An Exploratory Study: Examining Emergency Department Design-Layout and Nursing Physical Fatigue

by

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ABSTRACT

Nursing physical fatigue is a critical issue that may lead to degradation of care delivery and ultimately result in medical errors. This issue is equally relevant due to the looming shortage of nurses, which has been linked to the physical demands and potential occupational hazards intrinsic to the profession; as well as to the graying of the nursing workforce who experiences gradual loss of strength and agility that accompanies aging as time in the career advances.

In a hospital Emergency Department, the level of nursing physical fatigue can potentially reach its threshold in light of challenging workloads, scope of job assignments and demanding schedules. While in other safety-sensitive industries such as aviation and nuclear plants, similar concerns have been the object of systematic research and addressed with consequent regulations, just recently, the healthcare sector has been engaged in further investigations.

This study proposed to explore the linkage between Emergency Department design-layout and nursing physical fatigue. It was expected that further understanding on this relationship would support evidence-based design propositions linking nursing wellness, job satisfaction, and performance to a higher quality of care and improved patient safety levels. To this end, data collection was performed during four weeks in a community-based hospital. A convenience sample of twenty-four eligible nurses was invited to participate in this two-part study. The first section consisted of the completion of a self-administered questionnaire, which assessed nurses’ perception of the impact of working conditions on nursing physical fatigue. The second section included the monitoring, through the use of accelerometers, of nurses’ actual activity intensity levels during three consecutive shifts.

Among other findings, data demonstrated that nurses perceive several attributes or components of the built environment as potential contributors to physical fatigue. In addition, various operational practices and organizational protocols were linked to physical
fatigue. Contrary to nurses’ perception of physical fatigue, their actual physical activity levels fell mostly between sedentary or light intensity ranges. This paradox offers the opportunity for design interventions that, in alignment with operational practices and organizational protocols will enhance nurses' performance and improve nurses' retention.
DEDICATION

I dedicate this research project with love to my mother who, while alive, always supported my professional career by instilling in me the passion for knowledge, culture, and the pursuit of new horizons. She always supported me financially and emotionally in my journey as an Architect and as an immigrant to the United States of America.

To my son Philipe, who, even though unwittingly, has always been a protagonist of this journey of a too busy mother, that was never there when he needed me most, and was always there when he needed me least.

To my husband Bob, who has been always present to help me to bridge the cultural and language gaps as an immigrant.

I dedicate this research project to the United States of America, a great country with plenty of opportunities for those who appreciate God’s blessings and are willing to work hard to pursue the American dream.
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I want to express my special admiration to Dr. Barbara Ainsworth. Her passion and commitment to public health is overwhelming. Her knowledge, expertise in physical activity, and advocacy to the general public welfare amazes me. I consider it an honor having been able to attend her classes and to be introduced to important issues that are directly correlated to the social role of architects and designers.

Thanks to Betsabe Duenas, friend and colleague, who helped me to overcome my presentations skill limitations, often bridging gaps between the younger, technically savvy student and the older, technically challenged “old school generation”. Thanks to Lisa Barber-Stores, friend and colleague, who helped me to improve my analytical and synthesizing skills when doing my literature research, often pinning me down from the high clouds of the field of all possibilities, to the sound ground of the simple “fundamentals”.

Thanks to Kerri Badura who provided so much support by proposing a weekly group meeting so that all of us could sustain the momentum and move forward with our studies. Finally, thanks to all the nurses for being part of such an altruistic profession. Your contribution to society is priceless.
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Chapter 1

INTRODUCTION

“There has been an unfortunate disconnect between the physical design of healthcare facilities and the development of outcomes at the operational, clinical, and service design-layout” (Marberry, 2006, p. 25).

This study proposed to examine the linkage between Emergency Department design-layout and nursing physical fatigue. It was expected that further understanding on this relationship would support evidence-based design propositions linking nursing wellness, job satisfaction, and performance to a higher standard of care and improved patient safety.

This chapter introduces the issue of nursing physical fatigue and its adverse repercussions on healthcare delivery processes. Additionally, the significance of this study, its problem statement, scope and delimitation are depicted. Finally, key definitions are elucidated.

Background information

There is an urgent need to address the problems in the healthcare environment that are impeding patient safety efforts and contributing to staff dissatisfaction and workplace injuries. An opportunity exists for architects, administrators, and clinicians to work together to design, develop, and implement innovative care delivery models to improve the quality of patient care and the workplace environment for staff (Ulrich, Berry, Quan, & Parish, 2010, p. 57).

“Patient safety is the cornerstone of high-quality health care” (AHRQ, 2008). To this effect, “nurses are critical to the surveillance and coordination that reduce adverse outcomes” (AHRQ, 2008, p.4), and crucial in preventing the lasting effects of comorbidities and symptoms (AHRQ, 2008, p. vii).
Nursing physical fatigue has been the norm, not the exception. The daily work of nurses in the hospital setting is intrinsically stressful. Prolonged shifts, excessive walking or standing positions, patient handling tasks, high case loads, time pressures, poor sleep habits, and high performance expectations contribute to the well-documented rates of burnout, depression, job dissatisfaction, and workplace fatigue among nurses. In addition, the hospital nurse workforce is experiencing greater workloads resulting from shorter hospital stays, rising average patient acuity, fewer support resources, and a national nurse shortage (Hey, Aiken, Sloane, Clarke, & Vargas, 2004).

By nature, emergency medicine contributes to this rather unfavorable clinical setting for both patients and providers. A hospital Emergency Department is notorious for being a stressful, chaotic, and unpredictable environment within the hospital (Levin et al., 2006). In this sense, nurse retention, performance, job satisfaction, nursing skills and experience are the predominant issues on account of nurse turnover. There is an urgent need to improve nurses’ working conditions to retain the existing work force and attract nurses into emergency nursing. A failure to do so will result in an acute emergency nurse shortage (How Severe Is Nurse Burnout, 2007, p. 5).

In this context, the “physical environment is an important component in the acute care setting that can affect nursing and medication accuracies, as any inadequacy would contribute to staff fatigue, stress, and burnout and result in errors” (Chaudhury, Mahmood, & Valente, 2009, p. 755). Conversely, “the reduction of staff stress (and error) by ergonomic interventions, as well as environmental considerations can have significant impact on staff health, which in turn, can influence staff efficiency and contribute toward patient safety” (Chaudhury et al., 2009, p. 756).
By definition Evidence-Based Design is “the deliberate attempt to base building
decisions on the best available evidence with the goal of achieving the best possible

The best available research to make building decisions requires a merger of
evidence from the healthcare field with environmental science, interior design,
arquitecture, engineering, and other disciplines. The goal of the multi-professional
design team is to create an environment that promotes healing, supports family
involvement, facilitates efficient staff performance, and reduces stress in all users of
the facility. At the same time, the design should result in measurable improvement
in the facility’s clinical outcomes, economic performance, employee productivity,
customer satisfaction, and cultural congruency (p.284).

It is imperative, therefore, for architects, designers and all decision-making parts of a
healthcare facility construction endeavor, new or existing, to shift the paradigm from
traditional anecdotal project delivery processes to evidence-based design models, warranting
this way the alignment between the existing or proposed built environment, organizational
protocols and operational practices. In this context, the role of nurses is crucial. Nurses are
increasingly accountable for patient outcomes (Tabone, 2004). Therefore, their participation
in healthcare facility design processes represents an immense opportunity to bring to the
table critical issues and potential pertinent solutions. Their lived experience of patient care is
unparalleled by any other profession. Not only nurses are conversant about the most
efficient methods for care delivery practices, they are more experienced and familiar with the
demographics of the populations their facilities serve than other members of the design team
(Cesario, 2009).
In conclusion, nurses’ contribution to the design process is a sine qua non condition to the success of a healthcare facility project.

Significance of the study

Concerns about the effects of nursing physical fatigue and workforce staffing are at the top of the list with three of the 26 most recently funded studies focused exclusively on fatigue, and six of the 26 AHRQ (Agency for Healthcare Research and Quality) studies addressing the issues of nursing workload and fatigue on patient safety within the context of care delivery. (Robinson, Jagim, & Ray, 2004, p.1).

In 2001, the Institute of Medicine (IOM) published “Crossing the Quality Chasm”, which identified U.S. hospitals as dangerous places for patients, families and staff members. Moreover, medical errors and nosocomial infections are among the leading causes of death in America, taking more lives than AIDS, breast cancer, and car crashes (Ulrich et al., 2004).

To this date, there is sufficient evidence that demonstrates that nurse fatigue has a negative impact on nursing performance, retention and threatens patient safety (Tabone, 2004). Interestingly, “while reducing staff stress and fatigue through a healing and supportive environment seems like an obvious goal, there are relatively few studies that have dealt with this issue in any detail” (Anscombe, 2010, p.4). Most of these studies are focused on sleep debt, nurse-patient ratio, workloads and nurse shifts (How Severe Is Nurse Burnout, 2007).

The present study proposed to examine the linkage between Emergency Department design-layout and nursing fatigue through both a subjective and physiologic approaches.
Problem statement

“Medical errors and hospital-acquired infections are among the leading causes of death in the United States, each killing more Americans than AIDS, breast cancer, or vehicle accidents” (Ulrich et al., 2004, p.2).

Nursing physical fatigue is a critical issue that may lead to degradation of care delivery and ultimately result in medical errors (Kunert, King & Kolkhorst, 2007). This issue is equally relevant due to the looming shortage of nurses (Welton, Decker, Adam, & Zone-Smith, 2006), which has been linked to the physical demands and potential occupational hazards intrinsic to the profession (Chiu & Wang, 2007; Menzel, Brooks, Bernard, & Nelson, 2004; Page, 2004); as well as to the graying of the nursing workforce (Page, 2004; Welton, 2006), who experiences gradual loss of strength and agility that accompanies aging (Page, 2004), as time in the career advances.

In a hospital Emergency Department (ED), the level of nursing physical fatigue can potentially reach its threshold in light of challenging workloads, scope of job assignments and demanding schedules (Menzel et al., 2004; Page, 2004).

While in other safety-sensitive industries such as aviation and nuclear plants, similar concerns have been the object of systematic research and addressed with consequent standards and regulations, just recently, the healthcare sector has been engaged in further investigations (Page, 2004).

The design-layout and other elements of the built environment influence the delivery of healthcare and its outcomes. Furthermore, “the built environment conveys multiple clues about the competence and caring of the provider organization” (Ulrich, 2010, p. 95). Moreover, “an organization’s workers and their work environment have a reciprocal relationship, each influencing the other in an ongoing, dynamic interplay that affects the
level of safety within the organization” (Page, 2004). The IOM, in its “Keeping Patients Safe: Transforming the Work Environment of Nurses report, contents that (Page, 2004):

To construct a nursing work environment that maximizes patient safety, the characteristics of the nursing workforce, the settings in which they provide care, and the nature of their work, as well as the implications of these elements for patient safety, need to be considered (p.65).

Scope of study

“Healthcare cannot be separated from its built environment” (Ulrich, Berry, Quan, & Parish, 2010, p.95).

This study proposed to examine the linkage between Emergency Department design-layout and nursing physical fatigue. To this end, data collection was performed during a 4-week period in 2011 in a community-based hospital located in a large metropolitan area in the southwest region of the United States. A convenience sample of twenty-four eligible nurses was invited to participate in this two-part study.

It was determined that a two-part study was the most appropriate to gather information from the subjects. The first part consisted of the completion of an online survey instrument, which assessed the respondent’s perception of the impact of design-layout, organizational protocols and operational practices on nursing physical fatigue. The second part included the measurement, through the use of accelerometers, of nurses’ actual physical activity intensity levels during three consecutive shifts.
Key definitions

**Design-layout.** For purposes of this study, the definition of *design* ranged from furniture, fixtures and equipment to materials, colors and finishes, being associated mainly with ergonomic, functional and aesthetic aspects of the built environment. Additionally, and in the same context, the word *layout* meant the physical location, distribution and sequence of spaces, being associated mostly with the way these spaces correlate with each other and how they dictate the users’ serial experiences (time-motion experiences).

**Operational practices.** Operational practices are associated mainly with workflow designs. These include nurses’ job activities, their interactions among teams, the nature and scope of their work and task, and how efficient is the sequence of these tasks are performed.

**Organizational protocols.** Organizational protocols include structural and processes aspects of the organization as a whole (Hickam, Severance, Feldstein, Ray, & Gorman, 2003) such as use of teams, policies, resources, culture, social norms, management commitment and training programs.

**Efficiency.** Efficiency, for the purposes of this study, refers to the use of physical, human or time resources by the organization so as to maximize outcomes. A process is said to be more efficient than another if it can provide the same amount of outcome quality using less resources.

**Performance.** Performance, for the purposes of this study, refers to the subjective measure of how well an individual accomplishes what is expected in terms of tasks, activities and services and, additionally, terms of time, quality and quantity. A better performance nurse is the one that contributes to a healthcare organization’s efficiency.
Key definitions related to physiological approaches

For a better understanding of the physiological processes behind physical fatigue, a few concepts and important definitions were presented in order to elucidate the rationale used for one part of this study’s of the data collection.

**Definition of fatigue.** By definition, “fatigue is a protective response, an indicator of an individual’s response to physical and psychological demands, or a precursor of disease states. It is “the awareness of a decreased capacity for activity (physical and/or mental) attributed to an imbalance in the availability, utilization, and/or restoration of the resources an individual needs to perform activity” (Witkoski, & Dickson, 2010, p.490); and the inability or unwillingness to continue effective performance of a physical or mental task (Warren & Tart, 2008). Causes of fatigue include time on task, workload, circadian rhythm alterations, sleep debt, shift work, or illness (Warren & Tart, 2008) as well as a lack of adequate rest, sleep loss, or nonstandard work schedules (Page, 2004).

**Physical activity.** By definition, "physical activity is the bodily movement that is produced by the contraction of skeletal muscle, and that substantially increases energy expenditure" (Ainsworth, 2010, p.201). Physical activity can be considered occupational, i.e. activities done during paid employment, and non-occupational, i.e. leisure, family, transportation, household and other activities (Ainsworth, 2010).

**Physical activity intensity.** The energy cost of performing an activity is known as physical activity intensity (Ainsworth, 2010). It is measured by Metabolic Equivalent Units (METs), which is the activity metabolic cost divided by the resting metabolic rate. Physical activity may be classified as vigorous, when the average rate is higher than 6 METs, moderate intensity, when the average rate is between 3 and 6 METs, and low intensity, when the average rate is lower than 3 METs (Ainsworth, 2010).
Physical fitness. "The ability to carry out daily tasks with vigor and alertness, without undue fatigue, and with ample energy to enjoy leisure-time pursuits and to meet unforeseen emergencies" (Ainsworth, 2010, p. 201).

Conclusion

Nursing shortage is a growing public concern in the United States healthcare system and represents a continuous threat to quality and continuum of care. The physical demands of the nursing profession are among the main reasons nurses leave the workforce. These same physical demands are among the reasons younger generations do not enter the field.

The following chapter will provide a comprehensive literature review on a growing body of evidence that demonstrates that nursing physical fatigue has been the norm, not the exception.
Chapter 2

REVIEW OF LITERATURE

“Across the literature, it is suggested that key relationships may tie nurses’ health status and behaviors, retention, patient safety, and care quality together” (Tucker et al., 2010, p.255).

Introduction

This literature review is comprised of five sections. It is grounded on the premise that nursing physical fatigue is result of a combination of factors, and it builds upon the working condition categories created by the Agency for Healthcare Research and Quality (AHRQ) report: “The Effect of Healthcare Working Conditions on Patient Safety” (Hickam et al., 2003). This classification, which is in consonance with human factors research in different disciplines and industries such as aviation, transportation and nuclear power, was used as a framework for this study. Selection criteria consisted of inclusion of all aspects of the healthcare delivery process that can be related directly or indirectly to nursing physical fatigue as follows:

1. Workforce Staffing: Job Assignments, Volume of Work, and Work Schedules.
2. Workflow Design: Inefficiency, “A 36-Hospital Time and Motion Study” and Information Technology.
3. Personal and Social Aspects: Demographics and Life Style.
Under this taxonomy, three sub-categories were created with the purpose of clustering information: Causes, Effects and Solutions. Causes refer to the attributes, characteristics or quality of working conditions that generate or contribute to nursing physical fatigue. Effects include the outcomes of nursing physical fatigue on staff safety, patient safety, staff performance and staff retention. Solutions are interventions that potentially address these causes and effects. Figure 2.1 illustrates the framework used for this literature review.

Figure 1. Nursing physical fatigue cause and effect framework.
Source: Devised by the researcher.
Working conditions

Evidence revealed that the typical work environment of nurses is characterized by many serious threats to patient safety. These threats are found in all four of the basic components of all organizations - organizational management practices, workforce deployment practices, work design, and organizational culture (Page, 2004, p. 3).

This review of literature demonstrates how hospital working conditions directly affect nurse's safety, performance and job satisfaction; and, as a result, patient safety and quality of care. It illustrated how physical fatigue is not a product of isolated factors, but the result of a corollary of cause-effect dynamics referenced to in the study as "working conditions". In addition, sufficient evidence is provided to support a call for healthcare organizations to invest in their most valuable assets: healthcare providers. This scenario also creates an open invitation for architects and designers to incorporate evidence-based design protocols into their agenda, and honor their commitment to provide socially responsible design propositions.

Workforce staffing

"Research is now beginning to document what physicians, patients, other healthcare providers, and nurses themselves have long known: how well we are cared for by nurses affects our health, and sometimes can be a matter of life or death" (Page, 2004; p. 2)

Nursing physical fatigue is a serious issue whose effects percolate in all levels of care, ultimately impacting an organization’s bottom line. Healthcare organizations are being challenged to address this issue without further ado. They may leverage this powerful momentum by revising outdated regulations and establishing data-driven practices that will foster nursing performance while reducing physical fatigue. The following section explores
the issue of nursing physical fatigue within the context of scheduling patterns and the nature and magnitude of demanded physical tasks.

**Job assignments**

The nature of nurses’ assignments in a hospital setting is physically and psychologically demanding. In every work shift, “nurses risk exposure to hazardous chemicals, unhealthy food choices, violence, bullying, sharps/needle sticks, infectious disease exposure and occupational injuries such as musculoskeletal disorders in the healthcare workplace” (American Nurses Association, 2011). The following section of literature chronicles how certain patient-care related tasks may contribute to nursing physical fatigue and may result in eventual occupational injuries.

**Occupational injuries**

By definition, physical fatigue is both an indication of illness and a normal physiologic consequence of exertion (Rodriguez, 2000). In healthcare settings, prolonged physical exertion has been associated with occupational injuries.

The nursing profession requires standing and walking positions for prolonged periods of time (AHRQ, 2008), both being considered major contributors to physical fatigue. In addition, nurses are exposed to various patient-handling tasks considered of high-risk for producing occupational musculoskeletal disorders such as bending, twisting, lifting and pulling (Menzel, Brooks, Bernard, & Nelson, 2004).

Epidemiological evidence demonstrates that nursing professionals experience a higher prevalence of occupational musculoskeletal disorders than most other occupational groups (Chiu & Wang, 2007; Factors Associated with Work, 2006; AHRQ, 2008; Robinson et al., 2005). According to the United States Bureau of Labor Statistics, registered nurses are among the ten occupations reporting the greatest number of musculoskeletal disorders resulting in absence. According to the American Nurses Association, nursing personnel has
the higher rates of back-related claims of any trade or industry (AHRQ, 2008; Robinson et al., 2005). In 2001, registered nurses in the United States reached compensation claim rates comparable to construction workers and, in 2002, it was estimated that up to 38% of all nurses suffered from back injuries (Ulrich et al., 2008). Likewise, in 2003, the rate for occupational injuries, many of which were musculoskeletal disorders, was 7.9% full time equivalents (day of absence) for hospital workers (AHRQ, 2008), and, in 2008, the incidence of occupational injuries and illnesses in hospitals was still higher than the standard for private industry overall (United States Labor Department, 2011).

In addition to demanding physical workloads, evidence suggests that there is a positive association between time pressure and occupational injuries due to prolonged exposure to physical and postural demanding positions and insufficient recovery time (Menzel et al., 2004; AHRQ, 2008). Moreover, several common factors are thought to play a role in the occurrence of all types of occupational injuries, including demographics aspects, socioeconomic profile and lifestyle (Thomas, Brown, Hodges, Gandy, Louanne, Lord & Williams, 2006).

As a consequence, data has suggested that the physical workload demands, intrinsic to the nursing profession, is a top reason for nurses’ fatigue and high turnover rate (Chen, 2009). In a survey administered in more than five countries, a total of 39% of participant nurses reported they intended to leave their job in the next year due to physical and mental demands (AHRQ, 2008). In similar research, the percentage of nurses reporting a job transition due to musculoskeletal disorders ranged from 6% to 11%, depending on the body part injured, leading to sick days, disability, and turnover (Menzel et al., 2004; AHRQ, 2008).

Nurses’ safety from occupational injuries and illnesses is an essential prerequisite to patients’ safety. The literature review has demonstrated that the use of single-approach intervention methods has not been successful to reduce the risk of occupational injuries.
Reasons include the combination of possible etiologic factors, the need for a comprehensive organizational involvement (Menzel et al., 2004; AHRQ, 2008), and nurses’ active role in the process. The U.S. Occupational Safety and Health Administration (OSHA) position in this matter is that physical risk factors alone are necessary and sufficient to cause occupational musculoskeletal disorders and that, in reducing these risk factors, the incidence of occupational musculoskeletal disorders is reduced (Menzel et al., 2004). In this context, the role of the physical environment is significant as it may provide conditions that either augment or prevent nurses’ exposure to high-risk positions.

A study funded by the American Association of Occupational Health Nurses Foundation and the Central Arkansas Veterans Healthcare System suggested that healthcare employees may benefit from protective, proactive and preventive interventions such as customized training; health screening programs that focus on fitness and endurance; ergonomics; safety; and pre-placement screening (Thomas et al., 2006; AHRQ, 2008). In addition, the utilization of lift equipment has been proven to be effective in the reduction of incidence and the cost of injury claims. This is provided that the introduction of this equipment is accompanied by a comprehensive patient lifting program and corresponding change in culture (Ulrich, Zimring, Zhu, DuBose, Seo, Choi, Quan & Joseph, 2008). Furthermore, several commercial solutions have been suggested to eliminate, remediate or mitigate occupational injuries including lifting gear, telecommunication and monitoring devices; as well as anti-fatigue materials or products such as cushioned carpet or mats, shoe inserts, foot rails, sit and stand chairs, compression hosiery and orthopedic footwear (Chiu & Wang, 2007).
Volume of work

In addition to challenging physically demanding tasks, nurses have been exposed to greater workloads resulting from shorter hospital stays, rising average patient acuity, fewer support resources, and a national nurse shortage. The following sections of literature explore some of these issues.

Nursing shortage

Healthcare organizations have reported difficulties in attracting and retaining enough registered nurses to provide for patient care needs. Some attribute these difficulties as a result of adverse working conditions combined with an underlying shortage of nursing personnel (Page, 2004). Several working conditions components can be attributed as contributors of the nursing shortage, including job dissatisfaction, inadequate workforce staffing, physical workload demands, increased use of overtime, and meager wages (Robinson, Jagim & Ray, 2005). This section of literature demonstrates how nursing shortages have created an additional workload to the already overburdened nursing personnel.

Data provided by the Health Resources and Services Administration (HRSA) show that nursing shortages indicate a current and continuous supply and demand imbalance for registered nurses services, and projects a growing shortfall up to a 29% deficit by 2020 (Page, 2004). This deficiency of nurses is predicted to worsen in the near future, fueled by a projected 18% population growth by 2020 (Page, 2004), and a 65% growth in the population over age 65, which will require a disproportionately larger amount of healthcare services, both to occur exactly when a giant wave of baby boomers nurses gets ready to retire (Breslin, Gale, & Weitzner, 2003).

Critical nursing shortages are concentrated in specialty care units that require knowledgeable, skilled and highly trained nurses, such as in emergency departments,
Currently with an overall vacancy rate of 11.7% (Robinson et al., 2005). Besides the nursing shortage, registered nurses have experienced increasing workload demands resulted from a combination of the federally mandated “open access to emergency medical care” by the Emergency Medical Treatment and Active Labor Act of 1986 (Robinson et al., 2005); inadequate access to primary care, particularly specialty services; and, most recently, national healthcare reform initiatives (Gurney, 2010). In fact, the number of emergency department visits in the U.S. grew by 23% from 1992 to 2002, while the number of emergency facilities decreased by about 15%.

The human component of medical errors has been associated with inappropriate workforce staffing patterns (Tabone, 2005). Leaner nurse staffing and less nursing time devoted to patients have been associated with increased medication errors; length of patient stay; gastrointestinal bleeding; pneumonia; cardiac arrest; pressure ulcers; falls nosocomial infection; and death (Garrett, 2008; Page, 2004). More significantly, in a recent study, data suggested that each additional patient per nurse was associated with a seven percent increase in the odds of failure to rescue, a seven percent increase in the likelihood of 30-day mortality, a 23% increase in the odds of nurse burnout, and a 15% increase in the odds of a nurse’s job dissatisfaction (Tabone, 2005).

Shortages of clinical staff severely limit the healthcare organization’s ability to respond to increasing levels of demand; they also affect these providers’ ability to maintain current levels of service, quality, and profitability (Breslin et al., 2003). Moreover, surveys reveal that nursing fatigue caused by high nurse/patient ratios and prolonged working hours, as a result of the nursing shortage, is a threat to patient safety and a contributor to nurses’ turnover (Tabone, 2004).

In the face of the current and projected nursing shortage, it is imperative that nursing workforce staffing patterns are designed to facilitate the safe delivery of nursing care.
In 2001, the Emergency Nursing Association (ENA) began new methodologies to assist emergency departments in determining best-practice staffing protocols. To this end, it developed the ENA Guidelines for Emergency Department Nurse Staffing which factors, among others, the following components in the equation: patient census, acuity and length of stay; nursing time per patient acuity; and skill mix for providing patient care based on nursing interventions that can be delegated to a non-registered nurse (Robinson et al., 2005).

**Work schedules**

“Sufficient recovery is critical to repairing both a stressed body and a stressed mind” (Chen, 2009, p.4). This section of literature examines the linkage between workforce scheduling patterns and nursing physical fatigue.

*Duration of shifts | days per week*

The following section expands on the impact of duration of work shifts on nursing performance, hence on nursing physical fatigue.

It is a common and general practice for the nursing profession to work longer hours than the recommended or previously allocated to their schedules. In a recent study, more than half of shift nurses reported that they worked three to ten hours overtime per week, and 52% of them reported they worked shifts longer than 12 hours at least once or twice per week.

According to the Institute of Medicine report “Keeping Patients Safe: Transforming the Work Environment of Nurses” (Page, 2004), prolonged work hours and interrupted sleep patterns may lead to fatigue, which in turn may compromise nurses’ cognitive and physical abilities (Page, 2004). Similarly, in a recent report of the National Institute of Occupational Safety and Health (NIOSH), contended that working more than 40 hours per week, which is considered overtime; working extended shifts, i.e. more than eight hours; and
working both prolonged shifts and overtime may have adverse effects on staff health (AHRQ, 2008).

The Evidence is overwhelming that nurses who work longer than 12 consecutive hours or work when they have not attained sufficient sleep are risking their own health, putting their patients’ health at risk, and, if they drive while fatigued, also are putting the health of the general public at risk (Warren & Tart, 2008). In a study, with regard to shifts over 12.5 hours, drowsy driving was reported almost once every five shifts. In the same context, critical care nurses reported the same condition once out of every three shifts. In another recent study, critical care nurses who worked 12-hour shifts had an almost two percent higher risk of fighting sleep on their drive home from work than nurses working standard eight-hour shifts (AHRQ, 2008).

The adverse effects of extended work shifts are well known. Prolonged shifts have been associated with increased occupational injuries, cardiovascular symptoms, the development of hypertension, and higher exposure to risks for injuries and occupational hazards (AHRQ, 2008). Working overtime has also been linked with poorer perceived health, increased risk for preterm birth, diabetes, as well as increased morbidity, mortality, and higher rates of accidents (AHRQ, 2008). In the context of healthcare settings, longer work hours also mean nurses’ higher exposure to occupational hazards such as chemical and infectious agents and shapers accidents. Conjointly, increased physical, mental, and emotional demands reduce the time available for physical activities or healthy meals precluding nurses to engage in a healthy lifestyle. All these factors may contribute to job stress, which in turn has been associated with increased smoking habit, alcohol consumption, and caffeine use (AHRQ, 2008). In addition, in a self-reported study among nurses alertness, results demonstrated that performance and satisfaction wane with longer shifts (Tabone, 2005).
The Agency for Healthcare Research and Quality funded a project that reviewed evidence on how other safety-sensitive industries have placed restrictions and regulations on the work hours of personnel. Still, the healthcare industry, with few exceptions, has enforced no such limits (Page, 2004) challenging all stakeholders of the healthcare delivery system; particularly care providers, to take actions towards regulation and appropriate policies. Nurses representatives and policymakers should work together to promote a shift in culture that not only permits but often encourages nurses to work long hours without attaining sufficient sleep (AHRQ, 2008). To this effect, schools and state boards of nursing, in addition to healthcare organizations, should inform nurses about the threats and risks to patient safety caused by fatigue (Page, 2004). The Institute of Medicine report “Keeping Patients Safe: Transforming the Work Environment of Nurses” report (Page, 2004) called for regulatory bodies to regulate nurses’ schedules to safe levels.

In the “Patient Safety and Quality: an Evidence-Based Handbook for Nurses” (AHRQ, 2008), it is contend that:

“Several other "authorities have recommended the limitation of work shifts 12 hours in a 24-hour period, and no more than 48 to 60 hours per week. Concomitantly, authorities do not recommend the use of 12-hour shifts unless there are sufficient rest breaks, there are adequate arrangements for coverage of absentees, overtime will not be added, and shift systems are designed to minimize the accumulation of fatigue” (Chapter 40, p. 10).

Inter-shift recovery | insufficient sleep

In general, adults need at least six to eight hours of sleep to function adequately at work (Page, 2004). Studies suggest that average sleep durations have decreased from nine hours in 1910 to less than seven hours in 2002. Work schedules may be exacerbating this pattern among nursing professionals. This section explores the importance of sufficient
recovery time in workforce scheduling designs (AHRQ, 2008) and to the mitigation of
nursing physical fatigue.

"Fatigue and daytime sleepiness associated with stressful working conditions and
burnout is believed to be a result of insufficient sleep, rather than a direct result of stressful
working conditions or burnout" (AHRQ, 2008, p.11). Sleep debts, or insufficient sleep, is
likely to occur when a minimum amount of time is not utilized to sleep or recover, which
typically occurs with very short inter-shifts periods of eight hours or fewer. Concomitantly,
working more than four consecutive 12-hour shifts has been associated with excessive
fatigue and longer recovery times (AHRQ, 2008). In a research study, over two-thirds of the
participant nurses reported having struggled to stay awake while on prolonged shifts, and
20 % reported actually falling asleep while at work. In another study, critical care nurses
reported struggling to stay awake almost once every five shifts they worked (Scott, Rogers,
Hwang, & Zhang, 2006).

"According to the National Center for Sleep Disorders Research and the National
Highway Transportation Safety Administration Expert Panel on Driver Fatigue and
Sleepiness, sleep loss is the leading cause of drowsy driving and sleep-related vehicle crashes
(AHRQ, 2008, p.3). The effects of awaken periods for as long as 24 hours are equivalent to
drinking two to three alcoholic beverages. Such conditions result in impairment in cognitive
and psychomotor performance similar to that of an individual with a blood alcohol level of
0.10%, which is considered legally drunk (Kunert, et al., 2007; AHRQ, 2008).
Correspondingly, after being awake for 17 hours, cognitive and psychomotor performance
degrades similarly to a 0.05% blood alcohol level. These indications are substantiated by
laboratory studies which have shown that moderate levels of prolonged wakefulness can
incur in performance impairments equal to or greater than levels of intoxication considered
unacceptable for driving, working, or operating equipment (Kunert, et al., 2007; AHRQ, 2008; Warren et al., 2008).

The Agency for Healthcare Research and Quality in its report “Making Healthcare Safer: A Critical Analysis of Patient Safety Practice” endorses these facts and contents that sleep deprivation results in different adverse effects including decreased alertness and poor nursing performance (Page, 2004). Cognitive performance can fall to nearly 40% of baseline after two nights of missed sleep (Tabone, 2005). Other studies have demonstrated that prolonged wakefulness effects include significantly impairment of speed and accuracy, hand-eye coordination, memory (AHRQ, 2008), cognitive processes and reaction times. In addition, mental concentration also begins to wane, and emotional lability (a condition of extreme emotional reactions and frequent mood changes) becomes evident (Warren et al., 2008; Witkoski & Dickson, 2010). Interestingly, there is also a growing body of evidence indicating that insufficient sleep may be a contributing factor to the growing obesity epidemic in the U.S. (AHRQ, 2008).

These findings support an axiomatic fact: sleep duration is a significant predictor of medical errors (AHRQ, 2008; Warren & Tart, 2008), providing sufficient evidence that indicates that insufficient sleep or recovery time affects adversely patient safety (AHRQ, 2008). In her landmark study, Rogers demonstrated that nurses working 12.5 hours or longer in a 24-hour shift increased the possibilities of making an error by three times when compared to an eight and a half hour shift.

Despite nurses being well-versed in healthcare issues, which should include an understanding on the importance of sleeping and recovery patterns on a daily basis, their sleep habits have been no different from those of other Americans who obtain less than six hours sleep (AHRQ, 2008). Proper inter-shift intervals policies and regulations will have to
take place as no amount of training, motivation, or professionalism for that matter, will allow a person to compensate for the safety risks linked to fatigue (Page, 2004).

**Sleep quality | night shifts**

Sleep disorders have been amply recognized as an occupational health issue among shift nurses and a chief contributor to chronic fatigue (Chen, 2009). The following section of literature looks into how sleep quality affects nurses’ performance, which, in turn, has been associated with nursing physical fatigue.

Poor sleep quality, in the context of healthcare settings, is a condition characterized by shorter, lighter and fragmented sleep duration, primarily associated with stressful working conditions and nursing fatigue (Kunert et al., 2007; AHRQ, 2008). According to the Institute of Medicine (IOM) report “Keeping Patients Safe: Transforming the Work Environment of Nurses” (Page, 2004), extended work hours and interrupted sleep patterns can result in fatigue. In addition, in one of its reports, the Agency for Healthcare Research and Quality (AHRQ) contends that chronic fatigue and reduced overall sleep quality are common among healthcare personnel (Kunert et al., 2007; Page, 2004; Ruggiero, 2003).

In this context, night and rotating shifts nurses rarely obtain satisfactory quality or sufficient amounts of sleep, usually obtaining one to four hours less sleep per week than regular shifts nurses (AHRQ, 2008). In addition, daytime sleepers awaken feeling less restored (Kunert et al., 2007; Page, 2004; Ruggiero, 2003) and tend to experience more fatigue, sleep disturbances, anxiety and depression (AHRQ, 2008.; Ruggiero, 2003). Overall capacity for physical work, "reaction times, visual search, perceptual–motor tracking, and short-term memory are worse at night than during the daytime" (Page, 2004, p. 228).

The consequences of poor and insufficient sleep time include suboptimal nursing performance, and a constant battle to combat fatigue, or to recover and reestablish normal circadian rhythm patterns while at work. Circadian rhythms are cycles of 24 to 25 hours that
function like internal biological clocks regulating physiological functions such as mood and sleep, according to temporal factors such as light, dark, and social interactions. Night shifts tend to disrupt diurnal circadian rhythms patterns resulting in fatigue and other adverse effects (Ruggiero, 2003).

Findings suggest that the poorer sleep quality and greater feelings of fatigue in night shift nurses may lead to more mistakes in patient care (Kunert et al., 2007). A research study revealed that nurses who worked night shifts were almost twice as likely to make a medication error, compared with day shifts nurses. In another study, night or rotating shifts nurses also committed more procedural and medication errors due to sleepiness than did regular shifts nurses (Page, 2004).

Additionally, fatigued night shift workers are found to have decreased motivation, energy and on-duty performance (Page, 2004). In conclusion, fatigue and insufficient sleep quality among nurses significantly contribute to poor quality of life (Kunert et al., 2007) and job dissatisfaction, which may be the main reasons nurses often seek to be moved from night to day shifts (Kunert et al., 2007).

Strategies to ensure nurses proper sleep quality sufficient quantity include suitable work shift scheduling policies. Additionally, organizational protocols that will include rest and break intervals during and between shifts, and finally behavioral changes that will encourage nurses to take responsibility for their personal agenda and commit their time according to their physical limitations.

Breaks and naps

Consistently, findings have demonstrated that nurses across care settings are not only working long hours, but also often renouncing break or meal opportunities to provide care for patients (Witkoski & Dickson, 2010). Breaks are considered a valuable source of recovery. Studies have proved that after an eight-hour shift nurses naturally reduce their
work pace patterns in an attempt to cope with fatigue (Chen, 2009). This section of the literature elucidates the importance of advocating for compulsory and voluntary break policies within the nursing profession.

A survey conducted by the American Nurses Association (AHRQ, 2008) found that 35% of the participating nurses reported rarely or never taking a meal break. Another study concluded that nurses who did not smoke were less prone to take breaks than their smoking peers. A recent study also revealed that less than half of hospital nurses were entirely free of patient-related responsibilities during a meal or break period and, in addition, nurses working the longest hours were the least likely to receive appropriate breaks (AHRQ, 2008).

Studies suggest that short naps of 20 minutes may be beneficial to night shift nurses in combating fatigue, as well as increasing cognitive abilities such as mental acuity (Kunert et al., 2007). A study examined work breaks and errors in a sample of hospital staff nurses and found a 10% decrease in the prospect of making an error when nurses had an extra 10 minutes for their meal and break periods (Witkoski & Dickson, 2010). Studies have indicated that short breaks not only improve performance and reduce fatigue, but they are useful in discontinuing the built-up risk associated with prolonged task performance and sleepiness (AHRQ, 2008).

Healthcare organizations should give strong consideration when evaluating breaks, rest periods, scheduling patterns, and overtime protocols to improve working conditions of shift nurses. Providing such opportunities will likely improve nurses’ well-being, decrease job-related fatigue, promote safety, and increase staff retention (Kunert et al., 2007).

The presence of well-rested and healthy nurses is fundamental to administer vigilant monitoring, empathic patient care, and competent advocacy (AHRQ, 2008). Several strategies have been suggested to improve night shift nurses’ ability to remain alert throughout their entire shift. These include the monitored use of caffeine; the use of nap
intervals policies while at work; and the development of resting habits prior to commencing shifts since shift nurses are typically awake longer before the beginning of their shifts. Additionally, nurses should be aware that most individuals are not able to assess how impaired they are regarding fatigue or sleep deprivation. Therefore, nurses should be held accountable for the responsible allocation of the time to be dedicated to patient care.

**Workflow design**

A reconsideration of hospital design and work processes holds the potential to affect the efficiency and effectiveness of care delivery for the foreseeable future. Bold changes in the hospital work environment are imperative to ensure the sustainability and affordability of the hospital as part of the American healthcare delivery system (*A 36-Hospital Time-Motion*, 2008, p. 1).

Nurses are at the forefront of the healthcare delivery system (Hendrich, Chow, Skierczynski & Zhenqiang, 2008). They face herculean physical, emotional and cognitive demands on a daily basis. Effective workflow designs are fundamental to maintain staff safety, performance and retention, all of which are predictors of patient outcomes. This section of literature review looks into aspects of workflow designs and how they may impact nursing physical fatigue.

**Inefficiency**

Wasteful and inefficient processes are not limited to patient flows, as they are endemic throughout the healthcare system (The Case for Streaming Workflow, 2004). The next segment of literature review will illustrate how inefficiencies can have a ripple effect on nurses’ performance impacting all levels of the healthcare delivery process.

The largest, best-trained, and most dedicated workforce will still make errors. Its fallibility is an immutable part of human nature. However, this innate fallibility can be compounded when the practices, procedures, tools, techniques, and devices used...
by workers are unreliable, complex, and themselves unsafe—having been designed, selected, and maintained by other fallible humans. (Page, 2004, p. 226)

Workflow inefficiencies are often common in hospitals, usually threatening patient outcomes and ultimately an organization’s bottom line. Inefficiencies usually result in bottlenecks with consequent patient diversions, cancellations of elective surgeries, loss of patients’ loyalty to other facilities, and greater length of stay than necessary (Harrison, Henriksen, & Hughes, 2007). Some inefficient processes or systems include inadequate workforce staffing, deficient collaboration across health professions, poor decision-making processes, improperly designed work and workspaces, and organizational cultures that inhibit proactive systems to detect, manage and prevent healthcare errors and adverse events (Page, 2004). Similarly to other safety-sensitive industries, flaws in equipment or work design, equipment and human failures, and unanticipated interactions in work processes are recognized as major causes of inefficiencies in healthcare settings as well (Page, 2004).

All these factors add extra loads to an already overburdened healthcare workforce, affecting negatively staff and patient safety, and compromising staff and patient satisfaction.

Work design involves examining the cause-effect dynamics among the various elements of working conditions that workers encounter and experience when performing their duties. To this effect, nurses’ work processes and the physical environment need to be designed to be safer, more efficient, less conducive to the commission of errors, and more conducive to detecting and remedying errors when they occur (Page, 2004).

Consistent themes emerged throughout the literature review section. These themes suggest the reduction of nursing physical fatigue by the utilization of bundles of strategies aimed to promote the optimization of human resources, the alignment between the physical environment and operational practices, the capitalization of technological resources, and the creation of a culture that supports actions and fosters transformation (See Figure 2).
Figure 2. Bundles of strategies to reduce inefficiencies and improve performance. Source: Developed by the researcher.

Examples of how these bundles of strategies can be applied are present all along this literature review. In addition, the Institute of Medicine, in the “Keeping Patients Safe-Transforming the Work Environment of Nurses” (Page, 2004, p. 258), for example, establishes some principles that aim to create reliable and safe patient care processes. These principles include:

1. Nursing participation in all aspects and stages of work design processes, ensuring that all aspects of working conditions are addressed properly and according to the unit-specific structures, processes and expected outcomes.
2. Simplifying and standardizing common work procedures and equipment reducing the likelihood of errors and accidents by decreasing cognitive load demands.

3. Due to the enormous and expanding body of knowledge, and a whole gamut of information necessary for the provision of care, both automated and hard-copy memory aides can compensate for the limitations of human memory.

4. Reducing the commission of medication errors by eliminating lessening the levels of incidence of their utmost causes: distractions, interferences and interruptions.

5. Developing redundancy and back-up systems ensuring the detection of problems before these become catastrophic.

6. Workflow designs with automatic detection, management and correction mechanisms preventing workers from making or repeating errors.

7. Providing alternative sources for the monitoring, vigilance and management of patients reducing reliance on nurses’ cognitive or physical abilities.

8. Reducing the incidence of handoff (or transfer) of patients at any level decreasing the risk of errors, the risk of adverse patient events promoted by the discontinuing of care, and duplication of effort and waste. A number of strategies are being proposed to address this issue such as universal and acuity-adaptable rooms and single stay units.

9. Instant and easily accessible information expediting decision-making processes.

10. Data grouped properly with an integrated system allowing all members of the care team to examine existing conditions and predict future decisions, assigning responsibilities and ensuring proper coordination’s of care.
11. Ongoing knowledge acquisition should be supported. Patients’ records should be linked to the reference literature with respect to policies, procedures, prognosis, diagnoses, educational material, appropriate drug dose, drug contraindications, and the like.

12. The implementations of alerts, reminders, suggestions and rules ensuring that standard of care and other protocols are being followed accordingly.

13. The ability for team members to communicate without each member being present at the same location and point in time, also called asynchronous messaging. Inventories are updated when supplies are used, charges are generated by the entry of point-of-care documentation, and filing activities are optimized.

14. Nurses remain alert to the limitations of and risks created by technology. While being able to alleviate some problems, technology may also generate new forms of error and omission.

15. Ongoing monitoring, feedback, and redesign are needed to create and sustain effective change. Work redesign should be considered an ongoing process.

Other efficiency-driven strategies to be implemented by healthcare organizations include Lean and Toyota processes. Lean thinking is based on the premise that all processes are composed of value-added activities like the promotion of health, and non–value-added activities like spending time looking for supplies or information (The Case for Streaming Workflow, 2004). Most organizations, in an attempt to increase efficiency and the quality of their products or services, typically focus on value-added activities and core competencies (Page, 2004). In doing so, they are neglecting the root causes of non-value-added activities (waste and inefficiency) that result in poor performance and are often nurtured by the organization and institutionalized through policies and procedures (Page, 2004). Lean
techniques include visual controls and indicators; streamlined physical plan layout; standardized work; and point-of-use storage (Page, 2004). In a similar fashion, the Toyota Production System proposes the empowerment of the employee, who is entitled to make improvements by identifying the problem, observing its patterns, finding solutions, communicating results to relevant parties, and monitoring if the desired improvements are achieved and maintained (The Case for Streaming Workflow, 2004).

“A 36-hospital time and motion study”

This section of literature review assesses and builds upon the ground-breaking study “How do Medical-Surgical Nurses Spend their Time?” conducted by Hendrich et al. (2008), one of the few studies to measure how nurses allocate their time in real-time and work contexts. Although performed in a medical-surgical setting, its findings about nurses' time and motion patterns provide highly accurate clues of workflow within any hospital setting, including emergency departments. Therefore, this study can be used as reference for informed conclusions or to set the ground for further investigation. In the above mentioned study, nurses' activities were grouped together into categories and subcategories so nurses' time and motion could be tracked and accounted as follows: Waste, Non-Clinical, Unit-Related, Nursing Practice. Figure 3 illustrates the findings of this research.

![Figure 3](image-url)  
*Figure 3. Reported nurse time spent by category.  
Source: A 36-hospital time and motion study: how do medical-surgical nurses spend their time? (Hendrich et al., 2008).*
These categories were used by the researcher to expand upon workflow design efficiency as follows:

Waste

Waste includes waiting, looking, retrieving, delivering, and “gathering and hunting”.

A significant portion of registered nurses’ time is spent with non-nursing activities such as performing housekeeping duties or performing ancillary services such as the delivery of food trays or medical equipment or supplies (Page, 2004). The inefficient assignment of activities impacts nurses’ primary care responsibilities, such as patient vigilance, provision of therapeutic patient care, and interaction with patients and family members (Page, 2004).

Unit-related

Unit-related tasks include nurses’ time spent with activities such as preparing equipment, counting narcotics and transporting patients between departments. Although these tasks do not account for a significant amount of nurses’ time, they are essential to the continuum of care and may contribute to inefficiencies and physical fatigue. Gaps in the care delivery process demand nurses’ extra work, and time, in trying to compensate for failures or lack of resources to provide for care.

Nursing practice

Patient care activities, for purposes of the study, include nurses’ time spent with tasks such as bathing, monitoring, administering medication and preparing the patient for hospital admission or discharge; plus assessing patient care while off-unit.

Hendrich et al. (2008) demonstrated that nurses on medical-surgery units, spend more than three-quarters of their time on nursing practice-related activities, but less than one-fifth of all nursing time on activities defined as patient care activities. Documentation, care coordination, and medication administration accounted for the greater part of the nursing remaining practice time.
Assessment/reading vital signs

Only seven point two % (31 minutes) of nursing practice time was dedicated to patient assessment and recording of vital signs (Hendrich et al., 2008).

Care coordination

It is the management of any information regarding a patient and his/her care and case delivery plan. The study by Hendrich et al. (2008), it accounted for approximately one-fifth of nursing time.

Ineffective communication is inductive of nurse’s time misuse and poses threaten to patients’ safety (Hendrich et al., 2008). Failure to rescue, i.e. death following the occurrence of an adverse event, is an outcome on account of nurses’ performance, which in turn is associated with miscommunication and clinical negligence. Hence, an efficient flow of patient information through effective communication may decrease time waste and the risk of the commission of errors (Page, 2004).

The use of information technology for the delivery of patient information, as well as the use of intelligent systems that locate, monitor and communicate remotely with patients and team members, will likely enhance efficiency, reduce travel distances and number of trips, potentially increase the time available for direct patient care (Hendrich et al., 2008).

Medication administration

It is estimated that more than 770,000 people suffer injury or death in hospitals annually as a result of adverse drug events (ADEs) (Page, 2004). A six-month study of all ADEs in two tertiary care hospitals attributed 38% of adverse outcomes to medication administration errors commissioned by nursing staff. Within the hospital, the emergency department is the unit that has the highest rate of preventable hospital deaths, followed by medication error. Common risk factors associated with medication errors in the emergency department include frequent distractions and interruptions, often caused by the chaotic
nature of this type of environment; and medication administration errors, often caused by
gaps in the process or fragmentation of the informatics infrastructure (Page, 2004; Hendrich et al., 2008).

Approximately two thirds of all time spent on medication administration in the study by Hendrich et al. (2008) was related to drug delivery to the patient. The other third was spent preparing drugs for administration. The potential for errors within this process urges the nurse’s attention and time, and may be a source of additional distance traveled (Hendrich et al., 2008).

Several strategies have been proposed to address these issues, including ongoing in-service education, use of reference material as decision support, and medication administration assistance devices (Page, 2004). Ideally, medications should be administered as part of a flawless cycle system, with the provision of accurate and timely pertinent information about the patient (Hendrich et al., 2008). The Institute for Safe Medication Practices, along with the Agency for Health Quality and Research, has identified three medication administration technologies as indispensable resources for reducing medication errors at the point of medication administration by nurses: unit dose dispensing, bar-coding of medications, and use of “smart” infusion pumps (Page, 2004).

**Documentation**

Documenting patient care and completing other bureaucratic tasks, has been unanimously cited as representing a heavy demand on nurses’ time in all healthcare settings. In addition, time spent with documentation means reduced time for the monitoring of patients and provision of direct therapeutic care (Page, 2004). Besides being time-consuming, required documentation is often redundant, irrelevant, not followed-through (Page, 2004; Hendrich et al., 2008), and one of the main reasons why nurses work overtime. The careful
review of documentation requirements, in combination with integrated information technology, is crucial to the improvement of this process efficiency (Page, 2004).

**Information Technology**

Evidence suggests that healthcare is expanding in such a pace and volume that it can no longer be managed without healthcare informatics (Lavelle, 2002). In addition, the ever expanding and changing medical practices, as well as advances in technology and equipment, require a volume and level of information that exceed nurses’ cognitive capacity, demanding healthcare organizations to provide integrated and up-to-date information technology systems for the optimal delivery of care.

In today’s healthcare landscape, characterized by an extreme shortage of capital, physical and human resources, healthcare organizations can devise ways to proactively increase staff efficiency and patient safety through Information Technology. Healthcare information systems can be designed specifically to improve workflow processes, allowing clinicians and hospital executives to function as a highly coordinated team (Lavelle, 2002).

To this effect, technology equipment and solutions include wireless networks, handheld and ear communication devices, and intelligent systems that automatically track the physical location of a patient or care team member. Other devices that can contribute to workflow efficiencies are telemedicine, which provides for the shortage of specialty physicians, palm vein scanning for identification, and patient blood monitoring devices (Gurney, 2010). In a similar way, the nurse’s station itself can be optimized through design and process improvement, which includes the provision of healthcare informatics, improving communication, enhancing monitoring and optimizing workflow, reducing the time spent at the nurse’s station while increasing the amount of time available in the patient room (Hendrich et al., 2008).
Personal-social aspects

To construct a nursing work environment that maximizes patient safety, the characteristics of the nursing workforce, the settings in which they provide care, and the nature of their work, as well as the implications of these elements for patient safety, need to be considered. (Page, 2004, p. 65)

Personal characteristics and social idiosyncrasies of nursing professionals are factors that impact or are impacted by nursing physical fatigue, thus need to be taken into account in all levels and phases of the healthcare delivery process. The following section will expand on these factors.

Demographics

Emergency Department registered nurses are part of the 2.6 million of employed registered nurses, the largest demographic of healthcare providers in the United States (U.S. Department of Health and Human Services, 2011). Emergency, or trauma, nurses work in hospital or independent emergency department units, providing initial assessments and care for patients with life-threatening conditions (United States Labor Department, 2011). Nurses play a vital role in the delivery of care, and their personal and social profiles are expected to play a greater role in service delivery than in other domains. This means that “whether the healthcare professional chooses to go the extra mile is likely to have a far greater impact in healthcare than elsewhere” (Page, 2004, p. 62).

Age. The registered nurse workforce is older than the total U.S. workforce standard age with an average of 46 years (U.S. Department of Health and Human Services, 2010). This aging is attributed to three factors. First, a large number of the existing registered nurse workforce are in their fifties or sixties, a product of the baby boom generation; second, fewer young people are choosing to become registered nurses; and lastly, recent graduates of basic nursing programs have been older than in past decades (Page, 2004). Effects of an
aging nursing cohort include the loss of strength and agility required to turn, lift, or provide weight-bearing support to patients, inaptitude to maintain standard neurobiological tests across a 12-hour shifts (Page, 2004), greater sleeping issues than younger nurses, and insomnia (Kunert et al., 2007). In addition, research reveals that occupational injuries increase with aging (Thomas, Brown, Hodges, Gandy, Louanne, Lord & Williams, 2006) as well as challenges with hearing and vision (Page, 2004).

As healthcare organizations look to redesign or construct new facilities, particular attention to environments that better address the idiosyncrasies of an aging nursing workforce may improve working conditions and, therefore, enhance staff performance, safety and retention (Cesario, 2009).

**Gender.** The registered nurse workforce in general is predominantly female (94.6 percent) (Page, 2004). The predominance of women in the nursing profession has a number of implications such as more sleep issues (Ruggiero, 2003), higher rates of occupational injuries, and a tendency to report more fatigue than male nurses (Ruggiero, 2003). Additionally, family responsibilities may add to nurses’ physical workload demands, contributing to sleep deficits, fatigue and job stress (Chen, 2009; Page, 2004; Ruggiero, 2003). At the same time that family burden impact female nurses’ performance, conversely, unbalanced shift schedules tend to disrupt nurses’ private and social lives (AHRQ, 2008), thus impacting nurses’ job satisfaction and retention.

One solution is the tailoring of workflow and workspace designs to the unique demographics that serve a healthcare facility, capitalizing this way nurses’ performance and promoting efficiency, safety and retention (Page, 2004).

**Lifestyle.** The ability to provide self-care is a prerequisite to the practice of the nursing profession (AACN, 2011). “Still the research suggests that nurses’ physical activities,
smoking, and dietary patterns are no healthier than those of the general population, whose health they have been entrusted to improve” (Hensel, 2010, p.48).

Lack of physical activity among nurses is a predisposing factor for obesity and occupational injuries, a common issue in this profession (Thomas, Brown, Hodges, Gandy, Louanne, Lord & Williams, 2006; Kaewthummanaukul et al., 2005). In addition, failing to practice healthy lifestyles contributes to risks for a variety of health problems, and poor health has been cited as a key reason why nurses decide to leave the profession before retirement age (Henzel, 2011).

Nurses who are less physically fit may tire more quickly and become more predisposed to occupational injuries when performing physically demanding tasks (Chen, 2009; Kaewthummanaukul et al., 2005). Research suggests that the risk of developing physical fatigue tends to be reduced for nurses engaged in regular physical activities at leisure time (Chen, 2009) than for the nurses that do not engage in physical activities. In addition, physical strength, endurance and sleep quality are likely to be improved through physical activity (Warren, & Tart, 2008, Kaewthummanaukul et al., 2005). Additional strategies that promote nurses’ overall health and well-being, such as easy access to healthy diets and opportunities for power naps, may enhance fatigue coping and reduce perceived stress, especially when caring for high-acuity patients and working long shifts (Tucker, Harris, Pipe, & Stevens, 2010).

Nursing and other healthcare leaders can become facilitators within the design process, helping health facilities planners understand the importance of employee wellness initiatives, including fitness promotion programs and stress relief interventions. "Focusing on nurses' health will impact nurses’ morbidity and mortality (e.g., stress, weight, physical activity), and in turn their tenure and retention in the work force" (Tucker et al., 2010, p.266).
Physical environment

“Current research suggests that two interrelated elements—nurse work process and the physical hospital environment - contribute to the efficiency and safety of patient care” (Hendrich et al., 2008, p.26).

In her book, "Notes on Hospitals" (1857), Florence Nightingale, founder of the nursing profession, stated “First, do no harm” implying that hospitals should be a safe place, advocating for the improvement of care and conditions in these kind of settings (Audan, 2010). Paradoxically, in 2001, the Institute of Medicine published “Crossing the Quality Chasm”, which identified U.S. hospitals as dangerous places for patients, families and staff members (Ulrich, Quan, Zimring, Joseph & Choudhary, 2004). Moreover, medical errors and nosocomial infections are among the leading causes of death in America, having taken more lives than AIDS, breast cancer, and car crashes (Ulrich et al., 2004).

The structure and design of healthcare facilities impact the health and well-being of patients, staff members, and visitors (Cesario, 2009). Additionally, the physical environment can either contribute or hinder efficiency, performance and job satisfaction.

Currently, many hospitals are trying to provide state-of-the-art care in obsolete facilities. Very often, operational practices and work processes have been adapted to the hospital physical environment, rather than the other way around (Breslin et al., 2003).

In face of these challenges, a question is raised about the best way to serve patients and healthcare providers (Cesario, 2009). Healthcare must be accessible to all (Cesario, 2009). The needs of an increasingly diverse and increasingly acute patient population must be considered; older and larger size patients must be regarded; and existing and new construction must be compliant with the requirements set forth by the Americans with Disabilities Act (Cesario, 2009). More important, the peculiarities of the aging nursing workforce need to be addressed, and strategies to attract and retain younger generations to
the field need to be undertaken. Additionally, in order to remain financially solvent and competitive, healthcare organizations need to keep up with the latest technologies, state-of-the-art equipment, and provide for a well informed and demanding patient population.

In order to face these challenges, many healthcare organizations are turning to evidence-based design as the best way to take well-informed and cost-effective decisions.

**Evidence-based design**

In a report by Ulrich et al. (2004) entitled “The Role of the Physical Environment in the Hospital of the 21st. Century: A Once-in-a-Lifetime Opportunity, a call is made for a shift in paradigm within healthcare design processes. In this report, it is suggested that hospital design can “reduce staff stress and fatigue and improve effectiveness in delivering care, patient safety, reduce patient and family stress and improve outcomes and improve overall healthcare quality” (Ulrich et al., 2004, p 2). In addition, a parallel was established between “evidence-based medicine,” where clinical choices are informed by scientific rigor research, and healthcare design processes, which have been “increasingly guided by rigorous research linking the physical environment to measurable outcomes” (Ulrich et al. (2004). This new paradigm has been called Evidence-Based Design.

In this process, a multidisciplinary and collaborative team is formed, along with a well-informed client, to collaborate in the design process and decision-making is based on the best information available from current research, project evaluations, and evidence gathered from the operational practices of the client (McCullough, 2010).

Nursing performance (and errors) can be conceptualized at two levels, “active failures” and “latent conditions”. While active failures are caused by the person on the frontline, latent conditions refer to failures or inefficiencies resulting from decisions made by the management and architects (Chaudhury et al., 2009). Therefore, the physical environment needs to be supportive of nurses' practices as well as of their particular needs.
Key environmental variables, or latent factors, that have the most real or potential impact on occupational fatigue are noise, lighting, ergonomics and design/layout (Chaudhury et al., 2009). Other inefficiencies that result in fatigue arise from interruptions and distractions associated with nursing tasks; limited access to information systems; and inefficiencies of workflow designs, including the utilization of nurses’ time to perform janitorial or ancillary tasks (Page, 2004).

With obsolete healthcare facilities being renovated and new facilities being constructed today (Cesario, 2009), and with a projected construction boom to exceed $70 billion a year in facilities that will last from 30 to 50 years, many organizations are using evidence-based design in their capital facility investment processes (Harrison et al., 2007; Zimring et al., 2008).

Evidence-based design is fueled by the growing body of rigorous research showing that the appropriate design of the built environment contributes to significant, measurable improvements of key patient, staff, and organizational outcomes, such as increasing patient safety, improving patient and family satisfaction, increasing market share, increasing effectiveness of its work force, improving retention and reducing turnover, and increasing revenue and reducing cost (Zimring et al., 2008, p. 1).

Nurses’ repertoires on healthcare delivery systems, processes and expected outcomes are extremely valuable and better synchronized with the demographics of the populations served by their facilities. Their lived experience with patient care, unmatched by any other profession, is fundamental to user-centered design propositions and must be included in evidence-based design processes (Cesario, 2009).

Nurses have been increasingly accountable for patient outcomes. Their participation in healthcare facility design processes is fundamental as much as their input is crucial to the
optimal functioning of these. At the end, both facility and operational designs set the stage for their professional roles (Cesario, 2009).

**Environmental stressors**

Nurses experience a high level of job environmental stressors while at work. This contributes to occupational fatigue and has been associated with employees’ intention to leave the job. This issue is important due to the looming shortage of nurses which is projected to increase threefold by 2020 (Ulrich et al., 2008).

*Noise.* Noise levels have increased considerably in healthcare settings during the past 50 years and have been associated with negative effects on nurse performance. Noise, often cited by both patients and nurses as a major environmental stressor (Cesario, 2009), can originate from overhead paging systems and equipment alarms to heating, ventilation, and air-conditioning (HVAC) systems, plumbing, and ice machines (Page, 2004). Exceptionally high noise levels are prominent during shift changes, during orthopedic surgery, in the laundry area, and on the heliport (Cesario, 2009). Inadequately designed acoustical environments may compromise patient confidentiality, disrupt sleep, and cause fear or disorientation. In addition, it may interfere with communication between patients and nurses or between healthcare team members (Page, 2004; Chaudhury et al., 2009; Cesario, 2009). Compromised communication resulted from prolonged reverberation and speech clearness due to background noise has been associated to medical errors (Page, 2008; Cesario, 2009). Frequent or prolonged exposure to high noise levels has been associated with stress, hearing impairment, slower healing rate, hypertension; lapses in short-term memory, irritability, and patient sleep disruption, family dissatisfaction, and nurse burnout (Page, 2008; Cesario, 2009).

Environmental stressors are critical to creating a healing and productive environment. Noise and other sensory interference can be reduced by employing strategies
developed by a number of different disciplines, including human factors, ergonomics, engineering and evidence-based design. Among possible solutions, specific design features to reduce noise include nursing unit layout, the number of beds, nurses’ station typology, type of flooring, sound insulation in walls, high sound-absorbing ceiling tiles, elimination of overhead paging system, reduced noise in telemetry alarm system, electronic sound masking devices and employee training (Chaudhury et al., 2009). In addition, the use of hands-free communication devices eliminating overhead paging, the silencing of alarms in patient rooms, and the provision of areas for staff interaction away from patient care areas (Cesario, 2009) may reduce the levels of noise.

A supplementary suggestion to reduce noise levels is to introduce music. In a recent study, where an audible environment with specially designed music was introduced, staff members experienced reduced sound levels, a less stressful environment and greater relaxation. Moreover, it has been suggested that the use of a sound-control center may reduce noise levels as well as assist in reducing patients’ pain levels (Chaudhury et al., 2009).

*Lighting.* Environmental conditions, such as the type and degree of lighting in work areas affect nurses’ performance and, therefore, patient outcomes (Chaudhury et al., 2009). In addition, as the average age of nurses is increasing, bright work surface illumination levels may be necessary to compensate for sight difficulties, reducing medication dispensation errors and supporting patient-care tasks (Chaudhury et al., 2009).

Florence Nightingale in 1859 noted that lighting is one critical element of the hospital environment and till these days, the relationship between different types and levels of lighting and healthcare outcomes, has been well researched and documented (Chaudhury et al., 2009). For example, depression, agitation, and disrupted circadian sleep-wake cycles are improved by appropriate use of light. Positive distractions such as windows with a view and artwork features have been shown to have a calming effect promoting a more rapid
healing when compared to spaces without windows or with views of other buildings (Cesario, 2009).

Similarly, employees with a window with a view of nature tend to report less stress, better health status, and higher job satisfaction levels (Cesario, 2009).

**Ergonomics**

Ergonomics is a field that integrates knowledge derived from the human sciences such as anatomy, physiology and psychology to match jobs, systems, products and environments to the physical and mental abilities and limitations of workers. The aim of ergonomics is to optimize, first and foremost, the comfort of the worker, as well as his health, safety and efficiency. It has been estimated that at least 50% of all work-related musculoskeletal injuries among the working population could be prevented by appropriate ergonomic job design (Niu, 2010, p.748).

Nurses have many tasks that are physically demanding and, therefore are prone to occupational musculoskeletal disorders (Chaudhury et al., 2009; Cesario, 2009). Preventing ergonomic problems and occupational injuries while obtaining optimal performance can be achieved when equipment, workstations, products, systems and workflows are designed in alignment with nurses’ capabilities and limitations (Niu, 2010).

The most effective intervention programs seem to be those with multiple and coordinated strategies, including efficient design-layout, workstation improvement, provision of adjustable and adaptable furniture, and enhanced medical surveillance and management systems (Ulrich, Quan, Zimring, Joseph & Choudhary, 2004; Chaudhury et al., 2009; Niu, 2010). Research suggests that reduction of staff stress by ergonomic interventions, as well as environmental considerations, can have a significant impact on staff health, influencing positively staff efficiency and contributing toward patient safety (Chaudhury et al., 2009; Cesario, 2009). Additionally, caring for healthcare providers sends a positive message to all
stakeholders, sending clues that the health and safety of all individuals is incorporated in the mission of the organization (Cesario, 2009).

The article the “Effect of Environmental Design on Reducing Nursing Errors and Increasing Efficiency in Acute Care Settings: A Review and Analysis of the Literature”, by Chaudhury et al. (2009), suggests the following solutions to address ergonomic and functional issues:

1. The use of ergonomic devices such as walking belts, shower chairs, and lift equipment has been proven to decrease the rate of occupational injuries and nursing perception of physical fatigue. To this end, the utilization of mechanical devices, such as beds that move from side to side or gurneys that enable a patient to have an x-ray without being transferred to an x-ray table is also recommended.

2. Working areas should be designed to accommodate for extensive sitting and standing time, as well as different profile users. Chairs, tables, light fixtures, and other artifacts used by nurses should be provided with adjustable height capabilities and intensity levels.

3. Control links, such as access and use of a bedside computer, and movement links, such as having the ability to survey a patient or the ability to control an apparatus by foot movements are critical to certain areas.

4. The provision of proper furniture and equipment is primordial. Beds, tables, trolleys, and wheelchairs should be suitable, available, and easily maintained.

5. Nurses should be properly trained on equipment usage and lifting techniques.

6. Storage should be readily available and accessible.

7. The maximization of visual and tactile discrimination through the use of appropriate size, color, and texture of materials.
Design-layout

Layout configurations establish the way and how much nurses will move and walk inside and between departments. Walking is a predictor of physical fatigue and occupational injuries and should be reduced when possible, particularly in emergency departments and recovery rooms (Breslin et al., 2003).

Many factors contribute to optimal operational efficiency. Only the alignment between operational practices and design-layout will promote the best possible solution. To this end, flexibility, adaptability and universal capabilities should be considered as design features propositions. In all instances, the design-layout of a healthcare facility should aim to consolidate analogous functions together and enhance adjacencies of interconnected departments (Breslin et al., 2003), optimizing this way time-motion circumstances. These functions and adjacencies are dictated by operational practices and organizational protocols. Space layouts that are supportive of operational practices may reduce nurses’ time spent on non-value-added activities, increasing time to be spent with direct patient-care delivery.

Nursing unit. Healthcare managers can adopt a number of layouts for department configuration in pursuit of staff efficiency.

Nursing units usually hold three to four distinct sections: the patient space, the nursing station(s), the core space, and the hallway. The relationship, location and distances between these spaces, the provision of centered as opposed to disseminated support areas, the types and nature of materials and equipment used, and the technology required to deliver care vary immensely from hospital to hospital (Page, 2004).

While the open ward or “fishbowl” design maximizes observation and staffing efficiencies, patient’s privacy can be significantly compromised, and while the racetrack design maximizes the number of beds in a unit, it can increase significantly nurse travel time. At the same time triangle shape design requires less travel distance, it greatly reduces
available square footage in the patient’s room, reducing the area for family members and, therefore, compromising patient/family interactions (Page, 2004). A nursing unit design is influenced by patient acuity. A circular nursing station is preferred among nurses on units with high-acuity patients because its design facilitates visibility and, in intensive care units, open areas are preferred because monitoring is facilitated.

In general, nurses prefer unit design-layouts in which they have a visual connection with the patients while maintaining some audio privacy (Chaudhury et al., 2009). Additionally, spaces that endorse collaboration and privacy, while keeping control of noise levels, were found to be desirable as well (Chaudhury et al., 2009).

On an interesting note, nursing unit design-layout affects nurses’ job satisfaction and turnover rates (Chaudhury et al., 2009). In a recent study, medical-surgical nurses, when compared to other units’ nurses, reported lower levels of quality of care, higher numbers of tasks left undone and high levels of emotional exhaustion. Curiously, nurses working in acute medicine have higher levels of emotional exhaustion than nurses working in accident and emergency care (Chaudhury et al., 2009).

Patient room. Several factors contribute to the efficiency of patient rooms. For instance, the assignment of patient rooms is guided by several factors including patient gender, the presence or absence of contamination risks, insurance policies, and, if possible, patient preference. In addition, features of patient rooms such as the availability, location and distance from restrooms can directly affect patient safety. Data revealed that the majority of falls of hospitalized patients occur in the patient’s room, usually in association with elimination needs (Breslin et al., 2003).

"The design intervention that positively affects the largest number of outcomes in a hospital setting, including overall quality and patient satisfaction, is the provision of single-bed patient rooms” (Ulrich et. all, 2008, p.33). This design feature has been acknowledged as
a standard by the American Institute of Architects in the “2006 Guidelines for Design and Construction of Healthcare Facilities”. The advantages of single-bed over multiple-bed rooms include decreased rates of hospital-acquired infection, which lead to reduced length of stay; fewer patient transfers; fewer associated medication or communication errors; decreased sound levels; improved sleep; improved confidentiality, privacy and family accommodation (Cesario, 2009). In addition, nurses find easier and more efficient to provide care to patients in private rooms than in multiple-bed rooms (Chaudhury et al., 2009; Cesario, 2009).

**Staff amenities.** In healthcare facilities programming phases, there is usually a dilemma between the need for staff amenities and revenue-generating spaces such as support areas (Breslin et al., 2003). The lack of support space can promote inefficiency, compromise operational processes and eventually contribute to errors within a nursing unit. Not less important though, is adequate space for staff amenities such as zones for meals, breaks, collaboration and privacy. Moreover, adequate working, learning, and relaxation spaces, as well as worksite fitness and wellness centers facilities, contribute to the staff’s experience of the hospital, improving this way, performance and retention. Design that meets staff needs contribute to an organization’s positive image and corporate branding. A workforce that has many employment alternatives tends to choose organizations that make staff needs and convenience a priority (Breslin et al., 2003).

**Templates**

According to Christiansen, Bruce & Chung (2008), a template is a set of guidelines developed to capture and codify best design practices and constructive parameters for all design phases of a healthcare organization. The template set up is an opportunity to leverage the combined expertise of professionals both inside and outside the healthcare organization,
capitalizing resources and streamlining processes so the most beneficial outcomes can be achieved. By definition:

“The template is intended to be a reflective of or responsive to the unique needs of each medical institution. The goal is to keep the balance between standardization and flexibility in a rapidly changing and challenging environment in which concerns about consistency in performance and quality are vital in support of a healthcare organization’s image. Based on these variables and relationships, the template outlines common structural and building systems, planning concepts, floor plans, equipment, and furnishings and construction techniques adaptable to a variety of site conditions” (Christiansen, Bruce, & Chung, 2008, p.2).

Templates should be easily tailored to meet the business case needs of each particular healthcare organization. In addition, it should accommodate for the needs and requirements of each location and situation. Future flexibility and expansion should be accounted for in the master plan phase so as to minimize disruption to operations and cost when construction takes place. To this effect, consolidated and strategic shell space within the hospital, besides the space for additional construction onsite, should be provided to expedite future growth. In addition, the entire design should be scalable to fit the needs of various sized communities (Christiansen et al., 2008).

Critical issues are addressed in template including consistent design, reducing opportunities for clinical error (Christiansen et al., 2008); standardization, decreasing cognitive loads on end-users while promoting more efficient and safer environments; hospital security, workplace ergonomics and opportunities to increase communication and lessen staff physical fatigue.
Organizational factors

“An organization’s workers and their work environment have a reciprocal relationship, each influencing the other in an ongoing, dynamic interplay that affects the level of safety within the organization” (Page, 2004, p.65).

Organizational factors are structural and processes components of the healthcare institution as an entity. Team, structural chart, core values and mission are examples of organizational factors; others include scale, funding mechanisms, hospital typology, and culture. While some aspects of the organization are more permanent such as structure, other aspects, such as policies, programs and culture, are transformational (Hickam et al., 2003).

An organizational culture is translated by how the organization’s branding is perceived and how this perception creates a system of codes, core-values, and expectations. "Specific characteristics of organizational culture include managerial style, evaluation and reward systems, economic effects, hierarchy, accountability, decision latitude, and employee’s feedback" (Hickam et al., 2003, p.11).

In other industries such as aviation and nuclear power, organizational factors have been identified as essential for safety assurance. To this effect, the healthcare industry organizational inertia has shifted from a culture of safety that would focus on individual limitations towards a perspective with emphasis on conditions, processes and systems of the organization itself.

Emergency department work environment

The organizational context within which emergency department registered nurses practice includes nursing shortages, increased use of complex technological innovations, an aging nursing workforce, increasing numbers of very sick aging population and higher acuity levels patients (AHRQ, 2008.). This section of literature review will expand on
organizational factors within the context of emergency departments that contribute directly or indirectly to nursing physical fatigue.

Emergency Department nurses’ workloads have been exacerbated by the increase in patient volume brought about by the Patient Protection and Affordable Care Act (PPAC) of 2010 (Gurney, 2010); and the Federal Emergency Medical Treatment and Active Labor Act, also known as the Patient Anti-Dumping Law commonly referred to as EMTALA, which warrants proper emergency attention and around the clock operations, which pressures organizations to lean their operations to remain financially and operationally solvent (How Severe Is Nurse Burnout, 2007).

Nurses’ work in acute care environments is physically and psychologically demanding with a lot of likelihood for occupational fatigue (Page, 2004). The emergency department deals with life threatening conditions that call for immediate medical attention and handles exacerbations of various critical conditions, which demand training, expertise, cognitive abilities and vigilance from nurses. Hence, emergency nurse care is stressful (How Severe Is Nurse Burnout, 2007). Stressful working environments are of particular concern, with a body of literature suggesting serious implications for nurses’ health and functioning in the long run, intention to stay in the profession, and occupational injuries (Tucker et al., 2010).

Prolonged shifts in emergency departments have been associated with illnesses, work absence, and increased nurse errors. Additionally, mental health problems, including addictions, are common within the nursing work force (Tucker et al., 2010). All these factors may cause nurses’ intention to leave the profession, which can be costly as it can lead to increased employee tardiness, absenteeism, turnover, decreased performance, and difficulty in recruiting and retaining staff (Hey et al., 2004).

The challenges healthcare organizations are having in recruiting and retaining nursing staff are highly associated to those individuals’ dissatisfaction with their work
environment. (How Severe Is Nurse Burnout, 2007). The level of satisfaction of emergency nurses is one fourth of that seen in the general employed U.S. population (Page, 2004). Nurses’ safety, retention, performance, job satisfaction, skills, experience and change strategies are the predominant issues in emergency nursing today and major contributors to nursing fatigue and burnout (How Severe Is Nurse Burnout, 2007). The improvement of working conditions is essential to the recruitment of new and retention of the existing emergency department nursing workforce. Failing to do so will result in an acute emergency nurse shortage (How Severe Is Nurse Burnout, 2007).

Both the Institute of Medicine and the Agency for Health Research and Quality agree that remediation of factors in the nurse work environment are unlikely to be achieved by any single action. Rather, healthcare organizations will have to implement “bundles” of mutually reinforcing practices that will impact nurses’ safety, performance and job satisfaction in the long run (Tabone, 2004).

It is clear that nurse fatigue impacts directly patient safety (Page, 2004); what is not yet clear is the extent of the problem. Given what is known, the nursing profession should debate the evidence of what types of limits should be placed on nursing work hours. Statutory elimination of mandatory overtime and the regulations that allow nurses the unquestionable right to refuse an assignment are mandates the profession has pledged for years (Tabone, 2004). Strategies to decrease fatigue and improve safety include organizational policies and cultural transformation in support of the solutions proposed by the literature review.

**Policies-regulations**

Research in various safety-sensitive fields indicates that performance decline from sleep deprivation is a major contributor to the commission of errors and accidents. The transportation and aviation industries have enacted safeguard mechanisms to restrain the
number of working hours, but so far the healthcare industry has been slow to follow suit (Page, 2004; Warren & Tart, 2008). On the contrary, to compensate for the nursing shortage, mandatory overtime is often commanded by healthcare organizations and usually at short notice precluding any sort of pre adjustment or recovery arrangements to compensate for this working time (Page, 2004).

Although nurses’ work schedule patterns are often demanding, at present, there are no restrictions on the number of hours a nurse may voluntarily work in a 24-hour or a seven-day period in the United States (Page, 2004). Amending existing hours-of-service regulations has often been challenging, even when supported by scientific evidence. Stakeholders such as unions or employees often oppose any regulation that is perceived to reduce the earning power of employees, involve hiring more employees, or cost more money. Other resources such as guidelines and fatigue countermeasures programs, while abounding in flexibility, lack in efficacy and enforcement (Page, 2004).

With regard to occupational injuries, the United States Department of Labor offers ergonomics guidelines for several industries including Guidelines for shipyards, Poultry Processing, Retail Grocery Stores. Besides “Guidelines for Nursing Homes,” no guidelines for the emergency nursing profession in hospital settings exist (United States Labor Department, 2011).

The nursing profession has history of policing its own practice based on evidence considered commendable by the public and among professionals. The nursing workforce must consider existing evidence and put forward responding proactively to what has been presented, all the while realizing that proposals regarding work schedules, workforce staffing policies and working conditions are issues that the profession is been called upon to address. (Tabone, 2004, p.1)
There is sufficient evidence for a call to policy makers and healthcare organizations to enforce research-evidence based practices that optimize capital, human and environmental resources reducing the strain on the nursing profession. Enough is known to end the worse abuses of the human sleep-wake cycle resulted from non discriminatory work scheduling patterns, and there is an urgent need of a shift by both hospital employers and the nursing profession towards a solution to this issue (Page, 2004).

Medical errors result from the interplay of multiple factors that include nurses’ performance (and consequent nursing physical fatigue), regulatory environment, organizational protocols, complexity of tasks involved, organization culture, and physical environment (Chaudhury et al., 2009). In the context of critical care environments, the rate of preventable adverse drug events is nearly twice the error rate in noncritical care settings and has been associated with substantial increases in patients’ morbidity and mortality (Page, 2004).

Strategies to promote staff safety include restructured work schedules and supportive workflow design and redesign, and evidence-based design of the physical environment of care (Harrison et al., 2007). As many facilities are making important financial investments and system-level improvements to promote patient safety, it is important to leverage these efforts to improve nurses’ safety and, consequently, retention as well. In the long run, these improvements will also benefit patients (AHRQ, 2008.).

Across this review, several implications for research practice and policy have emerged.

- The nursing profession is being challenged to consider limiting the number of hours a nurse can work similarly to other safety-sensitive industries such as air transportation and nuclear power (Tabone, 2004).
• Hospital overcrowding can be reduced by the improvement of workflows, the enhancement of transitions between emergency departments and inpatient units and the overall optimization of a hospital’s capacity (Harrison et al., 2007).

• Organizations’ strategies aimed at strengthening recruitment and retention of staff requires fundamental department-level changes. These changes require cultural transformation, which should take place in the ways services are delivered and focus on improving the safety, performance and job satisfaction of existing staff (Harrison et al., 2007).

• Fatigue countermeasure programs can be developed to reduce sleepiness and fatigue-based errors based on educational components and proper schedule alterations (AHRQ, 2008).

• Statutory elimination of mandatory overtime (Tabone, 2004; Harrison et al., 2007). To date, legislative bills prohibiting mandatory overtime for nurses have passed in only four states. No measure, either proposed or enacted, addresses how long nurses may work on a voluntary basis (Page, 2004).

• Another resource to mitigate the effects of physical fatigue include the redesign of operational practices and organizational factors to provide for periods of rest within a work team structure, redesigning workflows so that napping and rotation are integrated in nurses’ shift patterns (Tabone, 2004; Witkoski & Dickson, 2010; Tabone, 2005).

• Public reporting serves to promote reduction of risks in the work environment and propose greater transparency about nurse staffing. Whether comparisons among institutions are used for public reporting or for payment, such comparisons require the development of accurate and nationally accepted benchmarking systems (Harrison et al., 2007).
Definitions of organizational culture are manifold but generally depict culture as the shared values, norms, and tacit assumptions of members within an organization (Hickam et al., 2003). The lexicon used to communicate about culture is large and confusing. To add another layer of complexity to the understanding of culture is the need to consider national, professional, and organizational layers of cultures in addition to the subcultures within organizations. Values, artifacts, symbols, and assumptions are well-accepted elements of culture (Hamilton, Orr, & Raboin, 2008) and pave the way for behaviors and beliefs and can be, simultaneously, active sources of cultural change.

The kaleidoscopic landscape presently experienced by healthcare organizations calls for transformational change, both in social (cultural) and technical (facility). This landscape has been shaped by changes in drug science, medicine, technology, work force, patient demographics, and capital and operating finance, reimbursement policies, governmental regulations and competition (Hamilton et al., 2008). To face these challenges, healthcare organizations will have to take Darwinian measures involving structure, policies, and procedures in order to remain competitive and financially solvent. According to Hamilton et al. (2008), transformational change is likely to involve organizational culture and facility change simultaneously, both relating interdependently and impacting organizational performance. In their article “Organizational Transformation: A Model for Joint Optimization of Culture Change and Evidence-Based Design,” a model for accomplishing joint optimization of culture change and facility design has been proposed. This model suggests that in order to accomplish organizational transformation and sustain positive change, organizations must be prepared to adopt collaborative efforts in culture change and facility design. “Organizations capable of transformative change can positively impact the quality of the patient experience, while creating safer healthcare delivery in their communities, more effective work
environments for their employees, and a positive future for the broader healthcare system.” (Hamilton et al., 2008, p.2).

In conclusion, nursing physical fatigue is an occupational safety issue and one that is deeply rooted in all working conditions levels. In order to instill a sustainable culture that prioritizes and focuses on this matter, transformational change will have to occur in all dimensions of the healthcare delivery process. Additionally, nursing professionals will have to unite, assess what there is to be done in a collective realm, and proceed with these changes in consonance mode.

**Research questions**

“Workplace design that reflects a closer alignment of work patterns and the physical setting has been shown to improve work flow and reduce waiting times, as well as increase patient satisfaction with the services” (Ulrich et al., 2004, p. 6).

The study proposed to explore the linkage between emergency department design-layout and nursing perception of physical fatigue. To this effect, the goal was twofold. First, to assess, through a subjective approach, nurses’ perception of the impact of design-layout, as compared to organizational protocols and operational practices, on physical fatigue. Nurses are at the forefront of care delivery and their lived experience of patient care is unparalleled by any other profession (Designing Healthcare Environments, 2009). Their input and point of view is an important source to evaluate functional aspects of design-layout of a healthcare setting. Secondly, to measure, through a physiological approach, nurses’ actual physical activity intensity levels. Previous studies demonstrate that excessive workload is a top reason for nurses’ fatigue and high turnover rate (Chen, 2009). The measurement of nurses’ actual physical activity intensity levels would shed some light on this issue and pave the way to evidence-based design (or practices) propositions.
To accomplish these goals, the following research questions were developed:

- How do emergency department nurses perceive the impact of the emergency department design-layout attributes on nursing physical fatigue?
- How do emergency department nurses perceive the impact of organizational protocols and operational practices on nursing physical fatigue?
- What are emergency department nurses’ actual physical activity levels on an average 12-hour shift?

**Conceptual diagram and framework**

*The health and performance of patient care staff directly influence the quality of care. A small but growing body of evidence suggests that effective facility design can reduce staff stress, enhance staff safety, boost productivity, and improve quality of care and job satisfaction. Limited existing evidence suggests that certain environmental approaches that benefit patients also benefit nurses and other staff by reducing job stress, burnout, dissatisfaction, and turnover (Ulrich et al., 2010, p.5).*

In order to provide a theoretical foundation for the study, a diagram and a conceptual framework were devised. While the first one illustrates the dynamic interplay between Emergency Department design-layout and nursing physical fatigue, the second one proposes a pro-active process, establishing a benchmarking system with embedded evaluation and adjustment tools that can be used along the development of products, services or goal-driven processes.

**Conceptual operational/design-layout diagram (odld)**

This diagram, based on the Word-Recovery Dynamic Model by Jie Chen (2009), is called the Operational/Design-Layout Diagram (ODLD). It reflects the dynamics that simultaneously impact and/or are impacted by nurses’ performance in hospital Emergency Department healthcare delivery processes. It correlates design-layout and operational
practices, while illustrates the external centripetal forces (public and private) that end up determining nurses’ performance and affecting nursing physical fatigue levels. Figure 4 provides the diagram that illustrates these relationships.

Figure 4. Conceptual operational/design-layout diagram (odld).
Source: Developed by the researcher.

Premises

While public agencies policies set up external rules and regulations with the goal of protecting public health and welfare, private organizations protocols set up internal tenets, which reflect the mission, core values and culture of the healthcare organization.

Working conditions, in this study within the context of Emergency Departments and based in the five categories classification created by the AHRQ, are comprised of: working staffing,
workflow design, personal/social factors, physical environment, and organizational factors. The unit design-layout is the stage and background where operational practices are protagonized and affects, while is affected, by these same operational practices. This is a dynamic process that has to be constantly adjusted depending on external factors. Nurses are the unit cells functioning as pivot forces that will hinge all the processes surrounding them, affecting and being affected simultaneously, according to their individual characteristics.

**Donobedian based conceptual framework**

This conceptual framework, based on the “Framework for Performance Assessment in Primary Healthcare,” is grounded in evaluation theory and on the Donabedian’s classic ‘structure’, ‘process’, ‘outcome’ model for assessment of performance and quality of care. The components ‘stewardship’ and ‘evaluation’ were added to the frame so outcomes can be benchmarked, performance metrics tools used, and eventual adjustments take place. This framework is objectives-based, that is, it recognizes that performance must be measured against a defined set of objectives. It assumes that the main objectives of a healthcare organization as a whole, and programs and services within it, relate to consumers, rather than to policy makers or providers.

![Donobedian based conceptual framework](image)

*Figure 5. Donobedian based conceptual framework*

*Source: Developed by the researcher.*
Propositions

In using this framework, the healthcare organization would start the cycle of quality and performance assessment. This way, any healthcare related product (program, service) is started with the end-user in mind (user-centered).

The stewardship component is comprised by the set of tenets of the healthcare organization (mission, core values and culture);

- Structure is represented by all working conditions: physical environment (design/layout), human resources (nurses), organizational protocols and operational practices;
- Process is the product (program, service) to be implemented;
- Outcome is the desirable result;
- Evaluation is the tool that can be used in order to assess the result and inform how components shall be either readjusted or taken as new tenets, becoming this way, part of the component ‘Stewardship’ and closing the cycle loop.

Conclusion

This chapter illustrated the impact of working conditions in nursing physical fatigue and proposed bundles of strategies to address this issue. In addition, the research questions and conceptual frameworks developed for the study were exposed. The following chapter will illustrate this study’s research methodology with details on the data collection process.
Chapter 3

RESEARCH METHODOLOGY

As Nightingale demonstrated, statistics provided an organized way of learning and lead to improvements in medical and surgical practices. She developed a Model Hospital Statistical Form for hospitals to collect and generate consistent data and statistics. She became a Fellow of the Royal Statistical Society in 1858 and an honorary member of the American Statistical Association in 1874. (U.S. Department of Health and Human Services, 2010.)

This study proposed to explore the linkage between Emergency Department design-layout and nursing perception of physical fatigue. To this effect, the goal of the study was twofold. The first goal was to assess, through a subjective approach, nurses’ perception of the impact of design-layout on physical fatigue, as compared to organizational protocols and operational practices. Nurses are at the forefront of care delivery and their lived experience of patient care is unparalleled by any other profession (Designing Healthcare Environments, 2009). Their input and point of view are important sources to evaluate functional aspects of the design-layout of a healthcare setting. The second goal was to measure, through a physiological approach, nurses’ actual physical activity intensity levels. Previous studies demonstrate that excessive workload is a top reason for nurses’ fatigue and high turnover rate (Chen, 2009). The measurement of nurses’ actual physical activity intensities during three consecutive shifts would shed some light on the issue of nurses’ physical fatigue, and pave the way to evidence-based design propositions.
Ethical considerations

This study’s approvals were granted by the Arizona State University Institutional Review Board and by the healthcare organization in which the data collection was performed. The Institutional Review Board approval process required the submittal of (a) Arizona State University Application for Exempt Research Form (See Appendix A), (b) “Letter of Approval of Research Project” from the healthcare organization in which the data collection took place, (c) a copy of the “Recruitment Cover Letter” to be extended to eligible participants, (d) a copy of the online survey questionnaire to be responded to by the nurses and (e) a copy of the researcher certificate of completion of the National Institutes of Health (NIH) Office of Extramural Research course “Protecting Human Research Participants.” Participation was voluntary; the informants could withdraw from the study at any time without giving reasons, and all information was treated confidentially.

Research design

A non-experimental, descriptive research methodology was devised. Collection of data was approached in two parts.

Subjective approach. A cross-sectional, self-administered questionnaire was developed by the researcher to address the study’s first two research questions. To this end, an online survey instrument was administered to participants in order to collect data on the study’s independent variables of: built environment (design-layout and ergonomic aspects), operational practices (workflow design) and organizational protocols (workforce staffing and schedules patterns), in order to determine the dependent variable (perception of physical fatigue). Demographics data were required from all participants and used as moderator variables.
Physiological approach. A direct monitoring assessment design was applied to address the study’s research second question. To this end, instrumental data was gathered through the use of accelerometer devices. These devices were used for the continuous measurement and monitoring of nurses’ actual activity intensity levels during three consecutive 12-hour shifts.

Study setting

This study was conducted in the emergency department of a 136-bed community-based hospital located in a large metropolitan area in the southwest region of the United States. This hospital has developed key programs and services in a broad range of inpatient and outpatient settings designed to meet the medical needs of its growing community. A copy of the floor plan illustrates the physical layout of the department. Figure 6 portrays the facility emergency department layout. Some of the characteristics of this particular emergency department are:

The average nurse/patient ratio is 4:1 but varies based on patient acuity; the number of visits per day is approximately 94; and the average length of stay (“door to discharge”) is 123 minutes; and the number of patient deviation rates is zero. The hospital is accredited by the Society of Chest Pain Centers as a “Cycle II Chest Pain Center with Percutaneous Coronary Intervention”; it is also certified by the Arizona Department of Health Services as a Cardiac Receiving Center; The facility was built in 1983 and an expansion project performed in 2004 converted waiting room space to seven patient spaces. Currently there are a total of 24 beds and seven chairs (31 patient spaces); the department is divided in Red Zone, Green Zone, Overflow and Triage.
Figure 6. Healthcare setting emergency department layout.
Source: Healthcare organization.
Subjects

Recruitment. A non-random, convenience sampling was devised for this study. Inclusion criteria consisted of nurses who were (a) registered professionals, (b) full-time employees (defined as working at least 36 hours per week), and (c) those who worked with direct patient care. Exclusion criteria consisted of part-time or per diem employees, and nursing management personnel (charge nurses). A convenience sampling was used to enable sufficient recruitment within the timeframe of data collection. A relationship between the researcher and the healthcare setting was established prior to this study and became a catalyst factor for this study’s approval.

Sample size. A total of 24 eligible nurses were recruited to participate in the study during a four-week period, between the months of March and April of 2011. A random drawing of three gift certificates for a local restaurant was offered as an incentive for participation. Although 23 nurses committed to participate, 17 nurses (74%) completed the surveys and eight of the 23 nurses (35%) wore the accelerometers as instructed.

Measurements

Two different measurement strategies were chosen for this study: self-administered questionnaire (online survey) and direct monitoring assessment (accelerometers).

Self-administered questionnaire. A questionnaire in the form of an online survey was devised by the researcher. It consisted of three sections of multiple forced choice questions or Likert scale. Each question provided a space for open-ended responses (See Appendix C).

Section 1. Section 1 was comprised of nine questions addressing nurses’ personal and social variables that could impact their perception of their physical fatigue. To this end, the first two questions (1.1 and 1.2) served to link the questionnaire respondent with the pertinent accelerometer data, as well as the date and time the devices were worn. The
following four questions (1.3 through 1.6) gathered demographic data. The previous literature review revealed that variables such as age, gender and biomass are factors that affect nurses’ physical fatigue levels.

Question 1.7 was used to inform nurses’ lifestyles such as smoking habits, family burden and exercise routines. The previous Literature review has demonstrated that these factors impact nurses’ fatigue recovery time and influence their perception of physical fatigue. A forced choice format was used for this question so that a numerical value could be assigned to each item for further statistical analysis.

The remaining questions in section one (1.8 through 1.12) included information on nurses’ work patterns and assessed the amount time and nature of tasks that could influence their levels of physical fatigue. The preceding literature review offers an overwhelming amount of evidence on how workforce staffing patterns such as job assignments and work schedules affect nursing physical fatigue. Answers to these questions were provided through open-ended responses and forced choice questions.

The final question of this section (1.13) was used to inform the researcher if the respondents had, at the time of the study or at any point in time of their career, any sort of occupational musculoskeletal disorder. This could represent a bias to their responses, as prior research has illustrated how pervasive occupational injuries are within the nursing profession. A five-point Likert scale from 1 (almost never) to 5 (almost always) was used on this question so that numerical values could be assigned to each item for further statistical analysis.

Section 2. Section 2 was comprised of five questions that addressed nurses’ opinions on the linkage between different aspects of the physical environment and that environment’s impact on nursing physical fatigue. The first question (2.1) explored nurses’ opinions regarding the efficiency of their unit layout. To this effect, items regarding the
distance between the different spaces, the relationship between them, and the alignment between the physical layout and patient-care tasks were addressed.

The following questions (2.2 and 2.3) explored nurses’ opinions on how travel distances between specific spaces (within the unit and among departments) promoted efficiency. The literature review has demonstrated that inefficient workflow and workspace designs are major contributors of nurses’ travel distances.

Question (2.4) measured nurses’ point of view on ergonomics and functional aspects of their unit’s equipment, furniture and accessories. The literature review has illustrated that several occupational injuries are associated with these factors.

Question of this section (2.5) looked into nurses’ opinions on their unit availability of technological devices as these may promote efficiency and waste reduction. The literature review is abundant in suggesting how technological devices may save nursing cognitive and physical demands.

A five-point Likert scale from 1 (strongly disagree) to 5 (strongly agree) was used for all the questions of this section so that numerical values could be assigned to each item for further statistical analysis.

Section 3. Section 3 was comprised of seven questions and addressed nurses’ opinions on the impact of various aspects of their current working conditions on physical fatigue, including shift patterns, unit design-layout, workflow design and organizational policies.

The first question (3.1) assessed nurses’ perception of their own physical fatigue levels at different times of their work shift, work week and in the course of their career. The objective was to measure recovery times’ impact on perception of physical fatigue. The literature review has suggested that perception of physical fatigue is associated with the amount of recovery times during and between shifts.
The second question (3.2.) looked into nurses’ opinions on several physically demanding tasks of their shift routines as potential contributors to physical fatigue. Across the literature review, workloads and physical demands have been proven to negatively impact nurses’ job satisfaction and, therefore, may impact their perception of physical fatigue.

The third question (3.2.) explored nurses’ point of view on travel distances and number of trips through the different spaces and between departments as potential contributors of nursing physical fatigue. In this context, travel distances were associated with workflow design inefficiencies such as registered nurses’ performing tasks that could be performed by lower levels personnel. The literature review suggests that inefficiencies are major contributors of nursing physical fatigue, dissatisfaction and burnout.

The fourth question (3.4) addressed nurses’ perception of several organizational factors as potential contributors of physical fatigue. Tasks considered waste and inefficiencies caused by misalignments between organizational protocols and operational practices are major contributors of nursing fatigue. Similar to the previous question, inefficiencies are considered major contributors of nursing physical fatigue. The last three questions (3.5, 3.6 and 3.7) explored nurses’ opinions on different items as potential physical fatigue relief agents, and the different design-layout interventions as potential contributors to the relief of physical fatigue. A five-point Likert scale from 1 (strongly disagree) to 5 (strongly agree) was used for all the questions of this section so that numerical values could be assigned to each item for further statistical analysis.
**Instrumental data.** The variable physical activity intensity was continuously measured and recorded by direct monitoring instruments, called, accelerometers.

**Accelerometers.** The accelerometer component used for this study was the Actigraph GT1M model (Actigraph, LLC, Fort Walton Beach, FLA). Accelerometers are non-intrusive, single devices clipped to a belt. These were loaned by the Arizona State University Exercise College of Nursing & Health Innovation for the purposes of this study. Data was processed by Nathanael Meakes, PhD student, under the supervision of Dr. Barbara Ainsworth, PhD, MPH, FACSM, FNAK, and Professor.

Accelerometers are non-intrusive, small (5.1 × 4.1 × 1.5 cm), lightweight (0.4 kg) single devices clipped to a belt that record integrated acceleration information as an activity count, which provides an objective estimate of the intensity of bodily movement (particularly ambulatory movement). As these activity counts are time and date stamped, detailed data on the time, volume, and intensity of movement can be derived. This differs from a pedometer, which only measures the volume of movement.

Respondents were requested to wear the accelerometer on the right hip during shifts for 3 days. Initial screening excluded data from monitors not in calibration and data identified as questionable at the download phase. Figure 7 illustrates accelerometers as non-intrusive, small (5.1 × 4.1 × 1.5 cm), lightweight (0.4 kg) single devices clipped to a belt. The following figure illustrates how accelerometers can be easily worn, with minimum interference with daily activities.
Validity of accelerometers as instruments. Abel et al.’s (2008) study demonstrated that Actigraph GT1M (AG) is technically reliable and valid. The AG utilizes a uniaxial accelerometer that senses vertical accelerations and is a popular instrument among researchers because it provides information regarding the intensity, duration, and frequency of the user’s physical activity bouts. This information is reported in the form of step counts and activity counts for a specified time period. The activity count data can be converted into energy expenditure output for youth or adults, based on the use of population-specific equations. Furthermore, the AG allows researchers to set activity count (i.e., count_min–1) to determine the amount of time the user spends in sedentary, light, moderate, or vigorous physical activity.
Data collection process

Participant recruitment. Prior to the start of the data collection, the researcher was invited to participate in a general meeting where most of study site emergency department the nurses would be present and, therefore, provided the opportunity to the researcher to explain the research proposal, data collection protocols, and other pertinent information. This meeting was canceled and was not rescheduled during the four weeks of the data collection.

After this, three meetings occurred between the researcher and the healthcare setting Emergency Services Director prior to the commencement of the data collection. The first meeting’s purpose was the introduction of the research proposal and to visit the unit so the researcher could become familiar with the setting. The second meeting’s goal was to coordinate where the accelerometers could be returned since the nursing station was open and unsecure. A big orange plastic bucket was placed under a counter at the center of the nursing station so nurses could easily see it and return accelerometers at any time of the day. The third meeting’s purpose was to introduce the research study to the nurses. The questionnaire was submitted earlier in the process to the healthcare setting Emergency Services Director for approval.

Recruitment. After arrangements between the researcher and the Emergency Services Director of the healthcare setting, it was agreed that any communication with the study participants would be done electronically and should be intermediated by the Emergency Services Director due to confidentiality policies. By the time the data collection was scheduled to begin, the server system of the entire hospital was shut down for two weeks (which amounts to two thirds of the time of the data collection), which severely limited communication.
Therefore, the recruitment process was performed in person by the researcher, who visited the unit almost every shift turn (sometimes four times a day), explaining the purpose and protocols of the study and requesting nurses' participation. The gift certificates that were offered as a way of motivate participation had an obvious positive impact on nurses’ participation rates. The gift was for a Brazilian Steakhouse and nurses seemed to be curious and excited by the prospective opportunity.

Flyers were handed out with a summary of the importance of the study (See Appendix B), and informing that the information collected would be treated confidentially. The same flyer was left at a table at the nurses shift turn room, as well as posted on the wall.

Twenty-three out of twenty-four eligible nurses committed to participate in the protocol (95.8%). While seventeen responded to the online survey (74%), only eight of the accelerometers data (30.4%) could be used.

**Conclusion**

The data collection process was accomplished with some obstacles, but these same obstacles offered a great way of learning how to conduct research. Lessons learned on how to interact with different levels of an organization, how to provide for eventualities, and how data collection should always have a contingency plan were worthwhile lessons.

Most of all, the data collection was a blessed opportunity for the researcher to experience emergency department shift routines and to observe how nurses work in such complex environments, being bombarded by all kinds of stimuli (such as visual, audio, tactile and olfactive), while still performing with excellence despite all these circumstances, and bringing magic to the healing process. The following chapter will discuss the analysis of these data.
Chapter 4
DATA ANALYSIS RESULTS

“Not everything that can be counted counts, and not everything that counts can be counted” (Albert Einstein).

This chapter focuses on the analysis of the results gathered from both approaches devised to address the study’s research questions: subjective (self-administered questionnaire) and physiological (direct monitoring assessment through the use of accelerometers). The presentation of findings is arranged in four sections: (1) sample demographics data; (2) subjective approach findings; (3) nurses’ rating on design-layout propositions to the reduction of physical fatigue; and (4) physiological approach findings.

The first section will illustrate demographics and personal-social findings of participant nurses. These characteristics were considered moderator variables in the study as they could indirectly impact nurses’ responses. The second section will illustrate nurses’ perceptions of the impact on physical fatigue of the following attributes of nurse working conditions: (a) design-layout, (b) operational practices and (c) organizational protocols. To this effect, nurses’ perceptions were considered dependent variables and working conditions were considered independent variables. In the sequence, nurses’ rating on design-layout propositions as potential contributors to the reduction of physical fatigue is demonstrated. The final section demonstrates intensity levels of nurses’ actual physical activity as measured during three consecutive shifts. To this end, physical activity was considered an independent variable. Figure 8 shows these variables’ relationships.
**Figure 8.** Dependent and independent variables diagram.
Source: Developed by the researcher.

### Data analysis

The survey results were analyzed with the aid of Microsoft Software. The demographics characteristic gender was treated as categorical data and the result was given in percentages. Questions addressing personal-social aspects of respondents and which required “yes or no” responses were treated as categorical data and were given in percentages as well. Other demographics data such as BMI (Body Mass Index) and age were calculated through averages (means) and their pertinent variability within the distribution was calculated through standard deviations. Similarly, with regards to the remaining questions, numerical values of one to five were attributed to each of the Likert scale responses so means and standard deviations could be calculated. Finally, questions addressing common themes were grouped together with aggregated means and standard deviations.
Sample demographics data findings

This section of the questionnaire included demographics data including gender, age, height, and weight. In addition, lifestyle aspects such as smoking, exercise, sleeping habits and family burden were included. Finally, work-related data including working schedule patterns, inter-shifts recovery time patterns, experience and incidence of occupational injuries were requested as well. Table 1 shows some results gathered from the questionnaire.

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<tr>
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<th>Mean</th>
<th>SD</th>
<th>Number</th>
<th>Percent</th>
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</tr>
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<td>70.6</td>
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<td>Has kids under the age of 16 or</td>
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<td>an elderly parent at home</td>
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<tr>
<td>Number of hours shifts</td>
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</tr>
<tr>
<td>Last on average</td>
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<tr>
<td>W 12 Hours</td>
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<tr>
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<tr>
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</tr>
<tr>
<td>Upper back</td>
<td>2.4</td>
<td>1.30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lower back</td>
<td>3</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Upper arm</td>
<td>2.17</td>
<td>2.66</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forearm and elbow</td>
<td>1.94</td>
<td>2.11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thigh and knee</td>
<td>1.81</td>
<td>1.28</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lower leg</td>
<td>2.12</td>
<td>2.12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Angle and foot</td>
<td>2.31</td>
<td>1.40</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Nurses are at the vanguard of patient care. Their inherent physical fatigue, which is a result of long hours and, oftentimes, chaotic work conditions, may adversely impact the quality of care delivery. Every day, millions of patients literally put their lives in the hands of these caregivers to help restore them back to health. Very often nurses’ competency and performance may ultimately define the line between a patient’s life and death. According to the Agency for Healthcare Research and Quality in its “Patient Safety and Quality:
An Evidence-Based Handbook for Nurses” report (2008), nursing performance can also have a significant impact in preventing not only adverse events but the lasting effects of comorbidities (sequels) and symptoms (AHRQ, 2008) derived by illnesses. The same report, on a five-tier conceptual framework developed to address the occurrence of adverse events in healthcare, considers individual characteristics as a first-tier factor that has a direct impact on provider performance and whether this performance is likely to be considered acceptable or inadequate. For these reasons, this section will discuss in detail individual characteristics of participant nurses with a focus on nursing performance in light of physical fatigue.

**Physical aspects**

*Gender.* The majority of nurses participating in the study were female, totaling 76.5% of all participants. This is consistent with the literature review, which reveals that the registered nursing workforce in general is predominately female with an average of 90.4% (U.S. Department of Health and Human Services, 2010).

The literature research suggested that the predominance of women in the nursing profession has a number of repercussions related to physical fatigue. Considering that the majority of the nursing workforce is female, gender should be considered a strong component regarding end-user targeted design propositions, organizational policies, branding establishment, and staff retention strategies.

*Age.* The average age of the sample was 40.7 ± 11.6, which is younger than the average age of U.S. hospital nurses at 46 years of age (U.S. Department of Health and Human Services, 2010). In addition, while 46% of older nurses provide direct patient care, only 38% of older nurses work in acute care settings (The Older Nurse in the Workplace, 2005).

The literature is abundant on the design implications of an aging nursing workforce. A look into this cohort and their characteristics is fundamental to healthcare organizations
staff retention strategies and deserves careful consideration by policymakers, healthcare leaders, architects and designers. As healthcare organizations look to redesign or construct new facilities, paying particular attention to address the needs of an aging workforce is a sine qua non condition to provide safe and satisfactory working conditions.

**BMI (Body Mass Index).** Among all participants, 52.9% were considered normal weight while 25% were considered overweight (23% of females and 50% of males) and 11.76% obese (7.7% of females and 25% of males). The obesity rates were lower than the obesity prevalence (33.8%) for women reported by the 2007 Behavioral Risk Surveillance System survey (Chen, 2009).

Nurses as ambassadors of health should portray an image of wellness, which is in concert with a healthy lifestyle. The adage “Do as I say not as I do” will not translate well when dispensing advice to the patient population, only a sea change involving collaboration between the healthcare system and its practitioners demonstrating that their way of living is in alignment with their core beliefs and values. Healthcare facilities present useful settings for introducing and maintaining health-promotion programs for employees, as it will be discussed below.

**Lifestyle**

**Exercise.** Data findings demonstrated that 52.9% of participants (45.15% of all female nurses) exercise at least three days a week. Conversely, 47.1% (53.85% of all female nurses) of participants do not exercise on a regular basis.

Healthcare facilities present useful settings to provide wellness and fitness centers for employees and for introducing and maintaining health-promotion programs. Usually representing a concentrated group of professionals who share a common site, purpose and culture, these facilities provide a common ground in which communication and information exchange are facilitated, both very important in health-promotion processes. Findings of
several studies have demonstrated that healthcare organizations may benefit from investing toward the promotion of healthy lifestyles among nurses. Nevertheless, in addition to its cost-benefits, nurses’ health and well-being should be a priority in a healthcare organization agenda and in concert with the organization’s mission of promoting health.

*Smoking habits.* The average of participants of the study that smoke or have smoked in the past is 29.5%. This is higher than the 15% of the nation's average of smoking registered nurses, which, in turn, is the highest rate among all healthcare professionals. Additionally, this average is higher than the 20% average reported among women by the Centers for Disease Control and Prevention (Centers for Disease Control and Prevention, 2011). Interestingly, all active or ex-smokers of the study claimed not to exercise on a regular basis. The study “Nurses, Smoking and the Workplace” by Sarna (2005) provided important evidence that supports the need to develop:

“…work-based strategies and programs to support cessation efforts, and to address norms and policies around smoking and cessation in the workplace.” Knowledge about cessation and withdrawal symptoms (symptoms that may be interpreted as “stress”), and sensitive issues such as the impact of quitting on friendships and strategies to provide positive social support for cessation needs to be provided to all nursing personnel, not just nurses who smoke” (p. 88).

*Sleeping habits.* All participants of the study claimed to sleep from six to eight hours a day. This leads the researcher to believe that there has been enough inter-shifts recovery time among the participant nurses. Some of the findings with regard to this issue are contradictory and were considered worthy of further attention, as it will be shown below. Additionally, six participant nurses (35.3% of) of the study have claimed to work 13-hours shifts, five of them have claimed to have another part-time job besides their primary nursing
position, and four of them have claimed to work night-shifts. These factors, when aggregated, lead to the conclusion that nurses may not be having sufficient inter-shifts recovery time. Literature research is compelling towards the impact of nursing physical fatigue in all realms of the healthcare delivery process. It is the role of healthcare organizations to provide appropriate work scheduling patterns as well as physical areas for breaks, meals and resting opportunities in alignment with other safe-sensitive industries such as aviation, nuclear power and transportation.

*Family burden.* A total of five participants (29.4%) claimed to have a family burden, represented either by caring for children less than 16 years old or for an elderly parent at home. Interestingly, two were male nurses (50% of all male participants) and three were female nurses (30.8% of all female participants). According to the 2008 National Sample Survey of Registered Nurses (U.S. Department of Health and Human Services, 2010), approximately 55% of Registered Nurses reported having household dependents, either adult or children. Nearly 74% of registered nurses were married or in a domestic partnership in 2008 and, among them, 15.2% had a dependent adult at home while 51.7% had children at home (U.S. Department of Health and Human Services, 2010).

Data are plenty on the repercussions of family burden on nursing physical fatigue. Additionally, among nurses under 50 years of age, 68.5% attributed to family burden the reason they left temporarily or permanently the profession (U.S. Department of Health and Human Services, 2010). The shortage of nurses and the cost of turnover are alone sufficient reasons why healthcare organizations should consider employer-sponsored childcare facilities and programs in their agendas. In a female-dominated profession, this seems a cost-effective strategy to recruit or retain skilled nurses.

*Part-time or another regular activity incidence.* A rate of 58.8% of all participants claimed to have another part-time job or regular activity besides this primary job. This rate is far
higher than the national average of 12% of registered nurses who have a full-time principal nursing position and that have reported to have at least one other nursing job, and 14% of those with part-time principal positions that have reported to have more than one nursing job (U.S. Department of Health and Human Services, 2010). Hospitals have the largest percent of secondary nursing positions, with 43.3% of registered nurses who have secondary nursing employment working in this setting (U.S. Department of Health and Human Services, 2010). Ambulatory care positions are reported by 13.5% of registered nurses who have secondary employment, while home health is reported by 11.4%. Academic education is another setting for secondary employment (10.6%). The nursing workforce is being demanded to review workforce-scheduling patterns to follow the hour restrictions enforced by other safety-sensitive industries such as air transportation and nuclear power (Tabone, 2004). Ironically, the nursing profession not only allows, but encourages nurses to work long hours without obtaining sufficient inter-shifts sleep or recovery time.

**Work-related patterns**

*Number of shifts per week, number of hours per shift and number of consecutive shifts.* As illustrated below (See Table 2) 82.4% of participants claimed to work three shifts a week while 17.6% work four shifts a week. While 64.7% of the participants claimed to work 12-hour shifts, 35.3% claimed to work 13-hour shifts. Additionally, while the majority of participants (53%) claimed to work three consecutive shifts per week, 17.6% claimed to work four consecutive shifts per week. Finally, while 47% of participants claimed to work day shifts, 11.8% work evening shifts and 41.2% work night shifts.
Table 2 | Work-related patterns among participant nurses.

<table>
<thead>
<tr>
<th></th>
<th>Number of shifts per week</th>
<th>Number of hours per shift</th>
<th>Number of consecutive shifts</th>
<th>Night (N), evening (E) Or day (D) shift</th>
<th>Another part-time job or regular activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of part.</td>
<td>14</td>
<td>3</td>
<td>12</td>
<td>13</td>
<td>2</td>
</tr>
<tr>
<td>Percent. of part.</td>
<td>82.4</td>
<td>17.6</td>
<td>64.7</td>
<td>35.3</td>
<td>29.4</td>
</tr>
</tbody>
</table>

Interestingly, five nurses have claimed to work 13-hour shifts and carry out another part-time job concomitantly. In addition, of these, three of them work night shifts. Finally, one of them has claimed to have either a child less than 16 old or an elderly parent at home.

Participants “a,” “b,” “c” and “d” schedules. Four sets of responses, participants “a,” “b” and “c” and “d,” seemed to be worth further discussion. Per these participants’ responses, the amount of hours spent with daily activities, including work and personal-social, are likely to be overwhelming and may be putting the individual’s health and overall performance at risk. Table 3 illustrates these participants’ work-patterns.

Table 3 | Work-related patterns among participants “a,” “b,” “c” And “d”.

<table>
<thead>
<tr>
<th>Particip.</th>
<th>Number of shifts per week</th>
<th>Number of hours per shift</th>
<th>Number of consec. shifts</th>
<th>Night (n) or day (d) shifts</th>
<th>Another part-time or regular activity</th>
<th>Has children under 16 or an elderly parent at home</th>
</tr>
</thead>
<tbody>
<tr>
<td>“a”</td>
<td>3</td>
<td>4</td>
<td>12</td>
<td>13</td>
<td>3</td>
<td>d</td>
</tr>
<tr>
<td>“b”</td>
<td>3</td>
<td>4</td>
<td>12</td>
<td>13</td>
<td>3</td>
<td>n/a*</td>
</tr>
<tr>
<td>“c”</td>
<td>3</td>
<td>4</td>
<td>12</td>
<td>13</td>
<td>3</td>
<td>n/a*</td>
</tr>
<tr>
<td>“d”</td>
<td>3</td>
<td>4</td>
<td>12</td>
<td>13</td>
<td>3</td>
<td>n/a*</td>
</tr>
</tbody>
</table>

* No answer.
As illustrated above, participants “a” and “b” claimed to work 13-hour shifts for four consecutive shifts a week and, additionally, they claimed to exercise for at least thirty minutes for three times a week. Furthermore, participant “a” and “d” claimed to have another part-time activity besides his/her primary nursing position and participants “c” and “d” claimed to have either a child under 16 or an elderly parent at home. Tables 4, 5 and 6 simulate three scenarios that suggest that the number of hours claimed by these participants would be insufficient for enough recovery time, or to provide an individual with enough time to carry out a healthy physical or emotional lifestyle.

The next table illustrates a schedule simulation of four 13-hour consecutive shifts on a 24-hour period for participants “a,” “b” and “c”.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Total hours/day period (hours)</th>
<th>Remaining (hours)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 work shift of 13 hrs</td>
<td>13</td>
<td>11</td>
</tr>
<tr>
<td>7 hrs of sleep/day (average)</td>
<td>7</td>
<td>4</td>
</tr>
<tr>
<td>Commuting</td>
<td>1 hr/shift</td>
<td>3</td>
</tr>
<tr>
<td>Hygiene time (1 hr/day to shower, to get dressed, to groom)</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Meals (1 hr/meal, 3 times a day, including time to prepare, or to drive, or order and wait)</td>
<td>3</td>
<td>-1</td>
</tr>
<tr>
<td>Time for relaxation or personal-social activities (to read, to interact with family members or partners**, to talk on the phone, to watching TV)</td>
<td>2</td>
<td>-3</td>
</tr>
</tbody>
</table>
The final remaining hours expressed in a negative number (-3) demonstrates that a 24-hour period would not be sufficient to allow for time for important daily activities in parallel to work such as preparing meals, exercising, relaxing or performing personal-social activities such as reading, talking on the phone, watching TV. Even though some meals may occur during the work shift period shown above, the literature review has shown that meal breaks and rest periods in healthcare settings are likely to be insufficient and fragmented (Witkoski & Dickson, 2010), implying that healthcare providers should allocate a minimum of number of hours per day besides their work shifts for healthy meals. Table 4.5 simulates the same time breakdown for a one-week period for participants “a” and “b.”

<table>
<thead>
<tr>
<th>Activity</th>
<th>Total hours/week period</th>
<th>Remaining (hours)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 work shifts of 13 hrs each</td>
<td>52</td>
<td>116</td>
</tr>
<tr>
<td>7 hrs of sleep per day (average)</td>
<td>49</td>
<td>67</td>
</tr>
<tr>
<td>30 min. of exercise 3 times per week (with 1 hr of allowance to shower, get dressed, to commute)</td>
<td>4.5</td>
<td>62.5</td>
</tr>
<tr>
<td>60 min per shift to commute</td>
<td>4</td>
<td>58.5</td>
</tr>
<tr>
<td>1 hr per day for hygiene (includes to shower, to get dressed, to shave)</td>
<td>7</td>
<td>51.5</td>
</tr>
<tr>
<td>1 hr per meal three times a day for main meals (includes time to prepare, to snack, to drive, or to order and wait)</td>
<td>21</td>
<td>30.5</td>
</tr>
<tr>
<td>5 hrs per day, three times a week to work on another part-time job or regular activity (includes 1 hr to commute, to get dressed, etc…)</td>
<td>15</td>
<td>15.5</td>
</tr>
</tbody>
</table>
### Table 5 (Continued)

<table>
<thead>
<tr>
<th>Approximate number of hours spent</th>
<th>Total hours/week period</th>
<th>Remaining (hours)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 hr per day for household chores (to buy groceries, to clean, to do the laundry, to put gas, to pay bills, to respond emails)</td>
<td>7</td>
<td>8.5</td>
</tr>
<tr>
<td>Time for relaxation and personal-social activities (reading, talking on the phone, watching TV)</td>
<td>8.5/7</td>
<td>0</td>
</tr>
</tbody>
</table>

The final remaining hours (8.5/7 = 1.2) demonstrates that only 1.2 hours per day on a week period would be available for relaxation and personal-social activities such as watching TV or reading a book, or for personal-social activities such as talking on the phone or responding to emails. In addition, as shown in table 6, participant “a” works night shifts, which indicates that this participant is working over the limit of hours recommended by the IOM (2004) (Kunert et al., 2007). Table 6 simulates the same scenario for participant “c.”
Table 6: Schedule simulation of four 13-hour shifts on a week period for participant “c”.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Total hours/week period (hours)</th>
<th>Remaining (hours)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 work shifts of 13 hrs each</td>
<td>39</td>
<td>129</td>
</tr>
<tr>
<td>7 hrs of sleep per day (average)</td>
<td>49</td>
<td>80</td>
</tr>
<tr>
<td>60 min per shift to commute</td>
<td>3</td>
<td>77</td>
</tr>
<tr>
<td>1 hr per day for Hygiene (includes to shower, to get dressed, to shave)</td>
<td>7</td>
<td>70</td>
</tr>
<tr>
<td>1 hr per meal three times a day for main meals (includes time to prepare, to snack, to drive, or to order and wait)</td>
<td>21</td>
<td>49</td>
</tr>
<tr>
<td>5 hrs per day, three times a week to work on another part-time job or regular activity (includes 1 hr to commute, to get dressed, etc…)</td>
<td>15</td>
<td>34</td>
</tr>
<tr>
<td>1 hr per day for household chores (to buy groceries, to clean, to do the laundry, to put gas, to pay bills, to respond emails)</td>
<td>7</td>
<td>27</td>
</tr>
<tr>
<td>30 min. of exercise (with 1 hr of allowance to shower, get dressed, to commute)*</td>
<td>7.5</td>
<td>22.5</td>
</tr>
<tr>
<td>Time for parenting, relaxation and personal-social activities (reading, talking on the phone, watching TV)</td>
<td>19.5/7</td>
<td>0</td>
</tr>
</tbody>
</table>

*This participant has claimed not to exercise; time allocated for exercising was input just for purposes of simulation as it will be shown below and it was based in the 150 minutes a week of moderate to vigorous intensity aerobic physical activity recommended by the 2008 Physical Activity Guidelines for Americans (PAGA, 2008).
Findings of participant “c”. Table 6 illustrates that participant “c,” provided that his/her schedule would allocate time for exercise for at least “thirty minutes a day five days a week” recommended by the 2008 Physical Activity American Guidelines (PAGA, 2008), would have 2.78 hours a day to be shared among parenting or caring for an elderly parent, relaxing and personal-social activities. Clearly not sufficient time to perform these remaining activities which usually results in taking the time for exercise to perform these other activities, which seems to be this case. This participant has claimed not to exercise at least three times for three days a week.

Findings of participant “d”. Similarly, participant “d” would potentially have little time for relaxation and personal-social activities as described above. Although this participant has claimed not to have another part-time or regular activity besides his/her current nursing position, he or she has claimed to have either a child under 16 or an elderly parent at the house. In a study by Chen (2008) it was suggested that the average hours spent caring for children or adult relatives is reported to be at least 21 hours per week, which is comparable to a part-time job. Furthermore, as shown by the literature review, nurses with family burdens tend to not have time for physical activities; indeed, this participant has claimed not to exercise for at least 30 minutes a day three times a week.

Although the tables above are simulations or scenarios, the allocated time for each activity are reasonably accurate and suggest that these three participants are likely to be experiencing more fatigue than the others. Moreover, they are likely to be putting their safety and of the others at risk. The next table allows the comparison between all participants.
<table>
<thead>
<tr>
<th>Question</th>
<th>Responses “a”</th>
<th>Responses “b”</th>
<th>Responses “c”</th>
<th>Responses “d”</th>
<th>Remaining responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.7.a. Smokes or smoked in the past</td>
<td>no</td>
<td>no</td>
<td>no</td>
<td>yes</td>
<td></td>
</tr>
<tr>
<td>1.7.b. Exercises at least 30 minutes a day/three times a week</td>
<td>yes</td>
<td>yes</td>
<td>no</td>
<td>no</td>
<td></td>
</tr>
<tr>
<td>1.7.c. Sleeps from 6-8 hours a day</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td></td>
</tr>
<tr>
<td>1.7.d. Has kids under 16 or elderly parent at home</td>
<td>no</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
<td></td>
</tr>
<tr>
<td>1.7.e. Has another part-time job or activity</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>no</td>
<td></td>
</tr>
<tr>
<td>1.8. Number of shifts per week</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>1.9. Number of hours shifts last</td>
<td>13</td>
<td>13</td>
<td>13</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>1.10. Number of consecutive shifts</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>n/a*</td>
<td></td>
</tr>
<tr>
<td>1.11. Experience</td>
<td>0-5</td>
<td>11-20</td>
<td>0-5</td>
<td>5-10</td>
<td></td>
</tr>
<tr>
<td>1.12. Nigh/day shifts</td>
<td>night</td>
<td>evening</td>
<td>night</td>
<td>morning</td>
<td></td>
</tr>
<tr>
<td>1.13. WMSD</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neck</td>
<td>4</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>2.12</td>
</tr>
<tr>
<td>Shoulder</td>
<td>4</td>
<td>-</td>
<td>4</td>
<td>-</td>
<td>2.19</td>
</tr>
<tr>
<td>Upper back</td>
<td>4</td>
<td>-</td>
<td>-</td>
<td>4</td>
<td>2.40</td>
</tr>
<tr>
<td>Lower back</td>
<td>4</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>3.00</td>
</tr>
<tr>
<td>Upper arm</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2.17</td>
</tr>
<tr>
<td>Forearm/elb./wris</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>-</td>
<td>1.94</td>
</tr>
<tr>
<td>Thigh/knee</td>
<td>-</td>
<td>-</td>
<td>4</td>
<td>-</td>
<td>1.81</td>
</tr>
<tr>
<td>Lower leg</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2.12</td>
</tr>
<tr>
<td>Ankle, foot</td>
<td>4</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2.31</td>
</tr>
<tr>
<td>3.1.a. Degree of physical fatigue at the beginning of the work shift</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1.47</td>
</tr>
</tbody>
</table>
Table 7 | (Continued).

<table>
<thead>
<tr>
<th>Question</th>
<th>Responses “a”</th>
<th>Responses “b”</th>
<th>Responses “c”</th>
<th>Responses “d”</th>
<th>Remaining responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1.e. Perception of the physical load demands on the nursing workforce has dramatically</td>
<td>5</td>
<td>5</td>
<td>3</td>
<td>n/a</td>
<td>3.69</td>
</tr>
<tr>
<td>3.2.a. Perception of the number of hours of work per shift as potential contributor to physical fatigue</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td>5</td>
<td>4.06</td>
</tr>
<tr>
<td>3.2.b. Perception of the number of shifts of work per week as potential contributor to physical fatigue</td>
<td>4</td>
<td>4</td>
<td>2</td>
<td>5</td>
<td>3.18</td>
</tr>
<tr>
<td>3.4.c. Duration of shifts as potential contribution to fatigue</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>5</td>
<td>4.18</td>
</tr>
</tbody>
</table>

* No answer

The Table 7 allows the comparison between participants “A,” “B,” “C” and “D” the remaining participants demonstrating the following interesting findings:

- At least one among participants “A,” “B,” “C” and “D” claimed to have a higher incidence of work-related musculoskeletal injuries (4, 3, 0 and 0, respectively, against the overall average 2.12 for neck; 4, 0, 4 and 0, respectively, against the overall average 2.19 for shoulder; 4, 0, 0 and 4, respectively, against the overall average 2.40 for upper back; 4, 3, 4 and 4, respectively, against the overall average 3.0 for lower back); 0, 0, 3 and 0, respectively, against the overall average 1.94 for forearm, elbow or wrist; and 0, 0, 4 and 0 against the overall average 1.81 for thigh and knee.
• The degree of fatigue at the beginning and at the end of the work shift were higher among at least one of participants “A,” “B,” “C” and “D” (2, 1, 2 and 1, respectively, against the overall average of 1.47) and (4, 5, 4 and 5, respectively, against the overall average of the 4.41).

• At least one among participants “A,” “B,” “C” and “D” has claimed a higher rate on the perception of the physical load demands of the nursing workforce as dramatically changed since their start in the profession (5, 5, 3 and n/a, respectively, against the overall average of 3.69).

• Unanimously, the perception of the number of hours of work per shift as potential contributors to physical fatigue ranked in the highest rates among all responses for the majority of participants. For participants “A,” “B,” “C” and “D” the rates were 4, 2,2 and 5, respectively while the overall average was relatively positive 4.06 with a standard deviation of 1.12 in question 3.2.a, similarly, in question 3.4.c, these rates were 4, 3, 2 and 5, respectively, against the overall average of 4.18 with a standard deviation of 1.01.

• Participants “A,” “B,” “C” and “D” perceived the number of work shifts per week as a potential contributor to physical fatigue as higher than the average responses (4, 4, and 5, respectively, against the overall average of 3.18).

Subjective approach findings

Nurses’ perception of the unit design-layout attributes as potential contributors of physical fatigue

This section of the questionnaire required nurses to rate their perception on the linkage between design-layout attributes or components of their current working environment and nursing physical fatigue. Design-layout attributes in this section included
space layout, ergonomic and functional aspects of the environment and provision of technology resources (See Table 8).

<table>
<thead>
<tr>
<th>Table 8</th>
<th>Nurses’ perception of the current design-layout attributes efficiency.</th>
</tr>
</thead>
<tbody>
<tr>
<td>#</td>
<td>Description</td>
</tr>
<tr>
<td>Space layout</td>
<td>Inter-department travel distances efficiency</td>
</tr>
<tr>
<td></td>
<td>Intra-department travel distances efficiency</td>
</tr>
<tr>
<td></td>
<td>Patient-care related travel distances efficiency</td>
</tr>
<tr>
<td>2.4</td>
<td>Provision of ergonomic and functional equipment, furniture, accessories and millwork</td>
</tr>
<tr>
<td>2.5</td>
<td>Provision of technology resources for the reduction of physical fatigue</td>
</tr>
</tbody>
</table>

Responses to these Likert scale style questions ranged from one being strongly disagree and five being strongly agree in questions 2.2, 2.3, 2.4 and 2.5; and from one being the lowest and five being the highest in question 3.3.

**Space layout.** Overall, participant nurses perceived their current healthcare setting inter- and intra-departments’ travel distances as efficient (mean=3.98 ±0.88 and mean=3.61 ±1.00 respectively). This is inconsistent with the literature review, which suggests that while the racetrack design maximizes the number of beds on a unit, it can significantly increase nurse travel times (Page, 2004). In the study’s “racetrack” unit layout, the travel distance around the core/nurse station is 245 feet long (See Figure 9). Outstanding rating deviations from the average include travel distance efficiency to patient toilet with an overall negative response average of 2.87±1.06; travel distance to the critical care unit with an overall negative response average of 3.12±1.05; and patient-care related travel distances with an overall negative responses of 2.94 ±1.14, suggesting that nurses may perceive the space layout differently when this space is linked to necessary walking. In this case, the shortest
distance from a patient’s room to the closest toilet is 30 feet while the longest distance is 93.5’.

One plausible explanation for the study’s participants’ conflicting responses is that nurses do not know how to differentiate unit space designs and therefore, tend to evaluate the physical layout according to different criteria. In her study, Hendrich et al. (2008) acknowledges that nurses’ “adaptability may allow them to compensate for limitations imposed by the physical design of the unit. This adaptation may mask potential effects of unit layout on distance traveled and time spent per activity” (Hendrich et al., 2008, p.33).

In this context, Hendrich et al. (2008) study findings suggest that only:

…process and policy, as well as relatively minor physical changes within a unit, such as distribution points of supplies or medications, can have a major impact on nurse workload. It may be that for unit layout to make a difference in nursing time spent on patient care activities, other contextual factors must also change. Such factors include the interoperability of technology, staff work assignments, and work processes (p. 3).

The following figure illustrates the study setting space layout and the distances between different spaces. The nursing station and support areas at the core, surrounded by a single loaded corridor is commonly called “racetrack layout”.

93
Figure 9. Healthcare setting emergency department unit “racetrack” layout. Source: Healthcare organization. 
Ergonomic and functional.
In general, participants overall responses regarding the provision of ergonomic and functional furniture, finishes and equipment (F,F&E); accessories and millwork at their current unit was relatively negative (mean=2.23 ±0.98). Among these low rates responses are rates for the provision of ergonomic, functional and of easy maintenance F, F&E (mean=2.0±0.79); opportunities to rest, lift or stretch legs when appropriate (mean=2.0±1.06); provision of adjustable height chairs and seating to reduce standing (mean=2.24±0.97) and provision of efficient and handy medical supply and storage (mean=2.53±0.94).

Design propositions that address the specific needs of the nurse population are fundamental to ensure satisfactory working conditions. These design propositions should be suitable for a gamut of end-user profiles, ranging from one to the other end of the spectrum of physical characteristics, accommodating for all ages, heights, weights and genders, as the same space will be continuously “occupied” and used by different staff members of the healthcare setting at different times of the day. Moreover, the healthcare setting physical environment is constantly changing according to operational practices, adapting to different workloads and accommodating for new technologies. Flexibility, adaptability and universal capabilities should be among the criteria to be considered in the development design propositions. Furthermore, benchmarking systems such as mock-ups and test-fitting evaluations should be embedded not only in design processes but in workflow design practices, so the continuous evaluation of staff safety and efficiency, design-layout functionality, and end-user satisfaction can be monitored and suitable actions can be taken.

*Technology resources.* Concerning the provision of technology resources, the overall response of nurses in the study was relatively negative with a mean of 2.53 and standard deviation of 0.84. Information technology is fundamental in today’s healthcare ever changing and expanding landscape. Traditional and suboptimal paper-based systems are not
an option any longer and should be replaced by proper information technology tools and systems so that the optimal utilization of resources, as well as processes and outcomes, can be accomplished.

**Nurses’ perception of operational practices as contributors of physical fatigue**

*Alignment between design-layout and operational practices.* This section of the questionnaire looked into nurses’ perception on the linkage between operational practices and nursing physical fatigue. This section included aspects such as the alignment between design-layout and operational practices, patient-care related tasks and workflow inefficiencies. Table 9 illustrates the results gathered from the questionnaire.

<table>
<thead>
<tr>
<th>#</th>
<th>Description</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1</td>
<td>Alignment between design-layout and operational practices</td>
<td>3.18</td>
<td>1.20</td>
</tr>
<tr>
<td>3.2</td>
<td>Workloads such as patient handling, sitting, standing and transporting</td>
<td>3.26</td>
<td>1.05</td>
</tr>
<tr>
<td>3.4</td>
<td>Inefficient operational practices</td>
<td>3.57</td>
<td>1.18</td>
</tr>
</tbody>
</table>

Responses to these Likert scale style questions ranged from one being strongly disagree and five being strongly agree (2.1), and from one being the lowest and five being the highest (3.2 and 3.4).

As shown in Table 9, nurses’ perception of the alignment between the current design-layout and operational practices is relatively positive (mean=3.18, standard deviation=1.20). Pertaining to workloads as contributors to nursing physical fatigue, nurses’ overall responses were relatively positive with a mean of 3.26 and standard deviation of 1.05. With reference to the contribution of inefficient operational practices to physical fatigue, nurses’ perception, overall, participant nurses perceived the alignment between design-layout of their current unit and operational practices as relatively positive (mean=3.18 ±1.20).
Once more, the question is raised if nurses know how to appraise attributes of the
design-layout and their direct impact on operational practices. “Healthcare cannot be separated
from its built environment” (Ulrich et al., 2010, p.95), yet the lexicon of the design field may be
difficult to be interpreted by some healthcare professionals just as the medical lexicon may
be difficult to be understood by design professionals. In complex environments such as
healthcare settings, this semiotic disconnect between the two fields may hinder the design
process with consequent negative ripple effects on operational practices and healthcare
delivery outcomes. Further investigations on how nurses read the built environment and its
multi-dimensional and temporal facets will contribute to an understanding on how important
it is to educate nurses on basic design principles so they can contribute to healthcare facilities
design processes and performance/functional evaluations. Nurses can bridge the gap
between designers and healthcare organizations. They may serve as catalytic agents that will
warrant a better alignment between design-layout and operational practices.

Operational practices inefficiencies and workload demands as potential
contributors to physical fatigue. With regard to the current inefficiency of operational
practices, participants’ responses were overall relatively positive (mean=3.57±1.18). Nurses’
perception of workloads such as patient handling, sitting and standing, and transporting and
hauling as potential contributors of physical fatigue, was relatively positive (mean=3.26±1.05) as well. Among the highest rates, standing time (mean=3.76±1.09) and patient
handling (mean=3.53±1.07) are worth of note.

These findings are corroborated by the literature review, which makes obvious the
physical and psychological demands inherent to the nursing profession. Moreover, these
responses reiterate once more how imposed physical workload demands by some
operational practices have been perceived by healthcare professionals among the larger
contributors of physical fatigue, challenging healthcare organizations to address this issue.
The use of efficiency-driven approach such as lean, six sigma or Toyota principles processes, must be periodically applied and benchmarked so gaps in workflow designs are detected and lines of action pursued accordingly. Optimizing all resources while reducing any waste is the only way healthcare organizations can maintain quality in the care delivery process and remain financially solvent at the same time. An alignment between all categories of working conditions, namely, workforce staffing, workflow design, personal/social aspects, physical environment and organizational factors, must be pursued and constantly monitored through scientific data so well-informed decision-making processes can be facilitated.

**Nurses’ perception of organizational protocols as contributors of physical fatigue.** This section of the questionnaire looked into nurses’ perception on the linkage between organizational protocols and nursing physical fatigue. This section included components of the working conditions such as working schedules, shift duration and inter-shift recovery time patterns. Responses to these Likert scale style questions ranged from one being the lowest and five being the highest.

<table>
<thead>
<tr>
<th>#</th>
<th>Description</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organiz. protocols</td>
<td>According to recovery time patterns and time in the career</td>
<td>3.08</td>
<td>1.04</td>
</tr>
</tbody>
</table>

As shown in Table 10, nurses’ perceptions of organizational protocols as potential contributors to physical fatigue were relatively positive (mean=3.18, standard deviation=1.20).
Figuratively, organizational protocols are the DNA structure of a healthcare organization. This DNA structure has encrypted in its core a series of procedures, codes, systems and processes that will inform the final identity of the institution. It encompasses all aspects of the healthcare delivery process, from working conditions to branding efforts; from physical to human resources; from core beliefs to value propositions; and from profit-driven to patient-centered models. The alignment between all categories of working conditions must be embedded in the culture of the organization, as any misbalance will create centrifugal forces affecting all stakeholders, impacting negatively expected outcomes.

**General findings**

Tables 11, 12, and 13 illustrate nurses’ perception of various aspects of their current working conditions as potential contributors of physical fatigue. To this effect, the table illustrates the most outstanding responses (mean≥3.5 or ≤2.5). Responses to these Likert scale style questions ranged from one being strongly disagree to five being strongly agree (2.4 and 2.5), and one being the lowest and five being the highest (3.1,3.2,3.3,3.4). As it can be noted, questions of the same nature were grouped together so they could be compared, and questions addressing inter-shifts recovery patterns were repeated in several instances so the researcher could evaluate consistency or discrepancies in responses.
### Table 11 | Nurses’ perception of the current design-layout attributes as potential contributors to physical fatigue.

<table>
<thead>
<tr>
<th>#</th>
<th>Description</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Space layout</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.2.c</td>
<td>Number of trips/ walking distances during shifts</td>
<td>3.53</td>
<td>0.80</td>
</tr>
<tr>
<td>3.3.a</td>
<td>Travel dist. Intra and inter-depart.</td>
<td>1.76</td>
<td>0.97</td>
</tr>
<tr>
<td></td>
<td>Physical demands</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.2.e</td>
<td>Patient handling (lifting, turning, bathing, etc…)</td>
<td>3.53</td>
<td>1.07</td>
</tr>
<tr>
<td>3.2.g</td>
<td>Standing Time</td>
<td>3.76</td>
<td>1.09</td>
</tr>
<tr>
<td>3.2.h</td>
<td>Sitting Time</td>
<td>1.56</td>
<td>0.81</td>
</tr>
<tr>
<td></td>
<td>Provision of ergonomic and functional furniture, finishes, equipment, accessories and millwork</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.4.a</td>
<td>Provision of lift and transp. equip. readily available and in sufficient #</td>
<td>2.24</td>
<td>0.97</td>
</tr>
<tr>
<td>2.4.b</td>
<td>Provision of ergonomic and easy to maintain F,F&amp;E</td>
<td>2.00</td>
<td>0.79</td>
</tr>
<tr>
<td>2.4.c</td>
<td>Provision of chairs and adjustable height seating to reduce standing</td>
<td>2.24</td>
<td>0.97</td>
</tr>
<tr>
<td>2.4.d</td>
<td>Provision of opportunities to rest/lift/stretch the legs</td>
<td>2.00</td>
<td>1.06</td>
</tr>
<tr>
<td>2.4.e</td>
<td>Provision of enough work surface to perform tasks proficiently</td>
<td>2.35</td>
<td>1.17</td>
</tr>
<tr>
<td></td>
<td>Prov. of tech. dev. &amp; resources</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.5.a</td>
<td>Provision of telecommunication systems improving efficiency and reducing waste</td>
<td>1.94</td>
<td>0.75</td>
</tr>
</tbody>
</table>

### Table 12 | Nurses’ perception of operational practices as potential contributors to physical fatigue.

<table>
<thead>
<tr>
<th>#</th>
<th>Description</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Operat. practices</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.3.d</td>
<td>Amount of efforts interacting with family members</td>
<td>3.76</td>
<td>1.03</td>
</tr>
<tr>
<td>3.4.e</td>
<td>Repetition of tasks and inefficient operational procedures</td>
<td>4.00</td>
<td>1.18</td>
</tr>
</tbody>
</table>

### Table 13 | Nurses’ perception of organizational protocols as potential contributors to physical fatigue.

<table>
<thead>
<tr>
<th>#</th>
<th>Description</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Organiz. protocols</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.1.b</td>
<td>The degree of physical fatigue at the end of work shift</td>
<td>4.41</td>
<td>0.87</td>
</tr>
<tr>
<td>3.1.d</td>
<td>The degree of physical fatigue at the end of the work week period</td>
<td>4.20</td>
<td>1.15</td>
</tr>
<tr>
<td>3.1.e</td>
<td>The perception of the physical load level demands dramatically changed since the start in the profession</td>
<td>3.69</td>
<td>1.40</td>
</tr>
<tr>
<td>3.2.a</td>
<td>Number of hours per shift</td>
<td>4.06</td>
<td>1.12</td>
</tr>
<tr>
<td>3.4.c</td>
<td>Duration of shifts</td>
<td>4.18</td>
<td>1.01</td>
</tr>
</tbody>
</table>
As shown in the tables above, work-related patterns were rated as the greater contributors of physical fatigue with (1) the degree of physical fatigue at the end of the work shift, (2) the number of hours per shift and (3) the duration of shifts averaging 4.20, 4.06 and 4.18 respectively. Second in the ranking were operational inefficiencies with aspects such as (1) amount of efforts interacting with family members and (2) repetition of tasks, with averages of 4.00 and 3.76, respectively. Following the pattern, third in the ranking, were design-layout- related attributes with aspects such as standing time, walking distances and patient handling averaging 3.76, 3.53 and 3.53 respectively. Although design-layout related attributes aspects such as (1) the provision of ergonomic and functional F, F &E, accessories and millwork and (2) the provision of technological devices presented outstanding averages, they were just purposeful to illustrate the current conditions of the healthcare setting but were not useful to measure nurses’ perception of their impact on nursing physical fatigue.

These findings suggest that physical fatigue is more likely to be perceived by nurses as a result of insufficient recovery time than from workload demands or strenuous conditions. This is consistent with the literature, which suggests that fatigue and daytime sleepiness associated with stressful working conditions and burnout is more likely the result of insufficient sleep than a direct result of stressful working conditions (AHRQ, 2008).

**Nurses’ ratings on design-layout propositions to the reduction of physical fatigue findings**

This section of the questionnaire looked into nurses’ rating on design-layout propositions that potentially can reduce physical fatigue. Responses to these Likert scale style questions ranged from one being the lowest and five being the highest.
Regarding design-layout propositions as potential contributors to the reduction of physical fatigue, Table 14 shows that outstanding responses include the reconfiguration of design-layout to reflect an alignment with patient-care related procedures, and provision of quick break areas with overall relative responses averaging 4.18 and 3.41 respectively. Conversely, the provision of wellness programs and unit proximity to staff lounge were ranked with the lowest rates.

**Physiological approach findings**

Per Table 15, it can be seen that the majority of participant nurses’ actual physical activity intensities fell within the range between sedentary and light levels. A total of 98.6% performed sedentary to light intensity physical activity, while 1.4% of participants performed moderate intensity levels. For an average 12-hour (720-minute) shift, the average amount of time a nurse performed moderate-or-greater activity was 0.014*720 ±10 minutes.
The most "active" nurse obtained an average of 23.6 minutes of "moderate intensity physical activity" per 12 hours and two of the nurses obtained less than 1.5 minutes of physical activity.

General findings

Paradoxically, while nurses’ perceptions of physical fatigue ranked at high rates, their actual physical activity intensity levels averaged between sedentary and light ranges. These findings suggest that, although nurses may have performed several physically demanding tasks, on average these were performed in a pace that is considered between light to sedentary intensities and, therefore, cannot be accounted as physical activity as required by the 2008 Physical Activity Guidelines for Americans (PAGA, 2008). This paradox offers the opportunity for design interventions that, in alignment with operational practices and organizational protocols, will contribute to nurse’s safety, performance and job satisfaction.

Conclusion

Although the sampling of the study prevents generalization, its findings were generally corroborated by the literature review. Among these findings, sedentary behavior patterns among nurses are controversial and deserve further investigation. Even though there is a growing body of evidence regarding the pervasiveness of sedentary behavior and its deleterious effects on health outcomes, the extent and the impact of these outcomes have been unrecognized and underestimated, particularly in healthcare settings research (Ainsworth & Macera, in-press). The next chapter will expand on these findings and, additionally, design propositions addressing nursing physical fatigue will be presented.
DISCUSSION OF RESULTS

“Evidence-based design is a problem-solving approach to decision making that integrates the best available scientific evidence with the best experiential evidence from architects or healthcare providers; considers internal and external influences on practice (budgets, resources, community standards, etc.); and encourages critical thinking in the judicious application of such evidence to the design of healthcare facilities” (Stichler, 2010, p. 9)

This chapter focuses on the discussion of the findings gathered from both research design approaches previously addressed, and in light of the study’s research questions. In addition, interpretations and design propositions will be presented.

Research questions discussion

**How do emergency department nurses perceive the impact of organizational protocols and operational practices on nursing physical fatigue?**

According to the study’s findings, work-related patterns were rated as the greater contributors of physical fatigue as follows: (1) the degree of physical fatigue at the end of the work shift, (2) the number of hours per shift and (3) the duration of shifts. Second in the ranking were inefficient operational practices as follows: (1) amount of efforts interacting with family members and (2) repetition of tasks and inefficient operational procedures.

As the literature review demonstrated in profusion, workforce staffing patterns such as job assignments, volume of work and work schedules, are great predictors of nursing physical fatigue, job dissatisfaction and burnout. All these factors, isolated or combined, directly impact patient’ outcomes and ultimately the institution’ bottom line. In order to deliver quality of care and, at the same time, remain competitive and financially solvent,
healthcare organizations shall provide optimal working conditions, investing this way, in their most valuable asset: caregivers.

**How do emergency department nurses perceive the impact of the emergency department design-layout attributes on nursing physical fatigue?**

According to the study’s findings, design-layout related attributes perceived as the greater contributors to nursing physical fatigue were standing time, walking distances and patient handling. In addition, aspects such as lack or insufficient provision of ergonomic and functional F, F&E (furniture, finishes or equipment), accessories and millwork; as well as lack or insufficient provision of technological devices were also perceived as contributors of physical fatigue.

The physical environment greatly impacts nursing physical fatigue levels, as it determines the way nurses will move (or not), interact, perform and experience the space. The alignment between operational practices and design-layout is awarded when features of the built environment support nurses’ performance with minimum waste and maximum possible comfort.

**What are emergency department nurses’ actual physical activity levels on an average 12-hour shift?**

Paradoxically, while nurses’ perceptions of physical fatigue ranked at high rates, their actual physical activity intensity levels averaged between the sedentary and light ranges. These findings suggest that, although nurses may have performed several physically demanding tasks, on average these tasks have been carried out in a pace considered between light to sedentary intensities and, therefore, cannot be accounted as physical activity performed as suggested by the 2008 Physical Activity Guidelines for Americans (PAGA, 2008). This paradox offers the opportunity for design interventions that, in alignment with
operational practices and organizational protocols, will contribute to nurse’s safety, performance and job satisfaction.

**The workload/fatigue phenomenon**

“The relationship between workload demands and the individual’s ability to tolerate and recover from a certain level of workload is fundamental to staffing design, nursing workload modification, as well as, individual work/rest scheduling” (Chen, 2009, p.2).

Physical activity (workload demands), performed either for occupational or leisure purposes, is a physiological energy exchange phenomenon intrinsic to life maintenance.

The following Workflow/Recovery-Tolerance diagram (See figure 10) was developed by the researcher to illustrate this physiological phenomenon under the light of nursing physical fatigue.

In healthy physiological exchanges, a balance between workload demands and recovery ability (time) or tolerance capacity (strength) is expected. Aiming to improve efficiency, or to provide for staffing shortages, an organization may gradually increase workload demands. After a point, these demands can cause physiological strain (e.g. elevated heart rate), adaptive behaviors (e.g. slower pace) and eventually physical fatigue, adversely impacting individuals’ well-being and work performance. There is so much efficiency that can be achieved before nursing physical exertion. Until then, if the imbalance remains persistent or remittent, occupational injuries may develop. The opposite is true. When recovery ability (time) is excessive, the result is inefficiency. The extreme in the inefficiency spectrum is waste.
Figure 10. Workload demands and physical fatigue biaxial graphic.
Source: Developed by the researcher.

The relationship between Emergency Department design layout and nursing physical fatigue is fundamental in the development of design propositions as well. To this effect, any cost-effective design that proposes the reduction of workload demands (or their impact), or improvement of an individual’s ability to recover (time) or capacity to tolerate (strength) under the same conditions, should be considered for validation purposes.

When grounded in human factor research and tenets, and cognitive-sensitive design principles, latent conditions, physical exertion and cognitive failures that lead to adverse events in nursing practice are minimized while staff safety, performance and satisfaction are achieved.
Design propositions

As with any cross-sectional, exploratory study, it is acknowledged that it is not possible to infer causation from the study’s findings. Moreover, its sampling is such that wider generalization of the results is unlikely. Nevertheless, because these findings were greatly corroborated by existing literature, it allows for design propositions that will serve as a road map for further investigations, eventual applications, proper evaluations and subsequent validation. These design propositions organization was based in the “Fatigue Cause and Effect framework diagram” proposed in chapter two and illustrated below (See Figure 12). As shown, these propositions aim to revert or reduce the effects of physical fatigue and its consequent impact on staff/patient safety, and staff performance and retention.
Grounded on the literature review, the optimization of all resources and alignment among working conditions can be accomplish by the following bundles of strategies:
Figure 13. Design propositions strategies diagram.
Source: Devised by the researcher.
Anchored on the strategies above, the following design propositions should be considered when addressing aspects of the working conditions that directly, or indirectly, impact nursing physical fatigue:

<table>
<thead>
<tr>
<th>Working conditions</th>
<th>Causes of physical fatigue</th>
<th>Design propositions to reduce physical fatigue</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Workforce staffing</td>
<td>Patient handling</td>
<td>• Minimize excessive standing by providing adjustable height tables and seating opportunities, including corridors &amp; pat. rooms.</td>
</tr>
<tr>
<td></td>
<td>Standing time</td>
<td>• Provide areas and opportunities for recovery, rest, breaks, privacy and silence. Consider niches with massage recliners, foot stand and stools. Upgrade lounge area to afford room for rest as well.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Minimize staff bending, turning and lifting by providing smart beds, grab bars, walkers, patient transportation, lifting and handling equipment. Install ceiling lifts and rubber floors and institute a no-manual lift policy to reduce staff back injuries*.</td>
</tr>
<tr>
<td></td>
<td>Job assignments</td>
<td>• Provide state-of-art remote monitoring and communication systems reducing walking distances and number of trips.</td>
</tr>
<tr>
<td></td>
<td>Volume of work</td>
<td>• Reduce walking by providing point-of-use storage by locating supplies, equipment, information, and procedure rules where they will be used, thus saving time **.</td>
</tr>
<tr>
<td></td>
<td>Work schedules</td>
<td>• Providing opportunities to exercise and anti-sedentary behavior training.</td>
</tr>
<tr>
<td></td>
<td>Number of hours per shift/duration of shifts</td>
<td>• Provide adjustable/ergonomic furniture/equipment to accommodate for various end-users.</td>
</tr>
<tr>
<td></td>
<td>Insufficient inter-shifts recovery time</td>
<td>• Provide areas and opportunities for recovery, rest, breaks, privacy and silence. Consider niches with massage recliners, foot stand and stools. Upgrade lounge area to afford room for rest as well.</td>
</tr>
<tr>
<td>Working conditions</td>
<td>Causes of physical fatigue</td>
<td>Design propositions to reduce physical fatigue</td>
</tr>
<tr>
<td>-------------------</td>
<td>---------------------------</td>
<td>-----------------------------------------------</td>
</tr>
<tr>
<td>2. Workflow Design</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Inefficiency</td>
<td>• Consider reducing redundant and inefficient documentation by efficient practices such as “exception based charting,” which focuses attention on abnormal or significant findings rather than on normal findings**.</td>
</tr>
<tr>
<td></td>
<td>• Time-Motion Patterns</td>
<td>• Consider implementing six sigma, lean and toyota principles to workflow designs by monitoring waste sources: poor utilization of resources, Excess Motion, unnecessary waiting, transportation, process inefficiency, excess inventory and defects/quality control.</td>
</tr>
<tr>
<td></td>
<td>• Information Technology</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Repetition of tasks and inefficient operational procedures</td>
</tr>
<tr>
<td>2. Personal-Social Aspects</td>
<td>• Demograph.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Lifestyle</td>
<td>• Provide food services facilities in alignment with healthy diets.</td>
</tr>
<tr>
<td></td>
<td>• Family burden</td>
<td>• Provide health fitness/wellness centers and programs as well. Consider nurses health in the beginning of the design process with strategies such as inclusion of open stairways, bike tracks, bike storages, showers &amp; lockers.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Physical fitness</td>
</tr>
<tr>
<td></td>
<td>• Gender</td>
<td>• Provide counseling, peer support and incentive programs to support healthy behaviors.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Age</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Life style</td>
</tr>
<tr>
<td></td>
<td>• Family burden</td>
<td></td>
</tr>
<tr>
<td>Working conditions</td>
<td>Causes of physical fatigue</td>
<td>Design propositions to reduce physical fatigue</td>
</tr>
<tr>
<td>--------------------</td>
<td>----------------------------</td>
<td>-----------------------------------------------</td>
</tr>
<tr>
<td>3. Physical Environment</td>
<td>• Environm. stressors</td>
<td>• Increase strategic placement of supplies, equipment and linen storage minimizing walking distances and number of trips*.</td>
</tr>
<tr>
<td></td>
<td>• Ergonomics</td>
<td>• Use of adequate materials and finishes to reduce environmental stressors and promote comfort.</td>
</tr>
<tr>
<td></td>
<td>• Layout</td>
<td>• Provide “family-friendly” quarters. Provide room &amp; conditions so that patients and families can be effectively included in the healthcare team*.</td>
</tr>
<tr>
<td></td>
<td>• Templates</td>
<td>• Red. nurses’ time spent with family members by providing support areas w/ice-makers, blanket warmers, phones, internet &amp; vend. machines.</td>
</tr>
<tr>
<td></td>
<td>• Improper staffing patterns</td>
<td>• Reduce injury risks. Conduct ergonomic evaluation of work areas to design spaces that are supportive of safe work practices.</td>
</tr>
<tr>
<td>4. Organizational factors</td>
<td>• Policies/regulations</td>
<td>• Provide proper rest, meals and break policies.</td>
</tr>
<tr>
<td></td>
<td>• Culture</td>
<td>• Instill and monitor proper scheduling policies.</td>
</tr>
<tr>
<td></td>
<td>• Improper staffing patterns</td>
<td>• Provide proper nurses/ patient ratios.</td>
</tr>
<tr>
<td></td>
<td>• Poorly designed or obsolete facility</td>
<td>• Support cultural transformation by implementing, enforcing and awarding positive changes.</td>
</tr>
<tr>
<td></td>
<td>• Lack of information technology devices or systems</td>
<td>• Include health and safety within the core values of the organiz.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Promote retention by recognizing staff needs and intricacies.</td>
</tr>
</tbody>
</table>

These propositions were organized so that they would fall into the working condition category they are more likely to impact. In reality, they are all inter-dependent.

**Design propositions images.** The following section illustrates some of these propositions.
Modularity, scalability, adaptability, flexibility and universal capabilities. The healthcare setting physical environment is constantly changing according to operational practices, adapting to different workloads and accommodating for new technologies. According to the Saba & Bardwell (2004), spaces change because their usage is typically transitory, administrative and ancillary needs will vary, operational practices will differ, and technology will become obsolete and be replaced.

*Figure 14. Modular and flexible grid system.*
Source: Saba & bardwell (2004)
Modularity, scalability, adaptability, flexibility and universal capabilities. The use of modular systems may accommodate for different configurations in accordance with the organization operational practices.

*Figure 15.* Different space planning configurations based on a grid system. Source: Devised by the researcher.
Access flooring systems grid. Allow changes in space layout with minimum physical and time impact by affording flexible, easy access and expandable wiring, plumbing and HVAC management.

Figure 16. Access flooring system grid samples.
Source: Google images.
**Universal ceiling grid systems.** Similarly, universal ceiling grid systems allow changes in layout and uses as it counts for height clearances and structural support for several instances, affording different light fixtures, loads and space planning configurations.

*Figure 17.* Different ceiling conditions based on a universal ceiling grid system. Source: Google images.
**Demountable wall systems.** Provide flexibility, easy assembly and different configurations of the space allowing for constant changes and adjustments to the optimal use of space, alignment between the physical environment and operational practices.

*Figure 18. Different spaces and layouts based on demountable wall systems. Source: www.teknion.com.*
Ergonomic, functional, versatile, interactive and easy-maintenance equipment, furniture and lighting systems.

Figure 19. Different furniture, light and equipment systems arrangements.
Source: www.teknion.com
Break areas, resting cocoons and niches with privacy.

*Figure 20.* Different arrangements for nurses’ rest, break and privacy. Source: www.teknion.com and google images.
An emergency department treatment room prototype proposed by the researcher. The following Emergency Department treatment room was proposed by the researcher for validation purposes. It encompasses several of the above mentioned design features such as modular, flexible, adaptable and universal capabilities. To this end, the use of demountable wall systems, ergonomic and functional furniture, finishes and equipment; as well as information technology devices facilitating, communication while reducing nurses’ workload demands, were proposed. Of special interest is the suggested multi-media rack with multiple monitors which would allow the patient and family members to remotely communicate with different staff members, such as doctors, pharmacy and diagnosis department personnel to request for information, reducing nurses travel distances and number of trips. In addition, a queuing/tracking integration system is suggested so patient’s exams results or diagnosis reports can be tracked through these monitors reducing time nurses would spend interacting with family members. In the same fashion, this multi-media system would afford the patient and family members to communicate with loved ones through cell phones or web cameras, reducing levels of stress or anxiety.

Design propositions, by definition, are hypothetical design recommendations and require, therefore, data-driven benchmarking protocols for the monitoring and evaluation of outcomes criteria and sub sequential applicability or validation. This will be discussed further down in details.
Figure 21. Emergency department treatment room schematic layout. Source: Developed by the researcher.
1. Pre-manufactured and demountable metallic wall and glazed systems
2. Elevated floor system w/ cushioned floor finish
3. Slots with tracks for ceiling-hung equipment/devices (light fixtures, monitors, lifts, curtains, etc…)
4. Niches for carts and other equipment
5. Adjustable foot rest
6. Organized storage for staff (left) and patient/family members (right)
7. Multi-media Monitors with real-time information (Lab, Pharmacy, Diagnostic)
8. Family Zone
9. Flexible and ergonomic furniture systems
10. Headwall system organizing power/data/gases
11. Bed Docker
12. Perimeter Magnetic Band for accessories
13. Staff Zone
14. Patient Zone
15. Support Zone
16. Hand Wash Sink with soap dispenser, storage above and niche underneath
17. Hand Sanitizer

Figure 22. Emergency department treatment room renderings.
Source: Developed by the researcher.
Validation

For validation purposes, the conceptual framework presented in the second chapter of the study should be used. This conceptual framework, grounded in evaluation theory and on the Donabedian’s classic model for assessment of performance and quality of care, provides a system that can be used by healthcare facilities design teams (See Figure 23). This framework with embedded in the healthcare culture and therefore familiar to clinicians and it incorporates evidence-based design in the process, which is in turn rooted in clinical research and evidence-based design practices.

As shown below, based on this conceptual framework, in order to address nursing physical fatigue, any design proposition should be developed through an evidence-based design process, aiming nursing performance as the main outcome, and seeking validation through proper evaluation criteria. If properly validated, these design propositions can eventually become templates, design standards, or guidelines. The process is represented as a cycle on purpose.

Design propositions need to be constantly reevaluated due to the organic nature of healthcare settings. Templates, guidelines and standards are just start points from where design teams can begin the design process discussion. While efficient because these are “boiler plates” that convey a lot of information necessary to the process, shortcut a lot of steps, and facilitate important decisions, they shouldn’t be accepted as permanent and, therefore, its validation should be monitored periodically.
Figure 23. Donobedian based conceptual framework for design propositions. Source: Developed by the researcher.

Conclusion

This chapter discussed the findings of the study. In addition, interpretations and design propositions were presented. The next chapter will tender the general discussion drawn from the study in addition to its limitations and final conclusions.
Chapter 6

CONCLUSION

Henceforth, architects and designers have the responsibility of applying evidence-based design models within project delivery processes, ensuring this way, healthcare facility design propositions that reduce the stress of facility users, improves safety and productivity, reduces resource waste, and enhances sustainability/ (Heard 2010-Vol. 4, No 1).

Nursing fatigue is an issue with negative ripple effects on important healthcare delivery outcomes including staff and patient safety as well as staff performance and retention. While in other safety-sensitive industries such as aviation, transportation and nuclear plants, fatigue has been the object of systematic research and addressed with consequent regulations, just recently, the healthcare sector has been engaged in further investigations. This chapter provides a general discussion of the study. In addition, its limitations and final conclusion will be provided.

General discussion

This study examined Emergency Department design-layout and nursing physical fatigue. Among other findings, one axiomatic fact is that while nurses care for others, they have not been able to care for themselves.

A call for nurses’ health

Nursing physical fatigue has been the norm, not the exception. Findings of the study suggest that a considerable number of nurses are working too many hours with too little time left for sufficient inter-shifts recovery ability, both of which have been considered predictors of chronic physical fatigue and lack of physical activity.
Moreover, these findings, corroborated by other similar studies such as the works of Hendrich et al (2008) and Chen (2009), have suggested that a considerable amount of nurse’s time may be considered or are conducive of sedentary behaviors.

In the long run, as the literature review substantiates, these factors combined: lack of physical activity, sedentary behavior and chronic physical fatigue, may result in deleterious consequences on nurses’ health and well-being. This is incongruous to what nurses proclaim to instill: healthcare. Moreover, it is inconsistent with the image they should portrait as ambassadors of health while at the forefront of many healthcare organizations.

**Time at work.** Data acknowledges that nursing working conditions are intrinsically strenuous, with significant physical workload demands including extensive walking, standing and patient-handling tasks. Ironically, most of these tasks are probably being performed in a pace that, most likely may be characterized as physical activity between light to sedentary intensity levels. Thus, while at work, nurses are doubtfully meeting the minimum physical activity daily requirements suggested by the 2008 Physical Activity Guidelines for Americans which is 30 minutes of moderate-intensity activity on five or more days per week, or 20 minutes of vigorous-intensity activity on three or more days per week (PAGA, 2008).

Adding to this equation is the fact that a considerable amount of nurses’ time has been allocated to patient-related tasks such as documentation, medication administration and care coordination and which are highly conducive of sedentary behaviors with prolonged sitting positions. Extensive time spent in sedentary behaviors has been linked with negative health outcomes such as early death, cardiovascular disease, diabetes, and cancer (Ainsworth &Macera, in-press).

Moreover, the literature review revealed that repetitive and intermittent workload demands required in patient-care related tasks have placed the nursing profession among the groups with the highest rates of occupational injuries.
The reviewed literature also showed that endorsing these rather stressful working conditions, is the lack of breaks, naps and resting policies, as well as appropriate work scheduling and workforce staffing patterns enforcement, from the part of healthcare organizations or governmental agencies.

These factors, isolated or combined together, have been major contributors to nursing physical fatigue and nurses’ failure to engage in physical activity behaviors while off work.

**Time off work.** Concomitantly, while off work, data has revealed that, among others reasons, personal-social aspects are precluding a considerable number of nurses to engage in a healthy lifestyle, particularly in physical activity behaviors.

In addition to the necessary time to recover from long work shifts, eventual family burden responsibilities, secondary position commitments and other social-economic issues, have imposed hardships beyond nurses’ physical tolerance precluding physical activity behaviors.

Moreover, modern life has promoted sedentary behaviors across the day and across every domain with the proliferation of computer-based activities and environmental factors, such as physical layouts that offer elevators in lieu of open stairways, and car-scale-driven urban configurations that do not promote walking (Saba & Bardwell, 2004).

Thus, while off work, nurses are doubtfully meeting the minimum physical activity daily requirements suggested by the 2008 Physical Activity Guidelines for Americans which is 30 minutes of moderate- intensity activity on five or more days per week, or 20 minutes of vigorous-intensity activity on three or more days per week (PAGA, 2008).

Once more, the lack of governmental regulations or mandatory policies with regard to recovery time patterns between shifts, has endorsed nurses to over commit their time with
serious repercussions to the healthcare delivery process, simultaneously posing a threat to their own health, the health of their patients and the health of the public.

**Nurses’ health status reality check**

Attributed to the above-mentioned facts, is that “although the profession of nursing exists to improve health, to date, nurses have failed to effect the wide-scale adoption of healthy lifestyles in the United States” (Hensel, 2010, p.47). Failure to carry out healthy lifestyles has been associated with several negative health outcomes and poor health has been cited as one of the top reasons nurses leave the profession before retirement age (Henzel, 2011). The health effects of physical activity within the nursing workforce are not only beneficial but also fundamental in order to enable the caregiver to withstand the physical demands of the profession and provide safe care.

**Physical Inactivity and Sedentary Behavior: Two Diametrically Opposed Dimensions of one same Spectrum**

While the benefits of physical activity in the reduction of high risk diseases is of public knowledge, the extent and negative effects of sedentary behavior outcomes has been unrecognized and underestimated, particular in healthcare settings research.

According to Ainsworth and Macera (in-press), prolonged time spent in sedentary behaviors, which involve prolonged sitting or reclining and minimal energy expenditure, has been linked with deleterious health outcomes such as early death, cardiovascular disease, diabetes, and cancer. Theses outcomes differ from those that can be accredited to a lack of moderate to vigorous physical activity. An individual may be both physically active and highly sedentary or, conversely, be inactive, but perform low levels of sedentary time.
Further investigations

To this end, further investigations on nursing sedentary behaviors patterns are recommended so nurses’ utilization of time can be assessed in real scale and time, and pertinent actions, policies and regulations can take place. While the use of accelerometers in the study enabled the researcher to investigate physical activity levels of nurses while at work, the sample was too small to support generalizations. Moreover, the use of inclinometers would be more suitable for this type of investigation as they provide more accurate measurements, as they record and distinguish between types of sedentary behaviors or different postures (Saba & Bardwell, 2004). This type of assessment provides the contextual information in which nurses spend their time and inform with scientific rigor how working conditions can be manipulated to support nursing healthier behaviors.

Time for change

Healthcare organizations have the social responsibility of promoting health among nurses by affording them the ability to carry out healthy lifestyles. Nurses’ health should be embedded in the culture and mission and set as a tenet of the organization. This new paradigm should percolate in all levels of working conditions, from the physical environment to workflow designs.

In addition, the nursing professional arena allows purposeful organizational and physical environmental interventions as nurses share similar socioeconomic status, job descriptions and education regarding the benefits of physical activity. A detailed look into the major barriers nurses have faced, and how to provide ways to overcome them, is a sine qua non condition to staff promotion and retention. Factors such as work shift hours, demanding physical labor, highly stressful working environment, and workplace social dynamic are a few to be considered in this quest.
A healthy bottom line depends on healthy people. Health promotion programs and design interventions that promote nurses’ health should be viewed as an economic business investment no different from investing in new technologies, equipment or supplies. Nurses are a healthcare organization’s most valuable assets.

**Physical environment**

The physical environment, in light of nursing physical fitness, plays an essential role as much in the promotion of physical activity as in the reduction of sedentary behaviors. Moreover, it can provide opportunities of recovery affording nurses to cope with physical fatigue while at work or off work.

**Limitations for the study**

Several limitations of this study should be mentioned.

1. **Design methodology.** As with any cross-sectional, exploratory study, it is acknowledged that it is not possible to infer causation from the study’s findings.

2. **Sampling.** Moreover, its sampling size is such that wider generalization of the results is unlikely.

3. **Location.** This study took place in one hospital Emergency Department. There may be greater variability in results among nurses of different hospitals, different sizes and different healthcare systems. Moreover, some Emergency Departments are specialized in different levels of care, which may include services such as burn, neurosurgery and stroke centers and cardiac or trauma care, requiring different workload demands.

**Self-administered questionnaire.** As in all self-administered questionnaires, responses are potential sources of social desirability nature responses. In addition, the validity of types and amount of questions regarding nurses’ perception of potential contributors of physical fatigue would have to be confirmed. Moreover, the fact that the survey was not responded at the same time as the accelerometers were worn prevented the research to correlate or
compare perceived against actual energy expenditure. Finally, questionnaires are limited in size and therefore do not warrant that all that should be asked in fact was. Among others, the following questions were not addressed:

Participant nurses existing break and rest routines; nature and time spent on other part-time jobs or regular activities; average time spent with children under the age of 16 or an elderly at home; level of satisfaction and intention to leave the field; impact of environmental stressors such as noise, glare and distractions; number of patients per shift and sedentary behavior patterns.

**Direct monitor assessment.** Accelerometers measure the intensity, duration, and frequency of walking and running movements and, therefore, the absence of these movements can be used to derive sedentary time (Ainsworth & Macera, in-press). Although, they measure movements, they are unable to distinguish between types of sedentary behavior or different postures (e.g., standing mode). The accelerometers of the study were not programmed to measure the number of steps nurses took per shift. This information was important, as travel distances are major contributors of physical fatigue.

**Data collection.** Several adverse occurrences happened during the accelerometers data collection process:

1. Due to confidentiality policies; the researcher was never able to have a list of names or number of eligible nurses, nor their email addresses or schedules. This represented a problem in the recruitment process since the recruiter did not know how many nurses should be recruited, when they would be working, and what their names were. The recruiter had to be present at every shift turn meeting (sometimes four times a day) and invite the nurses of that particular shift to participate in the research.
2. The lack of information on nurses was aggravated by the fact that the server of the hospital was down for two weeks, constituted a problem at the end of the data collection, when the researcher needed to inquire about missing accelerometers or surveys.

3. Due to the fact that the entire hospital server system was down for two weeks in the course of the study, several nurses did not respond to the online survey at the same time they wore the accelerometers. A lag of four days occurred between the day the server system went down and the time the researcher handed hardcopies with details of the online survey (with a link to the online survey) to the nurses. This effort was proven ineffective because the nurses still would not respond to the online survey out of their homes. Several nurses showed difficulties in understanding the process without actually seeing it. Some nurses did not have personal emails or home Internet connection.

4. The researcher then printed hardcopies of the online survey, leaving them in sealed envelopes on the counter so participant nurses who did not have access to the internet could fill them out manually. A total of nine nurses used this method, but most of them did not write down either the accelerometer's tag number, or the date and amount of hours per shift they wore the accelerometers.

5. One nurse complained the belt that held the accelerometer was too narrow and did not fit or his/her waist; one nurse stated the accelerometer tag fell off; and one nurse returned the accelerometer, voluntarily withdrawing from the study.
Conclusion

Nurses, as ambassadors of health, should portray an image of wellness, which is in concert with healthcare delivery. Healthcare organizations should provide working conditions and supportive environments to promote nurses’ performance, health and retention.

As stated before, isolated actions will not be effective. Only bundles of strategies in all spheres, from individual to organizational levels, will leverage the knowledge, skills, willingness and resources necessary to achieve these common goals. It is only by addressing these realms of patient care delivery that patient safety will be guaranteed.

The physical environment should be in alignment with these objectives. The findings of this study suggest that nurses are working too many hours and having too little time to avail themselves of healthy lifestyles. Further investigation on how working conditions may hinder nurses’ ability to care for themselves should be a priority in a healthcare organization’s agenda. “First things first.” First, do no harm, and that includes no harm to nurses.
REFERENCES


APPENDIX A

INSTITUTIONAL REVIEW BOARD PROCESS
Institutional Review Board Approval Letter

To: Diane Bender
CDN

From: Carol Johnston, Chair
BioSci IRB

Date: 02/15/2011

Committee Action: Exemption Granted
IRB Action Date: 02/15/2011
IRB Protocol #: 1102005973

Study Title: A Case Study: Exploring the Influence of Design on ED Nurse Physical Fatigue

The above-referenced protocol is considered exempt after review by the Institutional Review Board pursuant to Federal regulations, 45 CFR Part 46.101(b)(2).

This part of the federal regulations requires that the information be recorded by investigators in such a manner that subjects cannot be identified, directly or through identifiers linked to the subjects. It is necessary that the information obtained not be such that if disclosed outside the research, it could reasonably place the subjects at risk of criminal or civil liability, or be damaging to the subjects’ financial standing, employability, or reputation.

You should retain a copy of this letter for your records.
APPENDIX B

RECRUITMENT FLYER
Participant Recruitment Flyer

Introduction | Problem Statement

A Case Study: Exploring Emergency Department Layout and Nursing Physical Fatigue

Written by: [Name]

Purpose: The purpose of this study is to explore the relationship between Emergency Department layout and nursing physical fatigue in order to identify potential interventions that can improve nurse well-being and patient safety.

Methods: A mixed-methods approach was used, combining qualitative interviews with quantitative data collection through a survey. The study population consisted of nurses working in the Emergency Department with at least one year of experience. Data was collected over a six-month period.

Results: The results showed that nurses reported significantly higher levels of physical fatigue in areas with poor layout and poor access to resources. Nurses also expressed dissatisfaction with the design of workspaces, which contributed to increased physical strain.

Conclusion: The findings of this study highlight the importance of designing Emergency Departments with ergonomic considerations in mind to reduce physical fatigue and improve nurse satisfaction. Further research is needed to explore interventions that can address these issues.

Invitation to Participate

Thanks

Karen Shaker | 03.02.2011 | kashakman@asu.edu | 480.232.109
APPENDIX C

SURVEY QUESTIONNAIRE
A Case-study: Exploring The Influence of Design/Layout on ED Nurse

1. Personal Profile

This section will identify who you are and some aspects of your lifestyle.

1. Please write down your accelerometer tag. Once more, the results of this survey will be disclosed only in average numbers and therefore your privacy is ensured.

2. Please write down the date and time of each shift you have worn your accelerometer, including the time you clocked in and clocked out. For the most accurate results, please make sure that you wear your accelerometer during the entire shift.

3. What is your age?

4. Are you Male or Female?

   □ Female   □ Male

5. What is your height?

   □ 4'   □ 5'   □ 6'

6. What is your approximate weight?

7. Which of the following applies to you?

   □ You smoke or have smoked in the past.
   □ You exercise at least thirty minutes three days a week.
   □ You usually get 6-8 hours of sleep a day.
   □ You have kids under the age of 16 or an elderly parent at home.
   □ You have another part-time job or regular activity.
A Case-study: Exploring The Influence of Design/Layout on ED Nurse

8. How many shifts do you work per week?

9. How many hours does your shift last? Please state the actual not scheduled hours.

10. How many consecutive shifts do you usually work?

11. How long have you worked as an Emergency Department nurse?

12. What period of the day usually are your shifts?
   - Day / morning
   - Day / middle
   - Evening
   - Night

13. Please rate your experience with the following work-related musculoskeletal problems during the course of your career as an Emergency Department nurse (Please briefly describe below in the space provided the nature and circumstance).

<table>
<thead>
<tr>
<th></th>
<th>Almost never</th>
<th>Rarely</th>
<th>Sometimes</th>
<th>Frequently</th>
<th>Almost always</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Neck.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. Shoulder.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. Upper back.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. Lower back.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>e. Upper arm.</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>f. Forearm</td>
<td>Elbow</td>
<td>Wrist.</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>g. Thigh</td>
<td>Knee.</td>
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<td></td>
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<tr>
<td>h. Lower leg.</td>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>i. Ankle, foot.</td>
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<td></td>
</tr>
</tbody>
</table>

Nature and circumstance of my work-related musculoskeletal problem(s) experience:

2. Design/Layout and Ergonomics Related

This section will explore functional performance aspects of the built environment and its relationship with nurse physical fatigue.
A Case-study: Exploring The Influence of Design/Layout on ED Nurse

1. With regard to your department's existing physical design/layout, please respond to the following statements based on the rating scale provided:

<table>
<thead>
<tr>
<th></th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. The racetrack configuration (linear central nurse station with surrounding circulation) is efficient and contributes to your productivity.</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
</tr>
<tr>
<td>b. The distribution of spaces (rooms and corridors) aligns with your patient-care procedures and is conducive to an efficient throughput of patients.</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
</tr>
<tr>
<td>c. The design/layout offers acuity-adaptable patient rooms allowing for flexibility in nurse/patient assignments while promoting your efficiency relative to the volume of patients.</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
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<tr>
<td>d. The central nursing station configuration allows you to visually monitor your patients and perform care delivery related tasks proficiently.</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
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<tr>
<td>e. It provides decentralized nursing stations minimizing travel for documentation and coordination of care procedures.</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
</tr>
<tr>
<td>f. The design/layout provides multiple designated support areas (soils, linens, nourishment) minimizing travel within the unit.</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
</tr>
</tbody>
</table>

Please add any comment(s) or suggestion(s) regarding any of the above statements:
A Case Study: Exploring The Influence of Design/Layout on ED Nurse

2. Travel Distances between your department and the following critical areas are efficient:

<table>
<thead>
<tr>
<th>Area</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Imaging / Diagnostics-</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RADIO</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td></td>
<td>○</td>
</tr>
<tr>
<td>b. Imaging / Diagnostics-</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MRI</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td></td>
<td>○</td>
</tr>
<tr>
<td>c. Imaging / Diagnostics-</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CT</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td></td>
<td>○</td>
</tr>
<tr>
<td>d. Imaging / Diagnostics-</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CARD</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td></td>
<td>○</td>
</tr>
<tr>
<td>e. Surgery</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>f. Critical Care Units</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td></td>
<td>○</td>
</tr>
<tr>
<td>g. Laboratory</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td></td>
<td>○</td>
</tr>
<tr>
<td>h. Pharmacy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Please add any other areas outside your unit that you usually visit to perform patient-care activities and whose travel distances contribute to your physical fatigue.

3. Within your department, location of and travel distances to the following spaces promotes efficiency in patient-care related tasks:

<table>
<thead>
<tr>
<th>Area</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Supply Room</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. Medication Room</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. Equipment Storage</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. Clean Utility Room</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>e. Soiled Utility Room</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>f. Nourishment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>g. Patient Toilet(s)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>h. Nurses’ Station</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>i. Staff Toilet(s)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Please add any other areas inside your unit that you usually visit to perform patient-care activities and whose travel distances contribute to your physical fatigue.
A Case-study: Exploring The Influence of Design/Layout on ED Nurse

4. With regard to the existing equipment, furniture, accessories, and casework in your department, please respond to the following statements based on the rating scale provided:

<table>
<thead>
<tr>
<th></th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Patient lifting and transporting equipment is readily available and in sufficient numbers as to prevent occupational injuries.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>b. Equipment, furniture, accessories, and casework are ergonomic, functional and handy, as well as easy to use and maintain.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>c. Recliners, adjustable height pull-up stools and chairs are available in strategic areas minimizing the amount of unnecessary standing.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>d. There exist multiple opportunities for resting, lifting or stretching your legs when appropriate.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>e. It provides adequate work surface and space for you to perform all patient-care related tasks in a proper, efficient and comfortable manner.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>f. Medical supplies are stocked where you need them and replenishment is frequent, organized and performed in a consistent manner so you do not have to travel to find them.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>

Please add any comment(s) or suggestion(s) regarding any of the above statements:
A Case-study: Exploring The Influence of Design/Layout on ED Nurse

5. With regard to the existing Information Technology equipment available in your department, please respond to the following statements based on the rating scale provided:

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. It offers telecommunication systems (smart phones and teleconference devices) which facilitate communication between you and patients, family members and peers, saving you time while minimizing trips.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. It provides health integrated information systems between departments and within your department allowing you to input and exchange patient-care related information in real-time and at the point-of-care promoting efficiency while minimizing trips.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. It provides remote patient alert management systems such as smart beds and electronic vitals devices allowing you to monitor patients from a distance while keeping track of equipment and minimizing travel.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Please add any other technological equipment or device that in your opinion could be implemented at your department in order to reduce nurses' physical fatigue

3. Fatigue Levels

This Section will measure the healthcare provider’s physical fatigue on a personal level.
1. In regards to your perception of physical fatigue, please rate the following items on a scale from 1 to 5 (one being the lowest):

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. The degree of physical fatigue at the beginning of your work shift</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>b. The degree of physical fatigue at the end of your work shift</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>c. The degree of physical fatigue at the beginning of your work week</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>d. The degree of physical fatigue at the end of your work week</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>e. Your perception of the physical load level demands on the nursing workforce has dramatically changed since you started in this profession</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

Please add any comment(s) or suggestion(s) regarding any of the above statements:
2. Rate the following aspects which POTENTIALLY contribute to physical fatigue on a scale from 1 to 5 (one being the lowest):

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. The number of hours you work per shift.</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
</tr>
<tr>
<td>b. The number of shifts you work per week.</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
</tr>
<tr>
<td>c. The number of trips and walking distances during your shifts.</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
</tr>
<tr>
<td>d. The number of patient transports (stretcher or wheel chair).</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
</tr>
<tr>
<td>e. Patient handling (lifting, turning, bathing, etc…).</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
</tr>
<tr>
<td>f. Equipment Hauling (Stretchers, X-Ray equipment, etc…).</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
</tr>
<tr>
<td>g. Time standing.</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
</tr>
<tr>
<td>h. Time sitting.</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
</tr>
</tbody>
</table>

Please add any comment(s) or suggestion(s) regarding any of the above statements:
A Case-study: Exploring The Influence of Design/Layout on ED Nurse

3. Rate the following items that POTENTIALLY contribute to fatigue on a scale from 1 to 5 (one being the lowest):

<table>
<thead>
<tr>
<th>Item</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Walking distances between your unit and other critical areas such as Pharmacy.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. Walking distances and number of trips from patient room to soiled, linen and nourishment areas when performing patient-care delivery tasks including getting warm blankets, water and ice.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. Number of trips from patient room to central nurse station for purposes of documentation and/or coordination of care-delivery.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. Amount of effort managing patient family members' requests such as figuring out patient's health status or lab exams, answering calls or getting ice.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>e. Amount of trips to other spaces or departments to meet with team members with the purpose of coordination of care.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Please add any comment(s) or suggestion(s) regarding any of the above statements:
A Case-study: Exploring The Influence of Design/Layout on ED Nurse

4. As it relates to organizational processes, please rate the following items' POTENTIAL contribution to fatigue on a scale from 1 to 5 (one being the lowest):

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Multi-tasking demands.</td>
<td>O</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. Documentation and coordination of care-delivery procedures.</td>
<td>O</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. Duration of shifts.</td>
<td>O</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. Time spent with patients waiting to be admitted.</td>
<td>O</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>e. Repetition of tasks or performing of inefficient operational procedures.</td>
<td>O</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Please add any comment(s) or suggestion(s) regarding any of the above statements:


5. Please check the frequency of use of the following items for the RELIEF of your physical fatigue.

<table>
<thead>
<tr>
<th></th>
<th>Never</th>
<th>Rarely</th>
<th>Sometimes</th>
<th>Frequently</th>
<th>Always</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Compression garments.</td>
<td>O</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. Orthopedic footwear.</td>
<td>O</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. Orthotic insoles or shoe lift pads.</td>
<td>O</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. Ankle and posture supports.</td>
<td>O</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>e. Foot massagers.</td>
<td>O</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>f. Exercise to improve your fitness and resilience levels.</td>
<td>O</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Please write down any other items that you may use or actions that you may take in order to relieve your physical fatigue:
A Case-study: Exploring The Influence of Design/Layout on ED Nurse

6. Please rate the following items' POTENTIAL contribution to the RELIEF of fatigue on a scale from 1 to 5 (one being the lowest):

<table>
<thead>
<tr>
<th>Item</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>Highest</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Unit proximity to staff lounge.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. Provision of quick break areas with opportunities for nourishment and resting.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. Provision of wellness programs for staff members, providing orientation programs with emphasis on body mechanics.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. Provision of a conveniently located wellness center with rooms for fitness, yoga and stretching classes and anti-stress equipment (self-massage recliners, foot massagers, pools).</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>e. Installation of anti-fatigue performance flooring or mats where applicable.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>f. Reconfiguration of the design/layout to reflect and align with patient-care related procedures.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Please add any comment(s) or suggestion(s) regarding any of the above statements:
A Case-study: Exploring The Influence of Design/Layout on ED Nurse

7. Please rate the following items POTENTIAL contribution to the RELIEF of your physical fatigue on a scale from 1 to 5 (one being the lowest):

|   | 1 | 2 | 3 | 4 | 5 |  
|---|---|---|---|---|---|---|
| a. Increase of supplies storage capacity inside patient room. |   |   |   |   |   |   |
| b. Increase of supplies storage capacity throughout the unit. |   |   |   |   |   |   |
| c. Increase of the amount of toilets within the unit. |   |   |   |   |   |   |
| d. Provision of automated medication supply machines throughout the unit. |   |   |   |   |   |   |
| e. Provision of lift equipment in each patient room. |   |   |   |   |   |   |
| f. Provision of lift equipment in corridors and patient toilets. |   |   |   |   |   |   |

Please add any other suggestion that in your opinion may contribute to the relief of your physical fatigue inside your unit.