Chapter 30. Nursing Workload and Patient Safety—A Human Factors Engineering Perspective

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Background

The heavy workload of hospital nurses is a major problem for the American health care system. Nurses are experiencing higher workloads than ever before due to four main reasons: (1) increased demand for nurses, (2) inadequate supply of nurses, (3) reduced staffing and increased overtime, and (4) reduction in patient length of stay.

First, the demand for nurses is increasing as a result of population aging. Between 2000 and 2020, the United States population is expected to grow by 18 percent (31 million), but the over-65 population, with more health care needs, is expected to grow by 54 percent (19 million).[1, 2] Second, the supply of nurses is not adequate to meet the current demand, and the shortage is projected to grow more severe as future demand increases and nursing schools are not able to keep up with the increasing educational demand.[3, 4] When a nursing shortage occurs, the workload increases for those who remain on the job.[5] Third, in response to increasing health care costs since the 1990s, hospitals reduced their nursing staffs and implemented mandatory overtime policies to meet unexpectedly high demands, which significantly increased nursing workloads. Fourth, increasing cost pressure forced health care organizations to reduce patient length of stay. As a result, hospital nurses today take care of patients who are sicker than in the past; therefore, their work is more intensive.[6]

There are several important consequences of high nursing workload. Research shows that a heavy nursing workload adversely affects patient safety.[7] Furthermore, it negatively affects nursing job satisfaction and, as a result, contributes to high turnover and the nursing shortage.[8] In addition to the higher patient acuity, work system factors and expectations also contribute to the nurses' workload: nurses are expected to perform nonprofessional tasks such as delivering and retrieving food trays; housekeeping duties; transporting patients; and ordering, coordinating, or performing ancillary services.[9] A 1998–1999 survey of more than 43,000 nurses in five countries found that 17 percent to 39 percent of respondents planned to leave their job within a year because of job demands.[9] Heavy nursing workload increases burnout and job dissatisfaction, which in turn contributes to high nurse turnover.[10] This chapter focuses on the impact of nursing workload on patient safety. We first present different concepts and models of nursing workload, then discuss the impact of workload on patients and on nursing staff, presenting various mechanisms of the relationship between nursing workload and patient safety. Finally, we describe a human factors engineering approach on how work systems can be redesigned to reduce nursing workload or to minimize the negative impact of a heavy nursing workload.

Concepts and Models of Nursing Workload

Nursing workload measures can be categorized into four levels: (1) unit level, (2) job level, (3) patient level, and (4) situation level.[11] These measures can be organized into a hierarchy. The situation- and patient-level workloads are embedded in the job-level workload, and the job-level

workload is embedded in the unit-level workload. In a clinical unit, for example, numerous nursing tasks need to be performed by a group of nurses during a specific shift (unit-level workload). The type and amount of workload of nurses is partly determined by the type of unit and specialty (e.g., intensive care unit [ICU] nurse versus general floor nurse), which is the job-level workload. When performing their job, nurses encounter various situations and patients, which are determinants of the situation- and patient-level workloads.

Workload at the Unit Level

The most commonly used unit-level workload measure is the nurse-patient ratio. The nurse-patient ratio can be used to compare units and their patient outcomes in relation to nursing staffing. Previous research provides strong evidence that high nursing workloads at the unit level have a negative impact on patient outcomes.[7, 12, 13] These studies' suggestions regarding improving patient care are limited to increasing the number of nurses in a unit or decreasing the number of patients assigned to each nurse. However, it may not be possible to follow these suggestions due to costs and the nursing shortage. The major weakness of this type of research is that it conceptualizes nursing workload at a macro level, ignoring the contextual and organizational characteristics of a particular health care setting (e.g., physical layout, information technology available) that may significantly affect workload. Research should examine the impact on nursing workload of work factors in the health care microsystems.

Workload at the Job Level

According to this conceptualization, the level of workload depends on the type of nursing job or specialty (ICU nurse versus operating room nurse). For instance, Schaufeli and LeBlanc[14] used a job-level measure of workload to investigate the impact of workload on burnout and performance among ICU nurses. Previous research linked job-level workload (a working condition) to various nursing outcomes, such as stress[15, 16] and job dissatisfaction.[17] Workload measures at the job level are appropriate to use when comparing workload levels of nurses with different specialties or job titles (ICU nurses versus ward nurses).[18] However, workload is a complex, multidimensional construct, and there are several contextual factors in a nursing work environment (e.g., performance obstacles and facilitators) other than job title that may affect nursing workload.[19] In other words, two medical ICU nurses may experience different levels of workload due to the different contextual factors that exist in each ICU. The workload at the job-level conceptualization fails to explain the difference in the workloads of these two nurses.

Workload at the Patient Level

This conceptualization assumes that the main determinant of nursing workload is the clinical condition of the patient. Several patient-level workload measures have been developed based on the therapeutic variables related to the patient's condition (e.g., Therapeutic Intervention Scoring System)[15, 20, 21] and have been extensively discussed in the nursing literature. However, recent studies show that factors other than the patient's clinical condition (e.g., ineffective communication, supplies not well-stocked) may significantly affect nursing workload. As with the previous two workload measures, patient-level workload measures have not been designed to measure the impact of these contextual factors on nursing workload.

Situation-Level Workload

To remedy the shortcomings of the three levels of measures explained above and complement them, we have suggested using another way to conceptualize and measure nursing workload based on the existing literature on workload in human factors engineering: situation-level workload.[11] In addition to the number of patients assigned to a nurse and the patient's clinical condition, situation-level workload can explain the workload experienced by a nurse due to the design of the health care microsystem. In a previous study, we found that various characteristics of an ICU microsystem (performance obstacles and facilitators)—such as a poor physical work environment, supplies not well stocked, many family needs, and ineffective communication among multidisciplinary team members—significantly affect situation-level workload.[22] For example, sometimes several members of the same family may call a nurse separately and ask very similar questions regarding the same patient's condition. Answering all these different calls and repeating the same information about the patient's status to different members of the family is a performance obstacle that significantly increases the (situation-level) workload of nurse.

It is important to note that the impact of this performance obstacle on nursing workload would not be apparent if we used a unit-level or patient-level workload measure. Compared to workload at the job level, situation-level workload is temporally bound: it explains the impact of a specific performance obstacle or facilitator on nursing workload over a well-defined and relatively short period of time (e.g., 12-hour shift), rather than using the overall experience of the nurse in a given microsystem. Situation-level workload is multidimensional, that is, different types of performance obstacles and facilitators affect different types of workload. Whereas the distance between the patients' rooms assigned to a nurse affects physical workload, the condition of the work environment (noisy versus quiet, hectic versus calm) affects the overall effort spent by the nurse to perform her job.[23] No prior study investigated the impact of the microsystem characteristics on situation-level nursing workload.[19] In summary, by studying workload at the situation level, researchers can identify the characteristics of a microsystem that affects workload. This information is vital for reducing nursing workload by redesigning the microsystem. In the last section of this chapter, a human factors engineering approach based on the situation-level workload is described.

Research Evidence

Impact of Nursing Workload on Patients

A heavy nursing workload seems to be related to suboptimal patient care[10, 24] and may lead to reduced patient satisfaction.[25] A 2004 report by the Agency for Healthcare Research and Quality (AHRQ) describes several AHRQ-funded studies on the relationship between hospital nurse staffing and quality of care (e.g., urinary tract infection, hospital-acquired pneumonia) and patient safety outcomes (e.g., failure to rescue).[26]

Much of the research investigating the impact of nursing workload on patient safety focused on linking nursing staffing levels with patient outcomes. There is strong evidence in the literature that nurse staffing levels significantly affect several nursing-sensitive patient outcomes.[13, 26, 27]

Several studies found a significant relation between lower nurse staffing levels and higher rates of pneumonia.[28-30] For example, a multisite study in California found that an increase of 1 hour worked by registered nurses (RNs) per patient day correlated with an 8.9 percent decrease in the odds of pneumonia among surgical patients.[28] Another study found a significant relationship between full-time-equivalent RNs per adjusted inpatient day and rate of pneumonia: the rate of pneumonia was higher with fewer nurses.[31] However, other studies have not confirmed these findings;[31, 32] for example, the evidence regarding the impact of nurse staffing levels on pneumonia is conflicting. As workload is affected by more than just staffing levels, a deeper understanding of nursing workload is required to better assess the impact of workload on patient outcomes. Later, a human factors engineering approach to nursing workload that can provide this deeper understanding of nursing workload and its causes will be described, allowing for the development and implementation of solutions aimed at reducing or dealing with workload.

Nursing staffing levels have been shown to have a significant impact on nosocomial infections. For example, Needleman and colleagues[13] found that among medical patients, a higher number of hours of care per day provided by RNs was related to lower urinary tract infection rates. A retrospective cohort study in a neonatal ICU revealed that the incidence of *E cloacae* infection in the unit was significantly higher when there was understaffing of nurses.[33] A prospective study in a pediatric cardiac ICU found a significant relation between the monthly nosocomial infection rate in the unit and the nursing hours per patient day ratio: there were more nosocomial infections when the number of nursing hours per patient day was lower.[34]

Although not as strong, some evidence exists regarding the impact of nurse staffing levels on failure to rescue (death within 30 days among patients who had complications) and mortality. A study using administrative data from 799 hospitals in 11 States revealed that a higher number of hours of RN care per day was associated with lower failure to rescue rates.[13] In a study of 168 nonfederal adult general hospitals in Pennsylvania, Aiken and colleagues[10] found that each additional patient per nurse was associated with a 7 percent increase in the likelihood of mortality within 30 days of admission and in the likelihood of failure to rescue. An earlier study found that hospitals that had more RNs per admission had lower mortality rates.[35]

There were four studies that found a relationship between nurse staffing and patient outcomes. One study found that having a nurse-patient ratio of less than 1:2 during evening shifts was associated with a 20 percent increase in length of stay in patients who had abdominal aortic surgery in Maryland hospitals between 1994 and 1996.[36] Researchers conducted studies in 1992 and 1994 using hospital cost reports and discharge data in New York and California, finding that more nursing work hours were associated with reduced length of stay.[37] Additionally, a critical incident study of Australian ICUs revealed that insufficient nursing staff was linked to drug administration or documentation problems, inadequate patient supervision, incorrect ventilator or equipment setup, and self-extubation.[38]

A majority of the studies on nursing workload and patient safety used nurse-patient ratio as the measure of nursing workload. According to research on workload in human factors engineering (see section above), it is well known that workload is a complex construct, more complex than the measure of nurse-patient ratio.[11] It is unlikely that the multidimensional, multifaceted structure of workload can be captured by one unique, representative measure. Therefore, the belief is that researchers who use the nurse-patient ratio as a measure of workload offer a limited contribution to understanding the impact of nursing workload and designing solutions for reducing or mitigating nursing workload. One reason for the extensive use of the

nurse-patient ratio may be that this measure is easy to use and is readily available in existing databases. But tools used by human factors researchers can comprehensively assess workload, facilitate the identification of the sources of excessive workload, and provide direction for corrective interventions.[11]

How Does Nursing Workload Impact Patient Safety?

According to the Systems Engineering Initiative for Patient Safety (SEIPS) model of work system and patient safety,[39, 40] structural/organizational characteristics of health care work systems, such as nursing workload, can affect quality of care and patient safety. In this section, a description of how nursing workload can affect patient safety will be offered (see Table 1). The first five mechanisms describe the impact of a heavy workload experienced by one nurse on that particular nurse. The last mechanism describes the systemic and organizational impact of a heavy workload experienced by a nurse's coworkers and team members.

Table 1: Relationship Between Nursing Workload and Patient Safety

Mechanisms	Description	Examples
Time	Nurses who have a heavy workload may not have sufficient time to perform tasks safely, apply safe practices, or monitor patients, and may reduce their communication with physicians and other providers.	No or little time to double-check medications
Motivation	Nurses who have a heavy workload may be dissatisfied with their job, thus affecting their motivation for high-quality performance.	No or little motivation and commitment to high levels of performance High workload creating frustration and contributing to the development of negative attitude toward one's job.
Stress and burnout	Nurses who have a heavy workload may experience stress and burnout, which can have a negative impact on their performance.	Reduced physical and cognitive resources available for nurses to perform adequately
Errors in decisionmaking (attention)	High cognitive workload (one dimension of nursing workload) can contribute to errors, such as slips and lapses or mistakes.	Forgetting to administer medications
Violations or work-arounds	High workload conditions may make it more difficult for nurses to follow rules and guidelines, thus compromising the quality and safety of patient care.	Inadequate hand washing
Systemic/organizational impact	The heavy workload of a nurse, nurse manager, or another provider could affect the safety of care provided by another nurse.	A charge nurse may not be available to help other nurses with their patients when needed.

Nursing workload and lack of time. Nursing workload definitely affects the time that a nurse can allot to various tasks. Under a heavy workload, nurses may not have sufficient time to perform tasks that can have a direct effect on patient safety. A heavy nursing workload can influence the care provider's decision to perform various procedures.[41] A heavy workload may also reduce the time spent by nurses collaborating and communicating with physicians, therefore affecting the quality of nurse-physician collaboration.[42] A heavy workload can lead to poor nurse-patient communication.[43, 44]

Nursing workload and deteriorated motivation. Several studies have shown the relationship between nurses' working conditions, such as high workload, and job dissatisfaction.[10, 45, 46] Job dissatisfaction of nurses can lead to low morale, absenteeism, turnover, and poor job performance, and potentially threaten patient care quality and organizational effectiveness.[47] Researchers have found positive associations between job satisfaction and job performance,[48] and patient satisfaction and quality of care.[49]

Impact of workload on nursing stress and burnout. High workload is a key job stressor of nurses in a variety of care settings, such as ICUs.[15, 16, 50] A heavy nursing workload can lead to distress (e.g., cynicism, anger, and emotional exhaustion)[51] and burnout.[10] Nurses experiencing stress and burnout may not be able to perform efficiently and effectively because their physical and cognitive resources may be reduced; this suboptimal performance may affect patient care and its safety.

Nursing workload and errors. Workload can be a factor contributing to errors.[52, 53] Errors have been classified as (1) slips and lapses or execution errors, and (2) mistakes or knowledge errors.[52] High workload in the form of time pressure may reduce the attention devoted by a nurse to safety-critical tasks, thus creating conditions for errors and unsafe patient care.

Nursing workload and violations or work-arounds. Violations are defined as deliberate deviations from those practices (i.e., written rules, policies, instructions, or procedures) believed necessary to maintain safe or secure operations.[54] The literature on violations emphasizes the role of the social and organizational context, where behavior is governed by operating procedures, codes of practice, rules, and regulations.[54, 55] This approach emphasizes factors in the work system that can contribute to violations. The health care field has begun to explore caregivers' violations of protocols.[56] A survey describing medical practice was administered to 315 nurses, doctors, and midwives and 350 members of the general public in the United Kingdom. The study examined two factors manipulated within nine scenarios of surgery, anesthetics, and obstetrics. The first factor, behavior, was described as an improvisation (no rule available), a violation of clinical protocol, or compliance with a clinical protocol. The second factor, patient outcome, was described as good, bad, or poor. Samples of health care providers and the general public were asked to evaluate the nine scenarios with regard to the inappropriateness of the behavior, the likelihood that they would take further action (i.e., reporting by health care provider and complaining by the public), and responsibility for the outcome (e.g., the health care professional, the patient, the protocol itself, the hospital). Results showed that violations of protocols and bad outcomes were judged most harshly. Whether outcomes were good or bad, violations were evaluated more negatively. The authors of the study warned against overreliance on procedures (or protocols) as a form of organizational defense against accidents or claims. Procedures may stifle innovation and make people less able to function in novel situations.

Alper and colleagues[57] conducted a survey of 120 nurses (59 percent response rate) in three units of a pediatric hospitals to assess self-reports of violations in the medication administration process. Between 8 percent and 30 percent of the nurses reported violations in routine situations, and between 32 percent and 53 percent of the nurses reported violations in emergency situations. The most frequent violations or work-arounds occurred in matching the medication to the medication administration record and checking the patient's identification.

Further research is needed to understand the work system factors that lead to violations. Violations occur more frequently when nurses are under time pressure or high workload because of emergency situations. Under high workload, nurses may not have time to follow rules and

guidelines for safe care, especially if following the rules and guidelines necessitate additional time, such as hand washing.

Systemic, organizational impact of nursing workload. This final mechanism of the relationship between nursing workload and patient safety is based on the systemic, organizational impact of nursing workload: a heavy workload experienced by a nurse not only affects this nurse, but can also affect other nurses and health care providers in the nurse's work system. Understaffing may reduce time nurses have to help other nurses. This lack of time may also result in inadequate training or supervision of new nurses.

Practice and Research Implications

We propose a human factors engineering approach to nursing workload and patient safety, which is based on the SEIPS model of work system and patient safety.[58, 59] This approach is based on the key principle of human factors engineering, i.e., work system design.[60, 61] According to the work system model, several elements of the work system can affect nurses and their performance, safety, and well-being.[58] These work system elements are causes or factors contributing to nursing workload. The first step of the proposed approach is therefore to understand how the work system of nurses can contribute to their workload. Human factors engineers have developed and used various methods to assess each element of the work system model and the interaction between the elements,[62] such as observations of the work situation;[62, 63] direct measurement of the work environment and workstation; and interviews, focus groups, and survey of workers.[40, 64] Once the human factors engineers have identified the elements and characteristics of the nurses' work system that contribute to workload, they can redesign the work system to reduce the workload.

In a previous study,[23] the causes of situational workload experienced by nurses in 17 ICUs in Wisconsin were identified, demonstrating that there were differences in the factors that lead to a heavy nursing workload in different ICUs. For example, compared to their colleagues in other participating ICUs, a higher number of nurses of a 24-bed medical surgical ICU reported the following factors that led to high workload: difficulty finding a place to sit down and do paperwork, distance between patients' rooms, poor condition of the equipment, spending a lot of time searching for patients' charts, and a crowded and disorganized work environment. Since this ICU was larger than the other ICUs in the study and many specialties were involved in the care of patients in this ICU, it was not surprising to see such work system factors as a crowded and disorganized work environment, and spending a lot of time searching for patients' charts (e.g., different specialties searching for the chart during the day).

Once the work system factors contributing to nursing workload have been identified, interventions aimed at reducing or mitigating the workload can be designed. The work system redesign interventions should follow the two basic principles of the Balance Theory of Carayon and Smith: (1) eliminating the source of the excessive workload, or (2) compensating or balancing out the workload.[60, 61] According to the Balance Theory, redesigning the work system should aim at eliminating the negative aspects of work; however, this is not always feasible or practical. The Balance Theory, therefore, proposes an alternative approach aimed at compensating for or balancing out the negative aspects of work. For instance, "making available to nurses resources and social support to assist them in accomplishing their duties"[50, 51] can be conceptualized as a compensating mechanism: different types of support (e.g., informational

support, practical support, affective support) can be provided to help nurses deal with negative aspects of their work, such as workload.

Another key concept of the human factors engineering approach to nursing workload is the work *system*: any change in one element of the work system can affect other elements of the work system in negative and/or positive ways.[60, 61] For instance, work hour limits for physicians have affected nurse schedules. Nurses are often required to work increased overtime to compensate for reduced physician hours.[65] This is an example of how changing one element in the work system of physicians can negatively affect the work system of nurses. Table 2 summarizes the research implications of the proposed human factors engineering approach to nursing workload and patient safety.

Table 2: Research Implications on Nursing Workload and Patient Safety

Research Implications	Objectives
Measurement of situational workload	Test and evaluate various methods for measuring nursing workload at the situational level.
Identification of work system factors that contribute to situational workload	Identify the work system factors that contribute to nurses' situational workload under various conditions and in various care settings.
Evaluation of the impact of situational workload on outcomes	Evaluate the impact of situational workload on various outcomes, such as nurses' job satisfaction and stress, nurses' perceptions of quality and safety of care, and patient outcomes. Conduct this research in various care settings and organizational settings.
Development of strategies for reducing situational workload	Develop, implement, and evaluate interventions for reducing situational workload and its negative impact on nurses and patients.
Evaluation of barriers to improving nurses' work system and reducing situational workload	Identify the organizational and structural barriers to effective changes in nurses' work system and the challenges in reducing situational workload.

Conclusion

Nursing workload is affected by staffing levels and the patients' conditions, but also by the design of the nurses' work system. In this chapter, a description of different levels of workload, including situational workload, was offered, and a proposal for a human factors engineering approach aimed at reducing workload or at mitigating or balancing the impact of workload on nurses and patient care was suggested.

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Evidence Table. Nurse workload and patient safety

Source	Safety Issue Related to Clinical Practice	Design Type	Study Design & Study Outcome Measure(s)	Study Setting & Study Population	Key Finding(s)
Aiken 2002[10]	Hospital nurse staffing	Cross-sectional study	Risk-adjusted patient mortality, failure to rescue, job dissatisfaction, job-related burnout	Linked data from 10,184 nurses surveyed, 232,342 surgical patients discharged from the hospital between 04/01/1998 and 11/30/1999, and administrative data from 168 hospitals in Pennsylvania	In hospitals with high patient-to-nurse ratios, patients experience higher 30-day mortality and failure-to-rescue rates, and nurses are more likely to report burnout and job dissatisfaction.
Anderson & Maloney 1998[25]	Nurse workload and patient satisfaction	Cross-sectional study	Patient satisfaction	Survey data from 188 patients in a 250-bed Army medical treatment facility	Patient satisfaction was negatively correlated with average daily census, and positively correlated with the number of nursing care hours required and the number of registered nurses available.
Archibald 1997[34]	Nurse staffing levels and patient census in ICU	Cross-sectional study	Rate of nosocomial infections per 1000 patient days	One pediatric cardiac intensive care unit; 782 admissions during one year	Higher patient census was related to higher rates of nosocomial infections. There was an inverse correlation between the monthly nosocomial infection rates and the nurse/patient ratio.
Beckmann 1998[38]	Nursing staffing issues in incidents reported by ICU staff	Noncomparative study	Incidents associated with nursing staff shortage reported to the Australian Incident Monitoring Study-ICU (AIMS-ICU) project	89 nursing staff shortage incidents and 373 incidents involving nursing staff shortage contributing factors	Incidents involving nursing staff shortage contributed primarily to problems in unit management (65%) and patient management (48%).

Source	Safety Issue Related to Clinical Practice	Design Type	Study Design & Study Outcome Measure(s)	Study Setting & Study Population	Key Finding(s)
Keijsers 1995[24]	Burnout (emotional exhaustion and depersonalization)	Cross-sectional study	Standardized mortality ratio for each of the 20 participating ICUs; perceived personal performance; perceived ICU performance	576 nurses from 20 ICUs	High burnout of ICU nurses is related to poor perceived unit performance and poor perceived personal performance. Nurses in well-performing ICUs (as measured by the standardized mortality ratio) reported higher burnout than nurses in poor-performing units.
Lichtig 1999[37]	Nurse staffing	Cross-sectional study	Adverse patient outcomes (pressure ulcers, pneumonia, UTIs, postoperative infections), length of stay	Hospital cost reports and patient discharge data from hospitals in the States of California and New York	Higher nurse staffing and higher proportion of RNs were related to lower length of stay. Lower rates of adverse outcomes were related to a higher proportion of RNs.
Manheim 1992[35]	Regional variation in hospital mortality	Cross-sectional study	Severity-adjusted Medicare hospital mortality rate	3,796 hospitals in nine US Census regions	The percentage of RNs per adjusted admission was a negative predictor of mortality rates.
Needleman 2002[13]	Hours of nursing care per patient	Cross-sectional study	Rates of urinary tract infections, rates of failure-to-rescue, in-hospital death, rate of adverse outcomes	Administrative data from 1997 for 799 hospitals in 11 States	A higher proportion of hours of nursing care was related to better quality of care outcomes, such as lower rates of urinary tract infections among surgical patients and lower rates of pneumonia, shock or cardiac arrest and “failure-to-rescue” among medical patients. There was no association between hours of nursing care per patient and the in-hospital death rate and the rate of adverse outcomes.

Source	Safety Issue Related to Clinical Practice	Design Type	Study Design & Study Outcome Measure(s)	Study Setting & Study Population	Key Finding(s)
Pronovost 1999[36]	Organizational characteristics of ICUs	Observational study with patient data collected retrospectively and ICU data collected prospectively	In-hospital mortality and hospital and ICU length of stay	All Maryland hospitals that performed abdominal aortic surgery from 1994 to 1996	Having an ICU nurse:patient ratio of less than 1:2 was associated with increased resource use.