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NURSING WORKLOAD AND THE CHANGING HEALTH CARE ENVIRONMENT: A REVIEW OF THE LITERATURE

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Changes in the health care environment have impacted nursing workload, quality of care, and patient safety. Traditional nursing workload measures do not guarantee efficiency, nor do they adequately capture the complexity of nursing workload. Review of the literature indicates nurses perceive the quality of their work has diminished. Research has looked at tasks associated with nursing work, but not the nurse's perception of workload demands. Human factors research principles examine cognitive and perceptual abilities needed to meet the workload demands. A human factors framework focuses on mental demands and adds an understanding of why some demands are handled easily while others lead to mental overload and decreased performance. Study findings in human factors research indicate that human beings have the ability to attend to multiple details simultaneously and that the subjective perception of the worker is important in understanding the multiple, complex dimensions of workload. This review identifies the body of nursing workload research and establishes the need to include a subjective perception of the nurse as part of any workload measure.

Keywords: nursing workload, human factors, subjective mental workload, cognitive workload

The demands in nursing and health care have received increasing attention in recent years. Since the release of the Institute of Medicine (1999) report, *To Err is Human*, there has been a growing interest in understanding the workload of health care providers. As a result of this closer examination, a recognized need to examine the care provided and the caregiver characteristics using a human factors approach developed. A small number of nurse researchers began to incorporate the concepts of human factors in their studies of nursing workload, rather than simply focusing on the traditional measures of skill competency, task performance, and time required to complete a task. The purpose of this literature review is to examine the concepts of human factors research related to subjective workload measurement and to explore the application of these principles in nursing.

Over the past two decades, many changes have occurred in health services delivery as administrators have attempted to meet government mandates, and, as a result, the way that nursing care is provided has changed. Consequently, some researchers have voiced concerns that patient safety may be jeopardized as efforts to restructure patient care continue (Aiken, Clarke, & Sloane, 2002; McGillis-Hall, 1999, 2003). An analysis of intensive care unit (ICU) patient safety studies identified nursing workload as a primary contributor to source of safety and quality of care in these units (Carayon & Gürses, 2005). Workload variables such as number and acuity of patients; staffing pattern; interprofessional communication patterns; and environmental demands, including availability of supplies and noise level, contribute to quality and patient outcomes. However, little attention has been given to the contribution of nursing knowledge, intellectual capital, and mental workload demands for productivity, quality care, and patient safety (Aiken, et al., 2002; Carayon & Gürses, 2005; McGillis-Hall, 1999, 2003).

Nursing workload measures do not guarantee efficiency and do not adequately capture the complexity of nursing workload (Beaudoin & Edgar, 2003; Morris, et al., 2007; Weydt, 2009), especially as the measures relate to the work environment. Work environment variables have been the least studied aspect of nursing workload. However, some studies have reported that work environment factors such as support by the manager and colleagues and work content have a stronger relationship to job satisfaction than do economic variables. Nurses in five countries were surveyed over 20 months in 1998-1999 to determine factors related to nurses' job satisfaction and quality of care perceptions (Aiken, et al., 2002). Findings indicate that when staffing was inadequate to get nursing and other work done, patient outcomes declined. In this same study, 35-45% of the nurses in the United States and Canada reported spending time on non-nursing tasks such as transport and food delivery (Aiken, et al., 2002). While several studies

were located that have explored the multiple nursing tasks required in the delivery of patient care (Clini, Vitacca, & Ambrosino, 1999; Reis-Miranda, de Rijk, & Schaufeli, 1996; Reis-Miranda, Moreno, & Iapichino, 1997; Weydt, 2009; Yamase, 2003), no studies were found that examined the perception of the “staff nurse” about everyday mental workload demands.

Beaudoin & Edgar (2003) reported that nurses consistently recount that the quality of their work lives and work environment have deteriorated as a result of work content and work environment variables. Thirty to forty percent of the nurses surveyed reported a perceived decrease in quality of care over the past year as a result of the increasing workload environment demands (Aiken, Clarke, Sloane, & Sochalski, 2001). These perceptions were validated by comparing nurses’ assessments of quality of care with independent data sources and actual patient outcomes. The findings indicated that nurses “do accurately perceive the quality of care, and appear to be able to separate their own complaints from those that impact negatively on patients” (Aiken, et al., 2001, p. 260).

A study by the American Nurses Association (2001) reported that 75% (n = 7,353) of the respondents believed that the quality of nursing care in their work settings had declined over the previous two years. Ninety-two percent of these respondents related this decline in quality to inadequate staffing. Similar results were found in a study of medical-surgical nurses in Pennsylvania. Forty-seven percent (n = 2,969) stated that the quality of care in their hospitals had deteriorated over the past year (Aiken, et al., 2002).

HUMAN FACTORS RESEARCH BACKGROUND

Since the late 19th century, considerable effort has been expended in the fields of cognitive psychology and human factors research to separate workload into physical and mental components and to develop objective measures of the concept researchers described as mental workload (Kerr, 1973; Moray, 1969; Owen, 1991; Robinson, 1921; Welch, 1898). Mental workload can be defined as the amount of thinking, level of cognitive demand, or thought processing effort required by the worker to meet the physical, temporal, and environmental demands of the defined task. Human factors researchers have been interested in mental processing in an attempt to understand the human information processing system and why some demands are handled easily and others lead to signs of mental overload with associated decreases in performance. Research in human factors has attempted to address the multiple and complex dimensions of the mental workload concept from the subjective perception of the worker. Research studies on mental workload related to information processing and attention indicate that human beings have the ability to attend to multiple details simultaneously (Braarud, 2001; Georgia Tech., 2011; Haga, Shinoda, & Kokubun, 2002; Huddleston, & Wilson, 1971; Kahneman, 1973; Luximon & Goonetilleke, 2001; Navon, 1985; Owen, 1990, 1991, 1992b; Owen & Haugtvedt, 1993).

MENTAL WORKLOAD MEASURES

As work demands become more complex, the need for measures to determine mental workload increases. Several techniques have been proposed to quantify the ability to focus on multiple complex phenomena at the same time. Mental workload techniques can be grouped into three broad measures: psychophysical, performance, and subjective (Owen, 1992a; Veltman, 2002). Each measure has specific applications and limitations in determining the mental workload associated with the work demands and environment. Table 1 provides an overview of the three workload measures, highlighting the underlying assumption, measurement indicators, and measurement limitations of each.

Researchers in the aeronautics, engineering, and health care industries have emphasized the psychophysiologic and performance demands of workload with much less focus on the subjective perception of the individual performing the work. As the field of human factors research has developed within healthcare, there has been a growing recognition that personal perspective about work demands could provide valuable information that impacts quality care and patient safety. Psychophysiologic and performance measures of workload are traditionally accepted and used, while subjective measures have been used in only one identified study (Gregg, 1993). This review will focus on the current state of human factors research and establish the need for more nursing workload research utilizing a human factors framework.



Table 1
Mental Workload Measures

Measures	Underlying Assumption	Measurement Indicators	Measurement Limitations	References
Psycho-physiologic	Physical functioning changes when cognitive demands change	Heart rate, heart rate variability, respiratory changes, blood pressure fluctuations, eye blinks, cortisol levels, and oxygen consumption	Internal validity is impacted by complexity of effects, dependent and independent variable control, and presence of confounding and extraneous variables	Haga, et al., 2002; Robinson, 1921; Veltman, 2002
Performance	Attention load changes cause performance or behavior changes that can be measured and predicted	Change in reaction time and accuracy of the task or performance measure	Participant must perform a second task in order to assess the processing demands of a primary task	Gregg, 1993; Haga, et al., 2002; Kerr, 1973; Owen, 1992a, 1992b; Vercruyssen & Rodenburg, 2004
Subjective	Participants are aware of their mental workload or attention capacity and can estimate variations in mental workload and attention capacity	Self-reported responses to questions about the amount of work or mental processing required to complete the task	Validity relies on the human's ability to provide information about the effort investment required to complete the work	Hart & Staveland, 1988; Tomporowski, 2003; Veltman, 2002

CONCEPTUALIZATION OF SUBJECTIVE MENTAL WORKLOAD

Subjective mental workload is the amount of work the worker perceives is needed to meet a demand. The perceived workload is influenced by numerous factors pertaining to the worker, the environment, and the task. There is a presumption, based on subjective experience and the frequent inability of humans to perform two tasks simultaneously, that humans possess a limited capacity central processing system, (Kerr, 1973). Humans must often choose where to focus their attention when faced with competing options. Attention in the context of mental workload is the process of selecting from a variety of stimuli for information processing (Navon, 1985). Selection, motivation, and task interference determine the level of attention given to stimuli. Selection refers to the conscious choice to focus on selected information or a stimulus and is influenced by motivation, which is the person's desire to

focus on or process the stimuli. Task interference is anything that inhibits attention or slows down the information processing (Navon, 1984, 1985; Owen, 1992a). Novel stimuli require greater processing and more mental effort than stimuli that are more familiar. As the amount of mental effort for a task increases, the ability to perform concurrent tasks decreases.

The six distinct categories for attention theories and information processing identified in the literature are summarized in Table 2. Each theory sought to explain why some people perform a task more efficiently and with greater ease than other people do. The theories assumed a limit to the amount of cognitive stimuli an individual can process at any given time.

Table 2
Attention Theories

Theory	Key Points	Attention Limitation	References
Single Channel Theory	Serial processing is used except in cases of experience	Response time is dependent on experience	Kerr, 1973; Moray, 1969
Undifferentiated Capacity Hypothesis	Humans have a maximum performance capacity	Interference occurs when multiple task demands exceed the processor's total capacity	Kerr, 1973; Moray, 1969
Limited Capacity Central Mechanism Hypothesis	Some mental operations require space in a single limited capacity central mechanism	Operations requiring the limited capacity central mechanism interfere with other simultaneous operations	Kerr, 1973; Moray, 1969
Polychromic Time Use	Performance of multiple tasks simultaneously is an acquired skill associated with age, genetics, experience and environmental influences	Exceeding ability to meet information processing demands results in information overload and diminished performance	Huddleston, 1974; Huddleston & Wilson, 1971; Morganstem, Hodgson, & Law, 1974; Navon, 1985; Owen, 1991, 1992a 1992b; Stapleford, 1973; Tomporowski, 2003
Dual Process Theory	Information processing relates to previous learning and skill acquisition and varies from controlled processing (new information) to automatic processing (familiar information)	Concurrently performed tasks use a common resource and may decrease attention and performance	Navon, 1985; Owen, 1990
Task Switching	The brain alternates focus back and forth between the tasks	Task switching efficiency determines the amount of perceived ability to perform concurrent tasks	Navon, 1985; Owen, 1990



The theories point to limits in the human ability to process information. At times, humans are able to perform parallel activities (e.g., driving and talking) with varying levels of success. When two stimuli are presented together, the stimuli are addressed sequentially rather than simultaneously, suggesting the presence of a bottleneck in the individual's processing ability (Kahneman, 1973). Limited capacity theories assume that, when there is enough stimulation, the signals interfere with each other and reduce the efficiency and speed of the signal response (Kerr, 1973). As nurses' demands increase, the limited capacity to handle the incoming stimuli can lead to errors that decrease the quality and safety of patient care.

MENTAL WORKLOAD: THEORY AND RESEARCH

Mental workload is a complex construct with multiple dimensions. Mental workload perception is determined by the individual's processing capacity and the requirements of the task. Processing capacity is influenced by individual characteristics (e.g. skill level, energy, personal behaviors and perceptions), performance circumstances (e.g. work environment and time demands), activity complexity (e.g. routine activity vs. special or emergency procedure), and indirect influences (e.g. staffing pattern, administrative support, non-direct care requirements).

Like processing capacity, working memory is another limiting factor in processing stimuli and meeting mental workload demands for safe, quality patient care. Working memory and familiarity with demands created by task requirements impact the perceived mental workload demands. The complexity of mental workload is enhanced by individual differences that make adequate measurement using a single instrument difficult (Benner, 1984; Haga, Shinoda, & Kokubun, 2002; Huddleston, 1974; Huddleston & Wilson, 1971; Kerr, 1973; Morganstern, Hodgson, & Law, 1974; Moray, 1969; Navon, 1984, 1985; Owen, 1990, 1991, 1992a, 1992b; Tomporowski, 2003; Veltman, 2002).

Many attempts to quantify nursing workload rely on either patient acuity or time-to-task measures (Aiken & Patrician, 2000; Gregg, 1993). According to the Cognitive Load Theory, conditions that overload the working memory capacity lead to decreased performance. Similarly, as working memory demands are decreased with practice, performance improves (Tomporowski, 2003). To determine mental effort or work, a distinction must be made between the momentary effort that a task demands and the total amount of work associated with its completion.

Time-pressure is an important determinant of the total effort associated with mental work and may be imposed by the explicit instruction to hurry or by the demand characteristics of the task. Severe time pressure "arises in any task which imposes a significant load on short-term memory, because the subject's rate of activity must be paced by the rate of decay of the stored elements" (Kahneman, 1973, p. 26). Investing less than standard effort will cause deterioration in the performance. Consciously increasing personal effort beyond what is usual for an individual is not enough in most cases to eliminate all performance errors (Kahneman, 1973). Understanding concepts that contribute to decreased performance and to errors is critical to improving quality and safety in patient care.

MEASUREMENT OF SUBJECTIVE MENTAL WORKLOAD

During the late 1970s and throughout the 1980s, the concept of subjective mental workload became increasingly popular and was operationalized as the individual's ability to estimate the mental workload experienced at a given time (Luximon & Goonetilleke, 2001; Reid & Nygren, 1988). There were two major rating scales for estimating subjective mental workload: the NASA-Task Load Index (NASA-TLX) and the Subjective Workload Assessment Technique (SWAT).

The NASA-TLX, developed in 1988 for use with military pilots, is the most widely accepted subjective measure of human workload and has been utilized in research with adults of all ages and both genders (Tomporowski, 2003). The measure is a standardized multidimensional subjective rating scale that provides an overall estimation of workload associated with task performance. The NASA-TLX has been used in aeronautics, psychology, computer systems, transportation, and the health professions (Haga, et al., 2002; Young, Zavelina, & Hooper, 2008). Studies have found the NASA-TLX to have high validity and user acceptance and to have the smallest variability between subjects (Hart & Staveland, 1988; Tomporowski, 2003; Vitense, Jacko, & Emory, 2003; Young, et al., 2008). Six subscales measure the relative contribution of underlying psychological factors to overall workload: demand, physical demand, temporal

demand, performance, effort, and frustration (Hart & Staveland, 1988; Vitense et al., 2003; Young, et al., 2008). Gregg (1993) was the first to measure subjective mental workload in a group of intensive care nurses.

MEASUREMENT OF, AND INFLUENCES ON, NURSING WORKLOAD

The lack of a clear definition in the literature has been identified as one of the major problems with understanding and measuring nursing workload (Morris, MacNeely, Scott, Treacy & Hyde, 2007). Additionally, there is a tendency to use the concepts of nursing work and nursing workload interchangeably. Nursing work describes the functional tasks such as assessment or medication administration that the nurse carries out to benefit the patient. In contrast, nursing workload is best described as “the amount of performance required to carry out those nursing activities in a specified time period” (Morris, et al., 2007, p. 464). Workload has been identified by ICU nurses as one of the most important job stressors (Aiken et al., 2002; Carayon & Gürses, 2005). High workload levels have been associated with suboptimal patient care (Carayon & Gürses, 2005). Providers with high workloads also eliminate non-essential care tasks and procedures. Potential adverse outcomes linked to high workload include reduced patient satisfaction, poor nurse-patient communication, impaired nurse-physician collaboration, nurse burnout, and job dissatisfaction (Aiken et al., 2002; Carayon & Gürses, 2005).

Nursing workload is affected by many different factors, some of which are more stable and easier to measure than others (Scott, n.d.). Easily measured variables include the number of admissions, patient census, procedures, turnover, case mix, and average age of the clients. Less easily quantifiable factors with a direct impact on nursing workload at the point of care include environment, the institution’s philosophy of nursing, the type of staffing (e.g., primary care or team nursing), the individual characteristics of the nursing staff (e.g., education, experience, and skill level), and the patterns of medical treatment (Hegney, Plank, & Parker, 2003; Page, 2004; Stone, et al., 2003). One of the difficulties in measuring nursing workload is related to the varying definitions and standards used across systems that make comparison of data more difficult and research more challenging.

Traditional Measures

Workload in nursing has typically been measured in terms of the number of patients, the number of care hours per patient, or by applying a patient acuity system based on medical diagnosis and care activities (Claudio, 2004; Gregg, 1993; Holcomb, Hoffart, & Fox, 2002; Slomka, Fulton, & Fitzpatrick, 2001; Walsh, 2003). Using these measures is fraught with problems. Determining nursing workload by historical acuity or census calculations does not reflect the actual workload of caring for patients on the unit. A key problem is that acuity measures do not account for many of the activities involved in actual patient care, such as educating family, coordination of care activities with other health care team members to meet patient needs, and unanticipated changes in the patient’s condition (Walsh, 2003).

Attempts to measure nursing workload based on the perceptions of the head nurse assumed head nurses were aware of the patient care and nurse needs and could recognize when staff were overworked (Trivedi & Hancock, 1975). Patient load for a shift was determined by examining patient census and considering admissions, discharges, and transfers. Only two variables were found to be significant in determining the head nurse’s perception of the severity of need for nursing care: nursing hours available on the unit and unit census. Many of the measures used by nurse administrators to evaluate the nursing work environment, such as employee absenteeism, turnover, and patient satisfaction, are trailing indicators or markers of workload. Reliance on these trailing indicator measures is a reactive rather than proactive approach to dealing with workplace issues (McLennan, 2005).

Cognitive or Mental Measures

Besides using incomplete data, acuity system measurements lack the ability to measure mental demands placed on nurses (Gregg, 1993; Jennings, Rea, Antopol, & Carty, 1989; Yamase, 2003) and situation-level variability (Carayon & Gürses, 2005). Nurses in clinical settings have expressed concern that acuity or patient number-based staffing measures do not accurately reflect their workload, because such measures do not take into account the mental demands and stresses of workload (Jennings, Rea, Antopol, & Carty, 1989; Meierhoffer, 1991; Schneider, 1994). With



traditional workload measures, nurses may feel they are working too hard or that patient outcomes are unsatisfactory (Page, 2003). Ramanujam, Abrahamson, and Anderson (2008) reported that the nurses' perception of workload demands has an inverse relationship to their perceived ability to provide safe care. As the workload demands increase, the perception that safe care delivery can be achieved diminishes. Additional signs of increases in the workload of nurses might be seen in declining patient satisfaction scores; increasing numbers of nurses who work overtime; and signs of stress and burnout in nurses, such as fatigue and dissatisfaction with the job or with nursing as a profession (Walsh, 2003; McLennan, 2005).

NURSE WORKING CONDITIONS AND OUTCOMES

There is a growing body of literature supporting the conclusion that nurse staffing and workload affect nurse satisfaction (Beaudoin & Edgar, 2003; Smith, 2002), nurse turnover (Allen & Mellor, 2002; Jolma, 1990; Smith, 2002), and patient outcomes (Page, 2004; McLennan, 2005; Morrissey, 2003; Ramanujam, et al., 2008; Smith, 2002). Evidence supports an inverse relationship between RN staffing levels and the incidence of urinary tract infections, pneumonia acquired after surgery, and antibiotic resistant organisms in intensive care units (Stone et al., 2003). Other staffing factors related to patient safety outcomes include a link between fewer years of experience in the clinical unit and patient mortality, and the development of infection at higher rates for new admissions cared for by agency or "pool" nurses than with permanently assigned intensive care unit staff. High nursing workload has been shown to be related to suboptimal patient care and nurse burnout (Aiken et al., 2002). Staffing variables are one aspect of nursing practice environments that may affect outcomes not only for patients, but also for nurses and organizations (Stone et al., 2003).

Mandated nurse-patient ratios is a method that has been proposed to improve quality outcomes in hospitals and keep nursing workload at a manageable level. Some researchers feel that mandating nurse-to-patient ratios alone, without ensuring that other work environment characteristics are considered, is short-sighted (Smith, 2002; Stone et al., 2003). They argue that the stakes are high, not only because of the potential for poor patient outcomes, but also because having nurses who are overworked and overloaded may lead to even greater erosion of quality care.

Staffing effectiveness indicators adopted by The Joint Commission Accreditation of Hospitals (JCAH) in July 2002 and patient outcomes are two commonly used measures to evaluate nursing workload (McLennan, 2005; Smith, 2002; Stone et al., 2003). For JCAH accreditation, agencies are required to choose a minimum of four indicators (two clinical/service and two human resource) from a list of indicators provided, and they are then expected to report the data summary and analyses related to effectiveness of staffing on patient outcomes to their administration each year. This report also includes suggested actions that may be undertaken to improve outcomes, including alterations to nurse staffing (Stone et al., 2003). These staffing effectiveness measures require that workload measurement go beyond patient diagnosis and nurse patient ratios to uncover the care hours needed to meet a specific patient population's needs (Walsh, 2003). Until the composition of nurse work and factors affecting nurses' work lives are understood, the quality of nurse work cannot be enhanced (Beaudoin & Edgar, 2003).

NURSING WORKLOAD AND THE HUMAN FACTORS (SUBJECTIVE MEASURE) APPROACH

Review of the workload literature identified the common stress of technologically advanced work environments for pilots, air traffic controllers, flight deck operators, transportation industry drivers, and nurses and noted that the NASA-TLX had been used to evaluate the perceptions of workload associated with clinical education in anesthesia (Young, et al., 2008). The NASA-TLX served as the foundation for the Nursing Task Load Index (Nursing TLX) developed to measure ICU nurses' perceptions of workload (Gregg, 1993).

Many measures of workload in nursing are designed based on the needs and condition of the patient, thus evaluating nursing workload based on patient care activities. Carayon and Gürses (2005) conducted a literature review on nursing workload studies in intensive care settings and examined the findings for impact on the quality of patient care and

safety and nurses' quality of working life. They identified both macro and micro level influences on workload. Macro-level influences are common to all nurses, while micro-level influences are those that are short-term and unique to the combination of factors involved at a specific point in time (i.e. patient factors, interdisciplinary interactions, work environment, and personal characteristics of the nurse). Based on this review, Carayon and Gürses proposed a conceptual framework that defined causes, consequences, and outcomes of workload. Using a human factors engineering approach, they defined four different levels of nursing workload: unit level, job level, patient level, and situation level.

Levels of Nursing Workload

The unit level measure was based on measures such as nurse-patient ratio, nursing care hours, and bed occupancy, with some modification based on nurse education and experience levels. These workload measures were described as macro-level because they did not consider unique features of each ICU (i.e., the contextual and organizational characteristics) (Carayon & Gürses, 2005).

Job level workload provided information about ICU nursing compared to other jobs. The overall perceived workload was evaluated, and the quality of working life and patient care were considered (Carayon & Gürses, 2005). A variety of instruments are available for estimation of nursing workload based on patient care activities, including the simplified Therapeutic Intervention Scoring System (TISS) (Reis-Miranda, et al., 1996), Nine Equivalents of Nursing Manpower Use Score (NEMS) (Reis-Miranda, et al., 1997; Rothen, Küng, Ryser, Zürcher, & Regli, 1999), Revised Nursing Work Index (NWI-R) (Aiken & Patrician, 2000), and Comprehensive Nursing Intervention Score (CNIS) (Yamase, 2003).

Since measures that are based on the patient's condition are not particularly helpful in understanding the impact of situations on nursing workload, Carayon and Gürses (2005) introduced the situation-level workload to explain temporally bound events in the clinical micro system. The situation-level workload is evaluated for a particular event or over a short time period, such as a shift. Carayon and Gürses proposed the use of human factors engineering workload measures, such as the NASA TLX or SWAT, to assess this situation-level workload. They identified the need to consider both the contextual factors of the environment and patient demands and the individual attributes of nurses when examining nursing workload in the ICU setting. Using human factors engineering knowledge, approaches, and measurement methods to evaluate workload "can provide direction for specific interventions that can be implemented in ICUs in order to improve nursing quality of working life and quality and safety of patient care" (Carayon & Gürses, 2005, p. 298).

Measurement of Nursing Workload Using a Human Factors Approach

In the earliest study of subjective mental workload identified in nursing, Gregg (1993) developed the Nursing Task Load Index (Nursing TLX) to examine cardiovascular critical care unit nurses' subjective mental workload in relation to specialty and general experience and education. The Nursing TLX is based on the NASA Task Load Index and consists of both scales that measure work demand and scales that measure responses to those demands. The final version of the Nursing-TLX includes seven scales: mental demand, physical demand, temporal demand, environmental demand, effort, performance, and emotionalism. Internal consistency of the total Nursing TLX was reported as $\alpha = .82$, similar to that reported for the NASA-TLX, $\alpha = .87$ (Hart & Staveland, 1988). According to Gregg, the internal consistency was similar to that reported ($\alpha = .80 - .83$) in a study by Bertram which adapted the NASA-TLX for use with physicians. Inter-item correlations were highest between Temporal Demand and Effort, $r = .79$, $p = .0001$, and between Performance and Emotionalism, $r = .72$, $p = .0001$.

Gregg (1993) defined the task for her study as "four hours of patient care" (p. 108). She reported no significant relationship between specialty experience and subjective mental workload for participants in the study. Gregg suggested that the absence of a significant relationship between specialty experience and subjective mental workload may be an indicator that much of the information was processed automatically. She also reported an "essentially zero correlation coefficient between general experience and subjective mental workload" (Gregg, p. 106), which she found puzzling, based on the prior research indicating that more information can be processed by individuals with "a



broad base of experience than by those with no experience" (p. 106). The attention theory of automation suggests that consistent practice on a task reduces the cognitive demands of the task (Kahneman, 1973; Owen, 1991) and would indicate that nurses who were more experienced would have lower mental workload scores.

Gregg (1993) found no significant relationships between mental workload and nurse characteristics, work environment, or work schedule variables. The findings did reveal a significant relationship between subjective mental workload and the volume of patients cared for and the diagnoses of the assigned patients (Gregg, 1993). The findings indicated there may be a relationship between traditional nursing workload and subjective workload measures on the variables "patient volume" and "diagnoses" suggesting that current nursing workload measures may address the mental demands of patient care more than nurses think. Findings also revealed a positive association between subjective mental workload and the number of days that a nurse had been off prior to participating in the study, but only if a nurse had been off at least five days. Gregg suggested that a reason for this finding might be that, as the number of days off increased, the likelihood of being assigned all new patients increased. Additional study and expanded conceptual thinking related to nursing workload "may lead to improved administrative systems for nurses and better nursing care for patients" (Gregg, 1993, p. 114).

CONCLUSION

Nursing workload involves attention to multiple complex phenomena that often occur simultaneously. Attempts to measure the concept of nursing workload relying on traditional methodologies have yielded results that do not adequately explain the complex phenomena involved. Research has focused on determining the time, skills, tasks, and in a few cases, the mental demand associated with nursing workload.

Subjective measures provide a more accurate measure of a worker's perception of the effort being expended. The popularity of subjective workload measures in human factors research is based on the idea that only the worker truly knows how much work is required to meet demands. If the worker notes that there is too much work associated with a given system or function, then alternatives to reduce the workload need to be examined. A second important factor in utilizing subjective workload measures is that they are more directly related to the mental demand concept than are physiological measures and behavioral measures. An understanding of the factors that impact nurses' mental workload has the potential to improve quality and safety, thus improving patient outcomes. An additional benefit could be reduced burnout among nurses, which could keep more nurses at the bedside providing care.

When measuring workload, there is a need to recognize the critical link between the characteristics of the nurse and of the work environment and the impact of these personal and environmental factors on patients, nurses, and the system as a whole. Some attempts have been made to determine the impact of personal characteristics and environmental factors through attempts to develop valid tools such as the SWAT, the NASA-TLX, or the Nursing TLX, but the conceptual and empirical support, as well as a generally accepted definition of mental workload, has remained elusive.

Very few nursing workload studies have been conducted using human factors approaches. No studies were identified during this literature review that examined nurses' subjective perceptions in medical-surgical units, in community-based settings or at the situation level. Adequate workload measurement tools are necessary to gain insight into nurses' mental workload as they provide care in today's complex health care environment. There is a need for a valid and reliable instrument using human factors engineering measurement that will provide insight into the nurse's subjective perception of workload.

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