High-tech Tool

by David Boninger, Ph.D., and Carmine DiGiovine, Ph.D.

New technology assists with wheelchair selection and insurance justification.

In a world of improving

wheelchair design and an ever-increasing number of options, many consumers are left with two central questions: Which chair is best for me? Will insurance pay for it? When considering their clients' needs, clinicians and rehabilitation professionals ask themselves the same questions, and now a revolutionary tool may help answer them.

The new tool, the SmartWheel™, provides never-before-available data that may assist therapists and rehab professionals as they prescribe wheelchairs and may help them to justify their decisions to Medicare or third-party payers. The SmartWheel is unique because of its ability to provide hard data that, for the first time, would, for example, allow therapists to compare wheelchairs based on how easy they are to propel. As a result of research and development efforts and the involvement of several leading rehabilitation clinics, the SmartWheel is available as a tool that clinics can start using today.

What the SmartWheel Measures

To compare wheelchairs, there must be a method for measuring the forces (called propulsion biomechanics) people need to exert to propel their wheelchairs. To achieve this, the SmartWheel relies on sophisticated technology that includes "force sensing" beams and an onboard computer that calculates the forces an individual applies to the handrim during wheelchair propulsion.

For more than a decade, the SmartWheel has been used as a research tool to examine the factors (such as wheelchair design and setup) that influence how people propel their wheelchairs and to examine how propulsion style can in turn influence the development of pain in the wrists, arms, and shoulders of manual-wheelchair users.[1-8] For example, research from the Human Engineering Research Laboratories of the Department of Veterans Affairs and University of Pittsburgh, developers of the original SmartWheel, has shown that longer propulsion strokes (resulting in fewer pushes on the rim) and smoother strokes are associated with less pain and injury among wheelchair users.

It makes sense. Just like runners want long, smooth strides, wheelchair users want long,

smooth strokes that minimize banging on the handrims and reduce stress on the arms.

Today's SmartWheel mounts directly to most standard wheelchairs and uses a Wi-Fi high-speed wireless link and onboard memory that allows collection of propulsion data from almost anywhere: in the clinic or lab, down hallways, or outside at a park. As a person propels his or her wheelchair, the SmartWheel precisely measures forces applied to the handrim, how long and frequent each stroke is, acceleration and velocity, and distance traveled. Software provided with the SmartWheel uses these measurements to calculate propulsion efficiency (effort toward forward motion while minimizing any wasted efforts), stroke smoothness (amount of banging down on the rim), and ease of propulsion (how easy it is to propel the wheelchair). This type of information has never before been available to clinicians, rehab professionals, and equipment providers, and it opens the door to a variety of significant uses.

To simplify the wheelchair-selection process, the SmartWheel software creates comparison reports that allow for the direct and easy comparison of propulsion characteristics for two different wheelchairs. For example, as you can see in Table 1: Sample Report, a lighter wheelchair results in a lower value (easier to propel) for "ease of propulsion." For additional information about how these factors are calculated, visit www.thesmartwheel.com.

By facilitating wheelchair selection, insurance justification, and propulsion training, growing use of the SmartWheel may improve quality of life for wheelchair users and will result in economic benefits.

Uses of the SmartWheel

Wheelchair Selection: The SmartWheel is useful in comparing different types of manual wheelchairs because the chairs' weight and design will have a significant impact on factors such as ease of propulsion and propulsion efficiency. Although the most appropriate (or easiest to propel) wheelchair may be obvious to the consumer and the rehabilitation professional based on experience and observations, the SmartWheel now provides "hard data" that may serve as a quantitative justification for selecting one wheelchair over another. Prior to the SmartWheel, this quantitative justification was missing in attempts to justify a wheelchair's selection.

In this way, the SmartWheel facilitates wheelchair selection much in the same way force plates and gait analysis have been used to improve prosthetic-limb selection.

Insurance Justification: The SmartWheel may also be used to provide the quantitative justification that funding sources prefer and find more convincing than subjective assessments. These funding sources include medical insurance (e.g., Medicare or other third-party payers), workers compensation, and educational or private sources. The SmartWheel allows rehabilitation professionals and durable medical equipment (DME) providers to "paint a picture" with tables and reports that present hard data that describe the effect various wheelchairs have on propulsion and on individuals' mobility. The SmartWheel data also indicates an individual's overall ability to push, which may also help justify a power chair. Rather than relying on published research studies to defend the selection of one type of wheelchair over another or to justify power vs. manual, consumers, rehabilitation professionals, and equipment providers are now able to substantiate the fact that, for instance, for a specific individual, an ultralight wheelchair performs better than a given alternative, and they will be able to present data supporting their recommendation.

Table 1: Sample Report

The data presented here are for sample and discussion purposes only.

CLINIC INFORMATION

Name:	Three Rivers Clinic
Street Address:	1826 W. Broadway Rd. Ste. 43
City, State, Postal Code:	Mesa, AZ 85202

CLIENT INFORMATION

Full Name:	Joe A. Garrison	*Date of Birth:*	03/13/1980
Weight:	180	*Gender:*	Male
Additional Information:			

SESSION DESCRIPTION

Date:	Tuesday, July 20, 2004	*Starting Time:*	10:41
Purpose:	General Evaluation	*Clinical Protocol:*	Carpet
Notes:			

GENERAL SESSION RESULTS

Elapsed Time:	0:21 [minutes:seconds]		
Average Speed:	1.3 [mi/hr]	*Highest Speed:*	2.8 [mi/hr]
Total Distance:	0.008 [miles]		

PROPULSION STYLE AND ANALYSIS

Stroke Frequency [*strokes/second*] 1.00 A higher score means *more* frequent strokes.	Stroke Length [*degrees*] 55 A higher score means *longer* strokes.
Stroke Smoothness [*Average Peak Force/Average Propulsion Force*] 1.40 A larger ratio means *less* stroke smoothness.	
Average Propulsion Force [Newtons] 41.1 A higher score means *more* overall force (*Ft*) is being applied to the handrim.	
Average Peak Propulsion Force [Newtons] 57.9 A higher score means a *more* extreme force (*Ft*) is being applied to the handrim.	

PROPULSION EFFICIENCY

Efficiency: Total Forward Motion Force (Tangential) / Total Propulsion Force: 0.63 A larger ratio (closer to 1.0) means a *more* efficient propulsion stroke.
Ease of Propulsion: [*change of speed (mph) / time between strokes (s)*]: 0.45 *This score indicates how fast a wheelchair slows down when the user is not propelling. This "rolling resistance" determines how easy it is to propel the wheelchair and maintain a constant speed. Weight, chair design, and configuraton (i.e., axle position) will influence this score. Note: This score is most valid when propulsion is on a straight course and pushes are applied symmetrically to both handrims.*

OTHER OBSERVATIONS/NOTES

Aid	*Clinician*	*Supervisor*

Propulsion Training: The information the SmartWheel can display for a client about propulsion style may also assist with propulsion training (e.g., using longer, smoother strokes). Sonja de Groot and her colleagues assert that if propulsion techniques can be learned that improve the mechanical efficiency of wheelchair propulsion, it provides an avenue for novice wheelchair users to "optimize wheelchair performance much more effectively from the start of the rehabilitation process onward."[9] And, importantly, research suggests that propulsion skills can be learned relatively quickly in programs of just 2–3 weeks.[10-11] Because of the real-time feedback it provides, the SmartWheel enhances any propulsion training program, and early learning of wheelchair skills is likely to contribute to more positive rehabilitation outcomes.

Database, Clinical Evaluations

Because the SmartWheel automatically generates reports and stores the data and reports it creates, it simplifies a variety of tasks. For instance, a clinic that has implemented a wheelchair-propulsion training program now has easy access to data that will assist in documenting the program's before/after effects to allow for evaluation and justification of the program.

Databases created by the SmartWheel may also establish a foundation for testing the effectiveness of the services provided by a seating and mobility clinic. For example, a person's progression (in terms of effort exerted and propulsion style) as he or she migrates from an old wheelchair to a new one can be documented. Enhanced program-evaluation methods and documentation of the impact of services provided may also help pave the way for obtaining needed funding for equipment or targeted programs.

Leading the Way

Nineteen SmartWheels are already in use at 14 different sites in the U.S., Canada, and Europe. To create an active pipeline of shared information on these various uses and to keep these leading clinics in touch with each other, a SmartWheel Users Group was established in April 2004. It includes outstanding clinics such as the Mayo Clinic in Minnesota, the Center for Assistive Technology at the University of Pittsburgh Medical Center, the University of Illinois at Chicago, Schwab Rehabilitation Hospital in Chicago, the University College of London, Banner Good Samaritan Medical Center in Phoenix, Cardinal Hill Rehabilitation Hospital in Lexington (Ky.), Kessler Medical Rehabilitation Research and Education Corporation in New Jersey, and Washington University at St. Louis. This user group is leading the way in developing methodologies and applications of the SmartWheel and a standard clinical protocol for its use.

Better Quality of Life, Good Economic Sense

By facilitating wheelchair selection, insurance justification, and propulsion training, growing use of the SmartWheel may improve quality of life for wheelchair users and will result in economic benefits. By helping ensure that people get the chair that is best for them and by helping make sure they know how to propel it efficiently, use of the SmartWheel will ultimately help to prevent or delay the onset of pain in the hands, wrists, and shoulders that is so common among manual-wheelchair users.

By giving a person who requires a power chair the hard data to support its justification, the SmartWheel may help ensure he or she has the equipment necessary to maintain quality of life. Making sure that people have the right equipment not only improves quality of life but also saves significant medical costs associated with treatment of pain and injury in the wrists, arms, and shoulders that is exacerbated when the right equipment doesn't make its way to the person who needs it.

To achieve these aims, clinicians and rehabilitation professionals deserve the best tools—and now they are starting to get them.

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For references noted by superscripts in this article, visit: www.3rivers.com/References PNarticle2.php.