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Manual Handling Workload and Musculoskeletal Discomfort in Nursing Personnel

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Manual Handling Workload and Musculoskeletal Discomfort in Nursing Personnel

Nancy Nivison Menzel

A dissertation submitted in partial fulfillment
of the requirements for the degree of
Doctor of Philosophy
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College of Public Health
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Manual Handling Workload And Musculoskeletal Discomfort In Nursing Personnel

Nancy Nivison Menzel

(ABSTRACT)

Nursing staff members (registered nurses, licensed practical nurses, and nursing aides) have one of the highest incidence rates of work-related musculoskeletal disorders (WMSDs) of all occupations. Ergonomic research has identified patient handling and movement tasks that put the caregiver at high risk for a WMSD each time they are performed. The purpose of this study was to determine whether the frequency of performing the highest risk tasks, as well as certain other risk factors affecting physical workload, were related to the frequency of musculoskeletal discomfort. Also investigated was whether the manual handling workload varied by job category. The cross-sectional study was conducted at a Veterans' Administration hospital in Tampa, Florida in August 2001 on 11 in-patient units with 113 participants, who completed musculoskeletal discomfort and demographic surveys at the end of a week of observation of their workloads. Multiple regression analysis indicated that the number of high risk patient handling and movement tasks performed per hour, the number of patients cared for who weighed 212 pounds or more, and the interaction of the two were associated with the frequency of knee and wrist pain, but not with low back pain. The following variables were not associated with the frequency of musculoskeletal discomfort in any body part: patient census/able bodied staff ratio, patient classification rating, or number or use of patient handling and movement equipment. Manual handling workload did differ significantly among job categories, with registered nurses performing the fewest at-risk patient handling tasks and nursing aides the most. The seven-day prevalence rate of at least moderate discomfort in at least one body part was 62%. Recommendations include instituting recorded patient assessments to standardize the type of equipment and the number of staff members needed for specific handling and movement activities, as well as improved staff training. Further research is needed on the following: biomechanical forces on the wrist and knee during patient handling and movement tasks; the effect of patient weight on the risk of patient handling and movement tasks; and psychosocial stressors in addition to the physical workload of nursing staff.

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Chapter 1: Introduction

There are now about 126,000 vacant nursing positions in U.S. hospitals, a figure projected to increase to 400,000 by 2020, according to the American Hospital Association (“Growing Nursing Shortage,” 2001). Against this background of nursing shortages, nursing staff (registered nurses [RNs], licensed practical nurses [LPNs], and nurse aides/assistants, orderlies, and attendants [referred to collectively as NAs]) continue to be injured on the job and subsequently leave the field, either temporarily or permanently. Nursing staffs have one of the highest incidence rates of musculoskeletal disorders of all occupations. In the Occupational Safety and Health Administration’s preamble to its rescinded ergonomics standard, the agency estimated that the Standard Industrial Classification code Health Services has the fourth highest incidence of Lost Workday Work-Related Musculoskeletal Disorders (WMSDs), 13.8 per thousand (U.S. Department of Labor, 1999, p.65936). Most WMSDs in health care are back injuries, although they may also include neck, shoulder, arm, wrist, and knee disorders. Moving or handling a patient is the major cause of injury (Gagnon, Chehade, Kemp, & Lortie, 1987; Harber et al., 1985; Jensen, 1985; Knibbe & Friele, 1996; Owen, 1989; Stobbe Plummer, Jensen, & Attfield, 1988; Stubbs, Buckle, Hudson, Rivers, & Worryingham, 1981; Venning, Walter, & Stitt, 1987).

The U.S. Department of Labor (1989) categorizes WMSDs of the back as “injuries” and WMSDs of most other body parts as “illnesses.” “Back cases should be classified as injuries because they are usually triggered by an instantaneous event” (U.S. Department of Labor, 1989, p. 38). The U.S. Department of Labor, Bureau of Labor Statistics Log and Summary of Occupational Injuries and Illnesses describes a sub-category for Occupational Illness of “Disorders Associated With Repeated Trauma” and gives the following examples: “Noise induced hearing loss, synovitis, tenosynovitis, and bursitis, Raynaud’s phenomena, and other conditions due to repeated motion, vibration, or pressure” (U.S. Department of Labor, 1986, p. 64). The Occupational Safety and Health Administration (OSHA) has proposed an overhaul of this record keeping system to begin in January 2002; however, Secretary of Labor Elaine L. Chao is proposing to delay for one year the implementation of a new record keeping category “musculoskeletal disorder (MSD)” (U.S. Department of Labor, June 29, 2001).

There are few objective signs to diagnose many WMSDs, particularly back injuries. Those claiming to have a back injury may simply report the symptom of pain in the lower or upper back or radiating down the back of the leg. According to Rosenstock and Cullen (1994, p. 365), “the cause of up to 85% of back pain episodes remains

unclear.” There is adequate scientific evidence, however, that biomechanical stressors can produce back pain (Institute of Medicine, 2001, p. 246).

Studies have found that the lifetime prevalence of back pain among hospital and nursing home direct care staff ranges from 43% to 80% (Cato, Olson & Studer, 1989; French, 1997; Harber et al., 1985; Leighton & Reilly, 1995). This approximates the lifetime prevalence of low back pain in the general population, “estimated at nearly 70% for industrialized countries” (National Institute for Occupational Safety and Health, 1997, p. 6-2). In a study of home health nurses, Knibbe and Friele (1996) found a lifetime prevalence for back pain of 87%, while 67% of nursing staff reported back pain in the previous 12 months. Leighton and Reilly (1995) found a point prevalence of 24% and an annual prevalence of 59%, which figures were not statistically different from the prevalence rates for the same time periods for the general population ($N=315$). A survey of 1616 British nurses (Smedley, Egger, Cooper, & Coggon, 1995) found a lifetime prevalence of back pain was 60%, with a one year period prevalence of 45%. Nelson et al. (1996) found the prevalence of moderate musculoskeletal discomfort of 64% in the previous 30 days at a Veterans’ Administration hospital among staff on the Spinal Cord Injury and Nursing Home Care Units.

Scope and Cost of Back Pain

Due to its widespread prevalence, back pain is costly to industry, accounting for 20% to 40% of the workers’ compensation payments in general industry (Daltroy et al., 1997; Jensen, 1987; Snook, 1982; Webster & Snook, 1994). According to the Institute of Medicine (2001, p. 1), “In 1999, nearly 1 million people took time away from work to treat and recover from work-related musculoskeletal pain or impairment of function in the low back or upper extremities.”

Cohen-Mansfield, Culpepper, and Carter (1996) found that back injuries to nursing staff members in long term care facilities were responsible for more than half of workers’ compensation costs in that segment of health care. According to the Occupational Safety and Health Administration (n.d.), back injuries comprise 45% of all injuries in nursing homes.

The National Institute for Occupational Safety and Health (NIOSH) has put low back disorders on its National Occupational Research Agenda (NORA) (NIOSH, 1998). According to NIOSH (2001), the magnitude of this problem is large:

In 1993, back disorders accounted for 27% of all nonfatal occupational injuries and illnesses involving days away from work in the United States. The economic costs of low back disorders are staggering. In a recent study, the average cost of a workers’ compensation claim for a low back disorder was \$8,300, which was more than twice the average cost of \$4,075 for all compensable claims combined. Estimates of the total cost of low back pain to society in 1990 were between \$50 billion and \$100 billion per year, with a significant share (about \$11 billion) borne by the

workers' compensation system. Moreover, as many as 30% of American workers are employed in jobs that routinely require them to perform activities that may increase risk of developing low back disorders.

Two of Healthy People 2010's objectives address reducing injuries to health care workers and reducing WMSDs that result from overexertion in lifting, of which 52 % are back injuries (U.S. Department of Health and Human Services, 2000, pp. 20-11 - 20-12). Objective 20-2 calls for a 30% reduction in the 1997 baseline rate of 7.9 injuries per 100 full time workers in Health Services by 2010.

In a 2001 on-line survey conducted by the American Nurses Association (ANA), 4,826 nurses cited their top three health and safety concerns as "acute and chronic effects of stress and overwork," followed by "disabling back injury," and then "HIV or hepatitis from a needlestick injury" (2001, p. 1). "Additionally, nurse respondents stated that more than half the facilities in which they worked didn't have lifting and transfer devices readily available for moving patients" (ANA, 2001, p. 8.).

Relationship of Musculoskeletal Pain to Workers' Compensation Claims

Not all workers with symptoms of WMSDs file workers' compensation claims. One study showed that between 9% and 45% of those with occupational illnesses (not injuries) actually filed claims (Biddle, Roberts, Rosenman, & Welch, 1998). Cato et al. (1989) found that 78% of nurses with back pain in the previous 6 months did not report it to management. Nelson et al. (1996) found: "Nurses indicated they report musculoskeletal pain immediately for an acute injury attributed to a patient. Nurses indicated they report chronic musculoskeletal pain only when pain is unbearable and function is significantly limited (p. 14)."

Employees may fear repercussions from their employer if they file a claim or may have other reasons for not doing so. The factors influencing employees to file or not file workers' compensation claims have not been identified. Because of the difference between prevalence of symptoms and incidence of filing a claim or report, incidence rates are a lagging indicator of the true prevalence of WMSDs. As Lemasters and Atterbury (1996) note, "Symptoms are by definition subjective. Since symptoms are thought to be the earliest clinical manifestation of a musculoskeletal disorder, establishing the presence and severity of symptoms is critical to evaluating the prevalence of WMDs [work-related musculoskeletal disorders]" (p. 439).

Association with Strenuous Tasks

One problem NIOSH (2001) has identified in the health care industry is that risks from transferring and moving patients are not well defined and quantified. NIOSH's Revised Lifting Equation has a disclaimer that it does not apply to "lifting people" (Waters, Putz-Anderson, Garg, & Fine, 1993, p. 769). However, the equation does set the maximum amount that should be lifted under ideal conditions at 51 pounds. Virtually all adult patients exceed this weight limit.

When Leighton and Reilly (1995) surveyed 1134 British nurses about back pain, two-thirds of those reporting an annual back pain prevalence attributed their injuries to patient handling or movement. Of nurses in this group, 48% identified the precipitating incident involved “positioning a patient in bed as opposed to performing a patient-transfer task” (p. 265).

Through biomechanical studies and estimates of perceived exertion, several individual patient handling tasks at high-risk for causing WMSDs have been identified, such as turning a patient, pulling a patient up in bed, and transferring a patient from bed to stretcher or bed to chair or toilet and back again (Nelson et al., 1996; Owen & Garg, 1989; Owen, Keene, & Olson, 2000/2001). As Kumar (1990, p. 1311) put it, “Considerable attention has been paid to the peak stresses at which the injuries precipitate.” Owen & Garg (1989) and others have looked at these tasks individually and determined that by themselves, some present a risk to the caregiver by increasing compressive forces on the L₅/S₁ spine above the 3.4 kN level acceptable to NIOSH for spinal loading (NIOSH, 1981). For example, Owen and Garg (1991) found that transferring a patient from wheelchair to toilet exceeds NIOSH action limits for L₅/S₁ spinal loading each time it is performed. This type of task puts the caregiver at-risk for a back injury every time he or she performs it.

Although WMSDs are considered cumulative trauma injuries/illnesses, there has been only limited research on the risk associated with the frequency that these activities are performed during the course of a nurse’s workday, workweek, work year, or career. Stobbe et al. (1988) demonstrated that frequency of lifting was related to the incidence of back injury. Kumar (1990) found a positive relationship between cumulative load and back pain in nursing aides. Kelsey, et al. (1984) found a relationship between lifting frequency and prolapsed intervertebral disc. The hazardous weight threshold was 25 pounds if the lift was performed more than 25 times a day. Nurses handle and move many times that weight, often in an awkward posture. The nurse’s total workload, which encompasses the frequency that he or she performs a variety of care giving tasks in a normal workday (8-12 hour shift), increases the dose, over and above simply performing one hazardous patient handling activity.

According to Smith and Carayon-Sainfort’s (1989) Balance Theory of Job Design, the work system imposes physiological and psychological loads on the individual, resulting in challenges to physical, psychological, and biological resources, such as energy and strength. Not only are the individual’s perceptions of the load important, but also the load’s “objective physical properties independent of the perception of the properties” (Smith & Carayon-Sainfort, 1989, p. 74). In a more recent article, the same authors (Carayon & Smith, 2000, p. 651) explain the cumulative trauma model this way: “When the load becomes too great, the person displays stress responses, which are emotions, behaviors, and biological reactions that are maladaptive. When these reactions occur frequently over a prolonged time period, they lead to health disorders.” If the workload of a nurse is higher than safe limits, this may lead to an imbalance.

The Institute of Medicine (2001, p. 220) describes the cumulative trauma model this way:

...the cumulative trauma model assumes injury may result for the accumulated effect of transient external loads that may, in isolation be insufficient to exceed internal tolerances of tissues. It is when this loading accumulates by repeated exposures, or exposures of sufficiently long duration, that the internal tolerances of tissues are eventually exceeded. The cumulative trauma model therefore explains why many musculoskeletal disorders are associated with work, because individuals often repeat actions (often many thousands of times) throughout the workday, performing work activities in many occupations.

Chapter 2: Review of The Literature

Causes of Musculoskeletal Disorders

The World Health Organization (WHO) has classified occupational injuries and illnesses, including back pain and other WMSDs, as multifactorial, indicating that there are many factors (e.g., physical, work organizational, psychosocial, individual, and sociocultural) that cause them (WHO, 1985). NIOSH (1997, p. 1-1) cites this multifactorial etiology as “one important reason for the controversy surrounding work-related WMSDs.” The Institute of Medicine (2001) supports the multifactorial etiology of WMSDs in its report on WMSDs and the workplace.

Body Parts Affected by WMSDs in Nursing

Injuries to the back or back pain are the most frequent outcome variables in cohort or cross-sectional studies of nursing personnel (Fuortes, Shi, Zhang, Zwerling, & Schootman, 1994; Harber et al., 1987; Hignett, 1996; Kumar, 1990; Leighton & Reilly, 1995; Smedley et al., 1995; Stobbe et al., 1988; Stubbs et al., 1983). This focus is most likely due to the high incidence and high cost to the health care industry of work-related back injuries (Cohen-Mansfield et al., 1996). Some researchers have broadened the focus from the back to musculoskeletal discomfort in other body parts as well, particularly the arm, neck, shoulders or leg (Ahlberg-Hulten, Theorell, & Sigala, 1995; Engels et al., 1996; Estryn-Behar et al., 1988). Compression of the L₅/S₁ disc may produce subsequent radicular symptoms along the distribution of the sciatic nerve. Such sciatic pain “may occur with or without low back pain”(Beers & Berkow, 1999, p. 476.).

Most studies of the biomechanics of at-risk patient handling tasks focus on compressive force on the low back (L₅/S₁ disc) (Garg, Owen, Beller, & Banaag, 1991; Owen & Garg, 1994; Owen, Garg, & Jensen, 1992; Zhuang, Stobbe, Hsiao, Collins, & Hobbs, 1999). Nelson, Lloyd, Gross, and Menzel (2001) studied force on both the lumbar and shoulder regions. The Institute of Medicine (2001) focused on the scientific evidence for the association between lifting and the low back and upper extremities.

WMSD Risk Factors

Research on WMSDs, and back injuries in particular, has focused on identifying what the risk factors are and their relative contribution to causation, reporting, and subsequent disability. Cato et al. (1989) concluded that the risk factors were length of time in the job and a history of previous back injury. Other studies (Fuortes et al, 1994;

Josephson & Vingard, 1998; Ryden, Molgaard, Bobbitt, & Conway, 1989; Smedley, Egger, Cooper, & Coggon, 1997; Stubbs et al., 1983; Venning, Walter, & Stitt, 1987) have concluded that job-related (not individual) characteristics were the major predictors of back injuries in nurses, with a history of previous back injury also a risk factor.

Some studies have identified individual (personal) risk factors, including level of fitness (Legg, 1987), obesity (Gold, 1994; Lagerstrom, Wenemark, Hagberg, & Hjelm, 1995; Patenaude & Sommer, 1987), genetics (Gold, 1994), height (Dehlin, Hedenrud, & Horal, 1976; Kerr et al. (2001)) muscular strength (Kilbom, 1988), age (Kelsey & Golden, 1988; Lagerstrom, Wenemark, Hagberg, & Hjelm, 1995; Lavsky-Shulan et al., 1985), and stress (Hawkins, 1987). Some health-related behaviors and habits might to some extent confound associations between occupation and low back pain, including drug/alcohol consumption (Bigos et al., 1986; Manning, Leibowitz, Goldberg, Rogers, & Newhouse, 1984) and cigarette smoking (Frymoyer et al., 1980; Frymoyer et al., 1983; Heliovaara, Knekt, & Aromaa, 1987; Kelsey, 1975; Kelsey et al., 1984).

Contradicting the studies identifying obesity as a risk factor, in a case control study of 306 automobile workers, Kerr et al. (2001) found Body Mass Index (BMI) to be lower in those with reported work-related back pain. In a prospective cohort study of 961 female hospital nurses, Smedley et al. (1997) found no relationship between BMI and the development of low back symptoms.

The study by Kerr et al. (2001, p. 1069) found that both “physical and psychosocial demands of work of work...[are] independent risk factors for low back pain.” “[The] physical measure risk factors included peak lumbar shear force, peak load handled, and cumulative lumbar disc compression. Low body mass index and prior low back pain compensation claims were the only significant individual characteristics.” Psychosocial risk factors included “a physically demanding job, a poor workplace social environment, [and] inconsistency between job and education level,” while “better job satisfaction, and better coworker support” were factors associated in an unexpected direction (p. 1070). However, the cross sectional design of this study makes it impossible to draw etiological conclusions from the findings. Burton et al. (1995) surveyed Dutch and Belgian nurses and found that musculoskeletal symptoms and work loss in the past year were not related to work load but to psychosocial variables.

A laboratory study on the impact of psychosocial stress on muscle activity and spinal loading found that psychosocial stress increased spine compression and lateral shear in some subjects (Marras, Davis, Heaney, Maronitis, & Allread, 2000). The authors concluded that “psychosocial stress increases risk of low back disorders” (p. 3045).

OSHA’s Ergonomics Program Standard §1910.900 (rescinded by the U.S. Congress in March 2001) includes a checklist that identifies five risk factors (all of them physical) associated with a WMSD hazard:

- Repetition – e.g., repeating same motions every few seconds for 2 hours at a time, or using a device (such as a keyboard and/or mouse) steadily for more than 4 hours daily.
- Force – e.g., lifting more than 75 pounds at any one time, more than 55 pounds more than 10 times per day; or more than 25 pounds below the knees, above the shoulders, or at arms’ length more than 25 times per day; or pushing/pulling with more than 20 pounds of initial force (such as pushing a 65 pound box across a tile floor for more than two hours per day).
- Awkward Postures – e.g., repeatedly raising or working with the hands above the head or the elbows above the shoulders for more than two hours a day, or working with back, neck or wrists bent or twisted for more than two hours total per day.
- Contact Stress – e.g., using the hand or knee as a hammer more than ten times an hour for more than two hours total per day.
- Vibration – e.g., using tools or equipment that typically have high vibration levels (such as chainsaws, jack hammers, percussive tools) for more than 30 minutes per day or tools with moderate vibration levels (such as jig saws, grinders, etc.) for more than two hours per day (U.S. Department of Labor, 2000, p. 68848).

In the Health Effects section of its preamble to the final ergonomics standard, OSHA defended the standard’s exclusive focus on job risk factors (which it also refers to as “physical” or “biomechanical” risk factors) by summarizing the relative contribution of both individual and job risk factors:

...in those studies where the effects of age, gender, smoking, etc. have been controlled for, the physical risk factors discussed here have been consistently shown to be associated with the development of a particular MSD in exposed populations. This means that, regardless of whether or not age plays a role in the development of a particular MSD in a particular population, the influence of biomechanical risk factors is independent from other associated factors. Furthermore, it has been demonstrated repeatedly, that reducing these biomechanical factors in the workplace results in reductions in the incidence of work-related MSDs (U.S. Department of Labor, 2000, p. 68517).

OSHA emphasizes this viewpoint later in the Health Effects section as well:

OSHA concludes that, in general, each individual’s capacity is affected differently by many factors, including some of those presented here: age, gender, smoking, physical activity, strength, anthropometry, genetic factors, and activities outside the workplace. This is also true in the more specific case of the development of work-related MSDs. However, it is important to remember that exposure to biomechanical factors in the workplace is independent of those factors that each individual brings to

the workplace, i.e., when the influence of individual factors is controlled for in studies, effects due to exposure to biomechanical factors are still observed. It is also true that in the vast majority of cases, where exposure to biomechanical exposures is high, the effects due to biomechanical exposures are far greater than those associated with these types of individual factors (U.S. Department of Labor, 2000, p. 68518).

Moving and handling patients is the most frequent reason for work related back pain in health care (Bell, Dalgity, Fennell, & Aitken, 1979; Cato et al., 1989; Cust, Pearson, & Mair, 1972; Dehlin, et al., 1976; Harber et al., 1985; Ferguson, 1970; Greenwood, 1986; Jensen, 1985, 1987; Knibbe & Friele, 1996; Leighton & Reilly, 1995; Love, 1997; Owen 1985, 1989; Smedley, et al., 1997; Stobbe et al., 1988; Stubbs, Rivers, Hudson, & Worringham, 1981; Videman et al., 1984; Williamson et al., 1988). Owen et al. (2000/2001) found that nurses reported the following non-patient handling tasks as stressful as well:

- Pushing beds and stretchers
- Lifting and moving equipment
- Cleaning beds/unit after discharge.

The risk for moving and handling injuries increases for nurses who hold patients away from the body while lifting and when bending and twisting while lifting occurs (Andersson, 1981; Kelsey, et al., 1984). This awkward angle and position frequently occurs during bathing and feeding and is exacerbated by sustained stretching and reaching (Damkot, Pope, Lord, & Frymoyer, 1984) or postural stress (Baty & Stubbs 1987, Garg et al., 1991). Marras, Davis, Kirking, and Bertsche (1999) found that the greatest risk was associated with one person transferring techniques. Most evidence indicates that failing to bend the knees while lifting is also harmful (Kelsey et al., 1984), although this does not apply when lifting a patient on a horizontal plane, such as transferring a patient from a bed to a stretcher. Sudden maximal effort from unexpected events, such as preventing a patient from falling, is also associated with high risk for injury (Magora, 1973; Molumphy, Unger, Jensen, & Lopopolo, 1985).

Nursing activities involve force and awkward postures. OSHA's ergonomics standard set a threshold of two hours total per day as the point above which risk occurs for awkward postures, and it also set a frequency threshold for lifts depending on weight lifted (U.S. Department of Labor, 2000, p. 68848). However, OSHA did not cite research to validate that going above these thresholds was harmful.

Knibbe and Friele (1996) studied back pain prevalence and the physical working conditions of community nurses. From responses to questionnaires assessing back pain and job tasks, the authors identified both the frequency and the force associated with heavy lifting as risk factors. However, they did not quantify either the amount of force or a frequency threshold (how many heavy lifts) that increased the risk of developing back pain.

Johansson (1995) studied psychosocial work factors, physical work load, and associated musculoskeletal symptoms among home care workers and concluded that the highest relative risk was for a combination of poor psychosocial work environment and high physical workload. However, the measurement of physical workload was from a subjective scale provided to participants and not from an objective quantification and comparison of workloads. Houtman, Bongers, Smulders, and Kompier (1994) found work pace and intellectual discretion to be stressors significantly related to musculoskeletal discomfort, when considered in conjunction with physical workload.

Studies have found that nursing assistants (NAs) usually have the highest rates of injury, followed by Licensed Practical Nurses, then RNs, which may reflect the NA's higher rates of exposure to manual handling tasks (Fuortes, et al, 1994; U.S. Department of Labor, 1999, 65934-65935). However, the disparate injury rates by job may also reflect differing propensities to report work-related injuries (Pransky, Snyder, Dembe, & Himmelstein, 1999).

Some researchers have suggested a link between time pressure (an indicator of short staffing) and musculoskeletal injuries (Bongers et al., 1993). Larese & Fiorito (1994) found that units with low nurse-to-patient ratios had more back pain and injuries than units with higher ratios. Owen et al. (2000/2001, p.3) reported that nursing personnel identified "working when the unit [was] short staffed" as increasing the stress of manual handling. The Institute of Medicine's report, *Nursing staff in hospitals and nursing homes: Is it adequate?* (Wunderlich, Sloan, & Davis, 1996) called for more research on the correlation between patient load and staff injuries to verify this connection.

Patient Handling and Movement Risk Factor Assessment

Heavy patients are more burdensome than light ones due to the increased force needed to move them (Owen & Garg, 1991; Owen et al., 2000/2001; Winkelmoen, Landeweerd, & Drost, 1994; Zhuang et al., 1999). Increased frequency of lifting increases risk of injury to nursing staff (Stobbe et al., 1988). Tasks that require the caregiver to assume awkward postures (due to a confined environment or difficulty positioning or accessing the patient) are more physically stressful than those that do not (Garg et al., 1991). Tasks that take longer to complete are more hazardous than shorter ones (duration). Patients who can't assist or who resist the caregiver in turning and moving require more effort from the caregiver (Love, 1996). Nurses report additional patient characteristics that complicate patient handling and movement, including "amputees, stroke and back-fusion patients, ...new surgical cases, those with lines, tubes or orthopedic braces or equipment, paralyzed patients, and those with spasms or in a great amount of pain (Owen et al., 2000/2001, p. 3). Several studies have attempted to quantify these risk factors.

Pilling (1993) devised a Lifting/Handling Risk Calculator for assessing the manual handling risk presented by home care patients. Using a scoring system that assesses a patient's body weight, mobility, and psychological condition, as well as

environmental and personal factors for the caregiver, the instrument is designed to provide an early warning to the caretaker if the patient presents a handling and movement hazard. The instrument is not designed to calculate the additional risks, if any, from caring for more than one patient.

One French study found a relationship between WMSDs in female hospital workers and those with maximal postural and lifting loads (Estryn-Behar et al., 1990). Postural load was an assessment of the static postural risks, such as standing more than six hours a day or maintaining an uncomfortable posture. The lifting index was a threshold for the frequency of performing patient handling tasks, such as lifting patients more than ten times a shift. The authors called for hospitals to reduce nurses' workloads.

OSHA's Ergonomic Program Standard included several ergonomic risk assessment instruments in its Appendix D-1: Ergonomics Job Hazard Analysis Tools (Mandatory) (U.S. Department of Labor, 2000). One, Rapid Entire Body Assessment (REBA), is a postural analysis instrument "designed to be sensitive to the type of unpredictable working postures found in health care and other service industries" (Hignett & McAtamney, 2000, p. 201). This instrument assesses postures the worker must assume to complete tasks and assigns a REBA score with a corresponding Action Level for the need for intervention. Again, this instrument focuses exclusively on analyzing the hazard of a single task by looking at load, posture, movement distance, movement activity, and height. The tool's Activity Score focuses on the amount of activity required during performance of the task itself, not the number of times the task must be performed in a normal working day.

Other job hazard analysis instruments take into account the frequency that an activity is performed but are not suitable for use in assessing nursing workload. For example, the Moore and Garg Strain Index (1995) assesses hand and wrist activities. McAtamney and Corlett's Rapid Upper Limb Assessment (RULA) (1993) is not suitable for assessing risk of back injury because of its focus on upper limbs. The Snook Push/Pull Hazard Tables (1991) focus on the effort required to push or pull carts or carry objects. Because as much of the lifting done in nursing is done on the horizontal as well as the vertical plane, does not involve completely lifting a patient off the bed, and involves pushing carts or stretchers only occasionally, these tables are not appropriate for assessing the cumulative number of hours of activity that may be associated with injury.

When Waters et al. (1993) revised the NIOSH Lifting Equation, they maintained the same biomechanical cut-off value of 3.4kN (770 lbs) for maximum disc compression force that was used in the 1981 version (NIOSH, 1981). They state that this "biomechanical criterion limits the effects of lumbosacral stress, which is most important in *infrequent lifting tasks*" (Waters et al., 1993, p. 751). They chose compressive force over shear force due to Herrin, Jariedi, and Anderson's conclusion that "the biomechanical criterion of maximal back compression appears to be a good predictor not only of risk of low-back incidents but of overexertion injuries in general" (1986, p.329). However, Waters et al. stated the equation was not suitable for use in evaluating the lifting of patients.

Nevertheless, Owen and Garg (1991) made some estimates of high-risk (1st level) patient handling tasks using the first NIOSH Lifting Equation (NIOSH, 1981). In this study of transferring patients from a chair to a toilet,

the biomechanical results are estimates because the confined space in the lavatory made it difficult for all of the joint angles to be viewed via videotape. The estimates of compressive force to the L₅/S₁ disc according to percentile of patient weight were all above the Action Limit (AL) permitted as safe by the *Work Practices Guide* (NIOSH,1981) (p.28).

Patient Weight as Risk Factor

Not all patients weigh the same. L₅/S₁ compressive forces increase with patient weight, as Owen and Garg demonstrated in 1991(p. 28).

Table 1
L₅/S₁ Compressive Force to Caregiver During Toilet to Wheelchair Transfer

Percentile of Client Weight	Compressive Force (kN)
25 th	4.4
50 th	4.8
75 th	5.1
90 th	5.6

(Action Limit = 3.4 kN; Maximum Permissible Limit = 6.6)*

*NIOSH (1981)

Source: Owen & Garg, 1991.

Zhuang et al. (1999) found that “resident weight affect(s) a nursing assistant’s low-back loading” (p. 285). There was an increase in L₅/S₁ compressive force when participants lifted a 170 pound patient versus a 128 pound patient. Winkelmolten et al. (1994) found there was a significant difference in L₅/S₁ compressive force when a 75 kg patient was lifted versus a 55 kg patient, with the heavier patient producing more compressive force even in a two person manual lift.

Assessing Risk

Owen et al. (1992) studied nursing home personnel to identify and rank order high-risk nursing tasks. They used a 50th percentile for weight patient in their back compressive force model and found the mean compressive force on the L₅/S₁ disc was 4800 N for several types of patient transfer tasks. Owen and Garg (1994) redesigned a patient weighing task from manual lifting (compressive force on L₅/S₁ of 5000 N) to pushing a wheelchair on a scale (compressive force on L₅/S₁ of 1300 N).

In later studies, Owen stopped measuring compressive forces to the back and used Borg Ratings of Perceived Exertion (Borg, 1970) exclusively to assess stressful of tasks

because in 1992 she found “no significant difference in findings using the Borg scale for perceived exertion and the more complicated, time consuming, and labor intensive biomechanical model methods” (Owen & Fragala, 1999, p. 318). This is also the conclusion of Winkelmoen, et al. (1994).

Using a nine point exertion/stress scale, Owen and Garg’s 1991 study participants rank ordered client (patient) handling tasks for stressfulness as follows.

Table 2
Patient Handling Tasks Ranked for Stressfulness

Client Handling Task	Rank Order
Transferring client from toilet to chair	1
Transferring client from chair to toilet	2
Transferring client from chair to bed	3
Transferring client from bed to chair	4
Transferring client from bathtub to chair	5
Transferring client from chairlift to chair	6
Weighing client	7
Lifting client up in bed	8
Repositioning client in bed (e.g., side to side)	9
Repositioning client in chair	10
Changing absorbent pad	11
Making bed with client in it	12
Undressing client	13
Tying supports	14
Feeding bed ridden client	15
Making bed when client not in it	16

Source: Owen & Garg, 1991

Dehlin et al. (1976) determined the lifting burden of a nursing aide in a geriatric ward by using a force plate. The lifting burden during patient transfers equaled or exceeded the recommendations of various authors concerning permissible maximum weight loads.

In a pilot study by Nelson et al. (1996), she identified, videotaped, and analyzed 16 of the most hazardous patient handling tasks contributing to musculoskeletal injuries in nursing. The following activities were determined to be the most physically tasking.

Table 3
At-Risk Patient Handling Tasks

Task	Task
Transferring from wheelchair to bed; one person pivot transfer.	Pulling patient up in a dependency chair
Bathing a patient in bed	Transferring from shower chair to bed; one person pivot transfer.
Making an occupied bed	Repositioning a patient in bed (side to side)
Dressing a patient (clothing)	Pulling a patient up to the head of the bed
Transferring a patient from bed to stretcher	Pulling patient up in a wheelchair
Transferring from bed to wheelchair using a mechanical lift	Transporting a patient in a shower trolley (Surgi-lift)
Transferring from bed to shower trolley (Surgi-lift)	Bathing a patient in a shower chair
Lifting a patient up from floor using lifting device	Applying antiembolism stocking (TED hose)

Source: Nelson et al., 1996

To identify these high-risk tasks, Nelson et al. (1996) considered both posture and the Lifting Index (LI), described as the ratio of the load lifted to the recommended weight limit in the revised NIOSH equation (Waters et al., 1993). The postural stressor analysis was based on the Ovako Working (posture) Analysis System (OWAS) system (developed by Karhu, Kansu, and Kuorinka, 1977), which is described as a “multi-moment observation technique for working postures” (Doormaal, Driessen, Landeweerd, & Drost, 1995, p. 361.). A total of 5,040 postural analysis data forms were completed. The LI was over 3 during transfers.

Nelson et al. (1996) identified several patient and handling tasks that also put the nurse at risk for WMSDs but at a somewhat lower level than the tasks listed in Table 3:

- Showering a patient
- Transporting a patient on a stretcher
- Feeding a patient
- Administering medications
- Catheterizing a patient
- Taking vital signs (temperature, pulse, respirations, blood pressure)

The Nelson et al. study (1996) also analyzed the frequency that these tasks were performed on the day, evening, and night shifts, finding that every shift included a large number of physically stressful tasks, with the day shift having the largest variety. However, Nelson found that the greater number of full time equivalent employees (FTEEs) assigned to the day shift offset this preponderance. She found that the duration of high-risk tasks varied by patient characteristics, with the extent of dependency the key variable.

Nelson et al. (2001) had 71 control group participants rank the stressfulness of performing common nursing tasks performed on a 200 pound mannequin in a laboratory setting (Table 4). Because the patient was a jointed mannequin, it was not possible to assess tasks requiring partial assistance from the patient, such as transfers from bed to toilet or toilet to wheelchair. Nurses in Owen and Garg's 1991 study ranked these latter tasks, which require the caregiver to support a larger amount of patient body weight, as more stressful than the tasks shown in Table 4.

Table 4
Rank Ordering of Client Handling Tasks for Stressfulness

Client Handling Task	Rank Order
Transfer to stretcher	1
Pull up in dependency chair	2
Put clothing on patient	3
Use Arjo lift to move patient to wheelchair	4
Use Hoyer lift to move patient to dependency chair	5
Change sheets	6
Bathe patient in bed	7
Pull patient up in bed	8
Transfer patient to shower trolley	9
Apply TED hose	10

Source: Nelson et al., 2001.

Zhuang et al. (1999) found the following L₅/S₁ compressive forces associated with at-risk patient handling tasks. (See Table 5.)

Table 5
L₅/S₁ Compressive Forces with At-risk Patient Handling Tasks

Task	Mean Compressive Force (N)
Lifting torso to sitting position	3500 ± 600
Lifting legs	3200 ± 500
Rolling patient toward caregiver	3000 ± 500
Rolling patient away from caregiver	2700 ± 600
Stand assist lift (one person)	3500 ± 600
Sliding board (one person)	3500 ± 600

Source: Zhuang et al. (1999)

They determined that use of a stand assist lift produced more low back stress on the caregiver than use of a full mechanical lift, which requires installation of a sling by rolling a patient toward or away from the caregiver. The stand assist lift, however, requires the caregiver to first reposition the patient from a recumbent to a sitting position at the edge of the bed, which they found to be more stressful than rolling a patient toward or away from the caregiver.

Winkelmolen et al. (1994) studied a variety of two person manual techniques to move a patient up in bed. They report the following L₅/S₁ compressive forces. All but

one exceeded the NIOSH (1981) Action Limit of 3.4 kN. The heavier patient produced larger compressive forces.

Table 6
Compressive Forces

	Patient 1 (75 kg)	Patient 2 (55 kg)
Australian lift	3900 kN	3300 kN
Orthodox lift	4200	3500
Barrow lift	4500	4000
Through arm lift	4100	3700
Under-arm lift	4100	3700

Source: Winkelmoen et al. (1994).

The stressfulness of one task common to SCIUs and also found on NHCUs that has not been reported in the literature is bowel care. This task is performed on bedridden spinal cord injury patients and involves rolling patients to their side, holding them in place with one hand, inserting stimulants, and digitally removing feces with the other. During this intermittent two hour procedure, the nurse sustains an awkward posture for up to 20 minutes at a time. The nurse must frequently reposition the patient due to the patient's lack of muscle tone and inability to assist.

Exposure Assessment

Herrin, Jaraiedi, and Anderson (1986, p. 322) state that there are “two basic approaches to job evaluation -- biomechanical and psychophysical.” The biomechanical approach focuses on forces acting on muscle groups or joint centers, while the psychophysical approach “focuses on the individual's perception of pain or discomfort when doing a task” (p. 323). They concluded:

...overexertion injuries can be related to physical job stress. In particular, describing extreme job requirements – such as the most stressful tasks – seems to be more predictive, in general, than those indices which represent aggregations. The averaging or pooling of stressful and nonstressful aspects tends to obscure the differences between jobs which contribute most to overexertion injury (p. 329).

Research studies assessing physical load most commonly use self-reported questionnaires, rather than objective measurements, for reasons of cost and practicability (Wells, et al., 1997). However, these same authors described such surveys as “less valid and less reliable measures of exposure” than “instrumented measures” (1997, p. 52). Another study of the validity of self-reported questionnaires found this method “to be too crude if more detailed information is required” about workload (Wiktorin, C., Karlqvist, L., Winkel, J., & Stockholm MUSIC I Study Group, 1993). Uhl (1987) found an inverse relationship between the number of reported lifts and the number of observed lifts. However, Hollman, Klimmer, Schmidt, and Kylian (1999) report validation of a questionnaire for assessing physical workload in German nursing homes among four

groups of workers: nursing, service, social workers, and managing directors. The questionnaire used was able to discriminate among groups, with nursing personnel registering the highest workload, calculated as an estimate of “the total compressive force acting at the lower lumbar spine” (Hollman et al., 1999, p. 107).

Stobbe et al. (1988) divided study participants into two groups, based on high or low frequency of patient lifting.

In order to determine which nursing personnel belonged to which group, estimates of patient lifting frequency for each of the nursing personnel were obtained through discussions with the hospital’s director of nursing, the head nurse in each hospital unit, and some of the nursing supervisors (p. 23)

In other words, rather than depending on the self-assessment of workload by study participants, Stobbe et al. sought the opinion of their supervisors. This method did not allow quantification, just stratification into high and low frequency lifting groups.

Owen and Garg (1991) and Nelson et al. (2001) rank ordered at-risk patient handling and movement tasks in terms of participant-reported stressfulness. These studies focused on the hazards of individual tasks.

Because self-reported workplace exposure is not accurate, direct observation is required. One approach to conducting an exposure assessment is to count the number of times that a caregiver performs at-risk tasks each day. This counting by a trained observer avoids the weaknesses of having respondents fill out subjective questionnaires assessing their own exposures, the weaknesses of which Wells et al. (1997) have discussed. “It appears that respondents can identify whether exposure to some stressor, such as vibration or lifting, has occurred but they do not give reliable information either on the nature or on the magnitude of the exposure (Wiktorin et al., 1993)” (Wells et al., 1997, p. 52).

Nursing Workload Measurement Systems

When administrators determine the number and type of nursing staff to assign to a hospital or nursing home unit, they use a variety of “nurse demand methods” (Arthur & James, 1994, p. 558). These are sometimes referred to as “nursing workload measurement systems (WMSs)” (Hernandez & O’Brien-Pallas, 1996). Most common is some type of patient classification system that focuses on patient acuity (how acutely ill the patient is) and dependency (how much the patient must depend on others to perform the activities of daily living and other tasks, such as movement). These systems assess the patient’s level of illness and dependency in terms of staff qualifications and staff time required (Malloch & Conovaloff, 1999; Shroeder, Rhodes, & Shields, 1984). The total number of patients and their classifications factor into administrative decisions for staffing numbers and skill mix (RN, LPN, NA). Administrators also consider regulatory

requirements of hours per patient per day and the cost of staff, both total numbers and by job title.

Most studies of nurse demand methods/WMSs have looked at patient outcomes (morbidity and mortality) to assess whether an institution's staffing level is adequate. For example, the Department of Health and Human Services has recently recommended to Congress a minimum staff to patient ratio for nursing homes based on adverse events to patients when ratios are too low (Pear, 2000).

In other words, the focus has not been on health and safety outcomes for staff, despite studies of back injuries that have found those injured attributed their manual handling mishaps to inadequate staffing (Love, 1996; McAbee, 1988; Yassi, et al., 1995). The implication is that when there are too few nursing staff to perform manual handling tasks, the risk is increased for staff by virtue of their having to lift either unassisted or more frequently or both (Rodgers, 1985).

Under managed care cost reduction pressures and staff shortages, most hospital and nursing home administrators strive to provide only the minimum number of staff needed to provide acceptable care. When a back-injured staff member is returned to modified duty with limitations on lifting, administrators may not provide an additional staff member to compensate for this loss of lifting capacity. The manual lifting workload is then concentrated on fewer staff members or the injured staff member is pressured into exceeding his or her limitations (Helminger, 1997).

The Veterans' Administration Medical Center (VAMC) uses different nursing Workload Measurement Systems (WMSs) on the SCIU, NHCU, and MSUs. Patient classification scales range from 1-5 on SCIUs to 1-4 on MSUs to 1-3 on NHCUs and the MICU. At least once a day, a unit RN rates every patient on each unit and enters the rating into a central computer. Administrators at the hospital correlate the patient's score with a minimum number of staff hours required to provide acceptable care: the "hours of direct care scale." For example, a SCIU patient with an acuity rating of 5 (sickest) requires a minimum of 12.9 hours of direct care in a 24 hour period, while the sickest patient on an MSU (a 4) requires a minimum of 7.2 hours of direct care. On the NHCU, the sickest patient (a 3) requires a minimum of 3.6 hours of direct care.

Each patient classification scale and its corresponding "hours of direct care scale" have been in use for over ten years throughout the VA system. VAMC nursing administrators have commented that the Patient Classification Scales seem to under-predict the hours needed to adequately care for a dependent NHCU patient, while they over-predict the hours needed to care for an Intensive Care Unit patient in their facility. It is not known whether the patient classification system is associated with the manual handling requirements of patients through its incorporation of the patient's level of dependency.

The patient classification systems in use in the VAMC do not give any information on how much manual handling each patient requires. Part of the numerical

score indicates how dependent the patient is for Activities of Daily Living, such as toileting, turning, eating, washing, and dressing, while what is needed is a way to quantify the actual manual handling requirements associated with caring for a particular patient. This information would allow administrators to staff or equip a unit to avoid excessive exposure, such as the case of a back injured nurse cited by the American Nurses' Association in its July 13, 2000 U.S. Senate testimony in favor of the OSHA ergonomic standard.

During the week prior to her actual injury, Rice was assigned to care for a 400 pound patient for four consecutive 12 hour shifts. Short staffing and the critical condition of the patient forced Rice to turn and lift the patient with little or no assistance. Her intensive care unit still has no mechanical lifts available.

Risk Reduction Factors

Two factors can reduce risks: increasing the number of staff (thereby decreasing exposure) and increasing access to patient handling and movement equipment. Well-designed handling and movement equipment in good working order reduces manual handling risks by reducing force and awkward postures (Owen & Fragala, 1999; Nelson et al., 2001; Snell, 1995; Sykes, 1998; Ulin, et al., 1997; Zhuang, et al., 1999). However, use of some makes of handling and movement equipment has been found to be almost as stressful as manual lifting (Garg et al., 1991). Having sufficient numbers of staff members assigned to assist with handling and moving patients reduces the workload for each individual (Marras, Davis, Kirking, & Granata, 1999).

In the U.S., hospital and nursing home administrators have been slow to purchase adequate numbers of effective pieces of handling and movement equipment for patient care areas. Furthermore, available equipment may be in poor repair, located at an inconvenient distance from the patient rooms, or poorly designed, causing nurses to avoid it. Additionally, administrators have been very reluctant to increase staffing due to reimbursement issues.

The United Kingdom, as part of the European Union, adopted Manual Handling Operations Regulations in 1992 (Health and Safety Executive, 1992). These regulations require hospitals to assess patients for handling and movement needs upon admission and to provide sufficient handling and movement equipment to meet those needs.

Characteristics of James A. Haley VAMC High-Risk Patient Care Units

Most hospitals are able to use data from OSHA accident logs to obtain the number of OSHA recordable injuries and illnesses, as well as workers' compensation records, to identify patient care units at high risk and low risk for back injuries to direct care staff. For example, at the James A. Haley Veterans' Administration Medical Center (JAHVAMC), the two Spinal Cord Injury Units (SCIU) and three Nursing Home Care Units (NHCU) accounted for 57% (108) of the 189 musculoskeletal injuries due to

patient handling claims in the two year eight month period January 1, 1998 – August 31, 2000, whereas such injuries on the eight other in-patient units accounted for only 21% (40).

In the NHCUs in another internal study covering two years March 1, 1998 to March 1, 2000, on average, there were 37 events a year, 3 events per month, and 0.1 per day. NAs had 42% (n=30) of the sprains/strains in this nursing home. LPNs had 29% (n=21), and RNs had 24% (n=17). Sprains/strains to the back were most prevalent (n=45, 63%). Second were sprains/strains to the shoulder (n=9, 13%). Sprains/strains to the arm, knee, abdomen, groin, wrist, chest, and neck were also found.

What accounts for the higher incidence of WMSDs among nursing care staff on the JAHVAMC SCIUs and NHCUs? One difference is that these five high-risk units have the highest percentage of dependent patients in the hospital. On SCIUs, patients are either paraplegic or tetraplegic, requiring extensive manual handling assistance from the nursing staff. On NHCUs, patients are too dependent to be cared for at home. They may have mobility or cognitive impairments that require the nursing staff to provide extensive manual handling assistance for transfers, repositioning, toileting, dressing, bathing, and feeding. In NHCUs, staff must dress and get almost all patients out of bed, which increases the staff's handling and movement exposure, versus patients in the MICU, who are also dependent but stay in bed.

Screening for Musculoskeletal Disorders

A common way for determining prevalence of musculoskeletal complaints is through the use of symptom surveys or questionnaires (Engels, van der Gulden, Senden, & van't Hof, 1996; Hedge, Morimoto, & McCrobie, 1999; Kuorinka, et al., 1987; Lemasters, et al, 1998). Corlett and Bishop (1976) recommended using a body map diagram as a way to track musculoskeletal discomfort.

In 1987, Kuorinka, et al. combined body map diagrams with questions about the previous 12 month and seven day prevalence of musculoskeletal discomfort in various body regions, such as low back and neck and shoulder. This instrument is called the Nordic Musculoskeletal Questionnaire (NMQ). Kuorinka's goal was to "create a simple standardized questionnaire that could be used as a screening method for musculoskeletal disorders as part of ergonomic programs and for epidemiologic studies of musculoskeletal disorders" (Baron, Hales, & Hurrell, 1996, p. 609). Kuorinka et al. (1987) found reliability varied from 0% to 23%, whereas "validity tests against clinical history" showed the number of non-identical answers varied between 0% and 20%" (p. 235). Baron et al. reviewed subsequent studies on the NMQ's reliability, validity, sensitivity, and specificity and determined that it was "acceptable for the purposes of workplace ergonomics programs" (1996, p. 609).

In a 1999 study of musculoskeletal discomfort among keyboard users, Hedge et al. used a questionnaire that combined a body map diagram and questions about the seven day prevalence of musculoskeletal pain, its severity, and whether it interfered with

performance of job duties. This instrument is called the Cornell Musculoskeletal Discomfort Questionnaire (CMDQ). Because the survey was based on the NMQ, Hedge concluded that it had the same validity (0% to 20%), although it has not been clinically tested (Alan Hedge, personal communication, September 22, 2001). The CMDQ has face validity and test-retest reliability over a three week period demonstrated on 15 controls (Hedge, Morimoto, & McCrobie, 1999). Limitations of this tool include the lack of clinical validity testing for it specifically and its development for use as a tool for use in screening for upper body disorders. The tool doesn't assess if the musculoskeletal discomfort is work-related.

NIOSH developed a symptom survey for use in cross sectional epidemiologic studies assessing hand discomfort (Hales & Fine, 1989a, b; Hales et al., 1994; Kiken, Stringer, Fine, Sinks, & Tanaka, 1990; Hoekstra, Hurrell, & Swanson, 1994). Baron et al. (1996, p. 614) reported that it had adequate "simplicity, acceptability, reliability, and validity," all of which are sufficient for cross-sectional epidemiologic designs. However, Baron et al. caution that this instrument may not be adequate for longitudinal outcome studies.

Bjorksten, Boquist, Talback, and Edling (1999) evaluated a questionnaire using a visual analogue scale and pain drawings for validity in assessing WMSDs of the neck, shoulders, and thoracic spine. They found both sensitivity and specificity high for current pain and concluded that such questionnaires are "useful to reveal conditions in the neck and shoulders and thoracic spine, common sites of work related musculoskeletal disorders" (p. 325).

In a study of WMSDs among carpenters, Lemasters, Atterbury, Booth-Jones, Bhattacharya, Ollila-Glenn, and Forrester et al. (1998) developed a lengthy Musculoskeletal Symptom and Work History Questionnaire intended specifically for carpenters. Lemasters et al. found the instrument had adequate reliability and content and construct validity for these workers. However, Lemasters and Atterbury (1996) note that the criterion validity is difficult to determine in WMSD questionnaires.

Criterion validity is the degree to which the measures correlate with an external criterion commonly referred to as a gold standard. Finding a criterion for evaluation of symptoms of musculoskeletal disorders is problematic because there is no gold standard in diagnosing these conditions (p. 439).

This review of available tools reveals that there are none that were designed to determine musculoskeletal discomfort prevalence among nursing staff, who may report symptoms in many locations, not only lower back and upper body. The NMQ has some applicability in terms of its scope, but its length may preclude its widespread use among study participants.

Null Hypotheses

Hypothesis I: Frequency of musculoskeletal disorder symptoms in nursing staff is not associated with the high-risk (1st level) patient lifting and handling tasks they perform.

Hypothesis II: Frequency of musculoskeletal disorder symptoms in nursing staff is not associated with the census/able-bodied FTEE staff ratio.

Hypothesis III: Frequency of musculoskeletal disorder symptoms in nursing staff is not associated with the amount of handling and movement equipment available on the work unit.

Hypothesis IV: The number of at-risk patient handling tasks performed does not differ among RNs, LPNs, and NAs.

Hypothesis V: The Patient Classification Rating is not related to the frequency of musculoskeletal discomfort in nursing staff.

Definition of Terms

Able-bodied: A nursing staff member who is not on Modified Duty with restrictions for pounds lifted or tasks that can be performed.

At-Risk Patient Handling Tasks: Patient handling or movement tasks that have a risk of musculoskeletal injury for staff performing the tasks due to the awkward posture required by the caregiver to perform, the duration of the task, high L₅/S₁ compressive and shear forces, load lifted, asymmetry of load, horizontal and vertical distance the load is lifted, poor coupling, or other factors (author's definition).

Available Handling and Movement Equipment: Equipment used for handling or moving patients that is in good working condition and located in patient's room or on the patient care unit where it will be used (author's definition).

Average Patient Classification Rating: The researcher will determine the average Patient Classification Rating for each participant's weekly assignment by summing the Patient Classification Rating for each patient who required manual handling or movement cared for that week and dividing by the total number of patients that the staff member handled or moved (author's definition).

Awkward Postures: Deviation from ideal working posture of elbows at the side of the torso, with wrists and head neutral, back straight, and knees slightly flexed. Working with the back, neck or wrists bent or twisted. (Adapted from U.S. Department of Labor [1999], p. 68849.)

Census: The number of patients/residents resident on a particular in-patient hospital unit during a participant's assigned shift (author's definition).

Compressive Force: “A force that is applied perpendicular to a surface; for example, the pressure placed on the intervertebral discs due to forces generated during lifting or maintaining a posture” (Kodak Ergonomics Group, 1986, p. 573).

Dependency chair: A specialized type of chair, usually with a high back, wide arm rests, wheels, and other features to support highly-dependent patients in a sitting position (author’s definition).

Force: “A push or pull, defined as mass times acceleration, that an object exerts on another object. It is measured in newtons (N) or pounds of force (lbf)” (Kodak Ergonomics Group, 1986, p. 576).

Full Time Equivalent Employee (FTEE): A unit of measurement to indicate 40 hours of nursing service per week for 50 weeks a year (author’s definition).

High-Risk (1st Level) Patient Handling Tasks: Patient handling and movement activities that nursing staff have deemed as among the most stressful of all tasks performed or that research has shown have a mean compressive force on the L₅/S₁ spine of greater than 3400 N or that pose special risk due to exceeding the OSHA (2001) recommendation for task duration (author’s definition); specifically:

- transferring patient from bathtub to chair
- transferring patient from wheelchair to toilet or vice versa
- transferring a patient from wheelchair or shower/commode chair to bed; one person pivot transfer
- making an occupied bed
- dressing a patient (clothing)
- pulling patient up in a dependency chair or wheelchair
- bowel care for a bedridden patient
- transferring a patient from bed to stretcher without handling or movement equipment

High-Risk (2nd Level) Patient Handling Tasks: Patient handling or movement activities that nursing staff have deemed as more stressful than 3rd level patient handling tasks or that research has shown produces compressive L₅/S₁ force with an upper standard deviation that includes 3400 kN (author’s definition). These include:

- Repositioning a patient in bed (side to side)
- Transferring from bed to wheelchair using a mechanical lift with a full body sling
- Lifting a patient up from floor using a lifting device
- Pulling a patient up to the head of the bed
- Transferring a patient from bed to chair using a stand-assist lift
- Transferring from bed to shower trolley (using frame and netting)
- Weighing a patient using a sling lift/bed scale
- Bathing a patient in bed

High-Risk (3rd Level) Patient Handling Tasks: Patient handling and movement activities that nursing staff deemed as somewhat less stressful than 1st or 2nd level patient handling tasks or that research has shown have a mean L₅/S₁ compressive force at least one standard deviation below 3400 kN (author's definition). These include:

- Pushing a patient in a wheelchair
- Transporting a patient in a shower trolley/stretchers
- Bathing a patient in a shower chair/shower trolley
- Applying anti-embolism stockings (TED hose)

High-Risk Patient/Resident Care Areas: Spinal Cord Injury Units and Nursing Home Care Units at the JAHVAMC in Tampa, Florida. Adjudged to be high-risk due to their higher numbers of WMSD claims than other patient care units and due to their higher percentage of patients who are dependent and require manual handling (Audrey Nelson, personal communication, July 31, 2001).

Individual (Personal) Risk Factors: Characteristics of the person performing manual handling hypothesized to influence the incidence and prevalence of work-related WMSDs; such factors include age; gender; anthropometry; strength; physical activity; cigarette smoking; and alcohol, caffeine, and vitamins. In addition, psychosocial factors have been associated with upper-extremity and back disorders. (U.S. Department of Labor, OSHA, 2000, p. 68514).

Job (Physical) Risk Factors: Force, repetition, duration, awkward postures, contract stress, and exposure time associated with manual handling activities (author's definition).

Licensed Nursing Staff: Those who hold either an RN or and LPN license from a U.S. state or jurisdiction (author's definition).

Light Duty: Restriction of the work duties of a nursing staff member in accordance with a health care provider's written instructions about the staff member's physical abilities (author's definition). See Modified Duty.

Low Back Pain: "Pain in the low back area, excluding menstrual cramps and/or leg fatigue unassociated with low back pain" (Cato et al., 1989, p. 322).

Manual Handling: Lifting, transferring, repositioning, or moving patients using a caregiver's body strength without or with only partial assistance from handling and moving equipment (author's definition).

Manual Handling Workload: The amount of manual handling performed by a nurse in his or her workday. This measure does not include any part of the nurse's cognitive workload, such as administering medications, counseling patients, training others or being trained, or any activity that does not involve patient handling or repositioning (author's definition).

Modified Duty: Restriction of the work duties of a nursing staff member in accordance with a health care provider's written instructions about the staff member's physical abilities (author's definition). See Light Duty.

Nursing Home Care Unit: Residential facilities at the JAHVAMC that provide sub-acute care for dependent patients (author's definition).

Nursing Personnel: Registered nurses [RNs], licensed practical nurses [LPNs], and nurse aides/assistants, orderlies, and attendants [referred to collectively as NAs] who are employed (full or part time) (author's definition).

Nursing Staff: Registered nurses [RNs], licensed practical nurses [LPNs], and nurse aides/assistants, orderlies, and attendants [referred to collectively as NAs] who are employed (full or part time) (author's definition).

OSHA Recordable MSD Injuries: Those work-related MSDs that result in: loss of consciousness, restriction of work or motion, transfer to another job, or require medical treatment beyond first aid. (U.S. Department of Labor [1986], p. 28.)

Patient: A person who has been admitted to a hospital or nursing home for overnight care. The term also applies to residents of nursing homes (author's definition).

Patient Care Unit: A geographic designation for a hospital area that admits patients or residents for overnight stays and medical care (author's definition).

Patient Classification Rating: A method to categorize patients/ residents according to their degree of need for nursing assistance, by assessing the patient's level of dependence, level of acuity of illness, and other factors specific to each in-patient unit (author's definition).

Patient Handling: Lifting, transferring, repositioning, or moving patients using a caregiver's body strength without or with only partial mechanical assistance (author's definition).

Patient Handling and Moving Equipment: Equipment used to lift, transfer, reposition, and move patients, such as overhead lifts. Includes patient handling aids such as roll boards, sliding boards, full sling mechanical lifts, stand assist lifts, gait belts, and friction reducing transfer devices (author's definition).

Posture: "The relative arrangement of body parts, specifically the orientation of the limbs, trunk, and head during a work task" (Ergonomics Group, 1986, p. 584).

Prevalence: "The number of people in a given population who have an existing health problem within a specified time frame" (Lundy & James, 2001, p. 109).

Repositioning: Lifting or moving patients, such as pulling patients up in bed or chair or turning them (author's definition).

Shower Trolley: A stretcher-like device with netting in place of a mattress. Staff places netting under patient, then attaches the netting to the trolley frame with straps. Used by nursing staff on high-risk units to transport patients into showers for showering (author's definition).

Spinal Cord Injury Unit (SCIU): An in-patient hospital unit that provides acute care for patients with spinal cord injuries (paraplegics and tetraplegics) (author's definition).

Stand Assist Lift: A lift intended for patients who are partially dependent and have some weight bearing capabilities. The patient is brought to a sitting position; the caretaker installs a sling around the patient's torso or hips and attaches it to the lifting device for raising the patient to a standing position. The caregiver can then maneuver the patient into a chair or a bathroom (author's definition).

Unlicensed Nursing Staff: Medical assistants, student nurse technicians, and other direct care staff who do not have an RN or an LPN license (author's definition).

Work-Related Musculoskeletal Disorder (WMSD): A disorder of the muscles, nerves, tendons, ligaments, joints, cartilage, or spinal discs. This definition includes WMSDs only in the following areas of the body: neck, shoulder, elbow, forearm, wrist, hand, abdomen (hernia only), back, knee ankle, and foot, initiated or aggravated by on-the-job manual handling activities. WMSDs include such medical conditions as: low back pain, tension neck syndrome, rotator cuff syndrome, sciatica, tendonitis, and herniated spinal disc. WMSDs arising from slips, trips, falls, motor vehicle accidents, or similar accidents are not considered WMSDs for the purposes of this study. (Adapted from U.S. Department of Labor [2000], p. 68853.)

Chapter 3: Methods

Study Design

This was a cross-sectional study of the association between frequency of musculoskeletal discomfort among able-bodied nursing staff and factors hypothesized to be associated with such discomfort, such as the performance of manual handling tasks.

Sample and Sampling Procedures

The research was conducted at the James A. Haley Veterans' Administration Medical Center (JAHVAMC). This hospital has 681 beds divided among medicine, surgery, psychiatry, spinal cord injury, neurology, intermediate medicine, rehabilitation, and dialysis units. Average inpatient census is 570. A 240-bed Nursing Home Care Unit (NHCU) is adjacent to the main hospital. This facility has a patient mix that is predominantly male, with 8%-10% of the patients female (A. Nelson, personal communication, October 11, 2001). The LPNs and NAs are unionized by the American Federation of Government Employees (AFL-CIO) and the RNs by the Florida Nurses' Association.

USF Institutional Review Board 2 (IRB2) approval was obtained for one year, commencing January 31, 2001 (Appendix A). JAHVAMC approval (Appendix B) was also obtained. The Veterans Health Administration requires that an employee of the Veterans Administration be designated as the Principal Investigator (P.I.) for all research conducted on its premises. For that reason, Audrey Nelson, Ph.D., RN is listed as the P.I. on the IRB Informed Consent and on the JAHVAMC Research and Development Committee approval letter. However, Dr. Nelson served only as coordinator between the researcher and the institution and did not conduct the research described herein.

Participants were recruited who were nursing staff working on any of the five patient care units with the highest numbers of back injuries (two SCIUs and three NHCUs) and six patient care units with lower numbers of back injuries. This included all of the overnight stay units at the JAHVAMC except for the Surgical Intensive Care Unit, Coronary Care Unit, and the Rehabilitation Unit. The latter units were omitted due to reaching the participant recruitment goals from the units listed. The five high-risk units were 1BSW (SCIU), 5W (SCIU), NHCU-A, NHCU-C, and NHCU-D. The five low-risk units included four Medical-Surgical Units (4S, 5S, 6S, 7N) and one ICU (Medical Intensive Care Unit [MICU]). Additionally, ten participants from 2BSW, a psychiatric in-patient unit with virtually no routine patient handling and movement required, were recruited. (Some physical exertion is required on an infrequent basis during emergency

restraint procedures.) This unit was included to ensure the inclusion of some study participants with limited handling and movement exposure.

To obtain a sample of nursing staff, recruitment posters (Appendix C) were put up on each of the study's units, asking interested nursing staff members to contact the researcher for more information. In addition, participants were solicited by in-facility E-mail and by in-person visits. Volunteers who wished to participate were given a copy of the Informed Consent (Appendix D) to read and sign, as well as one to take with them. Each signed original copy of the Memorandum of Certification was sent to the JAHVAMC Research Office.

Inclusion criteria for participants were: age between 18 and 64; working at the JAHVAMC (full or part time); and providing direct care at least 80% of the time. An exclusion criterion was being on modified duty with any type of lifting restriction.

Volunteers were partially reimbursed for their time in telephone cards worth approximately \$20 for completing the questionnaires on their own time at the end of the observation week and returning them by mail. Participants' names and social security numbers were recorded when the cards were given out for tax reporting purposes. When the questionnaires were returned, they were coded and stripped of participants' names. The participants were not identified in the data analysis phase.

At the end of the designated study week, the participants were asked to complete the one page Cornell Musculoskeletal Discomfort Questionnaire (CMDQ), which is based on the Nordic musculoskeletal symptom survey (Kuorinka et al., 1987). The male version is found in Appendix E and the female version in Appendix F. The only difference is the gender of the body diagram.

The participants also completed a demographic questionnaire (Appendix G) that included individual factors, such as gender, and exposure factors, such as years of experience providing direct care, assigned unit, usual shift, and job category. In addition, the questionnaire included two questions with Likert scales of 1 to 5, with 1 equaling "Never" and 5 equaling "Always" to evaluate directly whether a participant was recruiting help with handling and movement and whether a participant was using handling and moving equipment.

Both the demographic questionnaire and the Cornell Musculoskeletal Discomfort Questionnaire were pilot tested in July 2001 with one participant to identify possible areas of confusion in completing them. As a result, the demographic questionnaire was reworded for clarity.

Data Collection Procedures

During two one-week periods, the researcher assessed each participant's manual handling workload during seven consecutive days commencing with a Sunday, the start

of the JAHVAMC's work week, using a work sheet (At-risk Tasks, Appendix H) with space for the following information:

- Identity of each patient assigned to a participant
- Patient weight for each patient requiring handling and movement assigned to the participant
- Frequency that high, medium, and lower risk repositioning tasks are performed on each patient
- VA patient classification rating for each patient assigned to the participant

If a patient who did not require manual handling was assigned to a participant, no information was gathered on that patient.

In addition, the researcher collected the following information on the work environment, using a data collection tool called Unit Statistics (Appendix I):

- Unit census
- Number of pieces of available handling and moving equipment
- Number and type of able-bodied full time equivalent staff members working the concurrent shift with the participant
- Unit identity
- Shift
- Shift length

The following units were assessed from August 5 through August 11, 2001: Low-Risk: MICU, 6S, 5S, and High-Risk: 5W and 1BSW. The following units were assessed from August 12 through August 18, 2001: Low-Risk: 7S, 4W, 2BSW, and High-Risk: NHCU-A, NHCU-C, and NHCU-D. There were no unusual internal events, such as layoffs, or external events, such as disasters, occurring during this time period.

Because the patient classification system includes dependency among the factors it evaluates, the researcher recorded the patient classification rating for all patients requiring handling and movement assigned to a participant to determine what predictive value, if any, this rating has. How dependent the patient is on nursing staff to complete the activities of daily living might be associated with how much handling and movement by staff the patient is likely to require. What it does not indicate, however, is the type and stressfulness of handling and movement activity.

The researcher gathered the needed information by reviewing the patient's chart and electronic medical record for physical examination data, medical orders, and nursing care plans and progress notes; by interviewing participants about their assignments; by direct observation of staff performing patient care activities; and by assessing the availability (and use) of patient handling and movement equipment in good working order.

Also assessed was whether there was a difference in the number of at-risk nursing tasks performed among RNs, LPNs, and NAs.

Chapter 4: Results

Outcomes of this study were to determine whether the following factors were associated with musculoskeletal discomfort frequency and severity in nursing staff:

- cumulative workload of high-risk (1st level) patient care tasks
- lifting heavy patients
- staffing ratios (number of able bodied full time equivalent employees to patients on the unit)
- patient classification rating as a percent of maximum for that unit
- ratio of pieces of patient handling and moving equipment to patients on the unit

Another outcome of interest was whether the manual handling workload differs among RNs, LPNs, and NAs.

Sample Size/Power Analysis

Prior to data collection, power analysis was used to estimate sample size. There were five independent variables (above) theorized to influence the dependent variable of musculoskeletal discomfort.

Assuming a moderate effect of R^2 of .10, an α of .05, and five predictors, $N=122$ was determined in advance to be sufficient to provide a power of 0.80 (Cohen, 1988). Although 121 participants were recruited, data were collected on $N=113$. This N would have produced a power of 0.77 under the same effect size assumptions. Based on the actual effect size found (0.09), the N would have to be 136 participants to obtain a power of 0.80.

Data Analysis

Sample

The researcher recruited 121 participants, of whom 113 (95%) returned their questionnaires. Six non-respondents did not respond to four follow up reminders to return their surveys. In addition, there were two participants from an outpatient geriatric clinic who signed informed consents but then requested to withdraw from the study because they stated they did not want the \$20 telephone card reported as income to the IRS. They did not return questionnaires, and the researcher did not assess their workload.

Table 7
Number and Percent of Participants Completing and Not Completing Study By Unit

	# Completing Study	% of Staff Assigned to Unit	# Not Completing Study
High-Risk Units			
1BSW (Spinal Cord Injury Unit)	17	38%	0
5W (Spinal Cord Injury Unit)	14	41%	0
Nursing Home Care Unit-A	11	25%	1
Nursing Home Care Unit-C	14	29%	1
Nursing Home Care Unit -D	16	36%	2
Low-Risk Units			
2BSW (Psychiatric)	10	24%	0
4S (Medical/Surgical)	4	9%	0
5S (Medical/Surgical)	5	12%	0
6S (Medical/Surgical)	8	14%	2
7N (Medical/Surgical)	5	17%	0
Medical ICU	9	38%	0
Totals	113		6

The sample ($N=113$) had the following characteristics:

Table 8
Sample Characteristics

	Count	Percent
Gender		
Female	100	89%
Male	13	12%
Type of Nurse		
RN	58	51%
LPN	30	27%
Nursing Aide	25	22%
Level of Risk of Unit Assigned		
Low-Risk Unit	42	37%
High-Risk Unit	71	64%
Shift		
Day/Evening Rotation	72	64%
Day/Night Rotation	22	20%
Permanent Evenings	13	12%
Permanent Nights	6	5%

Table 9
Sample Description

	<i>M</i>	Range	<i>SD</i>
Age	42	19-64	10.7
Years of Experience	13.0	0.3 - 40	10.7
Hours Worked During Study Week	38	8 - 64	8.0
High-Risk (1 st Level) Tasks in Study Week	24.0	0 - 103	21.6
High-Risk (1 st Level) Tasks Per Hour Worked in Study Week	0.6	0 - 2.58	0.6
Total At-Risk Tasks in Study Week	40.3	0 - 129	30.7
At-Risk Tasks Per Hour Worked in Study Week	1.1	0 - 3.2	0.8
Average Ratio of Census to Able Bodied Staff	3.8	0.3 - 12.3	2.0
Average Ratio of Handling and Movement Equipment to Census	0.2	0 - 1.6	0.3
Average Weight of Patients Handled/Moved	169	91 - 387	37.5
Average Patient Classification Rating/Maximum Classification Rating for the Unit	0.8	0-1	0.3
Answer to How Often the Staff Member Uses Patient Handling and Movement Equipment (Scale 1-5)	3.7	1-5	1.3
Answer to How Often Another Staff Member Assists with Handling and Moving Patients (Scale 1-5)	3.6	2-5	0.9

The 113 participants performed a total of 4525 at-risk tasks during the study period, of which 61% were categorized as high-risk (1st level). Of the patients lifted, 3.7% were female.

Data Coding

Independent variables. These were coded as shown in Table 10.

Table 10
Coding of Independent Variables

Variable	Code
High-Risk Unit	1
Low-Risk Unit	0
RN	1
LPN	2
NA	3
Female	1
Male	0
Rotating Days/Evenings	1
Rotating Days/Nights	2
Permanent Evenings	3
Permanent Nights	4

The following variables were treated as actual numbers:

- Caregiver Age
- Years of Experience
- Hours Worked
- Average Patient Classification Rating as a proportion of the maximum for that unit
- Average Census/Average Number of FTE staff
- Ratio of Number of Patient Handling Devices/Census
- Number of handling and movement activities performed: high, medium, and lower risk

The value 212 represents the weight at or above which 20% of a population 96% male falls (Bernard, 2001). A categorical variable was also created to indicate whether a nurse lifted patients weighing equal to or more than 212 pounds (1=yes).

Dependent variables. The Cornell Musculoskeletal Discomfort Questionnaire (CMDQ) was coded with numbers reflecting severity of discomfort and interference with work as shown in Table 11. Right and left sides were combined, with the highest rating given recorded for the body part. For example, if the participant selected once every day for discomfort in the right shoulder but never for the left shoulder, the response for shoulder was coded as 3.

Table 11
Coding of CMDQ

Response	Code
Never or Not at All	0
1-2 times last week	1
3-4 times last week	2
Once every day	3
Several times every day	4
Level of Discomfort: Slightly uncomfortable	1
Level of Discomfort: Moderately uncomfortable	2
Level of Discomfort: Very uncomfortable	3
Interference with work: Not at all	0
Interference with work: Slightly interfered	1
Interference with work: Substantially interfered	2

The index that Hedge (1999) used to collapse CMDQ data into two body regions and a categorical pain frequency variable was constructed as shown in Tables 12 and 13.

Table 12
Posture Index by Body Region

Index	Body Region
Upper Posture Index (UPI)	Neck, Shoulder, Upper Back, Upper Arm, Forearm, Wrist, Low Back
Lower Posture Index (LPI)	Hip/Buttocks, Thigh, Knee, and Lower Leg

Table 13
Frequency of Discomfort, Any Body Part in Posture Index

Response	Code
Never	0
Any response other than Never	1

Individual variables summed for a possible score of 0 to 7 for the UPI. For the LPI, the maximum score possible was 4, with the minimum score 0.

SPSS 8.0 was used to compute multiple linear regressions to determine how well a variety of models using number of at-risk tasks, unit, and individual characteristics were predictive of the Upper or Lower Posture Index. None of these analyses were significant. The UPI was recoded by removing Forearm and Wrist. The resulting analysis was not significant.

The Upper and Lower Posture Indexes were treated as categorical variables, with 1 = yes for discomfort of any frequency in any body part in the Index and 0 = no. SPSS 8.0 was used to compute logistic regressions to determine how well a variety of models using number of at-risk tasks, unit, and individual characteristics were predictive of UPI or LPI. The results of logistic regressions were not significant, as shown in the example in Table 14.

Table 14
Logistic Regression for Outcome Upper Body Discomfort: Yes/No

Variable	<i>B</i>	<i>SE B</i>	Exp (B)
(Intercept)	1.18	0.73	
Number of High-Risk (1 st Level) Tasks Per Hour (N)	0.80	0.55	2.22
Number of Patients \geq 212 Pounds (P)	0.20	0.17	1.22
Interaction Variable: N x P	0.68	0.41	1.98
Census/Staff Ratio	0.04	0.12	1.05
Handling and Moving Equipment (Categorical)	-0.58	0.43	0.56

Significance of overall regression $p > 0.05$ (0.15)

Severity index. Next, a severity index was constructed, with sub-categories for body regions, frequency of pain, and the degree to which pain interfered with work.

Table 15
Severity Index Body Region Coding

Body Region	Body Part(s)
Upper Body	Neck, Shoulder, Upper Back, Upper Arm
Arm	Forearm, Wrist
Lower Back	Lower Back
Lower Body	Hip/Buttocks, Thigh, Knee, Lower Leg

Table 16
Severity Index Discomfort and Work Interference Coding

Variable	Code
Frequency of Discomfort: Never	0
Frequency of Discomfort: Any response other than Never	1
Degree of discomfort: Slightly or Moderately uncomfortable	1
Degree of discomfort: Very uncomfortable	2
Interference with work: Not at all	1
Interference with work: Slightly or Substantially	2

Table 17
Severity Index Scoring

Frequency of Discomfort	Degree of Discomfort	Interference with Work	Severity Score
0	NA	NA	0
1	1	1	1
1	1	2	2
1	2	1	1
1	2	2	2

When the Severity Indexes were used as the dependent variables, there were no significant regression coefficients for any body part.

Next, the frequency that participants reported pain was coded as shown in Table 18.

Table 18
Pain Frequency Coding

Frequency of Discomfort	Code
Never	0
1-2 times last week	1
3-4 times last week	2
Once every day	3
Several times every day	4

Two variables were added: the actual number of patients equal to or over 212 pounds that participants handled or moved and a trichotomous variable to indicate the number of pieces of patient handling and movement equipment available.

Table 19
Coding of Equipment

Pieces of Handling and Moving Equipment Available	Code
0-1	1
4-8	2
47	3

Pearson correlations between these two new variables and frequency of pain reported for each body part were run to identify possible relationships for further analysis. Using $p < 0.15$ as a criterion, three regions emerged on which to focus: knees, wrists, and forearms.

Next, the prevalence of musculoskeletal discomfort of at least moderate severity in any body part was assessed overall, by type of unit, full or part time work status, by gender, and by job category, as shown in Table 20.

Table 20
At Least Moderate Discomfort Prevalence, Any Body Region

Type of Prevalence	Percent	Total N
Moderate Discomfort, Any Body Part	62	113
Moderate Discomfort, Any Body Part, High-Risk Units	66	71
Moderate Discomfort, Any Body Part, Low-Risk Units	57	42
Moderate Discomfort, Any Body Part, Worked \geq 21 Hours	61	109
Moderate Discomfort, Any Body Part, Worked \leq 20 Hours	100	4
Moderate Discomfort, Any Body Part, Female	66	100
Moderate Discomfort, Any Body Part, Male	30	13
Moderate Discomfort, Any Body Part, RN	62	58
Moderate Discomfort, Any Body Part, LPN	70	30
Moderate Discomfort, Any Body Part, NA	52	25

There was no significant difference in the discomfort prevalence between high-risk and low risk units. Age was not correlated with discomfort prevalence. There was a statistically significant difference in discomfort prevalence between females and males: $\chi^2 (1, N = 113) = 6.1, p = 0.014$.

As shown in Table 21, there was a difference in the mean number of at-risk tasks performed per hour among RNs, LPNs, and NAs. Analysis of variance showed this difference to be significant (Table 22).

Table 21
At-Risk Tasks Per Hour by Job Category

Job Category	<i>N</i>	<i>M</i>	<i>SD</i>
Registered Nurse	58	0.74	0.54
Licensed Practical Nurse	30	1.06	0.62
Nursing Aide	25	1.82	0.70
Total	113	1.06	0.73

Table 22
Analysis of Variance for At-Risk Tasks Per Hour by Job Category

Source	<i>SS</i>	<i>df</i>	<i>MS</i>	<i>F</i>	η^2	<i>p</i>
Job Category	20.6	2	10.30	25.8	0.34	.000
Within groups	44.0	110	0.40			

Following the significant ANOVA, post hoc t-test were used to compare the differences between pairs of means (RN vs. NA, RN vs. LPN, and NA vs. LPN). Due to the unequal sample sizes, the Games-Howell t-test was used. The results indicated that the NAs were significantly lower than the RNs and the LPNs. The two groups of licensed nurses did not differ significantly.

A chi-square analysis found no significant difference in the prevalence of at least moderate musculoskeletal discomfort in at least one body part among RNs, LPNs, and NAs: $\chi^2 (1, N = 113) = 0.65, p = 0.419$.

As shown in Table 23, there were significantly more High Risk (1st Level) Tasks per Hour performed on high-risk units than low-risk units (0.70 versus 0.33).

Table 23
Analysis of Variance for High-Risk (1st Level) Tasks Per Hour by High Risk/Low Risk Unit

Source	<i>SS</i>	<i>df</i>	<i>MS</i>	<i>F</i>	η^2	<i>p</i>
High Risk (1 st Level) Tasks Per Hour	3.7	1	3.7	13.7	0.11	0.000
Within groups	30.1	111	0.27			

Measures of Association

Because L₅/S₁ compressive force increases as the weight of the patient moved or handled increases, the weights of all patients moved or handled by the staff member were recorded. Based on the assumption that performing a high-risk (1st level) task on any patient who weighs in the top 20th percentile for the population constitutes an extreme job requirement, the number of patients weighing equal to or over 212 pounds that a nursing staff member moved or handled during his or her work week was entered into the regression equation, along with the number of high-risk (1st level) tasks performed per hour. Because the frequency of high-risk (1st level) tasks and high patient weight may have an interaction effect, an interaction variable was created and entered as well.

The following linear regression models were significant:

Model 1: Frequency of Knee Pain =
 # High-Risk (1st Level) Tasks per Hour
 + # Patients \geq 212 Pounds
 + Interaction Variable (High-Risk (1st Level) Tasks per Hour x # Patients \geq 212 Pounds)

Model 2: Frequency of Wrist Pain =
 # High-Risk (1st Level) Tasks per Hour
 + # Patients \geq 212 Pounds
 + Interaction Variable (High-Risk (1st Level) Tasks per Hour x # Patients \geq 212 Pounds)

Table 24

Model 1: Summary of Linear Regression Analysis for Variables Predicting Frequency of Knee Discomfort (N=113)

Variable	B	SE B	β
(Intercept)	.336	.158	
Number of High-Risk (1 st Level) Tasks Per Hour (N)	.060	.191	-.030
Number of Patients \geq 212 Pounds (P)	.195	.065	.290*
Interaction Variable: N x P	-.166	.125	-.131

Note: $R^2 = .080$. * $p < .05$. Significance of overall regression $p < .05$ (.027)

Table 25

Model 2: Summary of Linear Regression Analysis for Variables Predicting Frequency of Wrist Discomfort (N=113)

Variable	B	SE B	β
(Intercept)	.108	.127	
Number of High-Risk (1 st Level) Tasks Per Hour (N)	.322	.153	.203*
Number of Patients \geq 212 Pounds (P)	.062	.053	.113
Interaction Variable: N x P	.208	.100	.202*

Note: $R^2 = .095$. * $p < .05$. Significance of overall regression $p < .05$ (.012)

Logistic regression for the same predictor variables was also significant for both knee and wrist, as shown in the example in Table 26.

Table 26

Summary of Logistic Regression Analysis for Variables Predicting Frequency of Knee Discomfort (N=113)

Variable	<i>B</i>	<i>SE B</i>	Exp (B)
(Intercept)	-2.77	0.86	
Number of High-Risk (1 st Level) Tasks Per Hour (N)	0.32	0.44	1.4
Number of Patients ≥ 212 Pounds (P)	0.52	0.16	1.7
Interaction Variable: N x P	-0.33	0.27	0.7

Note: Significance of overall regression $p < 0.05$ (0.0100)

Chapter 5: Discussion

Sample

The majority of study participants (64%) were drawn from high-risk units. This may be due to the fact that the JAHVAMC has been researching back pain in the Spinal Cord Injury Units (SCIUs) and the Nursing Home Care Units (NHCUs) since at least 1997. The staff on those units are familiar with research purposes and procedures, and many have participated in previous and on-going studies. Staff members on the low-risk units are unfamiliar with research methods and goals and may have been more concerned about the purposes for which the information about their work activities and musculoskeletal discomfort status was being gathered. Propensity to volunteer may also have been related to degree of musculoskeletal discomfort the staff member was experiencing, which could have produced a biased sample. An indication of this propensity is found in the prevalence statistics for the psychiatric unit where no routine patient handling and movement tasks occur; 40% of participants from this unit reported at least moderate discomfort in at least one body part in the past seven days. However, the overall prevalence rate of 62% is within the range of prevalence rates reported for both the general population and populations of nurses, making sample bias unlikely.

The gender distribution of the sample (89% women) reflects the fact that the nursing profession is overwhelming female. “Males make up about 5% of all RNs working in the United States today” (Poliafico, 1998, p. 39). This sample was similar to the overall male/female ratio at the study facility. Veterans’ Administration hospitals may attract more male nursing staff as it gives preference to veterans in hiring, attracting former military corpsmen who wish to continue government service.

A little more than half of the participants were RNs, with LPNs and NAs each accounting for approximately one fourth of the sample, which approximates the staff qualifications’ mix of the study facility. The majority of the sample was drawn from those working the permanent day/evening shift rotation. Those working permanent nights constituted the smallest percentage the sample, which may have resulted from the researcher recruiting in person from members of that shift early in the morning when their shifts were ending; many refused to participate or even hear details about the study at that hour while they were tired and rushing to complete their assignments.

There was a wide range of experienced and inexperienced participants. The average age of the sample (42) reflects national trends of an aging nursing workforce. The average age of the RN workforce is 45 (Kilborn, 1999).

Participant Recruitment Method

Posters advertising the study produced only one telephone call for more information. A recruiting E-mail produced approximately 30 responses. Nurse managers were able to recruit approximately ten participants. The most effective recruitment method was in-person visits by the researcher to each unit with one of the telephone cards and a sample of the forms the participant would have to complete.

Prevalence of Musculoskeletal Discomfort

Almost two-thirds of the whole sample reported musculoskeletal discomfort of at least moderate severity in at least one body part in the previous seven days (Table 20). On high-risk units, the prevalence was 66% of the sample. This compares to the only baseline prevalence data available on this population at the JAHVAMC of 64% having at least moderate musculoskeletal discomfort in the past 30 days for nursing staff on the SCIUs and NHCUs in 1996. The period prevalence of musculoskeletal discomfort on these units has not improved in five years, which may have implications for productivity and job satisfaction. However, because staffing levels at the facility have declined since 1996 (Audrey Nelson, personal communication, November 14, 2001), the fact that the prevalence rate has not worsened concomitantly may indicate that the use of handling and movement equipment has offset the increased exposures. On low-risk units, the prevalence rate was 57%. These 7 – 30 day prevalence rates are high compared to the point prevalence of 24% found by Leighton and Reilly (1995) in British nurses but similar to the one year prevalence of 67% found by Knibbe and Friele (1996) in home health nurses. Because musculoskeletal prevalence rates on high-risk and low-risk units were very close (64% versus 57%), these similarities in the dependent variable may have contributed to the lack of significance findings in most of the regression analyses by failing to provide sufficient contrast. In addition, the high baseline prevalence rates of musculoskeletal discomfort among staff members may indicate the need for a larger sample size to detect differences.

The 100 % prevalence of musculoskeletal discomfort among the small sample of those who worked fewer than 21 hours a week is most likely due to the fact that those participants either called in sick or went out on a disability claim shortly after the study began. These data indicate that musculoskeletal discomfort is associated with absence from work. However, the sample is very small ($N=4$).

While two-thirds of the females reported musculoskeletal discomfort of at least moderate severity in any body part in the past 7 days, only one third of the males did. However, the sample size of males was small ($N=13$).

At-Risk Tasks Per Hour and Job Category

To account for the fact that participants worked a range of hours (8 to 64), a variable was created to compute the number of at-risk tasks per hour worked. This allowed comparisons among groups. Analysis of variance indicates that workload,

expressed as Number of At-Risk Tasks Per Hour, did differ significantly among RNs, LPNs, and NAs, with RNs having the lowest number and NAs having the highest. This supports what has been reported in the literature, that the exposure of NAs is greater than licensed staff. In this study, NAs performed 2.5 times the number of at-risk tasks per hour than RNs and 1.75 times more than LPNs. The null hypothesis, the number of at-risk patient handling tasks performed does not differ among RNs, LPNs, and NAs, is rejected. However, musculoskeletal discomfort frequency was not statistically different among NAs, LPNs or RNs.

Effect of Staffing

Although in the literature nurses have ascribed their injuries to insufficient staffing levels, this study did not show the staffing ratio to be predictive of the frequency or severity of musculoskeletal discomfort among participants. The NHCUs had the fewest able-bodied staff members and the highest numbers of patients of all the study units; the MICU and 6S (Medical/Surgical) had the most staff and fewest patients. Thus, the null hypothesis is not rejected for Hypothesis II: Frequency of musculoskeletal disorder symptoms in nursing staff members is not associated with the census/able-bodied FTEE staff ratio.

It is possible that all of the studied units were understaffed in terms of providing sufficient numbers to assist with patient handling and movement. This lack of contrast would have obscured the effect of insufficient staff on musculoskeletal discomfort by not providing for comparison a unit with adequate staff to care for the number of patients.

Effect of Handling and Moving Equipment

Surprisingly, patient handling and moving equipment, expressed as an absolute number, a trichotomous variable, a ratio of equipment/census, or a response to a question about frequency of use, was not associated with musculoskeletal discomfort frequency or severity. One explanation might be that some types of equipment provide more or less assistance than others. For example, NHCUC has 47 pieces of handling and movement equipment, with most being overhead lifts installed in each patient room. However, due to the ceiling configuration, these ceiling lifts are limited to activities on the bed and at the immediate bedside, making them less useful than ones with full maneuverability to the corners of a room and possibly less useful even than those on a moveable stand. Another explanation might be that staff members are not using the equipment or not using it as directed. However, the validity of the question about use of handling and moving equipment is in doubt, as evidenced by a nurse on the MICU, which has no patient handling and moving equipment, responding 5 (Always) when asked how often he or she used such equipment. There was no association between the degree of self-reported use of equipment and frequency or severity of musculoskeletal discomfort. Based on the study data, the null hypothesis is not rejected for Hypothesis III: Frequency of musculoskeletal disorder symptoms in nursing staff members is not associated with the amount of handling and movement equipment available on the work unit.

Effect of Patient Classification Rating

When treated as a ratio of the maximum for each unit, average Patient Classification Rating had no predictive effect on musculoskeletal discomfort frequency or severity. Thus, the null hypothesis is not rejected for Hypothesis V: The Patient Classification Rating is not related to the frequency of musculoskeletal discomfort in nursing staff. Because the Patient Classification Rating system is different from unit to unit in the hospital in both scale and associated meaning, the Patient Classification Rating was not found to be useful for predicting staff needed to address patient handling and movement needs.

High-Risk (1st Level) Tasks and Patients' Weights

In accordance with the finding of Herrin et al. (1986) that the most stressful tasks in a job are the most predictive of WMSDs, at-risk tasks were categorized into three risk groups: high, medium, and lower. (The rationale underlying the categorization is described in the Review of the Literature.)

The regression equation containing data on the number of patients lifted who weighed 212 pounds or more was associated with the frequency of musculoskeletal discomfort for two body parts: wrist and knee. The R^2 for wrist pain was higher than the R^2 for knee pain. There was no association with any other body part. In the knee pain regression, the significant variable was Number of Patients Equal To or Over 212 Pounds, while in the wrist pain regression, the significant variables were Number of High-Risk (1st Level) Tasks Per Hour and the Interaction Variable, suggesting that the mechanism of action may differ between the two body parts. Accordingly, the null hypothesis, frequency of musculoskeletal disorder symptoms in nursing staff is not associated with the high-risk (1st level) patient handling and movement tasks they perform, is rejected for wrist and knee and not rejected for all other body parts.

Although injuries to the knee and wrist are known to be associated with handling and moving patients, their incidence and prevalence in nursing is not well researched in the literature. Injury statistics from the NHCUs indicate that wrist and knee sprains have been a problem in the past, although their incidence is overshadowed by back injuries.

Nurses in the VA hospital system face an additional risk that nurses in general hospitals do not: caring for a primarily male patient population. Men weigh more than women on average, meaning that nursing staff in VA hospitals handle and move heavier patients on average than nurses in general hospitals. This may account for the higher period WMSD prevalence rates found in the study facility than those reported in the literature. In addition, the upper weight range of bariatric patients is higher for a predominantly male patient population. The heaviest patient moved or handled during this study was a male who weighed 387 pounds. Nurses in the MICU cared for the heaviest patients, who weighed an average of 211 pounds with a range of 107 - 289 pounds. This compares to Nursing Home Care Units A and D and the Medical/Surgical Unit (7N), which tied for the lowest average patient weight of 160, with a range of 91 to

234 pounds. The 50th percentile weight for a population 97% male is 182 pounds (Bernard, 2001), while the mean weight for all patients moved or handled was 169 pounds.

Three participants on a Spinal Cord Injury Unit mentioned during data collection that they were experiencing hand pain, which they attributed to the bowel care task. Because there is no category for “hand” on the Cornell Musculoskeletal Discomfort Questionnaire, participants with hand pain might have selected “wrist” as the closest alternative. The connection between wrist/hand pain and patient handling and movement tasks should be explored further.

Analysis of Results Compared to the Cumulative Trauma Model

The lack of association between frequency of high-risk (1st level) tasks and patient weight for pain prevalence or severity in body regions other than wrist and knee does not support the cumulative trauma model described in the literature. According to this model, it is the accumulation of external loads that ultimately exceeds the musculoskeletal system’s ability to withstand the stress of handling and movement tasks. (This model is in contrast to the instantaneous injury model, which posits that when a particular load exceeds a safe level, there is risk of immediate injury.) If the cumulative trauma model is correct, then the frequency that nursing staff performed high-risk (1st level) patient handling and movement tasks should have been associated with the frequency and severity of musculoskeletal discomfort in areas known to be stressed by these tasks; namely, the low back and shoulder. There are several possible explanations why this study did not show results that support the model.

High-Risk (1st Level) Task Assessment

The aggregation of tasks into 1st, 2nd, and 3rd level high-risk groupings may have concealed a relationship between particular tasks and the frequency of musculoskeletal discomfort. Tasks may have been grouped into the 1st level category inappropriately. Non-systematic (random) measurement error is also a possibility from the instrument, the rater, or “temporary fluctuations in respondents” (Pedhazur, 1997, p. 293).

Data Collection Method

This study’s method of counting the number of times a staff member performed at-risk patient handling tasks may have been inaccurate due to the variation among caregivers in their approach to completion of required tasks and to the variation in patient needs from shift to shift and day to day. Only partial information was available in patient records, which could not be relied upon to estimate workload. Hence, the researcher had to use more direct observation and questioning of nursing staff to identify and count the number of at-risk tasks performed. The researcher made fewer observations during the night shift than during the day shift, which may have resulted in an under- or over-count of tasks performed on those shifts.

Nursing staff are not required to write a note on every shift nor even every day describing their activities on behalf of the patient. Charting is done by exception; that is, if a required activity was not performed, nursing staff must record this and the reason why it was omitted. However, when exceptions occurred for moving and handling activities, they were not charted. For example, if a patient with an order to be turned every two hours left the unit for many hours, the nursing staff did not chart that he or she was not turned during this time period. Hence, the nursing notes were not a consistent or accurate source of information.

Physicians' written orders offer a framework for determining frequency that staff must perform at-risk patient handling tasks on a patient. For example, the physician orders activity level, such as bed rest or out of bed in a chair. In addition, the physician may specify the performance of other activities, such as turning frequency, or bowel care every two days. However, nursing staff determines many patient care activities and the frequency, time, and method by which these activities are performed as part of patient care planning and as a function of available personnel. For example, a nurse may institute a nursing order to turn a bedridden patient every two hours because this is part of appropriate care for such a patient to prevent bedsores and circulatory and pulmonary complications.

Based on a physician's order to get a patient out of bed in a chair, nursing staff may decide to get him or her out of bed in the afternoon and have the evening staff return him or her. In the nursing home and SCIUs, some staff members are scheduled to come in anytime between 4 a.m. and 6 a.m. to perform time-consuming tasks such as showering or getting patients out of bed for breakfast. There is no written documentation that captures the variety and schedule of these tasks.

Individual staff members vary in their selection and use of patient handling and movement equipment. Observation or questioning of nursing home staff members revealed that three handled or moved patients they regarded as "light" (under 100 pounds) without any handling or moving equipment at all. Five patients were transferred from their beds using stand assist lifts on one day and a full sling mechanical lift on another day. In other words, there was variability in approaches to handling and moving patients in the nursing home. This may be due to the large variation in patient handling and movement needs and patient assistance levels among nursing home patients, which ranges from completely independent to completely dependent. The nursing home staff did not complete any formal lifting and handling needs assessments on the residents. Knowledge of what was needed appeared to be passed through verbal reports at change of shift and from other staff members who had cared for a particular patient recently.

Patients on Spinal Cord Injury Units (SCIUs) are more uniform in their handling and movement needs, which are associated with the level of their spinal cord injury and whether they are paraplegic or tetraplegic. The SCIU staff also completes handling and movement needs assessments on each patient, which are entered into the patient's electronic medical record. These serve as a guide to staff members for handling and movement equipment selection, type and frequency of activity, and ability of the patient

to assist. There were no written handling and movement needs assessments on patients on other hospital units.

The researcher was unable to develop a consistent patient handling and movement task profile for patients on units other than SCIUs, which may have influenced the accuracy of task assessment. On the surgical and medical/cardiac floors (4S, 5S, 6S) and the MICU, there is a high patient turnover; i.e., the patients are transferred in and out after brief stays. In addition, the condition of the general patient population is in rapid flux as well. Pre-operative surgical patients are ambulatory one day, completely bed ridden the next, ambulating the second day, and often discharged shortly thereafter.

Patients on the Medical/Surgical Unit (7N) are a mix of acute short and long-term stays, with several patients in the latter group dependent on respirators and requiring extensive handling and moving assistance. Again, nursing staff on 7N does not complete handling and movement assessments, leaving it up to individual nursing staff members on every shift to determine *de novo* the best way of completing required tasks, resulting in task variation from caregiver to caregiver.

Various patient characteristics determined whether ordered tasks were carried out. For example, two patients on an SCIU refused to be turned. One refused to wear pajamas, which meant that although the nurse had to perform a complete bed bath and make an occupied bed, she did not have to dress the patient. On the SCIU where patients are admitted for rehabilitation (1BSW), about half of the patients spent most of the day shift off the unit receiving various services, such as physical therapy. Thus, a physician's order might read to turn the patient every two hours, but in fact the nurse does not perform this task during several hours a day because the patient is not available.

Tasks also varied by shift. For example, transfers from bed to stretcher are most frequent on the day shift as patients were transported off the unit to x-ray or for other appointments, and virtually not performed during the night shift, when the rest of the hospital departments are closed.

The immense variability in the time, frequency, type, and circumstances of at-risk patient handling tasks coupled with inconsistent or absent written documentation of their performance makes chart review a weak source for gathering exposure assessment information.

The researcher found that sharing the at-risk task list with a staff member and asking what tasks the staff member was going to perform or had performed on a particular patient that shift and how often, provided the best level of detail. The staff members were able to account for special circumstances that might have influenced the performance of these tasks (such as the patient's absence from the floor or refusal to turn) to a level of detail not possible from chart review. In the main hospital, where the average patient assignment for a nursing staff member was between 2 and 4 patients, such reporting was a very brief (1-2 minute) interruption in the staff member's workday. Often the charge nurse was familiar enough with patients' handling and moving needs to

identify patients not needing handling and movement assistance, eliminating them from further consideration. On the NHCUs, staff members (particularly nursing aides on the evening and night shifts) had assignments ranging from 4 to 20 patients, which required lengthier questioning. However, NHCU residents rarely changed in their handling and movement needs from day to day, and there was little patient turnover, giving the researcher a stable patient profile from which to determine the frequency and type of at-risk tasks required.

The most valid information on the frequency and type of at-risk patient handling and movement activities was a staff member when questioned during the work shift. When the researcher questioned a particular staff member about tasks performed 24 hours previously, the staff member could not even recall what her patient assignment had been. Even when shown a list of names of the patients for whom she had cared, she could not recall the specifics of their care. This may be due to information overload because patient assignments change every day, and care is delivered by a team approach. In the team approach, as opposed to primary care where one caregiver provides all care for a patient, tasks are divided by staff credentials and availability; e.g., licensed staff administer medications and do treatments, unlicensed staff provide for the activities of daily living (bathing, eating, movement). On all units, an RN makes the patient assignments.

Limitations of the Data Collection Tool

Another possible reason that this study may not have shown an association between the manual handling workload and musculoskeletal discomfort is that the data collection tool, which was focused on assigned patients, did not capture incidental handling and movement activities. Incidental handling and movement activities include those that the participant performed on patients to whom they were not assigned or physically stressful tasks not associated with a patient, such as pushing equipment or empty beds.

The tool also did not capture how many staff members performed a particular task; that is, whether the participant had help. The response to the demographics questionnaire indicates that on average, staff members ask for another staff member's help somewhat more than "sometimes" (3.63 out of a scale of 5). Having at least one other person assisting in task performance reduces the amount musculoskeletal stress for a single caregiver, which significantly affects the degree of risk to which the caregiver is exposed.

Cornell Musculoskeletal Discomfort Questionnaire

The Cornell Musculoskeletal Discomfort Questionnaire (CMDQ) is based on the Nordic Survey, which has established validity and reliability, as previously discussed. The brevity and ease of use may account for the high response rate. However, the CMDQ does omit naming certain body parts for which some participants wrote in their own categories: namely, elbows, feet, and fingers. Sensitivity and specificity have not

been evaluated. Because pain is subjective, the responses cannot be measured objectively.

Study Limitations

This study examined only physical risk factors for musculoskeletal discomfort in nursing staff. The findings indicate that the high-risk (1st level) physical workload is not associated with the frequency and severity of low back musculoskeletal discomfort, the outcome variable of most interest to researchers and employers due to the cost of low back injuries, should discomfort be a precursor to workers' compensation claims. This study did not assess the influence of psychosocial factors, thought by some researchers to act synergistically with heavy workload to produce musculoskeletal discomfort.

Because this study was cross-sectional, cause and effect cannot be ascribed to the finding that frequency of knee and wrist pain are associated with the number of high-risk (1st level) tasks per hour in conjunction with the number of patients who weighed equal to or over 212 pounds handled or moved. In addition, this study did not evaluate whether the respondent ascribed his or her musculoskeletal discomfort to work or non-work causes. This study had only a small number of participants who did not perform any at-risk patient handling and movement tasks. The study was of brief duration. The high prevalence of low back pain in both the general and nursing populations most likely requires a larger sample size to detect the effect of manual handling on musculoskeletal discomfort.

Many studies make incidence of a musculoskeletal disorder the dependent variable, not musculoskeletal discomfort. Little is known about the relationship between the amount and frequency of musculoskeletal pain and reporting a claim. As described previously, Nelson et al. (1996) found that nurses reported an acute injury only when it could be attributed to a specific patient. For chronic pain, the nurses waited to report until pain and limitation of function exceeded the individual's tolerance level.

Conclusions

- Nursing aides have a higher exposure to at-risk nursing tasks than do LPNs, who in turn have a higher exposure than do RNs. This higher exposure may explain the higher injury rate in NAs.
- The frequency of performing high-risk (1st level) handling and movement tasks and the number of patients moved or handled who weigh in the top 20th percentile are associated with the frequency of wrist and knee musculoskeletal discomfort, but not back.
- Assessing physical workload alone may not be sufficient to explain the variation in musculoskeletal discomfort among caregivers. However, the sample size was small compared to what might be needed to detect an association due to the high prevalence of musculoskeletal discomfort in the low back and upper body.

Recommendations

- The bowel care task should be studied using an upper extremity or hand evaluation tool.
- The VAMC should consider expanding its safe patient and handling interventions to include low-risk units, where the prevalence of musculoskeletal discomfort is only slightly less than that found on high-risk units.
- The VAMC should consider require periodic handling and movement needs assessments for all patients on all units to standardize the number of staff and type of equipment needed. This requirement, as well as enhanced staff training in assessing patients, using clinical decision algorithms for selecting equipment, and operating equipment properly, would help to insure that staff are using the correct handling and movement equipment in a consistent and appropriate manner.

Directions for Future Research

Using the same data set and participants, the researcher plans to collect workers' compensation and sick leave data for the year preceding and following this study to see whether frequency or severity of musculoskeletal discomfort in any body part is associated with filing a claim or missing work.

Future research will explore the relationship between individual tasks and musculoskeletal discomfort. This analysis may find an association that grouping high-risk tasks into levels obscured.

Further research on the biomechanical stress on the wrist and knee joints is needed. Further biomechanical assessment of the bowel care task is also needed.

The VAMC is conducting a longitudinal study of change in the WMSD incidence rate after an intervention program at one group of VA hospitals with another group serving as controls. It would be interesting to assess change in musculoskeletal discomfort as well, to evaluate whether the interventions decrease soreness as well as reporting of injuries and to evaluate the association, if any, between musculoskeletal discomfort and filing a workers' compensation claim. However, it is not clear how frequently musculoskeletal discomfort should be measured to determine trends and changes. For example, should discomfort be measured at the start of a work shift or workweek and at the end for comparison? Or is a longer interval, such as a month or six months, more informative?

The At-Risk Tasks data collection tool should be expanded to include incidental tasks, such as moving and handling tasks performed on patients other than those assigned, and other tasks, such as feeding patients and placing patients on a bedpan. It should also be expanded to factor in the number of staff members assisting the participant in the handling or movement activity. The study should be repeated using the revised At-Risk Tasks tool at a non-Veterans' Administration hospital with a larger control group of nurses with little or no patient handling and movement activities to see whether the

relationship among performing high-risk (1st level) tasks, lifting heavy patients, and knee or wrist discomfort is replicated. Any repeat of the study should include a concurrent assessment of psychosocial factors.

References

- Ahlberg-Hulten, G.K., Theorell, T., & Sigala, F. (1995). Social support, job strain and musculoskeletal pain among female health care personnel. *Scan J Work Environ Health, 21*, 435-9.
- American Nurses Association. (2000). *American Nurses Association denounces efforts to stall OSHA ergonomics standard*. Retrieved July 12, 2001 from <http://www.ana.org/pressrel/2000/pr0713.htm>.
- American Nurses Association. (2001). Nurses cite stress, overwork as top health, safety concern." *The American Nurse, 33* (5),1, 8.
- Andersson, G. (1981). Epidemiologic aspects on low-back pain in industry. *Spine, 6*, 53-60.
- Arthur, T., & James, N. 1994. Determining nurse staffing levels: A critical review of the literature. *Journal of Advanced Nursing, (19)*, 558-565.
- Baron, S., Hales, T., & Hurrell, J. (1996). Evaluation of symptom surveys for occupational musculoskeletal disorders. *American Journal of Industrial Medicine, 29*, 609-617.
- Baty, D., & Stubbs, D. (1987). Postural stress in geriatric nursing. *International Journal of Nursing Studies, 24*(4), 339-44.
- Beers, M.H. & Berkow, R. (Eds.) (1999). *The Merck manual of diagnosis and therapy*. Whitehouse Station, N.J.: Merck Research Laboratories.
- Bell, F., Dalgity, M.E., Fennell, M.J., & Aitken, R.C. (1979). Hospital ward patient-lifting tasks. *Ergonomics, 22*(11), 1257-73.
- Bernard, T. (2001). *Percentiles and values within distributions*. Retrieved October 14, 2001 from <http://www.hsc.usf.edu/~tbernard>.
- Biddle, J., Roberts K., Rosenman K.D., & Welch E.M. (1998). What percentage of workers with work-related illnesses receive workers' compensation benefits? *J Occup Environ Med, 40*(4), 325-31.

- Bigos, S., Spengler, D., Martin, N., Zeh, J., Fisher, L., Nachemson, A., & Wang, M.H. (1986). Back injuries in industry: A retrospective study. II, Injury factors. *Spine*, 11 (3), 246-241.
- Bjorksten, M.G., Boquist, B., Talback, M., & Edling, C. (1999). The validity of reported musculoskeletal problems. A study of questionnaire answers in relation to diagnosed disorders and perception of pain. *Applied Ergonomics*, 30, 325-330.
- Borg, G. (1970). Perceived exertion as an indicator of somatic stress. (1970). *Scandinavian Journal of Rehabilitation Medicine*, 2, 92-98.
- Burton, A.K., Symonds, T.L., Zinzen, E., Tillotson, K.M., Caboor, D., Van Roy, P., et al. (1997). Is ergonomic intervention alone sufficient to limit musculoskeletal problems in nurses? *Occup Med (Lond)*, 47, (1), 25-32.
- Carayon, P., & Smith, M.J. (2000). Work organization and ergonomics. *Applied Ergonomics*, 31 (6), 649-662.
- Cato C., Olson D.K., & Studer, M. (1989). Incidence, prevalence, and variables associated with low back pain in staff nurses. *AAOHN Journal*, 37 (8), 321-327.
- Cohen, J. (1988). *Statistical power analysis for the behavioral sciences*, 2nd ed. Hillsdale, N.J.: L. Erlbaum Associates.
- Cohen-Mansfield, J., Culpepper, W.J., & Carter, P. (1996). Nursing staff back injuries: Prevalence and costs in long term care facilities. *AAOHN Journal*, 44 (1), 9-17.
- Corlett, E.N., & Bishop, R.P. (1976). A technique for assessing postural discomfort. *Ergonomics*, 19, 175-182.
- Cust, G., Pearson, J., & Mair, A. (1972). The prevalence of low back pain in nurses. *International Nursing Review*, 19(2), 169-79.
- Daltroy, L.H., Iversen, M.D., Larson, M.G., Lew, R., Wright, E., Ryan, J., Zwerling, C., et al. (1997). A controlled trial of an educational program to prevent low back injuries. *New England Journal of Medicine*, 337 (5), 322-8.
- Damkot, D., Pope, M., Lord, J., & Frymoyer, J. (1984). The relationship between work history, work environment and low-back pain in men. *Spine*, 9, 395-399.
- Dehlin, O., Hedenrud, B., & Horal, J. (1976). Back symptoms in nursing assistants in a geriatric hospital. *Scandinavian Journal of Rehabilitation Medicine*, 8(2), 47-53.
- Doormaal, M.T.A.J., Driessen, A.P.A., Landeweerd, J.A., & Drost, M.R. (1995). Physical workload of ambulance assistants. *Ergonomics*, 38 (2), 361-376.

- Engels, J., van der Gulden, J.W.J., Senden, T.F., & van't Hof, B. (1996). Work-related risk factors for musculoskeletal complaints in the nursing profession: Results of a questionnaire survey. *Occup Environ Med*, 53, 636-641.
- Ergonomics Group. (1986). *Ergonomic design for people at work, Volume 2*. New York: Van Nostrand Reinhold.
- Estryn-Behar, M., Kaminski, M., Peigne, E., Maillard, M.F., Pelletier, A., Berthier, C., Delaporte, M.F., Paoli, M.C., & Leroux, J. M. (1990). Strenuous working conditions and musculo-skeletal disorders among female hospital workers. *Int Arch Occup Environ Health*, 62 (1), 47-57.
- Ferguson, D. (1970). Strain injuries in hospital employees. *Medical Journal of Australia*, I, 376-379.
- French, P., Flora W, Fung L, Ping, LS, Kar, B, Wee, R., & Wong, H. The prevalence and cause of occupational back pain in Hong Kong registered nurses. *Journal of Advanced Nursing*, 26 (3), 380-388.
- Frymoyer. J.W., Pope, M.H. Costanza M.C., Rosen, J.C., Goggin J.E., & Wilder, D.G. (1980). Epidemiologic studies of low-back pain. *Spine*, 5(5), 419-23.
- Frymoyer, J., Pope, M., Clement, J., Wilder, D., MacPherson, B., & Ashikaga, T. (1983). Risk factors in low back pain: an epidemiologic survey. *J Bone Joint Surg. Am.*, 65, 213-218.
- Fuortes, L.J. Shi Y, Zhang, M., Zwerling,C., & Schootman, M. (1994). Epidemiology of back injury in university hospital nurses from review of workers' compensation records and a case-control survey. *JOM*, 36 (9), 1022-1026.
- Gagnon, M., Cheahde, A., Kemp, F., & Lortie, M. (1987). Lumbo-sacral loads and selected muscle activity while turning patients in bed. *Ergonomics*, 30 (7), 1013-32.
- Garg, A. & Owen, B. (1992). Reducing back stress to nursing personnel: An ergonomic intervention in a nursing home. *Ergonomics*, 35 (11), 1353-75.
- Garg, A., Owen, B., Beller, D., & Banaag, J. (1991). A biomechanical and ergonomic evaluation of patient transferring tasks: Bed to wheelchair and wheelchair to bed. *Ergonomics*, 34(3), 289-312.
- Gold, M. (1994). The ergonomic workplace: Charting a course for long-term care. *Provider*, 20 (2), 20-2, 23, 26.
- Greenwood, J. (1986). Back injuries can be reduced with worker training, reinforcement. *Occupational Health Safety*, 26-29.

- Growing nursing shortage tied to recruiting woes, job demands. (2001, October 20). *The Los Angeles Times*, p. Part A; Part 1; Page 23; National Desk.
- Hales, T., & Fine, L. (1989a). *Health hazard evaluation report 88-180-1958*. U.S. Department of Health and Human Services, Public Health Service, Center for Disease Control and Prevention, National Institute for Occupational Safety and Health, NTIS Report No. PB-80-128992.
- Hales, T., & Fine, L. (1989b). *Health hazard evaluation report 89-251-1997*. U.S. Department of Health and Human Services, Public Health Service, Center for Disease Control and Prevention, National Institute for Occupational Safety and Health, NTIS Report No. PB-90-183989.
- Hales, T.R., Sauter, S.L., Peterson, M.R., Fine, L.J., Putz-Anderson, V., Schleifer, L.R., et al. (1994). Musculoskeletal disorders among visual display terminal users in a telecommunication company. *Ergonomics*, 37, 1603-1621.
- Harber, P., Billet, E., Gutowski, M., Soohoo, K., Lew, M., & Roman, A. (1985). Occupational low back pain in hospital nurses. *JOM*, 27 (7), 518-524.
- Hawkins, L. (1987). An ergonomic approach to stress. *International Journal of Nursing Studies*, 24(4), 307-18.
- Health and Safety Executive. (1992). *Manual Handling Operations Regulations*. London, HMSO.
- Hedge, A., Morimoto, S., McCrobie, D. (1999). Effects of keyboard tray geometry on upper body posture and comfort. *Ergonomics* (42), 10, 1333-1349.
- Heliövaara, M., Knekt, P., & Aromaa, A. (1987). Incidence and risk factors of herniated lumbar intervertebral disc or sciatica leading to hospitalization. *Journal of Chronic Diseases*. 40,(3), 251-8.
- Helminger, C. (1997). A growing physical workload threatens nurses' health. *American Journal of Nursing*, 97 (4), 64-66.
- Hernandez, C.A., & O'Brien-Pallas, L.L. (1996). Validity and reliability of nursing workload measurement systems: Review of validity and reliability theory. *Can J Nurs Adm*, 9 (3), 32-50.
- Herrin, G.D., Jariedi, M., & Anderson, C.K. (1986). Prediction of overexertion injuries using biomechanical and psychophysical models. *American Industrial Hygiene Association Journal*, 47, 322-330.

- Hignett, S. (1996). Work-related back pain in nurses. *Journal of Advanced Nursing*, 23, pp. 1238-1246.
- Hignett, S. & McAtamney, L. (2000). Rapid entire body assessment (REBA). *Applied Ergonomics*, 31, 201-205.
- Hoekstra, E., Hurrell, J., Swanson, N. (1994). *Health hazard evaluation report 92-382-2450*. U.S. Department of Health and Human Services, Public Health Service, Center for Disease Control and Prevention, National Institute for Occupational Safety and Health.
- Hollmann, S., Klimmer, F., Schmidt, K.H., & Kylian, H. (1999). Validation of a questionnaire for assessing physical workload. *Scand J Work Environ Health*, 25 (2), 105-114.
- Houtman, I.L., Bongers, P.M., Smulders, P.G., & Kompier, M.A. (1994). Psychosocial stressors at work and musculoskeletal problems. *Scandinavian Journal of Work, Environment & Health*, 20 (2), 139-45.
- Institute of Medicine. (2001). *Musculoskeletal disorders and the work place: Low back and upper extremities*. Washington: National Academy Press.
- Jensen, R. (1985). Events that trigger disabling back pain among nurses. Proceedings of the 29th Annual Meeting of the Human Factors Society. Santa Monica, CA. Human Factors Society.
- Jensen, R. (1987). Disabling back injuries among personnel: Research needs and justification. *Research in Nursing & Health*, 10, 29-38.
- Johansson, J.A. (1995). Psychosocial work factors, physical work load and associated musculoskeletal symptoms among home care workers. *Scandinavian Journal of Psychology*, 36, 113-129.
- Josephson, M., & Vingard, E. (1998). Workplace factors and care seeking for low-back pain among female nursing personnel. *Scandinavian Journal of Work, Environment, & Health*, 24 (6), 465-72.
- Karhu, O., Kansil, P., & Kuorinka, I. (1977). Correcting working postures in industry: A practical method for analysis. *Applied Ergonomics*, 8, 199-201.
- Kelsey, J. (1975). An epidemiological study of acute herniated lumbar intervertebral discs. *Rheumatol Rehabilitation*, 14, 144-159.

- Kelsey, J., Githens, P., White, A., Holford, T., Walter, S., & O'Connor, T. (1984). An epidemiological study of lifting and twisting on the job and the risk for acute prolapsed lumbar intervertebral disk. *Journal of Orthopedic Research*, 2 (1), 61-66.
- Kelsey, J., & Golden, A. (1988). Occupational and workplace factors associated with low back pain. *Occupational Medicine: State of the Art Reviews*, 3(1), 7-16.
- Kerr, M.S., Frank, J.W., Shannon, H.S., Norman, R.W.K., Wells, R.P., Neumann, W. P., et al. (2001). Biomechanical and psychosocial risk factors for low back pain at work. *American Journal of Public Health*, 91 (7), 1069 – 1075.
- Kilbom, A. (1988). Isometric strength and occupational muscle disorders. *European Journal of Applied Physiology and Occupational Physiology*, 57(3), 322-6.
- Kilborn, P.T. (1999, March 23). Hospitals face highly skilled nurse shortage. *The Plain Dealer*, p. 9A.
- Kiken, S., Stringer, W., Fine, L., Sinks, T., & Tanaka, S. (1990). *Health hazard evaluation report 89-307-2009*. U.S. Department of Health and Human Services, Public Health Service, Center for Disease Control and Prevention, National Institute for Occupational Safety and Health, NTIS Report No. PB-91-104620.
- Knibbe, J. & Friele, R. (1996). Prevalence of back pain and characteristics of the physical workload of community nurses. *Ergonomics*, 39(2), 186-198.
- Kodak Ergonomics Group. (1986). *Ergonomic design for people at work*. New York: Van Nostrand Reinhold.
- Kumar, S. (1990). Cumulative load as a risk factor for back pain. *Spine*, 15 (12), 1311-1316.
- Kuorinka, I., Jonssori, B., Kilbom, A., Vinterberg, H., Biering-Sorensen, F., Andersson, G., et al. (1987). Standardised Nordic questionnaires for the analysis of musculoskeletal symptoms. *Applied Ergonomics*, 18, 3, 233-237.
- Lagerstrom, M., Wenemark, M., Hagberg, M., & Hjelm, E.W. (1995). Occupational and industrial factors related to musculoskeletal symptoms in five body regions among Swedish nursing personnel. *International Archives of Occupational and Environmental Health*, 68, 27-35.
- Larese, F., & Fiorito, A. (1994). Musculoskeletal disorders in hospital nurses: A comparison between two hospitals. *Ergonomics*, 37 (7), 1205-1211.

- Lavsky-Shulan, M., Wallace, R.B., Kohout, F.J., Lemke, J.H., Morris, M.C., & Smith, I.M. (1985). Prevalence and functional correlates of low back pain in the elderly: The Iowa 65+ Rural Health Study. *Journal of the American Geriatrics Society*, 33 (1), 23-8.
- Legg, S. (1987). Physiological ergonomics in nursing. *International Journal of Nursing Studies*, 24(4), 299-305.
- Leighton, D.J., & Reilly, T. (1995). Epidemiological aspects of back pain: The incidence and prevalence of back pain in nurses compared to the general population. *Occup Med*, 45, 263-267.
- Lemasters, G.K. & Atterbury, M.R. (1996). Musculoskeletal and work history questionnaire. In A. Bhattacharya & J.D. McGlothlin (Eds.), *Occupational ergonomics: Theory and Applications* (pp. 420-462). Leeds, U.K.: Marcel Dekker.
- Lemasters, G.K., Atterbury, M.R., Booth-Jones, A.D., Bhattacharya, A., Ollila-Glenn, N., Forrester, C., et al. (1998). Prevalence of work related musculoskeletal disorders in active union carpenters. *Occup Environ Med*, 55 (6), 421-7.
- Love, C. (1996). A study of the circumstances of nurse injury from the perspective of the work injured nurse. *Nursing Standard*, 10 (46), 34-39.
- Love, C. (1997). Lifting injury: A study of the occupational health perspective. *Nursing Standard*, 11 (26), 33-38.
- Lundy, K.S. & Janes, S. (2001). *Community health nursing: Caring for the public's health*. Sudbury, MA: Jones and Bartlett Publishers.
- Malloch, K. & Conovaloff, A. (1999). Patient classification systems, Part I. *JONA*, 29 (7/8), 49-56.
- Manning W.G., Leibowitz, A., Goldberg, G.A., Rogers, W.H., & Newhouse, J.P. (1984). A controlled trial of the effect of a prepaid group practice on use of services. *New England Journal of Medicine*, 310(23), 1505-10.
- Marras, W.S., Davis, K.G., Heaney, C.A., Maronities, A.B., & Allread, W.G. (2000). The influence of psychosocial stress, gender, and personality on mechanical loading of the lumbar spine. *Spine*, 25 (23), 3045-54.
- Marras, W.S., Davis, K.G., Kirking, B.C., & Bertsche, P.K. (1999). A comprehensive analysis of low back disorder risk and spinal loading during the transferring and repositioning of patients using different techniques. *Ergonomics*, 42(7), 904-926.

- Marras, W.S., Davis, K.G., Kirking, B.C., & Granata, K.P. (1999). Spine loading and trunk kinematics during team lifting. *Ergonomics*, 42 (10), 1258-73.
- McAbee, R.R. (1988). Nurses and back injuries: A literature review. *AAOHN Journal*, 36, 10, 200-209.
- McAtamney, L. & Corlett, E.N. (1993). RULA: A survey method for the investigation of work-related upper limb disorders. *Applied Ergonomics*, 24 (2), 91-99.
- National Institute for Occupational Safety and Health. (1998). *Low back disorders*. Retrieved July 12, 2001 from <http://www.cdc.gov/niosh/nrlowbck.html>.
- National Institute for Occupational Safety and Health. (1997). *Musculoskeletal disorders and workplace factors: A critical review of epidemiologic evidence for work-related musculoskeletal disorders of the neck, upper extremity, and low back*. DHHS (NIOSH) Publication No. 97-141. Cincinnati, OH: National Institute for Occupational Safety and Health.
- NIOSH. (1981). *Work practices guide for manual lifting*. NIOSH Technical Report No. 81-122, U.S. Department of Health and Human Services, National Institute for Occupational Safety and Health, Cincinnati, OH.
- Nelson, A., Kroll, B., Loewenhardt, P., Doloresco, L., Quigley, P., McCright, P., et al. (1996). Identification of patient handling tasks that contribute to musculoskeletal injuries in SCI nursing practice. Unpublished research results from a study at the James A. Haley Veterans Administration Medical Center.
- Nelson, A., Lloyd, J.D., Gross, C., & Menzel, N. (2001). Redesigning patient handling tasks to prevent nursing back injuries. NRI #95-1502, Final Report. Unpublished research conducted at James A. Haley Veterans' Administration Medical Center.
- Owen, B. (1985). The lifting process and back injury in hospital nursing personnel. *Western Journal of Nursing Research*, 7(4), 445-59.
- Owen, B.(1989). The magnitude of low back problems in nursing. *Western Journal of Nursing Research*, 11 (2), 234-242.
- Owen, B., & Garg, A. (1991). Reducing the risk for back pain in nursing personnel. *AAOHN Journal*, 39 (1), 24-33.
- Owen, B., & Garg, A. (1994). Reducing back stress through an ergonomic approach: Weighing a patient. *International Journal of Nursing Studies*, 31 (6), 511-9.
- Owen, B., Garg, A., & Jensen, R.C. (1992). Four methods for identification of most back-stressing tasks performed by nursing assistants in nursing homes. *International Journal of Industrial Ergonomics*, 9, 213-220.

- Owen, B.D., Keene, K., & Olson, S. (2000/2001). Patient handling tasks perceived to be most stressful by hospital nursing personnel. *Journal of Healthcare Safety, Compliance & Infection Control*, 5 (1), 1-7.
- Patenaude, S., & Sommer, M. (1987). Low pain: etiology and prevention. *AORN Journal*. 46(3), 472-5, 477, 479.
- Pear, R. U.S. recommending strict new rules at nursing homes. (2000, July 23). *New York Times*, pp. 1, 15.
- Pedhazur, E.J. (1997). *Multiple regression in behavioral research: Explanation and prediction*, 3rd ed. Fort Worth: Harcourt Brace College Publishers.
- Pilling, S. Calculating the risk. (1993). *Nursing Standard*, 8 (6), 18-20.
- Poliafico, J.K. (1998). Nursing's gender gap. *RN*, 61(10), 39-42.
- Pransky, G., Snyder, T., Dembe, A., & Himmelstein, J. (1999). Under-reporting of work-related disorders in the workplace: A case study and review of the literature. *Ergonomics*, 42(1), 171-82.
- Rodgers, S. (1985). Back pain four: Positive lifting. *Nursing Times*, 81, 43-45.
- Rosenstock, L. & Cullen, M.R. (1994). *Textbook of clinical occupational and environmental medicine*. Philadelphia: W.B. Saunders Company.
- Ryden, L.A., Molgaard, C.A., Bobbitt, S., & Conway, J. (1989). Occupational low-back injury in a hospital employee population: An epidemiological analysis of multiple risk factors of a high-risk occupational group. *Spine*, 14 (3), 315-20.
- Shroeder R.E., Rhodes A.M. & Shields, R.E. (1984). Nurse acuity systems. *Nursing Forum*, 21, 72-77.
- Smedley, J., Egger, P., Cooper, C., & Coggon, D. (1995). Manual handling activities and risk of low back pain in nurses. *Occupational & Environmental Medicine*, 52 (3), 160-163.
- Smedley, J., Egger, P., Cooper, C., & Coggon, D. (1997). Prospective cohort study of predictors of incident low back pain in nurses. *British Medical Journal*, 314 (7089), 1225-1228.
- Smith, M.J., & Carayon-Sainfort, P. (1989). A balance theory of job design for stress reduction. *International Journal of Ergonomics* 4, 67-79.
- Snell, J. (1995). Raising awareness. *Nursing Times*, 91 (3), 20-1.

- Snook, S.H. (1982). Low back pain in industry. In: White, A.A., & Gordon, S.L. (Eds.), *American Academy of Orthopaedic Surgeons Symposium on Idiopathic Low Back Pain* (pp. 23-28). St. Louis, MO: C.O. Mosby Company.
- Snook, S.H., & Ciriello, V.M. (1991). The design of manual handling tasks: Revised tables of maximum acceptable weights and forces. *Ergonomics*, 34 (9), 1197-1213.
- Snook, S.H., & Webster, B.S. (1987). The cost of disability. *Clinical Orthopedica*, 221, 77-84.
- Stobbe, T.M., Plummer, R.W., Jensen, R.C., & Attfield, M.D. (1988). Incidence of low back injuries among nursing personnel as a function of patient lifting frequency. *J. Saf. Res.*, 19, 21-28.
- Stubbs, D.A., Rivers, P.M., Hudson, M.P., & Worringham C.J. (1981). Back pain research. *Nursing Times*, 77(20), 857-8.
- Stubbs, D., Buckle, P., Hudson, M., Rivers, P., & Worringham, C.J. (1983). Back pain in the nursing profession: I. Epidemiology and pilot methodology. *Ergonomics*, 26(8), 755-756.
- Sykes, K. (1998). Sweden: Preventing health workers' back injuries. *Public Health Report*, 113 (6), 559.
- Uhl, J.E., Wilkinson, W.E., & Wilkinson, C.S. (1987). Aching backs? A glimpse into the hazards of nursing. *AAOHN Journal*, 35 (1), 13-17.
- Ulin, S., Chaffin, D., Patellos, C., Blitx, S., Emerick, C., Lundy, F., & Misher, L. (1997). A biomechanical analysis of methods used for transferring totally dependent patients. *SCI Nursing*, 14 (1), 19-27.
- U.S. Department of Health and Human Services. (2000). *Healthy people 2010, 2nd ed. With understanding and improving health and objectives for improving health*. 2 vols. Washington, DC: U.S. Government Printing Office.
- U.S. Department of Labor, Bureau of Labor Statistics. (1986). *Recordkeeping guidelines for occupational injuries and illnesses*. Pub. No. 1220-0029.
- U.S. Department of Labor, Occupational Safety and Health Administration. (n.d.). Worker safety and health in the nursing home industry. *OSHA Nursing Home Initiative Fact Sheet*. Retrieved 4/20/1999 from <http://www.osha-slc.gov:80/NewInit?nurseHome/factsht.html>.

- U.S. Department of Labor, Occupational Safety and Health Administration. (1999). Ergonomics program; Proposed rule. *Fed. Reg.*, November 23.
- U.S. Department of Labor, Occupational Safety and Health Administration. (2000). 29 CFR Part 1910. Ergonomics program: Final rule. *Fed. Reg.*, November 14.
- U.S. Department of Labor, Office of Public Affairs. (June 29, 2001). OSHA rule on record keeping for workplace injuries to go into effect as scheduled. Retrieved 9/23/01 from <http://www.osha.gov/media/oshnews/june01/national-20010629.html>.
- Venning, P.J., Walter, S.D., & Stitt, L.W. (1987). Personal and job-related factors as determinants of incidence of back injuries among nursing personnel. *J Occup Med*, 29 (10), 820-5.
- Videman, T., Nurminen, T., Tolas, S., Kuorinka, I., Vanharanta, H., & Troup, J. (1984). Low back pain in nurses and some loading factors of work. *Spine*, 9(4), 400-404.
- Waters, T.R., Putz-Anderson, V., Garg, A., & Fine, L.J. (1993). Revised NIOSH equation for the design and evaluation of manual lifting tasks. *Ergonomics*, 36 (7), 749-776.
- Wells, R., Norman, R., Neumann, P., Andrews, D., Frank, J., Shannon, H., & Kerr, M. (1997). Assessment of physical work load in epidemiologic studies: Common measurement metrics for exposure assessment. *Ergonomics*, 40 (1), 51-61.
- Wiktorin, C., Karlquist, L., Winkel, J. & Stockholm MUSIC I Study Group. (1993). Validity of self-reported exposures to work postures and manual materials handling. *Scandinavian Journal of Work and Environmental Health*, 19, 208-214.
- Winkel, J., & Mathiassen, S.E. (1994). Assessment of physical work load in epidemiologic studies: Concepts, issues, and operational considerations. *Ergonomics*, 37 (6), 979-88.
- Winkelmolen, G., Landeweerd, J., & Drost, M. (1994). An evaluation of patient lifting techniques. *Ergonomics*, 37, 921-932.
- Williamson, K., Turner, J., Brown, K., Newman, K., Sirles, A., & Selleck, C. (1988). Occupational health hazards for nurses part 2. *Image - the Journal of Nursing Scholarship*, 20(3), 162-8.
- WHO. (1985). Identification and control of work-related diseases. *WHO Technical Report Series 714*. Geneva, Switzerland: World Health Organization.
- Wunderlich, G., Sloan, F., & Davis, C.K. (1996). *Nursing staff in hospitals and nursing homes: Is it adequate?* Washington, D.C.: National Academy Press.

- Yassi, A., Khokhar, J., Tate, R., Cooper, J., Snow, C., & Vallentyne, S. (1995). The epidemiology of back injuries in nurses at a large Canadian tertiary care hospital: Implications for prevention. *Occup Med (Oxf)*, 45 (4), 215-20.
- Zhuang, A., Stobbe, T.J., Hsiao, H., Collins, J.W., & Hobbs, G.R. (1999). Biomechanical evaluation of assistive devices for transferring residents. *Applied Ergonomics*, 30 (1999), 285-294.

Bibliography

Norwood, S.L. (2000). *Research strategies for advanced practice nurses*. Upper Saddle River, N.J.: Prentice Hall Health.