Advances in technology have affected all aspects of health care, including patient-handling activities. New equipment can be used to assist with the performance of hands-on movement tasks such as transferring, repositioning, and ambulating patients. Hand-cranked lifts are no longer needed to mobilize totally dependent patients because a variety of mobile lifts powered by battery or electricity are available. Overhead ceiling lifts, both portable and track mounted, are quickly becoming more widespread. Powered standing lifts, or sit-to-stand assist devices, can be used to assist patients with some weight-bearing ability. The use of equipment can promote rehabilitation and facilitate functional recovery for people with a wide variety of acute and chronic conditions. The application of this technology can also improve safety for patients and healthcare providers.

Work-Related Musculoskeletal Disorders and Healthcare Work

The important work of healthcare professionals has long been associated with work-related musculoskeletal disorders (WRMSDs). In the United States, the Bureau of Labor Statistics (BLS) uses the Survey of Occupational Injuries and Illnesses to collect data from private industry about nonfatal injury and illness reported in the workplace. Since 2003, the BLS has used the North American Industry Classification System to classify businesses by industry type. The broad industry category of “education and health services” encompasses a variety of healthcare settings including hospitals, nursing and residential care facilities, and a number of ambulatory healthcare services. Historically, the healthcare industry has reported high rates of work-related injury and illness. For the past 3 years, hospitals and nursing and residential care facilities have been at the top of the 14 industries, with at least 100,000 reported injuries and illnesses (BLS, 2006).

Numerous studies and literature reviews have reported associations between nursing (registered nurse, licensed practical nurse, and nursing assistant) and high rates of WRMSDs (Hignett, 1996; Lagerstrom, Hansson, & Hagberg, 1998; Pheasant & Stubbs, 1992). It is difficult to directly compare studies because exposure characteristics are not defined consistently and outcome measures are not uniform. Nevertheless, taken as a whole, this body of literature consistently describes links between nursing work and musculoskeletal disorders, particularly of the back. Additional biomechanical and epidemiological evidence suggests that manually caring for patients is associated with increased risk for musculoskeletal disorders. Biomechanical studies indicate that patient-handling activities, such as transferring and repositioning, result in high physical loads on the structures of the musculoskeletal system (Marras, Davis, Kirking, & Bertsche, 1999; Ulin et al., 1997). Epidemiological studies report that providing direct patient care involves frequent exposure to manual handling, awkward or sustained postures, repetition, and heavy loads (Estryn-Behar et al., 1990; Jensen, 1990). These same exposures are hypothesized to be key risk factors for WRMSDs (Bernard, 1997).

Compared with nursing, however, other healthcare professions have not been well studied with respect to WRMSDs, including the profession of physical therapy. Physical therapists provide direct patient care in a wide variety of settings that are not independently captured by the BLS injury and illness data. This makes it difficult to estimate the burden of work-related musculoskeletal disorders in physical therapy practice.

In addition, only a handful of peer-reviewed studies have been published about physical therapists and WRMSDs. A methodological limitation of all these studies is their reliance on self-reported survey measures of exposure and outcomes. Taken as a whole,
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however, they suggest that physical therapists experience a variety of musculoskeletal disorders related to the practice of their profession. Across studies, activities reported to contribute most to work-related symptoms and injuries included transferring and handling dependent patients, consistent with the nursing literature.

Technology and Safe Patient Handling

Despite much attention, WRMSDs in health care have remained difficult to contain and control. For years, nurses have received education on safe lifting techniques and good body mechanics despite weak evidence of their effectiveness in reducing the burden of musculoskeletal disorders (Bohr & Weber, 1998; Hignett et al., 2003). However, new evidence supports the use of ergonomic strategies to decrease risk and prevent WRMSDs in healthcare providers (Evanoff, Wolf, Aton, Canos, & Collins, 2003; Hignett et al.; Nelson, 2006).

Programs that apply the ergonomic strategy of routinely using new equipment to assist with patient handling have been called zero-lift, low-lift, or simply safe patient-handling programs (Garg, 1999). Successful program implementation requires a number of key elements be in place, including equipment, patient assessment, training, policies and procedures, active medical case management, management commitment, and employee involvement. These programs have demonstrated reductions in WRMSDs for employees and decreased costs for facilities (Collins, Wolf, Bell, & Evanoff, 2004; Garg; Nelson et al., 2006; Spiegel et al., 2002).

Globally, policies, procedures, and regulations for safe patient handling have been increasing in number. In Great Britain, the Royal College of Nursing released its Code of Practice for Patient Handling in 1996, and the Chartered Society of Physiotherapists followed with its Guidance in Manual Handling for Chartered Physiotherapists in 2002. In British Columbia, Canada, there is a memorandum of understanding between unions, employers, and government with the goal of “eliminating unsafe manual patient handling” in nursing homes (Occupational Health and Safety Agency for Health Care in British Columbia, 2003). In the United States, the American Nurses Association introduced the Handle with Care initiative in 2003, promoting multiple strategies to minimize manual patient handling. Legislation has been passed in Texas and Washington requiring safe patient handling and movement programs in healthcare settings (hospitals and nursing homes), and similar bills have been proposed in other states and in Congress (Anderson, 2006). There is a growing movement for facilities, organizations, and government to adopt safe patient-handling programs and to recommend or even require the use of equipment for patient handling and movement tasks.

Technology and Therapeutic Patient Handling

In the rehabilitation setting, the goals of improving caregiver safety, patient safety, and functional outcomes are not mutually exclusive. Technology has improved and provided a greater number of equipment options for assisting patients across the spectrum of mobility. Creative use of technology can increase the overall amount of therapeutic handling provided to patients. Increased amounts and intensity of therapy were related to improved outcomes for patients after stroke (Duncan et al., 2005), patients in nursing homes (Jette, Warren, & Wirtalla, 2004; Morris, Fiatarone, Kiely, & Belleville-Taylor, 1999), and patients with orthopedic conditions (Drabsch, Lovenfosse, Fowler, Adams, & Drabsch, 1998; Kirk-Sanchez & Roach, 2001). Every interaction with a patient can provide an important therapeutic opportunity to facilitate rehabilitation and improve outcomes.

Overhead Lifts and Partial Body Weight Support Training

The use of partial body weight support (PBWS) treadmill training as part of rehabilitation is increasing in research and practice. Devices that use some type of harness suspension to support a percentage of a patient’s body weight during ambulation are available. The technology is similar to that used with overhead lift devices for patient handling.

For many rehabilitation patients, conventional therapeutic interventions try to compensate for impairments. Strength and endurance training targets individual muscles while patients are taught new methods to accomplish activities of daily living such as transfers. Assistive devices (walkers, crutches, braces, and wheelchairs) often are used. However, newer research suggests that these strategies may not take full advantage of the inherent plasticity of the neuromusculoskeletal system. In an overview article in Physical Therapy, Behrman, Bowden, and Nair (2006) proposed a new model of activity-dependent plasticity and recovery after spinal cord injury. They suggested that therapists shift their paradigm of rehabilitation from compensation to recovery and described their rationale along with supporting research.

Research suggests that a number of critical sensory cues, along with repetitive practice, are important for stimulating locomotor abilities in animals and
humans (Dietz & Harkema, 2004; Harkema, 2001). These cues include facilitating maximal weight bearing by the lower limbs and minimizing the amount of support provided by the upper extremities. Upright head and trunk posture, normal walking speed, and normal kinematics of the hip, knee, and ankle joints should all be encouraged. Exogenous sensory input, pain, and fatigue should be minimized. Using PBWS support treadmill training equipment has the potential to facilitate all these cues while providing a safe environment for practice. The technology might be applied to patients with a variety of neurological and orthopedic conditions.

In a pilot study, Protas and colleagues (2001) investigated a 12-week PBWS treadmill training program for three adult patients with chronic, incomplete thoracic spinal cord injuries. Outcomes included measures of gait, energy expenditure, muscle function, neurological exam, motor control, and self-report. Gait speed and endurance improved for all subjects, and the training was well tolerated. A large controlled clinical trial is under way. Several other studies of patients with spinal cord injuries have reported positive and encouraging findings with the use of PBWS treadmill training in this population (Behrman & Harkema, 2000; Field-Fote, 2001; Behrman et al., 2005).

Da Cunha and colleagues (2002) conducted a randomized controlled pilot study of acute stroke survivors in which PBWS treadmill training was substituted for standard gait training to investigate the potential of supported training. The clinical gait outcomes of reduced energy cost and increased walk distance demonstrated positive effects, although the statistical power of the study was low because of the small sample size. Barbeau and Visintin (2003) conducted a larger randomized clinical trial in which patients were randomized to two groups of locomotor training: one using PBWS and one full weight bearing. After 6 weeks of training, results indicated that the PBWS group had significantly better clinical outcomes. The authors suggested that PBWS treadmill training is well tolerated and an effective rehabilitation strategy for patients with stroke. Current clinical practice guidelines recommend that PBWS training be used as part of multidisciplinary rehabilitation for patients after a stroke (Duncan et al., 2005), and a large multisite randomized clinical trial of this strategy is being conducted.

Treadmill training has also been studied for its potential benefits in treating patients with Parkinson’s disease. Protas and colleagues (2005) investigated the use of PBWS gait and step training for people with Parkinson’s disease in a controlled pilot study. Reduced falls, along with statistically significant differences in gait speed, cadence, and step length, were reported in the trained group. A larger randomized clinical trial is under way. Miyai and colleagues (2002) concluded that PBWS treadmill training in this patient population improved short-step gait and that improvements lasted beyond the time of the intervention.

Several studies have investigated the use of PBWS treadmill training for children with both ambulatory and nonambulatory cerebral palsy. Provost and colleagues (2007) reported significant improvements in walking velocity and energy expenditure after a 2-week period of intensive treadmill training for six school-aged children with cerebral palsy who were ambulatory. Based on a preliminary study, Schindl, Gostner, Kern, and Hesse (2000) concluded that treadmill training was well tolerated in children with nonambulatory cerebral palsy and that further studies were justified to evaluate the potential of this treatment.

Supported treadmill training also has been used in studies of patients with orthopedic conditions. Whitman and colleagues (2006) conducted a randomized clinical trial comparing two physical therapy programs for the treatment of patients with lumbar spinal stenosis. One treatment group included PBWS treadmill training along with manual physical therapy and exercise. Treatment for the other group emphasized flexion exercises and walking. Results suggested that both groups improved at 6 weeks and 1 year, but that the group that received PBWS training reported greater rates of improvement. Another randomized clinical trial (Hesse et al., 2003) of patients using PBWS treadmill training after total hip arthroplasty concluded that treadmill training was more effective than conventional therapy for promoting symmetrical independent walking.

PBWS appears to hold promise for enhancing rehabilitation outcomes for patients with a variety of neurological and orthopedic conditions. For their caregivers, the use of overhead lifting technology has led to reduced risk of injury and decreased costs related to patient handling (Chhokar et al., 2005; Miller, Engst, Tate, & Yassi, 2006).

Sit-to-Stand Assistive Devices and Rehabilitation

Rising from and returning to a seated position is an important functional task. The use of the stand-pivot transfer technique to move patients from one seated position to another is very common in rehabilitation. A literature review by Sparkes (2000) suggested that evidence supporting this technique in neurological rehabilitation is lacking and that therapists continue to use it in the belief that it facilitates “normal” movement patterns. Newer research (Van Peppen et al., 2004) questioned the assumptions behind using this technique and suggested that training for function rather than for “normal” movement results in better outcomes for stroke patients.
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Research suggests that there are a number of important factors for recovery of sit-to-stand function, including strength of lower extremity musculature and weight-bearing ability on the involved leg (Lomaglio & Eng, 2005). Chou and colleagues (2003) studied the relationship of sit-to-stand performance and gait in patients with chronic stroke and healthy age-matched controls. They found that patients who had better performance on a sit-to-stand task also had better gait parameters. In patients with Parkinson’s disease, Inkster, Eng, MacIntyre, and Stoessl (2003) found that patients had lower force-generation capacity into hip and knee extension and that hip strength was related to sit-to-stand ability.

Canning and colleagues (2003) found that intensive sit-to-stand training was feasible and beneficial during early inpatient rehabilitation after traumatic brain injury. After total hip replacement, Drabsch, Lovenfosse, Fowler, Adams, and Drabsch (1998) found improvements in walking and sit-to-stand performance after supervised task-specific training practicing sit-to-stand movements.

Other studies found that patients had difficulty judging the amount of weight being placed on a supporting limb (Hurkmans et al., 2007; Sutton, Stedman, & Livesley, 2007). This finding raises concerns about consistency and safety during ambulation and sit-to-stand activities. The use of equipment that partially assists patients with sit-to-stand activities can help provide a safe and consistent practice environment for patients with a variety of musculoskeletal, neuromuscular, or cardiopulmonary conditions. Patients can practice weight-bearing and balance activities while being protected from falls or other unanticipated events. Nurses and therapists can concentrate on rehabilitation without the concurrent risks of also supporting and moving the patient.

The use of sit-to-stand assistive devices may be applicable during rehabilitation for a variety of patients. These devices are not yet consistently used in rehabilitation settings. Ruszala and Musa (2005) studied a small number of therapists and patients with both orthopedic and neurological conditions to evaluate the use of four types of stand-assist devices in rehabilitation. They concluded that the use of equipment did assist with sit-to-stand activities and was preferable to poorly executed manual techniques. They also noted that equipment could be used to supplement other therapeutic interventions and called for the creation of evidence-based guidelines for such use.

Mutch (2004) described the process of changing handling practices in a stroke rehabilitation unit. Rehabilitation nurses and therapists together evaluated sit-to-stand devices before integrating their use into practice. There were a number of positive outcomes for both caregivers and patients. Patients appreciated the consistency of being transferred with a reliable method and having the opportunity to stand, stretch, and bear weight. There was an increase in interaction between nurses and therapists, and decreases in the total number of transfers needed and the time spent waiting for assistance from another caregiver.

Other Therapies, Technologies, and Classification Strategies

Constraint-induced movement therapy (CIMT) is another new approach in neurological rehabilitation (Vearrier, Langan, Shumway-Cook, & Woollacott, 2005). The strategy “targets motor recovery by limiting the use of the unaffected limb and promoting normal coordinated movement of the affected limb through massed practice” (Vearrier et al., 2005, p. 154). Although research has been conducted primarily on the upper extremity, CIMT has implications for improving lower extremity function as well. It is possible that the use of stand-assist devices may encourage patients to use an affected extremity and limit use of the uninvolved limb. Patients can engage in repetitive practice of sit-to-stand movements while being protected in the event of fatigue or balance loss.

A quickly emerging technology in health care is the use of robotic devices, which also may have implications for therapeutic safe patient handling. Simon, Gillespie, and Ferris (2007) trained healthy subjects using a robotic device (somewhat resembling a sit-to-stand assist) to improve force symmetry in the lower extremities. They hypothesized that people with neurological or orthopedic impairments could benefit from rehabilitation interventions with similar devices and are conducting further research. Robotic-assisted, body-weight-supported treadmill training was used by Hornby, Zemon, and Campbell (2005) to facilitate motor recovery and ambulation in patients with incomplete spinal cord injury. Additional research was recommended to develop clinical decision-making algorithms to match the use of technology with groups of patients most likely to benefit from its application.

Patients in rehabilitation settings present with diverse characteristics and often are classified based on a medical diagnosis or hypothesized disorder. Patients might also be classified on patterns of signs or symptoms presented during clinical examination. A growing body of evidence suggests that rehabilitation outcomes are improved when the delivery of specific therapeutic interventions is matched to subgroups of patients shown to be likely to benefit from them.
For example, patients with a “diagnosis” of non-specific low back pain (NSLBP) often are seen in physical therapy practice, yet NSLBP is not a homogeneous condition stemming from a defined patho-anatomical process (Kent & Keating, 2004). Research has begun to more accurately and reliably classify subgroups of patients presenting with NSLBP based on patterns of signs and symptoms (Fritz, Brennan, Clifford, Hunter, & Thackeray, 2006; Fritz & George, 2000). Treatment based on classification schemes resulted in better outcomes than treatment based on broad diagnostic categories in several studies (Brennan et al., 2006; Fritz, Delitto, & Erhard, 2003).

Classification research has tended to focus on patients seen in orthopedic settings, but there are clearly implications for neurological rehabilitation as well. Toussignant, Arsenault, Corriveau, and Philippe (2000) used cluster analysis methods to develop a classification scheme for stroke patients and recommended that these findings be expanded and tested in a multicenter study. Baer and Smith (2001) found that patterns of gait recovery in patients with hemiplegia varied between subgroups based on a classification framework. Pomeroy and Tallis (2002) argued that for the science of neurological rehabilitation to mature, it will be critical to tailor therapeutic interventions to specific subgroups of patients. An editorial in the Journal of Neurological Physical Therapy emphasized the need for research on the patterns of signs and symptoms that form the basis for classification of patients with neurological conditions (Field-Fote, 2005).

Classification provides a tool for matching specific patients with specific therapeutic interventions that are most likely to result in positive outcomes. Classification may also assist in identifying the most appropriate patient-handling technology to use with specific patients under specific circumstances. The development, validation, and use of clinical algorithms to guide decision making for patient handling and movement tasks have been strongly advocated and researched by Nelson (2006). Additional work on the development of evidence-based algorithms for the use of patient-handling equipment in rehabilitation is an important next step toward shifting the paradigm in how nurses and therapists approach patient handling and movement.

Summary and Conclusions

Advances in technology, knowledge gained through research, and legislative trends will continue to affect patient-handling approaches in rehabilitation settings. Rehabilitation nurses and physical therapists should become familiar with the equipment options for therapeutic safe patient handling. Professional clinical judgment, along with evidence-based knowledge, should be used to match patient characteristics, needs, and goals with the appropriate technology. Research should continue to investigate relevant questions related to patient handling in rehabilitation. There are ample opportunities and possibilities for the creative use of new technology to promote the complementary goals of improving safety for patients and caregivers and facilitating functional rehabilitation outcomes.

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References


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