Evidence-based Practice Initiative – Simulator

"Comparison of the strength endurance parameters for the Baltimore Therapeutic Equipment (BTE) Simulator II and the Jamar Handgrip Dynamometer."

Myers E, Trsicari R: Comparison of the strength endurance parameters for the Baltimore Therapeutic Equipment (BTE) Simulator II and the Jamar Handgrip Dynamometer. Work. 2017. doi:10:3233/WOR-172542.

ABSTRACT:
BACKGROUND: The purpose of this study was to provide evidence regarding the Baltimore Therapeutic Equipment (BTE) Work Simulator II's recommended grip endurance protocol. The grip endurance protocol of the BTE Simulator II has never been validated, though it has been used often for the rehabilitation of work-related injuries and other occupational dysfunctions. Without validation, the grip endurance protocol may or may not be providing skilled clinicians with appropriate evaluation results. This study evaluated a protocol comparing the BTE Simulator II to the Jamar Dynamometer to determine how the BTE compares to the Jamar device.
OBJECTIVE: To establish whether the recommended grip endurance protocol for the BTE Simulator II is comparable to the parameters established for the Jamar handgrip dynamometer.
METHODS: Data were gathered from 140 participants ages 18 to 40 at the time of the study. Participants completed protocols established for the BTE Simulator II and compared to a performance of a grip strength endurance protocol for the Jamar Handgrip Dynamometer. After establishing baseline strength levels for the participants, they were timed to see how long they could sustain a 30% maximum voluntary contraction (MVC) on each device. Sample t-tests were calculated to compare the results of the BTE Simulator II to the previously validated Jamar device.
RESULTS: A dependent sample t-test found no statistically significant difference between the times a participant sustained 30% of their maximum voluntary contraction (MVC) on the BTE Simulator II with attachment #162 versus the Jamar Dynamometer when comparing the differences of the means. This provides possible evidence of validity for the BTE endurance protocol. The independent sample t-test found no statistically significant difference between the grip endurance of the males versus the females, however, the means indicate men sustained 30% of their MVC longer than their female counterparts on the BTE.
CONCLUSIONS: The findings indicate that the 30% MVC may be a reliable baseline for grip strength endurance testing following the BTE Simulator II protocol. This suggests that the BTE Simulator II's endurance protocol may be a useful tool to document client progression during rehabilitation after sustaining an upper extremity dysfunction. Further research is needed to validate this protocol using different populations.

Use of Simulator: validation study of endurance protocol related to musculoskeletal evaluation of endurance of muscles involved with hand grip.

"Donor activation focused rehabilitation approach – maximizing outcomes after nerve transfers."

Kahn LC, Moore AM: Donor activation focused rehabilitation approach – maximizing outcomes after nerve transfers. Hand Clin. 2016;32:263-277. http://dx.doi.org/10.1016/j.hcl.2015.12.014.

ABSTRACT:
In this article, the factors influencing outcomes after nerve transfers are reviewed, including preoperative and postoperative interventions. Rehabilitation protocols for specific nerve transfers also are addressed.

Although not all-inclusive, the general principles presented can be applied to any nerve transfer performed.

Use of Simulator: neuromuscular re-education post-various nerve transfers.

"Quantitative assessment of scalene muscle block for the diagnosis of suspected thoracic outlet syndrome."

Braun RM, Shah KN, Rechnic M, Doehr S, Woods N: Quantitative assessment of scalene muscle block for the diagnosis of suspected thoracic outlet syndrome. J Hand Surg Am. 2015; article in press.

ABSTRACT:
Purpose: To measure changes in upper limb work and power capacity before and after anterior scalene muscle block (ASMB) to suggest thoracic outlet syndrome caused by costoclavicular space compression.
Methods: We evaluated 34 patients disabled by symptoms suggesting thoracic outlet syndrome. An ASMB was performed via a supraclavicular injection. The sternocleidomastoid muscle was injected as a control. We captured data obtained from work simulator measurements before and after ASMB. Each patient performed a push-pull test with the forearm at waist level (test 1), an overhead bar push-pull test with the arm elevated (test 2), and the extremity abduction stress test with repetitive hand gripping during static arm elevation (test
3). We measured the work product, time to fatigue, and power generation. Sensory testing was performed after ASMB to rule out improved performance associated with possible sensory nerve block.
Results: In contrast to sternocleidomastoid injection controls, symptomatic and functional improvement was noted in all patients (n = 34) after ASMB. Work product measurement improved 93%, 108%, and 104% for tests 1, 2, and 3, respectively. Time to fatigue and power output also increased after the block.
Conclusions: Temporary symptomatic improvement after ASMB may be anticipated in patients with TOS. This study documents a significant concurrent increase in upper limb motor function after the block. Increased work and power measurements after ASMB may draw diagnostic inference regarding a dynamic change in the scalene muscle and the costoclavicular space associated with symptomatic thoracic outlet syndrome.

Use of Simulator: musculoskeletal evaluation of the functional work capacity of patients with suspected thoracic outlet syndrome. Isotonic mode was utilized to measure dynamic endurance.

"The use of occupation-based assessments and intervention in the hand therapy setting – a survey."

Grice KO: The use of occupation-based assessments and intervention in the hand therapy setting – a survey. J Hand Ther. 2015;28:300-306.

ABSTRACT:
Study design: Descriptive survey.
Introduction: This study specifically explored the use of occupation-based assessments and intervention in the hand therapy setting, but also more generally, current practice trends about all assessments being utilized in this setting, frequency of their use, and therapists' perceptions about them.
Methods: An online survey was distributed via email to members of the American Society of Hand Therapists (ASHT). The survey consisted of ten questions and was administered via Survey Monkey.
Results: Responses were received from 22% of those surveyed. A descriptive analysis was completed of the results and indicated that over half use occupation-based assessments on a daily basis; most are related to ADL function and used for the development of goals. The primary reason for not utilizing

occupation-based assessments is time limitation. Seventy-nine percent believe these measures are important for the services provided in the hand therapy setting.
Conclusion: Occupation-based assessments and intervention are not utilized as much as therapists would like in the hand therapy setting, primarily due to time constraints. While not formally assessed, the majority of those who responded indicated that they do address occupation in their assessments and interventions.

Use of Simulator: musculoskeletal evaluation and treatment of ADLs, functional tasks, work activities, leisure activities, and sports.

"Pisiform excision for pisotriquetral instability and arthritis."

Campion H, Goad A, Rayan G, Porembski M: Pisiform excision for pisotriquetral instability and arthritis. J Hand Surg. 2014;39(7):1251-1257.

ABSTRACT:
Purpose: To evaluate wrist strength and kinematics after pisiform excision and preservation of its soft tissue confluence for pisotriquetral instability and arthritis.
Methods: We evaluated 12 patients, (14 wrists) subjectively and objectively an average of 7.5 years after pisiform excision. Three additional patients were interviewed by phone. Subjective evaluation included inquiry about pain and satisfaction with the treatment. Objective testing included measuring wrist flexion and extension range of motion, grip strength, and static and dynamic flexion and ulnar deviation strengths of the operative hand compared with the nonsurgical normal hand. Four patients had concomitant ulnar nerve decompression at the wrist.
Results: All patients were satisfied with the outcome. Wrist flexion averaged 99% and wrist extension averaged 95% of the nonsurgical hand. Mean grip strength of the operative hand was 90% of the nonsurgical hand. Mean static flexion strength of the operative hand was 94% of the nonsurgical hand, whereas mean dynamic flexion strength was 113%. Mean static ulnar deviation strength of the operative hand was 87% of the nonsurgical hand. The mean dynamic ulnar deviation strength of the operative hand was 103% of the nonsurgical hand.
Conclusions: Soft tissue confluence-preserving pisiform excision relieved pain and retained wrist motion and static and dynamic strength. Associated ulnar nerve compression was a confounding factor that may have affected outcomes.

Use of Simulator: musculoskeletal evaluation of wrist muscle performance in patients post-pisiform excision. Isometric and isotonic modes were utilized to measure maximum strength capabilities dynamic power output of the wrist flexors and extensors.

"Traumatic hand injury involving multiple structures."

Kurtz PE: Traumatic hand injury involving multiple structures. In Cooper C (ed). *Fundamentals of Hand Therapy. Clinical Reasoning and Treatment Guidelines for Common Diagnoses of the upper Extremity.* 2nd ed. St. Louis, MO: Elsevier Mosby; 2014:508-523.

Use of Simulator: musculoskeletal treatment to increase muscle strength and endurance of patients post-digital amputation and laceration and repair of tendons, nerves, and vessels.

“Supercharged end-to-side anterior interosseous to ulnar motor nerve transfer for intrinsic musculature reinnervation.”

Barbour J, Yee A, Kahn LC, MacKinnon SE: Supercharged end-to-side anterior interosseous to ulnar motor nerve transfer for intrinsic musculature reinnervation. J Hand Surg. 2012;37A:2150-2159.

ABSTRACT:
Functional motor recovery after peripheral nerve injury is predominantly determined by the time to motor end plate reinnervation and the absolute number of regenerated motor axons that reach target. Experimental models have shown that axonal regeneration occurs across a supercharged end-to-side (SETS) nerve coaptation. In patients with a recovering proximal ulnar nerve injury, a SETS nerve transfer conceptually is useful to protect and preserve distal motor end plates until the native axons fully regenerate. In addition, for nerve injuries in which incomplete regeneration is anticipated, a SETS nerve transfer may be useful to augment the regenerating nerve with additional axons and to more quickly reinnervate target muscle. We describe our technique for a SETS nerve transfer of the terminal anterior interosseous nerve (AIN) to the pronator quadratus muscle (PQ) end-to-side to the deep motor fascicle of the ulnar nerve in the distal forearm. In addition, we describe our postoperative therapy regimen for these transfers and an evaluation tool for monitoring progressive muscle reinnervation. Although the AIN–to–ulnar motor group SETS nerve transfer was specifically designed for ulnar nerve injuries, we believe that the SETS procedure might have broad clinical utility for second- and third-degree axonotmetic nerve injuries, to augment partial recovery and/or “babysit” motor end plates until the native parent axons regenerate to target. We would consider all donor nerves currently utilized in end-to-end nerve transfers for neurotmetic injuries as candidates for this SETS technique.

Use of Simulator: neuromuscular treatment to “stimulate both donor and recipient muscles facilitate cortical remapping and strengthen the recipient ulnar-innervated muscles” of patients post-nerve transfers. The system was also used to monitor the patient’s progression through therapy.

“Differences in posture–movement changes induced by repetitive arm motion in healthy and shoulder-injured individuals.”

Lomond KV, Cote JN: Differences in posture–movement changes induced by repetitive arm motion in healthy and shoulder-injured individuals. Clin Biomech. 2011;26:123-129.

ABSTRACT:
Background: Neck/Shoulder pain is linked to movement repetition, awkward postures, prolonged maintenance of static postures, and muscular fatigue. Studies have examined the influence of pain and fatigue on movement characteristics, but few reported multi-dimensional adaptations to movement repetition. We compared the adaptations measured in three-dimensions during a repetitive reaching task in persons with chronic neck/shoulder pain and healthy subjects.
Methods: A shoulder-injured group (intensity >3/10, duration >3 consecutive months) and an age–sex-matched control group (n=16 in each) performed a repetitive reaching task to voluntary termination. Kinematics, kinetics, heart rate and muscle activity were recorded throughout. Power output on a 10-s pushing/pulling task was assessed pre- and post-reaching. Group comparisons were made in absolute time and at task end.
Findings: Control subjects performed the task 55% longer than the pain group; yet, both groups demonstrated task-related increased heart rate (6 beats per minute) and decreased power output (6 W). Throughout the task, the pain group demonstrated: higher supraspinatus activity, and less elbow flexion and endpoint movement. The control group increased movement amplitude of the endpoint, elbow, and

shoulder, while the pain group moved the shoulder less and increased center of mass excursion to maintain the task.
Interpretation: Both groups adapted to the task in unique ways. The control group continually increased elbow and endpoint range of motion, bringing the arm closer to the targets, possibly to prolong task performance. The pain group used a fixed, en block arm strategy, likely to reduce the load on the injured structures; however, this may place other structures at risk for pain and injury.

Use of Simulator: musculoskeletal evaluation and treatment of upper extremity strength of healthy individuals and others with neck/shoulder pain. Isometric and Isotonic modes were utilized to measure maximum strength capabilities and power output during pushing and pulling tasks.

"Shoulder functional assessment in persons with chronic neck/shoulder pain and healthy subjects: Reliability and effects of movement repetition."

Lomond KV, Cote JN: Shoulder functional assessment in persons with chronic neck/shoulder pain and healthy subjects: Reliability and effects of movement repetition. Work. 2011;38:169-180.

ABSTRACT:
Objective: Obtaining reliable functional capacity measures from injured workers is an essential part of the return to work (RTW) process. The present study compares shoulder functional outcomes between healthy individuals and others with neck/shoulder pain, assesses reliability and examines the influence of repetitive movements on shoulder function.
Methods: Subjects performed trials of flexion and abduction active range of motion (ROM), and cumulative power output (PO) in a pushing/pulling task on the Baltimore Therapeutic Equipment Simulator II in two consecutive sessions. Tasks were assessed before and after performing a repetitive arm task, during which heart rate (HR) was recorded, until scoring 8 on the Borg CR10 scale or on a 11-point numeric rating scale (NRS) for pain.
Participants: Persons with chronic neck/shoulder pain (intensity ≥ 3/10 for > 3 months) (n = 16) and an age- and sex-matched control group (n = 16).
Results: Functional shoulder measures demonstrated strong inter-session reliability, except PO in the pain group. Average repetitive task duration was shorter in the pain group (4 min vs. 7 min).
Conclusions: The protocol detected both pain- and time-related impairments, with HR and PO being sensitive to movement duration and ROM to pain.

Use of Simulator: musculoskeletal evaluation and treatment of upper extremity strength of healthy individuals and others with neck/shoulder pain. Isotonic mode was utilized to measure power output during pushing and pulling tasks.

"Individualized functional work evaluation and vision: A case study in reasonable accommodation."

Robertson D: Individualized functional work evaluation and vision: A case study in reasonable accommodation. Work. 2011;39:31-35.

ABSTRACT:
A case study is provided where functional capacity evaluation, work place assessment, and driver rehabilitation assessments were combined to produce an individualized functional work evaluation. A human rights complaint was launched by worker who alleged that her employer had determined that her vision impairment rendered her incapable of meeting her job demands, which could not be 'reasonably accommodated'. An evidence based practice approach and clinical reasoning process utilized by the

assessor in developing an individualized evaluation is described. The individualized evaluation developed by the assessor is consistent with the clinical trend towards the inclusion of direct observation of actual occupational performance, in making a determination of work ability. The resulting individualized evaluation was integral to the Human Rights Tribunal in determining whether the worker's limitations could be "reasonably accommodated."

Use of Simulator: musculoskeletal evaluation of driving via simulated tasks (as part of FCE). The Simulator is cited as a computerized tool that can simulate a variety of tasks, including driving a car.

"Surgical treatment of partial distal biceps tendon ruptures."

Frazier MS, Boardman MJ, Westland M, Imbriglia JE: Surgical treatment of partial distal biceps tendon ruptures. J Hand Surg. 2010;35A:1111-1114.

ABSTRACT:
Purpose: To demonstrate that surgical repair of partial distal biceps tendon ruptures allows return of supination and flexion strength nearly equal to the contralateral side without compromising range of motion.
Methods: We performed a retrospective study of 17 patients with unilateral partial biceps tendon ruptures who underwent surgical repair between 2003 and 2009, and who returned for further evaluation and strength testing. The follow-up examination included questionnaires, x-rays, strength testing, and range of motion with comparison to the opposite side. We used the Baltimore Therapeutic Equipment work simulator to objectively test isometric and dynamic elbow flexion and forearm supination strength of both extremities.
Results: A total of 17 patients returned for additional testing, 14 of whom had failed nonsurgical treatment. One patient had asymptomatic heterotopic ossification. Two patients reported mild lateral antebrachial cutaneous nerve dysesthesias. There was one partial re-rupture 4 years after the original surgery. The second repair consisted of suture anchor fixation; 15 months after re-repair, the patient remains asymptomatic. Average postoperative Disabilities of the Arm, Shoulder, and Hand score was 9 (range, 0–33). One patient had limited pronation (50° degrees). The average isometric and dynamic elbow flexion was 3% and 11% stronger, respectively, compared with the opposite side. Average isometric supination was 6% and average dynamic supination was 10% weaker.
Conclusions: After surgical treatment of partial distal biceps tendon tears, most patients achieved good return of strength with full motion. Surgical treatment of partial distal biceps tendon tears is a viable option after failed nonsurgical treatment.

Use of Simulator: musculoskeletal evaluation of muscle strength of the elbow and forearm of patients post-partial distal biceps tendon repair. Isometric and isotonic modes were utilized to measure maximum strength capabilities and power output of elbow flexors and forearm supinators.

"Results after delayed axillary nerve reconstruction with interposition of sural nerve grafts."

Moor BK, Haefeli M, Bouaicha S, Nagy L: Results after delayed axillary nerve reconstruction with interposition of sural nerve grafts. J Shoulder Elbow Surg. 2010;19:461-466.

ABSTRACT:
Hypothesis: Satisfactory results after repair of isolated axillary nerve lesions using sural nerve autografts have been reported, but a delay between injury and surgical repair exceeding 6 months was one of the most important negative predictors of functional outcome. From our experience, we hypothesize that good results can be obtained even after a delay exceeding 6 months and we opted in this study to assess the value of delayed axillary nerve reconstruction.
Materials and methods: We evaluated clinical outcome and donor-site morbidity in 12 patients (mean age, 37; range, 19-66 years) who underwent axillary nerve repair with sural nerve graft with an average 11.25-month a delay between trauma and surgery (range, 8-20 months). Follow-up examination at least 24 months after treatment included assessment of shoulder range of motion, deltoid muscle strength in near full extension, deltoid extension lag, and sensibility. Constant Score, subjective shoulder value, and the Disabilities of Arm, Shoulder and Hand score were also assessed.
Results: All patients showed an improved deltoid function of at least M3. Postoperative extension lag, as the most specific sign of isolated deltoid function, improved from 57.5º to 14.2º. All stated that they would have identical elective surgery again. Relevant donor-site morbidity was not observed.
Conclusion: Our data indicate that even delayed axillary nerve grafting may lead to satisfactory functional results with a low morbidity and should therefore be done in selected patients.

Use of Simulator: musculoskeletal evaluation of muscle strength of shoulder extension in patients post-repair of isolated axillary nerve lesions using sural nerve autografts. Isometric mode was utilized to measure maximum strength capacity of the deltoid in near full extension of the shoulder.

"Endobutton repair of distal biceps tendon ruptures."

Greenberg JA: Endobutton repair of distal biceps tendon ruptures. J Hand Surg. 2009;34A:1541-1548.

ABSTRACT:
Anatomic reconstruction is now recognized as the optimal treatment for distal biceps ruptures to maximize functional upper extremity potential. Reconstruction minimizes the loss of flexion and supination strength and endurance that is associated with neglected or untreated ruptures. A single-incision, anterior approach for reconstruction of distal ruptures is facilitated by the use of a titanium button that is anchored to the end of the tendon and then engaged on the posterior proximal radius. This construct has been shown to have superior strength, facilitating early rehabilitation and return to activity.

***Use of Simulator: musculoskeletal evaluation of muscle strength of the elbow and forearm* in patients post-distal biceps tendon repair.**

"Ergonomics and work assessments."

Innes E: Ergonomics and work assessments. In Jacobs K (ed). *Ergonomics for Therapists.* St. Louis, MO: Mosby Elsevier; 2008:48-72.

Use of Primus: in functional and work capacity evaluations.

"Functional outcomes after arthroplasty of the distal radioulnar joint and hand therapy: A case series."

Kaiser GL, Bodell LS, Berger RA: Functional outcomes after arthroplasty of the distal radioulnar joint and hand therapy: A case series. J Hand Ther. 2008;21:398-409.

ABSTRACT:
The purpose was to present a therapy protocol for use after implantation of an ulnar head endoprosthesis and to describe the functional outcomes after hand therapy. This is a retrospective review of a series of eight patients treated with a specified therapy protocol after ulnar head resection and implant arthroplasty. Marked improvements in pain and function were reported, though some pain with exertion remained. Two patients were on worker's compensation and both have returned to their premorbid work status. Functional use of the extremity was achieved by two to six weeks, with a mean of four weeks. Maximum medical improvement with good-to-excellent early results was achieved in all patients by 16 weeks. It is our experience that with this directed therapy protocol patients undergoing this procedure experience rapid recovery and an ability to return to activities of daily living in a timely manner. This paper provides a baseline protocol and rationale for use with patients who have undergone surgery with an ulnar head endoprosthesis.

Use of Simulator: musculoskeletal treatment to improve strength and function of the hand, wrist, forearm and elbow in patients post-ulnar head arthroplasty.

"Treating the war casualty: Case reports of polytrauma."

Smurr LM, Robinson M, Smith-Forbes E: Treating the war casualty: Case reports of polytrauma. J Hand Ther. 2008;21:177-188.

ABSTRACT:
The new generation of wounded Warriors is vastly different from those seen in the past, and military occupational therapists (OTs) must adapt to the challenges to meet the needs of these young men and women. Three case reports will be presented demonstrating the adaptability and flexibility of military OTs serving the combat wounded Warrior. The first case report reviews the rehabilitation process of a Sailor who was hit by an improvised explosive device (IED) and sustained an open shrapnel wound to his left upper extremity. The second case report presents the complex rehabilitation process of a Soldier who sustained an open distal radius and carpal fractures with soft tissue loss to his left hand from a gunshot wound after his helicopter was shot down. The final case report represents a Soldier who was injured using a table saw while in Iraq and sustained lacerations to his left hand thumb, index, and ring fingers. These case reports represent some of the demands and challenges that military OTs face when treating the war casualty.

Use of Simulator: musculoskeletal treatment of upper extremity strength deficits. Task specific training was used. (Case #2)

"Computers and assistive technology."

Weiss PL. Chan CCH: Computers and assistive technology. In Jacobs K, (ed). *Ergonomics for Therapists*. St. Louis, MO: Mosby Elsevier; 2008:221-245.

Use of Simulator: in functional and work capacity evaluations.

“Common peripheral nerve problems.”

Moscony AMB: Common peripheral nerve problems. In Cooper C, (ed.) Fundamentals of Hand Therapy: Clinical Reasoning and Treatment Guidelines for Common Diagnoses of the Upper Extremity. St. Louis, MO: Mosby Elsevier; 2007:201-250.

Use of Simulator: musculoskeletal evaluation and treatment of patients post-nonoperative and operative peripheral nerve problems.

“Dupuytren’s disease.”

Benson C: Dupuytren’s disease. In Cooper C, (ed.) Fundamentals of Hand Therapy: Clinical Reasoning and Treatment Guidelines for Common Diagnoses of the Upper Extremity. St. Louis, MO: Mosby Elsevier; 2007:452-464.

Use of Simulator: musculoskeletal treatment of patients post-surgical management of Dupuytren’s disease. Isolated joint motions and work simulations were incorporated into the strengthening program.

“Rehabilitation following repair of a torn latissimus dorsi tendon.”

Burks R, Burke W, Stevanovic M: Rehabilitation following repair of a torn latissimus dorsi tendon. Phys Ther J. 2006;86:411-423.

ABSTRACT:
Background and Purpose: This report describes the rehabilitation of a patient following surgical repair of a torn latissimus dorsi tendon. The scientific rationale for the treatment progression is discussed.
Case Description: A 35-year-old man with a ruptured latissimus dorsi tendon 6 weeks following surgical repair was referred for physical therapy to recover range of motion and strength sufficient for return to work as a police officer on the SWAT team. A review of tendon healing in animal studies is presented and related to the development of the plan of care for this patient.
Outcomes: Latissimus dorsi muscle isometric force generation on the injured side was 92% of that of the uninjured side. The patient returned to work as a SWAT team member.
Discussion: No detailed reports of postoperative latissimus dorsi tendon rehabilitation are available. The program for this patient was based on research demonstrating the timeline for recovery of tensile strength in healing tendons. This approach can direct rehabilitation following repair of other tendons, especially in uncommon injuries where specific guidelines have not been developed.

Use of Simulator: musculoskeletal evaluation and treatment of muscle strength of the upper extremity through isolated and integrated movements in patient post-repair of a torn latissimus dorsi tendon.

“Effects of age on muscle activity and upper body kinematics during a repetitive forearm supination task.”

Jiang Z, Shu Y, Drum J, Reid S, Mirka GA: Effects of age on muscle activity and upper body kinematics during a repetitive forearm supination task. Intl J Industrial Ergonomics. 2006;36:951-957.

ABSTRACT:

The principal objective of this study was to assess the effects of age on upper extremity muscle activation patterns and upper body kinematics during a forearm supination task. Age-related physiological and biomechanical changes in the musculoskeletal system have been documented in the literature. It was hypothesized that these changes may have an impact on muscle recruitment and work technique (postural/kinematic) employed during work tasks. A simple repetitive forearm supination task was used to evaluate these hypotheses. Twenty subjects (ten in each age group 19–29 and 55–65) performed a series of static and dynamic forearm supination tasks on a work simulator. These exertions were performed at eight different levels of supination torque: 5–40 in-lb in 5 in-lb increments. As the subjects performed the static exertions the activation levels of several key muscles of the upper extremity were captured using surface electromyography. As the subjects performed the dynamic exertions, the motions of the upper body and upper extremity were captured using a magnetic field-based motion analysis system. The results of the static exertions showed that older subjects generated 135% greater trapezius muscle activity (significant at $p < 0.05$ level) but no other muscle group sampled showed a significant difference between the age groups. In the dynamic exertions, age had no effect on upper limb/torso kinematic responses. In both the static and dynamic exertions, supination torque level had a significant impact on muscle activity and kinematics. These results provide empirical evidence that age alone does not have a consistent impact on biomechanical responses during physically demanding work tasks.

Use of Simulator: musculoskeletal evaluation of isolated wrist/forearm motions of healthy adults. Isometric and isotonic modes were utilized to measure maximum strength capabilities and strength and power output.

"Industrial rehabilitation services."

Keegan DM, Kahlert RC: Industrial rehabilitation services. In Burke SL, Higgins J, McClinton MA, Saunders RJ, Valdata L, (eds). *Hand and Upper Extremity Rehabilitation: A Practical Guide.* (3rd ed). St. Louis, MO; Elsevier Churchill Livingstone; 2006:727-738.

Use of Simulator: in functional and work capacity evaluations.

"Glenohumeral instability."

Lynch GM: Glenohumeral instability. In Burke SL, Higgins J, McClinton MA, Saunders RJ, Valdata L, (eds). *Hand and Upper Extremity Rehabilitation: A Practical Guide.* (3rd ed). St. Louis, MO: Elsevier Churchill Livingstone; 2006:359-367.

Use of Simulator: musculoskeletal treatment of patients post-surgery for traumatic instabilities of the shoulder. Closed chain exercises specified.

"Humeral fractures."

Murphy MS: Humeral fractures. In Burke SL, Higgins J, McClinton MA, Saunders RJ, Valdata L, (eds). *Hand and Upper Extremity Rehabilitation: A Practical Guide.* (3rd ed). St. Louis, MO: Elsevier Churchill Livingstone; 2006:369-387.

Use of Simulator: musculoskeletal treatment of patients post-nonoperative and operative humeral fractures. Use to prepare for return to functional tasks.

“Triangular fibrocartilage injuries.”

Pitts G, Burgess R: Triangular fibrocartilage injuries. In Burke SL, Higgins J, McClinton MA, Saunders RJ, Valdata L, (eds). *Hand and Upper Extremity Rehabilitation: A Practical Guide.* (3rd ed). St. Louis, MO: Elsevier Churchill Livingstone; 2006:475-487.

Use of Primus: musculoskeletal treatment of patients post-nonoperative and operative TFCC tears. Use to prepare for return to functional tasks.

“Salvage of post-traumatic arthritis following distal radius fracture.”

Nagy L: Salvage of post-traumatic arthritis following distal radius fracture. Hand Clin. 2005;21:489-498.

ABSTRACT:
The goal of this article is to make recommendations and simplify the decision between the different treatment options based on the author’s experience and data and evidence from the literature. This article is not only retrospective but also includes a clear bias; however, better or more scientific evidence has not been found.

Use of Simulator: musculoskeletal evaluation of wrist and grip strength pre- and post-test anesthesia at the tactic nerve passages sites to mimic effect of denervation.

“Static wrist splint use in the performance of daily activities by individuals with rheumatoid arthritis.”

Pagnotta A, Korner-Bitensky N, Mazer B, Baron M, Wood-Dauphinee S: Static wrist splint use in the performance of daily activities by individuals with rheumatoid arthritis. J Rheumatol. 2005; 32:2136-2143.

ABSTRACT:
Objective. In individuals with rheumatoid arthritis (RA), to identify the influence of wrist splint wear on pain, work performance, endurance, perceived task difficulty, and perceived splint benefit while performing various upper limb tasks.
Methods. This crossover study included 30 individuals with wrist involvement. Pain, work performance, endurance, and perceived task difficulty were assessed with the splint on and off. Using a work simulator, participants performed 14 tasks, 10 assessing work performance and 4 assessing endurance. A visual analog scale (VAS) was used to rate pain, task difficulty, and perceived splint benefit.
Results. With the splint on, pain was significantly lower in 5 tasks, as was perceived difficulty in task performance. Work performance did not differ significantly with the splint on versus off. While mean endurance scores were always better with the splint on, differences reached significance on only one task. The task with greatest overall perceived splint benefit was “chopping with a knife.”
Conclusion. Results revealed that for most tasks, there was generally a positive effect of splint use on hand function; however, perceived splint benefit was marginal. For most tasks splint use improved or did not change pain levels, did not interfere with work performance, increased or maintained endurance, and did not increase perceived task difficulty. The findings suggest that wrist splint prescription is not a simple process; clinicians and clients need to work together to determine the daily wear pattern that maximizes benefit and minimizes inconvenience according to the client’s individual needs.

Use of Simulator: musculoskeletal evaluation and treatment of upper extremity strength. Isometric strength and work performance (dynamic power output) were measured. Computerized readouts were generated for each task.

“Robot-aided neurorehabilitation of the upper extremities.”

Reiner R, Nef T, Colombo G: Robot-aided neurorehabilitation of the upper extremities. Med Biol Eng Comput. 2005;43:2-10.

ABSTRACT:
Task-oriented repetitive movements can improve muscle strength and movement coordination in patients with impairments due to neurological lesions. The application of robotics and automation technology can serve to assist, enhance, evaluate, and document the rehabilitation of movements. The paper provides an overview of existing devices that can support movement therapy of the upper extremities in subjects with neurological pathologies. The devices are critically compared with respect to technical function, clinical applicability, and, if they exist, clinical outcomes.

Use of Simulator: neuromuscular training and evaluation of a wide variety of movements, including many different work and ADL tasks, as well as warming up and stretching exercises.

“The value on interdisciplinary pain management in complex regional pain syndrome Type 1: a prospective outcome study.”

Singh G, Willen SN, Boswell MV, Janata JW, Chelimsky TC: The value on interdisciplinary pain management in complex regional pain syndrome Type 1: a prospective outcome study. Pain Physician, 2004; 7:203-209.

ABSTRACT:
Background: Complex regional pain syndrome (CRPS) type I is a symptom complex of severe, chronic limb pain, often associated with allodynia, vasomotor, and sudomotor changes. Optimal management of this condition is not well understood. The role of a traditional, comprehensive pain management program with long-term follow-up has not been evaluated.
Objective: To define the benefit of the interdisciplinary approach in patients with CRPS type I.
Design: Prospective, case series, outcomes evaluation.
Methods: Patients with a diagnosis of CRPS type I entering the University Pain Center’s intensive, outpatient pain management program were enrolled in an objective assessment study through the duration of the program, with a follow-up of 2 years. This program involved 4 weeks of interdisciplinary management comprised of 20 sessions of physical therapy, 20 sessions of occupational therapy, 12 sessions of water therapy, 20 sessions of group psychotherapy, stellate ganglion blocks, and drug therapy.
Outcome Measures: Specific objective measurements of upper extremity function, sensation and strength over time, and functional status 2 years after program completion.
Results: Upper extremity weight tolerance increased dramatically by 29-pounds ($p<0.05$). Function improved, with a 35 inch-pound gain in BTE (Baltimore Therapeutic Equipment) extension ($p<0.005$) and a 50 inch-pound increase in flexion ($p<0.02$). Jebsen-Taylor multifunctional testing (fine and gross motor skills) normalized from 72 to 48 seconds ($p<0.04$). Stable anxiety levels despite increased patient effort implied improved pain tolerance. At the 2-year follow up, 75% of the patients were employed.
Conclusion: Patients with CRPS type I may benefit from a 4-week outpatient pain management program emphasizing rehabilitation.

Use of Simulator: musculoskeletal evaluation of the physical capacity of the upper extremity of patients with CRPS. Isometric strength and maximum dynamic endurance were measured.

“An update on the management of carpal fractures.”

Brach P, Goitz R: AN update on the management of carpal fractures. J Hand Ther. 2003;16:152-160.

ABSTRACT:
This article reviews the appropriate management of common carpal fractures. The fundamental principles used by clinicians to choose appropriate stabilization and length of immobilization for these various injuries are discussed. The principles behind the progression of therapeutic intervention and the relation of progression to the stages of healing are emphasized.

Use of Simulator: musculoskeletal treatment for strengthening of the upper extremity in patients post-non-operative and operative wrist fractures.

“Medical history of carpal tunnel syndrome.”

Michelsen H, Posner MA: Medical history of carpal tunnel syndrome. Hand Clin. 2002;18:257-268.

ABSTRACT:
None offered.

Use of Simulator: diagnostic provocative stress testing for dynamic carpal tunnel syndrome.

“Partial rupture of the distal biceps tendon.”

Vardakas DG, Musgrave DS, Varitimidis SE, Goebel F, Sotereanos DG: Partial rupture of the distal biceps tendon. J Shoulder Elbow Surg. 2001;377-379.

ABSTRACT:
We report on 7 cases of partial rupture of the distal biceps tendon. The mean patient age was 52 years (range, 38-58 years). There were 5 men and 2 women. The dominant arm was affected in all 7 patients. Pain was the chief complaint in all patients. Immobilization and physiotherapy were attempt-ed in all patients, and 4 had at least 1 local steroid injection. No patient improved from the conservative treatment. All patients eventually underwent surgical debridement and reattachment of the biceps tendon with use of a 1-incision technique with suture anchors. After a mean follow-up of 31 months (range, 25-44 months), all patients reported a significant decrease in their pain. No complications were noted.

Use of Simulator: musculoskeletal evaluation of upper extremity strength in patients post-distal biceps tendon repair. Isometric mode was utilized to measure maximum strength capabilities of elbow flexion and forearm supination.

“A simplified method for repair of distal biceps tendon ruptures.”

Sotereanos DG, Pierce TD, Varitimidis SE: A simplified method for repair of distal biceps tendon ruptures. J Shoulder Elbow Surg. 2001;9:227-233.

ABSTRACT:
Repair of distal biceps brachii tendon ruptures is recommended for active individuals desiring maximum return of elbow supination and flexion strength. A 2-incision method of repair has been most popular but carries a risk of radioulnar synostosis. In the past, repair through a single anterior incision required more dissection and risked injury to the posterior interosseous nerve. The authors present a simplified method for the repair of distal biceps tendon ruptures through a single anterior incision. The use of suture anchors

provides secure fixation to the radius with minimal volar dissection. This method was used successfully in 16 patients, 8 acutely (<6 weeks) and 8 chronically, with excel-lent functional results. Patients who received acute repairs regained elbow strength and power; patients who received chronic repairs showed slight deficits of supination strength (16%) and flexion power (14%). Of 10 chronic ruptures treated, only 2 tendons could not be mobilized back to the radial tuberosity and had to be transferred to the brachialis. There were no failures and no complications of radioulnar synostosis or posterior interosseous nerve palsy. The single anterior incision approach in which suture anchors are used is recommended as an alternative to the traditional 2-incision method.

Use of Simulator: musculoskeletal evaluation of upper extremity strength in patients post-distal biceps tendon repair. Isometric and isotonic modes were utilized to measure maximum strength capabilities and power output of elbow flexion and forearm supination.