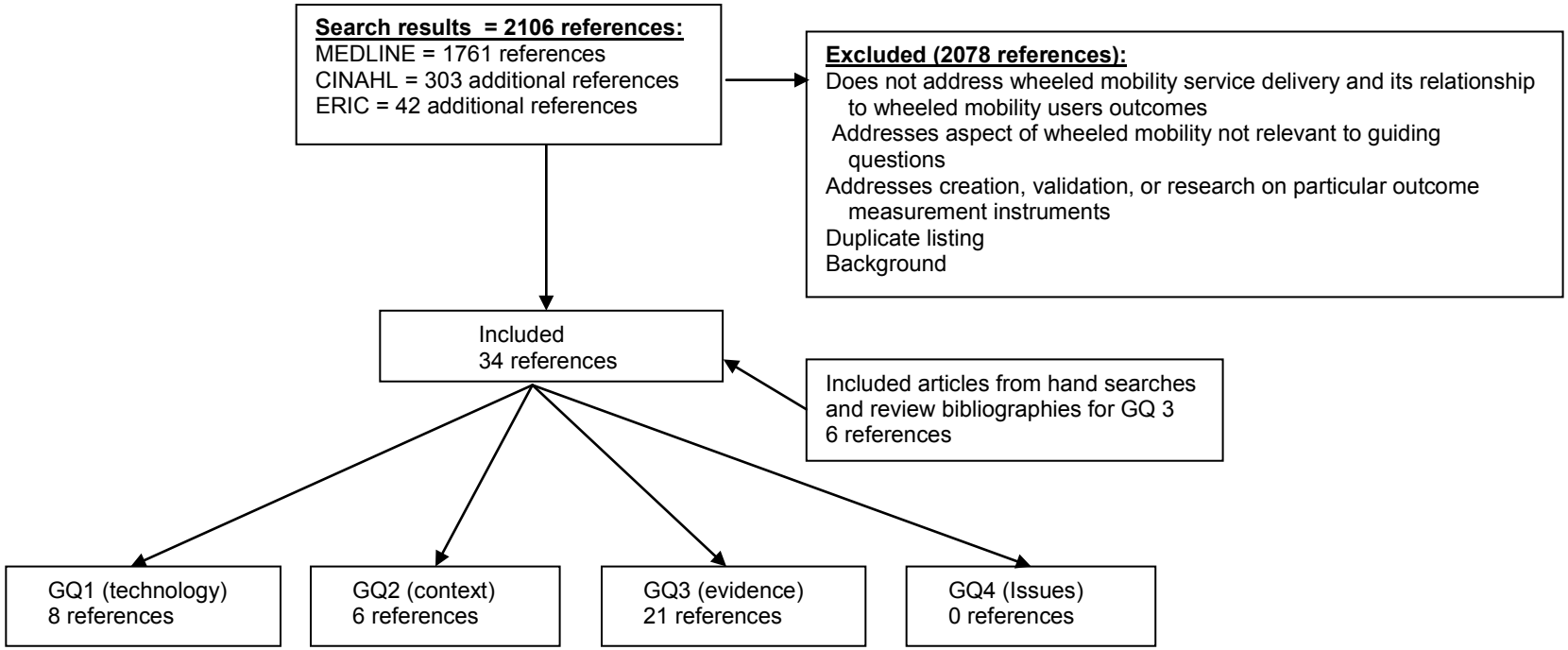

Table 2: Summary of studies on wheeled mobility service delivery

		Elements of Wheeled Mobility Service Delivery									
		Access	**Setting**	**Provider**	**Patient Evaluation**	**Device Selection**	**Device Delivery**	**WC User Training**	**Followup**	**Maintenance and Repairs**	**Overall Process**
Outcomes Assessed	Mobility	Schein, 2010[49]	Dicianno, 2009[52] Schein, 2010[49]			Hoenig, 2007[51]				Dicianno, 2009[52]	Evans, 2007[54]
	Use			Hoenig, 2005[50]	Hoenig, 2005[50]	Samuelsson, 2008[55]	Evans, 2007[56]	Evans, 2007[56]; Garber, 2002[57]	Hoenig, 2005[50]	Evans, 2007[56]	Evans, 2007[54] Hoenig, 2005[50]
	Goal Achievement	Barlow, 2009[48]	Barlow, 2009[48]								Pimentel, 2008[47] Ward, 2010[43]
	Satisfaction with device	Barlow, 2009[48]	Barlow, 2009[48] Dicianno, 2009[52]	Hoenig, 2005[50]	Hoenig, 2005[50]	Hoenig, 2007[51] Samuelsson, 2008[55]	Evans, 2007[56]	Evans, 2007a[56]; Garber, 2002[57]	Bergstrom, 2006[58] Hoenig, 2005[50]	Bergstrom, 2006[58] Dicianno, 2009[52] Evans, 2007[56]	Beaumont-White, 1997[46] Bergstrom, 2006[58] Suzuki, 2000[59] Ward, 2010[43] Batavia, 1990[42] Hoenig, 2005[50] Samuelsson, 2008[55]
	Satisfaction with service	Post, 1997[60]	Barlow, 2009[48]			Samuelsson, 2008[55]			Bergstrom, 2006[58]	Bergstrom, 2006[58] Telfer, 2010[45]	Beaumont-White, 1997[46] Bergstrom, 2006[58] Evans, 2007[54] Suzuki, 2000[59] Samuelsson, 2008[55]
	Medical/Health Issues					Hoenig, 2007[51]					Richardson, 2009[61]
	Abandonment										Kittel, 2002[40]

F. Summary and Implications

Wheeled mobility service delivery is not a new concept or technology, but elements related to the process (including funding, provider qualifications, and advances in technology) have undergone dramatic changes over the past few decades. These changes make it more difficult for providers, payers, and consumers to gain the appropriate knowledge and awareness necessary to ensure all individuals get the seating and mobility services and equipment most appropriate to their needs. There is no high-quality evidence to guide decisionmaking on this topic. The lack of evidence demonstrating effectiveness in approaches to wheeled mobility service delivery is the major finding of this report.

Guiding question four includes the identification of issues and implications arising from the evidence reviewed in this report. The implications of this lack of evidence are far and wide. While there is general agreement among seating and mobility experts about how wheeled mobility service delivery should work in practice, without evidence of effectiveness, health care systems may not feel obligated to offer specialty clinics, and ongoing services and third party payers have no rationale for funding the recommended steps. Without adequate funding, providers and suppliers may need to limit the equipment and services they provide, and manufacturers may be reluctant to develop high quality products that may not reach consumers. A first step towards addressing these issues is the funding of high-quality research related to the wheeled mobility service delivery process. Once an evidence base is established, evidence-based guidelines can be developed and validated.

To address Guiding Question 4 "Issues," we focused on our review of the grey literature and our discussions with key informants. From these sources, we identified many issues that impact the ability of patients to obtain wheeled mobility equipment and services that match their needs. These issues are listed below under the general categories of payer and reimbursement issues, provider issues, consumer issues, service delivery process issues, and research issues.

Payer and Reimbursement Issues

a. Payers have expressed concern about the increasing number of requests for power mobility devices. The lack of high-quality, authoritative, easy to understand guidance supported by evidence to assist them in determining the most effective equipment for an individual may have resulted in the creation of more restrictive reimbursement policies.
b. Payers are unsure about the role of health insurers in the acquisition of equipment that addresses non-health related needs (i.e., school and/or work needs).
c. Medicare covers seating and mobility services and equipment necessary for performance of MRADLs in the home. It is not realistic to assume that individuals will remain confined to their homes when one of the advantages of wheeled mobility is the greater capacity and endurance for community activities.
d. The type of chair for which an individual qualifies is determined by diagnosis as opposed to functional status. For many complex diseases and injuries that result in mobility limitation, the diagnosis may be the same but the functional abilities vary widely.
e. Under Medicare, individuals who rent wheeled mobility equipment for 13 months effectively own the device. This often catches individuals by surprise and, more importantly, makes them ineligible to be fitted for a more appropriate device until they reach the requisite replacement time.

f. Payers typically specify an amount of time (often 5 years) before a replacement chair will be approved regardless of the degree to which the equipment is used.
g. Current Procedural Terminology (CPT) codes may not adequately reimburse providers for their services in assessing patients (especially individuals with complex medical or functional needs) and their environment (i.e., performing home, school, and/or workplace assessments), selecting the equipment (i.e., equipment trials), and delivering the equipment (i.e., fitting, training).
h. The Healthcare Common Procedure Coding System (HCPCS) defines the reimbursement for categories of equipment but may not adequately distinguish between levels of complexity or quality within those categories. Additionally, the supplier is reimbursed for the equipment. Time spent training the user and/or adjusting the equipment is not directly reimbursed.
i. Recent Federal payment policy issues include reducing payments for DME by 9 percent and a proposed move towards requiring competitive bidding for DME.

Consumer Issues

a. Many individuals are ill-equipped to appropriately advocate for seating and mobility equipment and services they need because they lack necessary knowledge and awareness about the wheeled mobility delivery process.
b. Access to providers who specialize in seating and mobility and to experienced, dependable DME vendors may be a major obstacle in achieving an appropriate match between individuals and seating and mobility equipment and services, especially in rural areas.
c. Third party payer networks may limit patient options by specifying the providers and vendors who will be reimbursed.

Provider Issues

a. In recommending wheeled mobility equipment and services, providers must consider what they believe is right for the individual and what will get reimbursed.
b. The medical model, with the physician responsible for the prescription and the letter of medical necessity, may not be the most appropriate model for all patients or all situations.

Service Delivery Issues

a. Under prescription of technology due to provider or supplier inexperience or concerns about reimbursement could result in a lower quality of life than could be realized with the provision of equipment with greater functional capabilities and services that enable users to benefit from the equipment.
b. Few studies address outcomes when individuals obtain equipment from a vendor storefront or Web site or as a result of direct-to-consumer advertising.
c. The service delivery process differs for patients with short term or minimal use needs (such as after an injury) versus patients with complex medical rehabilitation needs (such as individuals with multiple sclerosis, cerebral palsy, spinal cord injury, or other

disabling and potentially progressive mobility impairments). Stakeholders advocate for restructuring benefits for complex patients to address the delivery process differences.

d. Assessments of and recommendations for wheeled mobility equipment for individuals who may experience major changes over a short period (e.g., children, patients with progressive disease conditions) must take into consideration restrictions on the frequency of equipment replacement.
e. The presence of a supplier at a seating and mobility assessment is considered essential due to rapid changes in the technology and the need for experience with a broad array of products. However, there are potential economic incentives for the supplier and therefore selection of a reputable supplier is important. Certification of suppliers is a recent development.
f. Home (and school or workplace, if appropriate) assessments and equipment trials are important so that the needs and goals of the individual are assessed in the environments in which they function.
g. Outcomes assessment should focus on how the equipment provided meets the individual's needs and goals.

Research Issues

a. There is a need for research to enable the development of an evidence base for wheeled mobility service delivery. Issues such as provider qualifications, setting, and outcomes should be addressed.
b. Research in this area is challenging due to issues related to study design, population, environments, and equipment variations.[51]
c. Frameworks for modeling assistive technology device outcomes[62] and usage[63] have been developed and may provide a basis for future research.

G. Next Steps

The issues identified and compiled in this Technical Brief of Wheeled Mobility Service Delivery deserve further attention. Research is needed to investigate and identify factors that contribute to effective wheeled mobility service delivery. This evidence will guide providers, payers, and consumers. Intriguing concepts (such as seating and mobility specialist certification, vendor accreditation, specialized seating clinics, and multifactorial seating interventions) need evidence to demonstrate whether they will lead to more effective wheeled mobility prescriptions, thereby justifying the additional resources. Components of service delivery such as consumer-focused evaluations, consumer training, and followup need more rigorous evaluation to demonstrate their relationship to effectiveness so that a case can be made to initialize reimbursement-related incentives for their provision. Further exploration and diffusion of telerehabilitation to alleviate access issues to individuals in geographically isolated areas is another high priority research topic.

This Technical Brief focused on the process of wheeled mobility service delivery and aspects of that process that may affect the quality of the match between an individual and their wheeled mobility device. There are many existing studies that address a device or a specific feature of the device and the relationship to outcomes. Those studies were beyond the scope of this study.

However, a comprehensive review of this body of research would be a valuable contribution to clinical decisionmaking in this field.

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Appendix A. Terminology and Abbreviations

Terminology

Manual Wheelchair – Self-propelled; push hand rims are used to propel the rear drive wheels; may be designed to be propelled by the user's legs.

a. Standard – Not usually tailored to an individual; simple sling seat; very limited adjustability.
b. Standard hemi – Lower seat height (17 to 18 inches); for individuals of shorter stature or to enable user to place feet on ground for propulsion.
c. Growth – Designed to meet needs of children as they change and grow.
d. Lightweight/ultralight – Frames made of lighter materials (e.g., aluminum, titanium, or chrome); easier to propel and transport.
e. Heavy duty – For individuals who weigh more than 250 pounds or who have severe spasticity.
f. Extra heavy duty – For individuals who weigh more than 300 pounds.
g. Reclining – Backrest reclines independently of the rest of the seating system.
h. Tilt-in-space – Wheelchair frame can tilt greater than or equal to 45 degrees from horizontal while maintaining the same back to seat angle.

Manual Wheelchair Push-Assist – Bridge between manual and power wheelchair; may be battery operated device attached to rear wheels or manually shiftable gears (similar to a bicycle); also referred to as PAPAW – push rim activated power assist wheelchair.

Mobility Assistive Equipment (MAE) – Manual wheelchairs, power wheelchairs, scooters; also includes canes and walkers.

Power Mobility Device (PMD) – Power wheelchair or power operated vehicle (POV).

Power Wheelchair – Battery powered motor that propels wheels; includes front-, center-, or rear-wheel drive options; joystick control is most common; includes power seating system.

a. Tilt frame – Tilts user backward in seated position to change pressure points and help prevent pressure ulcers; also to improve seating balance.
b. Reclining – Reclining backrest opens hip angle; for pressure relief, resting, or self-catheterization.
c. Elevating – Lifts user while remaining in a seated position; can improve reach and enhance ability to socially interact on a more eye-to-eye level.
d. Standing – Lifts user from seated to standing position; pressure relief and improved reach.

Power Operated Vehicle (POV) or "Scooter" – Powered three-wheeled carts with seats; require good upper body strength and arm function and ability to support oneself in upright seated position for extended periods.

Abbreviations

ADL	Activities of daily living
AT	Assistive technology
ATP	Assistive Technology Professional
CF	Cystic Fibrosis
CMS	Centers for Medicare & Medicaid Services
CP	Cerebral palsy
CPT	Current Procedural Terminology
DME	Durable medical equipment
EPIOC	Electronically powered indoor/outdoor wheelchair
HCPCS	Healthcare Common Procedure Coding System
IWWG	Interagency Wheelchair Work Group
MAE	Mobility assistive equipment
MD	Muscular dystrophy
MS	Multiple sclerosis
MRADL	Mobility related activities of daily living
NARIC	National Rehabilitation Information Center
NRRTS	National Registry of Rehabilitation Technology Suppliers
OA	Osteoarthritis
OT	Occupational therapy
PAPAW	Push rim activated power assist wheelchair
PMD	Power mobility device
POV	Power operated vehicle
PT	Physical therapy
RA	Rheumatoid arthritis
SB	Spina bifida
SCI	Spinal cord injury
SMS	Seating and Mobility Specialist
VA	Veterans Administration
WHO	World Health Organization

Appendix B. Key Informants and Potential Questions

Appendix Table B1. Key informants

Name	Affiliation	Recommendation and Topic Area
Edward Amaya, MBA, RT (R), CPM	Ohio Department of Job and Family Services	Recommended by topic nominator, Mary Applegate Payer representative
Kory Badertscher, OT	Veterans Health Administration Minneapolis, MN	Recommended by EPC team member contact Local practitioner
Tim Caruso, PT, MBA, MS, Cert. MDT, CEAS	Shriners Hospital for Children Chicago, IL	Recommended by EPC team Pediatric Wheelchair expert
Donald E. Clayback	Executive Director N.C.A.R.T	Recommended by another key informant Wheelchair benefits expert
Laura Cohen, PT, PhD, ATP	Rehabilitation & Technology Consultants, LLC Atlanta, GA	Recommended by topic expert Rory Cooper, PhD National content expert, researcher
Elizabeth Leef	Administration on Aging	Recommended by another key informant Consumer representative
Alison Little, MD, MPH	Center for Evidence-based Policy Oregon Health and Sciences University	Recommended by SRC Medicaid perspective
Colleen Michals, PT	Courage Center Golden Valley, MN	Recommended by EPC team member contact Local practitioner
Jeanne Olson	Courage Center Golden Valley, MN	Recommended by EPC team member contact Local content expert
Stephen Sprigle, PhD, PT	Professor of Applied Physiology, Bioengineering & Industrial Design Georgia Institute of Technology	Recommended by another key informant Research
David Williams	Chairman, Ohio Rehabilitation Services Commission	Recommended by another key informant Consumer representative
Becky Wittig, PT	Veterans Health Administration Minneapolis, MN	Recommended by EPC team member contact Local practitioner

Appendix Table B2. Guiding questions for key Informant interviews

Key Informant Perspective	Potential Questions
Payers	1. Do you have any guidelines/checklists that you use? 2. Do you perceive any barriers in service delivery? 3. Are there ways to make the process better? 4. What impact does the provider and/or setting have on the process? 5. What research would you like to see completed?
Providers/Assessors	1. What guidelines/checklists do you use (or are you aware of)? 2. Describe the delivery process (from initial contact to final delivery). 3. What are the barriers to achieving a successful match of patient and wheelchair? 4. How can the process be improved? 5. How could future research help you in your practice?
Equipment Suppliers	1. How do you perceive your role in the service delivery process? 2. What prevents the ideal patient/wheelchair match? 3. Is there technology that is not getting to the patients? If so, why? 4. How does product research and development interface with the delivery process?
Researchers	1. Are you aware of any research on the delivery process (or aspects of it)? 2. What are the barriers to research on the delivery process? 3. What are the key areas for future research?
Patients/Patient Advocates	1. What has your experience been with different types of payers? 2. What has your experience been with different types of providers? 3. What has your experience been in different settings? 4. What barriers do patients face in the typical wheelchair delivery process? 5. What prevents patients from getting the “ideal” wheelchair for their needs?

Appendix C. Search Strategy

Concept Analysis

Two concepts related to all key questions addressed in this Technical Brief; therefore, one search strategy was used in multiple bibliographic databases. The concepts included wheeled mobility and patient assessment. Appendix Table C-1 explains the concept analysis and terminology that was used in searching Ovid MEDLINE®. MeSH terms (or other terms relevant to the specific bibliographic database as determined by database thesaurus) and text words (with truncation used as necessary) relating to each concept were aggregated. Concepts were combined together to compile a set of literature inclusive of both concepts for screening. Limitations imposed on the Ovid MEDLINE® search (and other databases if available) included human studies published in English. The search process was an iterative process with updates to restrict or expand the search as new terms were identified and the search process and resulting sets of literature were analyzed.

Appendix Table C-1. Identification of search terms for relevant concepts

	Concept	
	Wheeled Mobility	**Service Delivery**
Search terms [MeSH] and text words	Wheelchairs [MeSH] wheelchair$.tw. scooter$.tw. "power mobility device$" "wheel chair$".tw. "wheeled mobility".tw. powerchair$.tw. "power chair$".tw. ("assistive technolog$" and "mobility").mp. [mp=abstract, heading words, title] "seating clinic".tw. (seating and mobility).mp. [mp=abstract, heading words, title]	assess$.tw. evalu$.tw. select$.tw. prescri$.tw. match$.tw. "service delivery".tw. provi$.tw. acquir$.tw. procur$.tw. fit$.tw. recommend$.tw. purchas$.tw. refer$.tw.

MEDLINE® Search Strategy

1 *Wheelchairs
2 wheelchair$.tw.
3 scooter$.tw.
4 "power mobility device$".
5 "wheel chair$".tw.
6 "wheeled mobility".tw.
7 powerchair$.tw.
8 "power chair$".tw.
9 ("assistive technolog$" and "mobility").mp. [mp=abstract, heading words, title]
10 "seating clinic".tw.
11 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10
12 assess$.tw.
13 evalu$.tw.
14 select$.tw.
15 prescri$.tw.
16 match$.tw.
17 "service delivery".tw.
18 provi$.tw.
19 acquir$.tw.
20 procur$.tw.
21 fit$.tw.
22 recommend$.tw.
23 purchas$.tw.
24 refer$.tw.
25 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24
26 11 and 25
27 (seating and mobility).mp. [mp=abstract, heading words, title]
28 26 or 27
29 limit 28 to (english language and humans)
30 limit 29 to (addresses or biography or case reports or dictionary or directory or in vitro or legal cases or news or newspaper article or portraits)
31 29 not 30

Appendix D. Evidence Tables

Appendix Table D-1. Models and descriptions of wheeled mobility service delivery

A. Provider and Individual Resources				
Cooper, 1998[8] AT	Minkel, 2002[10] AT	Cook, 2008[12] AT	Batavia, 2010[15] Wheeled Mobility	Paralyzed Veterans of America, 1997[7] Wheeled Mobility
Establish goals/expectations	Need assessment/establish goals	Referral and intake	Evaluate patient	Referral
Assess functional abilities	Assessment of functional capacity and environments	Initial evaluation	Hypothesize (best-suited equipment)	Prescription
Assess ability of technology to augment	Development of intervention strategy	Recommendations and report	Trial/simulation	Evaluation and fitting
Integrate person and AT	Implementation of intervention	Implementation	Recommendation and documentation	Verify eligibility and order
Identify appropriate AT	Determination of outcomes	Followup	Identify funding	Delivery and set up
Train person to use AT		Follow along	Order	Training
Compare outcomes to goals			Fitting Dispensing Followup	
Clinician Task Force, 2004[11] Wheeled Mobility	Schmeler, 1999[9] Wheeled Mobility	World Health Organization, 2008[13] Wheeled Mobility	Taylor, 2009[14] Wheeled Mobility	
History and interview	Client screening	Referral and appointment	Evaluation	
Goal setting and device feature determination	In-depth evaluation	Assessment	Trial of equipment	
Feature and product matching	Final specifications	Prescription	Specific recommendations	
Fitting and delivery	Documentation	Funding and ordering	Funding	
Training	Funding approval	Product preparation	Fitting	
Determination of outcomes	Fittings	Fitting	Training	
Followup program	Delivery Training Followup	User training Followup, maintenance, and repairs		

B. Published Resources	
Ferguson-Pell, 2005[64]	Eggers, 2009[27]
AT	Wheeled Mobility
Clinical domain – pathology, assessment, goals	Referral/clinic selection
Technical domain – products, standards, characteristics	Needs assessment
Prescription	Device selection
Justification	Device evaluation
Funding	Device justification Device provision and fitting Education, counseling, followup

Appendix Table D2. Studies of wheeled mobility service delivery

Reference Study Purpose	Population Included	Study Design Sample Size	Elements of Service Delivery Studied	Primary Outcomes Assessed (Assessment Tool)	Adverse Events
Barlow, 2009[48] To compare the effectiveness, client satisfaction, cost, and timeliness of wheelchair seating and positioning interventions provided by telerehabilitation and face-to-face.	Cases included clients assessed by telerehabilitation by the GlenRose Seating Service based in Edmonton. Two comparison groups (one urban and one rural) were assessed face-to-face. Comparisons matched by age, diagnosis, and type of seating components received. Age range: 3-87 Conditions included: progressive neurological diagnosis, Acquired neurological diagnosis: 56%	Case-control N=30 (10 per group)	Setting (telerehabilitation vs. face-to-face) Travel costs Service provision time Wait times Completion times	Satisfaction (QUEST 2.0), achievement of seating intervention goals	Not reported
Batavia, 1990[42] To identify and prioritize factors used by long-term users of assistive technology in assessing their devices.	A panel of consumer experts with mobility impairments. Age range: 31-51 Conditions included: MS, SCI, polio, MD, and CP	Qualitative N=6	Identification of assistive technology factors important to consumers.	Consumer defined satisfaction	Not reported
Beaumont-White, 1997[46] To identify problems with issue and possible areas for improvements to the practice of wheelchair issuance in a London wheelchair service.	Experienced wheelchair users of a London wheelchair service. Age: Not reported Conditions included: Not reported	Cross-sectional N=27	Issue detail, therapy input before supply, general maintenance, written information offered and issued, use of the approved repairer service, wheelchair service support, and additional needs unmet by the	Current level of usage, Problems with wheelchair issue	Not reported

Reference Study Purpose	Population Included	Study Design Sample Size	Elements of Service Delivery Studied	Primary Outcomes Assessed (Assessment Tool)	Adverse Events
			wheelchair service and ideas for improvement.		
Bergstrom, 2006[58] To investigate how adults with SCI assess their satisfaction regarding several aspects of their manual wheelchair.	Individuals with SCIs using manual wheelchairs. Mean age: 49.7 Conditions included: SCI	Cross-sectional N=124	Service delivery Repair service Professional service Followup	User satisfaction with various aspects of the wheelchair as well as the service. (QUEST 2.0)	Not available
Dicianno, 2009[52] To evaluate the association between the use of mobility devices and socialization.	Adults with SB attending University of Pittsburgh-based clinic. Mean age: 34 Conditions included: SB	Retrospective Cohort N=208	Setting (attainment of wheelchair at specialized AT clinic or not)	Physical and Cognitive independence, Mobility, Occupation, Social Integration, Economic , Satisfaction, WC repairs (CHART-SF)	Not reported
Evans, 2007[56] To qualitatively examine the older EPIOC users' satisfaction with the chair and service providers.	Older adult EPIOC users with severe mobility disabilities recruited through a specialist wheelchair service database. Mean age: 69 Conditions included: SCI, MS, Stroke, RA, Multiple disabilities, and RA	Qualitative N=15	Provision of safety training; waiting times for assessments and delivery; repair services	Frequency and quality of chair activity; safety and satisfaction with their EPIOC-related services provided, feelings of insecurity in the chair	Accidents, minor mishaps, shaking of chair on uneven terrain, limited battery life, and dealing with pedestrian traffic.
Evans, 2007[54] To qualitatively examine young EPIOC users' satisfaction with the chair and service providers.	Young EPIOC Users recruited through a specialist wheelchair service database. Mean age: 14.5 Conditions included: MD, CP, and other	Qualitative N=18	Provision of safety training; waiting times for assessments and delivery; repair services	Functioning with the EPIOC, safety of EPIOC, Pain/discomfort, satisfaction with service and support (EQ-5D)	Accidents or mishaps, safety issues concerning curbs, ramps, mechanical mishaps.
Garber, 2002[57]	Veterans currently on the patient roster of	Cross-sectional Qualitative	Receipt of written information about	Use and satisfaction with wheelchair	Pain, spasticity, contractures, falls,

Reference Study Purpose	Population Included	Study Design Sample Size	Elements of Service Delivery Studied	Primary Outcomes Assessed (Assessment Tool)	Adverse Events
To determine the extent to which wheelchairs prescribed during rehabilitation after cerebral vascular incident are used and perceived as satisfactorily meeting individual mobility, functional, psychological, and social needs of veterans who have had a stroke.	the Rehabilitation Service at the Houston Veterans Affairs Medical Center (VAMC), discharged with a primary diagnosis of stroke between 1989 and 1999 and being followed for medical, mobility, or functional problems or stroke recurrence, living in Houston metropolitan area, not deceased, not currently hospitalized, and provided wheelchair upon discharge. Mean age=65 Conditions included: previous stroke	N=49.	wheelchair, receipt of verbal instructions about use or maintenance of the wheelchair, informed who to contact if they had problems with wheelchair, receipt of verbal safety information.		pressure ulcers, neurological or medical changes
Hoenig, 2005[50] To determine the effect of differing methods of dispensing wheelchairs.	Community-dwelling, cognitively intact patients prescribed a standard manual wheelchair. Mean age: 65 Conditions included: symptoms of weakness, poor balance/dizziness, fear of falling, shortness of breath, and other	Quasi-randomized trial N=84	Multifactorial intervention consisting of an expert physical/occupational therapist who used a scripted evaluation that included an evaluation based on medical record review and self-reported and physical performance measure; individualization of the wheelchair and initiation or orders for additional occupational/physical therapy, equipment, or	Amount of wheelchair use. Secondary outcomes of shoulder pain, wheelchair comfort or confidence, or home modifications.	Not reported

Reference Study Purpose	Population Included	Study Design Sample Size	Elements of Service Delivery Studied	Primary Outcomes Assessed (Assessment Tool)	Adverse Events
			home modifications as needed; multimodal patient education; and telephone followup at 3 and 6 weeks vs. usual care.		
Hoenig, 2007[51] To investigate the effects of providing a motorized scooter on physical performance and mobility.	Ambulatory community-dwelling adults without cardiac disease and stable rheumatic disease. Mean age=63 White: 60% Male: 79% Conditions included: RA or OA of the knee	Randomized Controlled Trial N=43	Provision of motorized scooter and lift vs. usual care.	Six-minute walk distance, Mobility, Scooter accidents, Satisfaction	Scooter accidents
Kittel, 2002[40] To identify factors which influence individuals with a spinal cord injury to abandon their first wheelchair before 5 years of use.	Individuals who abandoned first manual wheelchair before five years of use. Ages: 26, 33, 37 Conditions included: SCI	Qualitative N=3	Reflections on wheelchair prescription experience	Abandonment	Not reported
McDonald, 2007[44] To investigate and compare opinions of parents and therapists of children using adaptive seating systems.	Parents and local therapists matched and assessed regarding child. Age: Not reported Conditions included: severe CP	Qualitative/Cross-sectional N=30 matched parent-therapist pairs	Level of agreement about between parent therapist pair on opinions regarding child's seating and mobility needs, abilities, preferences.	Use, comfort, satisfaction	Not reported
Pimentel, 2008[47] To explore assessment practices for clients requiring standard wheelchairs in one wheelchair	1. Individuals assessed for wheelchair during 4-month timeframe once new assessment practices were put in place.	Qualitative 6. N=35.	Evaluation of new assessment practices focusing on soliciting goals from clients and using these as a framework for the prescription process.	Achievement of goals	Not reported

Reference Study Purpose	Population Included	Study Design Sample Size	Elements of Service Delivery Studied	Primary Outcomes Assessed (Assessment Tool)	Adverse Events
service in the UK.	2. 3. Mean age: 73 4. Age range: 12-102 5. Conditions included: Not reported				
Post, 1997[60] To examine individuals with SCI satisfaction with available services and service delivery procedures.	Adults previously rehabilitated in a specialized rehab center between 1986 and 1992 currently living in the community. Mean age: 39.4 Conditions included: SCI	Qualitative n=318	Availability of services	Functional health status, life satisfaction, satisfaction with available services, satisfaction with service delivery procedures	Not reported
Richardson, 2009[61] To identify areas of difficulty encountered by a regional wheelchair service in providing EPIOCs to those with MD in the early years of their provision.	EPIOC users at the EPIOC clinic in Stanmore, UK departmental database seen between April 1997 and March 2000. Mean age: 25 Conditions included: MD	Retrospective cohort N=29	Medical chart documentation of outcomes 1) at initial assessment, 2) within the first 12 months and 3) between 13 and 24 months following the delivery of the chair.	Weakness Pain or discomfort Deformities Other medical issues Weight change Functional issues Posture Wheelchair driving skills Other issues	Not reported
Samuelsson, 2001[53] To analyze the effects of an intervention to address wheelchair problems improves effectiveness from the consumer perspective.	Active wheelchair users consecutively visiting the wheelchair seating department due to problems with seating at the University Hospital in Linköping, Sweden. Mean age: 43 Conditions included: SCI, MS, Stroke, CP,	Retrospective cohort N=38	Visits to wheelchair seating department for problems with wheelchair	Wheelchair functionality, seating comfort, pain, occupational performance, pressure distribution	Not reported

Reference Study Purpose	Population Included	Study Design Sample Size	Elements of Service Delivery Studied	Primary Outcomes Assessed (Assessment Tool)	Adverse Events
	SB, Mental disability				
Samuelsson, 2008[55] To evaluate user satisfaction with, use and usefulness of, and make comparison between two types of mobility devices.	Random sample of mobility assistive device users (rollators and manual wheelchairs) in Sweden. Mean age: 69.8 Conditions included: Not reported	N= 262 (175 rollator users, 87 wheelchair users)	Device type prescribed (Rollator or manual wheelchair provision); Service delivery, repairs and services, professional service, and followup.	Use, satisfaction with device and services (QUEST 2.0)	Not reported
Schein, 2010[49] To evaluate the equivalency of wheeled mobility and seating assessments delivered in-person (IP) vs. Telerehabilitation (TR) at remotely located clinics.	Adults in need of new wheeled mobility in Western Pennsylvania. Mean age: 54.9 (TR), 50.3 (IP) Conditions included: Progressive, SCI, Orthopedic, Cardiovascular, CNS	Controlled trial n=98	Setting: In-person vs. telerehabilitation	Functioning (FEW)	Not reported
Suzuki, 2000[59] To explore client satisfaction and identify program areas needing improvement at the Rehabilitation Hospital of the Pacific's Wheelchair Seating Clinic in Honolulu, Hawaii.	Adults serviced by the formal seating clinic who had completed the initial interview and received their equipment by April 1999. Age: Not reported Conditions included: Not reported	Cross-sectional n=26	Assessment process and followup	Satisfaction	Not reported
Telfer, 2010[45] To investigate the views of teaching staff members at special needs schools and of the parents of children who attended these	Teaching staff and parents of children in special needs schools in central Scotland. Teachers that had worked with the children for at least 6 months and parents	Cross sectional/Qualitative N= 33 teaching staff, 17 parents	Importance of different functions of seating system, satisfaction with speed at which new or replacement models are issued, descriptions of completed repairs or	Time spent transferring child between and to and from seating systems on an average day, satisfaction with how seating system accommodated	Accidents

Reference Study Purpose	Population Included	Study Design Sample Size	Elements of Service Delivery Studied	Primary Outcomes Assessed (Assessment Tool)	Adverse Events
schools on the provision and current technology of seating systems.	whose children had used a piece of adaptive seating equipment for at least 6 months. Parents were encouraged to discuss the survey with their child. Age: Not reported Conditions included: neuromuscular disorder.		adjustments.	growth, and other additional comments from participants.	
Ward, 2010[43] To determine the features most frequently selected in a PWC, level of satisfaction with the selections, and how often the PWC features are used by patients diagnosed with ALS/MND.	Convenience sample of current patients of ALS/Muscular Dystrophy Association center in Charlotte, NC. Mean age: 57.9 Conditions included: ALS	Cross-sectional N=32	Patterns of wheelchair selection and other aspects of decision-making processes that patients experience before, during, and after acquiring a PWC.	Initial and current satisfaction and use of chair and specific features (cushion, headrest, armrests, joystick, backrest, leg rests, overall comfort, ease of use)	Not reported

Note: Reference listing appears in section H.

Outcomes Measurement Instruments
CHART-SF – Craig Handicap Assessment Reporting Technique-Short Form
EU-5D - EuroQoL
FEW – Functioning Everyday with Wheelchair
QUEST – Quebec User Evaluation Satisfaction with Assistive Technology