CHAPTER 23

Health Care Ergonomics*

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CONTENTS

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23.1 INTRODUCTION

Workers in the health care industry who perform physically demanding tasks as part of their jobs, such as nurses, nurses' aides, physical therapists, and health care technicians, are at high risk for the development of work-related musculoskeletal disorders (MSDs). These workers are exposed to major risk factors for MSDs, such as lifting and moving heavy patients and equipment, pushing and pulling heavy equipment, working in extreme postures, and standing for long periods of time without adequate rest periods. When the demands of the job (physical demands, work environment, and workplace culture) exceed the capacity of the worker, the risk of an MSD is increased, and is highest when exposures are intense and prolonged and when there are several risk factors present at the same time [1–3].

Although health care workers have widely reported that injuries to the shoulder and neck have prevented them from doing their work and caused them to leave their job, by far, the most common occupational injuries in the health care industry involve back disorders [4]. Nurses working in the private sector had 11,800 MSDs reported in 2001, with the majority (nearly 9,000) of the reported injuries to the back, and more than a third (36%) of the injuries resulting in lost time from work were reported to be back injuries. Another study revealed that 12% of nurses planning to leave the profession indicated back injuries were either a main or contributing factor [5].

Work-related MSDs are very important in the health care industry. Employees that experience pain and fatigue are less productive, less attentive, more prone to make consistent mistakes, more susceptible to injury, and may be more likely to affect the health and safety of others. Nurses suffering from disabling back injuries and fear of getting injured have contributed to nurses leaving the profession, thus increasing the nursing shortage [5]. Workplaces with high incidences of MSDs report increases in lost/modified workdays, higher staff turnover, increased costs, and adverse patient outcomes [6]. The extent of the problem is likely worse than reported in official injury reporting records due to likely widespread underreporting of injuries. In a study by Cato et al. [7], it was reported that 78% of nurses with back pain in the previous 6 months did not report it to management. In another study of nurses, Owen [8] reported that 67% of nurses who reported low-back pain related to work did not report the incident in writing. Others have consistently demonstrated that injury reports on the Occupational Safety and Health Administration (OSHA) log are underreported.

In the past decade, tremendous strides have been made in identifying high-risk tasks and in developing and implementing solutions for reducing the risk. Programs have been developed and many states have passed legislation mandating implementation of these safety programs. Ergonomic guidelines have been developed to provide useful information to the industry that will help them efficiently implement the programs that have been shown to be effective in reducing risks and costs associated with work-related MSDs. Most importantly, easy-to-use equipment that reduces the amount of physical demand required to perform these tasks has been developed for many of the high-risk tasks and is widely available. Also, studies have been conducted demonstrating that implementation

of these programs and use of this equipment is cost effective, often paying for itself in less than 3 years time. Lastly, there has been recent evidence that implementation of a safe patient-handling (SPH) program can also increase the quality of care provided to the patient [9].

It is clear that a large number of workers are routinely exposed to work-related risk factors for MSDs, often at very high levels of exposure. It is also clear that many of them develop one or more serious work-related MSDs as a consequence of their work during their working lifetime. Nevertheless, it should be recognized that these hazards can be identified and controlled so that work-related MSDs can be prevented.

23.2 HIGH-RISK TASKS AND RISK FACTORS

By far, the most common risk factor for MSDs is performance of patient-handling tasks. Patient handling occurs in numerous acute care health care environments including, critical care, orthopedic, surgical, rehabilitation, and radiology units of hospitals, as well as long-term health care facilities, nursing homes, and in home care environments. Transferring partially or fully dependent patients from beds to chairs or wheelchairs, sliding patients up in bed, transferring patients from stretcher to stretcher, or anybody positioning activity requiring extreme muscular exertions, or work in awkward or extremely bent or twisted postures have been shown to be very high risk for the development of work-related MSDs [10].

Another significant risk factor for MSDs is pushing and pulling heavy equipment, such as occupied beds, unoccupied surgical beds, diagnostic equipment, and floor-based patient lifting devices fully loaded with a patient, food carts, and carts for dispensing medicine. Often these tasks require pushing and pulling of objects weighing several hundred pounds, sometimes over long distances, across uneven or carpeted surfaces. These tasks have been identified as high risk for work-related MSDs [11–13].

An additional risk factor for health care workers is working in awkward or extreme body postures. This may occur during specific nursing tasks, such as when inserting IVs or catheters, or during treatment activities, such as applying embolism stockings, or setting up treatment equipment at the bedside. Bed height is a critical factor associated with the extent of exposure to awkward postures. If the bed or table height is not adjusted properly, the worker will have to bend or reach in order to perform the specific task. For example, in an operating room, a health care worker may have to spend many hours standing in a static, flexed posture with the back and arms in a specific posture while retracting tissues or holding assistive devices during the performance of the surgical procedure.

A variety of other risk factors are also present in the health care industry, including long work hours, mandatory overtime, shift work, exposure to work stress, and other work organizational risk factors that have been shown to increase the incidence and severity of work-related MSDs [1,2,14,15].

Research evidence related to high-risk tasks in specific health care settings is limited, but there is evidence that the highest risk settings include operating rooms, medical/surgical wards, psychiatry, rehabilitation/spinal cord injury, critical care units, trauma/emergency units, long-term care, and home care [16,17].

23.3 OTHER FACTORS AFFECTING RISK OF MSDs

23.3.1 Overreliance on "Body Mechanics" as a Prevention Strategy

From about 1945 to the present, the health care industry began recommending reliance on "body mechanics" as a way to protect the caregiver from risk of injury due to patient-handling activities. Although there was little or no empirical evidence that this approach would actually reduce the risk of work-related MSDs, it was widely adopted because other solutions were not available. Recently, researchers have shown that there is no safe way to manually lift and transfer a fully dependent patient weighing as little as 110 lb, even with two caregivers performing the task [10]. Unfortunately, many schools of nursing and physical therapy continue to teach these outdated patient-handling methods.

23.3.2 Majority of Exposed Population Is Female

The direct patient care segment of the health care industry employs the highest percentage of female employees of any industry. Because females generally have lower strength and lifting capacity than males, on average, they must work at a higher percentage of their maximum physical capabilities than males when performing the same physically demanding tasks. Thus, the risk to the worker likely would be greater for females than for males when performing most patient care tasks. Therefore, tasks must be designed such that the strength demands are sufficiently low (i.e., designed for female workers), so that nearly all workers will be able to safely perform the task.

23.3.3 Shortage of Nursing Staff

It has been reported that there is a shortage of nursing staff at many health care facilities [18]. There is little doubt that work-related MSDs contribute to the critical nursing shortage in the health care industry that also leads to more overtime for working nurses. According to a 2006 report by the Health Resources and Services Administration (HRSA), by the year 2020, the supply of RNs is projected to fall 29% below predicted requirements [18]. Factors that contribute to the shortage include professional burnout, unappealing work climates, lack of job satisfaction, quality of care issues, and lack of managerial support [18]. It is likely that excessive physical workloads associated with direct patient care, such as manual patient handling, increasing patient weights, and use of heavy equipment contribute to the shortage of nurses. Thus, a reduction in the physical demands of the work tasks by using assistive technology will help keep nurses in the profession, thereby helping to maintain nurse staffing levels.

23.3.4 Aging Workforce

As in most industries in the United States, the health care industry workforce is getting older [19], and this trend is likely to continue as the retirement age to qualify for full Social Security benefits increases. The American Nurses Association (ANA) has reported the average age of a registered nurse in the United States to be 46.8 years of age. From an ergonomics perspective, increasing worker age is a concern because on average, physical strength and muscular endurance generally decreases with age, especially above 50 years of age. Since the

risk of MSD is a function of the ratio of strength demands-to-worker capacity, any reduction in physical strength would increase MSD risk for a specific task. This is because when the workers strength is diminished, the workers will have to expend a higher percentage of their maximum capacity. Although older workers often have developed more knowledge and better skills, these improvements cannot compensate for decreased physical capacity, especially when the physical demands are high. Therefore, an effective ergonomic approach would be to provide assistive technology to reduce job demands so that aging workers can continue to safely perform their job. This approach has the added benefit of broadening the pool of workers, which will alleviate the nursing shortage discussed previously [20].

23.3.5 Obesity Epidemic

Another changing demographic characteristic of concern to the health care industry is the rapid increase in body weight of the U.S. population over the past three decades, including patients and caregivers [21]. The current epidemic of obesity in the United States is playing a major role in the increased risk of MSDs for health care workers. The percentage of U.S. citizens who are classified as obese has increased from 15% in 1980 to 35% in 2006 [22]. The percentage of citizens who are reported to be either overweight or obese (BMI $\geq$ 25) was 68.0% in 2007–2008. The percentage of U.S. citizens who are classified as extremely obese (BMI of 40 or higher) has increased from 1.4% in 1980 to 6.2% in 2006 [22]. Patients are becoming heavier, and it is not uncommon to see patients requiring hospitalization who weigh over 400 lb. As the weight of the patient increases, the risk of injury to the patient and the health care worker who must transfer, move, and treat the patient also increases. Also, many tasks that may have been considered acceptable to perform manually in the past are no longer safe for the caregiver, such as lifting an arm or leg for treatment or reaching across a patient to perform a task.

23.3.6 Earlier Hospital Discharge Times

In addition to the risk factors listed earlier, shorter hospital stay times may play a role in increasing the risk of MSDs for health care workers. Due to spiraling health care costs, patients are not staying in the hospital following surgery and other treatments as long as they did in the past. In 1980, for example, the average length of hospital stay was 7.5 days compared with only 4.9 days in 2001 [23]. This reduction in hospital stay time has resulted in two significant effects. First, there is a concentration of acute patient needs associated with patient transfers and movement while in the acute care environment. Second, there is now a need for a higher level of patient transfer assistance in the home care environment at an earlier stage of recovery than was previously required. Unfortunately, the home care environment is often lacking in the availability of assistive patient-handling technology. Both of these factors have increased the risk of work-related MSDs for health care workers.

23.4 PREVENTION AND CONTROL

In the past, attempts to prevent work-related MSDs due to heavy physical exertion associated with lifting, pushing, pulling, and carrying focused on adopting arbitrary weight or force limits for handling loads, hiring strong workers, or using training procedures that

emphasized "correct" (but not necessarily safe) lifting techniques. None of the approaches noted earlier, however, has proven to be effective in significantly reducing risk of overexertion injuries [24]. As previously noted, since the 1940s, the health care industry has relied almost exclusively on teaching "good body mechanics" for controlling the risks of patient-handling injuries. This approach, however, has been shown to be ineffective in reducing risk of work-related MSDs. More recently, industry has recognized the risks associated with performance of physically demanding tasks, and to reduce costs and increase productivity, companies have begun to implement ergonomic programs or practices aimed at preventing these injuries. The core element of these programs is reliance on use of state-of-the-art equipment designed to assist the worker in carrying out the prescribed task. Two excellent resource books that provide comprehensive and detailed descriptions of effective evidence-based SPH programs are available. The first is a Practical Guide for Safe Patient Handling and Movement for Health Care Professionals [16] and the second is The Illustrated Guide to Safe Patient Handling and Movement [25]. For guidelines on solving nonpatient-handling manual material-handling problems, the reader is referred to the National Institute for Occupational Safety and Health (NIOSH) Guidelines for Manual Material Handling [26].

23.4.1 SPHM Algorithms

The patient safety center of inquiry, a research arm of the Veterans Health Administration (VHA), in collaboration with a number of partners, has developed a series of algorithms for assisting in assessing the safest and most effective approach to various patient-handling tasks. These algorithms are simple decision logic that allows caregivers to quickly determine when assistive technology should be used and how many caregivers are needed to perform a specific patient-handling task. The algorithms cover patient-handling tasks such as bed to chair, lateral transfers between beds, movement on a bed, lift from the floor, etc. The algorithms can be found at the Veterans Health Administration (VA) patient-handling website [27].

23.4.2 Guidelines for Bariatric Patient Handling

The VHA, in collaboration with partners, has developed a bariatric toolkit for assessing patient-handling tasks for bariatric patients that can also be found at the VA website [27]. A bariatric patient is defined as an individual who exceeds standard capacity equipment (300 lb) with a Body Mass Index (BMI) of 50 or higher. The BMI for a person is calculated by multiplying their weight (kg) times their height squared (m^2). The bariatric guidelines, which can be found at the VHA website, provide patient-handling algorithms for (1) transfer to bed to chair, chair to toilet, or chair to chair; (2) bariatric lateral transfer to and from bed to stretcher or trolley; (3) bariatric reposition in bed: side to side, up in bed; (4) bariatric reposition in chair: wheelchair, chair, or dependency chair; (5) patient-handling tasks requiring sustained holding of limb to access body parts; (6) bariatric transporting (stretcher, wheelchair, and walker); and (7) bariatric toileting tasks.

23.4.3 Ergonomic Recommendations for Nursing Home and Home Health Care

Researchers at NIOSH have developed recommendations for prevention of work-related MSDs in nursing homes [28,29]. Patient handling in nursing homes typically involves work

with older, increasingly frail patients, who may have significant impairments, complicating even simple transfer tasks. The NIOSH recommendations demonstrate the effectiveness of implementing SPH programs in nursing homes, show how use of technology in the context of an overall program significantly reduce risk of MSDs, and the economic benefits of purchasing equipment and implementing an SPH program. In fact, the cost of obtaining patient-handling equipment and implementing an SPH program can be recovered in as few as 3 years of implementation.

OSHA recently published an ergonomics guideline that provided an overview of the risks of work-related MSDs in nursing homes, provided information about the most effective approaches for mitigating or reducing those risks, and discussed training needs [6]. One of the most important statements in the OSHA nursing home guideline was that "manual lifting of residents be minimized in all cases and eliminated when feasible." OSHA also recommended that employers implement an effective ergonomics process that provides management support, involves employees, identifies problems, implements solutions, addresses reports of injuries, provides training, and evaluates ergonomics efforts. The document also provided a section titled "Identifying Problems and Implementing Solutions for Activities Other Than Resident Lifting and Repositioning," which included sections dealing with storage and transfer of food, supplies, and medications; mobile medical equipment; working with liquids in housekeeping; working with liquids in kitchens, hand tools, and linen carts; handling bags; reaching into sinks; loading or unloading laundry; and cleaning rooms (wet method and electrical).

23.4.4 Ergonomic Guidelines for Home Health Care Settings

NIOSH researchers have also developed a series of guidelines for application of ergonomics in the home health care environment [30–33]. These guidelines describe the high-risk environment associated with patient handling in the individual's home. Home health care workers are at additional risk of MSDs due to lack of available assistance, space restrictions, lack of assistive technology, and lack of control over the workplace environment. These guidelines provide a range of ideas and solutions for reducing risk to home health care workers due to patient handling.

23.4.5 Weight Limit Recommendations for Patient Lifting

Recently, based on the Revised NIOSH Lifting Equation, NIOSH researchers assessed typical patient-handling tasks and suggested that no caregiver should manually lift more than 35 lb of person's body weight for a vertical lifting task [34]. The author recommended that when the weight to be lifted exceeded this limit, then assistive devices should be used. This recommendation has been adopted by the VHA and incorporated into their current patient-handling algorithms.

23.4.6 NAON Ergonomics Guidelines

The National Association for Orthopaedic Nursing also recently developed ergonomics guidelines for prevention of work-related MSDs in the orthopedic setting [35–40]. The guidelines included recommendations for (1) turning a patient in bed from side to side [36];

(2) performing a vertical transfer of a postoperative total hip replacement patient from a bed to chair, chair to toilet, chair to chair, or car to chair [37]; (3) performing a vertical transfer of a patient with an extremity cast/splint [38]; (4) assisting an orthopedic patient with ambulation [39]; and (5) lifting a leg or an arm with a cast [40].

23.4.7 AORN Ergonomics Guidelines

A task force organized by the VA and the Association for periOperative Registered Nurses (AORN) recently developed ergonomic guidelines for prevention of work-related MSDs in the operating room setting [13,41–46]. These guidelines were developed by a task force including representatives from AORN, the NIOSH, the Patient Safety Center of Inquiry at the James A. Haley Veterans Administration Medical Center (VMAC) in Tampa, and the ANA. The task force was formed to identify high-risk tasks performed in the perioperative area and to develop evidence-based solutions to minimize the risk of MSDs. The guidelines consist of seven clinical tools/algorithms to guide perioperative registered nurses and other perioperative team members incorporating current ergonomic safety concepts, scientific evidence, and available technology including SPH equipment and devices. The seven tools include lateral transfer from stretcher to operating room (OR) bed [41]; repositioning patients on OR beds [42]; lifting and holding legs, arms, and heads for prepping [43]; prolonged standing [44]; holding retractors for extended periods of time [45]; lifting and carrying supplies/equipment [46]; and pushing, pulling, and moving equipment on wheels [13].

23.4.8 APTA Guidelines

Physically demanding patient-handling and transferring tasks in the rehabilitation setting have been shown to present high risk for the development of work-related MSDs for therapists. Factors that have been shown to increase risk of work-related MSDs in the rehabilitation setting include patient transfers, patient repositioning, working in bent or twisted postures, joint mobilization, soft tissue work, PROM treatments, and job strain [47]. Traditional tasks have a practical goal, such as transferring a patient from a bed to wheelchair, while therapeutic tasks have more targeted goals of facilitating patient function and independence. Therapeutic patient-handling tasks likely present greater risk of WMSD to the caregiver than do typical patient-handling tasks due to the longer times of exposure to the high mechanical loads on the spinal tissues of the worker. The American Physical Therapy Association (APTA) recognized the importance of ergonomics in prevention of work-related MSDs during rehabilitation treatment. The APTA in collaboration with the VHA developed a white paper outlining the need for ergonomics in patient handling for the rehabilitation setting [48]. The APTA white paper contained six important recommendations, including the following:

1. Implement the *OSHA Ergonomics for Prevention of Musculoskeletal Disorders: Guidelines for Nursing Homes.*
2. Build and support a culture of safety in rehabilitation settings that protects staff as well as patients.

3. Improve communication channels between nurses and physical therapists to facilitate SPH and movement tasks.
4. Develop policies and procedures for the therapeutic use of patient-handling equipment, including selection of equipment that first provides safety for staff and patients and equipment with features, as appropriate, that allow for or promote active use of the assistive equipment by the patient for therapeutic benefit.
5. Develop competency-based assessments that demonstrate proficiency for use of all patient-handling equipment used on the respective patient care unit, including return demonstration (i.e., training through role playing and teaching other staff members).
6. Encourage research that supports the improvement of patient and staff safety while maximizing patient rehabilitation potential, including investigation of the cost-effectiveness of ergonomics interventions, impact of injury-risk reduction to physical therapists, and determination of the efficacy of patient-handling equipment when integrated into therapeutic activities.

23.4.9 Safe Patient-Handling Training for Schools of Nursing

In an attempt to provide information on SPH concepts to nurses at an early stage in their careers, NIOSH recently published curricular materials for a training program on SPH for use in schools of nursing [49]. The training materials include a narrated slide show with imbedded video and a booklet with the actual training materials that can be downloaded for free from the NIOSH website: www.cdc.gov/niosh/. The training materials have been shown to be effective in changing the knowledge, attitude, and beliefs regarding evidence-based SPH concepts and procedures [50].

23.4.10 State-of-the-Art Ergonomic Technology

Recently, the health care industry has recognized the risks associated with performance of physically demanding patient-handling tasks, and to reduce costs and increase productivity, companies have begun to implement ergonomic programs or practices aimed at preventing these injuries. The core element of these programs is reliance on use of state-of-the-art ergonomically designed equipment to assist the worker in carrying out the prescribed task. As an added incentive to adopt technology-based patient-handling practices, OSHA recently published an ergonomics guideline that provided an overview of the risks of work-related MSDs in nursing homes. The guideline provided information about the most effective approaches for mitigating or reducing those risks, and discussed training needs [6]. One of the most important statements in the OSHA nursing home guideline was that "manual lifting of residents be minimized in all cases and eliminated when feasible." This is best accomplished by implementing a technology-based SPH program.

A wide range of ergonomic patient-handling technology is available that can be applied to most types of patient-handling activities [51–54]. The most common patient-handling activities include (1) *lateral transfers* of patients between two lateral surfaces, such as bed to bed or between a bed and an examining table; (2) *vertical transfers* of patients, such as from

a bed to a chair or between chairs; (3) *standing a patient from a sitting position*; (4) *ambulation*; (5) *transporting heavy equipment*, such as pushing or pulling occupied or unoccupied beds, heavy treatment equipment, OR beds, etc.; (6) *repositioning people in bed*, side to side or up and down; and (7) *working in extreme or awkward postures* for long periods of time, including standing. Each specific health care setting may have unique requirements for patient-handling technology, such as operating rooms, critical care environments, orthopedic, home care, and rehabilitation settings. Examples of common state-of-the-art patient-handling devices are shown in Figure 23.1a–f.

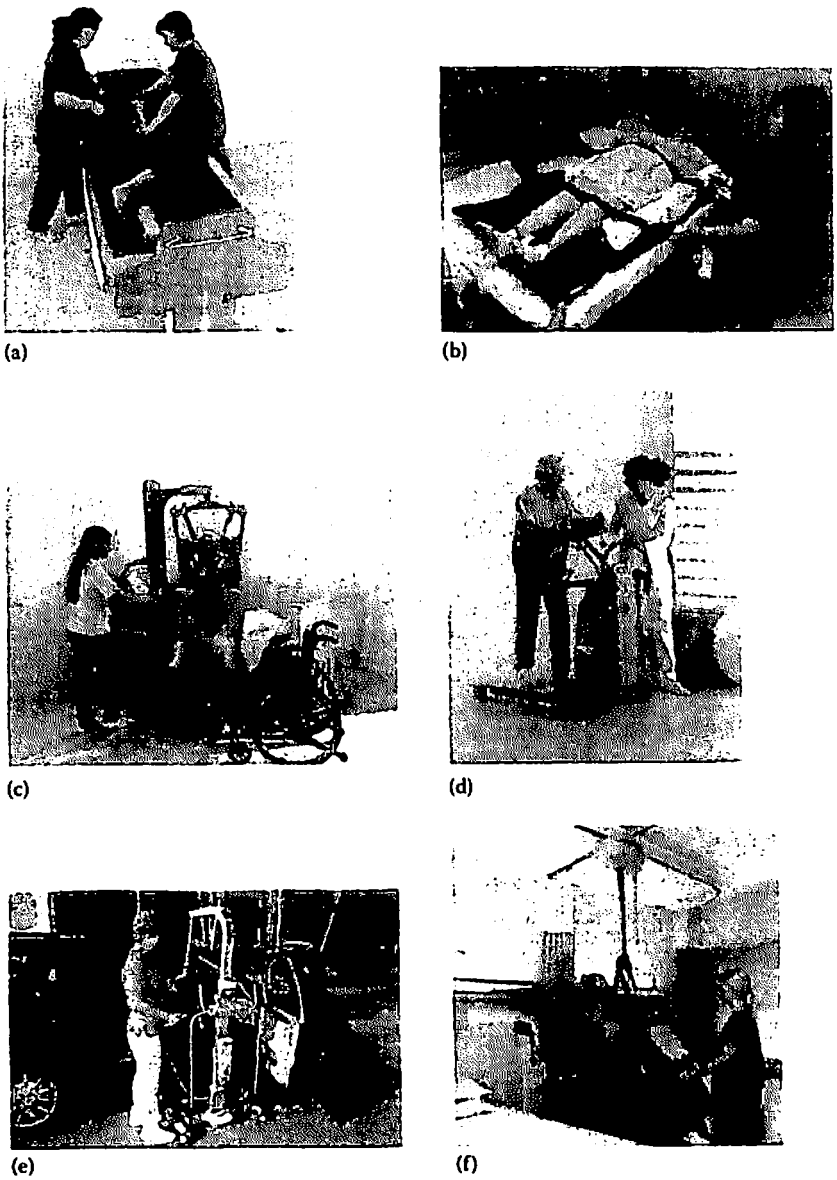

FIGURE 23.1 Examples of common state-of-the-art patient-handling devices.

TABLE 23.1 Categories of Ergonomic Patient-Handling Technology Available

Air-assisted lateral transfer aids	Bed systems (frames/surfaces/assist devices/other bed safety devices)
Car lifts/vehicle extraction	Ceiling lifts
Dependency/Geri/specialty chairs/wheelchairs	Floor-based lifts
Friction reducing lateral transfer aids	Gait belts w/handles
Lifts (other)	Mechanical lateral transfer aids
Other mobility aids	Powered standing lifts
Repositioning devices	Sliding boards
Slings	Standing assist aids
Transport devices/powered beds	
Bariatric devices (patient BMI > 40)	
Bariatric ambulatory/mobility aids	Bariatric bathing equipment (other)
Bariatric beds/mattresses/transportation	Bariatric ceiling lifts
Bariatric commodes/shower chairs	Bariatric lateral transfer systems
Bariatric repositioning systems	Bariatric powered lifts
Bariatric standing assist aids	Bariatric transfer/dependency chairs and cushions
Bariatric wheelchairs	

A wide range of assistive devices have been developed for each type of patient-handling activity. The VHA has developed a technology resource guide that lists a wide range of technology for use in SPH and movement. The technology resource guide classifies patient-handling technology into the broad categories listed in Table 23.1. Brief descriptions of the most important categories of technology are provided later. The VHA technology resource guide can be found at the VA website [27]. The OSHA Ergonomics Guidelines for Nursing Homes also provides an overview of technology available for SPH [6].

23.5 CRITICAL REVIEW OF CURRENT STATUS

23.5.1 Gaps in Technology

Although a wide range of equipment is available, gaps in technology remain. For example, ceiling lift devices for vertical transfer of patients in operating rooms where the patient may need to be moved laterally but also may need to be turned from supine to prone position are lacking. Also, more devices specifically designed for use in rehabilitation settings where the handling equipment must provide dual function are needed. That is, the equipment must be designed so that it can provide adequate assistance for patient transfers when needed, but also must be flexible enough so that it can quickly be adjusted for use during therapeutic procedures where the patient is required to use more and more of their own capabilities as they recover. Also, more research is needed to identify issues related to equipment usage. There are three areas of gaps in technology application. These include the following:

1. Equipment that is needed, but has not been developed.
2. Equipment that has been developed, but facilities have not obtained it.
3. Equipment that has been developed and facilities have obtained it, but it is not being used.

These issues need to be addressed in order to maximize the effectiveness of technology-based solutions in health care.

23.5.2 Implementation and Sustainability of SPH Programs

There are a number of research questions that need to be answered. These include the following:

- What elements are most important to make SPH programs effective?
- How can SPH programs be made more sustainable?
- What are the barriers to implementation of SPH programs and how can they be overcome?
- What is the impact of regulation on implementation and sustainability of SPH programs?
- How do SPH programs affect the quality of care for patients?
- Can quality-of-care issues be a driver for increased implementation of SPH programs?
- How does cost–benefit analysis impact implementation and sustainability of SPH programs?

23.6 FUTURE CONCERNS

Problems with physical therapy
Aging and need for higher levels of care for older individuals
Health care costs

In conclusion, there is strong evidence that (1) manual patient-handling presents high risk for the development of work-related MSDs; (2) reliance on body mechanics alone is not effective in reducing the risk of patient-handling injuries; (3) effective technological solutions are available to reduce or eliminate the risk of these health problems; and (4) implementation of an SPH program that relies on use of state-of-the-art technology is cost effective and, on average, will provide a positive return on investment within 3 years of implementation. Unfortunately, many health care settings are still relying on unsafe manual lifting techniques rather than investing in newer, safer patient-handling technology. Recent state legislation and possible U.S. federal legislation may force implementation of programs, but proactive ergonomics based on implementation of a SPH program will provide a safe work environment for both workers and for patients.

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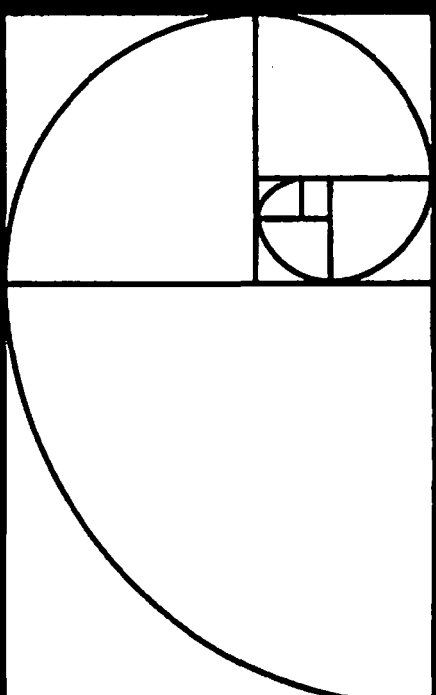

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Second Edition

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In the fifteen years since the publication of **Occupational Ergonomics: Theory and Applications**, significant advances have been made in this field. These advances include the impact of aging and obesity on workplace, the role of ergonomics in promoting healthy workplaces and healthy life styles, the role of ergonomic science in the design of consumer products, and much more. The caliber of information and the simple, practical ergonomics solutions in the second edition of this groundbreaking resource, though, haven't changed.

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