



## reSearch

A collection of research reviews on rehabilitation topics from NARIC and other information resources.

Volume 1, Issue 2, May 2006: Best Practices in Prosthetics and Orthotics.

In this edition of *reSearch* NARIC Information Specialists explored the topic of Best Practices in Prosthetics and Orthotics. The citations and programs listed in this research brief are the result of extensive keyword searches in several databases.

We combined more than 60 terms to create, expand, and narrow our searches. Four databases offered relevant citations: NARIC's REHABDATA database of disability and rehabilitation literature, the Cochrane Database of Systematic Reviews, the database of the Educational Resources Information Center (ERIC), and PubMed a database serving the National Library of Medicine and the National Institutes of Health. Of the keywords searched, 19 terms were common to all three databases:

-  Allied Health Occupations
-  Allied Health Occupations Education
-  Amputations
-  Assistive Technology
-  Body Image
-  Curriculum
-  Humans
-  Orthotics
-  Professional Education
-  Prosthetics
-  Questionnaires
-  Randomized Controlled Therapy
-  Research Design
-  Research Methodology
-  Self Assessment/Concept
-  Teaching methods
-  Therapy

The REHABDATA search resulted in 11 documents ranging from 2005 to 1998. Searches in the ERIC database resulted in one abstract from 2005. Two systematic reviews were found in The Cochrane Library. Finally, 10 documents ranging from 2006 to 2000 were located through NLM's PubMed database. Complete citations are included at the end of this research brief.

In addition to document searches, NARIC searched its Program database of the National Institute on Disability and Rehabilitation Research (NIDRR) projects to locate grantees/projects related to topics of prosthetics and orthotics. Five projects fell within the research scope. These projects and their publications are offered as additional resources for our patrons:

-  Efficacy of a Custom-fitting Cognitive Orthotic with Automatic Planning and Cueing Assistance  
Project Number: H133G040145  
(Active)
-  Rehabilitation Engineering Research Center in Prosthetics and Orthotics  
Project Number: H133E030030  
(Active)
-  Rehabilitation Engineering Research Center on Technology Access for Landmine Survivors  
Project Number: H133E030017  
(Active)
-  An Anthropology of the Prosthetics Field  
Project Number: H133F70011  
(No longer Funded)
-  Applications of Technology to the Rehabilitation of Children with Orthopedic Disabilities  
Project Number: H133E00015  
(See also H133E50006)  
(No longer Funded)

For project information, you may visit [www.naric.com/research/default.cfm](http://www.naric.com/research/default.cfm), select Research Projects and type in the project number. Each project listing includes citations from NARIC holdings.

**Documents from NARIC's REHABDATA search listed are listed below:**

**2005**

Hafner, Brian J. (2005). **Perceptive evaluation of prosthetic foot and ankle systems.** *Journal of Prosthetics and Orthotics*, 17(4 (Supplement)), S42-S46.

NARIC Accession Number: J49826

ABSTRACT: Article describes the outcome measures used to assess prosthetic function, performance, and preference and reviews the literature on the tools that have been used to compare prosthetic feet. The outcome measures generally fall into one of three categories: descriptive dialog, functional assessment questionnaires, and numerical rating scales. Descriptive dialog, or subjective feedback, is quick and easy but offers no way to standardize or statistically assess the results. Functional assessment questionnaires offer a way to standardize the results, but lack the ability to statistically analyze the results. Only numerical rating scales allow statistical analysis of the results; however, to date, only four comparative studies have used this method in the perceptive evaluation of prosthetic feet. In general, the literature shows a preference for and increased performance from high-end energy storage and return feet.

Hansen, Andrew H. (2005). **Scientific methods to determine functional performance of prosthetic ankle-foot systems.** *Journal of Prosthetics and Orthotics*, 17(4 (Supplement)), S23-S30.

NARIC Accession Number: J49821

ABSTRACT: Article describes two methods used to study the function of prosthetic ankle-foot mechanisms, lists the most consistent results of both approaches, and discusses a new method of analyzing these devices that may explain the contradictory results of both types of tests. The advantages and disadvantages of human subjects testing and mechanical properties testing are reviewed. The most consistent result of human subjects testing is the lack of significant differences that have been found in gait characteristics when people walk with various kinds of prosthetic feet. The most consistent result of mechanical properties testing is that prosthetic feet have widely different properties when tested outside the human-device system. The new method of analyzing prosthetic ankle-foot function involves the measurement of the center of pressure of the net force on a prosthetic foot during walking or under loads that simulate walking within a rocker shape, or rollover shape, taken by the

foot during the period between heel contact and opposite heel contact. Rollover shapes of prosthetic ankle-foot systems can be found using mechanical testing devices or directly from gait analysis data and the resulting shapes from both measurement techniques are similar.

**2004**

Carroll, Aine and Neil Fyfe. (2004). **A comparison of the effect of the aesthetics of digital cosmetic prostheses on body image and well-being.** *Journal of Prosthetics and Orthotics*, 16(2), 66-68.

NARIC Accession Number: J47803

ABSTRACT: Survey study examined patient satisfaction with silicon and polyvinyl chloride (PVC) digital prostheses, and examined the relationship between subjective body image and emotional status among patients with digital or partial hand amputation. Participants completed three questionnaires: the Hospital Anxiety and Depression scale, the Attitude to Artificial Limbs Questionnaire, and the adapted Body Image Questionnaire (BIQ). Analysis revealed: (1) most digital amputations are performed in males after industrial injuries, (2) patients with silicon digital prostheses clinically have a better attitude toward their prostheses, (3) there was little difference in body image as measured by the BIQ, and (4) patient with silicon digital prostheses experienced less anxiety and depression. The results suggest that enhanced cosmetics imply greater psychological well-being independently of body image.

**2003**

Fisher, Keren and Marion Price. (2003). **The use of a standard measure of emotional distress to evaluate early counseling intervention in patients with amputations.** *Journal of Prosthetics and Orthotics*, 15(1), 31-34.

NARIC Accession Number: J45112

ABSTRACT: Study used a 12-item version of the General Health Questionnaire (GHQ) to measure the emotional distress of patients during the first six months after amputation and to assess the effects of counseling. Participants completed the GHQ at their initial limb-fitting appointment and again four to six months later. Of the participants responding to the second questionnaire, 31 percent had participated in counseling. At the first appointment, those who chose counseling had higher GHQ scores than those who did not. Patients who reported problems with anger, effect on relatives,

and depression were significantly more distressed than those who did not report these problems initially. At follow-up, the scores of both groups had increased, suggesting more awareness of emotional distress four to six months after surgery. Results suggest the need to target patients for counseling around six months after amputation and then evaluate the effect of intervention later.

Shaperman, Julie and S. Landsberger. (2003). **Early upper limb prosthesis fitting: When and what do we fit.** *Journal of Prosthetics and Orthotics, 15(1), 11-17.*

NARIC Accession Number: J45110

ABSTRACT: Presents results of survey of child amputee clinics in North America regarding their current practices for early fitting of children with unilateral below-elbow amputations. Responses indicate that most children are fitted with a first prosthesis when they can sit independently and most clinics prefer to fit by age 6 months. Passive hands are the most frequently used terminal devices in the first fitting. Myoelectric hands are often fitted at 10 months and body-powered terminal devices by 18 months. No significant differences were found for timing and device preferences between different regions of North America or in Shriners versus non-Shriners hospitals. Cost was an important consideration in active terminal device selection in one-third of the clinics. Therapists recently decreased the amount of training given in clinics and rely more on parents to teach children at home.

## 2002

Desmond, D. and M. MacLachlan. (2002). **Psychosocial issues in the field of prosthetics and orthotics.** *Journal of Prosthetics and Orthotics, 14(1), 19-22.*

NARIC Accession Number: J43802

ABSTRACT: Article reviews key psychosocial issues relevant to prosthetic and orthotic practice and of special importance to the rehabilitation of the amputee. These include preparation for surgery, adjustment to life after surgery, posttraumatic stress disorder, body image, implications of age and developmental stage, phantom sensations, and phantom pain.

Horvorka, C. F.; D.G. Shurr. (2002). **The concept of an entry-level interdisciplinary graduate degree preparing orthotists for the new millennium part 2: Master of orthotic science.** *Journal of Prosthetics and Orthotics, 14(2), 59-70.*

NARIC Accession Number: J44074

ABSTRACT: Discusses the need for advanced orthotic and prosthetic education and describes a new model interdisciplinary graduate degree program, the master of orthotic science (MOS). The MOS program integrates several themes including research; clinical education; human anatomy and movement analysis; business and leadership/management; geriatrics, pediatrics and special populations; and unique topics. Pathways to the MOS, the program curriculum, faculty, funding, student recruitment, and program evaluation are discussed.

Malas, B. (2002). **Implementing outcome measurement in O & P education.** *Journal of Prosthetics and Orthotics, 14(2), 78-81.*

NARIC Accession Number: J44077

ABSTRACT: Paper examines the effectiveness of outcome measurement as a means of assessing orthotic and prosthetic educational programs. Assessment of the learner is emphasized rather than institutional structure and function. Provides specific examples of educational outcomes and measurement instruments, discusses achievement and evidence of outcomes, and explores the use of standardized outcomes.

## 1999

Hart, D L. (1999). **Orthotics and Prosthetics National Office Outcomes Tool (OPOT): Initial reliability and validity assessment for lower extremity prosthetics.** *Journal of Prosthetics and Orthotics, 11(4), 101-111.*

NARIC Accession Number: J39624

ABSTRACT: Study evaluating the validity and reliability of the Orthotics and Prosthetics National Office Outcomes Tool (OPOT), which was developed to assess health status, client satisfaction, and prosthetists' perception of function for clients with lower extremity prosthetic needs. The data set included 840 adults requiring lower extremity prostheses, as seen in 56 practices by 278 prosthetists from 25 states. Results support the reliability and construct validity of the OPOT for clients with lower extremity prosthetic needs.

## 1998

Gauthier-Gagnon, C and M.C. Grise. (1998). **Predisposing factors related to prosthetic use by people with a transtibial and transfemoral amputation.** *Journal of Prosthetics and Orthotics, 10(4), 99-109.*

NARIC Accession Number: J35883

**ABSTRACT:** Survey intended to evaluate prosthetic use and factors predisposing to prosthetic use among respondents, 396 adults with unilateral amputations. Prosthetic use (including daily use, length of use, cosmetic versus active use, and indoor versus outdoor use) is related to level of amputation (transtibial versus transfemoral) and various predisposing factors in the areas of physical health status, demographics, time frames of rehabilitation programs, and adaptation to the prosthesis and the amputation.

Kanny, E M and D.K. Anson. (1998). **Current trends in assistive technology education in entry-level occupational therapy curricula.** *American Journal of Occupational Therapy*, 52(7), 586-591.

NARIC Accession Number: J35370

**ABSTRACT:** Article about a 1994-1995 survey intended to determine what changes had occurred in the education of entry-level occupational therapy (OT) students related to assistive technology since a previous survey in 1989. Questionnaires were sent to all entry level OT programs in the United States (N = 79), and responses were received from 70. It was found that assistive technology education had increased in 11 identified areas. The highest increases were found in environmental access and robotics, sensory aids, augmentative communication, and prosthetics and orthotics. Only 10% of the responding programs had less than 20 hours of assistive technology education, compared with 50% in 1989. Thirty (43%) included one or more technology courses in their curricula compared with 17 (29%) in 1989, and 62 (89%) included assistive technology content in lectures or units throughout the curriculum compared with 32 (54%) in 1989.

*To order any of the documents listed above, note the accession number and call an information specialist at 800/346-2742. There is a charge of 5¢ per page for copying and shipping with a \$5 minimum on all orders.*

**Documents from the Cochrane Database of Systematic Reviews search at [www.thecochranelibrary.org/](http://www.thecochranelibrary.org/) are listed below:**

## 2002

N.E. D'hondt, P.A.A. Struijs and G.M. Kerkhoffs. (2002). **Orthotic devices for treating patellofemoral**

**pain syndrome.** *The Cochrane Database of Systematic Reviews: Reviews 2002 Issue 2.*

Cochrane ID: CD002267

**ABSTRACT:** Five trials involving 362 participants were included in this review. Five other trials await possible inclusion if further information can be obtained and one awaits further assessment. Due to clinical heterogeneity, we refrained from statistical pooling and conducted analysis by grading the strength of scientific evidence. The level of obtained research-based evidence was graded as limited as all trials were of low methodological quality. This limited research-based evidence showed the Protonics orthosis at six week follow-up was significantly more effective for decrease in pain (weighted mean difference (WMD) between groups 3.2; 95% confidence interval (CI) 2.8 to 3.6), functional improvement on the Kujala score (WMD 45.6; 95% CI 43.4 to 47.7) and change in patellofemoral congruence angle (WMD 17.2; 95% CI 14.1 to 20.3) when compared to no treatment. A comprehensive programme including tape application was significantly superior to a monitored exercise programme without tape application for decrease in worst pain (WMD 1.6; 95% CI 0.4 to 2.8) and usual pain (WMD 1.2; 95% CI 0.2 to 2.1), and clinical change and functional improvement questionnaire scores (WMD 10, 95% CI 2.07 to 17.93) at four weeks follow-up. The trials reported statistically significant differences in patient satisfaction after applied therapy (WMD 3.3; 95% CI 0.5 to 6.1) in favour of the McConnell regimen compared with the Coumans bandage at six weeks follow-up. The evidence from randomised controlled trials is currently too limited to draw definitive conclusions about the use of knee and foot orthotics for the treatment of patellofemoral pain. Future high quality trials in this field are warranted.

## 2000

Spencer, S. (2000). **Pressure relieving interventions for preventing and treating diabetic foot ulcers.** *The Cochrane Database of Systematic Reviews: Reviews 2000 Issue 3.*

Cochrane ID: CD002302

**ABSTRACT:** Four RCTs of pressure relieving interventions were identified. Interventions for the prevention of diabetic foot ulcers indicated that in-shoe orthotics are of benefit. The relative merits of different in-shoe orthotics are unclear; cushioning and pressure redistribution appear of equal benefit. Other pressure

relieving interventions such as running shoes have not been adequately evaluated and removable casts (Scotchcast or Hope) or foam inlays do not appear to have been evaluated at all in randomised controlled studies. One RCT of total contact casting indicated that it was effective in the treatment of diabetic ulcers although the evidence was limited. Results showed that for prevention there is limited evidence of the effectiveness of orthotic interventions over removal of callus. There is some evidence evaluating the relative effectiveness of two types of orthotic devices. There is very limited evidence of the effectiveness of therapeutic shoes. In terms of treatment, there is very limited evidence of the effectiveness of total contact casts in the treatment of diabetic foot ulcers. Overall there is a need to measure the effectiveness of the range of pressure relieving interventions for the prevention and treatment of diabetic foot ulcers as there is a small amount of poor quality research in this area.

*Full details of these reviews are available at [thecochranelibrary.org](http://thecochranelibrary.org). Fee-based subscription is required.*

**Document from the Education Resource Information Center (ERIC) search at [www.eric.ed.gov/](http://www.eric.ed.gov/) are listed below:**

#### 2005

Hope, J. (2005). **Francis Tuttle's Orthotic and Prosthetic.** *Techniques: Connecting Education and Careers*, 80(5), 28-33.

ERIC #: EJ718624

**ABSTRACT:** The Francis Tuttle name has long been associated with career and technical education. As director of Oklahoma's State Department of Vocational and Technical Education for almost two decades, Dr. Tuttle pioneered the way for career and technical education nationwide. His progressive ideas continue to flourish at the Francis Tuttle Technology Center, where success is found through academic studies such as those offered in its Orthotic and Prosthetic Technician Program. This article describes the developmental history of the Francis Tuttle Orthotic and Prosthetic Program. It is divided into the following sections: In the Beginning; Francis Tuttle's Program; and Bracing for the Future. A brief list of resources for more information is also included.

*Full text of articles in the ERIC database may be available at [eric.ed.gov](http://eric.ed.gov). Links to publishers are also included.*

**Documents from the National Library of Medicine (NLM) PubMed search at [www.pubmed.gov](http://www.pubmed.gov) are listed below:**

#### 2006

Spaeth, J.P. (2006). **Laser imaging and computer-aided design and computer-aided manufacture in prosthetics and orthotics.** *Physical medicine and rehabilitation clinics of North America*, 17(1), 245-63.  
PMID: 16517353

**ABSTRACT:** Although Hanger Orthopedic Group, Inc., has been developing clinical protocols for its INSIGNIA scanner for more than two years, there are many applications that are currently in development and will be released over the next two-year period after this publication. It is the goal of Hanger Orthopedic Group, Inc., to replace all plaster casting procedures with the laser scan and move toward a paperless environment where all images and documents are passed through its virtual network. INSIGNIA currently has five major production centers throughout the United States, which support more than 600 INSIGNIA certified clinicians. These clinicians staff more than 600 clinics in North America, all under the Hanger company name. The central fabrication service and the central design center processes hundreds of shapes per day. So that any clinician in the field can use the expertise of the central designers and central fabricators to help with overflow or problems they might be having, the network that exists within Hanger is tied together and enhanced by INSIGNIA. Through virtual modification and centralization of these services, each patient receives the virtual collaboration of several clinicians with a total of years of experience. INSIGNIA has enhanced the patient experience. The enhancement is not only in removing the plaster from the process, but also in exposing each patient to the team of prosthetic experts working collaboratively behind the scenes. The rehabilitation industry continues to be bombarded with compliance paperwork and justifications. The INSIGNIA scan and resulting measurement reports give inherent strength to justifications based on volume change, surgical revisions, or tissue change. The files are kept in a data warehouse where they are vaulted and preserved presumably forever. Also, any of the shape graphics or measurement instruments can be printed into a discrete report that can become part of the patient's permanent record. Many physicians receive update letters from their orthotic and prosthetic clinician with a status update before and after treatment of their patient. This update includes a descriptive narrative, a printout of

the pertinent metrics, a printout of the scan graphic, and often a digital image of the patient wearing the device. The network is HIPAA compliant, and all private health information is held in tight security. If a practitioner does not have a HIPAA agreement in place with Hanger Orthopedic Group, Inc., and would like one, or if a practitioner would like to have an INSIGNIA representative call or visit with more information, the practitioner is encouraged to call 1-800-4-HANGER and request an INSIGNIA in-service or visit INSIGNIA on the web at [www.hanger.com](http://www.hanger.com).

## 2005

Morris, C. (2005). **The design, conduct and reporting of clinical trials in prosthetics.** *Prosthetics and Orthotics International*, 29(1), 115-7.

PMID: 16180385

(No abstract available).

Shangali, H.G. (2005). **A vision towards a brighter future in prosthetics and orthotics.** *Prosthetics and Orthotics International*, 29(3), 207-8.

PMID: 16466150

(No abstract available).

## 2004

International Society for Prosthetics and Orthotics and World Health Organization. (2004). **The relationship between prosthetics and orthotics services and community-based rehabilitation. A joint ISPO/WHO statement revised December 2003.** *Prosthetics and Orthotics International*, 28(1), 3-8.

PMID: 15171572

(No abstract available).

Wong, M.S., Lemaire E.D., Leung, A.K. and M.F. Chan. (2004). **Enhancement of prosthetics and orthotics learning and teaching through e-Learning technology and methodology.** *Prosthetics and Orthotics International*, 28(1), 55-9.

PMID: 15171579

ABSTRACT: A Write-Once Publish-Everywhere model was used to create and deliver on-line clinical training and education for undergraduate prosthetics and orthotics students. This project consisted of three phases: developing multimedia learning and teaching tools, integrating these tools into the curriculum (combination of e-Learning and live practical sessions),

and evaluating the outcomes. Video-based multimedia contents were captured and integrated with graphic, audio and text into a PowerPoint presentation software format. The web-based content was integrated into the WebCT platform for course management. Questionnaires were used to obtain student feedback on this e-Learning approach. Results were compared within the prosthetics and orthotics (P&O) programme, with other Health Sciences programmes, and overall with the University. P&O student responses were significantly higher than other groups for career relevance and problem solving. Qualitative feedback indicated that students appreciated the easy access, integrated and interactive approach of the text materials, concise PowerPoint presentation, demonstration video and the on-line case discussion via the WebCT platform. Educators appreciated the ability easily to maintain contents and publish the modules across multiple media without recreating the contents.

## 2003

Heinemann, A.W., Bode, R.K. and C. O'Reilly. (2003). **Development and measurement properties of the Orthotics and Prosthetics Users' Survey (OPUS): a comprehensive set of clinical outcome instruments.** *Prosthetics and Orthotics International*, 27(3), 191-206.

PMID: 14727700

ABSTRACT: The need to measure and evaluate orthotics and prosthetics practice has received growing recognition in the past several years. Reliable and valid self-report instruments are needed that can help facilities evaluate patient outcomes. The objective of this project was to develop a set of self-report instruments that assess functional status, quality of life, and satisfaction with devices and services that can be used in an orthotics and prosthetics clinic. Selecting items from a variety of existing instruments, the authors developed and revised four instruments that differentiate patients with varying levels of lower limb function, quality of life, and satisfaction with devices and services. Evidence of construct validity is provided by hierarchies of item difficulty that are consistent with clinical experience. For example, with the lower limb function instrument, running one block was much more difficult than walking indoors. The instruments demonstrate adequate internal consistency (0.88 for lower limb function, 0.88 for quality of life, 0.74 for service satisfaction, 0.78 for device satisfaction). The next steps in their research programme are to evaluate

sensitivity and construct validity. The Orthotics and Prosthetics Users' Survey (OPUS) is a promising self-report instrument which may, with further development, allow orthotic and prosthetic practitioners to evaluate the quality and effectiveness of their services as required by accreditation standards such as those of the American Board for Certification in Orthotics and Prosthetics that mandate quality assessment.

## 2002

Desmond, D. and M. MacLachlan. (2002). **Psychological issues in prosthetic and orthotic practice: a 25 year review of psychology in Prosthetics and Orthotics International.** *Prosthetics and Orthotics International*, 26(3), 182-8.

PMID: 12562064

**ABSTRACT:** In the inaugural edition of *Prosthetics and Orthotics International*, Fishman identified the psychological sciences as one of six indispensable areas of skill and knowledge in professional prosthetic-orthotic practice. Given the journal's significant role in reporting and developing pertinent research and practice, this review assesses the profile of psychology in prosthetic and orthotic research, as evidenced by the content of *Prosthetics and Orthotics International* since its inception. A MEDLINE search of the journal's abstracts over a twenty-five year period was conducted using the search terms: 'psychology', 'psychosocial', 'quality of life', 'developmental' and 'coping'. Results of this search are summarised under the following headings: (a) body image; (b) coping and adjustment; (c) developmental issues; (d) psychosocial well-being; (e) quality of life; and (f) psychological factors leading to amputation. On the basis of this review, the authors conclude by highlighting a number of key areas where the psychological aspects of prosthetics and orthotics warrant further investigation and dissemination.

Geertzen, J.H., Gankema, H.G., Groothoff, J.W. and P.U. Dijkstra. (2002). **Consumer satisfaction in prosthetics and orthotics facilities.** *Prosthetics and Orthotics International*, 26(1), 64-71.

PMID: 12043928

**ABSTRACT:** The aim of this study was to assess consumer/patient satisfaction with the services of the prosthetics and orthotics (P&O) facilities in the north of the Netherlands, using a modified SERVQUAL questionnaire. In this questionnaire, consumer interests

and experiences are assessed on a 5-point Likert scale. The questionnaire consisted of 30 items covering 5 domains: tangibles, reliability, responsiveness, assurance and empathy and the consumers were invited to give an overall rating of satisfaction (scale 1-10). Consumers of four P&O facilities were asked to participate. In total 496 consumers (aged 0-76) participated; 279 consumers received orthopaedic shoes and 217 consumers received either prostheses or orthoses. An overall satisfaction rating of 8 or higher was given by 75% of the consumers (mean 8.0; sd=1.2). Consumers were defined as satisfied with the services of the P&O facility if they rated their experiences on a certain item equal or better than their rating of its importance. Eighty-five percent (85%) or more of the consumers were satisfied with the P&O facility in 24 of the 30 (80%) items of the SERVQUAL questionnaire. Of the six less unsatisfying items, three were related to the domain "tangibles", two were related to the domain "empathy" and one to the domain "responsiveness". The management of the P&O facility can use this information to increase consumer satisfaction by improving quality and service at these items. In general, the degree of consumer overall satisfaction was not related to age, gender, and type of assistive device or "length of relationship of consumer" and P&O facility. Only consumers who received orthopaedic shoes rated their overall satisfaction significantly lower (0.3) than consumers who received other types of devices. This difference is clinically not relevant.

## 2001

(2001). **ISPO consensus conference on appropriate orthopaedic technology for low-income countries: conclusions and recommendations.** *International Society for Prosthetics and Orthotics.* *Prosthetics and Orthotics International*, 25(3), 168-70.

PMID: 11860089

(No abstract available).

Smith, D.G. and E.M. Burgess. (2001). **The use of CAD/CAM technology in prosthetics and orthotics—current clinical models and a view to the future.** *Journal of Rehabilitation Research and Development*, 38(3), 327-34.

PMID: 11440264

**ABSTRACT:** This report examines the current clinical uses of CAD/CAM in prosthetics and orthotics. We conducted interviews to contrast patterns of CAD/CAM use in different private practice settings, at two different

teaching institutions, and within two large Prosthetic and Orthotic delivery systems. Investigation into these patterns of use has revealed several lessons. First, there currently exist several very different models of use in clinical practice and these different models will most likely continue. The clinical models range from all traditional techniques with no use of CAD/CAM, to full in-house suites of CAD/CAM equipment with extensive utilization, to a simplified office with minimal in-house equipment and minimal fabrication and a near total dependency on central fabrication. Second, a growing number of prosthetic and orthotic devices are successfully being fabricated and fit with CAD/CAM technology after starting the process with simple measurements instead of casted, scanned, or digitized exact anatomic data. Starting the CAD process with "by-the-numbers approach" has revealed the reality that for some devices, the "input" needed to define the shape of the residual limb or torso, may not need to be as accurate as originally thought. Third, the fabrication techniques that are currently being used with CAD/CAM systems are still rather traditional techniques. Most devices are still laminated or formed over computer carved models. Although research continues into advanced fabrication techniques, the prosthetics and orthotics industry has not yet taken advantage of the possibilities in the computer-assisted manufacturing side of the equation. Finally, the business of manufacturing and selling up-to-date CAD/CAM equipment and software has a tremendous impact on how this technology is used in prosthetics and orthotics. The size of the prosthetics and orthotics industry and the potential number of customers for major equipment are relatively small. Being in the business of providing the advanced CAD/CAM systems of tomorrow is an expensive and difficult proposition. Current users of full in-house CAD systems have expressed concern that upgrading equipment and software might not be economical with today's decreasing revenues. For all of these reasons, many believe that the number of practitioners who use a central fabrication model will grow more rapidly than the number of practitioners who own and operate a full in-house system.

**2000**

Brncick, M. **Computer automated design and computer automated manufacture.** *Physical medicine and rehabilitation clinics of North America*, 11(3), 701-13.

PMID: 10989487

**ABSTRACT:** The introduction of computer aided design and computer aided manufacturing into the field of prosthetics and orthotics did not arrive without concern. Many prosthetists feared that the computer would provide other allied health practitioners who had little or no experience in prosthetics the ability to fit and manage amputees. Technicians in the field felt their jobs may be jeopardized by automated fabrication techniques. This has not turned out to be the case. Prosthetists who use CAD-CAM techniques are finding they have more time for patient care and clinical assessment. CAD-CAM is another tool for them to provide better care for the patients/clients they serve. One of the factors that deterred the acceptance of CAD-CAM techniques in its early stages was that of cost. It took a significant investment in software and hardware for the prosthetists to begin to use the new systems. This new technique was not reimbursed by insurance coverage. Practitioners did not have enough information about this new technique to make a sound decision on their investment of time and money. Ironically, it is the need to hold health care costs down that may prove to be the catalyst for the increased use of CAD-CAM in the field. Providing orthoses and prostheses to patients who require them is a very labor intensive process. Practitioners are looking for better, faster, and more economical ways in which to provide their services under the pressure of managed care. CAD-CAM may be the answer. The author foresees shape sensing departments in hospitals where patients would be sent to be digitized, similar to someone going for radiograph or ultrasound. Afterwards, an orthosis or prosthesis could be provided from a central fabrication facility at a remote site, most likely on the same day. Not long ago, highly skilled practitioners with extensive technical ability would custom make almost every orthosis. One now practices in an atmosphere where off-the-shelf orthoses are the standard. This reduced fabrication time, but compromised the accuracy of the fit of a custom made orthosis. Computer aided design and manufacturing has the ability to combine the accuracy of custom made with the speed and labor savings of off-the-shelf systems. This would be a substantial benefit to patients, practitioners, and third party payors as well. The field may run full circle and return to custom made systems at off-the-shelf costs. As scientific knowledge base increases and computer aided design improves, one still needs the interface between the design methodology and the patient. That interface is the

prosthetist/orthotist. The clinician and the clients they serve have a lot to gain from further research in this field. If one does not lose focus on how one can improve prostheses and orthoses for the consumer, one can expect great things from the methodology of CAD-CAM. There is no question that computerization is here and will continue to influence the fields of prosthetics and orthotics.

Full text of articles in the PubMed database may be available at [pubmed.gov](http://pubmed.gov). Links to publishers are also included.

## Quick Looks



### Google Scholar Search

“Best Practices” for Prosthetics or Orthotics results in 3,560 documents  
[scholar.google.com](http://scholar.google.com)

### Center for International Rehabilitation Research Information and Exchange

“Prosthetics” results in 735 abstracts,  
“Orthotics” results in 183 abstracts  
[cirrie.buffalo.edu](http://cirrie.buffalo.edu)

### NARIC

“Prosthetics or Orthotics” results in 618 abstracts  
[www.naric.com](http://www.naric.com)

### About *reSearch*:

*reSearch* is a new information product from the National Rehabilitation Information Center (NARIC). Each issue is based on real-world queries received by our information specialists from researchers, educators, and rehabilitation professionals around the world.

We search several sources both in-house and online, to fill these requests including:

- 📖 REHABDATA and the NIDRR Program database
- 📖 Education Resources Information Center
- 📖 National Clearinghouse of Rehabilitation Training Materials
- 📖 Campbell and Cochrane Collaborations
- 📖 PubMed and other National Library of Medicine databases
- 📖 Agency for Health Care Policy and Research databases
- 📖 Center for International Rehabilitation Research Information and Exchange

and other reputable, scholarly information resources.

We hope you find these *reSearch* briefs informative in your own research.

- NARIC Information and Media Team