Evidence-based Standards for Measuring Nurse Staffing and Performance

September 2004

Linda O’Brien-Pallas, RN, PhD
Donna Thomson, RN, MBA
Linda McGillis Hall, RN, PhD
George Pink, PhD
Mickey Kerr, PhD
Sping Wang, PhD
Xiaoqiang Li, PhD
Raquel Meyer, RN, PhD Student

Funding Provided by:
Canadian Health Services Research Foundation
Ontario Hospital Association Change Foundation
The nursing effectiveness, utilization, and outcomes research unit of the faculty of nursing at the University of Toronto
Contributing Hospitals
Principal Investigator:

Linda O’Brien-Pallas  
Professor, Faculty of Nursing  
University of Toronto  
50 St. George Street, Room 179  
Toronto, Ontario M5S 3H4  

Telephone: (416) 978-1967  
Fax: (416) 946-7142  

E-mail: lobrien.pallas@utoronto.ca

This document is available on the Canadian Health Services Research Foundation Web site (www.chrsf.ca).

For more information on the Canadian Health Services Research Foundation, contact the Foundation at:  
1565 Carling Avenue, Suite 700  
Ottawa, Ontario  
K1Z 8R1  
E-mail: communications@chrsf.ca  
Telephone: (613) 728-2238  
Fax: (613) 728-3527

Ce document est disponible sur le site Web de la Fondation canadienne de la recherche sur les services de santé (www.fcrss.ca).

Pour obtenir de plus amples renseignements sur la Fondation canadienne de la recherche sur les services de santé, communiquez avec la Fondation :  
1565, avenue Carling, bureau 700  
Ottawa (Ontario)  
K1Z 8R1  
Courriel : communications@fcrss.ca  
Téléphone : (613) 728-2238  
Télécopieur : (613) 728-3527
Evidence-based Standards for Measuring Nurse Staffing and Performance

Linda O’Brien-Pallas, RN, PhD 1
Donna Thomson, RN, MBA 1
Linda McGillis Hall, RN, PhD 1
George Pink, PhD 1
Mickey Kerr, PhD 2
Sping Wang, PhD 1
Xiaoqiang Li, PhD 1
Raquel Meyer, RN, PhD Student 1

1 University of Toronto
2 Institute for Work & Health

Acknowledgements:

The investigators wish to thank the Canadian Health Services Research Foundation, the Ontario Hospital Association Change Foundation, the nursing effectiveness, utilization, and outcomes research unit of the faculty of nursing at the University of Toronto, and the contributing hospitals for the financial support that made this research project possible.

The advisory committee members are acknowledged for their guidance in the development of the data collection tools and for their assistance in interpreting the results and their input on the feasibility of collecting significant data elements on an ongoing basis.

Dr. Judith Shamian — Health Canada
Kathleen MacMillan — Health Canada
Jill Strachan — Canadian Institute for Health Information
Barbara McGill and Nancy Savage — Atlantic Health Sciences Corporation
Jane Moser — University Health Network
David McNeil — Sudbury Regional Hospital
Margaret Keatings — Hamilton Health Sciences
Heather Sherrard — Ottawa Heart Institute
Carol Wong — London Health Sciences Centre
Lucille Auffrey — Canadian Nurses Association
Sue Williams — Ontario Joint Provincial Nursing Committee
Beverly Tedford — New Brunswick Department of Health and Wellness
Sue Matthews — Ontario Ministry of Health and Long-Term Care

Hospital and site co-ordinators and data collectors are recognized for their efforts to collect comprehensive and accurate data about their organization, patients, and nurses in order to support this project. Staff and patients at participating hospitals are thanked for their willingness to participate in this study by completing surveys. Health records departments are thanked for providing patient-specific diagnoses and outcomes.

Hospitals and Site Co-ordinators:
Sudbury Regional Hospital: Claire Gignac
London Health Sciences Centre: Nancy Hilborn
University Health Network: Elke Ruthig
Hamilton Health Sciences: Bernice King
Atlantic Health Sciences Corporation: Trevor Fotheringham
Ottawa Heart Institute: Judith Sellick

A special thank you is given to project co-ordinators Shirliana Bruce and Min Zhang and research assistant Irene Cheung.
# Table of Contents

Key Implications for Decision Makers ........................................................ i

Executive Summary ................................................................................... ii

Context.........................................................................................................1

Implications..................................................................................................2

  * System Implications .................................................................2
  * Nursing Implications..............................................................6

Approach......................................................................................................8

Results.........................................................................................................10

  * Descriptives.................................................................................10
  * Research Question 1 ............................................................13
  * Research Question 2 ............................................................13
  * Research Question 3 ............................................................20
  * Research Question 4 ............................................................21

Additional Resources................................................................................21

Further Research.......................................................................................22

References..................................................................................................23
Key Implications for Decision Makers

Variations in nursing productivity/utilization and staffing patterns are frequently observed between, as well as within, hospitals. Decision makers are challenged to maximize productivity/utilization and minimize staffing costs, while ensuring the quality of care. Recommendations from this study inform decision-making on these important issues within hospital cardiac and cardiovascular units.

- Nursing unit productivity/utilization levels should target 85 percent, plus or minus five percent. Levels higher than this lead to higher costs, poorer patient care, and poorer nurse outcomes.

- Maximum productivity/utilization is 93 percent (because seven percent of the shift is made up of paid, mandatory breaks). Units where nurses frequently work at or beyond maximum productivity/utilization must urgently reduce productivity/utilization and implement acceptable standards.

- Productivity/Utilization targets can be met by enhancing nurse autonomy, reducing emotional exhaustion, and having enough staff to cope with rapidly changing patient conditions.

- Overall costs are reduced when experienced nurses are retained. Retention is more likely when there is job security, when nurses can work to their full scope of practice, and when productivity/utilization levels are below 83 percent.

- Retention strategies must address the physical and mental health of nurses, balancing the efforts and rewards associated with work, nurse autonomy, full scope of practice, managerial relationships, innovative work schedules, hiring more nurses into full-time permanent positions, and reasonable nurse-to-patient ratios based on targeted productivity/utilization standards. These will minimize the effect of persistently high job demands and reduce absenteeism and the use of overtime.

- Investment is needed for infrastructure to collect data that will monitor and improve care delivery processes and measurement of performance outcomes. Data that should be routinely captured, but are not yet, include valid workload measurement; environmental complexity; patient nursing diagnoses and OMAHA ratings of knowledge, behaviour, and status; nurse and patient SF-12 health status; nurse to patient ratios; and productivity/utilization.
Executive Summary

Policy makers and hospital administrators are seeking evidence to support nursing staffing decisions that includes both the volume and mix of nurses required to provide efficient and effective care. The principal objective of this study was to examine the interrelationships between variables thought to influence patient, nurse, and system outcomes. The results provide quality, evidence-based standards for adjusted ranges of nursing productivity/utilization and for staffing levels for patients receiving cardiac and cardiovascular nursing care.

Although hospitals have little control over patient severity and complexity, organizations can manage nurse characteristics, system characteristics and behaviours, and environmental factors that influence patient, nurse, and system outcomes. Numerous findings provide important evidence to guide policy and management decisions related to the deployment and use of nursing personnel. These findings suggest that organizations can implement many strategies to improve the cost and quality of care.

In the past, actions to minimize expenses have focused on reducing the cost of inputs, the number of nurses, and the skill level. The findings of this study suggest that to actually reduce the cost and improve the quality of patient care, organizations will benefit from 1) hiring experienced, full-time, baccalaureate-prepared nurses; 2) staffing enough nurses to meet workload demands; and 3) creating work environments that foster nurses’ mental and physical health, safety, security, and satisfaction. The evidence supports the need for
a significant change in the way organizations view costs and suggests that the emphasis on cost of inputs should shift to the cost of outputs and the quality of care.

The study found nursing productivity/utilization should be kept at 85 percent, plus or minus five percent. When rates rise above 80%, costs increase and quality of care decreases. Patient health is more likely to be improved at discharge if productivity/utilization levels are below 80 percent and if patients are cared for by nurses who work less overtime. When productivity/utilization levels are kept below 80 percent, nurses are more likely to be satisfied with their jobs and absenteeism is reduced, and nurses are less likely to want to leave their jobs when productivity/utilization is less than 83 percent.

Costs are lower when hospitals maintain productivity/utilization levels below 90% and implement strategies to improve nurse health and incentives to retain experienced nurses. Autonomy can be enhanced by balancing the number of patients assigned to each nurse and each nursing unit, and emotional exhaustion is less likely when nurses are satisfied, mentally and physically healthy, and feel that they receive appropriate rewards for their efforts. Nurses are more likely to be physically healthy when there are good relationships with the physicians on the unit, and these relationships tend to improve when nurses’ autonomy and decision-making abilities are respected.

Aggression- and violence-free workplaces are key to enabling nurses to do their nursing interventions on time. There also needs to be enough nursing staff to deal with the rapidly
changing conditions in hospitalized patients, so that nurses have enough time to complete patient care.

Patient care is improved when units are staffed with degree-prepared nurses and when nurses can work to their full scope of practice. This not only improves job satisfaction, but nurses are also less likely to leave their jobs.

Patients’ health behaviour improves when nurses have a satisfying work environment, secure employment, and when unit productivity/utilization does not exceed 88 percent. Enhanced nurse autonomy, full-time employment, and fewer shift changes are shown to improve patients’ knowledge about their conditions when they are discharged.
Context

Nurse staffing is closely linked to patient outcomes and system effectiveness. A greater understanding of the causes and outcomes of hospital nurse staffing is essential to meet increasing demands for both cost and quality accountability in healthcare. Recent Canadian reports highlight the urgent need to identify methods for valid measurement of nursing workload and productivity/utilization, and to understand their relationship with patient, nurse, and system outcomes,\(^1,2,3,4\) a need further underscored by the current and predicted nursing workforce shortages.\(^2,5\)

Policy makers and hospital administrators are seeking evidence to support nursing staffing decisions that includes both the volume and mix of nurses required to provide efficient and effective care. Prior studies have provided insight into some of the factors contributing to the need for nurses and the effect of different staffing approaches on patients, providers, and systems (Appendix A). Recent evidence suggests that adding one patient to each nurse’s caseload in acute-care hospitals is associated with increases in 30-day mortality (seven percent), failure-to-rescue (seven percent), nurse burnout (23 percent), and job dissatisfaction (15 percent).\(^6\) Another study demonstrated that an increase of one hour of overtime per week increases the odds of a work-related injury by 70 percent.\(^7\) Part-time and casual employment can also negatively impact continuity of care and the nurse’s ability to influence clinical and work-related decisions.\(^8\) A review of relevant studies is presented in Appendix A.

The principal objective of this study was to examine the interrelationships between variables thought to influence patient, nurse, and system outcomes, in order to provide quality evidence-based standards for adjusted ranges of nursing productivity/utilization and for staffing levels for patients receiving cardiac and cardiovascular nursing care. This evidence will help policy makers develop mechanisms and policies to measure the need for nursing service in light of appropriate staffing and productivity/utilization standards. By examining specific cardiac and cardiology
diagnoses, as well as nurse and nursing work indicators within hospital cardiac and cardiovascular unit settings, this research study examined four questions:

1. To what extent do patient, nurse, and system characteristics and behaviours, and environmental complexity measures, explain variation in nursing worked hours and patient, nurse, and system outcomes, such as length of stay?

2. To what extent is there agreement between the estimates generated by a gold standard for measuring nursing resource needs (PRN workload methodology) and the worked hours of care per patient, and how does variance affect patient and nurse outcomes?

3. At what nurse-patient ratio and with what proportion of registered nurse worked hours are productivity/utilization and patient and nurse outcomes improved, after controlling for the influence of patient, nurse, organizational, and environmental factors?

4. Which data elements, in addition to those routinely collected within administrative databases, are critical for routine data collection in Canada? To what extent do policy and administrative decision makers support the feasibility of routine data collection?

**Implications**

Numerous findings provide important evidence to guide policy and management decisions related to the deployment and use of nursing personnel. Although hospitals have little control over patient severity and complexity, organizations can manage nurse characteristics, system characteristics and behaviours, and environmental factors that influence patient, nurse, and system outcomes. The implications of this study are directed at those latter factors, which are amenable to policy and management intervention.

**System Implications**

1. Results of this study suggest a target of 85 percent (plus or minus five percent) unit productivity/utilization on a daily basis. Sustained productivity/utilization outside this range will result in higher costs and poorer quality of care. **Rationale:** Different levels of unit productivity/utilization are associated with different outcomes as summarized in Table 1. Although the goal is to maximize nurse activity, at productivity/utilization levels above 80 percent, negative outcomes emerge because there aren’t enough nurses to meet demands. The
maximum work capacity of any employee is 93 percent, because seven percent is allocated to paid breaks during which time no work is contractually expected. At 93 percent, nurses are working flat out with no flexibility to meet unanticipated demands or rapidly changing patient acuity. This study demonstrates that significant benefits, both fiscal and human, can be achieved by moderating productivity/utilization levels within a range of 85 percent, plus or minus five percent. It must be noted however, the suggested range may not be applicable to specialty units with variable patient flow demands, such as emergency and labour and delivery departments.

Depending on performance goals, organizations may wish to target specific unit productivity/utilization values in Table 1. These values are cumulative in nature, such that, if a unit works at a 92 percent productivity/utilization level, not only will lengths of stay be longer, but all of the other negative outcomes that occur with productivity/utilization values below 92 percent will apply.

<table>
<thead>
<tr>
<th>Productivity/Utilization Levels (%)</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; 91</td>
<td>Longer length of stay</td>
</tr>
<tr>
<td>&gt; 90</td>
<td>Higher costs per resource intensity weight</td>
</tr>
<tr>
<td>&gt; 88</td>
<td>Less improvement in patient behaviour scores at discharge</td>
</tr>
<tr>
<td>&gt; 85</td>
<td>Higher nurse autonomy</td>
</tr>
<tr>
<td></td>
<td>Deteriorated nurse relationships with physicians</td>
</tr>
<tr>
<td>&gt; 83</td>
<td>Higher intention to leave among nurses</td>
</tr>
<tr>
<td>&gt; 80</td>
<td>More nurse absenteeism</td>
</tr>
<tr>
<td></td>
<td>Less improvement in patient physical health at discharge</td>
</tr>
<tr>
<td></td>
<td>Less nurse job satisfaction</td>
</tr>
</tbody>
</table>

Although the Canadian Institute for Health Information defines productivity/utilization as “workload over worked hours,” this neither accounts for the quality and outcomes of care delivered, nor the impact of length of stay on total cost. This definition is not a measure of productivity/utilization as an output, but rather a measure of use as a process. “Workload over worked hours” actually measures use of nursing resources and thus evaluates an organization’s ability to operate to meet patient care standards and needs.
2. Unit productivity/utilization levels below 90 percent, strategies to address nurse health, and incentives to retain experienced nurses who are expert in their field should lower resource intensity weight costs (the cost of providing services to groups of people with different characteristics). **Rationale:** Lower costs per resource intensity weight are associated with higher physical health scores for nurses, expert clinical practice, reduced length of stay, and unit productivity/utilization levels below 90 percent.

3. Attendance at pre-operative clinics as a routine process for surgical patients, adequate staffing to prevent medical problems, and unit productivity/utilization levels below 91 percent are recommended. **Rationale:** Shorter-than-expected length of stay is 185 percent more likely when patients attend pre-operative clinics and 57 percent less likely when patients suffer medical problems as a consequence of their treatment.

4. Maintaining unit productivity/utilization levels below 90 percent and recognizing the effect of complex and numerous nursing diagnoses will optimize the actual worked hours per patient. **Rationale:** Increases in actual worked hours per patient are associated with increases in nursing worked hours and with higher numbers of nursing diagnoses. Actual patient care hours decline as unit productivity/utilization exceeds 90 percent and with increases in the proportion of both full-time nurses and average clinical expertise on the unit.

5. Efforts should be made to prevent adverse events to reduce overall costs. **Rationale:** Patients who suffer medical consequences are 319 percent more likely to be referred to homecare, and for each additional hour of care given, the patient is 13 percent more likely to suffer a medical consequence.

6. Staffing should be sufficient to account for the rapidly changing conditions in hospitalized patients so that all key nursing interventions can be done. **Rationale:** Patient interventions are more likely to be left undone when there are more unanticipated changes in patient acuity or when nurses experience violence. The likelihood of patient interventions not being completed increases by 260 percent for nurses at risk of feeling their efforts are not properly rewarded.
7. Providing innovative programs to create aggression-free work environments will enable nurses to complete key nursing interventions on time. **Rationale:** Delays in interventions are more likely when nurses on the unit experience violence, but they are 27 percent less likely for every 10 percent increase in degree-prepared nurses on the unit.

8. Efforts to improve the job satisfaction of nurses will lead to better ratings of quality of nursing care. **Rationale:** Nurse ratings of good/excellent quality of nursing care are 606 percent more likely when nurses rate the quality of patient care over the past year as improved and 159 percent more likely when nurses are satisfied.

9. Staffing units with degree-prepared nurses and ensuring that nurses can provide the quality nursing care that they deem appropriate will improve nurse perceptions of patient care quality over the last year. **Rationale:** Ratings of improved quality of patient care over the past year are 915 percent more likely when nurses report good/excellent quality of nursing care and are 40 percent more likely for every 10 percent increase in degree-prepared nurses on the unit.

10. Unit productivity/utilization levels should be kept below 80 percent, and work environments should be assessed to determine why there is higher absenteeism among full-time nurses. **Rationale:** Absenteeism is reduced when unit productivity/utilization remains below 80 percent. Full-time nurses are 152 percent more likely to be absent than those who work part-time or casually. Nurses who are physically healthy are five percent less likely to be absent.

11. Job security and allowing nurses with degrees to work to their full scope of practice will prevent nurses from leaving. **Rationale:** Intent to leave is 197 percent more likely among nurses who are concerned about job security and 101 percent more likely among degree-prepared nurses. As unit productivity/utilization exceeds 83 percent, intent to leave increases. However, intent to leave is 97 percent less likely for every 10 percent increase in proportion of nurse ratings of improved quality of nursing care on unit, 58 percent less likely when nurses are satisfied, and 51 percent less likely when nurses work full-time.
**Patient Implications**

12. Reducing overtime hours and unit productivity/utilization levels below 80 percent will improve patient’s physical status at discharge. **Rationale:** Improvements in patient SF-12 physical scores at discharge are 45 percent less likely when productivity/utilization exceeds 80 percent and seven percent less likely for each additional hour of nurse overtime.

13. Creating satisfying work environments, offering secure employment, and ensuring unit productivity/utilization does not exceed 88 percent enhances changes in patient behaviours related to nursing diagnoses. **Rationale:** Patient behaviour scores are more likely to decrease when unit productivity/utilization exceeds 88 percent. Improvements in patient behaviour scores at discharge are 176 percent more likely when nurses are satisfied but 53 percent less likely when nurses were forced to change units within the past year or anticipate forced changes in units in the next year.

14. Employing more nurses in full-time positions, facilitating autonomy, and reducing the frequency of shift changes improves patients’ knowledge about their conditions at discharge. **Rationale:** Improved patient knowledge scores at discharge are 74 percent more likely for every 10 percent increase in nurses’ worked hours on the unit and 24 percent more likely for every 10 percent increase in full-time nurses on the unit. Patient knowledge scores are 44 percent less likely to improve for every 10 percent increase in nurses on the unit with more than one shift change during the past two weeks.

**Nursing Implications**

15. Ensuring sufficient numbers of nurses who are physically healthy and continuity of care providers, as well as facilitating autonomy and decision-making will improve nurse-physician relationships. **Rationale:** Improved nurse-physician relationships are associated with higher proportions of physically healthy nurses and increases in nurses’ hours worked on the unit. Deterioration in nurse-physician relationships is associated with unit productivity/utilization beyond 85 percent.
16. Finding balance between the number of patients assigned to a nurse, the rate of occupancy on the unit, and unit productivity/utilization is recommended to enhance autonomy. **Rationale:** Lower nurse autonomy is associated with higher unit occupancy rates, nurses experiencing effort and reward imbalance, more degree-prepared nurses, and greater nurse clinical expertise. Higher nurse autonomy is associated with unit productivity/utilization greater than 85 percent, nurse satisfaction, and higher nurse-patient ratios.

17. Hiring degree-prepared nurses, increasing average hours per patient, promoting autonomy, ensuring good quality nursing care, and maintaining unit productivity/utilization levels below 80 percent are recommended to improve nurse job satisfaction. **Rationale:** Higher nurse job satisfaction is 301 percent more likely when nurses rate the quality of nursing care as good or better, and 10 percent more likely for every hour increase in the average worked hours on the unit. Improved job satisfaction is also 56 percent more likely for every 10 percent increase of nurses with degree preparation and 24 percent more likely for each one point increase in ratings of nurse autonomy. Higher job satisfaction is 57 percent less likely when unit productivity/utilization levels exceed 80 percent.

18. Environmental scanning for factors that cause full-time nurses to be more emotionally exhausted is recommended. **Rationale:** Emotional exhaustion is 242 percent more likely when nurses experience effort and reward imbalance and 179 percent more likely when nurses work full-time. However, emotional exhaustion is 66 percent less likely when nurses are satisfied, 10 percent less likely with every one point increase in mental health scores, and four percent less likely with every one point increase in physical health scores. For every 10 percent increase in satisfied nurses on the unit, nurses are 32 percent less likely to suffer from emotional exhaustion.

19. Improving nurse-physician relationships at the unit level, balancing the demands placed on nurses and the rewards they receive for their work, and enhancing job satisfaction will improve nurses’ physical health. **Rationale:** Nurses are 49 percent less likely to be physically healthy when they experience an effort and reward imbalance and 41 percent less likely to be
physically healthy when they are emotionally exhausted. However, as relationships between nurses and physicians improve, nurses are more likely to be physically healthy.

**Approach**

This study, which comprised cross-sectional and longitudinal components, included the cardiac and cardiovascular care units of six hospitals in Ontario and New Brunswick. The Patient Care Delivery System Model\(^{10}\) was adapted for this study (Appendix B). This model emphasizes that characteristics of patients, nurses, and the system, as well as system behaviours, interact with communication and co-ordination, environmental complexity, and care delivery activities to produce system outputs (intermediate outputs include unit productivity/utilization and daily hours of care per patient; overall outputs include patient, nurse, and system outcomes) and provide feedback for the entire system.

Ethical approval was received from the University of Toronto and from hospital sites. Patient and nurse consent was obtained on site. Eight hospitals met the inclusion criteria (high volumes of patients in the cardiac case mix groups of interest). The first six hospitals approached agreed to participate. Each hospital’s chief nursing officer or designate joined the study’s advisory committee and became a local investigator to oversee hospital ethics approval, hiring of project staff, and data quality at the site.

On participating units, data for study patients, all nurses, and the unit itself were collected on each patient for each day of stay. Data were collected from patients and nurses directly as well as from administrative sources. The key variables and data sources are summarized in Table 1 (Appendix C). A detailed summary of each measure and its related psychometric properties appears in Appendix D, and data collection forms are presented in Appendix E. In addition to this unit-level data, nurses completed a survey package questionnaire that addressed issues like burnout, the balance between work efforts and rewards, nurse-physician relationships, autonomy, and health. Nurses provided input into the PRN workload measurements, identification of nursing diagnoses, and ratings of patient knowledge, behaviour, and status.
Data were collected between February and December 2002. Data collection periods averaged six months at each site to maximize the number of patients assessed, but the target of 145 patients for all specified case mix groups was not achieved. Inter-rater reliability on the application of all measures remained at 90 percent during orientation and throughout the study.

Of 1,107 surveys provided to nurses at all six sites, 727 were returned (66 percent response rate). In total, 1,230 patients housed in 24 nursing units from the six hospitals were included in the full study, accounting for 8,113 patient days of data.

Decision makers were involved in developing the proposal and reviewed all data collection forms and methods prior to implementation. They also reviewed drafts of the descriptive data for the study’s final report. They made recommendations on additional data elements that should be routinely collected and assisted in the overall interpretation of the study’s findings.

The findings will be published in peer reviewed and trade journals to target different audiences. The report, fact sheets, and a video will be sent to hospital executives, non-government bodies which influence health policy, and each ministry of health in Canada.

**Analysis Techniques**: Data were analysed using SPSS version 11 and MLwin beta version 2.0. Initially, the distribution and transformation of variables was conducted. Descriptive statistics were compiled, and subscale scores and alpha reliabilities for the various research tools used were generated. Basic comparisons between hospitals or units were made using analysis of variance (ANOVA). Where applicable, the Pearson Product Moment Correlation was used to explore interrelationships between variables.

Hierarchical linear modeling is useful for understanding relationships in multilevel structures. Since data in this study were collected at both the hospital unit level and at the individual nurse and patient level, a multilevel approach to the analysis was proposed as a way to better account for the possible clustering of effects within hospitals. That is, questionnaire responses from nurses within hospitals were likely to be affected by things that are “fixed” for all employees in that organization, such as the size and type of the organization. The advantage of hierarchical
linear modeling methods is that they can account for this clustering or grouping of variation in scores on questionnaire measures within a given organization. Without accounting for the possible clustering of effects within hospitals, the conclusions of the study could be invalid, since other statistical measures assume that no such clustering occurs.

For multilevel modeling, most variables were dichotomized and hierarchical logistic regressions were completed. Only unit productivity/utilization, worked hours per patient, cost per resource intensity weight, nurse-physician relationship, violence, and autonomy were kept as numeric variables. Worked hours per patient and cost per resource intensity weight were logarithm transformed due to their highly skewed distributions. The order of entry of variables into the statistical modeling process was consistent with the theoretical framework at two levels. The first level included individual nurse and patient variables, while the second unit level included system characteristics and behaviours and throughput factors. Some of the nurse questionnaire measures were also aggregated to the unit level as a measurement of unit atmosphere or morale. Multicollinearity among independent variables was examined, but none of the variables was very strongly associated with any other. To determine whether or not variables were associated with outcomes, individual variables were sequentially added to statistical models and the properties of each newly expanded model were compared to the previous one to see if the new variable was of any importance (see Appendix F).

**Results**

**Descriptives**

Descriptive results pertaining directly to the implications outlined above are presented here. More detailed results and tables are presented in Appendix G.

**Patient Characteristics:** For 1,230 patients in the study, the mean age was 63.5 years, and 66.7 percent were male. The most common cardiac case mix group was percutaneous transluminal coronary angioplast. Of the surgical patients, one-third (33 percent) attended a pre-operative clinic and more than half (57.5 percent) received post-operative education. About one in 10 (10.9 percent) was referred to homecare. On a scale of 1 to 5, OMAHA knowledge, behaviour, and status scores regarding nursing diagnoses averaged 3.4, 4, and 3.3 respectively, upon admission
or identification of new nursing diagnoses. At admission, 87 percent and 49.2 percent of patients scored below the standardized American norms for physical and mental health, respectively.

**Nurse Characteristic:** Of 727 nurses who completed the survey, most (93.9 percent) were female, registered nurses (96.6 percent), with a mean age of 40.6 years. More than 42 percent of nurses held a bachelor or higher degree. On average, 59.8 percent of nurses were employed full-time, with 97.8 percent indicating permanent employment. Almost 40 percent of nurses rated their approach to care delivery as expert, rather than novice.

**System Characteristics and Behaviour:** On an average day, nurses on each nursing unit admitted 6.1 and discharged 6.1 patients per 24 hour period. Overall, 64.3 percent of nurses reported significant increases in employer expectations for overtime in the last year and actual increases in overtime worked per week: zero to one hour (45.1 percent), two to four hours (32.2 percent), and greater than four hours (22.7 percent). Of the overtime reported, 26.7 percent was unpaid and 22.8 percent was involuntary. Eight percent of nurses experienced a forced change in their work unit in the previous year, and 15.1 percent anticipated such a change in the upcoming year. Nurses continue to perform tasks that could be delegated to non-nursing personnel, including ancillary services (83.5 percent), venipunctures (64.8 percent), housekeeping (55.1 percent), delivering trays (55.1 percent), and starting intravenous sites (51 percent).

**Intermediate System Output:** Unit productivity/utilization was determined by dividing unit workload by total worked hours on the unit. The maximum capacity of any employee is 93 percent, because seven percent is allocated to paid breaks when no work is contractually expected. At 93 percent, nurses are working flat out with no flexibility to meet unanticipated demands or rapidly changing patient acuity. On 46 percent of the days, units worked beyond the ceiling value of 93 percent, and on 61.5 percent of the days units worked beyond 85 percent.

**Patient Outcomes:** Few medical consequences were reported, although variation existed among hospitals. Medical consequences included falls with injury (0.7 percent), medication errors with consequences (1.6 percent), death (0.4 percent), and complications such as urinary tract infections (1.5 percent), pneumonia (1.3 percent), wound infections (1.4 percent), bed sores (0.4
percent), and thrombosis (0.2 percent). Between admission and discharge, patients’ scores for SF-12 physical health status improved (41.1 percent) nearly as often as they declined (44.9 percent). A similar pattern was noted for patients’ mental health status (42.3 percent improving and 44.9 percent deteriorating). For physical and mental health status scores, 12.8 percent of patients showed no change. Overall, general improvement of patients was evidenced through mean changes in OMAHA knowledge (0.43), behaviour (0.25), and status (0.79) scores between admission and discharge (or appearance and resolution of new nursing diagnoses).

**Nurse Outcomes:** On average, nurses scored 22.7 for emotional exhaustion, six for depersonalization, and 12.2 for personal accomplishment using Maslach’s Burnout Inventory. Almost 30 percent of nurses were at risk for emotional burnout. Additionally, 18 percent of nurses said their work efforts exceeded work rewards. On average, 17.7 percent of nurses were dissatisfied with work, primarily due to inadequate opportunities to interact with management (45.5 percent).

Of the nurse survey respondents, 34.8 percent and 49.2 percent scored below the standardized American norms for physical and mental health, respectively. During the two weeks preceding the survey, 32.4 percent of nurses changed their shift time more than once. During the week preceding the survey, nurses experienced emotional abuse (24.9 percent), threat of assault (13.6 percent), and physical assault (10.2 percent) while at work. The main sources of this workplace abuse were patients (31.1 percent), other nurses (21.5 percent), physicians (15.8 percent), and families (10.7 percent).

**System Outcomes:** Nurse ratings of quality of care and omission or delay of patient interventions comprised the measures of quality of care. Of 714 responses, 13.4 percent of nurses rated the nursing care quality on the last shift as fair/poor, while 41.9 percent said patient care quality had deteriorated over the last year. When faced with insufficient time, nurses generally omitted nursing (as opposed to physician-dependent) interventions. The most frequently omitted interventions included care planning (48.2 percent), comforting/talking (38.6 percent), back/skin care (31.4 percent), oral hygiene (28.7 percent), patient/family teaching (23.3 percent), and documentation (22.6 percent). Delayed interventions included vital signs/medications/dressings
(37.3 percent), mobilization/turns (30.5 percent), call bell response (25.9 percent), and PRN pain medications (16.6 percent). In total, nurses reported missing 1,768 work episodes in the last year, with each episode averaging 2.42 shifts. Although 16.4 percent of nurses were never absent, frequency of missed episodes ranged from one to two (42.9 percent), three to four (25.2 percent), and greater than four (15.5 percent). Reasons for absenteeism were reported as physical health (71.4 percent), mental health (5.4 percent), injury (4.8 percent), and other (18.4 percent). Almost five percent of nurses planned to leave their job in the next year. Only 5.6 percent of nurses expected to have difficulty in securing a new job if they wanted one.

**Research Question 1.**

To what extent do patient, nurse, system characteristics and behaviours, and environmental complexity measures explain variation in nursing worked hours and patient, nurse, and system outcomes, such as length of stay?

**Intermediate System Outputs**

**Unit productivity/utilization:** As indicated earlier, at 93 percent productivity/utilization, nurses are working at maximum capacity, and high rates of productivity/utilization on the unit directly influence patient outcomes. This analysis identifies the variables associated with higher and lower productivity/utilization at the unit level. Higher productivity/utilization levels were more likely when there were more nursing worked hours on the unit, higher nurse-to-patient ratios, higher nurse autonomy, and when nurses required more time to complete the work as specified by the patient care plan. Productivity/Utilization was more likely to be lower when units were specialized (such as units that only service patients with cardiology conditions) and where a higher proportion of nurses on the unit were emotionally exhausted or mentally healthy. When nurses are emotionally exhausted they may not be able to work at the same level of productivity/utilization than when they are not. Nurses who are mentally healthy may be inclined to say no to unrealistic work expectations.

**Actual Worked Hours per Patient:** The actual worked hours per patient were likely to increase with a higher proportion of nursing worked hours on the unit and when patients had more nursing diagnoses. Increases in worked hours per patient were associated with increases in unit
productivity/utilization up to the cut-off point of 90 percent. Units with more clinical expertise or with a higher proportion of full-time nurses were more likely to provide fewer hours of patient care.

**Patient Outcomes**

Tables 2 to 19 (Appendix C) display the variables modeled in relation to patient health and safety outcomes.

**Medical Consequences**: Since there were so few medical consequences of any one type, all types of consequences were summed into one category. In this analysis, the factors associated with the presence or absence of any medical consequences during a patient’s stay were examined. As patients experienced greater numbers of nursing diagnoses, reflecting more complex nursing needs, they were more likely to suffer medical consequences. Medical consequences were 53 percent more likely for each additional nursing diagnosis. In contrast, patients with better mental health at admission were less likely to have medical consequences. Patients who experienced medical consequences were more likely to require greater actual worked hours of nursing care during their stay and 319 percent more likely to be referred to homecare for follow-up after discharge, resulting in additional expense to the health system.

**OMAHA Knowledge, Behaviour, and Status at Discharge**. Helping patients understand the cause and course of their conditions is seen to improve the overall health of patients. A ceiling effect was observed among the OMAHA knowledge, behaviour, and status scores, in that patients with higher scores at admission were less likely to demonstrate improvements in these scores at discharge (because there was less room for improvement). Improved patient knowledge scores at discharge were 74 percent more likely for every 10 percent increase in nursing worked hours on the unit and 24 percent more likely for every 10 percent increase in full-time nurses on the unit. When patients were cared for by nurses who reported higher autonomy in their jobs, they were more likely to show increases in knowledge about their condition at discharge. However, patient knowledge was 44 percent less likely to improve for every 10 percent increase in the proportion of nurses who had at least one shift change in the last two weeks.
Helping patients understand which behaviours they need to change in order to improve their health status is another important role function of the nurse. When cared for by nurses who were very satisfied with their work, patients were 176 percent more likely to demonstrate improvements in their behaviour scores at discharge. Conversely, patients cared for by nurses with concerns about job security were 53 percent less likely to demonstrate improved behaviour scores at discharge. Productivity/Utilization levels below 88.2 percent were associated with increased possibility of improvements in patients’ behaviour scores at discharge.

**SF-12 Health Status at Discharge:** As with the OMAHA scores, patients with higher physical and mental health scores at admission were less likely to see improvements in these scores at discharge. Improvement in patients’ physical health status at discharge was less likely for patients with higher resource intensity weights and for patients with more nursing diagnosis. These two factors reflect the medical acuity and nursing complexity of patients’ needs for nursing care. Patient physical health scores were 45 percent less likely to improve when unit productivity/utilization exceeded 80 percent and were seven percent less likely to improve for each additional hour of nurse overtime. However, patients who scored higher in physical health status at admission were more likely to have improvements in mental health status at discharge. Patients who stayed longer in hospital were less likely to show improvements in mental health status scores at discharge. More hours of care were likely to be used if patient mental health was not improved at discharge.

**Nurse Outcomes**

Although improving patient outcomes and reducing the risk of medical consequences are goals of healthcare, achievement of these goals may sometimes occur at the expense of nurse health and safety. In order to retain and recruit nurses — senior and experienced nurses in particular — understanding which factors influence nurse outcomes is pivotal. Ten nurse outcome variables derived from the literature were subsequently used in this analysis. Tables 10 to 19 (Appendix C) display the variables modeled in relation to nurse outcomes.

**Emotional Exhaustion:** Physically and mentally healthy nurses were less likely to experience emotional exhaustion (burnout). The likelihood of emotional exhaustion increased by 242
percent when nurses were at risk of an effort and reward imbalance and by 179 percent when nurses worked full-time. Nurses were 32 percent less likely to suffer high emotional exhaustion for every 10 percent increase in the proportion of satisfied nurses on units.

**Autonomy:** Nurses reported higher autonomy in practice when they reported stronger relationships with physicians, were more satisfied with their job, or said the quality of patient care improved over the last year. Autonomy was also higher when patients had attended a pre-operative clinic and when the nurse-patient ratio was high. As unit productivity/utilization exceeded 85 percent, nurses reported more autonomy, possibly since nurses have to make decisions on their own under such circumstances. However, lower autonomy scores were reported by degree-prepared nurses and by nurses who rated themselves as expert clinicians, perhaps due to organizational constraints imposed on their practice. When occupancy is high on the unit or when nurses were at risk of an effort and reward imbalance, autonomy was likely to be lower.

**Job Satisfaction:** Nurses who were at risk for emotional exhaustion were 71 percent less likely to be satisfied with their jobs, and when unit productivity/utilization levels were higher than 80 percent, nursing staff were 57 percent less likely to be satisfied. Nurse satisfaction was 301 percent more likely when nurses rated the nursing care given on the last shift as good/excellent and 56 percent more likely among degree-prepared nurses. As the average hours available for care on the unit increased and when nurses’ autonomy increased, so did nurses’ satisfaction.

**Nurse-Physician Relationships:** On units with higher proportions of physically healthy nurses and of nursing worked hours, nurses were more likely to have better relationships with physicians. Nurses who perceived their practice to be more autonomous and those who rated the quality of nursing care on the last shift as good/excellent were also more likely to have better relationships with physicians. However, nurse-physician relationships tended to deteriorate when there was a higher proportion of nurses with frequent shift changes on the unit and as nurses took on more patients in their daily assignment or care for patients with more nursing diagnoses. Deteriorated relationships were also more likely as unit productivity/utilization levels exceeded 85 percent.
SF-12 Health Status: Higher physical health status scores were 59 percent less likely for female nurses; 49 percent less likely when nurses were at risk for an effort and reward imbalance; and 41 percent less likely for nurses at risk of emotional exhaustion. In contrast, nurses were more likely to be physically healthy when stronger nurse-physician relationships were reported on the unit and as the average worked hours available for care on the unit decreased. The likelihood of being physically healthy increased by 58 percent when nurses were satisfied with their job, and decreased by 28 percent for every 10 percent increase in nursing worked hours probably because increased nursing hours came from the same nurses worked on the unit rather than from new hired nurses.

Female nurses were 52 percent less likely to be mentally healthy than male nurses, and older nurses reported better mental health. Nurses with one point increases in their physical health scores were four percent less likely to be mentally healthy. Nurses were less likely to be mentally healthy when they were at risk of emotional exhaustion and as the average worked hours on the unit increased. The likelihood of being mentally healthy increased by 74 percent when nurses were satisfied with their current job and decreased by 79 percent when nurses were at risk of emotional exhaustion.

System Outcomes

Tables 20 to 29 (Appendix C) display the variables modeled in relation to system outcomes.

Length of Stay: Patients in units where the productivity/utilization of the unit exceeded 91 percent were more likely to have longer-than-expected lengths of stay. Patients with more nursing diagnoses and with higher resource intensity weights, reflecting greater medical acuity, were also more likely to have longer lengths of stay. Shorter-than-expected lengths of stay were two percent and 185 percent more likely for patients whose physical health status scores were one point higher at admission and for those who attended a pre-operative clinic, respectively. Shorter-than-expected length of stay was 57 percent less likely when patients experienced medical consequences and 13 percent less likely for each additional nursing diagnosis.
**Interventions Not Done or Delayed:** Older, experienced nurses were less likely to have interventions not completed at the end of their shift. The likelihood of interventions not being completed increased by 260 percent when nurses were at risk for an effort-reward imbalance. The more often patients had unanticipated changes in acuity, the more often interventions were left undone. The more frequently violence was experienced by individual nurses and the higher the medical complexity (as indicated by the resource intensity weight), the more likely interventions were not completed. The greater the number of nursing diagnoses, the less likely interventions were not completed. The likelihood of interventions being left undone was reduced as units hired nurses with more clinical expertise and reduced for units that increased average overtime. Interventions not completed were 12 percent less likely with every one point increase in the ratings of nurse autonomy. The more nurses re-sequenced their activities in response to demands from others, the less often interventions were left undone.

Delayed interventions were 74 percent more likely when nurses worked full-time, 87 percent more likely when nurses had concerns about job security, and 123 percent more likely when nurses were at risk of an effort and reward imbalance. Interventions were 27% less likely to be delayed for every 10% increase in the proportion of degree-prepared nurses on the unit. More complex patients with increasing numbers of nursing diagnoses were less likely to experience delays in receiving interventions. However, when individual nurses experienced violence or where the average level of violence was high on a unit, interventions were more likely to be delayed. Interventions were 71 percent more likely to be delayed for every 10 percent increase in absenteeism at the unit level.

**Quality of Patient Care Over the Past Year:** When nurses rated themselves as expert clinicians, they were less likely to rate the quality of patient care on the unit as improved. Likewise, when interventions were delayed, nurses were 46 percent less likely to report improvements in the quality of patient care. The likelihood of improved nurse ratings of patient care increased by 915 percent when nurses rated the quality of nursing care given on the unit as good/excellent (as opposed to fair/poor) and when nurse autonomy was higher. Improved quality of patient care was 41 percent less likely with every 10 percent increase in nursing worked hours on the unit but 40 percent more likely with every 10 percent increase in degree-prepared nurses on the unit.
**Quality of Nursing Care on the Last Shift:** Good or excellent ratings by nurses of the quality of nursing care on the last shift were 606 percent more likely when individual nurses rated the quality of patient care as improved over the last year; 159 percent more likely when nurses were satisfied; and more likely when nurses rated themselves as clinical experts. Nurses’ reports of strong nurse-physician relationships were also associated with good/excellent ratings of nursing care on the last shift. However, nurses who changed shifts at least once during the past two weeks were 50 percent less likely to rate the quality of nursing care as good/excellent. Likewise when a 10 percent increase in the proportion of ratings of quality of nursing care at the unit level were good/excellent, individual nurses on the unit were 93 percent more likely to rate individual scores of quality of nursing care as good/excellent. However, for units with higher ratings of nurse-physician relationships on average, individual nurses were less likely to rate nursing care as good/excellent.

**Absenteeism:** Full-time nurses were 152 percent more likely than part-time and casual nurses to miss work. Nurses who scored one point higher in physical health status scores were five percent less likely to miss work. When unit productivity/utilization was below 79.7 percent, nurses tended to have fewer days absent.

**Intent to Leave:** Degree-prepared nurses were 101 percent more likely to leave as compared to diploma-prepared nurses. Nurses who reported job instability were 197 percent more likely to report intentions of leaving than those who did not. Satisfied nurses were 58 percent less likely to intend to leave. Full-time nurses were 51 percent less likely to leave than part-time or casual nurses. When productivity/utilization was below 82.8 percent on the unit, nurses were less likely to leave.

**Cost Per Resource Intensity Weight:** Patients who were admitted with higher mental health status scores and with a higher number of nursing diagnoses were more likely to have higher costs per resource intensity weight, as were patients who attended pre-operative and post-operative education. Lower costs per resource intensity weight were more likely when care was provided in part in step-down units, when nurses rated themselves as clinical experts, and with emergency admissions, higher nurse-patient ratios, and higher physical health status scores.
among nurses. As length of stay increased and as unit productivity/utilization exceeded 90 percent, so did the cost per resource intensity weight.

**Research Question 2**

To what extent is there agreement between the estimates generated by a gold standard for measuring nursing resource needs (PRN workload methodology) and the worked hours per patient, and how does variance affect the patient and nurse outcomes?

Table 30 (Appendix C) reveals that only two significant variables were found when examining the PRN estimates and actual worked hours. When actual worked hours were less than PRN predicted hours, nurses were more likely to leave in the next year and productivity/utilization was more likely to be high.

**Research Question 3**

At what nurse-patient ratio and with what proportion of nursing worked hours are productivity/utilization and patient and nurse outcomes improved, after controlling for the influence of patient, nurse, organizational, and environmental factors?

As shown in Table 31 (Appendix C), when a nurse was assigned more patients, the relationship with physicians deteriorated and autonomy increased. When more patients were assigned to a nurse, unit productivity/utilization increased and cost per resource intensity weight decreased. For every additional worked hour per patient, the odds of medical consequences increased by 13 percent, and the odds of improvement in patient mental health at discharge decreased by six percent. For every additional hour increase in the average worked hours on the unit, the likelihood of nurses being satisfied with the current job increased by 10 percent, but their odds of being physically and mentally health declined by 10 percent and seven percent respectively. For every 10 percent increase in the proportion of nursing worked hours the odds of patients having improved knowledge scores increased by 74 percent, but nurses were 28 percent less likely to be physically healthy, were 41 percent less likely to rate the quality of patient care as improved.
Given that the maximum productivity/utilization for any unit should not exceed 93 percent, productivity/utilization levels range from 79.7 percent for absenteeism to 91.4 percent for shorter-than-expected length of stay. These findings highlight the difficulties nurses face in this study, where almost 50 percent of the nursing units worked over productivity/utilization levels of 93 percent.

**Research Question 4**

Which data elements, in addition to those routinely collected within administrative databases, are critical for routine data collection in Canada? To what extent do policy and administrative decision makers support the feasibility of routine data collection?

Discussion with our policy and practice decision-making partners identified that:

1. nurse SF-12 physical and mental health status, emotional exhaustion, autonomy, effort and reward imbalance, and quality of nurse-physician relationships should be monitored annually in the new National Nursing Health Survey;

2. unit workload data should be checked for reliability and validity at least annually, and these data, in combination with worked hours, should be tracked regularly by nursing unit managers to determine if actual values exceed those recommended in this study. The Environmental Complexity Scale should be completed on each shift by nurses. Productivity/Utilization and environmental complexity should become quality indicators used by the Canadian Council of Health Services Accreditation to monitor healthy workplaces; and

3. nursing diagnoses and OMAHA tool ratings should be used daily in practice. Automated care planning systems that are easy to access and use are recommended. These are important indicators of patient goal achievement.

**Additional Resources**

The reader is referred to the works of Aiken et al, O’Brien-Pallas et al, and Shamian and O’Brien-Pallas et al as referenced in Appendix A.
Further Research

Develop and validate a shorter version of the effort and reward imbalance scale. Conduct studies to examine the influencing factors and nature of short- and long-term illnesses among nurses. Evaluate strategies (such as access to fitness centers, improved hot meals in the hospital, and mandatory breaks) that may enhance the health of nurses. Replicate this study on other patient populations to determine if the productivity/utilization cut-off points hold.

Explore experienced nurses’ perceptions of quality and develop measures of quality that can be evaluated yearly at the nursing unit level.
References


