Towards a Theoretical Model of Aggregate Fatigue in Nursing

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Burnout among shiftwork personnel such as nurses are prevalent, and the evidence suggests an increasing trend of nurse drop out in complex healthcare settings. While nurses' acute and chronic fatigue have been studied, current models of fatigue do not capture the pre-chronic phase we refer to as "aggregate fatigue" – the buildup of fatigue and stress exceeding the capacity for physiological and cognitive recovery processes. Understanding aggregate fatigue requires a holistic understanding of a wide range of contributors including sleep, work, non-work-related stress, cognitive load and other psychosocial factors. This paper proposes an integrated model of fatigue in hospital nursing and presents a comparison to the common models of fatigue and burnout. We use a narrative review of literature to ground this multi-attribute model of aggregate fatigue which may shed light on future methods to identify and mitigate fatigue build-up contributing to burnout.

INTRODUCTION

Burnout among shift workers in many occupational areas ranging from air traffic control (Martinusses & Richardsen, 2006) to daycare personnel (Maslach & Pines, 1977) has been well-documented. Personnel burnout cost the global economy around $300 billion annually (Bretland & Thorsteinsson, 2015). An estimated 37.9% of the workforce in the United States have some level of occupational fatigue build-up (Ricci et al., 2007) which has contributed to almost 70% of industrial injuries and accidents (Golden & Jorgensen, 2002). The Nursing profession has been suffering from significant fatigue issues since at least the 1930s (Gilbreth, 1935/2016) with a recent increased trend of burnout (Steege & Dykstra, 2016). This shortage has become a major problem in post-industrial countries (Leiter & Maslach, 2009).

Nursing has also been associated with high-stress (Riahi, 2011) and such stress has been shown to lead to burnout (Maslach et al., 2001). While the constructs of stress, fatigue and workload have been studied in isolation, the complex interrelations between these constructs and their combined effects that leads to burnout need further investigation. Indeed, fatigue combined with stress and workload have been shown to impair performance and accuracy (Mock & Crumpton-Young, 2005) which may result in injury or fatality. Extreme healthcare environments and shiftwork further expose the personnel to stressors and limit the amounts and types of fatigue recovery (Sagherian et al., 2016). Such extreme environments may separate nurses and physicians from their social networks chronologically due to long work days and/or night shifts and may impact work/life balance (Mullen, 2015). Investigation of this varied and inter-related problem requires a comprehensive model that evaluates a wide range of contributors to fatigue, stress, and psychosocial factors. Such a holistic model not only helps understanding the contributors to acute and chronic fatigue but also promotes a more proactive approach in understand fatigue buildup. In this paper, we document our initial review of some of the relevant models that can be used to describe the phenomenon of aggregate fatigue and propose a conceptual model of aggregate fatigue in nursing.

METHOD

A narrative review of literature was used to identify relevant multi-attribute models, stressors, and fatigue recovery models that can be used to describe the phenomenon of aggregate fatigue. The review included Pubmed/Medline, Compendex, and Scopus, searching for (Fatigue or Stress or Burnout) and (Professional or Occupational) while excluding Chronic Fatigue syndrome or children or Post Traumatic Stress Disorder (PTSD) and limiting to English language. This resulted in 12,612 articles after removal of duplicates. These were screened by category and resulted in 176 final articles included for synthesis. Next, a conceptual chronological model of aggregate fatigue is presented and discussed.

RESULTS

Three multi-attribute models were selected for theoretical grounding based on their prevalence in the literature and their influence in experimental design: Effort Reward Imbalance (ERI) (Siegrist, 1996), the Job Demands-Resources model (JD-R) (Bakker & Demerouti, 2007), and the Job Demands Control Model (JD-C) (Karasek, 1979) which later evolved into the Demands Control Support Model (DC-S) (Karasek & Theorell, 1990). The Effort Reward Imbalance Model (Siegrist, 1996) and the Job Demands-Resources Model (Bakker & Demerouti, 2007) are rather simplistic and describe the balance between effort and reward or available resources and the task demands as illustrated in Figures 1 and 2 respectively.

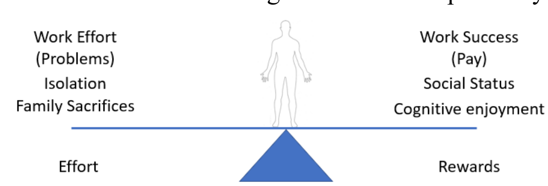

Figure 1: A graphical representation of the Effort Reward Imbalance (ERI) model of occupational stress.

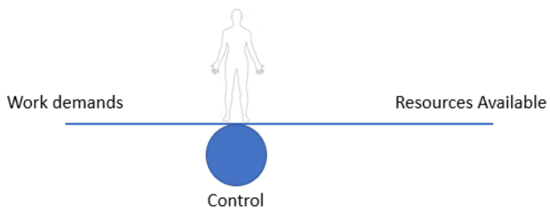

Figure 2: A graphical representation of the Job Demands-Resources (JD-R) model of occupational stress.

While both ERI and JD-R models capture the overall tradeoffs that can be used to describe aggregate fatigue, these models are overly simplistic and do not capture individual control factors, social interactions, and other systemic factors (van Vegchel et al., 2002; De Jonge et al.,1999). The Job Demands Control Model (Karasek, 1979) adds an element of employee control and describes the positive effects of employee empowerment on stress levels (Figure 3). This model was later expanded into the Demands Control Support Model (Karasek & Theorell, 1990) which captures the support received from outside of work and the non-work-related stressors as illustrated in Figure 4. While these models provide a useful abstraction, several important contributors such as sleep, general health, and social interactions were left out.

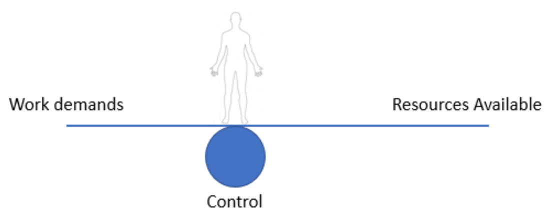

Figure 3: Job Demands- Control Model of Occupational Stress. A graphical representation of the Job Demands-Control (JD-C) model of occupational stress.

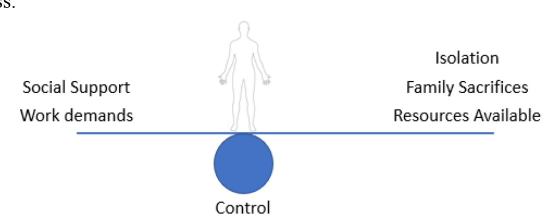

Figure 4: Demands-Control-Support Model of Occupational Stress. A representation of the Demands-Control Support (D-CS) model of occupational stress.

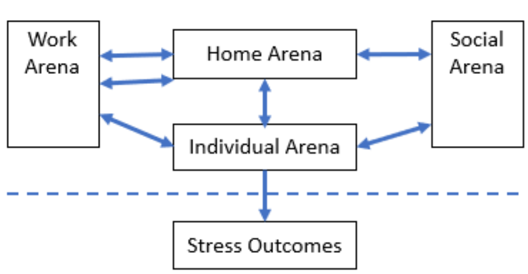

Figure 5: Davidson-Cooper Model of Occupational Stress (adopted from Davidson & Cooper, 1981) visualizing the interplay between several stressors and conditions.

The multifaceted model proposed by Davidson and Cooper (1981) addresses the limitations of the above-mentioned models by including other home, work, social and individual factors; however, it does not capture important individual factors such as general health and sleep.

While including all factors contributing to aggregate fatigue is challenging, a descriptive model that captures operationalized elements would shed light on future mitigation efforts. We propose a holistic aggregate fatigue model which includes several stressors and contributors to fatigue at individual, task, team, and environment levels while considering the temporal aspect of carrying over fatigue from acute to chronic status. This model incorporates recovery time and positive activities in addition to individual factors such as health issues. Nurses have been shown to be at a higher risk of migraines (Kuo et al., 2015), gastrointestinal, cardiovascular and musculoskeletal issues (Weyers et al., 2006), and other health issues associated with shiftwork, heavy workload and stress. Other individual factors relating to personality, resilience, stress resistance and toughness that moderate the effects of stress (Truffino, 2010; Swinder & Zimmerman, 2010; Langelaan et al., 2006) should also be addressed. Figure 6 illustrates our first effort in describing aggregate fatigue. The model represents the human (unit of analysis), being affected by variety external factors. Unique characteristics create variability in resistance to different contributing factors. The severity of exposure to stressors and recovery will shift the human along the fatigue spectrum.

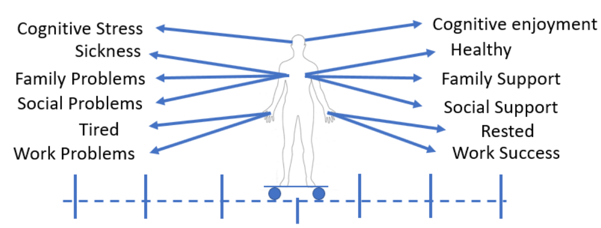

Figure 6: Aggregate fatigue model

In the case that complete recovery does not occur, a build-up of fatigue and stress may progress to prolonged fatigue, burnout, and chronic fatigue (Figure 7). This conceptual timeline shows the estimated time periods required for fatigue to build. Time is important partly because Chronic Fatigue Syndrome (CFS) is defined by at least a six-month duration of severe symptoms (Fukuda et al., 1994), while prolonged fatigue is disabling and has symptoms that last longer than one month (Elliott, 1999). Prolonged fatigue and burnout also overlap and can occur separately or in combination (Leone et al., 2007).

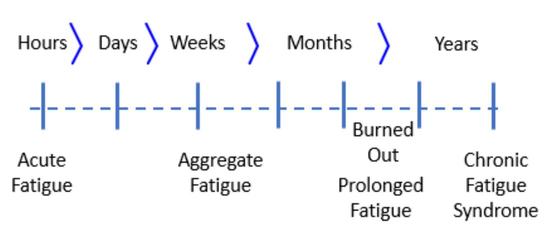

Figure 7: Timeline of fatigue buildup

RECOVERY

While the ideal approach to aggregate fatigue is to prevent fatigue and stresses from accumulating, understanding and measuring the intricate relationships between contributors is challenging. Given the current limitations, ensuring proper recovery seems to have more immediate impact. Acute fatigue is common and is remediated by rest or working at a slower pace (Bultmann et al., 2000) both for physical and cognitive work (Ackerman & Kanfer, 2009). Stressful events or working shifts could require more recovery time (Depue & Monroe, 1986), and the recovery time available might not be sufficient to prevent carry over stress and fatigue. This is a common enough occurrence that there is now a term “recovery debt” (Geurts & Sonnentag, 2006) to go along with “sleep debt” (Sallinen, 2008). While researchers claimed that stress and recuperation must balance during a day (Grandjean, 1979), this assumes the best-case scenario that does not involve carry-over. The lack of full recovery during the rest period could be a precursor for prolonged fatigue (Jansen, Kant, & van den Brant, 2002). Recovery time or time available for recovery is highlighted in light of long working hours, commute time, and sleep, in addition to other personal and social activities (Figure 8). Nursing shifts consume a large portion of daily activities with 8-hour shifts lasting at least 9 hours and a 12-hour shift lasting 13 due to handover requirements. Long commute times are common among nurses and cannot be considered recovery time. While a 42.8 minute (one way) commute is considered acceptable (Milakis et al., 2015), commute times may be higher especially for the evening commute (Kung et al., 2014). Traffic congestion can also cause higher than normal stress levels (Higgins et al., 2017). The average recommended 7 hours of sleep is not always possible due to social and family commitments (Hirshkowitz et al., 2015). The average American spends only 37 minutes preparing food and cleaning up daily, and picking up fast food saves about 30 minutes cooking (USDA ERS, n.d.). Awake recovery time when the employee is not thinking about work is essential for recovery especially in the evening before bedtime (Sonnentag & Bayer, 2005). However, given other personal and social responsibilities and activities, the time for optimal recovery is extremely limited.

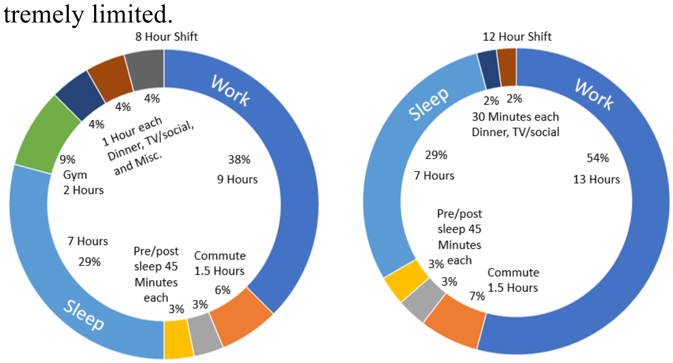

Figure 8: Simplified model of daily time allocation for 8 vs 12 hour shifts.

CONTRIBUTING FACTORS

Nursing possesses many factors synonymous with an extreme environment. Extreme environments tend to involve 24-hour or long shift operations in addition to exposure to traumatic events (e.g., death or injury). To investigate fatigue accumulation, a wide range of systemic factors contributing to such aggregation should be identified. Due to the complex relationship between contributing factors and difficulties in measurement, the existing models of fatigue and burnout have been intrinsically limited. However, addressing a complex construct such as aggregate fatigue requires more inclusive models. One such multi-attribute representation, capturing a wide range of factors, is provided in Figure 9. In this model, the “ideal” worker would be represented by the solid circle. Various sleep, recovery, work, social, and health-related factors and interactions between them would negatively affect the individual’s fatigue levels (represented as unique red lines) where the gradual move towards the outer edge represents chronic fatigue. The data captured for each variable can be normalized to the radius of the median circle represented by a solid line. The dashed lines represent operating toward the bounds of human capability. Some of these factors are discussed below.

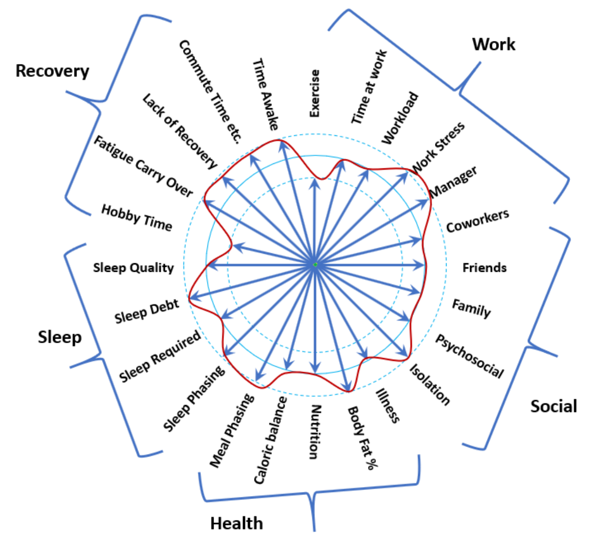

Figure 9: Representation of various factors affecting aggregate fatigue.

Time at work is a major contributor to aggregate fatigue among nurses. While each workday is divided into three 8-hour shifts or two 12-hour shifts, handovers may add an additional 1 hour to each shift resulting in an effective 189 hours and 182 hours of work per week for 3 or 2 daily shifts respectively (Table 1).

Table 1: comparison of shift systems and hours worked*

Shift type (actual hours)	8-hour shift (9)		12-hour shift (13)	
Weekly handover hours (HO)	21		14	
Work hours weekly (168+HO)	189		182	
Teams (full time) rotating shifts	3	4	3	4
Working hours per week	63	47	61	46
Working days per week	7	~5	~5	3.5

*assuming only full-time employees

Psychosocial stressors for nurses are compounded by long work hours (Valente & Berry, 2015) and by shifts (Kurumatani et al., 1994). Additionally, demographics cannot be ignored as most nurses are women (Kaur, 2017). This can lead to a greater chance of role conflict between the roles of nurse, mother, and wife (Simon, 1995). Working night shifts can also be an impact to spouses and relationships. While intermittent husband syndrome (Rigg & Cosgrove, 1994) has been studied for aviators and oil rig workers, a corollary has not yet been defined for shift-working wives. Additionally, most meals are still prepared by women (USDA ERS, n.d.).

Other work-related stressors faced by a nurse are high workload (Karhula et al., 2013), bodily fluid exposure (Much & Cotteta, 1993), patient suffering (Nagy, 1998), and possible death (Xianyu & Lambert, 2006). Nurses' own health may also get affected due to exposure to germs and high risk of mental health due to exposure to suffering and life or death situations. In fact, Post-Traumatic Stress Disorder PTSD symptoms (Darves-Bornoz et al., 2008) or Secondary Traumatic Stress (STS) (Beck, 2011; Samson & Shvartzman, 2016) are common among nurses. Conflicts may occur with staff, patients, or patients' families (Campana and Hammond, 2015). Interactions with patient families can be stressful while expressing empathy and maintaining a demeanor of emotional control (Mauno et al., 2015). The hospital is typically a noisy environment which can also be stressful (Choiniere, 2010). There is bullying, verbal abuse, harassment, and mobbing (Gorgulu et al., 2014) as well as potential for violence (Magnavita & Heponiemi, 2012) which may be under-reported (Campbell et al., 2015).

Stressors involving non-work-related activities are widespread and involve barriers to social interaction. Having meals with friends who are not shift workers has been shown to contribute to dissatisfaction (Witkoski & Dickson, 2010). While nurses are expected to have nutritious meals during an 8-hour or 12-hour shift, in reality many nurses may skip meals or replace them with snacks (Stewart-Knox, 2014). Skipping breakfast due to time constraints is also common (Yoshimura et al., 2017). Not eating well during the day combined with stress and long days can lead to overeating during late dinners (Suzuki et al., 2016), which in turn can contribute to obesity (Takaki et al., 2010).

CONCLUSION

Burnout and aggregate fatigue are affecting nurses in complex healthcare environments. While models of fatigue exist, these models are oversimplified and don't capture the temporal aspect of fatigue aggregation. In this short paper, we presented a conceptual model of aggregate fatigue that requires understanding multiple contributing factors. Many of such contributors depend on available time such as exercising, socializing, or even getting a meal break. Such available time for recovery cannot be made unless the work hours or sleep hours are reduced. Due to inflexibility in work hours, the latter may occur which may exacerbate the negative effects on aggregate fatigue.

The progressive nature of fatigue makes early detection and treatment desired while treatment and recovery are more easily accomplished (Hambly, 2004). Work is in progress to measure a wide range of contributors to estimate recovery time and to detect fatigue at an early stage (pre-chronic) using a combination of self-reported surveys and physiological measures including heart rate and blood volume pulse. These tests will also involve psychomotor and cognitive tests to detect impairment caused by fatigue.

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