PATIENT HANDLING: RESTRICTIONS & CONDITIONS

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PATIENT HANDLING: RESTRICTIONS & CONDITIONS

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A Dissertation

Submitted to

the Graduate Faculty of

Auburn University

in Partial Fulfillment of the

Requirements for the

Degree of

Doctor of Philosophy

Auburn, Alabama
December 17, 2007

PATIENT HANDLING: RESTRICTIONS & CONDITIONS

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Grady Talley Holman, son of Lodge Holman and Gina Holman, was born in Opelika, Alabama on March 8, 1972. He graduated from Southwest Georgia Academy in 1990 and began matriculating at Georgia Southern University in August of 1990. In May 1995, he received a Bachelor of Science in Physics from Georgia Southern University and in August 1995, he received a Bachelor of Science in Manufacturing from Georgia Southern University. Following graduation, he worked for Shaw Industries, INC in Andalusia, Alabama for 5 years. In 2001, he resigned from Shaw Industries and entered the Graduate School at Auburn University in the Industrial and System Engineering Department. In 2002, he was also accepted to the Masters of Business Administration program at Auburn University and entered into the Joint Masters Program between the two departments. After completing both Masters degrees in August of 2004, he enrolled in the PhD program in Industrial & Systems Engineering at Auburn University to pursue a research interest in biomechanics related to occupational injury in healthcare.

DISSERTATION ABSTRACT

PATIENT HANDLING: RESTRICTIONS & CONDITIONS

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Doctor of Philosophy, December 17, 2007
(Master of Business Administration, Auburn University, 2004)
(Master of Science, Auburn University, 2004)
(Bachelor of Science in Manufacturing, Georgia Southern University, 1995)
(Bachelor of Science, Georgia Southern University, 1995)

119 Typed Pages

Directed by Robert E. Thomas, Jr.

Injuries to healthcare personnel performing patient transfers are a worldwide problem and have been listed as a primary research interest by the National Institute for Occupational Safety and Health (NIOSH) since the 1980's. Analyses of the last ten years of injury data show that in forty percent of these cases, injury to the back was sustained, and in most cases, patient handling was the primary cause. Research on patient handling has provided valuable insights, but very few of the subsequent interventions have resulted in long-term benefits. Hence, a research idea was developed around a fresh approach, which led to a progressive multi-part study to quantitatively define and test aspects of the patient handling problem. This approach was to structure a study based on the feedback of working nurses, allowing each progressive study to be defined by the previous. The

outcome was a three part study examining conditions and restrictions of patient handling.

The first part of the study was purely descriptive. Its goal was to define and map the direct and indirect variables associated with both the decision making process of the patient handler and the transfer. Interviews, focus groups and published literature were used to define the people and environment of influence. Results mapped 25 variables that directly influenced a patient transfer.

The purpose of the second part of the study was to evaluate the level of importance of most of the previously defined 25 variables. For this purpose, a multi-section survey was developed to collect data from 1000 Alabama nurses who had been registered in the state for at least one year. Results of the 87 completed surveys returned confirm that nursing is a female dominated profession (92%). Analysis of the personal health of Alabama nurses revealed significant deficiencies in three of the eight outcomes measures compared against normative populations: Social Functioning; Physical Functioning; Bodily Pain. Further, the body mass index (BMI) for Alabama nurses indicated only 28% had a "healthy" BMI with 37% and 35% of the nurses being "overweight" or "obese", respectively. Analysis of environment variables showed nurses perceive four types of patient transfers as significantly difficult: floor to toilet, floor to chair, tub to chair or toilet, chair or toilet to tub. Additionally, locations perceived as difficult to perform transfers were the bathroom and a hallway or lobby. Self-reported work measurement showed nurses spend approximately 19 to 20 percent of their time performing patient handling tasks within a safety culture that gives first priority to patient safety. Analysis of factors influencing patient transfers showed that the size and weight of the patient and understaffing were most influential, but the size or shape of the room

and/or congestion of usable space dictated the method of transfer attempted.

Finally in spring of 2007, ten actively working, healthy nurses participated in a biomechanical laboratory study. The objective was to evaluate the level of influence that space restriction has on a patient transfer. Results from previous studies suggested the apparatus should be a hospital bathroom and the event, a floor to toilet transfer. To achieve this objective, a bathroom mockup was built of clear Plexiglas from dimensions provided by a hospital. Patients were simulated by a dummy that had been weighted by body segment to a 5^{th} percentile female. Hence, all protocols and equipment were designed to test the "best case scenario". Data collection was accomplished using a five camera PEAK Motus Motion Capture system with an integrated AMTI forceplate. Results showed that for the environment tested when space was restricted, an average of 14% more time was spent in a medium to high risk postural position for which the average peak moment on the low back was estimated at 2880 N. Hence, this finding suggests that few "real world" floor to toilet transfers would produce low back stress less than the 3400 N limit, where spinal disk damage is known to start. Therefore, mechanical assistance should be required for this transfer. Finally, participating nurses' opinions of the study being representative of actual patient handling events was viewed as positive, receiving an average effectiveness rating of 4.9 on a 6.0 modified Borg scale.

Significance to Healthcare

Nurses constitute the largest proportion of the healthcare industry's workforce. Understanding job factors that impact the health and subsequent working life of this employee group is essential to sustain the contributions of nurses as demands on the healthcare system increase with an aging population.

ACKNOWLEDGEMENTS

The author wishes to thank Dr. Rob Thomas for his insight and direction as dissertation Chair. Thanks to Dr. Jerry Davis, Dr. Troy Blackburn, Dr. Kathy Ellison, and Dr. Kathleen Brown for their responsiveness and expert advice. A debt of gratitude is given to Dr. Saeed Maghsoodloo for his patience, understanding, and dedication in molding individuals such as myself into something better than we were, all the while conveying to us the tools and understanding for future success. In addition, thanks are due to the Deep South Center for Occupational Health and Safety and the National Institute for Occupational Safety and Health (NIOSH) for their funding support. Finally, I wish to thank my family and friends for their constant support and encouragement, especially my parents, grandparents, brother and sister-in-law.

The author wishes to add a special thanks to Dr. Arthur Woodrum of Georgia Southern University for taking a chance on someone when no one else would.

Style manual or journal used:

National Occupational Research Agenda (NORA) Young/New Investigators Symposium, Rocky Mountain Center for Occupational and Environmental Health

American Association of Occupational Health Nursing (AAOHN), American Association of Occupational Health Nurses Inc

Research in Nursing and Health (RINAH), Wiley Periodicals, Inc

Publication Manual of the American Psychological Association (APA), 5th Edition, 2001, American Psychological Association (APA)

Computer software used:

SAS, Minitab, PEAK Motus, Cinema 4D, Microsoft Word, Microsoft Excel and Microsoft PowerPoint

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CHAPTER 1

INTRODUCTION

Irony is defined by Merriam-Webster as “incongruity between the actual result of a sequence of events and the normal or expected result”. This word seems to be an appropriate description of subsequent events befalling many individuals seeking to join the nursing profession whose sole premise is to help others. For more than 5 years, nursing and health workers have been identified annually as having the second highest overall injury and severity rates among listed professions in the United States (US) by the National Institute for Occupational Safety and Health (NIOSH) and the Occupational Safety and Health Administration (OSHA) (BLS, 2000a, 200b, 2005). Current estimates indicate an injury rate of 12.6 injuries per 100 full time workers (BLS, 2004, 2005). The Bureau of Labor Statistics (BLS) reports 42% of all nursing injuries were back related in 2003 (BLS, 2005). Nursing personnel rank second among all occupations filing worker’s compensation claims for back injury (Arad and Ryan, 1986) accounting for 63.1% of the total workers’ compensation costs across several states from 1990 to 1996 (Fuortes et al, 1994; Meyer and Muntaner, 1999), a trend that continues today. So, the question now becomes why so many injuries to the back? Why does this profession have a problem of this magnitude, which has been prevalent for more than 30 years (Hignett, 2003)? A review of literature shows studies evaluating all aspects of healthcare from

psychology of the workplace to biomechanical analysis of a patient transfers with most having produced significant findings and recommendations that seem beneficial. From the nurses' standpoint, they acknowledge there is a problem, and they as a profession have been progressive in the acceptance of new approaches. However, they have seen very little long-term improvements due to intervention (Nelson et al, 2006). It is simply that the problem is complex (Stetler et al, 2003). When examining nursing back injuries, one finds that most of the time, the injury was likely due to cumulative trauma. Trauma resulting over time from multiple different tasks set in a variety of scenarios/conditions, which have finally in one instant takes its toll on this nurse, while performing an everyday routine task. And although literature relating to the analysis of common healthcare tasks performed is in abundance, analysis of the variables that comprise the conditions under which these tasks are performed is not. Therefore, this study aims to examine the most common cause of back injury in nursing, a patient transfer, under the conditions and restrictions around which it is performed based on the input of practicing nurses.

Research Objectives

This research was approached from the standpoint of an outside consultant hired to evaluate a task known to cause on-the-job injuries to a specialized job class, i.e. nurses. For this research, this task was identified as patient transfers. Further, four main objectives were developed to outline the who, what, when, why and how this task is performed. The first objective was to research patient handling to determine the causal factors, influencers and/or conditions, which make this task unique. The second objective

was to define the personal health of the specialized population, both physical and mental. The third objective of this research was to examine the association between patient handling and the healthcare environment and culture. Finally, the fourth objective was to directly sample a patient handling task under the conditions specified by pervious objectives for the purpose of quantifying the conditions.

The first objective involved conducting a descriptive study to define and map the interactions of known variables/conditions that influence, change or control a transfer procedure or task. As with most physical tasks, variables or conditions can be classified as either relating to people or the immediate environment. For patient handling, it was no different, except there are two sets of rules rather than one. This is due to the fact that the item being transferred is not inanimate but a person. Thus general manufacturing industry rules and safety procedures, designed to protect workers performing normal manual material handling tasks (MMH) are not applicable. Healthcare has as many rules/procedures written for the person being transferred as for the person doing the transferring. Hence, the interaction of direct and indirect variables is complex, for which no simple solution exists (Stetler et al, 2003).

The second objective was to define the personal health of the at-risk population. For this, the previously validated SF-36© was chosen in light of its established reputation as a simple but informative survey tool over the last 15 years (Ware & Sherbourne, 1992). Next, a single state, Alabama, was selected to be evaluated. Alabama was selected due to collaborator interest and subsequent follow-on studies to be performed. Finally, defining the at-risk population gave perspective as to how many job classifications were affected by patient handling. Hence, it was decided that not all

classifications could be evaluated given the scope of the study. Therefore, skill level and experience were selected to take precedent. Consequently, only individuals with one year of licensing with the Alabama Board of Nursing, who had a degree of licensed practical nurses (LPN) or higher were included in the potential selection pool.

The third objective of this research was to examine the association between patient handling and the healthcare environment and culture. To accomplish this, a multi-sectional survey was developed from focus group sessions to be sent out with the SF-36© survey. The goal of each section was to gather overlapping specific information using methodologies that would facilitate validation. Categories of data collected were sociodemographics, hierarchy of influence of predetermined environmental factors, use of patient handling equipment, on-the-job safety culture and identification of on-the-job stressors relative to individual nursing tasks.

The final objective of this research was to examine the most influential environmental factors found in the previous objectives. Therefore, a biomechanical laboratory study was developed to investigate the effect of restricting space while performing a patient transfer. Thanks to a grant provided by The American Society of Safety Engineers Foundation (ASSEF) and information from collaborators, an apparatus was developed in a biomechanics laboratory that simulated a working bathroom from dimensions provided by a Missouri hospital. The unique feature of this bathroom was that it was made of Plexiglas to allow for motion capture through the walls. Coupled with a forceplate, this facilitated collection of the dependent variables time, postural assessment and joint moment to evaluate how restricting space affects a patient transfer.

Research Significance

This research will have implications across multiple industries with the most obvious being healthcare. The potential benefit of this research is that it quantified the effects of environmental restriction on a job task, providing a basis for countermeasures to be developed for otherwise potentially negative outcomes. Additionally, other industries and organizations such as mining, energy, firefighters and the military can find crossover benefits from understanding how limiting, restricting, or confining spaces affect job efficiency and inherent jobsite risk.

Dissertation Organization

This dissertation is organized following the manuscript format. The manuscripts constitute the body of the dissertation. Chapters 1 and 6 are a traditional dissertation introduction and conclusion, respectively. Chapter 2, 3, 4, and 5 are stand-alone manuscripts reporting the results and conclusions of this study. Chapter 2 is a descriptive research paper outlining and mapping the known factors which influence patient transfers. Chapter 3 comparatively evaluates Alabama nurses' personal health, both physically and mentally using the SF-36©. Chapter 4 presents the effects of job environment and culture on patient handling as reported by practicing nurses, and Chapter 5 reports the findings of the biomechanical laboratory study examining the effects of space restriction on patient transfers.

CHAPTER 2

DECISION FACTORS IN PATIENT HANDLING

Introduction

Nursing and healthcare workers are annually listed as having the second highest injury and severity rates among listed professions in the United States (US) by the National Institute for Occupational Safety and Health (NIOSH) and the Occupational Safety and Health Administration (OSHA) for better than five years (BLS, 2000a, 2000b, 2005), and are estimated at 12.6 injuries per 100 full time workers (BLS, 2004, 2005). This number is considered to be a low estimate, since underreporting of injuries in nursing is common (USDHHS, 1999). The Bureau of Labor Statistics (BLS) reports show 42% of all nursing injuries were back related in 2003 (BLS, 2005), and nursing personnel rank second among all occupations filing worker's compensation claims for back injury (Arad and Ryan, 1986) accounting for 63.1% of the total workers' compensation costs across several states from 1990 to 1996 (Fuortes et al, 1994; Meyer and Muntaner, 1999), a trend that continues today. Results from over 80 studies across a number of countries indicated that back injury to nurses show a worldwide prevalence of approximately 17 percent (Engkvist et al, 1992, Engkvist, 2006; Gonge et al, 2001; Hignett and Richardson, 1995), an annual prevalence of 40 to 50 percent and a lifetime prevalence of 35 to 80 percent (Hignett, 1996). Overall, there has been a reduction in occupational injury rates

(Murphy and Volinn, 1999), but when work-related injuries for caregivers were examined, no such improvement is noted (Fragala and Bailey, 2003; Nelson et al, 2006). An even greater issue that one researcher found was that only 34% of nurses with back pain actually filed incident reports (Nelson et al, 2006). Further, studies showed 12% of these nurses were contemplating leaving the profession because of occupational hazards (CNA, 2005; Nelson, 2003). Moreover, the high dropout rate of nursing students and decreasing average career life of practicing nurses has created a major shortage in the field. This, in turn, has created higher industry turnover rates and now has prompted a major concern with the 'baby boom' generation getting older. In the United Kingdom (UK), it has been reported that as many as 27% of student nurses who graduate never become registered, with some programs having nearly a 40% dropout rate (Jennings, 2000). The UK national attrition rate in 1996 was 15% (Newton, 1996), and in 2000, the Royal College of Nursing (RCN) stated the number of graduates that had failed to join the nursing register was increasing annually (Sanders, 2000). Similar numbers have been seen in the US.

For the past thirty years, research focused on various aspects of manual techniques and methods to reduce low back injury rates in nurses performing these tasks, has shown to be ineffective in reducing long-term injury rates (Bobick, 2000, Hignett, 1996, Nelson et al, 2006). The last ten years has seen an evolution of devices for assisting nurses and caregivers in patient handling (Charney and Hudson, 2004; Marras, 2005). A review of literature has revealed studies modeling nurses' workload and perceptions (Hignett & Richardson, 1995; Wolf, 2006), analyzing mechanical devices such as slings (Elford et al, 2000, Owen et al, 2002), proposing a comprehensive long term ergonomic

program development and evaluation (Collins et al, 2004, Engkvist, 2006; Nelson et al, 2006; Owen et al, 2002), and biomechanical analysis approaches (Gagnon et al, 1987; Marras et al, 1999a, 1999b, 2000; Caboor et al, 2000; Marris, 2000; Elford et al, 2000; Skotte et al, 2002; Schibye et al, 2003). Upon analysis, the strength of these studies and others is that they approach the same problem from different perspectives of methodology which yield unique solutions to the patient handling problem. The weakness is that none of these studies currently consider the more difficult variables to quantify that affect the patient lift externally, such as restriction of space.

Defining the Problem

In the United States, sprains and strains are very common injuries (Jensen, 1985, 1990a, 1990b), accounting for 85% of all injuries. Moving, lifting and transferring patients, equipment or supplies have been perceived by healthcare workers to be the most frequent cause of back injury (Janizewski & Caley, 1995; CNA, 2005) with as high as 89% of one hospital's claims implicating this cause. Of nursing personnel, nurse assistants, or NAs, were found to be at greatest risk for back problems (Personik, 1990; CNA, 2005) with staff registered nurses, or RNs, running a close second. When examining the issue, the first and obvious solution is not to move patients until they may move themselves. However, having an industry where your product is the well-being of people eliminates this solution. From a medical standpoint, patients must often be moved frequently to prevent skin disorders, muscular contractions, lung congestion, poor blood circulation and other ailments caused by immobility. However, some patients often require assistance in moving about to accomplish routine activates such as (ANA, 2003; Nelson et al, 2003a; Hignett, 2003; CNA, 2005):

- Ambulation (walk about)
- Sitting up in bed
- Turning from side to side
- Moving from bed to chair and opposite
- Moving from bed to wheelchair and opposite
- Moving to or from the toilet (from wheelchair or walk)
- Moving to or from a shower or bathtub (from wheelchair or walk)

When considering both groups of patients needs, common transfers become apparent, Table 1 (Garg et al, 1992; Hignett and Crumpton, 2006; Nelson et al, 2003c).

Table 1

Common list of patient transfers

Patient Transfers		
Bed to Bed	Floor to Chair	Car to Chair
Bed to Chair	Floor to Toilet	Chair to Car
Chair to Bed	Floor to Bed	Chair to Chair
Chair/Toilet to Tub	Chair to Toilet	Gurney to Ambulance
Tub to Chair/Toilet	Toilet to Chair	Ambulance to Gurney

Of these, toileting and bathing transfers are considered the worst, having been ranked in the top six tasks for perceived physical stress (CNA, 2005). The manual lifting on and off toilets and into and out of baths are highly stressful tasks since they require awkward body postures and introduce the possibly of slipping and because they are usually performed in the confined space of a lavatory or bathroom (CNA, 2005). However, the best description of the variables present when bathing a patient was given by Larese and Fiorito (1994) as twisting-turning, lowering, pushing-pulling, prolonged standing, heavy

lifting, frequent lifting, slipping, bending, and lifting (normal). From this list, one can then understand why Caley and Janizewski (1995) stated, “Most back injuries are not the result of a one-time incident but of cumulative trauma caused by three primary categories of factors: general health, organization, and personal factors.” However, these individual categories do not stand alone. Factors interact with multiple others across categories, influencing and ultimately defining the complex tasks known as Patient Handling Operations. Some common factors are (Hignett and Richardson, 1995; ANA, 2003; Lloyd, 2004):

- Physical Space
- Management Support
- Time/Urgency
- Assistance (sought/available)
- Patient (Load) compliance, mobility, size
- Equipment (design, availability)
- Furniture (design, maintenance)
- Caregiver (attitude, experience, training)

Additionally, groups like the Back Action Cooperative (BAC) found that there was no standardization of work environments, especially in home healthcare, and that the lack of room and maneuverability often interferes with attempts to use good body mechanics and equipment (Janizewski and Caley, 1995; CNA, 2005). Other problems resulting from organizational issues can be characterized as mechanical stress of little control over work performed, low status, and anxiety about being held accountable for outcomes not within their control (Janizewski and Caley, 1995). However since 1996, both international and domestic agencies have published guidelines addressing some of these issues. Table 2 shows guidelines by agency, by year.

Table 2

Guidelines relating to patient handling issues

Guideline	Agency	Year
RCN code of practice for patient handling	* Royal College of Nursing (UK)	1996
No Lift, No Injury (Policy)	* Australian Nursing Federation (ANF)	1998
Guidelines for Nursing Homes: Ergonomics for the prevention of musculoskeletal disorders	Occupational Safety and Health Administration (OSHA)	2003
Patient Handling Solutions (2nd Ed.)	Occupational Safety and Health Department of the New York State Public Employees Federation (PEF)	2003
Work techniques in lifting and patient transfers (by Kjellberg)	* National Institute for Working Life (Sweden)	2003
How to Evaluate Safety and Health Changes in the Workplace	National Institute of Occupational Safety and Health (NIOSH)	2004
Designing workplaces for safer handling of patients/ residents. In: Back Injury among healthcare workers	* Victorian WorkCover Authority (Canada)	2004
Overtime and Extended Work Shifts: Recent findings on illnesses, injuries, and health behaviors	National Institute for Occupational Safety and Health (NIOSH)	2004
Back Injury Risk Control for Healthcare Facilities	CNA (commercial insurer)	2005
Safe Lifting and Movement of Nursing Home Residents	National Institute for Occupational Safety and Health (NIOSH)	2006

* International Agency

Finally, when examining the patient handling problem as a whole, even with all the effort, research, collaboration, and developed guidelines, it continues to be a major problem. Many reasons can be given for this, but one of the most obvious is that we still do not understand all of the factors that directly and/or indirectly influence a patient handling lift.

Methodology

A descriptive methodology was chosen to incorporate as much of the complexity and variability of the patient handling setting as possible (Richardson and Hignett, 1994) in an effort to address all factors affecting a patient lift. Using the modified grounded theory method, a model was developed. This model utilized a systematic research approach for the allocation and analysis of qualitative data for the purpose of generating exploratory theory (Chenitz and Swanson, 1986; Morgan, 1997; Bader and Rossi, 2002) and subsequent future research. This was achieved by systematically and intensively analyzing data, often sentence by sentence and phrase by phrase (Strauss, 1987, Morgan, 1997). It relies on structured and unstructured interviews, focus groups, observations and other sources of primary data (Morgan, 1997; Bader and Rossi, 2002), which were obtained by questioning, diagramming and other techniques that have been suggested for participatory ergonomics projects and evaluations (Wilson, 1991, Holman et al, 2006). Additional information included data generated from nurses' perceptions of manual handling operations (Hignett and Richardson, 1995) such as lifting, transferring, and/or repositioning patients relative to personal bodily stress (Nelson, 2003), environmental factors (Hignett and Richardson, 1995; CNA, 2005; Gimeno et al, 2006), and psychosocial risk factors (Devereux et al, 1999, Engkvist, 2006; Hignett and Richardson, 1995). Figure 1 shows the conceptual model for progression of the study, which is similar to the Hignett and Richardson (1995) model:

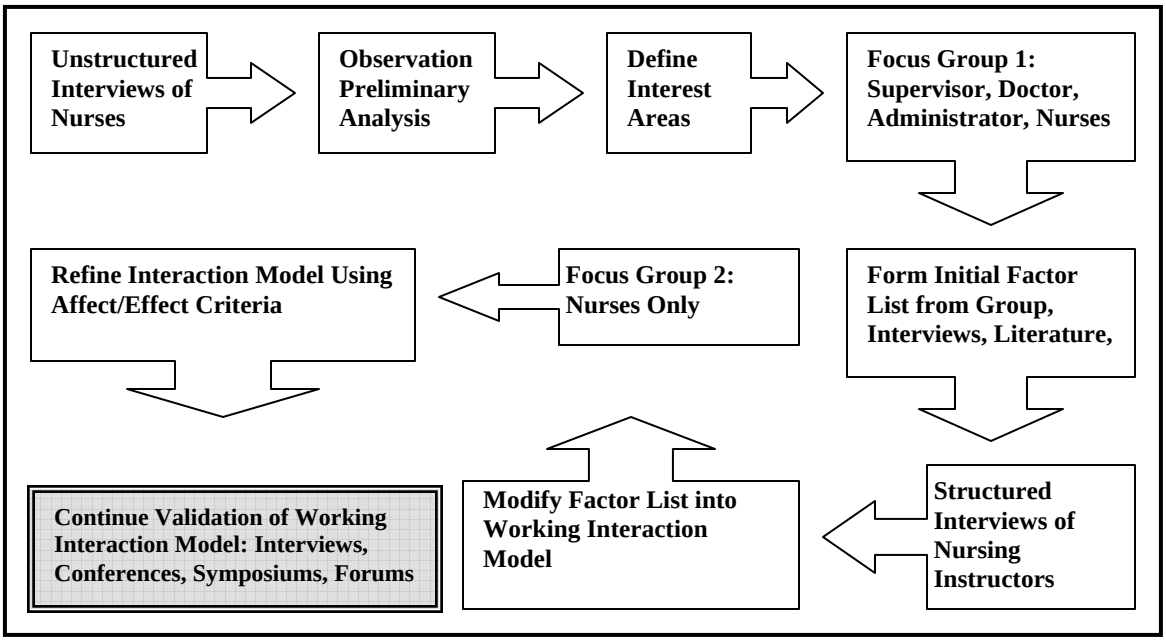

Figure 1: Conceptual model of study progression.

From the model, unstructured interviews were conducted with currently practicing staff nurses, retired nurses, and individuals who were once practicing staff nurses but have completed an advanced degree and since have taken another position within healthcare. Next, observations of two hospitals, a clinic, and a nursing home were performed and assimilated into a series of interest areas for which literature was collected. The first focus group was then conducted with six people, all from different medical organizations: one doctor, one administrator, one nurse administrator (supervisor), and three staff nurses. This group was selected for the specific purpose of open conversation without potential retribution. Therefore, no one within the group had met before or experienced organizational overlap except for meeting the exam or educational requirements of the Alabama Board of Nursing. All personal information was kept confidential. First names and generic position were used during the discussion of

general topic areas relating to patient handling. From this session, an initial factor list was formed and compared against the existing literature for completeness. Structured short interviews were then performed with college nursing instructors from Auburn University and University of Alabama Birmingham regarding current methods taught and soliciting their views concerning influential factors. From this information, the list was modified into an interaction model and Focus Group Two was held using the same criteria as before except all five participants were staff nurses. The purpose of this group was primarily to answer two questions: (1) Is this a valid model; (2) How could continued validation and subsequent quantification of the influencing factors be accomplished. All information was then combined into the current working interaction model, which is still evolving as more information becomes available about the relationship of individual factors to patient handling and each other.

Results

The areas of interest defined early in this process directed this descriptive study. This is because many of the areas have not been previously quantified in literature; and therefore, there was no definite understanding of their true relationship to the patient handling problem. Interestingly, these variables are all openly discussed as major to minor confounders in both general conversation and in journals. Table 3 presents a listing of 16 general areas of interest with brief information focusing on the area's history and multiple factors of influence on patient handling (ANA, 2003; CNA, 2005; Hignett and Richardson, 1995; Lloyd, 2004; Wolf, 2006).

Table 3

General influence areas relating to the patient handling problem with description

Influence Areas	Description
Patient Characteristics	Patient characteristics such as patient height, weight, and body shape become significant factors in the context of patient handling (ANA, 2003; CNA, 2005). Also, the human body has an asymmetric distribution of weight and does not provide stable "handles" to grip its load (Nelson et al, 2003a; Marras, 2005). In some circumstances, a patient can offer limited levels of assistance in moving themselves, i.e. degree of dependence, but depending on their current cognitive state some may have limited or no communication ability causing them to become agitated or combative, ceasing to cooperate (ANA, 2003; CNA, 2005)
Caregiver Characteristics	Sociodemographic variables including age, gender, education, nursing experience, ward experience, history of prior back injury, and nature or cause of the injury were considered (Gimeno et al, 2006). Age and nursing/ward experience have not been found to be significant factors in predicting injury (Fuortes et al, 1994; Engkvist et al, 2000; Engkvist, 2006; Gimeno et al, 2006). Personal risk factors are known to be poor body mechanics, alcohol abuse, smoking, pregnancy, obesity, previous back injury, osteoporosis, poor nutrition, lack of exercise, severe job stress, and emotional home stress (Caley and Jenizewski, 1995).
Quality of Care	The quality of patient care is a topic of great concern with the 'baby boom' generation getting older. Further research is needed to see if the presence of musculoskeletal discomfort in nurses affects quality of patient care (Menzel et al, 2004).
Training	Training should involve learning proper techniques for evaluation and decision making of patient handling situations, proper lifting techniques, and how to utilize patient handling equipment appropriately based on the factors present (Myers et al, 1993, Spratt et al, 1997).
Equipment	Nelson and associates (2006) reported that patient handling equipment was subject rated 96% effective for the applicable situation. There are 11 categories of Patient handling technology (Nelson et al, 2003b; CNA, 2005).

Environmental Characteristics (Physical)	Physical and environmental hazards commonly found in hospitals include slippery floors, electrical hazards, noise, poor lighting, and inadequate ventilation (Triolo, 1989; Hignett and Richardson, 1995). Physical environment such as room dimensions and fixed architectural fittings can pose restrictions on movement and positioning while performing a patient lift (Hignett and Richardson, 1995; CNA, 2005).
Environmental Characteristics (Event/Task)	Several individual patient handling tasks are considered high-risk for producing disorders, such as turning, bathing, or dressing a patient; pulling a patient up in bed; and transferring a patient to a stretcher, bed, chair, or toilet and back (Garg et al, 1992; Nelson et al, 2003c).
Insurance and Accrediting Agencies	Insurance companies, accrediting agencies, federal organizations, and legislative bodies have all started to take roles in patient handling. Consequently, insurance companies have been taking a vested interest in healthcare injuries for years by promoting research and interest in the field and endorsing technology, which can potentially benefit the industry as a whole. They have even, in some cases, tried to dictate healthcare facility policy by requiring the purchase and use of a selected patient handling device for those having policies with them.
Workload and Staffing	A typical nurse's has a patient ratio depending on the care setting ranging from 12 to 1 down to 4 to 1, patients to caregiver (Menzel et al, 2004). This means that on average, the RN was required to refocus attention from one patient to another every 6 to 7 minutes based on workload while being interrupted 3.4 times per hour (Wolf et al, 2006). Routinely, a hospital staff nurse lifts 20 patients in bed and assist 5 to 10 patients with transfer from bed to chair in a single shift (McAbee, 1988).
Work Schedule	Work Schedule in healthcare was described by one group of nurses as 'organized chaos.' Normal schedules have nurses rotating to meet the demand of a 24 hour a day, seven day a week business.
Safety Culture	Safety culture is believed to be a key predictor of safety performance and practice of an organization relative to incident and injury outcomes (Gershon et al, 1995; Gershon et al, 1999; Harvey et al, 2002).
Administration Policy/Program	The international nursing community has long recognized manual patient handling as a significant occupational hazard with the United Kingdom and Australia, having published official stances (ANA, 2003). Reinforcing, the cost-benefit ideology stating that it is much less expensive to implement a comprehensive back injury prevention program than to pay for an employee's rehabilitation from work-related back injuries (Smith, 1995).

Psychosocial	Known psychosocial factors related to nursing are rotational shift work of varying lengths (Triolo, 1989), fatigue (Hignett and Richardson, 1995), physical and/or mental abuse by patients, their family members or the doctors (Estryn-Behar et al, 1990; Hignett and Richardson, 1995), family support (Damkot et al, 1984), cultural differences (Damkot et al, 1984), and caregiver role (Damkot et al, 1984; Estryn-Behar et al, 1990).
Musculoskeletal Injury, Incidence, Disorder	Most work-related musculoskeletal disorders among nursing personnel are back injuries, although they also include neck, shoulder, arm, wrist and knee disorders (Daraiseh et al, 2003, Menzel et al, 2004). Subsequently, 62 to 66 percent of nurses frequently experienced discomfort at or above a moderate severity level in at least one body part (Meyer and Muntaner 1999; Menzel et al, 2004).
Lost Time	Days lost from work due to injury of a specific body part were as follows: shoulders 94 days, knee 76 days, and back 90 days (Meyer and Muntaner, 1999). Overall, 60-70% recover by 6 weeks, and 80-90% by 12 weeks. Recovery after 12 weeks is slow and uncertain. Fewer than half of those individuals disabled for longer than 6 months return to work, with the rate going to zero after 2 years (Helminger, 1997; Andersson, 1999; Lewis, 2002, Menzel et al, 2004). Canadian data shows injury recurrence rates of 20% in 1 year and 36% over 3 years (van Doorn TWC, 1995)
Budgets and Injury Economics	From 1990 to 1996, comparing claims originating from nursing service across several states accounted for 63.1% of the total workers' compensation costs (Fuortes et al, 1994; Meyer and Muntaner, 1999).

Interaction Model

The current working model for interactions includes 25 direct variables shown in Figure 2. This model is condensed for overlapping areas, which was fundamentally reduced to two primary groups, e.g. environment and people, with three areas each. However, indirect variables, which are numerous, have not been entered into the model and are expected to at least double its complexity. Upon completion, the new model should yield a better understanding of the decision process a nurse must go through each time a patient handling activity is performed.

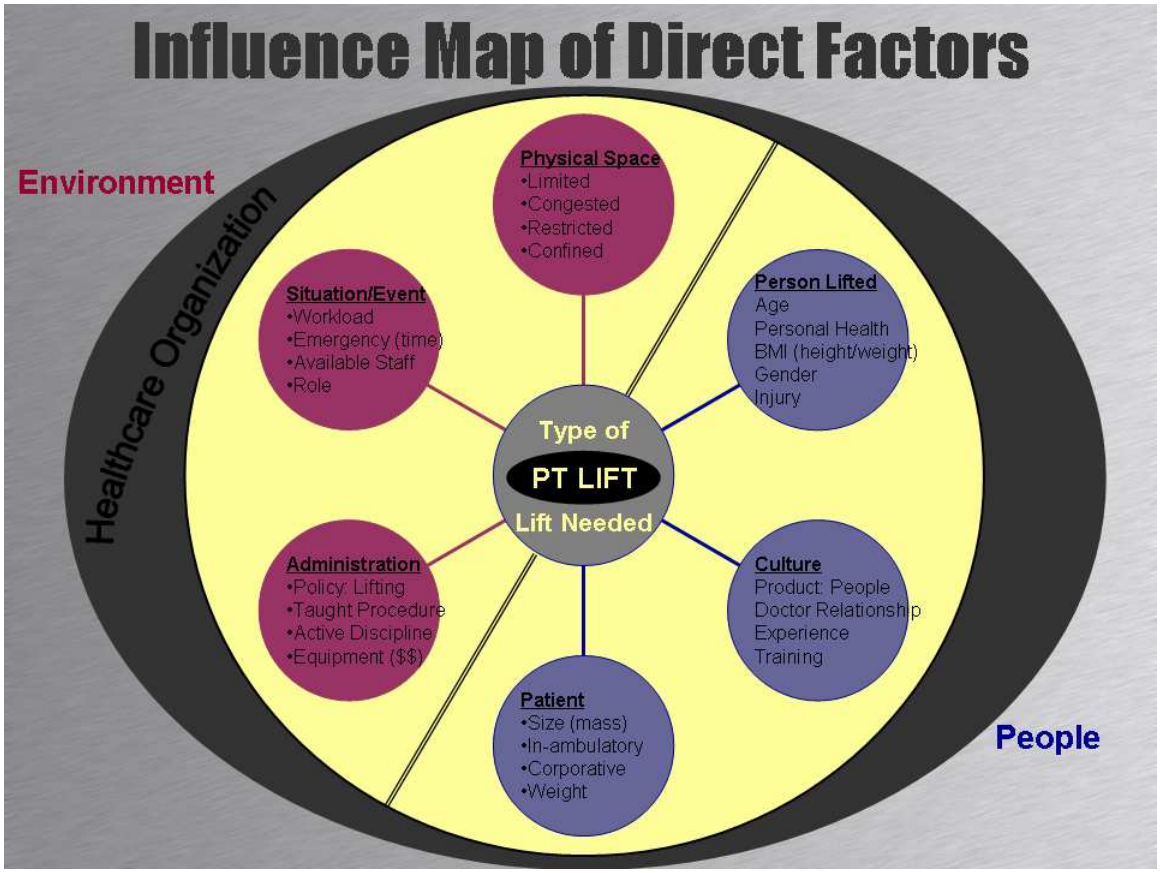

Figure 2: Interaction model of direct variables (Influence Map of Factors)

Discussion

Over the last 30 years, most efforts to reduce work-related musculoskeletal disorders in nursing have focused on body mechanics and lifting techniques. However, these efforts have consistently failed to reduce the risk associated with patient handling and movement (Nelson et al, 2006). Overall there is little to substantiate the continued practice of training in single person manual lifting and handling techniques as it has been the case for many years (Hignett, 1996; Marras et al, 1999b). Consequently, some experts

believe that training in proper body mechanics and patient handling procedures should not be relied upon as the only component of a back injury prevention program (Owen, 1987; Buckle et al., 1992; Corlette et al., 1992, Hignett, 1996). The best currently available solution is patient handling equipment, being widely accepted by both staff and patients. Current studies show that patient handling equipment was rated by caregivers as the most effective aspect of a comprehensive ergonomics program, but it still does not cover all situations (Hignett, 1996; Nelson et al, 2006), leaving manual handling the only option in some circumstances. An example is that there are no viable technology solutions for a high-risk, high volume patient handling task such as repositioning a patient in a bed or chair (Nelson et al, 2006), emphasizing the need for ergonomically designed workplaces and practices (Andersson et al, 1999).

In 2003, Stetler et al. determined that no simple solution or single intervention would be effective in solving the patient handling problem. Consequently, the complex, contextual aspect of the work environment cannot be ignored and has not yet been completely assessed due to a lack of full understanding of all problem variables. Confounding issues, which limit researchers, are (Stetler, 2003; Nelson et al, 2006):

1. Nurses notoriously under-report injuries
2. End points in data collection are difficult to determine due to the length and nature of the injuries
3. Nursing turnover rates impede data collection and skew results
4. Self-reporting is known to allow for under-reporting, omission, and selection bias
5. Rotational floating and schedule change make data collection difficult
6. Exposure in previous jobs (pre-existing injury/ailment) is difficult to assess.

These findings suggest that nurses need additional training to fully understand and participate in ergonomics assessment of their work and environment. Consequently, if any progress is going to be made in the near future, it will be this type of collaboration which allows us to understand the controlling variables associated with restrictions and conditions of patient handling tasks.

Potential limitations

This study was based on a limited population cross-section of healthcare professionals within the state of Alabama. Gender and ethnic representation was not proportional to current U.S. population (according to census.gov). However, representation was proportional to the current gender and ethnic population in healthcare (BLS, 2004) in the state of Alabama (Alabama Board of Nursing, 2005). Additionally, all results were examined against known literature including books, peer-review publications, conference proceedings, and practitioners' magazine and news articles.

Conclusion

Occupational injuries entail great costs for society, employers, and employees (Bigos et al, 1991, Seferlis, 1999, Wolf, 2006). For nurses, injury can be debilitating physically, mentally, and socially, because in 42 percent of the cases, it involves injury to the back, directly attributed to patient handling. In the USA, back pain is the most common cause of activity limitation in people younger than 45 years (Andersson, 1999; Caley and Janizewski, 1995), the second most frequent reason for physician visits behind respiratory infection (Janizewski and Caley, 1995), the fifth-ranking cause of admission to the hospital, and the third most common cause of surgical procedure (Cherkin et al,

1994; Hart, 1995). It is the third leading cause of physical limitations and disability, and annually, back injuries account for approximately 27 million lost workdays (Janizewski and Caley, 1995) with about 2% of the US workforce being compensated for back injuries each year.

In this descriptive study, 25 direct factors that influence patient handling have been mapped through literature, interviews, and focus groups in an effort to understand the magnitude of the problem from a nurse's perspective (Owen, 2004). However, this list is incomplete. Findings suggest that nurses need additional training to fully understand and participate in ergonomics assessment of their work and environment. Consequently, the unique work environment of nurses, combined with high levels of risk and environmental hazards, warrants closer collaboration between ergonomists and direct care providers (Nelson et al, 2006) with the goal of preventing occupational back strain (Fuortes et al, 1994) through better understanding of the variables controlling the restrictions and conditions of patient handling tasks.

Proposed Research

The research proposed here is based on this list of 25 direct variables and seeks to provide two things. One is to develop a hierarchy of importance for the variables, which control a lift. Second is to examine existing deficits in literature beyond technique. Specifically, to understand the effects of space restriction (one variable) on a lift and quantify it in terms of increased risk based on the unobstructed lift. This study was a section of part one of a two part study looking at the restriction and conditions which influence patient handling. The goal was to determine, by setting, the specific conditions or restrictions that confound a patient's lift. From this, a questionnaire was developed and

distributed to determine characteristics, attributes, and weight of these confounders as well as to determine the general health of the nurses taking the survey. These characteristics included both dependent and independent variables for analysis. Independent variables were medical setting, safety aversion, previous on-the-job injury, and availability of patient handling equipment. Dependent variables were location and type of lift, distribution of time, physical restrictions, and influencing factors. The approach used was similar to a Delphi study where known experts are used to develop and guide the study (Last & Fulbrook, 2003). The second step in this study is to examine existing deficits in literature beyond technique. Specifically, the goal is to understand the effects of space restriction (one variable) on a lift and quantify it in terms of increased risk based on the unobstructed lift through a biomechanical laboratory study. This variable was chosen due to its prevalence in interviews and focus groups and its absence in literature. The research is postulated on the belief that quantification of this variable will yield some possible guidance for settings that currently are inappropriate for mechanical assistance when performing a patient lift.

CHAPTER 3

A HEALTH COMPARISON OF ALABAMA NURSES VERSUS U.S., U.K., AND CANADIAN NORMATIVE POPULATIONS

Introduction

The demand for healthcare workers, especially nurses, is becoming critical as the general population is increasing and the current working cohort of nurses is aging. The profile of the American population continues to get older as life expectancy continues to extend (ANA, 2003). The U.S. Census Bureau projected that those aged 65 years and older would comprise an estimated 12.64% of the U.S. population in 2005. This projection also estimated that those 55 years and older would constitute 22.97% of the population (US Census Bureau, 2002) and with respect to healthcare, with increasing age comes declining health and increased need for health care workers. An equally important factor is that an estimated one half of the current nursing population is expected to retire in the next ten years (Berliner & Ginzberg, 2002; Buerhaus, Staiger, & Auerbach, 2003)

The resulting burden that will be placed on an already challenged U.S. healthcare system is now starting to be realized, causing great concern over the future of the healthcare industry to meet the demands for services (Berliner & Ginzberg, 2002; Holman, 2006). General health of the population has become a major health concern, especially issues related to weight. The rate of increase of body mass index (BMI) in the U.S. is so rapid that a new BMI classification, for states, has been added approximately

every three years since 1986 (Marras, 2005; CDC, 2004) with no region of the U.S. being an exception. Increased BMIs of patient populations and increased BMIs of nurses can potentially increase the risk for musculoskeletal injury among nurses. Consequently, concerns over nurses' personal health, fitness for duty, risk of injury and ability to remain in physically and emotionally demanding jobs are now getting national attention. Questions of how and why occupational injuries are occurring, as well as how to address the high occupational burnout rate, are now being debated more than ever. Issues of work environment, job culture and personal health, to name a few, are "hot topics", because of the need to determine why this important group of workers is either leaving the profession early before retirement or is unable to continue to working due to injury.

Currently, 40% of occupational nursing injures are attributed to some type of manual material handling (MMH). In the healthcare industry, this refers to activities such as moving, repositioning and/or transporting of patients, transporting or moving carts or trays, changing or transporting of bulk linen, etc. In 2005, a report issued by CNA (2005), an insurance company, stated that individuals performing patient transfers can have increased susceptibility to back injury or other injury due to personal characteristics. Consequently, characteristics (sociodemographic variables) believed to increase susceptibility include age, gender, education, nursing experience, ward experience, history of prior back injury, and nature or cause of the injury were examined by Gimeno, Fedlknor, Burau, and Delclos (2006). Results demonstrated both age and nursing/ward experience were not significant factors in predicting injury (Fuortes, Shi, Zhang, Zwerling, & Schootman, 1994; Engkvist, Wigaeus Hjelm, Hagberg, Menckel, & Ekenvall, 2000; Engkvist, 2006; Gimeno et al., 2006). However, prevalence of injury

does increase up to age 65 (Andersson, 1999). Gender was also found not to be significant (Fuortes et al., 1994), but this could be skewed by selection bias due to having a limited pool of potential male subjects in a heavily female dominated profession (Garrett, Singiser, & Banks, 1992; BLS, 2004). Finally, obesity was found to be a significant risk factor for back injury with one study stating an odds ratio (OR) as high as 3.2 (Venning, Walter, & Stitt, 1987; Daltroy, Larson, & Wright, 1991; Fuortes et al., 1994). However, since obesity was gauged using only BMI in each of the studies, and BMI is known not be an absolute indicator of health, the actual health of the personnel in the study could not be stated due to no established baseline/reference. Hence, the goal of the study presented here was to gain an understanding of the general mental and physical health of Alabama nurses by comparing them to the general U.S., Canadian, and United Kingdom (U.K.) populations in order to determine a baseline of personal health for this important working class.

Methodology

The objective of this study was to determine and comparatively evaluate the mental and physical health of nurses to known general populations. For this purpose and considering regional components of future related studies, Alabama was chosen to be the testing population. The study was executed using a known survey instrument, i.e. Short Form 36 question (SF-36©, 2006). This instrument was selected due to its established validity and reliability (Ware & Sherbourne, 1992; Mchorney, Ware, & Raczek, 1993; McHorney, Ware, Lu, & Sherbourne, 1994; Ware, Kosinski, & Keller, 1994; Ware, Kosinski, Bayliss, McHorney, Rogers, & Raczek, 1995; Ware & Kosinski, 2005), wide

use (Watson, Firman, Baade, & Ring, 1996; Jenkinson, Coulter, & Wright, 1993; Jenkinson, Stewart-Brown, Peterson, & Paice, 1999; Lyons, Fielder, & Littlepage, 1995; Mishra & Schofield, 1998), and available normative population data: U.S. (Ware & Kosinski, 2005); Canadian (Hopman, Towheed, & Anastassiades, 2000); U.K. (Jenkinson et al, 1993; Jenkinson et al, 1999). The SF-36© is a copyrighted product of QualityMetric Incorporated from which a license was obtained for this study and subsequent publication. The survey is composed of four physical and four mental variables/scales, which are tabulated from the 36 base questions. From these eight combined variables/ scales, a composite physical and mental health score is assessed for the person, group, or population. A breakdown of the SF-36© components by question are shown in figure 3. Additional non-identifiable sociodemographic information was collected including height, weight, age, sex, years of experience, and type of healthcare organization.

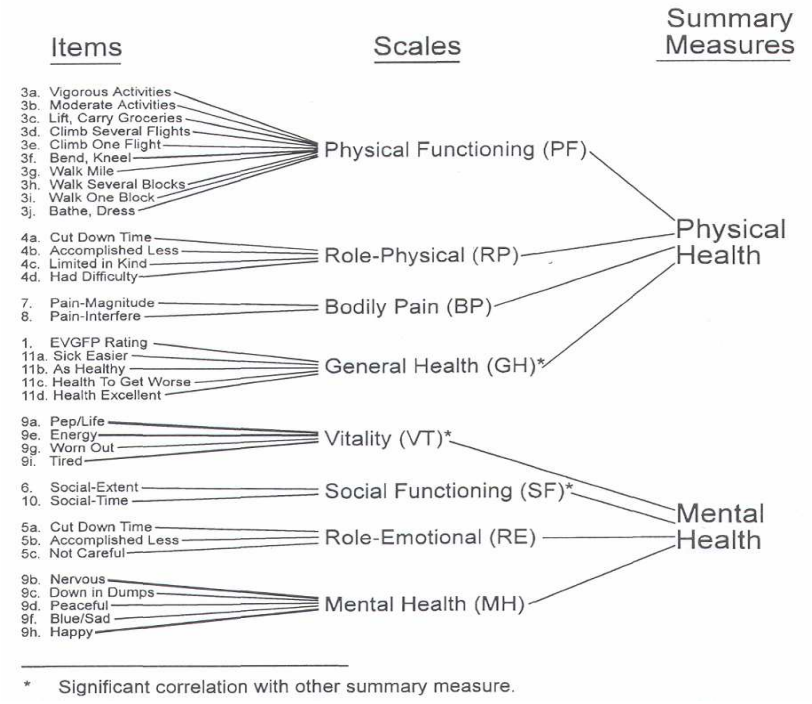

Figure 3: SF-36 Model (Ware & Kosinski, 2005).

Administration of the SF-36© was accomplished via a hard copy mailer with pre-paid self-addressed return envelopes enclosed. Alternate methods of return were via fax or email. A deadline return date of six weeks was placed on the survey. A reminder postcard was sent two weeks after the initial survey mailing, which contained a basic reminder to complete and return the survey and a backup website address. The website was available for anyone who had misplaced their survey for download of an electronic copy. All received surveys were categorized as "anonymous." No returns were received as "confidential" emails.

The health status of registered nurses in Alabama, a state with high cardiovascular and diabetes morbidity rates, was investigated for comparison purposes (UAB, 2003; Gardner, 2007). Alabama ranks number 1 in diabetes. Potential subjects were chosen randomly by computer at the Alabama Board of Nursing from the pool of approximately 49,000 registered nurses in the state of Alabama. Selection was based on one criterion: subjects must have been registered with the Alabama Board on Nursing for at least one year. One thousand nurses were randomly selected. This number was based on the number of returns needed to gain statistical significance relative to the minimum expected return rates, which traditionally are approximately 10% (Nelson, 2005). Approval for the study was received, prior to data collection, from the University's Institutional Review Board (IRB) for Human Subjects in Research.

Results

This study was approved by IRB in October of 2005 and was completed in May of 2006. A total of 101 returns (10.1%) were received with 87 having completed the SF-

36©. All information recorded was categorized as self-reported. To verify that respondents were actively working, data on type of employing healthcare organization were collected. Health status for each subject was assessed using the SF-36© data with all items and scales being scored from 0-100 with 100 being the best possible score. Results were mean age- and gender- standardized and are presented in Table 4. All statistical analyses were performed using SAS® v9.1.3. All data and results displayed in Table 1 are based on nonparametric analysis. Hence, reporting of the percentage of the samples exceeding the upper (ceiling) and lower (floor) 95% confidence interval are displayed in order to gauge the group's distribution. Further analysis by healthcare organization yielded no significant information related to SF-36© data.

Table 4

General statistics of SF-36© scores by age for Alabama nurses (n=87), age- and gender-standardized

Age, Yr	Physical Function	Role Physical	Bodily Pain	General Health	Energy / Vitality	Social Function	Role Emotional	Mental Health	Physical Component Scale	Mental Component Scale
25-34 (n = 5)										
Mean Score	95.0	85.0	82.5	72.0	53.0	90.0	93.3	77.6	53.4	49.9
SD	8.7	33.5	9.8	9.1	12.5	16.3	14.9	13.7	5.7	9.1
95%CI										
% at floor										
% at ceiling										
35-44 (n = 21)										
Mean Score	84.8	88.1	74.5	72.6	55.7	81.5	82.5	76.8	51.7	48.8
SD	24.4	31.2	23.3	25.9	20.0	21.5	30.9	18.8	9.6	9.8
95%CI	73.8-95.7	74.1-100	64.1-85.0	61.0-84.2	46.7-64.7	71.9-91.2	68.6-96.4	68.3-85.2	47.3-56.0	44.5-53.2
% at floor	4.8	9.5	14.3	19.0	14.3	9.5	19.0	23.8	14.3	19.0
% at ceiling	38.1	61.9	28.9	38.1	38.1	42.9	52.4	28.6	28.6	33.3
45-54 (n = 31)										
Mean Score	89.8	86.3	77.1	75.8	63.2	79.0	74.2	76.8	53.6	47.8
SD	13.2	30.8	23.0	17.0	18.2	24.9	40.1	14.0	7.9	10.7
95%CI	85.0-94.7	75.0-97.6	68.6-85.6	69.6-82.0	56.5-69.9	69.9-88.2	59.5-88.9	71.6-81.9	50.7-56.5	43.9-51.7
% at floor	16.1	12.9	38.7	19.4	32.3	32.3	22.6	29.0	19.4	32.3
% at ceiling	48.4	77.4	54.8	35.5	58.1	41.9	64.5	51.6	41.9	54.8
55-64 (n = 30)										
Mean Score	71.5	70.8	66.6	70.2	56.8	75.8	75.6	70.5	47.5	47.9
SD	33.8	44.6	29.9	26.4	24.9	29.5	40.1	21.9	11.9	11.9
95%CI	58.7-84.3	53.9-87.8	55.2-77.9	60.2-80.2	47.4-66.3	64.6-87.0	60.3-90.8	62.2-78.9	43.0-52.0	43.4-52.4
% at floor	30.0	30.0	26.7	33.3	36.7	33.3	26.7	26.7	36.7	30.0
% at ceiling	60.0	66.7	46.7	46.7	46.7	56.7	70.0	46.7	60.0	46.7
All ages (n = 87)										
Mean Score	82.6	81.3	73.2	72.9	58.6	79.2	77.8	74.7	51.0	48.2
SD	25.7	36.6	25.4	22.4	20.6	25.3	36.9	18.2	10.0	10.7
95%CI	77.1-88.1	73.5-89.1	67.8-78.6	68.1-77.6	54.2-63.1	73.8-84.6	69.9-85.6	70.8-78.5	48.9-53.2	45.9-50.5
% at floor	19.5	19.5	36.8	26.4	36.8	28.7	31.0	34.5	26.4	33.3
% at ceiling	62.1	75.9	49.4	52.9	55.2	57.5	69.0	54.0	57.5	55.2

SD = Standard Deviation
CI = Confidence Interval;
Floor = Percentage of sample exceeding lower CI
Ceiling = Percentage of sample exceeding upper CI

Reliability of the data was accomplished using Cronbach Coefficient Alphas and Pearson Correlation Coefficient procedures for each of the eight scale outcomes. In each case, scale outcomes had acceptable raw alpha scores (range 0.7887 – 0.9519). Additionally, the Pearson Correlation Coefficient procedure was also found to have acceptable results in all outcomes.

Following confirmation of validity, the data were stratified for comparison. Examination of the gender distributions revealed a disproportional amount of females

reporting in the study, 92.0%. However, this is consistent with the male to female percentage for the U.S. registered nursing population, which has been reported to be 92.2% females (BLS, 2004). Therefore, in order to achieve an accurate assessment of the current nursing population's health, results of female respondents were analyzed. Subsequently, gender stratification found 80 of the 87 respondents were female. Table 5 shows the female stratified data mean age- and gender- standardized. The number of male respondents yielded a sample size (7) that was too low for further statistical analysis.

Table 5

General statistics of SF-36© scores by age for female Alabama nurses (n=80), age- and gender- standardized

Age, Yr	Physical Function	Role Physical	Bodily Pain	General Health	Energy / Vitality	Social Function	Role Emotional	Mental Health	Physical Component Scale	Mental Component Scale
25-34 (n = 4)										
Mean Score	93.8	100.0	83.8	72.5	52.5	90.6	91.7	76.0	55.1	48.8
SD	9.5	0.0	10.9	10.4	14.4	18.8	16.7	15.3	4.7	10.1
95%CI										
% at floor										
% at ceiling										
35-44 (n = 19)										
Mean Score	83.2	86.8	72.9	70.3	55.3	82.2	82.5	75.6	50.9	48.8
SD	25.2	32.7	23.7	26.1	20.0	21.0	32.1	19.4	9.9	10.0
95%CI	71.0-95.3	71.1-100	61.5-84.3	57.7-82.8	45.6-64.9	72.1-92.3	67.0-97.9	66.2-84.9	46.2-55.7	44.0-53.6
% at floor	21.1	15.8	26.3	31.6	26.3	15.8	26.3	21.1	26.3	31.6
% at ceiling	42.1	84.2	31.6	47.4	47.4	47.4	73.7	31.6	36.8	36.8
45-54 (n = 28)										
Mean Score	89.5	85.7	77.8	76.8	64.1	79.9	77.4	77.4	53.5	48.6
SD	13.5	32.2	23.0	16.7	16.4	23.7	38.5	13.7	8.1	10.2
95%CI	84.2-94.7	73.2-98.2	68.9-86.7	70.3-83.3	57.7-70.5	70.7-89.1	62.4-92.3	72.1-82.8	50.3-56.6	44.6-52.5
% at floor	14.3	14.3	35.7	32.1	28.6	32.1	17.9	32.1	17.9	28.6
% at ceiling	46.4	78.6	57.1	35.7	42.6	42.9	67.9	53.6	39.3	57.1
55-64 (n = 29)										
Mean Score	70.7	69.8	66.2	70.2	56.4	75.9	74.7	70.8	47.3	47.9
SD	34.1	45.0	30.4	26.8	25.2	30.1	40.5	22.3	12.0	12.1
95%CI	57.7-83.7	52.7-86.9	54.7-77.8	60.0-80.4	46.8-66.0	64.4-87.3	59.3-90.1	62.3-79.2	42.7-51.8	43.3-52.5
% at floor	31.0	31.0	27.6	27.6	37.9	34.5	27.6	27.6	37.9	27.6
% at ceiling	58.6	65.5	48.3	48.3	44.8	58.6	69.0	48.3	58.6	48.3
All ages (n = 80)										
Mean Score	81.4	80.9	72.7	72.6	58.6	79.5	78.3	74.5	50.7	48.4
SD	26.4	37.4	25.9	22.8	20.8	25.3	36.8	18.5	10.2	10.7
95%CI	75.5-87.2	72.6-89.2	67.0-78.5	67.6-77.7	54.0-63.3	73.9-85.1	70.2-86.5	70.4-78.6	48.4-53.0	46.0-50.8
% at floor	21.3	20.0	37.5	27.5	36.3	28.8	30.0	35.0	26.3	32.5
% at ceiling	60.0	76.3	50.0	53.8	56.3	57.5	70.0	53.8	57.5	56.3

SD = Standard Deviation
CI = Confidence Interval
Floor = Percentage of sample exceeding lower CI
Ceiling = Percentage of sample exceeding upper CI

Results for the female data were then tested against the most current known normative population data, which were collected from 1998-1999 (Jenkinson et al, 1993; Jenkinson et al, 1999; Hopman et al., 2000; Ware & Kosinski, 2005). The two additional comparison populations were chosen for several reasons:

1. The UK and Canada are socially similar to the US.
2. Population data were published and readily available.
3. Through research, literature, and industry (healthcare) benchmarking sessions, many of the same problems in nursing were shown to exist in all three countries.
4. Given the mutual similarities/status, it is reasonable to make comparisons between the health of U.S. Alabama nurses and U.S, Canadian, and U.K. normative populations in that each has been under a modern healthcare system for many years. Additionally, minor differences were expected in each country's population data due to cultural and healthcare system differences. However, none were found to be significantly different.

Figure 4 illustrates the eight outcome scores for female Alabama nurses compared to the U.S., Canada, and U.K nursing populations.

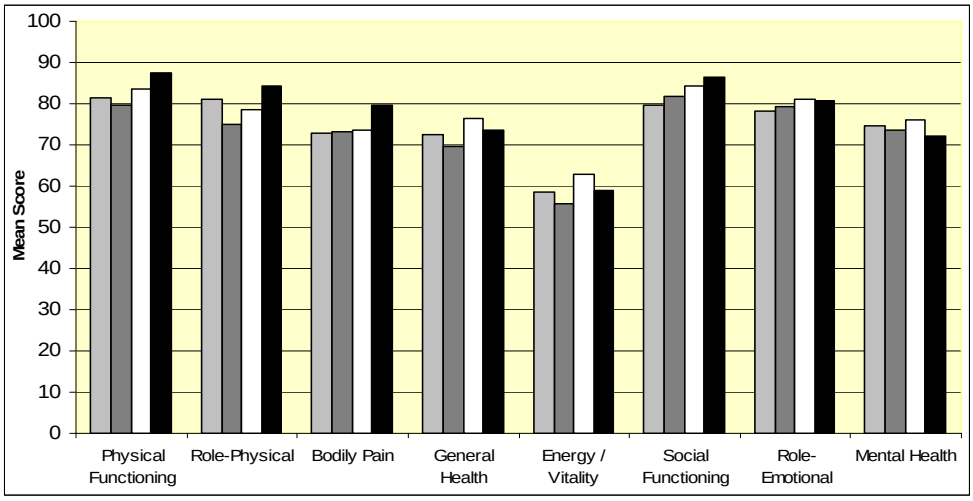

Figure 4: Female Alabama nurses (light gray) compared with normative female US (medium gray), Canadian (white), and UK (black) populations.

Deviations from the normative populations were then examined using Z-statistics at a significance level of 0.05. Results showed three outcomes to be significant: physical functioning, bodily pain, and social functioning. For each of these outcomes shown in Table 6, the t-value indicated female Alabama nurses in this study had worse health than one or more of the normative female populations of significance. For each outcome, the associated *t-value* and *p-value* for the population are displayed. Further, Table 3 gives a stratified breakdown of the three outcomes by age in order that individual differences may be seen.

Table 6

Significant Comparisons of female Alabama nurses to US, Canadian, and UK female populations by age

Social Functioning

Age	Alabama Nurses (Comparison Group)	United Kingdom (t_o = 2.58, p = 0.012)
25-34 years*	90.6	87.7
35-44 years	82.2	86.7
45-54 years	79.9	87.0
55-64 years	75.9	85.9
All Ages	79.5	86.6

Physical Functioning

Age	Alabama Nurses (Comparison Group)	United Kingdom (t_o = 2.47, p = 0.016)	Canada (t_o = 2.29, p = 0.025)
25-34 years*	93.8	92.9	90.9
35-44 years	83.2	89.4	90.1
45-54 years	89.5	84.8	86.6
55-64 years	70.7	74.8	79.9
All Ages	81.4	87.5	83.5

Bodily Pain

Age	Alabama Nurses (Comparison Group)	United Kingdom (t_o = 3.68, p < 0.001)	United States (t_o = 2.12, p = 0.037)
25-34 years*	83.8	82.1	79.6
35-44 years	72.9	79.4	74.9
45-54 years	77.8	77.4	72.1
55-64 years	66.2	75.0	66.6
All Ages	72.7	79.5	73.3

* The size of sample (n) was not large enough to support any conclusions

Discussion

The goal of this study was to evaluate the health of one group of nurses compared to the U.S., Canadian, and United Kingdom (U.K.) populations to determine a baseline of overall health. For this purpose, a survey was administered to collect mental and physical health information with sufficient sociodemographic information to stratify the results.

Results confirmed nursing is a female dominated profession in Alabama and in the U.S., 92%. Comparisons to the most current available U.S., Canadian, and U.K. populations found health deficiencies in outcomes of physical functioning, bodily pain, and social functioning among Alabama nurses relative to these normative populations, particularly in the 35-44 year age group. Further, although this group had consistently poorer health in all three outcomes, specifics as to why this occurred have yet to be determined. Upon discussions with research members and focus groups, plausible but not verified reasons for the reduced health status are:

1. Most nurses' initial jobs out of school have been shown to be heavily slanted toward patient handling tasks, which become less frequent as they become more integrated into all aspects of healthcare either by seniority or qualification. Since physical stress associated with patient transfer, a manual material handling activity, is known to be cumulative in nature, the reduced physical health and bodily pain seen in respondents age 35-44 could be a result of the effects of cumulative physical job stress.
2. The health of nurses follows the same declining trend in physical fitness of the US population reported by numerous public health organizations (Mokdad, Marks, Stoup & Gerberding, 2004; Sturm, 2005). Hence, nurses may be less physically fit than those in previous decades and/or generations, possibly resulting in a quicker decline of physical health in early to middle-age adulthood. Results seen from this type of trend could potentially correspond to lower physical, mental and social function of the individual and could explain Table 6, which shows respondents in

the 35-44 age group as the only group that is consistently lower in all three significant outcomes.

3. Another possible explanation for the decline in health status in this age group may be attributed to the demands of work and family. Nurses may become overwhelmed by the pace and hours (12 hour shifts) in combination with family responsibilities for young children that are common in this age group. This could result in stress, which has been shown to cause a variety of personal issues both mental and physical.
4. In addition, the increased Body Mass Index (BMI) found in all ages in the US since 1986 are considered strong predictors of the nation's overall health and fitness by many public health professionals. Hence, two decades of data show a constant decline of health in the US. This trend was also seen in many of the stratified age groups of nurses during this study. Some supporting data for this relationship can be seen in Table 7, where subjects' BMI have been stratified by age. In both the total group and the female participants, the age group 35-44 years shows the highest average BMI. Additionally, this group also has the lowest percentage of "healthy" individuals and the highest level of obesity. Perhaps nurses in this age category have multiple responsibilities at home and work and are unable to attend to their own health and fitness needs.

Table 7

Alabama nurses Body Mass Index (BMI) from self-report height and weight by age by category.

All Subjects

Age	Average BMI (SD)	Total Count (not reporting)	Counts by Category			
			Healthy "18.5-24.9" (%)	Overweight "25.0-29.9" (%)	Obese "30.0-39.9" (%)	Extremely Obese "≥40" (%)
25-34 years*	28.88 (7.28)	5 (0)	1 (20%)	2 (40%)	1 (20%)	1 (20%)
35-44 years	29.78 (6.89)ǂ	20 (1)	4 (20%)	7 (35%)	8 (40%)	1 (5%)
45-54 years	27.07 (5.34)	28 (3)	11 (39%)	10 (36%)	6 (21%)	1 (4%)
55-64 years	29.03 (5.63)	26 (4)	6 (23%)	10 (38%)	9 (35%)	1 (4%)
All ages	28.52 (5.97)	79 (8)	22 (28%)	29 (37%)	24 (30%)	4 (5%)

ǂ 2002 US average 28.0 (CDC, 2004)

Female

Age	Average BMI (SD)	Total Count (not reporting)	Counts by Category			
			Healthy "18.5-24.9" (%)	Overweight "25.0-29.9" (%)	Obese "30.0-39.9" (%)	Extremely Obese "≥40" (%)
25-34 years*	26.02 (4.00)	4 (0)	1 (25%)	2 (50%)	1 (25%)	0 (0%)
35-44 years	29.92 (7.17)§	18 (1)	4 (22%)	6 (33%)	7 (39%)	1 (6%)
45-54 years	27.16 (5.41)	27 (1)	10 (37%)	10 (37%)	6 (22%)	1 (4%)
55-64 years	29.13 (5.73)	25 (4)	6 (24%)	9 (36%)	9 (36%)	1 (4%)
All ages	28.44 (5.96)	74 (6)	21 (28%)	27 (37%)	23 (31%)	3 (4%)

* The number of sample (n) is not large enough to support any conclusions
§ 2002 US average 28.2 (CDC, 2004)

Potential limitations

This study was based on a self-selected limited population cross-section of 87 nurses of a possible 1000 nurses, which had been randomly selected from the pool of 49,000 nurses registered/licensed in the state of Alabama. With 87 participants, the minimum sample needed to insure statistical power for the unstratified (population) results was achieved. However, stratified results did not reach the minimum sample size for all groups to support definitive conclusions about relationships between groups. Specifically, since the 25-34 age group did not have sufficient response to support

individual or comparative analysis to other stratified groups, the speculative reasons in the discussion remain tentative. Therefore, additional research is obviously needed to further address and/or clarify these preliminary findings. The findings do, however, raise serious concerns about the health of the nursing workforce in general and their ability to continue delivering healthcare to an aging population.

Other limitations and concerns related to self-reporting (Garrett et al., 1992, Holman, 2006) include: (1) low response rates, which raise a question of whether "selection bias" has occurred, since only 5 nurses responded in the 25-34 age group; (2) the possibility of omissions in self-reported data questions thus impacting accuracy and completeness; (3) response bias, which is a known issue with performing surveys in healthcare. Specifically, problems known to exist with surveying nurses relate to under-reporting injuries and events leading to injury have been widely reported in multiple studies (Stetler, Burns, Sander-Buscemi, Morsi, & Grunwald, 2003, Nelson et al., 2006).

Conclusion

The Alabama nurses' scores presented here for the eight outcomes and two summary measures of the SF-36© are similar to the normative nurse population data for the US, Canada and UK. However, three of the eight outcomes showed a significant difference between Alabama nurses and at least one of the normative population groups, and in each case, Alabama nurses had significantly worse health. For the areas which differ, each seems to be potentially linked to common physical stressors found in healthcare settings (Holman, 2006) and their cumulative effect. For example, frequent patient transfers and/or heavy lifting (greater than 50lbs or 22kg) could potentially result

in greater bodily pain than normally experienced by the average person. However, other results show personal health factors such as BMI for Alabama nurses have the same increasing trend as the general U.S. population, thus questioning the amount of increased risk for injury a nurse has due to personal characteristics. Hence while only future research can answer that question, this study does provides some limited insight into the health of a segment of the nation's nursing population. The findings raise serious concerns about the health of the nursing workforce in this sample and their ability to continue delivering healthcare over time. Administrators and policymakers need to consider the importance of the findings as they relate to nurse retention. Influences on health status need to be discussed. For example, the twelve hour shift, which is the common shift schedule in nursing, requires extended professional decision-making, physical and emotional demands that may impact health. Shift-work also influences social functioning of workers (Monk & Folkard, 1992; Costa, 2003). An aging nursing workforce may not be willing to risk injury and negative influences on health status associated with the demands of the profession. Alternative shift schedules with fewer hours and careful consideration of the demands of nursing jobs should be topics of discussion in all institutions interested in proper placement of their nurses for nurse retention.

One recommendation for nursing education involves the need to provide essential instruction to students on maintaining their health as they perform in their chosen career. Education is needed not only with regards to critical thinking and decision making in the professional nursing role but also in how to manage personal mental and physical health as related to the everyday rigors of their future jobs. Simply, education should provide

realistic information on the job requirement, possible impact on physical, mental and social functioning, and the appropriate coping tools.

The future role of the healthcare industry in the U.S. will only increase as the population ages. Therefore, it is essential to understand issues related to health status of the major employee group, i.e. nurses, in order to sustain the consistent, uninterrupted contributions of these workers over their careers.

Future Research

This study has shown significant differences among nurses from three different general populations, but it questions if this difference is uniform throughout the U.S. Additionally, questions have been raised as to the level of influence a nurse's personal characteristics have in on-the-job injury. In each case, future research is needed to define and understand associated personal and environmental risks to prevent occupational injury and illness and burnout. Finally, research is needed to explore the three outcomes for which nurses in this sample were shown to have a reduced health status. Only through further research to define the specific influencing factors affecting these outcomes can proper countermeasures be developed and subsequent policy and procedure recommendation be made for improving overall health status of this valued group.

Acknowledgments

This study is a collaboration of: Auburn University Department of Industrial & Systems Engineering, Auburn University School of Nursing, the School of Nursing at the University of Alabama Birmingham, University of North Carolina Department of Exercise and Sport Science, and the National Institute of Occupational Safety and Health

(NIOSH) Deep South Educational and Research Center, NIOSH Grant 5 T42 OH008436. Funding for this study was provided in part by a grant from the American Society of Safety Engineers Foundation (ASSEF).

CHAPTER 4

THE EFFECTS OF JOB ENVIRONMENT AND CULTURE ON PATIENT HANDLING: A NURSES PERSPECTIVE

Introduction

In the United States, sprains and strains are very common workplace injuries (Jensen, 1985, 1990a, 1990b), accounting for 85% of all injuries, and are frequently associated with the back. In healthcare, moving, lifting and transferring patients, equipment or supplies have been perceived by healthcare workers to be the most frequent cause of back injury (Fuortes et al, 1994; Janizewski & Caley, 1995; CNA, 2005) with up to 89% of one hospital's claims indicating this cause. Nurses exposed to these types of job demands had a 26% higher risk of injury than those unexposed (Gimeno et al, 2006). Among nursing personnel, nurse assistants, or NAs, were found to be at greatest risk for back injury (Personik, 1990; CNA, 2005) with registered nurses, or RNs, a close second. In 1985, Patterson et al. (1985) stated that "most (back injuries) frequently occur while personnel are manipulating patients or equipment", a trend that continues today. So why has this problem persisted for more than 20 years? Most experts believe it is due to the multitude of complex factors, both direct and indirect, which must be assessed and balanced simultaneously. For example, organizational risk factors include type of healthcare setting (homecare, assisted living, emergency department, geriatric unit, operating room suite, medical-surgical unit, critical care, etc.) due to their direct association with job specific tasks, as well as, environmental conditions (Gimeno et al,

2006). Further, physical and environmental hazards are also commonly found in hospitals and include slippery floors, noise, poor lighting, and inadequate ventilation (Triolo, 1989; Hignett & Richardson, 1995). The physical environment of care can also pose restrictions on managing a patient's care. Depending on the care setting (e.g., standard hospital patient room, skilled nursing facility, etc.), nursing staff must work within the constraints of the physical area in order to perform patient handling tasks. This is commonly referred to as a 'space limitation' and is common in healthcare settings. Space limitation can be caused by numerous things but the most common are room dimensions and fixed architectural fittings, such as walls, cubicle rails, and floors (Hignett & Richardson, 1995, CNA, 2005). The result is that nurses may be forced, because of limited space to work in awkward and twisted postures. Hospital furniture and equipment, as well as, the presence of other hospital staff can create barriers that restrict movement (ANA, 2003). Additionally, congestion plays a similar role. Typical items found to cause congestion were: tables, wardrobes, trolleys, wheelchairs, and commodes (Hignett & Richardson, 1995). Other factors which contribute to the difficulty of managing a patient, particularly with tasks requiring lifting, transferring, and/or moving, i.e. patient handling, include the size and weight of the patient, combativeness, propensity for the patient to fall, and a 90% female nursing staff (BLS, 2004; CNA, 2005; Nelson et al, 2006).

In 2003, Stetler et al. determined that no simple solution or single intervention would be effective to solve the complex problem of patient handling. For this reason, many multi-level prevention programs have been, or are being, introduced around the world to avoid or decrease the manual lifting of patients. Administrative support for these programs is high due to the cost-benefit perspective that it is much less expensive to

implement a comprehensive back injury prevention program than to pay for an employee's rehabilitation from a work-related back injury (Smith, 1995). Additionally, the cost and comprehensiveness of a program seems to be dictated by the type of healthcare organization. Of the injury prevention programs sampled, most were based on different concepts/approaches but were more or less comprehensive (Hignett, 2003; Nelson et al, 2006) in order to allow for not only horizontal implementation in the organization but vertical as well. However, a common flaw exists with the programs examined. They do not take into account the 'hierarchy of influence' of how the type of organization, job environment, current situation, or safety culture influences how handling situations will be managed (Holman, 2006). Therefore, the purpose of this study was to determine the hierarchical effects of organization, environment, and safety culture on patient handling from a nurse's perspective.

Methodology

For this research, a survey instrument was developed for nurses from multiple focus groups and individual interviews of various healthcare personnel (Holman, 2006). Similarly, this approach follows a Delphi study where known experts (nurses) were used to develop and guide the study (Last & Fulbrook, 2003). The instrument was then piloted and refined over a period of six months to its final form. Primary information/questions meant to be answered with the instrument are:

1. What are the most difficult patient transfers performed?
2. Where are the most difficult locations to perform a transfer?
3. Who is performing these transfers?

4. What type of safety culture is present in nursing?
5. Why would a nurse choose to not use patient transfer equipment?
6. What are the most influential factors controlling a patient transfer?

The survey instrument utilized collection methods associated with multiple choice, ranks, True/False, weighted comparison, and self-reported work measurement. Instrument validation was determined using Pearson Correlations and Cronbach's Coefficient Alpha for three outcomes: safety culture, work environment, and influencing factors. For which, three to five items/questions were scored for each outcome. Additional sociodemographic information was collected including height, weight, age, gender, race, certificate/degree, years of experience, and type of healthcare organization. Administration of the survey instrument was accomplished via a hard copy mailer with pre-paid self-addressed return envelopes enclosed. Alternate methods of return were fax or email. A deadline return date of 6 weeks was placed on the survey. A reminder postcard was sent two weeks after the initial survey mailing, which contained a basic reminder to complete and return the survey and a backup website address. The website was available for anyone who had misplaced their survey to download an electronic copy.

Potential subjects were chosen randomly by computer from a pool of approximately 49,000 registered nurses in the state of Alabama. Selection was based on one criterion: subjects must have been registered with the Alabama Board on Nursing for at least one year. One thousand nurses were randomly selected. This number was based on the number of returns needed to gain statistical significance relative to the minimum expected return rates, which traditionally are approximately 10% (Nelson, 2005). Approval of the study was received from the University's Institutional Review Board

(IRB) for Human Subjects in Research.

Results

A total of 101 questionnaire returns (10.1%) were received with 86 having completed all sections. All information recorded was categorized as self-reported. All items and scales were scored from 0-100 with 100 being the best possible score. General sociodemographics of respondents were viewed as normal with gender and age distributions being equivalent to both the state of Alabama and U.S. statistics (BLS, 2004). Table 8 shows the distribution of sociodemographic data.

Table 8

Sociodemographics of responding Alabama nurses (n=86)

Age, Yr (%)	*Gender (%)	Race (%)	License/Degree (%)	Experience, Yr (%)	Healthcare Organization (%)
20-29 (5.9%)	Male (7.0%)	Caucasian (91.9%)	ADN (37.2%)	0 to 1 (2.3%)	Hospital (64.0%)
30-39 (24.4%)	Female (93.0%)	African-American (7.0%)	BSN (32.6%)	2 to 3 (9.3%)	Outpatient Clinic (9.3%)
40-49 (34.9%)		Hispanic (1.1%)	MSN (12.8%)	4 to 6 (4.7%)	Rehabilitation Clinic (1.1%)
50-59 (24.4%)			Other (17.4%)	7 to 9 (10.4%)	Homecare / Hospice (9.3%)
> 60 (10.4%)				10+ (73.3%)	Other (16.3%)

* Note: the 2004 BLS showed 92.2% of nursing personnel were female

Validation of the survey instrument was accomplished using Cronbach's Coefficient Alpha and Pearson Correlation Coefficient procedure for each of four scale outcomes. In each case, scale outcomes had a low but acceptable raw alpha score (range 0.63 – 0.66). Normal range for Cronbach's Alpha is from 0 to 1. Low alphas occur when grouped responses to similar questions do not correlate, which in this case was considered to be a product of the range of healthcare settings reported. Specifically, healthcare setting is important when considering environmental factors for nurses, a point that is illustrated

throughout this paper. Additionally, the Pearson Correlation Coefficient procedure was also found to have acceptable results in all outcomes.

Following confirmation of scale reliability, the data were analyzed as a population and then stratified for sample comparison. Items examined include type of transfer, location of transfer, factors considered when transferring, reasons not to use patient handling equipment, and general questions about job safety culture. Responses given for items were Yes/No, rankings (rank order), or weighted value using a six point Borg scale. Hence, statistical methods for analyzing responses included both parametric and nonparametric tests. Tests were performed at a significance level of 0.05.

Results for the types of transfer considered to be the most difficult yielded a rank order of the 12 most common transfers, which were identified by focus groups prior to survey development. Analysis was done using a Kruskal-Wallis Test to determine overall significance ($H = 374.33$, $p < 10^{-16}$) with a post ANOVA to determine hierarchy and groups of related transfers, i.e. task or items that had similar responses and considered to be associated based on their importance to nurses. These groups are denoted by connected arrows in the following tables. A Z-statistic of the rank and variance was then used to show which transfers deviated from the average cumulative rank. Results showed four of the transfers were considered to be significantly more difficult than the other eight for both combined and stratified responses. Interestingly, three of these four are attributed to bathroom transfers. Table 9 gives an assessment of each transfer with a rank of 1 being most difficult. Stratified assessment of the transfers by healthcare organization yielded minor differences but no significant changes to the results. For the table, the associated *z-value* and *p-value* for significant transfers are displayed along with the post

ANOVA groupings.

Table 9

Alabama nurse's average ranked response of most difficult transfer to perform.

*Group	Transfer	^All Respondents, Average Rank (n = 86)	Median Rank	Composite Rank
	Floor to Toilet	2.32 (z = -10.39, $p < 10^{-24}$)	1	1
	Floor to Chair	3.12 (z = -8.14, $p < 10^{-15}$)	2	2
	Tub to Chair/Toilet	3.98 (z = -5.75, $p < 10^{-8}$)	3	3
	Chair/Toilet to Tub	5.02 (z = -2.93, p = 0.002)	5	4
	Car to Chair	5.62	6	5
	Chair to Car	6.10	6	6
	Toilet to Chair	6.53	7	7
	Chair to Toilet	6.67	7	8
	Chair to Bed	7.57	9	9
	Bed to Chair	8.86	9	10
	Chair to Chair	8.98	11	11
	Bed to Bed	9.32	12	12

* Kruskal-Wallis post ANOVA Groupings, $\alpha = 0.05$

^ Z-statistic (one-sided), $\alpha = 0.05$

The next item examined was how much does the location of the transfer change the difficulty of the task. For this, six locations were ranked based on the focus groups. Of the six, two were considered to be a more difficult location to perform a transfer by Alabama nurses ($H = 112.56$, $p < 10^{-16}$). Table 10 gives both an assessment of each

transfer location with a rank of 1 being most difficult. Similar to transfers, stratified assessment of locations by healthcare organization yielded minor differences but no significant changes to the results. For the table, the associated *z-value* and *p-value* for significant transfers are displayed along with the post ANOVA groupings.

Table 10

Alabama nurse's average ranked response of most difficult location to perform a patient transfer.

*Group	Location	^All Respondents (n = 86)	Median Rank	Composite Rank
●→	Bathroom	1.98 (z = -8.18, $p < 10^{-15}$)	1	1
●→	Hallway / Lobby Area	2.64 (z = -4.07, $p < 10^{-4}$)	2	2
→	Patient's Room (Main)	3.73	3	3
→	Trauma Unit / ICU	3.75	4	4
→	Emergency Room	3.77	4	5
●→	Operating Room	4.49	5	6

* Kruskal-Wallis post ANOVA Groupings, $\alpha = 0.05$

^ Z-statistic (one-sided), $\alpha = 0.05$

After determining which transfers and locations were believed to be the most problematic for nurses, attention was focused on the question of how much patient handling is involved in a typical nurse's workday. From the focus groups and one-on-one interviews, it was determined that this varies depending on education level and associated position in their respective organizations. However, an effort to capture this information by allowing nurses to self-report the percentage of their workday spent on seven tasks

commonly associated with nursing. Additionally, a catch all category, “other”, was employed to allow for 100% of a day to be reported. Table 11 presents the distribution of responses by both nursing degree and healthcare organization. Further analysis of table 4 yields three points of interest, the first is that most nurses will spend approximately 20% of their day performing tasks traditionally associated with patient handling. The second is nurses with a MSN or higher spend approximately half as much time as other nursing personnel doing tasks traditionally associated with patient handling. Finally, the amount/frequency of tasks traditionally associated with patient handling seems to be a substantially less outside of hospital settings/organizations.

Table 11

Average percentage distribution of time spent on common nursing tasks by Alabama nurses.

Task	All (n = 86)	By Degree				By Healthcare Organization	
		ADN (n = 32)	BSN (n = 28)	MSN or Higher (n = 11)	Other (n = 15)	Working in Hospitals (n = 55)	Working in other Healthcare Settings (n = 31)
Administrative (filling, charting, etc.)	27.01%	27.97%	26.04%	32.27%	22.93%	26.04%	28.74%
Administering Medication	18.78%	24.38%	13.57%	13.00%	20.80%	19.24%	17.97%
*Toileting / Bathing Patient	6.01%	6.59%	6.04%	3.64%	6.47%	8.56%	1.48%
Responding to Calls	12.22%	11.38%	11.86%	10.91%	15.67%	12.09%	12.45%
Responding to Emergencies	5.85%	7.47%	6.50%	4.64%	0.87%	7.89%	2.23%
*Transporting Patients	5.02%	5.66%	5.86%	2.45%	4.00%	6.22%	2.90%
*Moving / Repositioning Patients	8.44%	9.34%	7.86%	5.64%	9.67%	11.22%	3.52%
Other	16.67%	7.21%	22.27%	27.45%	19.59%	8.74%	30.71%
+Tasks Associated with Patient Handling	19.48%	21.59%	19.75%	11.73%	20.13%	26.00%	7.90%

* Tasks traditionally associated with patient handling

+ Task/Item is the sum of tasks traditionally associated with patient handling

Following quantification of the hierarchy and daily magnitude of transfers and locations, questions regarding safety culture among nurses were addressed. For this, questions were asked in such a way as to avoid the standard status-quo response. This technique was necessary since nurses know from experience, education, and facility safety programs what they should do in most circumstances. However, procedures, circumstances, physical environment and personnel available do not always make this possible. Therefore, they were asked hypothetically about decisions they would make given circumstances or about their personal beliefs concerning patient handling or general safety. Responses to these questions were insightful about the internal safety culture of Alabama nurses. Table 12 gives a listing of True/False questions and the distribution of responses.

Table 12

Response distribution to True/False questions relating to the internal safety culture of Alabama nurses.

Category	Question	True	False
General Safety	I consider myself a responsible, safety conscious person	100.0%	0.0%
General Safety	I wear my seat belt 100% of the time	71.6%	28.4%
Situational	I place my patient's safety above myself in most circumstances	85.7%	14.3%
Opinion	Strains, sprains, and sore backs are just part of the job (nursing)	40.5%	59.5%
Actual	Have you ever had a back or shoulder patient handling injury on the job	43.0%	57.0%
Opinion	Program taught safe lifting practices are real world practical	77.4%	22.6%
Knowledge	There are a set of OSHA guidelines on patient handling in nursing homes	88.1%	11.9%

Examination of Table 12 shows that nurses are both safety conscious and knowledgeable about safety. However, it also shows that most nurses believe they must place patient's safety over themselves with the consequences being "just part of the job". This

assessment was then compared with another situational question, which asked “when in a normal situation of needing to lift a patient alone, you are more likely to _____”. Responses to this question are found in Table 13 and showed that more than 85% would either “Use learned techniques” or “Seek out another person to assist”. Notable is the fact that only 6.7% said they would go “Find and use the patient handling equipment”. This response differs from the expectation implied in literature and documented safety programs. However, these responses are reflective of the discussions within the focus groups prior to survey development. Simply, “the idea of the immediate availability and use of patient handling equipment in healthcare is much different than the reality of the events which must occur in a given time”. Further conversation within the same group revealed that the use of patient handling equipment is related to whether the equipment fits the immediate situation rather than the premise that patient handling equipment is generic to all situations.

Table 13

Distribution of responses to: ”When in a normal situation of needing to lift a patient alone, you are more likely to”

Responses	True
a. Use techniques learned during hospital or college training	30.0%
b. Follow instruction / techniques shown to me by an experienced nurse	6.7%
c. Seek out another person to assist	55.5%
d. Use techniques learned in a CEU course on patient handling	1.1%
e. Find and use the patient handling equipment	6.7%

The final situational question was a direct assessment of why nurses do not use patient handling equipment. However, since nurses are conditioned by education and

safety programs to respond that patient handling equipment is suited for and to be used in all circumstances given that it is not an emergency. This question was worded to allow nurses to answer based on their experience and opinions of why not to use the equipment. Table 14 gives the question and responses as ranked by Alabama nurses ($H = 130.10$, $p < 10^{-16}$). Under the same reporting criteria, Table 15 gives a stratified assessment by healthcare organization, which did show significant differences in opinion on this subject. For each table, the associated *z-value* and *p-value* for significant transfers are displayed along with the post ANOVA groupings.

Table 14

Alabama nurses average rank response to: "Please RANK the issue or reason, based on experience, why NOT to use patient handling equipment from best (1) to worst (12)"

*Group	Reason	^All Respondents, Average Rank (n = 86)	Median Rank	Composite Rank
●→	No time, it is an emergency	3.30 ($z = -7.95$, $p < 10^{-15}$)	2	1
→, ↓	No room to use it (shape and size of room and/or door)	4.72 ($z = -3.72$, $p < 10^{-4}$)	4	2
→	No patient handling equipment	5.12 ($z = -2.90$, $p = 0.002$)	4	3
→	Too congested in room (furniture, equipment, etc.)	5.29 ($z = -2.28$, $p = 0.012$)	5	4
→, ↓	Patient is not large enough to justify use of equipment	6.27	6	5
→	Patient handling equipment is in use somewhere else	6.28	6	6
→, ↓	Two person lifting is better	6.47	7	7
→	It is faster and more convenient without it	6.73	7	8
→, ↓	It is safer to lift without	7.16	7	9
→	Scheduling does not allow for time (staffing issue)	7.24	8	10
→	It is difficult to operate	7.31	8	11
→	It is to far away (distance to travel)	7.72	8	12

* Kruskal-Wallis post ANOVA Groupings, $\alpha = 0.05$

^ Z-statistic (one-sided), $\alpha = 0.05$

The last section in the survey allowed Alabama nurses to compare factors against one-another. Each subject was asked to rank the importance of eight criteria, i.e. influential factors of patient handling, through a series of two value weighted comparisons using a six-point Likert scale (Likert, 1932; Woodworth, 1933). All factors were weighted against each other, giving a total of 28 comparisons throughout the survey. The following example gives the section's instructions with a sample of a normal response.

> **PLEASE GIVE YOUR GENERAL BELIEFS ABOUT WHICH OF THE PAIRS OF FACTORS ARE MORE INFLUENTIAL CONCERNING PATIENT HANDLING. PLACE AN (X) BETWEEN THE PAIRS OF CRITERIA THAT FOLLOW, CLOSEST TO THE INFLUENCING FACTOR:**
>
> **Example, if you generally believe that "limited space" has a greater influence on patient handling when compared to patient cooperation, you might place a (X) as follows:**
>
> **Limited Space** :____:_X__:____:____:____:____: **Uncooperative Patient**

The use of this method allows for several different types of statistical analysis. First using the weighting of each interaction, a composite score can be determined to gauge the level of influence of an individual factor. An example of how this method works is that the scale is a 6 point scale ranging from -3 to 3. Therefore for the example above, "limited space" would receive a +2 and "uncooperative patient would receive a -2. Using all comparisons, a composite score can then be determined. Consequently, a T-test can then

be used, testing a mean about zero with the assumption that all factors are of equal importance. Additionally, other analyses performed include a Kruskal-Wallis Test with post ANOVA groupings which utilizes the rank order of the values as determined by the each factors composite score and a Mann-Whitney Test for comparing a factor's rank order between groups. Table 16 shows the significant results of all three tests performed.

Table 15

Alabama nurses average rank response to: "Please RANK the issue or reason based on experience why NOT to use patient handling equipment from best (1) to worst (12)" by healthcare setting.

ǂWorking in Hospitals ($n = 55, H = 80.25, p < 10^{-16}$)				ǂWorking in other Healthcare Settings ($n = 31, H = 58.94, p < 10^{-14}$)			
*Group	Reason	^Average Rank	Median Rank	*Group	Transfer	^Average Rank	Median Rank
	No time, it is an emergency	3.28 ($z = -5.25, p < 10^{-7}$)	3		No time, it is an emergency	2.27 ($z = -6.27, p < 10^{-9}$)	1
	No room to use it (shape and size of room and/or door)	4.33 ($z = -3.67, p < 10^{-3}$)	4		No room to use it (shape and size of room and/or door)	5.17	5
	No patient handling equipment	5.04 ($z = -2.96, p < 0.002$)	4		No patient handling equipment	5.59	5
	Too congested in room (furniture, equipment, etc.)	4.96 ($z = -2.23, p = 0.013$)	5		Too congested in room (furniture, equipment, etc.)	5.59	5
	Patient is not large enough to justify use of equipment	6.63	6		Two person lifting is better	5.86	6
	Patient handling equipment is in use somewhere else	6.93	6		Patient handling equipment is in use somewhere else	5.93	5
	It is faster and more convenient without it	6.70	7		Patient is not large enough to justify use of equipment	6.24	6
	Two person lifting is better	6.80	7.5		It is safer to lift without	6.62	6
	Scheduling does not allow for time (manning issue)	7.00	7		It is faster and more convenient without it	6.76	7
	It is difficult to operate	7.39	8		It is difficult to operate	7.17	8
	It is safer to lift without	7.44	8.5		Scheduling does not allow for time (manning issue)	7.69	8
	It is to far away (distance to travel)	7.57	8		It is to far away (distance to travel)	8.00	9

ǂ Kruskal-Wallis Test, $\alpha = 0.05$

* Kruskal-Wallis post ANOVA Groupings, $\alpha = 0.05$

^ Z-statistic (one-sided), $\alpha = 0.05$

Examination of table 16 shows that "Understaffing" and "Weight/Size of Patient" are

significant factors that control how a lift is performed, while the t_o of "Lifting Polices of Facility" seem to show that it significantly has no effect on how the lift is performed. Reasons for differences in the two tests are that the Kruskal-Wallis Test is a one-sided test, while the T-test is a two-sided test. To further examine this, data were stratified by healthcare organization, for which only minor differences were seen. However, additional testing showed that "Space Congestion" was found to be significant at 0.10 using a Mann-Whitney test, $p = .088$, suggesting that congestion of space becomes more of an issue outside of a hospital in alternate healthcare settings such as nursing homes or home healthcare. However, this is not conclusive since it was not significant at the 5% level, but it does give merit to further investigation.

Table 16

Alabama nurses average weighted and rank response for general factors influencing patient handling

*Group	Reason	¥Average Weighted Response (n = 86)	ǂ^Average Rank Response (n = 86, H = 113.22, $p < 10^{-12}$)	Median Rank	Composite Rank
→	Understaffed	4.66 ($t_o = 4.94$, $p < 10^{-5}$)	2.88 ($z = -6.52$, $p < 10^{-10}$)	2	1
→	Weight / Size of Patient	4.21 ($t_o = 5.34$, $p < 10^{-6}$)	3.28 ($z = -4.78$, $p < 10^{-6}$)	3	2
→	Space Congestion	-0.73	4.38	4	3
→	Limited Space	-0.57	4.50	4	4
→	Patient Handling Equipment Unavailable	-0.70	4.47	5	5
→	Uncooperative Patient	-0.92	4.63	5	6
→	No Patient Handling Equipment	-0.81	4.80	5	7
●→	Lifting Policies of Facility	-6.71 ($t_o = -8.92$, $p < 10^{-13}$)	6.15	6	8

ǂ Kruskal-Wallis Test, $\alpha = 0.05$

* Kruskal-Wallis post ANOVA Groupings, $\alpha = 0.05$

^ Z-statistic (one-tailed), $\alpha = 0.05$

¥ T-Test (two-tailed), $\alpha = 0.05$

Discussion

The goal of this study was to evaluate the job environment and culture of patient handling from a nurse's perspective. For this purpose, a survey was administered to collect opinions about patient handling experiences with sufficient sociodemographic information to stratify the results. Results from the survey yielded insights on how Alabama nurses perceive patient handling tasks and the associated environment, as well as their role in the process. Nurses responded that there are four transfers of significant difficulty: floor to toilet, floor to chair, tub to chair/toilet, chair/tub to tub. Based on this, it was not surprising to find that nurses perceive bathroom and hallways/lobbies to be the worst locations to perform a needed transfer. Subsequently, reaction from nursing professionals was that most of the time there is insufficient room for assistance or mechanical lifts in bathroom areas, and three of the four transfers defined as most difficult are related to bathroom transfers. Further, two of the four significant reasons given for not using patient handling equipment were the space/room was too congested and size or shape of the room did not permit. However, in general, overall analysis shows these two factors are actually contributors to primary problems (factors) in patient transfers.

The primary two factors, which nurses found to be most important in determining the difficulty of a transfer were the size and shape of the patient and the unavailability of staff for assistance (understaffing) (Marras, 2006). Interestingly though, one other factor was found to be significant among general factors, specifically, lifting policies of the facility. However, it had a negative t-value indicating that it is significantly unimportant to nurses when performing a patient transfer. Follow-up inquires found that patient

safety, well-being, and care of patients and their needs are what controls the methods used in patient transfers, not polices, which reinforces the fundamental difference between the healthcare and other industries. Their product is the people's health.

Other significant findings of interest were that in the event of an emergency there is insufficient time to use patient handling equipment. This finding supports the exceptions found in the no-lift polices found throughout the U.S., U.K., and Australia (Engkvist, 2006). Another factor was that there are still healthcare environments with no patient handling equipment. And while patient handling equipment is not applicable for all lifting environment situations, it is still the best resource that nurses have available to them for performing most patient transfers.

Finally, safety culture provided perhaps the most interesting insight into how nurses perceive their role in patient handling. In general, the surveys revealed that nurses are safety conscious, well educated and informed about current information/guidelines in their profession. However, when it comes to their jobs and particularly patient handling, they place their patient's safety above their own, thus reinforcing previous findings from focus groups. Therefore, it is not surprising that 42% stated that they have had a back or shoulder injury related to patient handling on the job.

Potential limitations

This study was based on a self-selected cross-sectional sample of 86 of a possible 1000 nurses, which had been randomly selected to receive the survey from the pool of 49,000 nurses registered/licensed in the state of Alabama. This yielded an effective return of only 8.6%. However, with 86 participants, the minimum sample needed to get statistical power for the unstratified (population) results was achieved. Additionally,

stratified results did reach the minimum sample size for all groups to support definitive conclusions about relationships between groups.

Survey validation yielded low Cronbach's Alpha Coefficients (range 0.6299 – 0.6584 when grouped responses to similar questions do not correlate. Analysis of why data were not correlating as predicted yielded a stratification of data by healthcare setting, which is a point that is illustrated throughout this paper. Hence, the alphas were deemed acceptable.

Other limitations are concerns related to self-reporting (Garrett et al., 1992, Holman, 2006) and are defined by the following. An issue related to the low response rate (10.1% returned, 8.6% completed) raises the question if "selection bias" has occurred within the study. Additionally, omissions in self-reported data have been known to cause reporting inaccuracies in this type of study. Finally, "response bias" is a known issue with performing surveys in healthcare, specifically problems with nurses under-reporting injuries and events leading to injury have be widely reported in multiple studies (Stetler, Burns, Sander-Buscemi, Morsi, & Grunwald, 2003, Nelson et al., 2006).

Conclusion

Methods that Alabama nurses use to handle patients are substantially impacted by a number of factors and these factors facilitate either positive or negative perceptions of job duties/tasks. One negative perception is that the "floor to toilet lift" is the most difficult of the patient handling transfers. They also regard the location of the lift as important, perceiving bathrooms as the most desirable area to avoid. Alabama nurses are knowledgeable, and understand the importance of using patient handling equipment, but

they also understand it is not always possible or available. Further, nurses view their patient's safety and health to be of the utmost importance to the point that they will risk their own health and safety in order to provide timely and effective service to their patients, regardless of corporate training culture or the availability of patient handling equipment. The Alabama nurses' responding to this survey took personal time and hence a vested interest in expanding the understanding of the problems nurses are confronted with regarding patient transfers. Based on their responses, this study was able to better define aspects of patient handling previously not addressed. One example is finding that nurses are making decisions within a stressful work environment where they perceive certain decisions to protect patient safety are justified even if they pose a risk to their own safety. This has strong implications for the management of work environments.

Reduction in job stress and fatigue by improvement of work schedules and work loads and attention to factors in the work environment that may be psychologically unhealthy is needed (Waters, Collins, Galvisky, & Caruso, 2006). Hence, information presented here can be used reduce the number of obstacles in development of practical solutions to the patient handling problem. Unfortunately though, it is both understood and accepted among nurses, administration, and professionals that patient handling is a complex problem, which will not be solved simply by one catch-all solution. Only through defining the problem from the perspective of the people currently doing the job will advances be seen. From this study, basic information about the what, where, and why particular transfers are difficult is available with an understanding of why current practices (patient handling equipment) are not being utilized. Now, the burden rests with the administrators, nurses, and healthcare professionals to contribute time and knowledge

to quantify these factors for integration into models and equipment designs to give nurses and healthcare practitioners more options in patient transfer situations (Nelson, 2003).

Future Research

This study has shown that job environment and culture play a large role in what methods are utilized by nurses to perform patient handling tasks. Therefore, future research should focus on quantifying these types of factors in order to understand their role in the patient care process. Specifically, controllable factors such as congestion and/or limited space should be address for the purposes of developing building standards related to minimum access/space needed to/around a patient during care. Additionally, research should examine the specific stressors associated with all nursing tasks in order to understand the true burden being placed on nursing professionals, both physically and mentally. This understanding is critical to adequately addressing work environment issues that may be the key in reducing the incidence and severity of patient handling injuries.

Acknowledgments

This study is a collaboration of: Auburn University Department of Industrial & Systems Engineering, Auburn University School of Nursing, University of Alabama Birmingham School of Nursing, University of North Carolina Department of Exercise and Sport Science, and the National Institute for Occupational Safety and Health (NIOSH) Deep South Educational and Research Center, NIOSH Grant 5 T42 OH008436. Funding for this study was provided in part by a grant from the American Society of Safety Engineers Foundation (ASSEF).

CHAPTER 5

THE EFFECTS OF RESTRICTING SPACE ON PATIENT HANDLING: A NURSES PERSPECTIVE

Introduction

For more than five years, nurses and health workers have been listed as having the second highest injury and severity rates among listed professions in the United States (US) by the National Institute for Occupational Safety and Health (NIOSH) and the Occupational Safety and Health Administration (OSHA) (BLS, 2005). Consequently, this has caused many nurses to consider alternate careers, decreasing the average career life span of practicing nurses during this period. One of the reasons given for the short career life of nurses is the high incidence of severe injuries, especially to the lower back. The latest Bureau of Labor Statistics (BLS) data note that 42% of all nursing injuries were back related in 2003 (BLS, 2005). Some experts estimate most of the injuries were attributed to patient transfers tasks (Evanoff et al., 2003; Nelson et al, 2006).

For the past twenty years, much of the back injury related research has focused on techniques and methods to reduce low back injury. Further, the past ten years have witnessed an evolution in devices for assisting nurses in patient handling, a primary contributor to lower back injury (Marras, 2005; Nelson et al, 2006). A review of literature have found notable studies in modeling nurses' perceptions of on the job influences (Hignett & Richardson, 1995), analysis of mechanical devices such as slings (Elford,

Straker & Strauss, 2000), long term ergonomic program evaluation (Owen, Keene & Olson, 2002), and biomechanical analysis of manual handling techniques (Schibye, Hansen, Hye-Knudsen, Essendrop, Bocher & Skotte, 2003). The strength of each of these studies is that they approach the low back issue from different perspectives. The weakness is that none consider the task environment and/or physical restrictions, i.e. space, or conditions affecting the patient transfer. Hence, the research presented here is the third part of a three part, three year, study investigating the physical restrictions and conditions affecting patient handling. Part one was a descriptive study defining and mapping the interaction of known factors affecting patient handling (Holman, 2006). Part two examined the personal health of nurses and determined what environmental factors have the most influence on a patient transfer based on the opinions of working nurses. Part three was a biomechanical study based on findings from parts one and two, which found the worst location to perform a transfer was in the bathroom while transferring a patient from the floor to toilet given a fall had occurred in the main bathroom or shower. The rationale for this finding was that space was restricted and/or congested, thus not allowing for team lifts or use of patient handling equipment (a common problem). Related specific physical and/or psychological stressors identified by nurses were: (1) lowering or lifting heavy loads; (2) pushing or pulling heavy loads; (3) twisting of the back; (4) bending forwards/towards work (stooped posture); (5) carrying heavy loads; (6) highly repetitive motion; (7) pace or duration. Hence, the goal of this study was to quantify the effects of space restriction on a patient transfer.

Methodology

The research team recognized that the success of this study was dependent on creating a setting that replicated a “true to life” hospital bathroom environment. This was accomplished by constructing a mockup bathroom in a biomechanics laboratory. Attention to detail was given the highest priority in an effort to insure the fidelity of the recreated environment. Only participant safety was considered more important.

Biomechanics Laboratory

The biomechanics laboratory is equipped with a five camera PEAK motion capture system (Motus 8.5), an AMTI OR6-7 1000 forceplate, four lumbar motion monitors and a pressure pad system. General lab specifications include variable level remote lighting, synchronized time encoding, anti-glare flooring, blackout curtains, and 80 square feet of capture area. However, for this study, only the five camera motion capture system with integrated forceplate sampling at 60Hz would be utilized.

Equipment

To best expedite the motion capture process and to standardize clothing and footwear between subjects, participants wore full body motion capture suits with a black hairnet and black latex gloves. Footwear included form fitting black diving boots with polymer treaded soles to ensure firm, stable footing, i.e. no slipping. For tracking, a series of 30 markers were placed on the subjects using anthropometric landmarks as guides, thus allowing for a full body spatial model representation (Daynard et al., 2001). Figure 5 presents a general diagram of marker placements and the subsequent spatial model rendered.

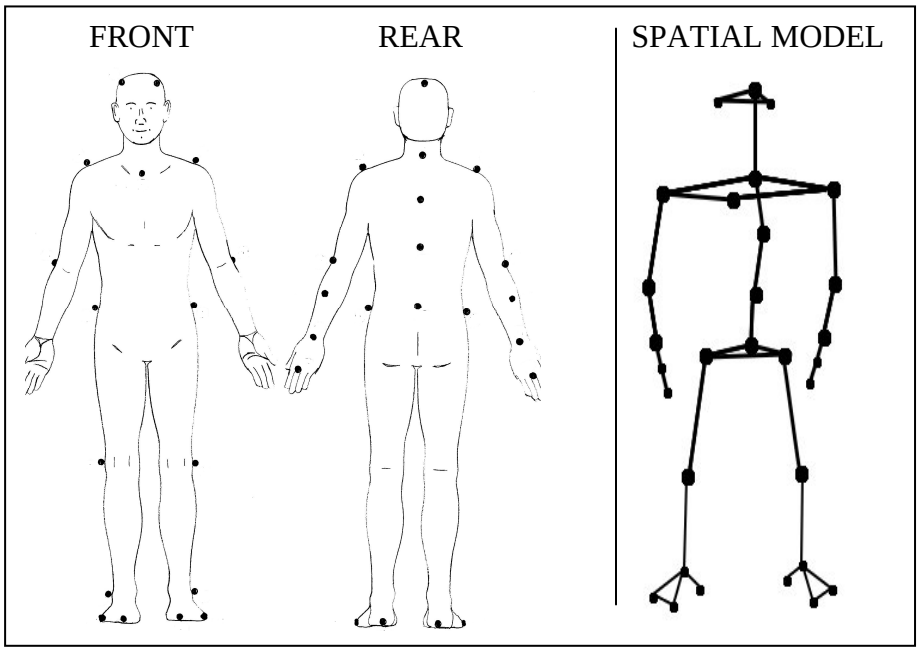

Figure 5: Tracking markers transitioned from subject to spatial model

Testing Apparatus

The testing apparatus was constructed from dimensions provided by collaborating Missouri hospital. The objective was to emulate a private room bath fitted with standard hardware, including a toilet measuring 16 inches in height and three handrails, one for each wall. The unique feature of this bathroom was that it was made of Plexiglas to allow for motion capture through the walls. The walls were made of 3/8 inch Plexiglas with clarity of 0.92 with clear Lexan angle strips to re-enforce the corners. Both upper and lower track supports were used to ensure structural stability, and no door was used as though a pocket door was installed. The overall design was created to be modular, allowing for the bathroom to be assembled or disassembled in 25 minutes. This allowed for testing of restricted versus unrestricted space for the same subject. Figure 6 shows the

bathroom apparatus in the biomechanical laboratory.

Figure 6: Biomechanics Laboratory and the bathroom apparatus

Other apparatus employed in this study included the use of a dummy to simulate a human. The choice to use a transfer dummy instead of a live person was based on several criteria. First, the introduction of uncontrollable variables associated with a person, such as level of patient assistance, was seen as unnecessary since we were evaluating the effect of restricted space not the patient cooperation (which can impact a transfer either positively or negatively). Second, participant availability could have become problematic and an uncontrollable factor in test scheduling. Third, the conditions for which each trial was performed must be repeatable. And finally, based on the activity, safety issues for the person being transferred were viewed as unacceptable. Therefore, it was decided that a

transfer dummy representing the “best case scenario” would be used. Hence, a grapping dummy was procured for this purpose. The reasoning for choosing this dummy was as follows:

1. It was designed to be durable with a metal rod and cable re-enforced frame.
2. It was first constructed using a human mold and then sculpted to give representative range of motion in the joints.
3. The outer shell is a life-like polymer skin, which gives a “natural feel”.
4. Initial weight was 60 lbs, but its design allows for it to be load weighted by body segment to a desired weight based on cadaver studies (Clauser et al., 1969; Kroemer et al., 1997). This allowed the dummy to be weighted to a target weight of 110 lbs with the final weight being 113.7 lbs. The target weight was considered to be representative of a 5^{th} percentile female based on a combination of multiple anthropometric tables examining body weight by nationality (Kroemer et al, 1997; Roebuck, 1995; Thompson & Floyd, 1998) and military tables (Gordon et al, 1989).
5. The limitation with the dummy was that it was 71 inches tall, thus roughly five inches taller than preferred, and with the stature of a medium-build male, rather than a small female. However, these characteristics were standardized across subjects and conditions, thus the influence on the results was negligible compared to using a live subject.

Figure 7 illustrates the transfer dummy and its weight distribution by body segment.

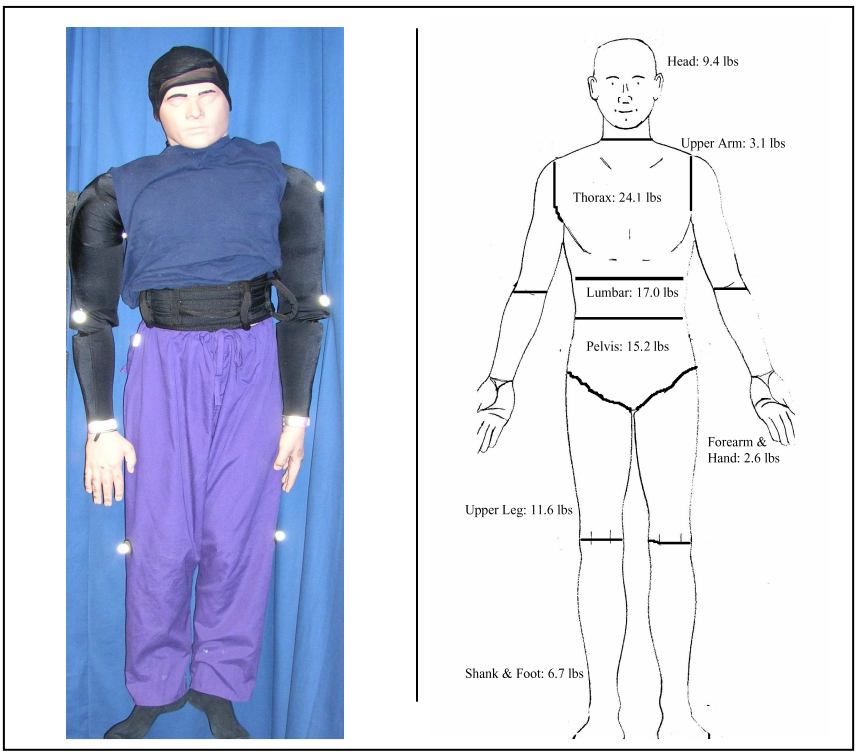

Figure 7: Patient transfer dummy with distribution of load weight by body segment

Subjects

Approval of the study was received from the University's Institutional Review Board (IRB) for Human Subjects in Research prior to subject recruitment. Based on the statistical model, a priori power analysis showed ten licensed nurses were needed for this study to gain to obtain a power of at least 0.80. Compensation was provided to all participants. Potential subjects were required to clear both a telephone prescreen and physical activity questionnaire (PAQ) before activate participation was allowed. The screening criteria were as follows:

1. Participants must have been licensed for at least one year with the Alabama Board of Nursing as a Licensed Practical Nurse (LPN) or greater.

2. Participants must have been currently employed for a period of greater than 3 months as a nurse with patient handling duties composing at least 15% of their daily regiment.
3. Participants must have been between the ages of 20 and 50 with a body mass index (BMI) of less than 30.0.
4. Participants must have been in good health with no current injuries or illness.
5. Participants must have use of and full range motion in joints and extremities.
6. Participants could not have been on medications that could effect mood, thought process, postural stability, physical strength or impair judgment.
7. Participants must verbally indicate and then demonstrate that they can successfully transfer the dummy.

Statistical Model

The statistical model for this portion of the study was a randomized complete block with a replicate. The independent measure was restricted versus unrestricted space and the mechanism for testing was determined to be the floor to toilet transfer, which was indicated as the worst transfer to perform by nurses surveyed. Dependent measures were determined based on four categories:

- Time – Time to complete a task is an accurate indicator of the effect/impact sustained by a person's body relative to conditions. Additionally, time is also a strong indicator of task efficiency and/or performance. Time intervals were measured via frame rate or time encoding.
- Posture – The posture that a person's body assumes while completing a given task is normally directly correlated to the requirements of the task and the immediate

surroundings (Chung et al., 2003). Therefore, two methods of postural evaluation were determined to be needed to accurately depict the effects of restricting space:

Rapid Entire Body Assessment (REBA) (Hignett & McAtamney, 2000) – This tool was selected due to its ability to account for most joint angles and body positions required when performing a patient transfer (Chung et al., 2003). Its ability to provide a single composite score for each individual video frame captured made it ideal for use in a biomechanical laboratory setting. Additionally, this application eliminate the two most common causes of error previously experienced when performing evaluations in workplace settings: lack of a sufficient number of samples to gain validity and single perspective user error in which joint angles are inaccurately determined.

Ovako Working Analysis System (OWAS) (Karhu et al., 1977) – This tool is a well known classification tool, which has been used extensively for evaluation of nurses' working postures (Engels et al., 1994; Lee & Chiou, 1995). Limitations of the tool are that its sensitivity only allows for bulk classification of samples taken from a single event. However, this should be adequate when coupled with the REBA analysis.

- Joint Moment – In light of the abundance of literature relating to the prevalence of back injuries in nursing (Hignett et al., 2007; Nelson et al.; Waters et al, 2006), it is reasonable to include an estimated measure of moment about the L5 vertebra in this study. For this purpose, the revised Utah Back Compressive Force Equation was used.

Utah Back Compressive Force Equation (Loertscher et al, 2006) – This tool is a gender specific equation that predicts the peak moment about the L5 given specific body angles and the weight of the load being transferred. Body angles used in the equation are specific and were measured based on anatomical landmarks, coordinate axis, or reference planes. Initial testing of the equation showed an $r^2 = 0.96$ and $r^2 = 0.95$, for males and females repetitively (Loertscher et al, 2006). For the current study, the Utah equation was utilized both statically and dynamically. The static equation had a constant load, which was introduced into the system as a constant. The constant load was determined using a push/pull dynamometer prior to laboratory testing. The dynamic equation received the calculated hand moment directly from the forceplate, which allowed for direct sampling and a second load estimate for analysis. The hand moment was calculated using upward inverse dynamics from the resulting forceplate moment less the mass of the subject, yielding a resulting moment related to only the dummy's mass.

- User perception – User perception and perceived ratings were important parts of this research. The objectives were to understand what the subjects were feeling, e.g. stress/fatigue/difficulty (Chung et al, 2003), and if they felt the situation created for testing corresponded to environments and situations in the real world (Hignett et al, 2007). Note: an underlying premise of this study was that working nurses were involved in each aspect of the study design based on information provided in earlier studies. Therefore, surveying user perception was a critical

step to the overall evaluation of the study being performed and omission would leave out an important step in the validation of this research. Hence, surveys were given for each individual trial after completion and then for the study after all trials were complete. Each survey consisted of seven questions using a six point Borg scale with verbal anchors. Information collected related to transfer planning, execution, difficulty, equipment, and resemblance to real life.

Procedures

Testing procedures were defined in detail through pilot studies prior to testing. They were designed with three objectives in mind: participant safety, study repeatability, and standardization of data collection through use of protocol. Therefore, the following activities were undertaken in either the introduction or testing phases of this study:

- Familiarization – After prescreening was completed and the IRB consent signed, participants were asked to watched a 10 minute video explaining the research progress to date and finishing with the purpose of the laboratory study that they were about to participate in. Following the video, each participant was required to examine the bathroom's handrails, toilet position and sturdiness. They were then asked to perform a trial transfer to gain perspective of the dummy's weight and motion when being moved. Finally, they were instructed on what to do in the event of interruption, marker loss, or if something "just did not feel right". The goal of these procedures was to ensure all participants received the same instructions and to reduce the learning curve relative to transferring a dummy instead of a human.
- Recovery time – It was noted during prior pilot testing that while a patient transfer

is a relatively a short task, consisting of only seconds, a patient transfer requires a high percentage of the maximum voluntary contraction (MVC) capability of most of the active muscles used due to the weight being transferred. Therefore, it was determined a minimum recovery period of 5 minutes would be required between transfers to minimize fatigue (Hebestreit et al., 1993; Holbein & Chaffin, 1997; Burnley et al., 2006).

- Patient Transfer Belt – A common patient handling device recommended by most hospital programs and nursing professionals is a patient transfer belt, sometimes called a "gait belt" (Menzel et al, 2004; Nelson et al, 2006). For most circumstances where normal lift/transfer equipment cannot be used, these belts are recommended. They are described as easy to use, allowing the user handles to better maintain grip and leverage during the transfer process. Hence, it was decided in the interest of participant safety to use a patient transfer belt when performing the laboratory trials. In addition, the belts also provided a standardized hand hold, which proved to be beneficial in testing.
- "Best Case Scenario" – An item that was not controlled in the study was the participants' approach and/or method to the transfer. This was due to the fact that there is no set or standardized procedure for patient transfers consistently taught to all nurses in every nursing school. Therefore, it was decided that our approach, in light of the subject pool being experienced nurses, was to allow them to accomplish the transfer by the method they knew best. This reasoning was supported by the logic that we were testing the effects of restricting space on the task based on the person, not the procedure. Consequently, the goal was to permit

each participant to use the most beneficial method to them, while still accomplishing the task, i.e. “the best case scenario for the nurse”. Additionally, from a statistical standpoint, allowing subjects to use their preferred lifting technique will improve within-subject reliability. As the design of the study with respect to space restriction is completely within-subjects, this will improve the internal and external validity.

Results

Testing was performed from March 2007 to June 2007. During that time over 100 potential subjects were contacted to be in the study with 14 being invited to the laboratory. Of the 14, 10 cleared all screening protocols and were allowed to participate. Reasons the other four potential participants did not clearing the screening process were:

1. Was not currently in a position where their tasks involved transferring adult patients.
2. Could not physically perform the transfers.
3. A previous back injury had occurred and was noted as “flaring up from time to time”. Therefore, it was in the best interest of participant safety to not allow participation in the study.

Subject testing time from entry into the laboratory until exit was approximately four hours. Analysis of participants’ body’s positioning, accelerations, and velocities relative to the subjects transfer technique showed that there were three distinct activities/stages in the floor to toilet transfer task.

- Stage 1 – Was the positioning stage. A participant would enter the

bathroom/testing area and position himself/herself in preparation to perform the transfer. No loading occurred in this stage.

- Stage 2 – Was the vertical lift portion of the transfer. It began immediately after the frame/point where the participant gained control of the transfer belt handles and the wrist marker initiated a positive z-axis, i.e. vertical, increase/displacement in position.
- Stage 3 – Was the horizontal repositioning portion of the transfer. It began immediately after the frame/point where the ratio of z-axis displacement divided by the resultant of the x and y axis displacement became less than one. Stage three continued until the dummy was stationary on the toilet with no load present on the hands due its weight.

As testing proceeded through each of these stages, body posture and force were being continuously captured relevant to time by the biomechanics laboratory's various data acquisition systems (described previously) (Daynard et al., 2001; Zhang & Chaffin, 1999; Zhang et al., 2000). Statistical tests conducted on the resulting data included balanced ANOVA and paired T-test. Tests were performed at a significance level of 0.05. In addition to testing each stage, the entire transfer, (i.e. the event), and loading stages, (i.e. combining stages 2 and 3), were tested. Detailed results for each of the four dependent measures are explained in the following sections.

Time

The difference in the average time required for lifting in unrestricted as opposed to restricted space was found to be significant using a paired T-test for both the vertical lifting stage (p = .036) and the combined stages 2 and 3 (p = .049). For the stage 2

vertical lift, time increased 28.20% from 2.357 seconds to 3.022 seconds, when the space was restricted. When examining the combination of the two stages, 2 and 3, time was found to increase 14.02% from 5.313 seconds to 6.058 seconds when space was restricted.

Posture

Postural differences were found to be significant in one of the two postural analysis tools used when comparing restricted to unrestricted transfers. REBA showed significant differences using a paired T-test to analyze the horizontal repositioning (p = .002), stage 3. During the horizontal repositioning of the dummy, the REBA composite score decreased 19.70% from 5.33 to 4.28 when the space was restricted. Hence, REBA scoring is the lower the score the better the posture. However, both scores are considered to be a “medium” risk factor, where “action necessary” to reduce the risk level is recommended.

Testing using OWAS did not yield any statistically significant results. However, OWAS was used in a slightly different way in this experiment. The normal application of OWAS is to classify position of the entire body. However, our focus was limited to evaluation of the back. Therefore, only the distributions of the thousand category ranges, (i.e. back position), and the percentage of time the task was loaded during that category were charted and analyzed. While there were no significant results, the charting did provide insight into the manipulation and loading of the spine required to complete the patient transfer. Table 17 shows the average distribution of OWAS classifications, by restriction, for a patient transfer from the floor to the toilet.

Table 17

OWAS distribution by back position with percentage of time posture was loaded per category for the transfer event.

Measure	Category: 1000 "Back Straight"		Category: 2000 "Back Bent"		Category: 3000 "Back Twisted"		Category: 4000 "Back Twisted & Bent"	
	Event (%)	Loaded (%)	Event (%)	Loaded (%)	Event (%)	Loaded (%)	Event (%)	Loaded (%)
Unrestricted	25.10%	22.06%	51.30%	50.59%	8.30%	9.84%	15.30%	48.26%
Restricted	25.40%	33.20%	56.53%	45.70%	5.88%	12.64%	12.19%	32.68%
Difference	0.30%	11.14%	5.22%	4.89%	2.41%	2.80%	3.11%	15.58%

Joint Moment

Peak moment about the L5 vertebra of the spine was not found to be significantly different based on restriction in the floor to toilet transfer. However, the average estimated peak load was approximately 2880 N of compressive stress on average, which is substantial considering the "gold standard" is not to exceed 3400 N (Marras, 2005). This conclusion is also based on the fact that this study was designed to be the "best case senerio"with the transfer dummy weighted at the level of a 5^{th} percentile female. Table 18 shows the Utah Back Compressive Force Equation's average peak estimated moment about the L5 vertebra for both static and dynamic loads.

Table 18

Utah Back Compressive Force Equation's average peak estimation of the L5 moment for restricted and unrestricted patient transfers using both static and dynamic loading.

Measure	Utah Back Compressive Force Estimation		
	Static Load (N)	Dynamic Load (N)	Average Estimation (N)
Unrestricted Transfer	3094	2661	2878
Restricted Transfer	3100	2662	2881

Additionally, in three individual trials, shock/spring loading of the transfer occurred when the participant generated momentum prior to the beginning of the vertical lift, i.e. jerking motion (Commissaris et al., 1997). In at least one case, inverse dynamics predicted the moment about the L5 vertebra to be greater than two times the gold standard, which has the potential to cause an acute low back injury. However, this result is only preliminary due to the sample size not having sufficient statistical power.

User perception

The opinions of the working nurses who chose to participate were collected via survey after each trial and then again after all trials were completed. Results for individual trials showed that only 68% of the time did participants believe that they performed the transfer correctly during the trial and 73% of the time did they believe the transfer was performed the way they planned to do it. Further, 73% of the time they believed that the transfer was difficult, but 90% of the time they still believed real life transfers were still more difficult than the trials. Time to complete the task was

considered to be consistent with real life receiving 2.9 out of 6.0 for a scale using the verbal anchors “took more time in real life” and “took less time in real life”. Overall, it was believed that 80% of trials were realistic compared to the real world with a combined effectiveness rating of 4.1 out of 6.0.

For the study, 90% believed both body and back stress increased when space was restricted. Additionally, 100% of participating nurses stated they believed restricting the space made the transfer more costly in terms of time to complete and more difficult. However, results only show that time to complete the task increased. The difficulty remained statistically constant. Hence, the true reasoning for this response is unknown, but speculation suggests that it could possibly be attributed to psychosocial factors related to nursing or that it is a conditioned response based on education and/or experience.

Finally, when asked if the study was representative of real life, 90% of participants stated it was, giving it an overall effectiveness rating of 4.9 out of 6.0. Table 19 gives the average ratings and responses to each question.

Table 19

Participating nurses average responses to "user perception" questions.

Trial / Study	Question	*Yes (%)	Modified Borg Scale Response (out of 6)		
			Unrestricted Trials	Restricted Trials	All Trials
Trial	I believe the transfer was correctly performed.	68%	4.1	3.8	3.9
Trial	I performed the transfer as I planned.	73%	4.4	4.2	4.3
Trial	The transfer was difficult.	73%	4.1	4.6	4.4
Trial	The transfer was representative real life.	80%	3.9	4.3	4.1
Trial	The transfer was more difficult in real life.	90%	4.3	3.9	4.1
Trial	The transfer took more time in real life.	30%	2.9	2.9	2.9
Trial	The transfer belt was beneficial in perform the transfer.	80%	5.0	4.7	4.9
Study	When space is restricted, transfers take more time.	100%	-----	-----	5.4
Study	When space is restricted, transfers are more difficult.	100%	-----	-----	5.3
Study	When space is restricted, transfers place more stress on the body.	90%	-----	-----	4.8
Study	When space is restricted, transfers place more stress on the back.	90%	-----	-----	5.0
Study	This study was representative of the real world.	90%	-----	-----	4.9

* Six-point Modified Borg scale yes/no response: position 1,2, or 3 was a "no"; position 4, 5, or 6 was a "yes"

Discussion

The goal of this study was to evaluate the effects of restricted space on a patient transfer, which involved moving a patient from the floor to a toilet while in the main bathroom or shower. Responses examined included the time to complete the lift, body posture, and joint moment about the L5 vertebra. Of these, time was the most effected, showing an increase of 28.20% for the vertical lifting stage and a 14.02% increase during both vertical and horizontal loaded stages combined. This was particularly important since these are the two stages of the transfer that the nurse was lifting/carrying a load, i.e.

the dummy. Hence, the obvious implication is that working in a restricted space such as a bathroom substantially increases the time during which the person (nurse) executing the transfer is exposed to an associated high risk posture while lifting/carrying a heavy load.

For posture, results showed that the REBA posture score improved slightly overall for the horizontal repositioning when space was restricted. However, it is believed that this improvement was due to the restriction limiting the ranges of motion of the participant's body. Further, neither score for restricted nor unrestricted transfers was found to be below a "medium" risk level, which is considered to be an action "necessary" level for REBA. Additionally, both the average restricted and unrestricted transfer scores for the vertical lift stage were at the "high" risk level, an action "necessary soon" level.

The final physical component based on task time, posture, and force was a measure of the stress on the low back. Since back injuries were the most prevalent injury seen among nurses in statistical reports and literature (BLS, 2005), the moment about the L5 vertebra was evaluated. However, no significant difference in back moment was found when comparing the restricted and unrestricted transfers, but this was not the only goal. The goal was to determine the moment under the "best case scenario", i.e. quantify, and then analyze for differences. Hence, the average combined peak moment at the L5 was estimated by the Utah Back Compressive Force Equation at approximately 2880 N. This level of moment is considered to be substantial, since the transfer weight was only 113.7 lbs, i.e. weight of a 5^{th} percentile female. Since most American males weigh upwards of one and a half times this amount, it is reasonable to conceive 3400 N limit would be exceeded in a typical patient transfer. In addition, this moment does not include estimations of spring/shock loading, which could assist a nurse in performing a transfer

but could more than double the normal stress/moment on the low back.

An overall assessment was accomplished for the physical characteristics by examining the postural results in stages over time for both restricted and unrestricted transfers. The purpose was to examine events such as the participant's posture when loading was initiated. Hence, figure 8 illustrates the average REBA postural score by time for both restricted and unrestricted transfers. Event lines were used to show the beginning and ending of each transfer stage.

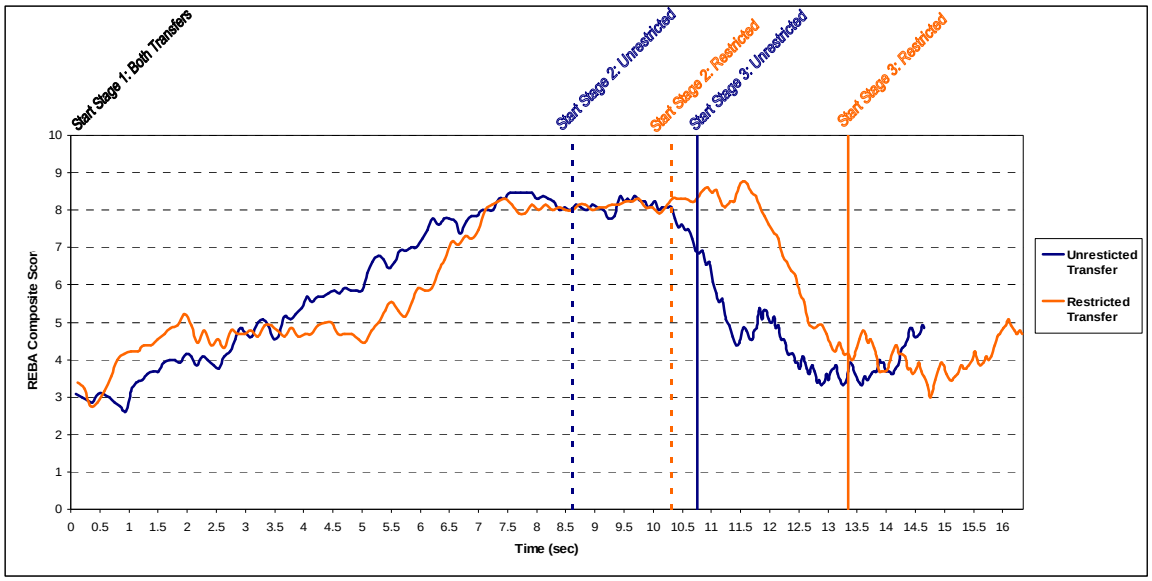

Figure 8: Average REBA postural score for both restricted and unrestricted transfers.

Analysis of this graph shows initial loading, (i.e. stage 2 vertical lift), begins with the participant in the worst posture given the event. For the unrestricted transfer, the participant quickly transitions from the stage 2 vertical lift into the stage 3 horizontal repositioning before resuming a more upright posture. This event can be seen by examining the intersection of the start stage 3 unrestricted event line and the unrestricted

transfer, which is at the top of the declining slope. Further, this gives insight into why time was significant. Specifically, if the participants were not allowed (due to space or other restriction) to transition to the horizontal repositioning as they normally would before being required to come to a complete upright position then additional time would be required to complete the stage 2 vertical lift, accounting for the significant time difference. This comparison can be seen visually in the figure 8 by comparing the slope intersection point of "start stage 3" event lines with the corresponding REBA line plot. However, given the estimated average moment present during the loaded stages, it is believed that neither floor to toilet transfers tested here would be capable of producing an L5 moment less than the 3400 N limit, while transferring a person of average (50% percentile) height and weight.

Finally, user perception of this study was found to be positive. In general, participants believed time to perform the task was consistent with "real life". However, laboratory simulations were still believed to be less difficult. The transfer belt was viewed as beneficial by 9 out of 10 participants when performing the floor to toilet transfer. Overall, perception of each individual trial being "realistic" was rated at 80%. Further, 9 out of 10 participants felt the overall study was a good representation of "real life", giving an effectiveness rating of 4.9 out of 6.0.

Potential limitations

Restriction in workspace is normally categorized as an environmental situation or condition that effects work being performed both from a worker safety and efficiency perspective. While this study focused on the effects of restricting space when performing a patient transfer, there are numerous other industries that have a similar task for which

restricted, confined or congested space is a known problem. However, no published literature was found for a comparison or basis that attempted to quantify this condition. This absence in literature is likely due to the large number of variables, which need to be controlled in order to get valid, reliable research data. Some of the variables are spring/shock loading of the transfer, directional forces generated from brushing, hitting or leaning on an obstruction such as a wall or handrail, unilateral and/or unbalanced lifting, feet/foot not being completely on the forceplate, etc. For this study, efforts were made to design and build a high fidelity representation of an actual hospital bathroom. Protocols and procedures were developed to ensure uniform instruction in order to minimize the number of confounding variables. However, as with all laboratory studies, there is a limit to what can be recreated from “real life”.

A limitation of the study was that a weighted dummy was used for transfer and not an actual person. The dummy met desired criteria including skin texture, weight, weight distribution and proper joint movement and range. However, given the weight, the dummy was taller than desired, and its stature was a male of medium build.

Another limitation was based on experience from pilot trials there was no way to ensure participants would keep their foot/feet completely on the forceplate for the duration of a transfer. Therefore, the recently published revised Utah Back Compressive Force Equation was used to estimate the peak moment about the L5. The research team believed, based on the literature, the equation would provide accurate moment estimates for the study, as well as, allow for an external validation of the equation itself. However, the choice to use the equation meant losing the ability to measure dynamic spring/shock loading, since it is a static predictor.

Conclusion

Methods that Alabama nurses use to handle patients are substantially impacted by a number of factors, and these factors facilitate either positive or negative perceptions of job duties/tasks. One negative perception is that the “floor to toilet transfer” is the most difficult of the patient handling transfers due to the conditions and restrictions that dictate this transfer. Consequently, they also regard the location of the transfer as important, perceiving bathrooms as the most undesirable area for a transfer that should be avoided if possible. However, negative perceptions not withstanding, the nurses participating in this study were asked to do just that. Specifically, they were asked to perform a series of floor to toilet transfers for the purpose of quantifying the effects of restricted space. Results from this study showed restricting the space, as it occurs in a hospital environment, does not place any significant additional moment on the low back. What does occur is it alters how the nurse moves when transferring a patient, thus significantly increasing the transfer time during the loaded portions of the transfer. When examining the loaded part of the transfer, which is the moment of initiation of vertical lift to the stationary placement of the patient/dummy on the toilet. The time needed for a restricted transfer increased by an average of 14% when compared to the unrestricted. Putting this in context, this is 14% more time in a medium to high risk postural position for which the best case scenario estimates the moment on the low back at an average of 2880 N. Hence, the negative perceptions nurses have of this transfer seem to be justified.

Information presented here comprises only one set of variables relating to one transfer performed in one location. Many more studies of this type are needed before valid multi-level recommendations can be made, which could facilitate long-term

benefits. Results of this study suggest that very few real world floor to toilet transfers would produce low back stress, i.e. a peak L5 moment, less than the 3400 N limit. Therefore, mechanical assistance should be required for this transfer. Unfortunately, this is a statement made all too often, since it is both understood and accepted among nurses, administration, and professionals that patient handling is a complex problem, which will not be solved simply by one catch-all solution. Only through defining the problem from the perspective of the people currently doing the job will advances be made. Now, the burden rests with the administrators, nurses, healthcare professionals, and engineers to contribute time and knowledge to quantify factors for integration into models and equipment designs to give nurses and healthcare practitioners more options in patient transfer situations (Nelson, 2003).

Future Research

This study has shown that the conditions and restrictions of the job environment play a large role in the selection of methods that are utilized by nurses to perform patient handling tasks. Results from this study quantified the effects of restricting space on one of the two transfers regularly performed in a hospital bathroom. This suggests that if the second transfer could be quantified in future research, an overall risk factor could be developed based on the unrestricted transfer, which could ultimately lead to understanding how risk changes when work areas are increased or decreased.

Acknowledgments

This study is a collaboration of: Auburn University Department of Industrial & Systems Engineering, University of North Carolina Department of Exercise and Sport

Science, University of Utah Department of Mechanical Engineering, Auburn University School of Nursing, University of Alabama Birmingham School of Nursing, and the National Institute for Occupational Safety and Health (NIOSH) Deep South Education and Research Center, NIOSH Grant 5 T42 OH008436. Funding for this study was provided in part by a grant from the American Society of Safety Engineers Foundation (ASSEF).

CHAPTER 6

CONCLUSION

A Summary of Findings

Four conclusions relative to future research of this type can be drawn from this study. The first conclusion is that when performing a study related to a specialized group/population, to not include input from this group is a fatal research flaw. The second conclusion is that input from individuals who were once part of this specialized group/population but have moved to positions where they no longer perform the task being evaluated is useful, but not necessarily valid. The third conclusion is when using a specialized group/population as subjects, partner with an institution or organization that can organize and provide these subjects over a reasonable time period. Finally, the fourth conclusion is real world situations can be recreated in a laboratory setting that facilitate the capture and quantification of crucial variables known to be difficult, if proper attention is paid to details. Hence, the following is a research summary of findings by category:

Table 20

Summary of findings by category for the research study: "Patient Handling: Conditions and Restrictions"

Category	Finding
General	In the descriptive study, 25 factors that directly influence patient handling have been mapped through literature review, focus groups, and interviews.
Personal Health	Analysis of the personal health of Alabama nurses revealed significant deficiencies in three of eight outcome measures when compared against general normative populations: Social Functioning; Physical Functioning; Bodily Pain.
Personal Health	The body mass index (BMI) for Alabama nurses indicated 28% had a "healthy" BMI while 37% and 35% of the nurses were classified as being "overweight" or "obese", respectively.
Environment	Alabama nurses perceive that four transfers are significantly more difficult than other transfers: floor to toilet, floor to chair, tub to chair or toilet, chair or toilet to tub.
Environment	Locations perceived by Alabama nurses as significantly more difficult to perform a patient transfer were the bathroom and a hallway or lobby.
Work Measurement	Self-reported work measurement of Alabama nurses showed they spend approximately 19 to 20 percent of their time performing tasks traditionally associated with patient handling.
Safety Culture	The safety culture of Alabama nurses suggests that in patient handling situations most will place a patient's safety above their own.
Safety Culture	Over 40% of Alabama nurses stated sprains, strains and sore backs are just part of the job.
People	Analysis of influencing factors found that the size and weight of the patient and understaffing most influenced the difficulty of a patient transfer.
Environment	Analysis of influencing factors showed that the size or shape of the room and/or congestion of usable space dictated the method of transfer attempted.

General	Results showed that four issues were significant when Alabama nurses were asked, "why would you not use patient handling equipment": (1) it was an emergency, no time; (2) patient handling equipment was unavailable; (3) size or shape of the space did not permit use; (4) congestion of usable space did not permit use
Environment	When performing a floor to toilet transfer, testing time is increased by approximately 14% for the loaded portions of the transfer when space was restricted.
Environment & People	When performing a floor to toilet transfer, posture was found to actually have an improved score when space was restricted. However, this was seen as the function of the space restriction limiting the body's range of motion, which ultimately limits the nurse's ability to choose how to perform the transfer. In addition, neither posture score was better than a "medium" risk level with the stage 2 vertical lift being at a "high" risk level.
Environment & People	When performing a floor to toilet transfer low back stress, i.e. moment about L5, was estimated to be 2880 N, which is relevant since the known point at which spinal injury injuries have been shown to begin is 3400 N.

Overall, there were 14 different findings that contributed to the overall conclusion of this research, which is:

> 'Findings from this research study suggest that for the hospital bathroom environment tested when performing a floor to toilet transfer and space is restricted, the best case scenario that a nurse can expect is that 14% more time will be spent in a medium to high risk postural position for which the average peak moment on the low back was estimated at 2880 N. Hence, this conclusion suggests that few real world floor to toilet transfers will produce low back stress less than the 3400 N limit where spinal disk damage is known to start. Therefore, mechanical assistance should be required for this transfer.'

Limitations of study

In all research studies, there exist limitations and this research study was no different. Each of the three parts in this study contained limitations unique/specific to itself. The

following provides a summary by study part of the known limitations:

- The part one descriptive study was based on a limited population cross-section of healthcare professionals within the state of Alabama. Gender and ethnic representation was not proportional to the current U.S. population (according to census.gov). However, representation was proportional to the current gender and ethnic population in healthcare (BLS, 2004) in the state of Alabama (Alabama Board of Nursing, 2005).
- The part two survey study was based on a self-selected limited population cross-section of 87 nurses of a possible 1000 Alabama nurses. The following are limitations and/or concerns related to low response rates and self-reporting (Garrett et al., 1992, Holman, 2006):
    1. Low response rates, which raise a question of whether "selection bias" has occurred, since only 5 nurses in the 25-34 age group responded.
    2. Low response rates result in minimum sample sizes for stratified data yielding limited or no finding due to lack of statistical power.
    3. The possibility of omissions in self-reported data questions thus impacting accuracy and completeness.
    4. Response bias, which is a known issue with performing surveys in healthcare.
    5. Problems known to exist when surveying nurses relative to under-reporting injuries and events leading to injury (Stetler, Burns, Sander-Buscemi, Morsi, & Grunwald, 2003, Nelson et al., 2006). This type of misreporting can create gaps in data and result in low Cronbach's Alpha

Coefficients.

- Part three of the study was a biomechanical laboratory study. However, as with all laboratory studies, there are limitations regarding simulation of real life situations. An example of this is that some job tasks are inherently hazardous and can not be entirely recreated due to participant safety. Other problems relate to accounting for uncontrollable variables. Some uncontrollable variables known to confound biomechanical data are spring/shock loading of the transfer, directional forces generated from brushing, hitting or leaning on an obstruction such as a wall or handrail, unilateral and/or unbalanced lifting, feet/foot not being completely on the forceplate, etc. Other limitations impacting the laboratory component of the study were:
    1. A weighted dummy was used for transfer rather than an actual person. The dummy used met set criteria including: skin texture, weight, weight distribution and proper joint movement and range. However, given the weight, the dummy was taller than desired and its stature was a male medium build.
    2. The revised Utah Back Compressive Force Equation was used to estimate the peak moment about the L5. Based on the literature, an assumption was made that the equation would provide accurate moment estimation for the study. However, the choice to use the equation meant losing the ability to measure dynamic spring/shock loading, since it is a static predictor.

Recommendations for future research

Future research should examine the specific stressors associated with all nursing

tasks in order to understand the true burden both physically and mentally being placed on nursing professionals. Examples of future research that could benefit from this study are:

1. Significant deficiencies were seen in the SF-36© results for Alabama nurses when they were compared to three different general populations. Additional research is needed to determine if these were isolated events or if these results are representative of the U.S. nursing population.
2. The findings from the SF-36© health survey showed significant deficiencies in social functioning, physical functioning and bodily pain. Further research is needed to explore and define the specific influencing factors affecting these outcomes. Only then can proper countermeasures be developed through engineering, education, and policy.
3. Future research should focus on quantifying controllable factors such as congestion and/or limited space, which could be addressed by developing building standards related to minimum access/space needed to/around a patient. Currently, there are only recommendations regarding bathrooms, which are primarily dictated by architects and construction companies (National Kitchens & Bath Association, 2006).
4. Future research should focus on the development of increased risk factors based on conditions present. Based on findings from the biomechanical portion of the study, a risk factor could be developed based on a bathroom's configuration, which could ultimately lead to understanding how risk changes when work areas are increased or decreased for other industries.

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