

Impact of nursing on hospital patient mortality: A focused review and related policy implications

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ABSTRACT

Understanding the determinants of patient mortality can lead to the development of strategies that reduce mortality and prevent unnecessary death. This paper synthesizes the body of published research that explores determinants of mortality for patients who have experienced acute care hospitalization. Fifteen research manuscripts were found to meet the selection criteria through an electronic search in MEDLINE and CINAHL (1986–2004). Seven categories of determinants of mortality were found: nurse-physician relationships, nurse staffing characteristics, physician characteristics, professional practice environment, nurse experience, registered nurse educational preparation, and clinical nursing support. Implications and recommendations for improving quality and safety in hospital care are discussed.

Introduction

Pressures to improve patient safety within our healthcare system continue to gain momentum as a priority global health policy issue.¹ This is due, in part, to the release of several reports over the last decade that have indicated that approximately 5–15% of patients admitted to hospitals experience an adverse event.^{2–8} Moreover, these reports suggest that 37–52% of adverse events are preventable.^{2–8} The current state of patient safety science continues to focus predominately on the occurrence of adverse events as important indicators of safety and quality. Focusing solely on the examination of the incidence of adverse events and their consequences shifts the emphasis away from the importance of examining organisational and system conditions that lead to adverse events and that are often associated with the design and delivery of patient care. Understanding the determinants of adverse events can illuminate important practice and policy implications, can further patient safety research, and can ultimately improve organisational and system conditions that promote safe clinical practices and outcomes.

In this context, we suggest that more focus should be placed on determining the multiple causes that lead to specific adverse events, particularly organisational determinants. As well as exploring rates of adverse events, we propose that risk and case mix adjusted mortality rates are important indicators of patient safety. Mortality rates are important indicators of quality and patient safety because, after effective risk adjustment for patients' own characteristics and case mix within hospitals, some hospitals have structures and processes that minimize avoidable or unnecessary patient death better than others.⁹ Because nurses provide most of the ongoing care to hospitalized patients, it is reasonable to assume that nursing care structures and processes—a subset of hospital characteristics—are important determinants of patient mortality. The purpose of this paper is to provide an explanation of the hospital characteristics which act to prevent mortality and to minimize unnecessary patient death based on an integrated literature review. A synthesis is presented

of the state of science related to determinants of mortality for hospitalized patients. Building on this synthesis, policy and administrative implications and strategies are proposed that can prevent unnecessary patient death and reduce mortality rates for hospitalized patients. Because this review focuses on determinants of mortality, implications and suggested strategies may or may not lead to improvements in other important healthcare outcomes.

Synthesis of published research on determinants of mortality for hospitalized patients

Methods

An electronic search was conducted to identify potential relevant research literature. For inclusion, manuscripts had to meet each of the following three criteria: (1) a primary research report including calculated mortality rates in acute care hospitals as a study outcome and calculated indicators of hospital characteristics as predictors or determinants of mortality (at least one indicator of nursing care characteristics must have been included as a predictor of mortality); (2) mortality defined as either in-hospital mortality or mortality up to and including 30 days after admission to hospital; (3) an English language research manuscript published between 1986 and 2004.

Manuscripts that focused exclusively on paediatric, obstetrics, or emergency room patients were excluded. To avoid duplication, if several reports of the same research project were found, only those with unique findings were included.

Two databases were used to complete the electronic search: MEDLINE and CINAHL. The first set of keywords used to retrieve potential study reports (mortality rates OR failure to rescue AND hospital AND nurse OR nurse staffing) yielded 297 unique publications. All abstracts were reviewed to invoke inclusion criteria. For some citations, abstracts did not include adequate information to invoke inclusion criteria. For these, full text manuscripts were reviewed. This search revealed seven

manuscripts that met the three inclusion criteria.⁹⁻¹⁵ We completed an additional search using the key words mortality rates AND hospital characteristics. This search yielded 147 potential sources but only two additional relevant publications.^{16,17} References in these nine sources were reviewed to search for other potential appropriate research reports. This yielded six additional relevant publications that were older but important sources of information.¹⁸⁻²³ These 15 publications are used to describe the state of knowledge of nursing related determinants of mortality for acute care hospitalized patients.

Findings

Of the 15 studies relevant to this review and synthesis, nine focused on nursing related hospital determinants of mortality as a central study objective.^{2-8,10,13} The remaining six studies had primary objectives related to exploring medical care and general hospital attributes as determinants of mortality but also included at least one indicator of nurse staffing.^{16,18,19,21-23} Key attributes of each reported study are summarized in table 1.

Seven categories of determinants of mortality were derived by synthesizing findings across the 15 study reports. These categories included: nurse-physician relationships, nurse staffing characteristics, physician characteristics, nurse experience, registered nurse educational preparation, clinical nursing support, and professional practice environment.

Nurse-physician relationships and mortality

Nurse-physician relationships refer to nurse and physician evaluation of the adequacy of their communication and interactions related to the planning, implementation, management, and evaluation of patient care. Three studies examined relationships between nurse-physician collaboration and mortality. Only one study found no relationship.²³ When Knaus and colleagues investigated relationships between mortality and reported adequacy of nurse-physician relationships, they found that hospitals with the lowest mortality ratios had excellent nurse-physician communication.¹⁸ Hospitals with the highest mortality rates did not. These findings laid the foundation for the notion that effective collaboration between physicians and nurses is related to decreased patient mortality. Three years later, Mitchell and colleagues found lower mortality ratios were related to high nurse-physician collaboration.²⁰

Nurse staffing and mortality

Nurse staffing was measured in a variety of ways that fall into two categories: the dose or amount of nurse staffing and nursing staff mix. The overall dose of nursing care reflects the total number of nursing staff who care for patients and is usually characterized by a ratio such as number of hours of nursing care per patient day. Nursing staff mix reflects the strength of registered nurse care in the dose of nursing and is usually calculated as the proportion of nursing care provided by registered nurses of all nursing care provided. These two categories of nurse staffing variables have been found to have an inverse relationship ($r=0.47$, $p<0.0001$).⁹ Eleven studies included at least one measure of nurse staffing. Ten included a measure of nursing staff mix and four included a measure of

nursing dose. Three studies included a measure of both categories.

Seven studies found that a higher registered nurse staff mix was related to lower patient mortality. Hartz and colleagues found that a richer registered nurse staff mix was one of the two strongest predictors of lower patient mortality.¹⁶ Several years later, Manheim *et al*²² found that hospitals that employed higher numbers of registered nurses per admission had lower 30 day mortality. Around the same time, Farley and Ozminkowski found that higher ratios of fulltime equivalent registered nurses per inpatient day were associated with lower risk adjusted mortality.²¹ Five years later, Schultz reported similar findings of an inverse relationship between registered nurse hours per patient day and risk adjusted hospital mortality rates.¹⁰ More recently, Needleman *et al*¹³ examined relationships between indicators of nurse staffing and failure to rescue or death after complication. They found that higher proportions of registered nurse hours were associated with lower failure to rescue rates for medical patients, and that higher hours of care provided by registered nurses were associated with lower failure to rescue rates for surgical patients. Around the same time, Aiken and colleagues studied the association between patient-to-nurse ratios and surgical patient mortality.¹² They found that each additional patient per registered nurse increased the likelihood of dying within 30 days of admission by 7%. In a Canadian study, Tourangeau *et al*⁹ found that hospitals with a higher registered nurse staff mix had significantly lower mortality rates. Specifically, they found the mean risk adjusted 30 day mortality rate for acute medical patients was 15% but that a 10% increase in registered nurse staff mix caring for acute medical patients was associated with five fewer deaths in 1000 discharged patients. Finally, no evidence of a richer registered nurse staff mix and lower patient mortality was found in three studies.^{11,15,19}

Four studies included an indicator of nursing dose. Two of these four studies found a relationship with hospital mortality, although not in the same direction. Blegen and colleagues found a positive relationship between the total dose of nursing staff and patient mortality ($r=0.49$, $p<0.05$).¹¹ This finding indicates that more nursing staff providing patient care, regardless of categories of nursing staff, resulted in higher death rates. This supports the notion of the importance of a higher registered nurse staff mix to minimize mortality. Having a lower dose of nursing staff but one that is richer in registered nurses seems to contribute to lower patient mortality. When Sasichay-Akkadechanunt *et al*¹⁵ explored associations between in-hospital mortality and four nurse staffing variables, they found the variable “all nurse-to-patient ratio”, a measure of nursing dose, was the only nurse staffing variable associated with patient mortality. When nurse-to-patient ratios decreased, in-hospital mortality rates increased. Finally, no evidence was found of a relationship between nurse staffing dose and mortality in two studies.^{9,23}

Physician characteristics and mortality

Five studies included a measure of medical care characteristics. Four of these studies used US data. The indicator commonly used was the proportion of board certified physicians as the numerator and a measure of hospital output such as average daily patient census as the denominator. Board certified

Table 1 Summary of research included in synthesis

Reference	Research question (abbreviated)	Design	Sample	Outcome measures	Main findings
Aiken (2003)	Is there an association among proportion of baccalaureate prepared RNs and mortality or failure to rescue among surgical patients?	Cross sectional	168 US hospitals	30 day mortality and failure to rescue	10% increase in proportion of baccalaureate prepared nurses associated with 5% decrease in likelihood of death and failure to rescue
Aiken (2002)	Are there associations between patient-nurse ratios and mortality (failure to rescue) among surgical patients?	Cross sectional	168 US hospitals	30 day mortality and failure to rescue	Each additional surgical patient per nurse associated with 7% increase in likelihood of death and failure to rescue
Aiken (1994)	Do magnet hospitals have lower mortality than non-magnet hospitals?	Retrospective comparative	234 US hospitals (Medicare patients only)	30 day post admission mortality	Lower 30 day mortality rates found in magnet hospitals compared with non-magnet hospitals
Blegen (1998)	What are the relationships among total hours of nursing care, nursing skill mix, and inpatient death?	Retrospective	42 units in one US hospital	In-hospital deaths per 1000 discharged patients	Increased deaths associated with higher total nursing worked hours per patient day. No association between proportion of nursing hours worked by RNs and in-hospital mortality
Farley (1992)	What are the relationships between mortality and volume for specific diagnoses?	Retrospective	500 US hospitals	In-hospital mortality rates	Lower mortality rates associated with higher RN full time equivalents per 100 patient days and higher percentage of board certified physicians
Hartz (1989)	Is there an association between hospital characteristics and 30-day mortality?	Retrospective	3100 US hospitals	30 day post admission mortality	Lower 30 day mortality associated with higher percentage of board certified physicians and higher percentage of nurses who were RNs
Knaus (1986)	How do structures and processes of care influence mortality ratios in intensive care?	Descriptive prospective	13 US hospital ICUs	Inpatient standard mortality ratio	Lower standard mortality ratios associated with comprehensive clinical nursing education system and excellent nurse-physician collaboration
Manheim (1992)	To what extent do hospital structures and regional environmental variables predict 30 day mortality?	Retrospective	3796 US hospitals (Medicare patients only)	30 day post admission mortality	Lower 30 day mortality associated with higher percentage of board certified physicians and higher ratio of RNs per patient admission
Mitchell (1989)	Is there a relationship between organisational elements and mortality in critical care units?	Descriptive case study	Two ICUs in one US hospital	Inpatient standard mortality ratio	Lower inpatient standard mortality ratios associated with higher nurse-physician collaboration
Needleman (2002)	Are lower levels of nurse staffing at hospitals associated with increased mortality?	Retrospective	799 US hospitals	In-hospital death and failure to rescue rates	Lower failure to rescue rates for medical patients associated with higher proportion of RN hours of care and lower failure to rescue rates for surgical patients associated with greater hours of RN care. No association between increased levels of RN staffing and in-hospital death rates for medical or surgical patients
Sasichay-Akkadechanunt (2003)	Is there a relationship between nurse staff, mean years experience, and percentage of baccalaureate nurses with in-hospital mortality?	Retrospective cross sectional observational	17 medical-surgical units in one Thailand hospital	In-hospital mortality rate	Lower in-hospital mortality associated with increased nurse-patient ratio. No association between proportion of RNs in nursing staff, % baccalaureate nurses, or years of nurse experience with in-patient mortality
Schultz (1997)	What are the relationships of structural and financial hospital variables with inpatient hospital mortality rates for acute myocardial infarction patients?	Ex post facto correlational	373 US hospitals	In-hospital mortality rate	Lower in-hospital mortality associated with higher RN hours per patient day. No association between percentage of board-certified physicians and in-hospital mortality
Shortell (1988)	What are the influences of environmental and institutional factors on in-hospital mortality rates?	Retrospective	981 US hospitals (Medicare patients only)	In-hospital mortality rate	No association between in-hospital mortality rates and percentage of RN employees
Shortell (1994)	What are the factors associated with mortality in intensive care units?	Correlational	40 general US intensive care units	In-hospital standard mortality ratio	No association between in-hospital standard mortality ratios and RN hours per patient per shift or nurse-physician collaboration
Tourangeau (2002)	Is there a relationship between nurse staffing, nurse work environment and nurse characteristics with 30 day mortality?	Retrospective	75 Ontario, Canada hospitals	30 day post admission mortality rate	Lower 30 day mortality associated with higher RN staff mix and more years experience in clinical unit. No association between 30 day mortality and physician expertise, professional nursing practice environment, or clinical nursing education support

RN, registered nurse; ICU, intensive care unit.

physicians have successfully completed an approved residency program in one of 24 specialties of the American Board of Medical Specialties (ABMS) and have been certified by an ABMS member board (American Board of Medical Specialties; <http://www.abms.org/>). The fifth study was conducted using Canadian data. Tourangeau *et al*⁹ constructed a variable to reflect the overall level of physician preparation and specialized medical knowledge and skill. In the Canadian discharge abstract database, each patient is assigned a most responsible diagnosis (MRD). The MRD is the diagnosis contributing most to patient length of hospital stay. Associated with the MRD is a medical service code that identifies the category of physician most responsible for the medical care related to the MRD. Physician expertise was estimated as the proportion of sample patients in each hospital with a general medical practitioner as the category of medical care provider (general practitioner versus medical specialist) associated with the patient's MRD. A lower proportion indicates a physician skill mix richer in preparation and specialized knowledge and skill.

Three of these five studies found that medical care characteristics were related to lower mortality rates and the other two found no association. Hartz and colleagues found that hospitals with a higher percentage of board certified physicians per average daily census had significantly lower mortality rates.¹⁶ Manheim *et al*²² reported similar findings and found that the strongest predictor of mortality was a higher percentage of board certified physicians. Around the same time, Farley and Ozminkowski found a statistically significant negative association between the percentage of board certified physicians and mortality.²¹ Neither Schultz nor Tourangeau *et al* found a relationship between mortality and their measures of physician expertise.^{9,10} Tourangeau *et al* found a moderate correlation ($r=-0.51$, $p<0.0001$) between the proportion of registered nurses and the proportion of general practitioners.⁹ Hospitals with a richer registered nurse staff mix also tended to have a higher physician specialist skill mix.

Nurse experience and mortality

Two studies included a measure of years of registered nurse experience. Tourangeau and colleagues found that years of nurse experience on the clinical unit was significantly and inversely related to 30 day mortality in both urban and non-urban community hospitals.⁹ They found that, for each additional mean year of nurse experience on the clinical unit, there were 4–6 fewer deaths for every 1000 acute medical patients discharged (depending on hospital type). However, Sasichay-Akkadechanunt *et al*¹⁵ found no relationship between years experience as a registered nurse and patient mortality.

Registered nurse educational preparation and mortality

Two studies included a measure of nurse educational preparation. Aiken and colleagues found a statistically significant inverse relationship between the proportion of registered nurses with a baccalaureate degree and the likelihood of patients dying within 30 days of admission.¹⁴ A 10% increase in the proportion of baccalaureate prepared nurses was associated with a 5% decrease in the likelihood of patient death. However, Sasichay-Akkadechanunt and colleagues found no

relationship between the percentage of baccalaureate prepared registered nurses and patient mortality.¹⁵

Clinical nursing support and mortality

Two studies included a measure of clinical nursing support. Knaus and colleagues found that hospitals with the lowest mortality ratios had a comprehensive nursing educational support system such as clinical nurse specialists and focused nursing staff education programs.¹⁸ Findings from this study laid the foundation for the notion that clinical educational support for nursing staff is related to lower patient mortality. More recently, Tourangeau *et al*⁹ found no evidence of a relationship between the availability of professional role support resources such as clinical nurse specialists or nurse educators with mortality.

Professional nursing practice environment and mortality

A professional nursing practice environment is characterized by high levels of nurse autonomy, nurse control over their practice and setting, and effective relationships among team members. Two studies included measures of the professional nursing practice environment. A significant relationship was found in one study. Aiken and colleagues found that magnet hospitals, characterized by strong professional nursing practice environments, had significantly lower 30 day mortality than non-magnet hospitals.¹⁷ They found that magnet hospitals had five fewer deaths per 1000 discharges than non-magnet hospitals. Using a similar measure of the professional nursing practice environment, Tourangeau and colleagues did not find an association between the condition of the professional nursing practice environment and 30 day mortality in Canadian hospitals.⁹ They speculated that one reason for this unexpected finding was the low variability in practice environment scores among sample hospitals.

Summary of findings

There is incomplete and sometimes conflicting evidence of the determinants of mortality for patients in acute care hospitals. There is some consistency in findings about what are several determinants of mortality for hospitalized patients, nurse staffing characteristics and physician characteristics being the strongest predictors. Several reasons for inconsistency of findings across studies have been cited including differences in indicators used to measure common concepts, inadequate risk and case mix adjustment strategies used to account for the effects of patients' own characteristics and case mix of patients in hospitals, and lack of attribution theory that explains relationships among variables used to explore determinants of mortality.²⁴

Implications and recommendations to prevent unnecessary patient death

To address the global health policy issue of patient safety, measures must be taken to reduce risk and create environments that improve patient safety practices.²⁵ Identifying rates of adverse incidents and quality indicators such as mortality and their actual or potential consequences is insufficient knowledge to decrease adverse events and improve patient safety and

quality. Understanding determinants of such outcomes is critical to reducing adverse events and improving quality outcomes. Examining differences across hospital risk and case mix adjusted mortality rates for specific patient populations is an important patient safety monitoring activity. Differences in these rates among hospitals reflect the ability of hospitals to prevent unnecessary death. A shift towards understanding and improving the underlying causes of adverse events in health care broadens the focus to organisational, structural, and process dimensions of patient care.

As healthcare organizations emphasize and strengthen clinical practices such as use of medications to minimize mortality and promote other desirable patient outcomes, so should they also focus on strengthening organisational characteristics that have been shown to minimize patient mortality. Applying strategies that manage characteristics of hospitals shown to affect mortality, such as those described in this review, can lead to decreased mortality rates and avoidance of unnecessary patient death. For example, maximizing the proportion of registered nurses in nursing staff to provide patient care is one strategy shown to reduce mortality rates. Strategies aimed at strengthening collaborative relationships between nurses and physicians will also be effective in reducing patient mortality. Creating and nurturing hospital cultures with effective communication and collaboration among healthcare providers is essential to promoting safe patient care and can lead to avoidance of serious patient complications that, if not treated in a timely and effective manner, will lead to unnecessary or avoidable patient death.

Professional practice environments characterized as having high nurse autonomy, nurse control over their practice, strong leadership ability and support, and active participation of nurses in hospital affairs (such as in magnet hospitals) have been shown to produce better patient outcomes such as lower hospital mortality rates. Developing and supporting hospital practice environments that strengthen professional practice is one strategy that can improve the quality of care and patient safety. Such strategies may require large shifts in the balance of power and control with hospitals. Strengthening leadership knowledge and skills within the already established and future pool of nurse leaders may be required to lead this transformation and to strengthen professional practice hospital environments.

In addition, there is evidence to suggest that more years of nurse experience in the clinical area, a baccalaureate educated registered nurse workforce, effective clinical nursing support systems, and strong professional nursing practice environments might also lead to lower patient mortality. Organisational efforts to strengthen these hospital characteristics may lead to improved quality of care and patient safety.

Four strategies are suggested below for both policy development and healthcare decision making to minimize unnecessary patient death and enhance patient safety. Some of these recommendations have been previously suggested in different contexts as strategies to improve patient care quality and safety.

- Maximize the proportion of registered nurses and baccalaureate prepared registered nurses in hospital nursing staff.^{9,10,12,13,16,21,22}
- Develop and implement initiatives designed to strengthen collaborative relationships among nurses and physicians.^{18,20}

- Maximize the proportion of board certified or medical specialist care providers in hospital medical staff.^{16,21,22}
- Establish and sustain clinical nursing support systems to enhance the delivery of patient care.²⁶⁻²⁸

Conclusions

The capacity of healthcare systems to transform their environments to reduce risks for patients they serve is challenging. To address these challenges, the authors have provided an overview of the current state of science about the determinants of one important indicator of patient safety—namely, mortality rates for acute care hospitalized patients. The implications for policy and decision makers are discussed, and recommendations are made to prevent unnecessary patient death and reduce mortality rates. Further research investigating the determinants of mortality and other patient safety indicators is needed to strengthen the scientific body of patient safety knowledge that can result in the design and delivery of safer health care once translated into action.

Footnotes

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References

1. **World Health Organization.** World alliance for patient safety: forward programme. Available from <http://www.who.int/patientsafety/en> (accessed 5 March 2005).
2. **Baker GRP,** Norton G, Flintoft V, et al. The Canadian adverse events study: the incidence of adverse events among hospital patients in Canada. *Can Med Assoc J* 2004;**170**:1678–86.
3. **Leape LL,** Brennan TA, Laaird N, et al. The nature of adverse events in hospitalized patients. *N Engl J Med* 1991;**324**:377–84.
4. **Brennan TA,** Leape LL, Nan M, et al. Incidence of adverse events and negligence in hospitalized patients: results of the Harvard medical practice study. *N Engl J Med* 1991;**324**:370–6.
5. **Thomas EJ,** Studdert DM, Burstin HR, et al. Incidence and types of adverse events and negligent care in Utah and Colorado. *Med Care* 2000;**38**:261–71.
6. **Vincent C,** Neale G, Woloshynowych M. Adverse events in British hospitals: preliminary retrospective record review. *BMJ* 2001;**322**:517–9.
7. **Wilson RL,** Runciman WB, Gibberd RW, et al. The quality in Australian health care study. *Med J Aust* 1995;**163**:458–71.
8. **Schiøler T,** Lipczak H, Lilja Pedersen B, et al. Incidence of adverse events in hospitals. A retrospective study of medical records. *Ugeskr Laeger* 2001;**163**:5370–8.

9. **Tourangeau AE**, Giovannetti P, Tu JV, et al. Nursing-related determinants of 30-day mortality for hospitalized patients. *Can J Nurs Res* 2002;**33**:71–88.
10. **Schultz MA**. 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, 1997.
11. **Blegen MA**, Goode CJ, Reed L. Nurse staffing and patient outcomes. *Nurs Res* 1998;**47**:43–50.
12. **Aiken LH**, Clarke SP, Sloane DM, et al. Hospital nurse staffing and patient mortality, nurse burnout, and job satisfaction. *JAMA* 2002;**288**:1987–93.
13. **Needleman J**, Buerhaus P, Mattke S, et al. Nurse-staffing levels and the quality of care in hospitals. *N Engl J Med* 2002;**346**:1715–22.
14. **Aiken LH**, Clarke SP, Cheung RB, et al. Educational levels of hospital nurses and surgical patient mortality. *JAMA* 2003;**290**:1617–23.
15. **Sasichay-Akkadechanunt T**, Scalzi CC, Jawad AF. The relationship between nurse staffing and patient outcomes. *JONA* 2003;**33**:478–85.
16. **Hartz AJ**, Krakauer H, Kuhn EM, et al. Hospital characteristics and mortality rates. *N Engl J Med* 1989;**321**:1720–5.
17. **Aiken LH**, Smith HL, Lake ET. Lower medicare mortality among a set of hospitals known for good nursing care. *Med Care* 1994;**32**:771–87.
18. **Knaus WAE**, Draper A, Wagner DP, et al. An evaluation of outcome from intensive care in major medical centers. *Ann Intern Med* 1986;**104**:410–8.
19. **Shortell SM**, Hughes EF. The effects of regulation, competition, and ownership on mortality rates among hospital inpatients. *N Engl J Med* 1988;**318**:1100–7.
20. **Mitchell PH**, Armstrong S, Simpson TF, et al. American association of critical-care nurses demonstration project: Profile of excellence in critical care nursing. *Heart Lung* 1989;**18**:219–37.
21. **Farley DE**, Ozminkowski RJ. Volume-outcome relationships and inhospital mortality: the effect of changes in volume over time. *Med Care* 1992;**30**:77–94.
22. **Manheim LM**, Feinglass J, Shortell SM, et al. Regional variation in Medicare hospital mortality. *Inquiry* 1992;**29**:55–66.
23. **Shortell SM**, Zimmerman JE, Rousseau DM, et al. The performance of intensive care units: does good management make a difference? *Med Care* 1994;**32**:508–25.
24. **Tourangeau AE**, Tu JV. Developing risk-adjusted 30-day hospital mortality rates. *Res Nurs Health* 2003;**26**:483–96.
25. **Donaldson LJ**. Patient safety: global momentum builds. *Qual Saf Health Care* 2004;**13**:86.
26. **Aiken LH**, Clarke SP, Sloane DM. Hospital restructuring: does it adversely affect care and outcomes? *JONA* 2000;**30**:457–65.
27. **Baumann A**, O'Brien-Pallas L, Armstrong-Stassen M, et al. Commitment and care: the benefits of a healthy workplace for nurses, their patients and the system. Report submitted to the Canadian Health Services Research Foundation, Ottawa ON. Available from http://www.chsrf.ca/final_research/commissioned_research/policy_synthesis/index_e.php (accessed 5 March 2005).
28. **Canadian Nursing Advisory Committee**. Our health, our future creating quality workplaces for Canadian nurses. Final report of the Canadian Nursing Advisory Committee, Ottawa ON. Available from http://www.hc-sc.gc.ca/english/for_you/nursing/cnac_report/index.html (accessed 5 March 2005).