



A macroergonomic perspective on fatigue and coping in the hospital nurse work system



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ARTICLE INFO

Article history:

Received 4 September 2015

Received in revised form

12 November 2015

Accepted 17 November 2015

Available online 10 December 2015

ABSTRACT

Occupational fatigue in hospital nurses is associated with increased nurse turnover, and decreased nurse health and patient safety. The goal of this study was to explore the factors contributing to or preventing fatigue, and barriers and facilitators to individual nurse coping in hospital work systems. Interviews were conducted and analyzed using a directed qualitative content analysis approach guided by the Systems Engineering Initiative for Patient Safety (SEIPS) model. Themes related to sources of fatigue within each of the five primary components of the SEIPS work system were identified, along with barriers and facilitators to nurses' experiences and strategies for coping with fatigue. Findings from this study provide guidance on what nurses perceive as contributing to fatigue and factors that are helpful and harmful to coping with fatigue within their work system. Implications for fatigue risk management systems (FRMS) are also discussed, in particular the importance of maintaining nurse autonomy in decision-making when implementing fatigue interventions or countermeasures.

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1. Introduction

It is estimated that 37.9% of the US workforce experiences occupational fatigue at work (Ricci et al., 2007). Occupational fatigue can be defined as a multidimensional state that arises in workers who are exposed to excessive demands through their work tasks, environment, and schedules, and that can interfere with workers' physical and cognitive abilities and their ability to function at their normal capacity (Barker and Nussbaum, 2011; Rogers, 2008; L. M. Steege et al., 2015). This paper will refer to occupational fatigue as fatigue unless otherwise noted. There is an increased interest in research, regulation, and management of fatigue in industries where the public could be exposed to negative consequences of workers' fatigue, such as transportation, the military, and healthcare (Gander et al., 2011). While other industries, such as transportation, have developed safeguards to address fatigue through fatigue risk management systems (FRMS) and state and federal regulation, healthcare, specifically nursing, has not wholly developed or implemented such systems (Gander et al., 2011; Lerman et al., 2012). FRMS aim to manage risks, especially risks

to safety, associated with fatigue. They rely on data to understand sources of risk and develop strategies for removing, minimizing or mitigating identified risks (Lerman et al., 2012). FRMS generally span multiple levels of intervention and offer increased flexibility in addressing risks compared to interventions that solely focus on work hour restrictions. This is particularly true in industries that rely on shiftwork, such as healthcare (Lerman et al., 2012).

Fatigue is prevalent in hospital registered nurses (RNs), and one survey study of hospital RNs ($n = 745$) found 65% experienced acute fatigue and 50% experienced chronic fatigue (Barker and Nussbaum, 2011). The identified consequences of fatigue in hospital RNs are substantial and include: increased adverse patient events, including falls, medication errors, and mortality; as well as individual nurse consequences, such as decreased quality of decision-making, increased work injuries, decreased productivity, poor health, and job dissatisfaction and turnover (Bae and Fabry, 2014; Reese, 2014; Williamson and Friswell, 2013). Addressing occupational fatigue in hospital RNs has been identified as a priority of the American Nurses Association (ANA), the Institute of Medicine, and the Joint Commission (Addressing Nurse Fatigue to Promote Patient Safety and Health: Joint Responsibilities of Registered Nurses and Employers to Reduce Risks, 2014; Health care worker fatigue and patient safety, 2011; IOM, 2006; Page, 2004; Smith-Miller et al., 2014). Prior work on fatigue in hospital nurses has focused on temporal and circadian demands, as areas of

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concern and intervention because of the success of addressing these areas through regulation and FRMS in other industries, and the link between fatigue and circadian and shift demands. In fact, studies on shift work, circadian rhythms and scheduling act as the basis for many of the current recommendations on fatigue management for hospital RNs (Bae and Fabry, 2014; Smith-Miller et al., 2014). The *Addressing Nurse Fatigue to Promote Patient Safety and Health: Joint Responsibilities of Registered Nurses and Employers to Reduce Risks* (2014) on addressing fatigue includes nurse sleep hygiene, scheduling, and shift length recommendations.

However, fatigue in nursing is now understood to be a multifaceted issue due to the complex nature of overlapping constructs (e.g. stress, burnout), stigma, and blend of work environment and personal sources (Lee et al., 2014). As a result, more recent research on fatigue in hospital RNs has focused on identifying multidimensional work demands specific to nursing that need to be addressed in FRMS (Chen et al., 2014; Myny et al., 2012; L. M. Steege et al., 2015). Results of multiple survey, fatigue modeling, and data mining studies illustrate that fatigue is the result of many individual (e.g. age, circadian rhythm, prior work experience) and work system factors (e.g. repetitive tasks, shift work, and nighttime work) (Hallowell, 2010; Lee et al., 2014; Pasupathy and Barker, 2012; L. M. Steege et al., 2015). The breadth of fatigue sources identified in these studies points to the need for a macroergonomic approach to better understand and address factors contributing to and/or preventing fatigue within hospital nurse work systems.

One such macroergonomic approach is the Systems Engineering Initiative for Patient Safety (SEIPS) model (Carayon et al., 2006). The SEIPS model is derived from both Donebadian's model for quality improvement, incorporating structure, process, and outcomes (Donebadian, 1988), and balance theory (Smith and Carayon, 2001; Smith and Carayon-Sainfort, 1989). The SEIPS model was developed specifically to address patient safety and other organizational, employee, and patient outcomes for healthcare work systems. The model outlines five components for the work system structure: person, organization, task, environment, and tools and technology; and in its subsequent SEIPS 2.0 version, the ability of the system to adapt and respond to external forces' effects on the work system (Carayon et al., 2006; Holden et al., 2013). Balance theory emphasizes the relationships between components of the system and the importance of considering the entire system when evaluating healthcare processes and outcomes. Some components of a system may act as barriers to a particular process or outcome, but this may be offset by focusing on or enhancing more positive components of the system. The SEIPS model has been utilized as a basis for investigating the healthcare work system to gain understanding and carry out interventions (Carayon et al., 2014).

One component of the work system in the SEIPS model is the person, in this case the individual hospital RN. Models of FRMS also include personal protective approaches as hazard controls at the individual level (Williamson and Friswell, 2013). Examples of reducing fatigue through a personal protective approach include training, education, use of alertness aids, and evaluation and treatment of individual sleep. These protective approaches can also be considered as coping strategies. Coping strategies are cognitive and behavioral efforts employed by an individual to manage internal and external stressors (Chang et al., 2006; Samaha et al., 2007). Coping has been identified as a way to combat nursing workplace stressors and their consequences (e.g. burnout, and turnover), but limited research has studied the relationship between coping behaviors and their impact on nurse fatigue levels (Chang et al., 2006; Samaha et al., 2007). Samaha et al. (2007) looked at the relationship between chronic fatigue and lifestyle factors, psychological variables, and coping behaviors, and found that the relationship between fatigue and coping varied by coping

type and called for further investigation. Other prior work has focused primarily on coping strategies (e.g. sleep, scheduling, and recovery) employed by hospital RNs in preparation for or at the conclusion of a shift rather than during a shift (Chen et al., 2014). To improve FRMS in the context of the work environment, it is important to understand nurses' coping strategies with fatigue as a mechanism for personal protection in the context of their work system.

The overall aim of this study was therefore to explore barriers and facilitators within the hospital nurse work system to coping and fatigue. Specifically, this study addressed two primary research questions:

- What do hospital RNs identify as factors in the work system contributing to or preventing the development of occupational fatigue?
- What do hospital RNs perceive as barriers and facilitators to coping with fatigue in their work system?

2. Methods

2.1. Participants

Registered Nurses (RNs) were recruited from a large academic hospital in the Midwestern United States. RNs from adult intensive care (Cardiac Intensive Care, Neurological Intensive Care) and adult medical-surgical units (General Medicine, Oncology, Neurology) were selected for recruitment because of the generalizability to similar type hospital units at hospitals across the country. In order to explore the relationships between experience level and fatigue and coping, participants were eligible for the study if they had less than two years of work experience as an RN or greater than five years of experience as an RN. These different time frames were selected in line with Benner's work on the Novice to Expert framework (Benner, 1982).

2.2. Procedures

The study team developed a semi-structured interview guide based on the identified gaps in the literature discussed above and the work structure components of the SEIPS model. The guide included interview questions about participants' personal experiences with fatigue and coping strategies; perceived barriers and facilitators to fatigue and coping within the hospital work system; and potential solutions to fatigue. The responses to questions related to barriers and facilitators to fatigue and coping are reported in this paper along with a brief discussion of identified potential solutions.

Prior to participant recruitment and data collection, the local Institutional Review Board approved the study. The interviews were conducted by one of the authors in a private interview room and were audio recorded. Each interview lasted approximately 1 h. The audio recordings were then transcribed word-for-word by a HIPAA-certified transcriptionist. Complete transcripts were then uploaded to a qualitative analysis program, Dedoose (SocioCultural Research Consultants, 2014).

2.3. Data analysis

Interview transcripts were analyzed using directed content analysis. The SEIPS Model was used as a conceptual framework in the directed content analysis. Directed content analysis was selected due to its ability to support or extend an existing theory, and its capacity to merge conceptual models with reality (Hsieh

and Shannon, 2005).

The two authors acted as independent coders to create the coding structure and separately coded all 22 interviews. Table 1 shows the coding structure creation process.

3. Results

Twenty-two RNs participated in the study. Twelve participants had less than two years of experience (8 from Medical-Surgical units and 4 from Intensive-Care units), and ten participants had greater than five years of experience (4 from Medical-Surgical units and 6 from Intensive-Care units). Participants worked a variety of shifts, with seven working days, five working rotating shifts, and ten working night shift. The mean (SD) number of hours scheduled per week was 34.9 (4.6). A majority (19/22) of participants were female. Participants' ages ranged from 23 to 55 years of age. The mean age for the less than two years of experience participants was 26 years of age and the mean age for the greater than five years of experience participants was 35.8 years of age. A summary of participant demographic characteristics by type of unit is included in Table 2.

The content analysis revealed multiple themes characterizing barriers and facilitators to fatigue and coping within the hospital RN work system. Themes were identified in each of the five components of the SEIPS model. While some themes can be directly identified as contributing to or preventing fatigue, or as a barrier or facilitator to coping, the relationship between some of the themes and both fatigue and coping is more complex. For example, many nurses discussed their patient assignment as a source of fatigue (e.g. if the assigned patients were perceived as “demanding”) or as a facilitator to coping (e.g. if the patients helped the nurse remember why they became a nurse). Some participants referred to these factors as “double-edged” swords. In this section, thematic results will be reported for each component of the SEIPS work system. A summary of exemplar quotes for each work system component and identified sub-theme is provided in Table 3.

3.1. Physical environment

Themes related to physical environment included unit layout, break room layout, and patient room layout.

Unit layout. Overall, RNs viewed the layout of their unit positively. Some stated the layout prevented fatigue by minimizing walking distances while others said that easy access to different resources and supplies facilitated coping. ICU RNs, in particular, identified their ability to monitor patients through windows and nearby charting stations as preventing fatigue.

Break room layout. Nurses commonly cited poor break room layout as a barrier to coping. Specific elements of this subtheme

included: break room location, break room furniture, and size. Nurses explained that the close proximity of the break room to patient care areas made it difficult at times to feel like one was actually leaving the unit and taking an uninterrupted break.

Patient room layout. The patient room layout was identified as a source of fatigue, specifically physical fatigue. Nurses described the small room layout as requiring lots of reaching and making it difficult to maneuver with the equipment present in the room (e.g. IV pumps, chairs, ventilators).

3.2. Tasks

Themes related to tasks included: *non-care responsibilities*, and *tasks as a coping mechanism*. Nurses experienced fatigue as a result of tasks, but also viewed tasks as a coping strategy.

Non-care responsibilities. Nurses described tasks that took them away from the patient's bedside, such as charting, as sources of mental and emotional fatigue. More experienced nurses noted an increase in these tasks that took nurses away from the bedside over time with increasing time pressure. Physical fatigue was also commonly linked to the physical tasks associated with lifting and turning obese patients. In some cases, nurses mentioned that the use of technology, such as lifts, is helpful in preventing fatigue during these tasks; however not always useful (e.g. when the patient's weight is above the lift's rating).

Tasks as a coping mechanism. In describing their workflow, many RNs described planning and clustering tasks throughout the shift as a coping strategy. Night shift RNs in particular would save certain tasks (e.g. patient baths in the ICU) for downtime frequently experienced in the early morning hours to help them cope with increased fatigue at that point in the shift. RNs who did not have tasks to accomplish when they were feeling fatigued stated that volunteering to help coworkers with their tasks helped them to cope with and prevent their own fatigue.

3.3. Tools and technology

The theme identified related to technology was *availability and usability of technology*, which nurses viewed as both preventing fatigue and as a source when unavailable or difficult to use.

Availability and usability of technology. Nurses stated that technology (e.g. the electronic medical record (EMR), lifts, and medication scanners) prevented their fatigue. For example, the EMR prevents fatigue by enabling nurses to find needed information quickly. However, nurses cited the inefficiency of the EMR, specifically the need to chart the same information multiple places and the number of boxes to fill-in, as a source of fatigue that could be improved to decrease fatigue levels. Nurses reported that when the technology was not properly working that fatigue increased. For

Table 1
Development of coding structure and process for coding data.

- 1) Transcripts were uploaded to Dedoose. A total of three transcripts (one less experienced RN and two more experienced RN transcripts) were read and open coded by the two authors who acted as coders for all of the interviews. Themes were identified to develop codes in line with the SEIPS Model and other possible areas of interest.
- 2) A preliminary coding structure was established and agreed upon by the two coders.
- 3) The first three interviews were coded by both of the authors using the coding structure.
- 4) The two authors met and reviewed each coded section of the transcripts to ensure reliability and understanding of the definitions of each code.
- 5) The rest of the 22 total transcripts were coded by both of the authors. The more experienced RN transcripts were coded first and the less experienced RN transcripts were subsequently coded.
- 6) The two coders met to go through every disagreement in coding identified in Dedoose. A few new codes were added to the original coding structure when the two coders agreed that a new code was necessary to describe an emerging theme.
- 7) After coding all of the interviews and ensuring 100% reliability, preliminary themes were presented to and discussed with hospital nurses at the hospital used for recruitment, the School of Nursing affiliated with the authors, and at research conferences.
- 8) Follow-up coding for subthemes within the SEIPS coded excerpts was completed by one of the coders.
- 9) The subthemes were discussed between both of the coders and agreement was reached.

Table 2

Participant demographic characteristics by experience level and type of unit. Data are presented as counts (n) or as mean (SD).

		Type of unit	
		Intensive-care	Medical-surgical
<2 Years Experience	Gender		
	Female	3	6
	Male	1	2
	Age	27.8 (5.6)	25.3 (2.2)
	Shift Schedule		
	Day	1	1
	Night	3	3
	Rotating	0	4
	Shift Length		
	8-h	0	3
>5 Years Experience	12-h	4	5
	Hours Scheduled/Week	34.0 (4.0)	36.0 (5.2)
	Nurse:Patient Ratio	1:1.9 (0.3)	1:4.1 (0.8)
	Gender		
	Female	6	4
	Male	0	0
	Age	30.2 (4.3)	44.3 (9.9)
	Shift Schedule		
	Day	4	1
	Night	2	2
	Rotating	0	1
	Shift Length		
	8-h	0	3
	12-h	6	1
	Hours Scheduled/Week	34.0 (4.9)	35.0 (3.8)
	Nurse:Patient Ratio	1.8 (0.4)	1:3.3 (1.6)

example, when a medication scanner was not working, nurses described finding a working scanner and rescanning medication as a source of fatigue. Overall, technology and tools were seen as preventing fatigue; however, when the technology and tools were inefficient, did not work properly or had an inconvenient location, then technology and tools contributed to fatigue.

3.4. Organization

Organization was the most discussed component of the work system during the interviews. Themes identified related to organization included: *unit-level management*, *upper-level management*, *teamwork*, *scheduling*, *training*, and *staffing*. Most of these areas varied in their relation to fatigue and coping.

Unit-level management. Nurses discussed organization on multiple levels from the more micro unit level to the meso organization level or macro healthcare system level. Many of the unit level subthemes were described as a double-edge sword. For example, nurses who had positive experiences with their managers, care team leaders, and schedulers were more likely to view these individuals as facilitating coping with fatigue and/or preventing fatigue, while nurses who did not work well with their scheduler, care team leader, or manager's style viewed those individuals as causing fatigue and preventing coping.

Upper-level management. Upper-level management within the organization was viewed as both a barrier to coping and a source of fatigue.

"The top thing that fatigues me, mentally, emotionally, is people making decisions, management making decisions about things that directly affect me without ever asking the people that do the job." -Participant #14.

Some decisions made by higher-level management were controversial and some nurses supported the decision while others discussed the decision as causing fatigue or as a barrier to coping. For example, the hospital from which nurses were recruited for this study had recently enacted a policy for RNs that limited the number

of consecutive shifts that an individual is able to work. Some of our study's participants stated that this was an important step to addressing nurse fatigue while others explained how the new policy was a barrier to their individual coping and autonomy.

Teamwork. Nurses viewed their nurse coworkers as an important factor in preventing fatigue and helping them cope with fatigue, but also discussed situations where teamwork issues were a source of fatigue. For example, nurses identified the importance of other nurses stepping-in to help in fatiguing situations. In other examples, nurses described coping with fatigue by offering to help others with tasks, as well as interpersonal issues that caused increased fatigue. Nurses also discussed teamwork with other members of the healthcare team as a factor in their fatigue and coping and expressed concern for the fatigue levels of others.

Scheduling. Many nurses stated that scheduling was a minimal source of fatigue for them. We spent time in interviews discussing scheduling because of its prevalence in the literature and the strong feelings of participants about scheduling related issues (e.g. shift length). While some nurses did ascribe their schedule or shift as a source of fatigue or a barrier to coping, many more nurses described scheduling as a less important factor. Nurses discussed the positives and negatives of the different shifts and personal preferences. Day shift nurses explained that while their circadian rhythms were normal that the number of demands and work pace during the day contributed to fatigue. Night shift nurses discussed difficulties with their circadian rhythm being flipped, but praised the teamwork of nightshift nurses and slower pace as facilitators to coping. Similarly, the positives and negatives of eight and 12 h shifts were discussed and individual perceptions varied. It was instead the autonomy of the nurse to choose their schedule that was an important subtheme. Nurses who had families stated that choosing their schedule in a manner that allowed them to spend time with their children was a facilitator to coping more than working a shorter shift or a different schedule that would be less fatiguing.

Training. The less experienced nurses viewed the hospital's

Table 3
Sample quotes for each of the identified themes.

Work system component	Themes	Example quotes
Physical Environment	<i>Unit layout</i>	"[Things about participant's unit that prevent fatigue] Not having to walk all the way across wherever to get the supplies that you need. Everything you need is typically, usually, right there. We have nurse servers that we can get things out of. Um those are the main ones." – Participant #6
	<i>Break room layout</i>	"I guess this is part of the environment. Like having, having a break room that like really feels like you're taking a break from everything that's going on is helpful (for coping)." – Participant #19
	<i>Patient room layout</i>	"The environment of the patient rooms, too, so on our unit specifically in [unit name] our rooms are insanely tiny and it causes so much fatigue to have to move, I constantly have to move things in order to negotiate space. Half of the time I spend in my patient's room is just negotiating the space, and that's only if there's like maybe a recliner and the patient's bed and them in it, and an IV pump, you know. If we're dealing with like a filter for someone who recently had an organ transplant or any kind of respiratory machine at all, it immediately becomes impossible to navigate the room to do anything. Or, if like any patient family members are in there, more than 2 (family members), it becomes impossible." – Participant #19
Tasks	<i>Non-care responsibilities</i>	"I think about what I want to do with my patient in the organizational things that prevent me from doing those things ... I want to go in there and I want to do teaching ... what's happening is I'm getting a call on the phone you know every 10 min ... constant interruption, interruption, interruption ... that's a huge part of my emotional fatigue ... all these things are preventing me from doing what the patient actually needs." – Participant #13
	<i>Tasks as a coping mechanism</i>	"I think an appropriate level of activity prevents, uh, fatigue, but if you're going in and you have more, you're expected to handle more patients than you have tie for in reality then I think it contributes to more fatigues if you're having um, patient after patient after patient after patient after patient, you know. Either care activity or different patients or you know different needs then it's just back to back to back you're constantly running around the unit then I your fatigue level's gonna increase a lot more drastically, but if it's really slow and you just kind of don't have enough work to do (then that causes fatigue) ... It's a balance." – Participant #16
Tools and Technology	<i>Availability and usability of technology</i>	"I think when we have a lot, enough training to use (the technology), and the technology works the way it's supposed to, it's helpful. But, then when it malfunctions, breaks down, you know, we don't have (it), or we don't know how to use it in the way it's supposed to make our lives easier, it becomes fatiguing because it takes so much more time to do what we need to." – Participant #16
Organization	<i>Unit-level management</i>	"I think the level of the manager's engagement and perceived caring about you like definitely makes or breaks it, I think" – Participant #8
	<i>Upper-level management</i>	"I feel like there's a lot of underlying issues and a lot of you know pressing matters that the organization as a whole, is you know, kind of imposing on their employees, um, which kind of sets the stage for, for um, fatigue." – Participant #17
	<i>Teamwork</i>	"So, like I mentioned before, I feel like my relationships with my co-workers can't, I mean it's both a source of emotional fatigue like I said with knowing that people talk about each other all the time. I mean it's like the thing to talk about at work almost or talk bad about patients, which also bothers me. So um, I would say that's definitely contributing to emotional fatigue but then at times too like I mean there's some times when I am so mentally fatigued that I can barely function anymore and another nurse will step in and just be like 'I'm here,' like we have great teamwork." – Participant #18
	<i>Scheduling</i>	"I think (when) you're scheduling you can help prepare kind of with your life around it so that you know when you're going to be at work and kind of figure out, figure out your life as far as what you're going to do ... Yeah, I mean, I guess it (scheduling as a source of fatigue or facilitator to coping) can go both ways, like if, if you're not happy with your schedule or the schedule that you're given then we can, at work we can make trades or try to find someone to switch around their schedule for you." – Participant #9
	<i>Training</i>	"I think anywhere there's high turnover, high, um, training of new staff by staff who have not been there very long can be very draining because then you're not only putting energy into your patients, but you're putting it into the unit in ways that you may not have expected. And you just, you run out of mental and emotional energy a lot quicker when you're having to both teach the patient and a new colleague, you know, how things function, what's the expectation, what's the language of your unit and all of those kinds of things." – Participant #16
	<i>Staffing</i>	"I definitely feel the most mental fatigue when I feel like we're short staffed ... I mean it's never been, we've never had like an unsafe incident happen but just anticipating that the possibility. Um. It's very scary and I feel like that does make me way more fatigued and I feel like my brain has to be on all night, but then if it's my third night in a row then it's like I'm very sluggish and I feel like I'm going to miss something important and that makes me emotionally fatigued and mentally fatigued, and then it just, I feel overwhelmed." – Participant #18
Person	<i>Level of competence and confidence</i>	I do think if you're not as confident you get more fatigued, which is why the nurse residency program is so good because it kind of gives you support and helps you build on your own confidence um, versus nothing. No support." – Participant #10
	<i>Helplessness</i>	"And maybe it's just because of the population that I work with and the sadness that I see, but most, the majority of my fatigue comes from you know, just dragging patients on long and long and long and doing everything we can when it's probably not what they want when causing them pain, poking them everywhere, doing these bizarre things and usually they'll end up dying anyways and then they're not really dying with dignity and it's, it's just so hard to watch you know, doing everything you can on someone that's pretty much already dead and I think that's where all my fatigue comes from so to fix that we have to change the whole way we think about dealing with illness." – Participant #11

nurse residency program as promoting coping and preventing fatigue. A residency program aids in the transition of new nurses to nursing practice during their first year of employment with extensive training, and resources. However, more experienced nurses identified training new nurses and the experience mix (increased proportion of nurses with less experience) on a particular unit as sources of fatigue.

Staffing. One of the most frequently discussed sources of fatigue was lack of adequate staffing. In some cases, this was staffing of RNs while in other cases it was staffing of support staff. Many RNs suggested improved staffing ratios and/or staffing for acuity as

potential solutions to fatigue. In addition to fatigue, participants linked staffing to burnout, negative patient outcomes, and turnover rates. Nurses realized that the cost of staffing was a barrier to this solution being enacted.

3.5. Person

As expected, the barriers and facilitators to fatigue and coping related to the person varied due to differing individual motivations and characteristics. Two major themes that emerged were: *level of competence and confidence*, and *helplessness*.

Level of competence and confidence. The less experienced RNs cited their lack of experience, which resulted in less confidence and competence, as a source of fatigue. The less experienced RNs did suggest that this improved as they became more experienced and with the help of the hospital's residency program.

Helplessness. Nurses discussed that some of their fatigue stemmed from their inability to perform the care that they or patients families desired due to high demands, disagreement with plan of care, and/or compassion. Nurses often felt helpless as a result of prolonged exposure to high stress situations, which contributed to their overall fatigue level and often made them consider how long they would stay in their current position.

4. Discussion

This paper identifies themes to describe factors contributing to or preventing fatigue, and barriers and facilitators to coping using the SEIPS model to define the RN hospital work system. While the relationship between some of the themes and fatigue and coping was distinct, participants described many of the themes as having differential relationships with both fatigue and coping. Thus, fatigue and coping may need to be addressed separately when implementing FRMS. Table 4 below lists potential solutions to fatigue identified in our interviews.

The suggested solutions for physical environment components of the work system relate largely to architectural and design elements that are not always feasible to fix in an already standing hospital. However, in accordance with balance theory, this could potentially be offset by building up positive features of the system that prevent fatigue and/or facilitate coping. Physical environment changes may have particular impact on the levels of physical fatigue experienced by nurses when negotiating limited space. This can contribute to increased risk for injury due to poor posture or physical strain. Injuries within the nursing workforce, particularly low back injuries, are a significant concern due to costs, turnover, and lost productivity. The Bureau of Labor Statistics (BLS, 2013; Statistics, 2013) recorded 58,860 instances of healthcare work-related illnesses and injuries leading to missed work. Additionally, 24% of nurses and nursing assistants adjusted their schedules or took sick leave due to an unreported injury, which OSHA (OSHA, 2013) attributes to a unique “do no harm” culture of healthcare (Siddharthan et al., 2006). Specifically, nursing staff may place the health and wellbeing of patients and coworkers above themselves. This may be exacerbated in physical environments that act as barriers to nursing tasks or care processes (due to lack of space). Therefore, in addition to direct potential contributions to physical fatigue, the physical environment components of the work system may also interact with attributes of the person, tasks, and the organizational culture to increase risk of fatigue and negative consequences to nurse health and well-being.

With regard to the relationships between tasks and fatigue and coping, participants in this study did not consistently identify specific tasks as contributing to fatigue. Nurses across types of units and experience levels did identify non-patient care tasks, such as charting, and attributes of more physical tasks (e.g., moving obese patients) as sources of fatigue. Prior work describing nurses' perceptions of the most fatiguing tasks in their work supports these findings. Specifically, physically demanding tasks, particularly with overweight patients, have been identified by nurses as most frequently contributing to physical fatigue (L.M. Steege et al., 2015). Rather than identify specific tasks contributing to fatigue, nurses in the current study more frequently discussed management of tasks or the distribution of tasks across a shift versus identifying specific task-based sources of fatigue. Again, this supports prior findings that the organization of work tasks (multi-tasking, time management) more frequently contributes to fatigue than specific tasks (L.M. Steege et al., 2015). This may be due to a perception that certain tasks are a “part of the job” and cannot be changed. This idea is further supported by the interaction of tasks with themes identified related to other work system components in the current study. For example, as noted earlier, participants reported that the layout of patient rooms might contribute to their fatigue because it interferes with how they might choose to perform patient care tasks. Similarly, the availability and usability of technology to complete tasks, such as charting, were identified as factors that might prevent or contribute to fatigue. Therefore, while there may be some tasks that nurses consistently agree are more fatiguing than others, findings from this study point to the importance of understanding how the design of the work system impacts nurses' ability to manage and complete tasks as perhaps more critical to minimizing fatigue.

The suggested solutions for the person component of the work system were more variable across participants, but fell into categories related to development of coping strategies, leaving work at work, and sleep hygiene. For example, one of the most common solutions for nurses to combat fatigue in the literature is to develop a sleep schedule (Rogers, 2008). Every nurse that we interviewed had his or her own sleep-wake schedule and items to support their regimen. More experienced nurses developed their regimens over time, and many new nurses discussed sleep and finding coping mechanisms as an ongoing issue. Nurses with families also struggled with finding schedules to suit their family life and reduce fatigue. Evidence-based scheduling suggestions, such as those included in the recent ANA position statement on nurse fatigue (*Addressing Nurse Fatigue to Promote Patient Safety and Health: Joint Responsibilities of Registered Nurses and Employers to Reduce Risks, 2014*), do not always account for the importance of outside of work factors in individual nurses' fatigue management. However, these factors have been shown to be important in coping with fatigue and other work stressors (Chang et al., 2006; Chen et al.,

Table 4
Potential fatigue solutions identified by RNs and mapped to the SEIPS model.

Physical environment	Tasks	Tools and technology	Organization	Person
<ul style="list-style-type: none"> • Improve break room design to allow for quiet relaxation • More accessible hospital parking • Improve size and layout of patient rooms • Increase access to natural light 	<ul style="list-style-type: none"> • Simplify charting requirements • Provide more staff to aid in lifting and turning heavy patients 	<ul style="list-style-type: none"> • Make working technology/tools easily available and efficient • Regular maintenance of equipment to ensure proper functioning 	<ul style="list-style-type: none"> • Staff for acuity of patients and skills/preferences of nurse • Create culture of breaks • Consult nurses on policy changes that affect them • Provide education on fatigue and coping • Take into account individual scheduling preferences 	<ul style="list-style-type: none"> • Identify and practice coping strategies and support system that works for individual • Leave work at work • Ask for help • Find sleep hygiene habits that work for the individual

2014). The development of individual coping strategies for fatigue, a part of the personal protective approach level of hazard control in models of FRMS (Williamson and Friswell, 2013), needs to allow for inclusion of such individual factors.

At the same time, the literature suggests that nurses have relatively poor sleep hygiene and coping behaviors (Kato, 2014; Scott et al., 2010). Further, nurses in this study reported coming to work already fatigued and agreeing to work overtime or extended shifts while fatigued. Attendance at work when fatigued is an example of presenteeism, when an employee is unable to perform work tasks to their fullest ability due to stressors or medical conditions (Vera-Calzaretta, 2014). In its limited application in nursing (considering only nurses with back pain or depression), presenteeism has already been linked to higher rates of medication errors and patient falls, in addition to an estimated \$22.7 billion per year loss in productivity (Letvak et al., 2012). The potential relationship between fatigue and presenteeism calls for further research in order to improve patient safety, decrease healthcare costs and improve nurse health. Thus, strategies to support nurses in identifying appropriate coping strategies, sleep schedules, and overall sleep hygiene behaviors are needed. While training on these topics, as suggested by the ANA and others, could be one solution, training interventions alone may not account for individual differences and may meet resistance from nurses who value autonomy. Contemporary technologies that allow for individual monitoring of sleep and potential consequences, such as wearable devices, such as the Apple Watch (Cupertino, CA) and Fitbit Charge HR (San Francisco, CA), might offer an alternate strategy to training to facilitate nurses' individual awareness and development of personal protective approaches for fatigue management.

Organizational solutions identified by the RNs in this study largely centered on the role of the organization's culture and nursing culture as a whole. Nurses want to be a part of addressing fatigue and suggest more involvement with decision-making and education on fatigue and coping as solutions. For instance, scheduling, a fatigue source that has been extensively studied, was brought up in many interviews. Participants discussed how their ability to make their own schedule helped them to feel empowered in combating their fatigue because they knew that they chose the schedule, even if it was fatiguing. This idea of autonomy in scheduling has not been discussed extensively in the literature or in policy statements regarding fatigue. The idea of individual autonomy in scheduling runs contrary to the bio-mathematical fatigue models used as part of FRMS to predict fatigue levels and guide scheduling decisions in other industries. Bio-mathematical models take into account hours worked, shift times, and other quantifiable factors as a way to predict fatigue and sickness in employees (Mallis et al., 2004). However, existing bio-mathematical models do not account for factors nurses identify as barriers or facilitators to fatigue and coping, such as a negative psychosocial work environment, teamwork, or varying physical, mental, and emotional demands of both patient care and non-patient care tasks. Future work aimed at FRMS in healthcare, particularly nursing systems, may need to extend existing models and approaches from other industries to account for these more complex factors in order to mitigate hazards at work in addition to those created by shiftwork and scheduling.

FRMS hierarchies suggest that the role of the organization should be to eliminate and substitute hazards while creating controls to monitor fatigue (Williamson and Friswell, 2013). This includes following evidence-based scheduling guidelines promote recovery and prevent fatigue, which fall into the elimination and substitution of hazards category of management. The (*Addressing Nurse Fatigue to Promote Patient Safety and Health: Joint Responsibilities of Registered Nurses and Employers to Reduce*

Risks, 2014) outlines the responsibilities of both the RN and the work system in addressing nurse fatigue, but fails to fully address organizational considerations outside of scheduling. The themes identified in this paper provide additional considerations that should be addressed on an organizational level. Specifically, organizational culture, staffing, and education in order to combat fatigue should be integrated into organizational FRMS efforts.

4.1. Limitations

Limitations of this study include the participants' location within one hospital organization. However, identification of themes related to fatigue and coping within the work system would be difficult in a multi-site study and utilizing a qualitative design. The units selected were intended to be representative of nursing units common to many healthcare organizations in the hope that the findings from the work may be generalizable beyond the current study. In addition, while an attempt was made to increase generalizability of the findings by recruiting RNs from different experience levels, participants were all from a single teaching organization and thus findings across these experience levels may not be generalizable to other types of hospital organizations. Further, with regard to experience levels of the RNs interviewed, it is possible that RNs with greater than five years of experience are members of a survivor group who are able to thrive in the complex work system that not all RNs are capable of functioning in for a prolonged period of time. It is also possible that the less experienced RNs interviewed for this study experienced a higher level of fatigue related to adjusting to a new profession. However, research on less experienced RNs is timely as addressing new nurse turnover, which can be associated with fatigue, is important to saving hospital costs and stopping the cyclic nature of nurse turnover and shortage around the world.

4.2. Conclusion

A macroergonomic approach is valuable for understanding complexities of work system barriers and facilitators to fatigue and coping. Further, factors contributing or preventing fatigue and barriers and facilitators to coping identified in the current study may offer insight into opportunities to pursue balance in hospital nurse work systems by increasing positive factors when there are some negative factors that are not amenable to system redesign or intervention. Addressing aspects of organizational and unit culture, for example, may help to both minimize the occurrence of fatigue and also facilitate coping. Human factors practitioners and researchers, in partnership with nurses and healthcare leaders, may be able to use the findings from this study as a guide for future work. The Institute of Medicine Report, Building a Better Delivery System, specifically calls for increased partnership between engineers (including human factors engineers) and health care professionals (Reid et al., 2005). Such collaboration would integrate human factors practitioners' and researchers' knowledge and skills applying human factors and ergonomics tools to guide work system analysis and design with health care professionals' in depth knowledge and understanding of the context of care. Collaboration between both of these areas of expertise and experience is needed to address complex system challenges, such as fatigue, and improve quality.

In the current study, nurses also offered suggestions for work system redesign that span work system structural components. Several of these strategies may require continued support from the human factors community in order to ensure that too much emphasis is not placed on the employees being fully responsible for fatigue through individual coping and personal protective

approaches. Fatigue monitoring and risk management strategies that require nurses to continue to adapt to demands that exceed their capacity are not sustainable and will likely continue to lead to negative nurse, patient, and organizational outcomes. Human factors research to develop new fatigue monitoring systems may enable better understanding of dynamic fatigue levels for both individual nurses and organizations, and will be critical for creating a safe environment for both nurses and patients.

Acknowledgments

The authors would like to acknowledge Cassandra Brucker and Kelli Romine for assistance in data collection and analysis. This work was supported by a grant (PRJ87LM) through the University of Wisconsin-Madison Graduate School with funding from the Wisconsin Alumni Research Foundation and from the School of Nursing Research Committee.

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