Nurse Staffing and Work Environments: Relationships with Hospital Level Outcomes

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KEY IMPLICATIONS FOR DECISION MAKERS

- While it is important to acknowledge that both death and readmission to hospital are unpreventable outcomes for some patients, persistent wide variations in risk-adjusted rates (adjusted for the impact of patients' own characteristics) across hospitals suggest that some portion of these outcomes are in excess and are preventable.

- The evidence resulting from this study has significant and immediate practical use for managers and policy developers in the hospital sector of health care.

- Hospital decision makers and policy developers can use the evidence from this study to make plans and decisions to minimize 30-day mortality for acute medical patients.

- To minimize unnecessary acute medical patient death, medical unit staffing should:
  - Maximize the proportion of RNs in their nursing staff mix.
  - Hire and retain baccalaureate prepared nurses in their nursing staff mix.
  - Provide adequate staffing to deliver safe and effective care.
  - Consistently use care maps or protocols to guide patient care.

- Conclusions cannot be drawn about the determinants of unplanned readmission to hospital as analytic models had overall statistically non-significant p-values.

EXECUTIVE SUMMARY

Context

Hospital mortality and readmission rates are used as indicators of the quality of hospital care. The rationale for their use is that some hospitals have structures and processes that minimize unnecessary patient deaths and readmissions better than other hospitals. The challenge is to discover and explain what facet of hospital structures and processes affect patient readmission and deaths. Historically, the study of determinants of 30-day mortality and readmission rates for hospitalized patients has focused on medical processes of care and patients' own characteristics. Little focus has been placed on studying nursing related structures and processes that might influence hospital mortality and readmission rates. Since nurses provide most of the on-going care for hospitalized patients, we proposed that the structures and processes of nursing care are related to both 30-day mortality and readmission rates for their hospitalized patients. There has been some expressed belief that outcomes such as mortality and readmission are insensitive to nursing care. We disagree and propose that this belief is based on lack of research using appropriate analytical methods.

In Canada, readmission and mortality rates for hospitalized patients vary widely across hospitals even after risk and case mix adjusted methods have been applied to account for differences in patient characteristics and mix (1). Once we control for the impact of patients' own characteristics on the outcomes of mortality and unplanned readmission, what is impacting the outcomes? Why do some hospitals have much lower rates than others? What are these hospitals like or what do they do to attain such low rates? Tolerating such variations is an enormous financial cost and quality of life burden for hospitals, patients, and society. While it is important to acknowledge that death and readmission to hospital are unpreventable outcomes for some patients, persistent wide variations in risk-adjusted rates across hospitals suggest that some portion of these outcomes are in excess and are preventable. Determining the characteristics of hospitals with lower risk-adjusted 30-day mortality and readmission rates is a necessary first step to develop strategies that modify those characteristics to prevent unnecessary death and readmission.

The purpose of this study was to propose and test theoretical models describing relationships between nursing related and other hospital characteristics with two hospital quality of care indicators: 30-day mortality and 30-day readmission to hospital rates. Nursing related hospital characteristics such as nurse staffing, nurse experience, nursing care delivery system, condition of the nursing practice environment, and nurse response to these environments are included in the theoretical models. These models are attached as Appendices A and B.

Approach

This retrospective study occurred in two phases. In phase one of the project (year 2003), we surveyed all registered nurses and registered practical nurses working in acute medical and

combined medical-surgical units in Ontario teaching and community hospitals. This survey of was completed in conjunction with another study that surveyed surgical and critical care nurses. Nurses were surveyed to collect data about their work environments, their responses to these work environments, selected processes of care, their terms and their conditions of employment. In all, 13,100 medical, surgical and critical care registered and registered practical nurses were surveyed between both studies. We received 8,456 completed surveys for an overall response rate of 65%. The final sample for this study consisted of 3,886 medical nurse respondents working in medical clinical areas in Ontario acute care hospitals.

In phase two of the project (year 2004-2005), we linked nurse survey data with secondary sources of patient and hospital data to test hypothesized models of determinants of mortality and readmission. Patients had to have been discharged from an Ontario teaching or community hospital between April 1, 2002 and March 31, 2003 with a most responsible diagnosis in one of the four following acute medical diagnostic groups: acute myocardial infarction (AMI), stroke, pneumonia, or septicaemia. Patients also had to be an Ontario resident and 20 years of age or older. Patients discharged from pediatric, psychiatric, and small hospitals and those with a pre-existing diagnosis of cancer or HIV were excluded. The final sample consisted of 46,993 patients who were discharged from 75 different adult teaching and community hospitals. Data were analyzed using logistic regression and multiple regression analyses.

Results: Key Study Findings

Determinants of 30-day Mortality

- Using backward regression, 45% of variance in risk and case mix adjusted 30-day mortality rates for hospitals was explained.

- Lower 30-day hospital mortality rates were associated with hospitals that had:

    - Higher proportion of registered nurses in the staff mix (specifically, a 10% increase in the percentage of registered nurses is associated with six fewer deaths for every 1000 discharged patients).

    - Higher proportion of baccalaureate prepared nurses (specifically, a 10% increase in the percentage of baccalaureate prepared nurses is associated with nine fewer deaths for every 1000 discharged patients).

    - Lower dose or amount of nursing staff.

    - Higher proportion of nurse-reported adequacy of staffing and other resources (specifically, a 10% increase in nurse-reported adequacy of staffing and other resources is associated with 17 fewer deaths for every 1000 discharged patients).

- Increased routine use of care maps and other kinds of protocols to guide patient care.
- Higher nurse-reported quality of care.
- Lower nurse-reported adequacy of manager ability and support.
- Higher nurse burnout.

Determinants of 30-day Unplanned Readmission to Hospital

- Regression models exploring determinants of unplanned readmission were less informative and yielded statistically non-significant results.

Nurse Outcomes

- Medical nurses report low overall job satisfaction and being more likely to leave their jobs compared to surgical or critical care nurses. Medical nurses are most satisfied with coworkers and least satisfied with work-related control and responsibility.
- Medical nurses on average report experiencing moderate levels of burnout.
- Medical nurses report weak professional nursing practice environments.

Implications

This project furthers understanding of how nursing-related structures and processes of care affect two hospital quality of care indicators: 30-day acute medical patient mortality and 30-day unplanned readmission. Our analytic models exploring the determinants of 30-day patient mortality were very informative. Hospital decision makers and policy developers can use these results to make evidence-based plans and decisions to minimize 30-day mortality for acute medical patients. Our analytic models exploring determinants of 30-day unplanned readmission to hospital yielded unstable results and do not lead to evidence-based planning.

Based on study findings, we conclude that to minimize unnecessary acute medical patient 30-day death, medical unit staffing should maximize the proportion of RNs in their nursing staff mix, hire and retain baccalaureate prepared nurses in their nursing staff mix, provide adequate staffing to deliver safe and effective care, and consistently use care maps or protocols to guide patient care.

Further Research

Although a respectable 45% of variance in 30-day risk and case mix adjusted hospital mortality rates was explained by eight hospital care structures and processes, 55% of variance remained unexplained. Additionally, our analyses of models exploring determinants of 30-day unplanned readmission to hospital for acute medical patients yielded statistically non-significant results. Clearly, there is much to discover about the determinants of 30-day mortality and readmission rates for hospitalized patients. Future research should also include measures of the environment, including access to in-hospital and outside of hospital care.

RECENT KNOWLEDGE DISSEMINATION ACTIVITIES

Selected Manuscripts

1. Tourangeau, A. E., & Cranley, L. A. (in press). Understanding and strengthening determinants of nurse intention to remain employed. *Journal of Advanced Nursing*.

2. Tourangeau, A. E., & Cranley, L. (2005). Survey measures nurse response to work. *Registered Nurse Journal*, *17*(4), 26.

3. Tourangeau, A. E. (2004). ONA members' views tapped as survey links nursing data with patient outcomes. *Vision*, *31*(4), 7.

4. Tourangeau, A. E., McGillis Hall, L., Doran, D. M., & Petch, T. (2006). Measurement of nurse satisfaction using the McCloskey Mueller Satisfaction Scale. *Nursing Research*, *55*(2), 128-136.

5. Tourangeau, A. E. (2006). Risk and case mix adjusted 30-day mortality rates for acute medical patients in Ontario, Canada hospitals. *Risques & Qualite en Milieu de Soins*, 3(1), 25-31.

6. Tourangeau, A. E., Cranley, L. A., & Jeffs, L. (2006). Impact of nursing on hospital patient mortality: A focused review and related policy implications. *Quality and Safety in Health Care, 15*, 4-8.

7. Tourangeau, A. E., Coghlan, A. L., Shamian, J., & Evans, S. (2005). Registered nurse and registered practical nurse evaluations of their hospital practice environments and their responses to these environments. *Canadian Journal of Nursing Leadership, 18*(4), 54-69.

8. Tourangeau, A. E. (2005). A theoretical model of the determinants of mortality. *Advances in Nursing Science, 28*(1), 58-69.

Selected Presentations

1. Tourangeau A. E. (March 23, 2006). The Ontario hospital nursing workforce. Nursing Leadership Network of Ontario 27th Annual Conference, Toronto, ON.

2. Tourangeau, A., Doran, D., McGillis-Hall, L., O'Brien-Pallas, L., Pringle, D., Tu, J., & Verma, A. (October 27, 2005). Tests of models of mortality and unplanned readmission for acute medical patients in Canadian hospitals. IsQua 22nd International Conference, Vancouver, Canada.

3. Tourangeau, A. E., Doran, D., O'Brien-Pallas, L., Pringle, D., McGillis-Hall, L., Tu, J., & Verma, A. (October 7, 2005). Determinants of 30-day mortality for medical and surgical patients. 2005 National Nursing Administration Conference, University of Arizona College of Nursing, Tucson, Arizona.

4. Tourangeau, A. E. (October 7, 2005). Characteristics of the hospital nursing workforce: Similarities and differences among medical, surgical, and critical care nurses. 2005 National Nursing Administration Conference, University of Arizona College of Nursing, Tucson, Arizona.

5. Tourangeau, A. E., Coghlan, A., & Shamian, J. (February 15, 2005). Understanding similarities and differences between RN and RPN (LPN) members of the nursing workforce in acute care hospitals. Nursing Leadership Conference: Canadian Nurses' Association. Ottawa, ON.

6. Tourangeau, A. E. (June 13, 2005). Mortality and readmission outcomes for patients in Ontario acute care medical and surgical units. Joint Provincial Nursing Committee, Ontario Ministry of Health and Long-term Care, Toronto, ON.

Additional Resources

Study Website: **http://www.nursing.utoronto.ca/atourangeau/**

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FULL REPORT

CONTEXT

Hospital mortality and readmission rates are used as indicators of the quality of hospital care. The rationale for their use is that some hospitals have structures and processes that minimize unnecessary patient deaths and readmissions better than other hospitals. The challenge is to discover and explain what facet of hospital structures and processes affect patient readmission and deaths. Historically, the study of determinants of 30-day mortality and readmission rates for hospitalized patients has focused on medical processes of care and patients' own characteristics. Little focus has been placed on studying nursing related structures and processes that might influence hospital mortality and readmission rates. Since nurses provide most of the on-going care for hospitalized patients, we proposed that the structures and processes of nursing care are related to both 30-day mortality and readmission rates for their hospitalized patients. There has been some expressed belief that outcomes such as mortality and readmission are insensitive to nursing care. We disagree and propose that this belief is based on lack of research using appropriate analytical methods.

In Canada, readmission and mortality rates for hospitalized patients vary widely across hospitals even after risk and case mix adjusted methods have been applied to account for differences in patient characteristics and mix (1). Three categories or sources of variation in health-related outcomes traditionally believed to affect patient and organizational outcomes are: patients' own characteristics, structures and processes of care, and random variation. Environmental factors are commonly considered as a fourth source of variation. Environmental factors include such conditions as patient and hospital location, and availability of health care services. Though we often have little control over patients' own characteristics, we do have significant control over both the structures and processes of care as well as environmental factors. Therefore, we attempt to control for the impact of patients' own characteristics on the outcome of interest so that we can more clearly examine the impact of the structures and processes of care as well as environmental factors on outcomes such as mortality.

There is previous evidence of wide variation in rates across hospitals for outcomes such as 30-day mortality. For example, risk and case mix adjusted 30-day mortality rates for acute medical patients in Ontario hospitals were reported to range between 10.5 and 21.5 percent (1). Once we control for the impact of patients' own characteristics on the outcomes of mortality and unplanned readmission, what is impacting the outcomes? Why do some hospitals have much lower rates than others? What are these hospitals like or what do they do to attain such low rates? Tolerating wide variations is an enormous financial cost and quality of life burden for hospitals, patients, and society. While it is important to acknowledge that death and readmission to hospital are unpreventable outcomes for some patients, persistent wide variations in risk-adjusted rates across hospitals suggest that some portion of these outcomes are in excess and are preventable. Once the impact of patients' own characteristics are controlled for (as they are in our study), the search for other determinants from the other controllable sources of variation becomes imperative to assist us to reduce mortality and unplanned hospital readmission after discharge.

As we face both a shortage of experienced nurses and pressures to tightly manage hospital expenditures, hospitals will consider a variety of strategies to deal with these demands. No evidence-based tools exist to guide decision making about the effects of modifying nursing care structures and processes on hospital outcomes such as mortality and readmission. Once a hospital has established its goal of acceptable mortality and unplanned readmission rates, they will be able to identify what changes in hospital characteristics are required to meet their goals and develop strategies to modify these nursing-related characteristics to achieve goals. Understanding the determinants and their impact on 30-day mortality and readmission rates is a necessary first step to develop strategies that modify those characteristics to prevent unnecessary death and readmission.

The purpose of this study was to propose and test theoretical models describing relationships between nursing related and other hospital characteristics with two hospital quality of care indicators: 30-day mortality and 30-day readmission rates. Nursing related hospital characteristics such as nurse staffing, nurse experience, nursing care delivery system, condition of the nursing practice environment, and nurse response to these environments are included in the theoretical models. These models are attached as Appendices A and B.

APPROACH

A retrospective design guided this study. The unit of analysis is the acute care hospital. All Ontario teaching and community hospitals that existed during 2002-2003 were included in the study. Small, pediatric, and psychiatric hospitals were excluded. The final sample consisted of 75 hospitals: 9 teaching and 66 community hospitals. Ethical approval for this study was obtained from the University of Toronto Health Sciences I Ethics Committee in November 2002 and was renewed yearly thereafter until November 2005.

Primary Research Questions

1. What are the nursing related (and other) determinants of risk-adjusted 30-day mortality for the subpopulation of acute medical patients in a sample of acute care hospitals?

2. What are the nursing related (and other) determinants of risk adjusted 30-day unplanned readmission for the subpopulation of acute medical patients in a sample of acute care hospitals?

Because each team member had questions of interest they wanted addressed to assist decision making in their organization, there were many secondary research questions, such as how nurses describe their work environments and how they respond to their work environments.

Phase One

Hospital Sample

At the time of this study, there were 75 Ontario adult teaching and community hospitals: nine teaching hospitals, 23 large community hospitals, and 43 medium sized community hospitals. Large community hospitals were defined as those discharging at least 15,000 weighted cases during the 2002-2003 year. Medium sized community hospitals were defined as those discharging fewer than 15,000 weighted cases. Small, pediatric, and psychiatric hospitals were excluded from this study.

Nurse Sample

Primary data were collected by surveying all registered nurses and registered practical nurses working in acute medical and combined medical-surgical units in Ontario teaching and community hospitals. Nurses were surveyed to collect data about their work environments, their responses to these work environments, selected processes of care and their terms or conditions of employment. The survey of medical nurses was completed in conjunction with another study that surveyed surgical and critical care nurses. In all, 13,200 medical, surgical and critical care registered and registered practical nurses were surveyed between both studies. We received 8,456 completed surveys for an overall response rate of 65%. The final sample for this study consisted of 3,886 medical nurse respondents working in medical clinical areas in Ontario acute care hospitals.

Table 1 contains descriptions of the nurses who cared for medical patients in the 75 study hospitals. Data elements from the nurse survey were used to develop indicators to test the proposed models of determinants of 30-day mortality and unplanned readmission.

Phase Two

Patient Sample

In phase two of the project, we linked nurse survey data with secondary sources of patient and hospital data to test hypothesized models of determinants of 30-day mortality and readmission. Patients had to have been discharged from an Ontario teaching or community hospital between April 1, 2002 and March 31, 2003 with a most responsible diagnosis in one of the following four acute medical diagnostic groups: acute myocardial infarction (AMI), stroke, pneumonia, and septicaemia. Patients also had to be an Ontario resident and 20 years of age or older. Those discharged from paediatric and small hospitals and those with a pre-existing diagnosis of cancer or HIV were excluded. The final sample consisted of 46,993 patients. Table 2 provides a description of patients in each diagnostic group.

Data Sources

Four data sources were used to calculate risk and case mix adjusted hospital mortality rates:

1. The Ontario Discharge Abstract Database (DAD) 2002-2003: to select patients and their health information as well as to identify readmission events.
2. Statistics Canada 2001 Population files: to assign each patient one of five socioeconomic level indicators.
3. The Ontario Hospital Insurance Plan database: to develop proxy indicators for general preadmission health status.
4. The Ontario Registered Persons Database: to identify dates of death for patients within 30 days of hospital admission.

Three sources of data were used to create hospital level variables to address the research questions:

1. The Ontario DAD (2002-2003)
2. The Ontario Hospital Reporting System (OHRS) file 2002-2003
3. The Ontario Nurse Survey 2003.

All data sources, except the Ontario Nurse Survey 2003, were secondary sources of routinely collected data within Ontario, Canada and were accessed through the Institute for Clinical Evaluative Sciences in Ontario. The Ontario Nurse Survey 2003 database was created as part of this study.

1. Discharge Abstract Database

Patients discharged from Ontario hospitals each have a record in the DAD that is created through chart abstraction. For each patient, this database contains demographic information, codes for most responsible diagnosis and other co-morbidities, and codes for medical procedures received during hospitalization (2). In the DAD, the International Classification of Diseases-Version 10-Canadian is used to code medical diagnoses (3). The DAD was used to select study patients, to identify their health information for risk adjustment, and to identify readmission events.

2. Ontario Hospital Reporting System

The OHRS (formerly known as the Management Information System) file contains activity and financial information for Ontario hospitals. A subset of this file contains nurse staffing information for specific hospital clinical areas in each Ontario hospital. These data were used to develop nursing dose and nursing staff mix indicators.

3. Ontario Nurse Survey 2003

The Ontario Nurse Survey 2003 was sent to more than 13,000 nurses working in Ontario acute care hospitals. All registered nurse and registered practical nurse registrants with the Ontario College of Nurses who reported on their 2003 registration renewal form that they worked in a medical, surgical, or critical care area in an Ontario teaching or community acute care hospital were mailed the Ontario Nurse Survey 2003 to their homes. A reminder card was mailed 10 days after the initial survey was mailed. A second complete survey was mailed to non-responders four weeks after the initial survey was mailed and was followed 10 days later by a reminder card. Nurses were invited to answer questions about their evaluations of patient care quality, burnout, condition of their practice environments, job satisfaction, some processes of care, and demographic information. Three frequently used and well-validated instruments were included in this survey: The McCloskey Mueller Satisfaction Scale, the Revised Nursing Work Index, and the Maslach Burnout Inventory. Documentation of the psychometric properties and scoring procedures for these instruments has been previously published and is not reported here (4-10). Table 3 contains a brief description of each predictor variable for both the 30-day mortality and 30-day unplanned readmission models including operational definitions and data sources. The Institute for Social Research at York University, Toronto, Ontario, managed the mailings of the nurse survey and prepared the initial nurse survey data set.

Analyses

Analyses were completed using SAS® Version 9.1 at the Institute for Clinical Evaluative Sciences in Ontario. Risk adjusted rates for each hospital were developed using the general formula of ratio of actual number of deaths or readmissions divided by predicted number of deaths or readmissions. Logistic regression models were used to calculate predicted numbers of death. Descriptive statistics were generated to summarize hospital level predictors and the outcomes of risk and case mix adjusted 30-day mortality and unplanned readmission rates. To answer the first research question pertaining to 30-day mortality, two multiple regression analysis methods were implemented: one including all variables and the other using the backward method. To answer the second research question pertaining to 30-day unplanned readmission to hospital, two multiple regression analysis methods were implemented: one including all variables and the other using the stepwise method.

Development of Risk and Case Mix Adjusted Rates

We used an indirect standardization method to risk adjust for the impact of patients' own characteristics on the outcomes as well as for the mix of medical patients across hospitals. Standard 30-day mortality and unplanned readmission rates for hospitals were calculated using the general formula of the ratio of actual number of deaths or unplanned readmissions divided by the expected number of deaths or unplanned readmissions per hospital. Numerator values for both mortality and readmission outcomes were calculated thorough the secondary sources of data. Actual mortality information was obtained from the Ontario Registered Persons Database.

Actual readmission information was obtained from the Ontario DAD. Logistic regression models were implemented to develop values of the denominator for both outcomes for each hospital.

Risk factors or patient characteristics that included medical conditions at the time of patient admission to hospital and that were suspected of contributing to patient death were included as predictors in logistic regression models. Several categories of patient characteristics were selected for inclusion in prediction models because they have been shown to be predictors of death for similar groups of patients. These include age and sex, pre-existing co-morbidities, socio-economic status or income level, functional health status, and general health status. Twenty-eight indicators of patient characteristics pre-existing at time of admission were developed for each patient.

Four separate logistic regression models were implemented to calculate expected probabilities of 30-day death for each patient (separate models for AMI, stroke, pneumonia and septicaemia patients). Four separate logistic regression models were implemented to calculate expected probabilities of 30-day unplanned readmission to hospital for each patient (separate models for AMI, stroke, pneumonia and septicaemia patients). Further details of the procedures for calculating risk and case mix adjusted hospital mortality rates for hospitals have been reported elsewhere (1).

RESULTS

Risk and Case Mix Adjusted Rates

A common measure of logistic regression model performance or predictive ability is the c-statistic or area under the receiver-operating curve. Models with c-statistics greater than .70 are considered to have good model discrimination (11). All four logistic regression models for 30-day mortality performed well with c-statistics ranging from .72 to .78. Logistic regression models for 30-day unplanned readmission were less successful and ranged from .59 to .65.

- The mean **crude 30-day mortality rate** for acute medical patients across Ontario teaching and community hospitals was 16.8% and ranged from 8.3 to 24.3%.

- The mean **risk and case mix adjusted 30-day mortality rate** for acute medical patients across Ontario teaching and community hospitals was 17.4% (SD=3.4) and ranged from 9.9 to 28.3%.

- The mean **crude 30-day unplanned readmission to hospital rate** for acute medical patients across Ontario teaching and community hospitals was 15.8% and ranged from 8.2 to 24.6%.

- The mean **risk and case mix adjusted 30-day unplanned readmission to hospital rate** for acute medical patients across Ontario teaching and community hospitals was 16.4% (SD=2.8) and ranged from 9.9 to 22.1 percent.

Determinants of 30-Day Mortality

Descriptive statistics for all variables used in multiple regression analyses for both the 30-day mortality and 30-day unplanned readmission models are reported in Table 4. In the first regression analysis when all predictors were forced to enter the regression model, 50% of variance in 30-day mortality rates was explained (F-value=2.94, p<.001). Table 5 lists the results of this regression model, including parameter estimates, standard error, t-statistics, and p-values. Five of the 19 predictors had probabilities less than .10 including: percentage of registered nurses in nursing staff mix, percentage of baccalaureate prepared nurses, adequacy of nurse staffing and other resources, quality of care, and use of care maps or protocols to guide patient care. Lower 30-day hospital mortality rates for acute medical patients were associated with hospitals that have a higher percentage of registered nurse staffing mix, higher proportion of baccalaureate prepared nurses, higher nurse-reported adequacy of staffing and other resources, higher nurse-reported quality of care, and higher use of care maps or protocols to guide patient care.

Because the results of the first regression model indicated that not all variables added to the explanation of differences in 30-day mortality rates, backward regression was implemented to find a more parsimonious explanation. Forty-five percent of variance in 30-day mortality rates was explained by eight predictors (F-value =6.73, p<.0001). Table 6 lists the results of this model, including parameter estimates, standard error, t-statistics, and p-values. Lower 30-day hospital mortality rates were associated with hospitals that had a higher percentage of registered nurse staffing mix, a higher percentage of baccalaureate prepared nurses, a lower dose or amount of nursing staff, higher nurse-reported adequacy of staffing and other resources, higher use of care maps or protocols to guide patient care, higher nurse-reported quality of care, lower nurse-reported adequacy of manger ability and support, and higher nurse burnout.

Determinants of 30-Day Unplanned Readmission to Hospital

In the first regression analysis when all predictors were forced to enter the regression model, 20% of variance in 30-day unplanned readmission rates was explained (F-value=.97, p=.50). This model yielded statistically non-significant results. Table 7 reports the results of this regression model, including parameter estimates, standard error, t-statistics, and p-values.

Nurse Outcomes

The nursing practice environment for Ontario acute care hospitals continues to be rated poorly by medical nurses. For example, nurses reported their nurse manager ability and support at a mean score of 45.6 out of 100 (SD=27). They reported adequacy of staffing and resources at a mean score of 40.1 out of 100 (SD=24.2). Medical nurses' responses to their work environments were also rated poorly. Medical nurses in acute care hospitals reported low overall job satisfaction at a mean score of 53.6 out of 100 (SD=14.8) and being more likely to leave their jobs compared to surgical or critical care nurses. On average, Ontario nurses working in medical units reported

experiencing moderate levels of burnout (Mean score= 23.8, SD=11.2, range=0-54). Burnout is conceptualized as high scores on emotional exhaustion. Score of 16 or less indicate low burnout, scores between 17 and 26 indicate moderate burnout, and scores 27 or higher indicate high burnout (10). More findings on how Ontario nurses rated their work environments and responses are reported elsewhere (12).

IMPLICATIONS

Findings indicate that structures and processes of hospital care impact 30-day mortality for acute medical patients. Just as hospitals emphasize and strengthen clinical practices such as diagnostic procedures and clinical interventions to minimize mortality and promote other desirable patient outcomes, so should they also focus on strengthening organizational structures and processes of care to minimize 30-day patient death. Our analytic models exploring the determinants of 30-day patient mortality were very informative. Hospital decision makers and policy developers can use these results to make evidence-based plans and decisions to minimize 30-day mortality for acute medical patients.

Our analytic models exploring determinants of 30-day unplanned readmission to hospital yielded unstable results and do not lead to evidence-based planning.

Based on study findings, we conclude that to minimize unnecessary acute medical patient 30-day death, medical unit staffing should maximize the proportion of RNs in their nursing staff mix, hire and retain baccalaureate prepared nurses in their nursing staff mix, provide adequate staffing to deliver safe and effective care, and consistently use care maps or protocols to guide patient care.

In this study, a 10% increase in the percentage of registered nurses in the staff mix was associated with six fewer deaths for every 1000 discharged patients. Hospitals should, therefore, try to maximize their registered nurse staff caring for acute medical patients, which might result in lowering the total numbers of nursing staff available to provide care. Similar findings related to the impact of higher proportions of registered nurse staffing and total dose of staffing have previously been found both with the same patient population (13) as well as with other patient populations in American hospitals (14-20).

Findings also support the current movement toward legislating baccalaureate education as the minimum requirement for registered nurse entry to practice in many Canadian provinces, including Ontario. Hospitals with higher proportions of baccalaureate prepared nurses tended to have lower 30-day mortality rates for acute medical patients. Our findings indicate that a 10% increase in the percentage of baccalaureate prepared nurses was associated with nine fewer deaths for every 1000 discharged patients. This finding is similar to that of Aiken and colleagues with a sample of surgical patients discharged from American hospitals (21). We found a similar

relationship between one indicator of the condition of the hospital nursing practice environment, adequacy of staffing and resources, with mortality to those previously found by Aiken and colleagues with a sample of American magnet hospitals (22). In our study, we found that a 10% increase in nurse-reported adequacy of staffing and other resources was associated with 17 fewer deaths for every 1000 discharged patients.

Findings about the impact of expertise of physicians caring for patients on their mortality rates have been mixed. In this study, we found no evidence of this relationship. This is the same finding observed with the same general patient population in Ontario hospitals four years previously (13). It is important to note that we found a moderate correlation between the percentage of medical specialists caring for study patients (physician expertise) and the percentage of registered nurses in the hospital nursing staff mix ($r=.40$, $p<.001$). Previous research has linked higher levels of physician expertise, measured by the proportion of board certified physicians, with lower mortality rates for patient populations in American hospitals (14-16).

One study finding not previously identified in the research literature is the impact that the routine use of care maps or protocols has on lowering 30-day mortality. We found lower 30-day mortality rates for hospitals in which nurses reported more routine use of care maps and other kinds of protocols to guide patient care. This finding reaffirms the importance of establishing and maintaining best practice protocols or care plans for clinicians to guide patient care throughout hospitalization. This also highlights the importance for hospitals to establish support systems to develop and regularly revise these protocols.

Nurse retention has previously been found as directly related to the nature of the nursing practice environment, nurse job satisfaction, and nurse burnout (19, 23, 24). Hospitals interested in retaining competent nurses should develop, implement and evaluate strategies to improve acute medical nursing practice environments, job satisfaction, and maintain burnout at acceptable levels. Please refer to the upcoming manuscript: Understanding and Strengthening Determinants of Nurse Intention to Remain Employed in the Journal of Advanced Nursing, to understand more about determinants of nurse intention to remain employed in Ontario hospitals (25).

STUDY LIMITATIONS

This study had a number of limitations, including the impact of the quality of data to develop indicators for all concepts. Results found are only as credible as are the data used to produce the results. A recent study by the Canadian Institute for Health Information explored levels of agreement between patient data collected in the DAD with re-abstractions of these data elements from patient records. They found 87% agreement in most responsible diagnosis coding, 75.5% agreement with presence or absence of co-morbid conditions, and 83% agreement with type of co-morbid conditions (2). Other studies of the data quality in the DAD have consistently found under-coding of co-morbidities such as those used in this study to develop risk-adjustment models (26-28).

Other important limitations of this study relate to the potential lack of inclusion of indicators for environmental factors such as the availability of outside of hospital services to support patient recovery in the community. The impact of such factors may be significant but remain unexplored in this study.

FURTHER RESEARCH

It is important to note that although a respectable 45% of the variance in 30-day risk and case mix adjusted hospital mortality rates was explained by eight hospital care structures and processes, 55% of variance remains unexplained. Additionally, our analyses of models exploring determinants of 30-day unplanned readmission to hospital for acute medical patients yielded statistically non-significant results. Clearly, there is much to discover about the determinants of 30-day mortality and readmission rates for hospitalized patients. Future research should also include measures of the environment, including access to in-hospital and outside of hospital care.

KNOWLEDGE DISSEMINATION ACTIVITIES

Publications

Tourangeau, A. E., & Cranley, L. A. (in press, 2006). Understanding and strengthening determinants of nurse intention to remain employed. *Journal of Advanced Nursing*.

Tourangeau, A. E., McGillis Hall, L., Doran, D. M., & Petch, T. (2006). Measurement of nurse satisfaction using the McCloskey Mueller Satisfaction Scale. *Nursing Research*, 55(2), 128-136.

Tourangeau, A. E. (2006). Risk and case mix adjusted 30-day mortality rates for acute medical patients in Ontario, Canada hospitals. *Risques & Qualite en Milieu de Soins*, 3(1), 25-31.

Tourangeau, A. E., Cranley, L. A., & Jeffs, L. (2006). Impact of nursing on hospital patient mortality: A focused review and related policy implications. *Quality and Safety in Health Care, 15*, 4-8.

Tourangeau, A. E., Coghlan, A. L., Shamian, J., & Evans, S. (2005). Registered nurse and registered practical nurse evaluations of their hospital practice environments and their responses to these environments. *Canadian Journal of Nursing Leadership, 18*(4), 54-69.

Tourangeau, A. E., & Cranley, L. (2005). Survey measures nurse responses to work. *Registered Nurse Journal, 17*(4), 26.

Rajah, N., & Tourangeau, A. E. (2005). An undergraduate research experience. *Canadian Nurse, 101(4)*, 12-13.

Tourangeau, A. E. (2005). A theoretical model of the determinants of mortality. *Advances in Nursing Science, 28(1)*, 58-69.

Tourangeau, A. E. (2004). ONA members' views tapped as survey links nursing data with patient outcomes. *Vision*, 31(4), 7.

Tourangeau, A. E., & Tu, J. V. (2003). Developing risk-adjusted 30-day hospital mortality rates. *Research in Nursing & Health, 26*,483-496.

Tourangeau, A. E. (2003). Modeling the determinants of mortality for hospitalized patients. *International Nursing Perspectives, 3*(1), 37-48.

Tourangeau, A. E., Stone, P., & Birnbaum, D. (2003). Hidden in plain view: The importance of professional nursing care. *Clinical Governance: An International Journal, 8(2)*, 158-163.

Presentations

Tourangeau, A. E. (June 18-21, 2006). The mounting evidence of the impact of nursing on mortality for acute medical patients**.** Advancing Technology and Preserving Caring in Nursing: Canadian Nurses' Association Biennial Convention and Annual Meeting, Saskatoon, Canada.

Tourangeau, A. E., McGillis Hall, L., & Doran, D. (April 7, 2006). Psychometric properties of the McCloskey Mueller Satisfaction Scale. 39th Annual Communicating Nursing Research Conference, Albuquerque, New Mexico.

Tourangeau, A. E. (April 7, 2006) Risk adjustment in outcome research. 39th Annual Communicating Nursing Research Conference, Albuquerque, New Mexico.

Tourangeau A. E. (March 23, 2006). The Ontario hospital nursing workforce. Nursing Leadership Network of Ontario 27th Annual Conference, Toronto, ON.

Tourangeau, A., Doran, D., McGillis-Hall, L., O'Brien-Pallas, L., Pringle, D., Tu, J., & Verma, A. (October 27, 2005). Tests of models of mortality and unplanned readmission for acute medical patients in Canadian hospitals. IsQua 22nd International Conference, Vancouver, Canada.

Tourangeau, A. E., Doran, D., O'Brien-Pallas, L., Pringle, D., McGillis-Hall, L., Tu, J., & Verma, A. (October 7, 2005). Determinants of 30-day mortality for medical and surgical patients. 2005 National Nursing Administration Research Conference, University of Arizona College of Nursing, Tucson, Arizona.

Tourangeau, A. E. (October 7, 2005). Characteristics of the hospital nursing workforce: Similarities and differences among medical, surgical, and critical care nurses. 2005 National Nursing Administration Research Conference, University of Arizona College of Nursing, Tucson, Arizona.

Tourangeau, A. E., Coghlan, A., & Shamian, J. (February 15, 2005). Understanding similarities and differences between RN and RPN (LPN) members of the nursing workforce in acute care hospitals. Nursing Leadership Conference: Canadian Nurses' Association. Ottawa, ON.

Tourangeau, A. E. (July 22, 2004). Nurses, their hospital work environments, and their responses to these environments. Nursing Research Congress: Sigma Theta Tau. Dublin, Ireland.

Invited Presentations:

Tourangeau, A. E. (June 13, 2005). Mortality and Readmission Outcomes for Patients in Ontario Acute Care Medical and Surgical Units. Joint Provincial Nursing Committee, Ontario Ministry of Health and Long-term Care, Toronto, ON.

Tourangeau, A. E. (May 31, 2004). Shared leadership in nursing: Shaping work environments for better health outcomes. Keynote Address: The difference you do make to patient outcomes. University of Calgary and the Calgary Health Region, Calgary, AB.

Tourangeau, A. E. (May 12, 2004). Distinguished Speaker - Nursing knowledge and commitment at work: Nursing Week Celebration Dinner. The Difference You Do Make! Trillium Health Centre, Mississauga, ON.

Tourangeau, A. E. (December 3, 2003). Discussant: Regulatory issues and challenges – Patient safety: Developing the right staff mix. Canadian Nurses' Association, Ottawa, Ontario

ADDITIONAL RESOURCES

Further information about the study is available at:

Study Website: **http://www.nursing.utoronto.ca/atourangeau/**

Principal Investigator Email: **ann.tourangeau@utoronto.ca**

REFERENCES

1. Tourangeau, A. E., & Tu, J. V. (2003). Developing risk-adjusted 30-day hospital mortality rates. *Research in Nursing & Health, 26,*483-496.

2. Canadian Institute for Health Information. Discharge abstract database (DAD) / CMG/Plx data quality re-abstraction study. Ottawa, ON: Author; 2003.

3. Canadian Institute for Health Information. Canadian coding standards for ICD-10-CA and CCI 2003. Ottawa, ON: Author; 2003.

4. Tourangeau, A.E., McGillis Hall, L., Doran, D.M., & Petch, T. (2006). Measurement of nurse satisfaction using the McCloskey Mueller Satisfaction Scale. *Nursing Research,* 55(2), 128-136.

5. McCloskey, J. C. (1974). Influence of rewards and incentives on staff nurse turnover rate. *Nursing Research, 23,* 239-247.

6. McCloskey, J. C., & McCain, B. E. (1987). Satisfaction, commitment and professionalism of newly employed nurses. *Image: Journal of Nursing Scholarship,19*(1), 20-24.

7. Mueller, C. W., & McCloskey, J. C. (1990). Nurse job satisfaction: A proposed measure. *Nursing Research, 39,* 113-117.

8. Lake, E. T. (2002). Development of the practice environment scale of the nursing workload index. *Research in Nursing & Health, 25,*176-188.

9. Estabrooks, C. A., Tourangeau, A. E., Humphrey, C. K., Hesketh, K. L., Giovannetti, P., Thomson, D., Wong, J., Acorn, S., Clarke, H., & Shamian, J. (2002). Measuring the hospital practice environment: A Canadian context. *Research in Nursing & Health, 25,* 256-268.

10. Maslach, C., Jackson, S., & Leiter, M. (1996). *Maslach burnout inventory manual* (3rd ed.). Palo Alto, CA: Consulting Psychologists Press.

11. Hosmer, D. W., & Lemeshow, S. (2000). *Applied logistic regression*. (2nd Ed.). New York: John Wiley & Sons.

12. Tourangeau, A. E., Coghlan, A. L., Shamian, J., & Evans, S. (2005). Registered nurse and registered practical nurse evaluations of their hospital practice environments and their responses to these environments. *Canadian Journal of Nursing Leadership, 18*(4), 54-69.

13. Tourangeau, A. E., Giovannetti, P., Tu, J. V., & Wood, M. (2002). Nursing-related Determinants of 30-day Mortality for Hospitalized Patients. *Canadian Journal of Nursing Research, 33*(4), 71-88.

14. Hartz, A. J., Krakauer, H., Kuhn, E. M., Young, M., Jacobsen, S. J., Gay, G., Muenz, L., Katzoff, M., Bailey, R. C., & Rimm, A. A. (1989). Hospital characteristics and mortality rates. *New England Journal of Medicine, 321*,1720-1725.

15. Manheim, L. M., Feinglass, J., Shortell, S. M., & Hughes, E. F. (1992). Regional variation in Medicare hospital mortality. *Inquiry, 29*, 55-66.

16. Farley, D. E., & Ozminkowski, R. J. (1992). Volume-outcome relationships and in hospital mortality: the effect of changes in volume over time. *Medical Care, 30*, 77-94.

17. Schultz, M.A. (1997). The Associations of Hospital Structure and Financial Characteristics to Mortality and Length of Stay in Patients with Acute Myocardial Infarction. Los Angeles, CA: University of California.

18. Needleman, J., Buerhaus, P., Mattke, S., Stewart, M., & Zelevinsky, K. (2002). Nurse-staffing levels and the quality of care in hospitals. *New England Journal of Medicine, 346*, 1715-1722.

19. Aiken, L. H., Clarke, S.P., Sloane, D. M., Sochalski, J., & Silber, J. H. (2002). Hospital nurse staffing and patient mortality, nurse burnout, and job satisfaction. *JAMA, 288*, 1987-1993.

20. Blegen, M. A., Goode, C. J., & Reed, L. (1998). Nurse staffing and patient outcomes. *Nursing Research, 47*, 43-50.

21. Aiken, L. H., Clarke, S. P., Cheung, R. B., Sloane, D. M., & Silber, J. H. (2003). Educational levels of hospital nurses and surgical patient mortality. *JAMA, 290*, 1617-1623.

22. Aiken, L. H., Smith, H. L., & Lake, E. T. (1994). Lower Medicare mortality among a set of hospitals known for good nursing care. *Medical Care, 32(8),* 771-787.

23. Sourdif, J. (2004). Predictors of nurses' intent to stay at work in a university health center. *Nursing and Health Sciences,* 6, 59-68.

24. Shader, K., Broome, M.E., Broome, C.D., West, M.E. & Nash M. (2001). Factors influencing satisfaction and anticipated turnover for nurses in an academic medical center. *Journal of Nursing Administration,* 31(4), 210-217.

25. Tourangeau, A. E., & Cranley, L. A. (in press. 2006). Understanding and strengthening determinants of nurse intention to remain employed. *Journal of Advanced Nursing*.

26. Austin, P. C., Tu, J. V., Alter, D. A., Naylor, C. D. (2005). The impact of under coding of cardiac severity and co morbid diseases on the accuracy of hospital report cards. *Medical Care, 43*(8), 801-809.

27. Lee, D. S., Donovan, L., Austin, P. C., Gong, Y., Liu, P. P., Rouleau, J. L. et al. (2005). Comparison of coding of heart failure and co morbidities in administrative and clinical data for use in outcomes research. *Medical Care, 43*(2), 182-188.

28. Quan, H., Parsons, G. A., & Ghali, W. A. (2002). Validity of information on co morbidity derived from ICD-9-CCM administrative data. *Medical Care, 40*(8), 675-685.

Table 1: Description of Nurse Sample

	Teaching Hospitals	Community Hospitals	All Hospitals
Mean age (SD)	41.9 (10.0)	44.3 (9.6)	43.7 (9.8)
Mean years experience as nurse (SD)	15.9 (10.2)	18.5 (10.3)	17.8 (10.3)
Proportion female	94.6%	97.3%	96.6%
Proportion of registered nurses	94%	69%	75%

Note. There are statistically significant differences on all the above nurse characteristics between teaching and community hospital nurses ($p<.001$). Teaching hospital nurses are younger and have less career experience. There are also higher proportions of male nurses and lower proportions of registered practical nurses (versus registered nurses) in teaching hospitals.

Table 2: Description of Patient Sample

	AMI	Stroke	Pneumonia	Septicaemia	All Sample
# Cases	19,475	11,160	13,433	2,925	46,993
Mean age (SD)	69 (14)	74 (12)	72 (17)	70 (16)	71 (15)
Proportion male	63%	50%	49%	48%	55%
Crude Mortality Rate (SD)	13%	21%	16%	31%	16.9%

Note. SD = standard deviation

Table 3: Description of Predictor Variables for the 30-Day Mortality and 30-Day Unplanned Readmission Models

Concept	Operational Definition	Source of Data
Dose of nursing staff	Total inpatient clinical nursing worked hours (all nurse categories) / sum of resource intensity weights for hospital (for 2002-03)	OHRS / DAD
Nursing staff mix: % RNs in nursing staff mix	For medical hospital areas, % inpatient RN earned hours / all nursing staff earned hours (RN + RPN + UAP) (for 2002-03)	OHRS
Continuity of care: % of full-time nursing staff	For medical hospital areas, % RN full-time earned hours / all RN earned hours (full-time + part-time + casual) (for 2002-03)	OHRS
Unit experience: Years on current clinical unit	Mean hospital nurse-reported years experience on current medical unit	Nurse Survey 2003
Education level: % of baccalaureate prepared nurses	For medical hospital areas, % nurses in hospital reporting having a baccalaureate degree or higher educational preparation	Nurse Survey 2003
Overall self-reported health level	Hospital mean medical nurse response on survey item asking about level of health 5-point scale (standardized to be out of 100)	Nurse Survey 2003
Nurse capacity to work: Missed hours	Mean hospital response for medical nurses to item asking how many 8/10/12 hour shifts missed from work in previous 3 months (calculated in hours)	Nurse Survey 2003
Nursing practice environment: Nurse-physician relationships	Mean hospital response for medical nurses on 3-item subscale of NWI asking nurses to rate work relationships with physicians on 4-point scale (standardized to be out of 100)	Nurse Survey 2003
Nursing practice environment: Manager ability & support	Mean hospital response for medical nurses on 4-item subscale of NWI asking nurses to rate their manager ability and support on 4-point scale (standardized to be out of 100)	Nurse Survey 2003

Concept	Operational Definition	Source of Data
Nursing practice environment: Adequacy of staffing & other resources	Mean hospital response for medical nurses on 4-item subscale of NWI asking nurses to rate adequacy of staffing and access to other patient care resources on 4-point scale (standardized to be out of 100)	Nurse Survey 2003
Nursing practice environment: Teamwork in care delivery	Dichotomous variable reflecting care delivery pattern (value=0 if majority of nurses described providing patient care as a team; value =1 when majority of nurses report using total patient care)	Nurse Survey 2003
Overall nurse job satisfaction	Mean hospital response on global job satisfaction scale consisting of 31-items MMSS on 5-point scale (standardized to be out of 100)	Nurse Survey 2003
Nurse reported quality of care on unit	Percentage of medical nurses in hospital rating quality of care on unit as good or very good on 4-point scale (standardized to be out of 100)	Nurse Survey 2003
Nurse burnout	Mean hospital score for medical nurses on 9-item emotional subscale of MBI (low burnout = 0-16; moderate burnout = 17-26; high burnout is >26)	Nurse Survey 2003
Availability of professional role support	Mean hospital score on medical nurse agreement with item about availability of clinical nurse specialists or other experts on 4-point scale (standardized to be out of 100); higher score = more availability	Nurse Survey 2003
Use of care maps / protocols	Mean hospital score of nurse-reported routine use of care maps / protocols to assist with patient care management on 5-point scale (standardized to be out of 100); higher score = more routine use	Nurse Survey 2003
Physician expertise: % of specialist prepared	Percentage of study patients in each hospital with a specialist identified as most responsible physician for most responsible diagnosis	DAD
Patient capacity to manage own care at discharge	Percentage of nurses in each hospital who report being confident or very confident that patients can manage their own care after discharge	Nurse Survey 2003
Discharge preparation focus	Level of nurse agreement in each hospital that patient preparation for discharge is a focus on a 4-point scale (standardized to be out of 100)	Nurse Survey 2003

Concept	Operational Definition	Source of Data
Hospital type / location: Outside urban area hospital	Dichotomous variable identifying hospitals located outside urban areas with populations greater than 100,000 (0=no, 1=yes)	Statistics Canada 2001 Population Files
Hospital type / location: Urban non-teaching hospital	Dichotomous variable identifying non-teaching hospitals located in urban areas with populations greater than 100,000 (0=no, 1=yes)	Statistics Canada 2001 Population Files
Hospital type / location: Teaching hospital (left out of models as reference group)	Dichotomous variable identifying hospital as teaching hospital designated by Ontario Council of Teaching Hospitals (0=no, 1=yes)	Ontario Council of Teaching Hospitals

Notes.
OHRS = Ontario Hospital Reporting System
DAD = Discharge Abstract Database
RN = Registered Nurse
RPN = Registered Practical Nurse
UAP = Unlicensed Assistive Personnel
NWI = Revised Nursing Work Index
MMSS = McCloskey Mueller Satisfaction Scale
MBI = Maslach Burnout Inventory

Table 4: Descriptive Statistics for All Variables Used In Multiple Regression Analyses for the 30-Day Mortality and 30-Day Unplanned Readmission Models

Variable	Mean (SD)	Number / % Hospitals	Range
Risk and case mix adjusted 30-day hospital mortality rate	17.4 (3.4)		9.9-28.3
Dose of nursing staff	36.2 (9.3)		25.6-106.3
Nursing staff mix: % RNs in staff mix	66.3 (13.5)		36.1-100.0
Continuity of care: % full-time nursing staff	61.1 (12.5)		34.6-92.2
Unit experience: Nurses' years on current clinical unit	8.1 (2.4)		3.5-14.5
Education level: % baccalaureate prepared nurses	12.6 (10.8)		0.0-61.5
Overall nurse self-reported health level (out of 100)	67.9 (3.8)		60.4-79.2
Nurse capacity to work: Missed hours	15.1 (7.4)		4.9-49.8
Nursing practice environment: Nurse-physician relationships (out of 100)	59.5 (6.3)		39.8-75.6
Nursing practice environment: Manager ability & support (out of 100)	45.3 (9.7)		22.7-62.4
Nursing practice environment: Adequacy of staffing & other resources (out of 100)	40.3 (7.3)		19.3-52.8
Nursing practice environment: Teamwork in care delivery	--	52 / 69.3%	--
Overall nurse job satisfaction (out of 100)	53.9 (4.2)		44.1-66.4
Nurse reported quality of care on unit (out of 100)	96.3 (4.9)		79.4-100.0
Nurse burnout	23.2 (3.1)		17.2-30.1
Availability of professional role support (out of 100)	47.5 (14.8)		11.6-75.8
Use of care maps / protocols (out of 100)	62.8 (12.1)		29.2-85.1

Variable	Mean (SD)	Number / % Hospitals	Range
Physician expertise (% specialist prepared)	51.1 (35)		0.0-100.0
Patient capacity to manage own care at discharge	49 (12.8)		21.4-80.9
Discharge preparation focus	69.8 (5.8)		57.5-82.6
Hospital type / location: Outside urban area hospital	--	38 / 50.7%	--
Hospital type / location: Urban non-teaching	--	28 / 37.3%	--
Hospital type / location: Teaching hospital (left out of regression models as reference group)	--	9 / 12%	--

Note. SD = standard deviation.

Table 5: Multiple Regression Results When All Variables are Forced to Enter Model Together: 30-Day Mortality Model

Variable	Parameter Estimate	Standard Error	t-value	p-value
Intercept	47.04	19.01	2.47	.017
Dose of nursing staff	.06	.05	1.29	.202
Nursing staff mix: % RNs in staff mix	-.07	.03	-2.01	.049
Continuity of care: % full-time nursing staff	.02	.04	.56	.577
Unit experience: Nurses' mean years experience on clinical unit	-.09	.17	-.54	.594
Education level: % baccalaureate prepared nurses	-.10	.05	-1.94	.057
Overall nurse self-reported health level	.03	.11	.25	.802
Nurse capacity to work: Missed hours	-.07	.05	-1.37	.178
Nursing practice environment: Nurse-physician relationships	.06	.07	.79	.430
Nursing practice environment: Manager ability & support	.08	.07	1.23	.224
Nursing practice environment: Adequacy of staffing & other resources	-.21	.09	-2.41	.020
Nursing practice environment: Teamwork in care delivery	-.28	.95	-.29	.772
Overall nurse job satisfaction	.18	.16	1.15	.254
Nurse reported quality of care on unit	-.24	.10	-2.44	.018
Nurse burnout	-.32	.20	-1.64	.107

Variable	Parameter Estimate	Standard Error	t-value	p-value
Availability of professional role support	.02	.04	.56	.579
Use of care maps / protocols	-.12	.04	-3.43	.001
Physician expertise: % of specialist prepared	.01	.01	.59	.556
Hospital type / location: Outside urban area hospital	.82	1.76	.47	.642
Hospital type / location	.48	1.41	.34	.735

Note. R-square=.50; F-value=2.94; P<.001

Table 6: Multiple Regression Results for Backward Regression Model: 30-Day Mortality

Variable	Parameter Estimate	Standard Error	F-value	p-value
Intercept	52.61	10.28	26.21	<.001
Dose of nursing staff	.08	.04	5.34	.024
Nursing staff mix: % RNs in staff mix	-.06	.03	4.02	.049
Education level: % baccalaureate prepared nurses	-.09	.04	5.14	.027
Nursing practice environment: Manager ability & support	.16	.05	9.47	.003
Nursing practice environment: Adequacy of staffing & other resources	-.17	.08	4.79	.032
Nurse reported quality of care on unit	-.21	.08	6.66	.012
Nurse burnout	-.32	.15	4.71	.034
Use of care maps / protocols	-.10	.03	11.88	.001

Note. R-square=.45; C(p)=4.1; F-value=6.73; P<.0001

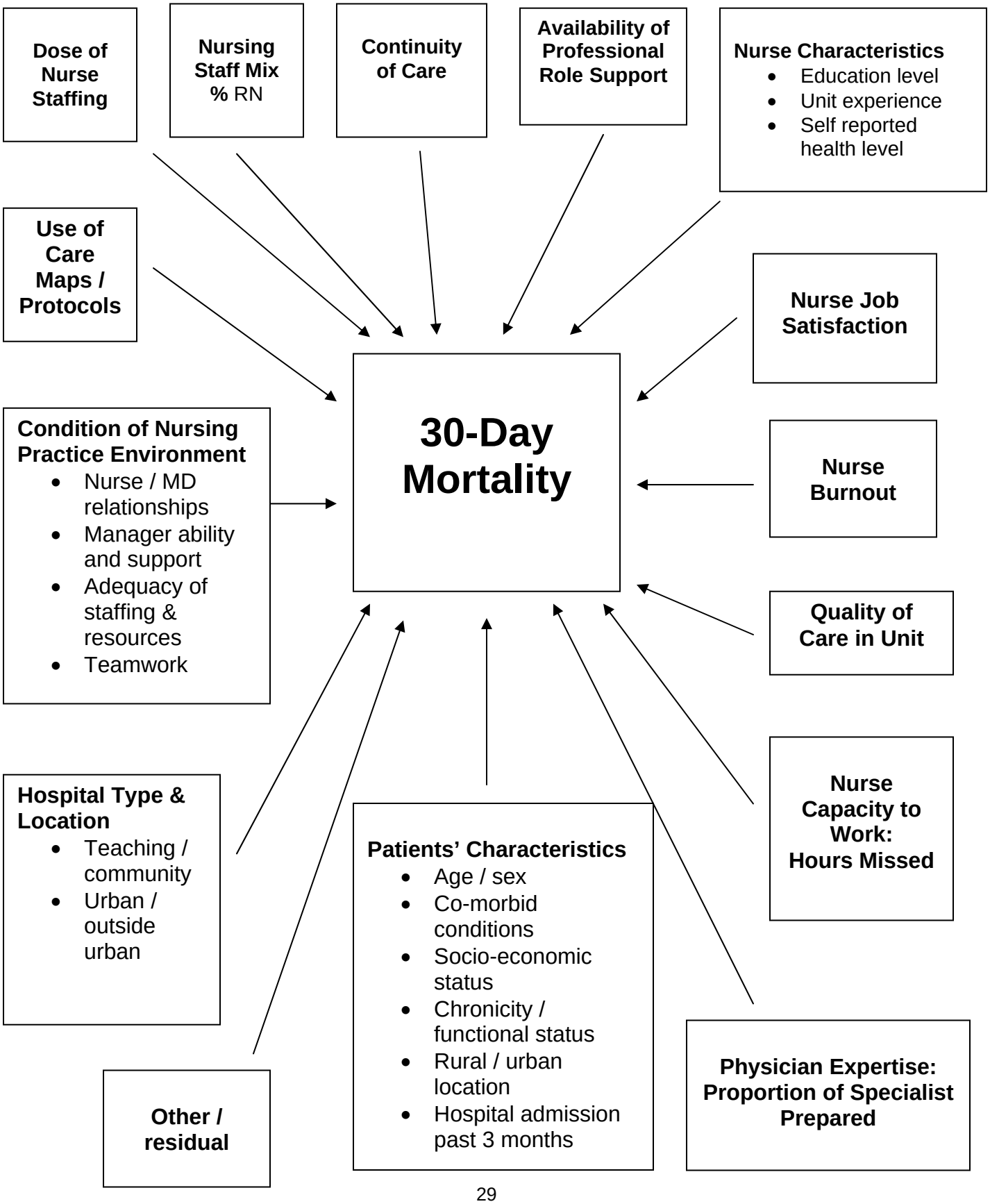
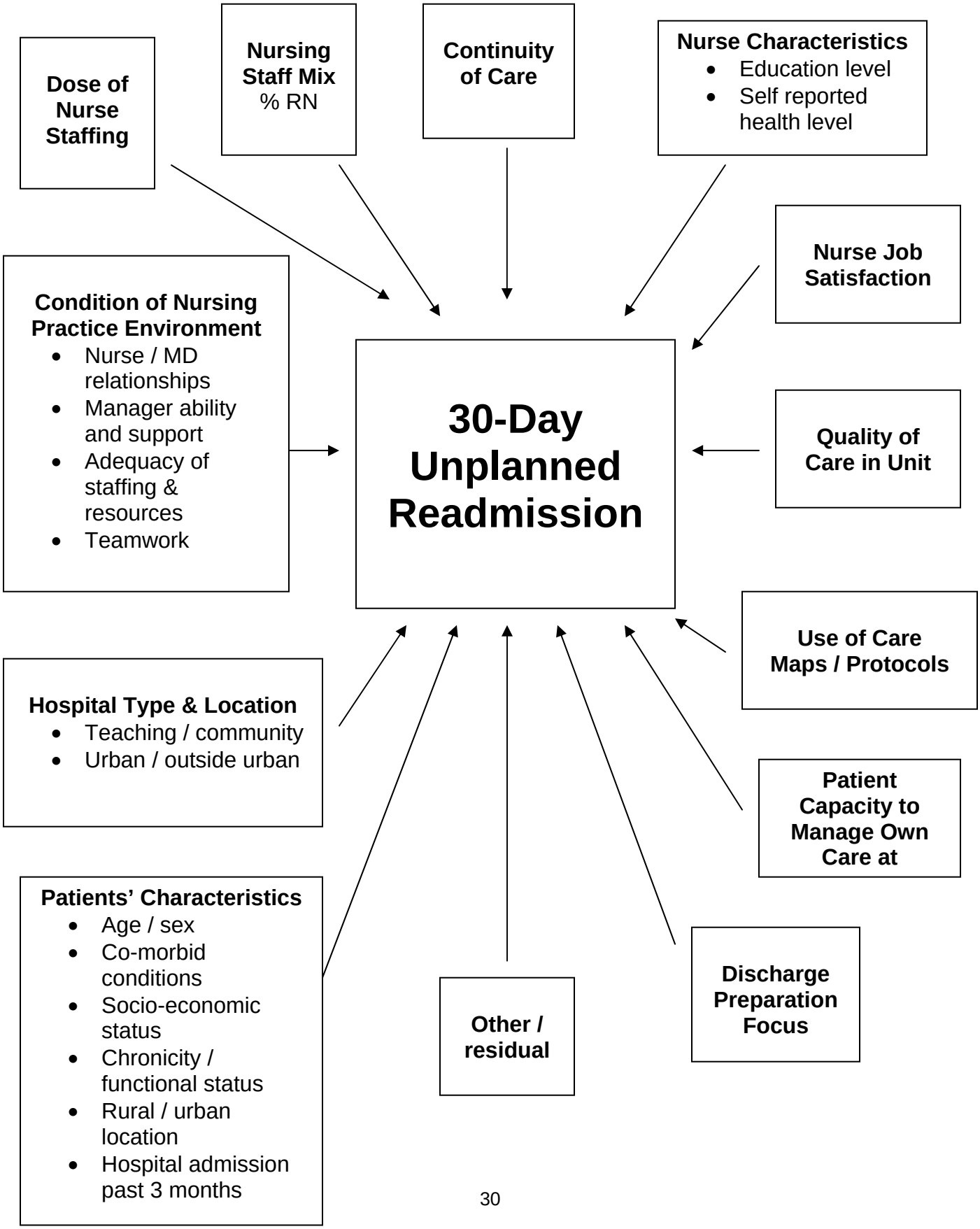
Table 7: Multiple Regression Results When All Variables Are Forced To Enter Model Together: 30-Day Unplanned Readmission Model

Variable	Parameter Estimate	Standard Error	t-value	p-value
Intercept	8.89	11.43	.78	.44
Dose of nursing staff	.09	.04	2.12	.04
Nursing staff mix: % RNs in staff mix	.04	.04	1.24	.22
Continuity of care: % full-time nursing staff	-.01	.03	-.34	.73
Education level: % baccalaureate prepared nurses	.02	.05	.046	.65
Overall nurse self-reported health level	-.07	.11	-.66	.51
Nursing practice environment: Nurse-physician relationships	-.06	.07	-.74	.46
Nursing practice environment: Manager ability & support	.08	.06	1.33	.19
Nursing practice environment: Adequacy of staffing & other resources	-.17	.09	-1.88	.06
Nursing practice environment: Teamwork in care delivery	.13	.97	.14	.89
Overall nurse job satisfaction	.03	.16	.18	.86
Nurse reported quality of care on unit	.11	.09	1.15	.25
Use of care maps / protocols	-.01	.03	-.45	.65
Patient capacity to manage own care after discharge	-.04	.04	-1.08	.29
Discharge preparation focus	.04	.09	.43	.67

Variable	Parameter Estimate	Standard Error	t-value	p-value
Outside urban area hospital	3.25	1.60	2.03	.05
Urban non-teaching hospital	2.99	1.35	2.22	.03

Note. R-square=.21; F-value=.97; P=.50

Appendix A: Determinants of 30-Day Mortality Model



Appendix B: Determinants of 30-Day Readmission Model