

A theoretical model of the determinants of mortality

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ABSTRACT

Outcome research in nursing has been criticized for being atheoretical. Although there has been research investigating patient mortality as an outcome, there has been little discussion about models or theories of nursing-related determinants of mortality for hospitalized patients. Yet, unnecessary patient mortality is an important patient safety outcome. This article describes development of beginning theory of determinants of patient mortality culminating with a revised mortality model. Conclusions are made related to plans for further testing and refinement of the revised mortality model. Further, the utility of the proposed model in practice is discussed.

Outcome research in nursing has been criticized for being atheoretical in nature because of lack of explanation of attribution and related mechanisms hypothesized to influence outcomes being studied.¹⁻⁶ Yet, if the knowledge base for nursing is to be theoretical in nature, then outcome research should focus on testing the validity of attribution claimed in theoretical models developed a priori. It is not simply evidence and research findings that are useful to guide nursing practice, administration, or education. Rather, it is the theory that is tested and refined through the research process that should guide practice in nursing.

There is little discussion in the nursing literature about models describing hypothesized relationships among nursing-related hospital characteristics and mortality for patients who have been hospitalized in acute care facilities. However, over the last 5 years, there has been increased research activity investigating relationships between nurse staffing with various patient mortality outcome indicators. The historical lack of theoretical discussion may be related to traditional assumptions that mortality outcomes, and conversely survival, and their determinants reside within the domain of medical care. Until recently, this assumption has remained unchallenged. However, evidence is mounting to support acceptance of patient mortality and survival as being “nursing sensitive” outcomes.

Mortality is an important and frequently used indicator of hospital quality. In reality, the important outcome is not mortality or death, as death is the terminal fate of all mankind, but rather the outcome of interest is unnecessary patient death. Others suggest that survival rather than death is the outcome of interest. Traditionally, and long before the current focus on patient safety, monitoring of quality in hospitals has focused on measuring adverse or unintended outcomes like mortality or hospital-acquired infections. For this reason, we continue to adopt mortality as an outcome indicator of interest rather than focusing on unnecessary patient death or even survival.

The rationale for using mortality as an indicator of quality is that some hospitals have structures and processes that minimize avoidable or unnecessary patient deaths better than others. There is evidence that mortality rates for hospitalized patients vary across hospitals even after risk-adjustment and case mix

weighting methods have been applied to account for differences in patient characteristics and patient mix across hospitals. In a study of 75 Ontario, Canada, hospitals that included a homogeneous group of medical patients, risk-adjusted and weighted 30-day hospital mortality rates ranged between 10.5% and 21.5%.⁷ Even after acknowledging the presence of error in measuring and risk-adjusting hospital mortality rates, these findings suggest that differences in patient characteristics and patient case mix among hospitals do not account for all variation in mortality rates. There are 3 known sources of variation in hospital mortality rates: individual patient characteristics, quality of care, and random sources.⁸ While it is important to acknowledge that death is an unpreventable outcome for some patients, persistent variation in risk-adjusted rates across hospitals suggest that some portion of this outcome is excessive and preventable, and is related to quality of care and random sources. The challenge is to discover and explain what facets of hospital characteristics act to minimize unnecessary patient death. Because nurses provide the bulk of care to acute care hospitalized patients, it is reasonable to hypothesize that nursing care structures and processes, a subset of hospital characteristics, are important determinants of patient mortality.

Despite acknowledgment that nurses provide the majority of ongoing care to hospitalized patients, study of determinants of mortality for hospitalized patients has historically focused on exploration of medical care and patients' own characteristics. Until 2002, 10 studies could be located linking either nursing structures or processes of care with patient mortality. The majority of these studies focused primarily on investigating relationships among medical care, patient characteristics, and patient mortality.⁷ Since 2002, at least 6 study reports of nursing-related determinants of mortality can be found through a CINAHL and Medline search.^{7,9-13}

It has been suggested that some patient outcomes such as mortality are not sensitive to nursing care.¹⁴ This skepticism may be related to challenges faced when studying these outcomes, including lack of theory linking hospital nursing characteristics with mortality, lack of implementation of effective risk-adjustment methodology that account for preexisting differences in patient characteristics to produce

reliable risk-adjusted mortality indicators,^{15–17} challenges involved in developing reliable and valid indicators of mortality, accessibility of administrative and clinical databases, and using sample sizes large enough to detect differences in hospital nursing characteristics that lead to differences in mortality rates.¹⁸ The purpose of this article is to begin to address the first challenge identified concerning lack of theory linking the outcome of mortality with its determinants. An emerging theory of the nursing-related determinants of hospital mortality is described.

Brief overview of research contributing to knowledge of determinants of mortality

To date, there is evidence of the following nursing-related hospital characteristics being associated with lower mortality for hospitalized patients: organizational commitment to nursing educational support programs,¹⁹ effective nurse-physician communication,^{19,20} higher proportion of RNs or what is also referred to as a richer RN skill mix,^{7,11,12,21,22} more RN hours per patient day or admission,^{9,11,13,22,23} more years of nurse experience in the clinical unit,⁷ and professional nursing practice work environments characterized as having more nurse autonomy and more nurse control over the practice setting.²⁴ Although these findings establish the existence of relationships between several nursing-related hospital characteristics and mortality, few of these studies were reported within the context of a hypothesized theoretical model. Until 2002, one notable exception was work by Aiken and colleagues^{25–29} at the University of Pennsylvania. They proposed that nurses and nursing care affect mortality by their direct actions and by their influence over the actions of others. They hypothesized that hospitals with organizational models that promote greater nurse autonomy, more nurse control over the practice setting, and better relationships between nurses and physicians will yield better mortality outcomes. Such environments are typically referred to as strong professional practice work environments.

They further suggested that organizations with strong professional practice environments expect nurses to practice the skills of their profession. This results in congruence between the authority of nurses and their high levels of responsibility. In such environments, nurses routinely exercise their professional judgment as they provide ongoing care to patients. Because RNs engage in ongoing patient surveillance, they are best positioned to effectively identify (and prevent) patient complications that could lead to unnecessary patient death if left not assessed or unresolved.

The original mortality model

Model premises

In 2001, Aiken's model related to mortality was extended to include other determinants of mortality for acutely ill hospitalized patients.^{7,22,30} Tourangeau and colleagues proposed, tested, and refined a simple linear model of determinants of mortality, as shown in Figure 1. Table 1 contains descriptions of conceptual and operational definitions for model concepts. Thirty-day mortality was chosen as the mortality outcome of interest and was defined as patient death within 30 days after admission to acute care hospital, whether death occurred while the patient was in hospital or after being discharged from hospital. Thirty-day mortality is regarded as an important quality outcome as it measures the full impact of hospitalization without introducing many other competing risks.^{27,34}

The overall model premise is that hospitals have unique mixes of structures and processes that affect patient outcomes and that a subset of these hospital characteristics reflects the organizational structures and processes associated with the delivery of nursing care to patients. As the need for nursing care is one of the most important reasons for patient hospitalization, it is reasonable to hypothesize that how nursing care is structured and delivered affects important patient outcomes such as death

Figure 1: Original mortality model

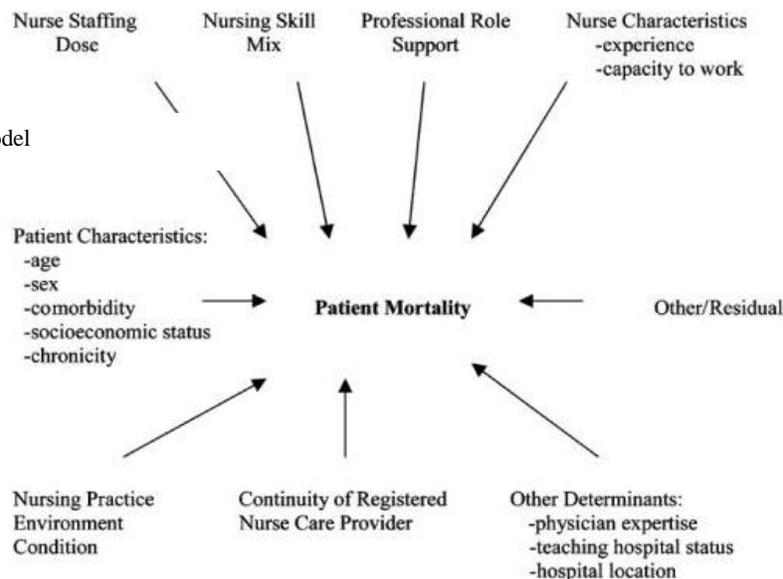


Table 1: Mortality model predictors

Concept	Description	Indicator
Nurse staffing dose	Average number of hours of nursing care provided by all nursing care providers per a patient-related unit of output	Total inpatient clinical nursing worked hours/sum of case weights for each hospital (over same period)
Nursing skill mix	Strength of the RN dose in each hospital area	RN earned hours (for that clinical area or functional centre)/all nursing staff earned hours (RN+ RPN + unlicensed assistive personnel)
Professional role support	The availability of in-hospital human resources (eg, clinical nurse specialists) to provide education and role modeling support for nursing staff who provide direct patient care	Mean hospital response (for that clinical area) to nurse survey item “The opportunity for staff nurses to consult with clinical nurse specialists or expert nurse clinicians/educators.”
Nurse experience	Average ears of RN experience on current clinical unit	Mean hospital response (for that clinical area) to nurse survey item “How many years have you worked as a RN or registered practical nurse?”
Nurse capacity to work	Degree to which nurses feel physically, psychologically, and emotionally capable of attending work consistently	Mean hospital response (for that clinical area) to nurse survey item “Over the past 3 months, how many scheduled shifts did you miss work?”
Nursing practice environment condition	Degree to which nurses’ work environments are professional practice environments that support nurse autonomy, nurse control over the practice setting, and effective nurse-physician collaboration	Mean hospital score (for that clinical area) on the Canadian Practice Environment Index of the Revised Nurse Work Index ³¹
Nurse burnout	Nurse level of emotional exhaustion	Mean hospital score (for that clinical area) on the emotional exhaustion subscale of the Maslach Burnout Inventory ³²
Continuity of RN care provider	Capability of hospital to provide continuity of nursing care providers to patients	Total full-time “worked hours” for RNs and RPNs in the particular clinical area or functional centre/all (full-time + part-time + casual) “worked hours” for RNs and RPNs in that clinical area or functional centre
Nurse satisfaction	Degree to which nurses report satisfaction with their current hospital job	Mean job satisfaction scores (in clinical area) on subscales of the McCloskey/Mueller Satisfaction Scale ³³
Teaching hospital status	Designated status of a hospital as either teaching or nonteaching	Dichotomous indicator in which hospital is designated as teaching by the Ontario Council of Teaching Hospitals
Hospital location	Location of a hospital in an urban or nonurban area	Dichotomous indicator in which hospital is designated as urban if located in urban area with at least 100,000 population
Physician expertise	Level of expertise of physicians with specialized knowledge and skills who care for study patients	Proportion of sample patients in each hospital who has a specialist (as opposed to a general practitioner) as the most responsible physician related to that patient’s most responsible diagnosis (the diagnosis contributing most to the patient’s length of stay)

and survival. Mortality is a sensitive measure of quality of care among hospitals because some hospitals are better able than others to effectively and promptly detect and intervene with serious patient complications that could lead to death. Through rapid detection of complications as well as swift and effective treatment of these complications, unnecessary patient death is prevented. Because of their continuous care at the bedside, the presence and actions of professional RNs with appropriate assessment, critical thinking, and judgement skills are vital to both early detection and prompt intervention of patients with serious complications.

Main concepts and their proposed relationships

In the original mortality model, it was hypothesized that in addition to patients' own characteristics, the following hospital factors each have a direct effect on 30-day postadmission patient mortality: amount or dose of nurse staffing, skill mix of nursing staff, amount of professional role support available for nurses, nurse experience in the clinical unit, nurse capacity to work, continuity of RN care provider, condition of the nursing practice environment, physician expertise, teaching hospital status, and hospital location (Fig 1). The mortality model predicts direct

relationships of each predictor or determinant with 30-day mortality.

Based on previous research, it had been hypothesized that hospitals providing a larger dose of nursing care consisting of a greater amount of nursing care hours 23,35,36 and employing a richer nursing skill mix consisting of a larger proportion of RNs to provide patient care 21 have structural components enabling more effective patient surveillance systems. These richer nursing skill mix surveillance systems more quickly and accurately detect early signs of serious patient complications and rapidly initiate and engage in responses that prevent patient death. Also, based on rational thinking by expert nurses, it was hypothesized that 2 RN characteristics were associated with patient mortality: number of years of RN experience in the clinical unit and the overall capacity of RNs to provide care. Nurses with more experience within their clinical units have developed specialized knowledge and skills for patient care in that particular clinical speciality and are, therefore, better prepared to assess and recognise serious patient complications more effectively than nurses with less experience in that clinical area. Increased experience in a clinical unit also facilitates the development of stable relationships among health team members. Further, hospitals with nurses who have enhanced capacity to work (less number of scheduled shifts of work missed) were hypothesized to have lower patient mortality. Nurses who feel physically, psychologically, and emotionally capable to attend work on a consistent basis will be prepared to act quickly and effectively to detect patient complications and treat these complications to prevent patient death.

This model also postulated that 2 other nursing-related hospital components affect patient mortality: the condition of the nursing practice environment 24 and the degree to which continuity of care is supported. Key issues related to the condition of the work environment are decision-making control over work and coordination of work effort across workers.³⁷ Two ideal types of work arrangement models addressing these issues have been described in the literature: the bureaucratic model and the professional practice model.³⁸ Bureaucratic practice models are task-oriented and value control exerted through hierarchical authority and adherence to rules. On the other hand, professional practice models are goal-oriented, emphasize qualifications and competence of practitioners, use collegial control systems, and value professional autonomy and control. In environments in which the nature of the work is complex and unpredictable, such as hospital environments, a professional model of practice is believed to be the more effective model to organize and deliver nursing care to achieve better patient and nurse outcomes.³⁹ The condition of nursing practice environments in hospitals reflects the degree to which professional practice models of nursing care exist. Hospitals that promote and have high levels of nurse autonomy and nurse control over the practice setting, as well as effective relationships among nurses and physicians are considered to have professional models organizing nursing care. The more these elements exist in a hospital environment, the more “professional” is the practice environment. While others have chosen to use several separate indicators to operationalize the strength and condition of the professional nursing practice environment (ie, the amount of nurse autonomy, control over the

practice situation, and effective nurse-physician collaboration), one composite measure of the professional practice environment was chosen for use in this model on the basis of the results of psychometric testing of the Revised Nursing Work Index, the tool commonly used to measure the condition of the practice environment.³¹ Stronger professional practice environments promote nursing surveillance systems for patients to quickly detect serious patient complications that could result in unnecessary patient death. Nurses who work in strong professional practice environments are better prepared to use their assessment, critical thinking and judgement, and interpersonal skills to promptly and accurately detect and treat complications to prevent unnecessary patient death. Second, the degree to which continuity of patient care existed within hospital environments was hypothesized to directly affect patient mortality, based on expert nurse opinion. It was hypothesized that hospitals with organizational systems that promote continuity or consistency of RN care providers would have lower mortality rates. Consistent RN teams working in clinical areas are better positioned to develop communication and collaborative skills that promote early detection of serious patient complications, thereby preventing unnecessary patient death.

Based on previous research, it was also hypothesized that greater amounts of professional role support provided to nurses promote early detection of serious complications and prevention of unnecessary patient death.¹⁹ Professional role support refers to hospital nursing personnel such as clinical nurse specialists and nurse educators whose primary roles are to assist nursing staff to implement knowledge, skills, and attitudes that maximize nurse role performance. Professional role support promotes competence and competence is a necessary precursor to nurse autonomy.⁴⁰ RN competence is developed, at least in part, through ongoing professional role support from personnel such as clinical nurse specialists and educators.⁴¹

Three additional hospital variables were included in the original mortality model because of evidence of their relationships with hospital mortality rates. These hospital-related factors have empirically been shown to affect hospital mortality: physician expertise,^{21,22,35} teaching hospital type,^{42–46} and hospital location or setting.^{23,42,43,45} Although the purpose of this model was to describe and explain nursing-related determinants of mortality, it would have been inappropriate not to include other known nonnursing predictors. Omitting these predictors from the mortality model could lead to erroneous conclusions about the impact of nursing-related determinants when testing the model.

When the mortality model was tested using traditional multiple regression modeling techniques, evidence was found supporting direct relationships of 3 model predictors with 30-day risk-adjusted mortality: nursing skill mix, years of nurse experience on the clinical unit, and nurse capacity to work.^{7,22} This model explained 32% of the variation in risk-adjusted 30-day postadmission mortality rates in a sample 47,000 discharged patients with an acute medical diagnosis in 75 Ontario, Canada, acute care hospitals. It was concluded that the original mortality model was overly simplistic and did not reflect complex mechanisms by which predictors influence mortality for hospitalized patients. It was noted that some model concepts and

their indicators covaried. It was also speculated that some predictors exert indirect effects on mortality so that their effects are mediated through other predictor variables. This led to the revision of the mortality model.

The revised model: Nursing and other determinants of hospital mortality

Model premises

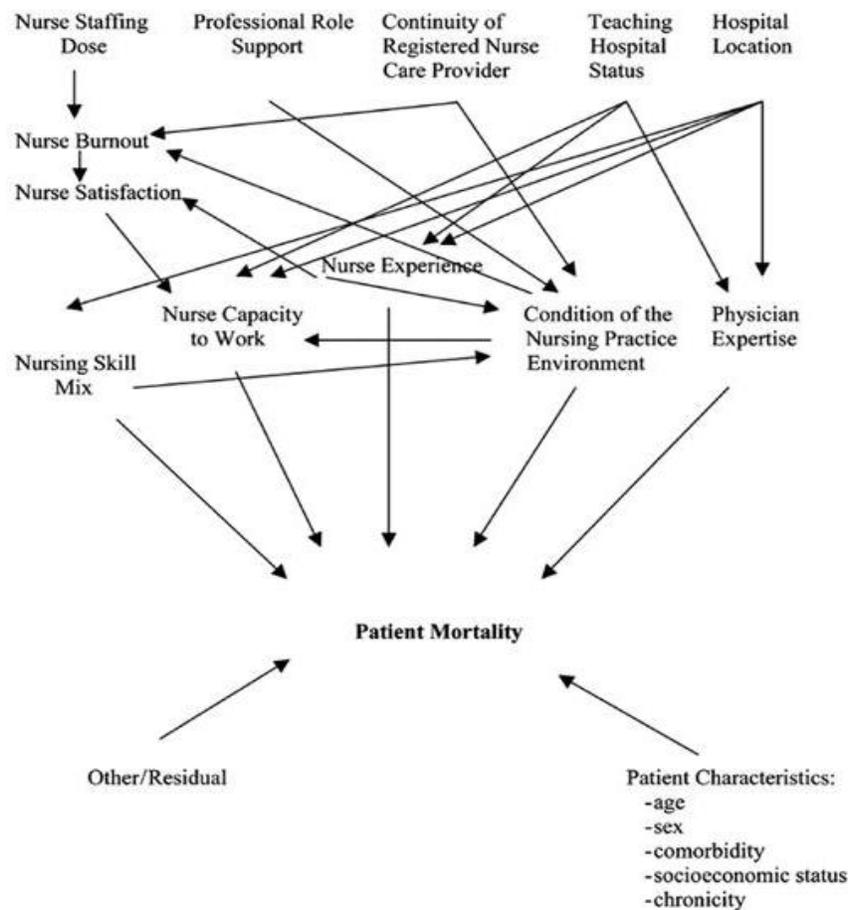
On the basis of initial testing of the mortality model, related research, and theorizing, the mortality model was revised, as shown in Figure 2. Conceptual and operational descriptions for model predictors are shown in Table 1. This revised model hypothesizes more complex relationships among predictors as well as both direct and indirect relationships of predictors with the mortality outcome. Although some model concepts are hypothesized to have either direct or indirect effects on mortality, other concepts (ie, nursing skill mix and condition of the nursing practice environment) are hypothesized to have both direct and indirect effects on mortality. The overall premise is

know there is wide variation in risk-adjusted mortality rates for similar groups of patients across hospitals, some hospitals are better able to effectively detect and intervene with serious patient complications that if left unresolved or addressed too late will result in unnecessary patient death. As nurses provide the majority of ongoing care to hospitalized patients, including ongoing patient surveillance, it is reasonable to hypothesize that hospital nursing care characteristics affect patient mortality.

Main concepts and their proposed relationships

The most significant revisions to the model include hypothesizing that the following 5 predictors exert indirect effects on patient mortality, which are then mediated by and exert their effects through other model predictor variables: nurse staffing dose, amount of professional role support available to clinical nurses, continuity of RN care provider, teaching hospital status, and hospital location. A second important revision in the model is the addition of 2 indirect predictors of mortality: nurse burnout and nurse satisfaction. On the basis of recent research⁹ and expert nurse opinion, these 2 variables were included in the revised “nursing and other determinants of hospital mortality model” because of their expected relationships with nurse

Figure 2. Revised model: Nursing and other determinants of hospital mortality.



similar in the revised “nursing and other determinants of hospital mortality model” as are in the original model. A subset of hospital characteristics affects patient mortality. Because we

staffing dose, nurse capacity to work, continuity of RN care provider, and the condition of the practice environment. Here, only explanations of nursing-related components of the revised

model are discussed. Hypothesized indirect impacts of teaching hospital status and hospital location, as well as the direct effects of physician expertise on mortality are included in the model to reflect their importance as determinants of mortality from previous research but are not further discussed in this article.

Previously, a moderately strong inverse correlation ($r = -0.47$, $P < .0001$, $N = 75$) was found between nurse staffing dose and nursing skill mix.⁷ As the dose of nursing care increased, the proportion of RNs in that nursing dose decreased, leading to the conclusion that both a higher dose of nursing staff and a richer RN skill mix may not both lead to lower mortality. Instead, it is proposed that nurse-staffing dose indirectly affects mortality. It is hypothesized that a higher nurse-staffing dose will result in increased RN feelings of burnout. In hospitals with higher nurse staffing doses, there are generally more “pairs of hands” providing care to patients but there are usually fewer professional RNs within the mix of nursing staff. In such teams of nurses, those RN team members carry a larger burden of patient surveillance care that leads to nurse burnout and higher levels of emotional exhaustion. It is further hypothesized that higher nurse burnout causes lower nurse satisfaction. Nurses who are emotionally exhausted are less likely to report being satisfied with their jobs. Less job satisfaction, in turn, results in lower nurse capacity to work, as reflected by nurses missing more shifts or tours of duty.

In the revised “nursing and other determinants of hospital mortality model,” it is postulated that more professional role support provided to clinical nursing staff leads to higher nurse-assessed condition of the practice environment. Role support personnel such as nurse educators and clinical nurse specialists assist clinical nursing staff to be autonomous, to exert control over their work settings, and to interact effectively with health team members, particularly physicians. It is also hypothesized that more continuity of RN care providers leads to higher nurse-rated condition of the nursing practice environment and lower nurse-reported feelings of burnout. A consistent team of RNs in the clinical area facilitates effective communication and collaboration patterns within the health team that enhances a professional practice environment and leads to nurses experiencing lower levels of work-related burnout.

Nursing skill mix is hypothesized to have both direct and indirect effects on patient mortality. A richer RN skill mix is believed to affect the condition of the nursing practice environment. A higher proportion of RNs promote a practice environment characterized by higher nurse autonomy, more nurse control over the practice setting, and better nurse-physician collaboration. Because of evidence of a direct negative relationship between nursing skill mix and lower mortality,⁷ the revised mortality model continues to propose a direct negative relationship between nursing skill mix and mortality. The rationale is similar to that of the rationale in the original mortality model; a richer RN skill mix facilitates increased direct contact time between RNs and their patients, allowing nurses to effectively care for patients, both independently within their scope of practice and collaboratively with other healthcare providers. Hospitals with a richer RN skill mix are better prepared to identify and treat patients with serious complications that might otherwise lead to unnecessary death.

The capacity of nurses to work reflects the degree to which nurses feel physically, psychologically, and emotionally capable to attend work on a consistent basis. Through observation and discussion with nurses, it is proposed that nurses engage in mechanisms to balance their experiences of burnout and satisfaction with their need and desire to work. One of the few available balance mechanisms under control of nurses is their ability to report absent for work. Nurses who reasonably use this mechanism of reporting absent for work may do this to recuperate and regain their capacity to work. In previous work, an unexpected and strong inverse relationship was found between self-reports of shifts missed (a measure of nurse capacity to work) and lower mortality within nonurban area hospitals.⁷ Therefore, in this revised model, it is hypothesized that in hospitals where nurses take more opportunity to recuperate and regain their capacity to work, patients will have lower mortality rates. It is important to qualify this predicted effect with an understanding that nurse capacity to work is affected by feelings of burnout and job satisfaction and that as burnout increases, satisfaction decreases and the number of shifts missed by nurses increases. This is referred to as decreased capacity of nurses to work.

Finally, it is proposed that the stronger the nurses characterize the condition of their work environments as being professional practice environments, the lower will be patient mortality. Evidence of such a direct relationship has been previously established.²⁴ Nurses who practice in environments that support autonomy, that expect nurses to exert control within their own practice setting, and that promote effective nurse-physician relationships are more likely to proactively engage in activities that prevent or detect patient complications, thereby preventing unnecessary patient death.

Future testing and refinement of the revised mortality model

Plans to test and refine the revised “nursing and other determinants of hospital mortality model” are underway. Because of the complexity of the revised model that hypothesizes direct, indirect, and spurious relationships among model variables, structural equation modeling (SEM) will be used to test and refine the model. There are at least 3 advantages of SEM analytic techniques that lead to more precise theory testing: the ability of SEM to incorporate multiple measures of theoretical model constructs, the ability to include estimates of measurement error in the analysis to remove error from the relationships between theoretical constructs, and the production of modification indices that predict the potential change in model fit associated with adding or deleting parameters.^{47,48} In SEM, testing the validity of a theoretical model is accomplished through estimating the “goodness of fit” between the theoretical model and the measurement or observed model. The better the fit between the theoretical model and the observed model, the stronger is the support that the model is an accurate representation of reality.

Use of the model in practice

This emerging theory of the determinants of hospital mortality describes and explains relationships between mortality

and its determinants for acutely ill hospitalized patients. Hypotheses can be deductively derived and tested to further refine the model. Also, others may propose additional determinants of mortality such as specific processes of care or may propose alternate models of the determinants of mortality.

Hospitals and those who care for hospitalized patients are interested in promoting quality care and outcomes for hospitalized patients and promoting patient safety. As one important indicator of hospital quality is mortality, there is strong motivation for hospitals and care providers to understand what hospital characteristics contribute to and prevent unnecessary mortality. Efforts to prevent unnecessary patient death clearly fall within the domain of promoting patient safety. As evidence is developed providing support for or refinement of the emerging theory, plans can be made and implemented to modify various determinants to target reductions in patient mortality. For example, a hospital may set its own acceptable target mortality rate on the basis of benchmarking activities. Using the model and findings from model testing, a hospital can explore which hospital characteristics can be modified to reach target rates. To determine which hospital characteristics should be modified, consideration would be given to understanding the current nursing-related hospital characteristics and the findings from model testing that specify the exact nature and total impact of each determinant on mortality for hospitalized acutely ill patients. A hospital might plan to adjust nursing skill mix or strengthen the condition of the nursing practice environment to achieve target mortality rates. Findings from model testing could be used to determine the amount of change needed in hospital characteristics to reach target mortality rates.

Finally, description of this model can lead to increased scholarly discussion about further development of models of determinants of mortality and unnecessary patient death. By broadening our understanding of the determinants of mortality for hospitalized patients, this knowledge will add to disciplinary knowledge that is useful to promote patient safety and prevent unnecessary patient death. This model and its further refinement leads to better understanding of the impact that nurses and nursing care have on important quality outcomes such as preventing unnecessary patient death.

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