Submission 008

09 February 2016

10 Feb 2016

Research Director
Health and Ambulance Services Committee
Parliament House
Brisbane Qld 400

JOONDALUP CAMPUS
270 Joondalup Drive, Joondalup
Western Australia 6027
☎ 134 328
www.ecu.edu.au

To whom it may concern

RE: Submission to support the legislation of safe nurse-to-patient ratios in Queensland

I am a registered nurse with 40 years nursing experience, and am currently employed as Professor of Nursing and Dean in the School of Nursing and Midwifery at Edith Cowan University, Perth Western Australia. I have over 15 years' experience in senior executive roles, primarily as Executive Director of Nursing Services at Sir Charles Gairdner Hospital (SCGH) and was acting Western Australian Chief Nursing Officer, Department of Health for six months prior to my appointment at Edith Cowan University.

During my tenure as the Executive Director of Nursing Services, I was instrumental in making SCGH a "Magnet" designated hospital. Magnet designation is a highly coveted international award that recognises hospitals that delivery high quality care to patients through focusing on a positive practice environment for nurses. Positive practice environments influence nurses' abilities to practise professionally and therefore provide safe, high quality care. There are a number of essential elements of a positive practice environment including having an adequate numbers of nurses to provide care and investing in a highly qualified nurse workforce.

Based on my Magnet and leadership experience, I have developed research interests that focus on investigating the relationships between nursing workforce, patient outcomes and quality care. These interests have led me to publish several peer reviewed papers on the matter, two of which I am submitting to the Health and Ambulance Service Committee in support of the nurse-to-patient ratios legislation in Queensland.

The first paper, "*The critical role of nurses to the successful implementation of the National Safety and Quality Health Service Standards*" published in the Australia Health Review in 2013, establishes the significant role nurses have in achieving compliance with the National Safety and Quality Health Service Standards. The standards were developed by the Australian Council on Healthcare Standards and have been endorsed for implementation by the Australian Health Ministers. The standards form the basis for health service accreditation and are the leading driver of quality and safety in healthcare performance.

Nurses play a significant role in the successful implementation of the National Safety and Quality Health Service Standards and therefore patient safety. Nine of the ten standards primarily require practice change at the ward level where nurses are the primary caregivers 24 hours per day. A number of the standards are identified as nurse-sensitive outcomes, which means the quality of patient outcomes achieved are influenced by nursing inputs such as staffing numbers, skill mix and practice environment. Research outlined in the paper has established more nursing hours per patient per day combined with higher numbers of registered nurses and an optimal practice environment is associated with improved patient outcomes and increased hospital efficiency.

The contribution of nursing in the delivery of safe, high quality healthcare peaks when there is a sufficient supply of appropriately skilled direct care nurses to meet the patient requirements. Direct care nurses are those who provide clinical care directly at the beside. Policy directions supporting health services to be more accountable for implementing safe nurse staffing levels will more than likely lead to improvements in patient safety and the quality of patient outcomes. The Queensland Government's resolution to legislate and regulate nurse-to-patient ratios increases

the likelihood of safe staffing levels being adhered to and Australian Council on Healthcare Standards accreditation being achieved in Hospital and Health Services.

The second paper, "*The economic benefits of increased levels of nursing care in the hospital setting*" published in the Journal of Advanced Nursing in 2013, refers to a longitudinal study investigating the economic impact of increased nursing hours of care on health outcomes in adult teaching hospitals in Perth, Western Australia. A key finding from this study was that increases in nursing hours per patient per day were cost-effective when compared with threshold interventions commonly accepted in Australia. This outcome was determined by comparing the reduction in adverse events and associated costs per life year gain before and after the increase in nursing hours.

For example, the study determined that increased nursing hours resulted in 1088 life years gained based on reductions in the number of 'failure to rescue' (death of a patient after a treatable complication has occurred) adverse events. The cost per life year gained was $8,907, which when compared to the cost-effective threshold in Australia of $30-60,000 per life year gained is efficient.

This study strengthens the economic case for investing in staffing methodologies that promote sufficient nursing hours and skill mix based on the efficiencies gained from reductions in the number of preventable adverse events experienced by patients. Investing in more nursing hours with a richer skill mix may involve costs upfront however, the long-term benefits for patients and health services are undeniable. There is much to be gained from legislating and regulating nurse-to-patient ratios in Queensland.

Yours sincerely,

Professor Di Twigg
Dean
School of Nursing and Midwifery
Edith Cowan University

CSIRO PUBLISHING
Australian Health Review
http://dx.doi.org/10.1071/AH12013

Feature

The critical role of nurses to the successful implementation of the National Safety and Quality Health Service Standards

Diane E. Twigg[1,2,4] RN, RM, PhD, Professor, Head of School, Research Consultant
Christine Duffield[3] RN, PhD, Associate Dean (Research)
Gemma Evans[1] RN, BSc(Hons), Research Assistant

[1]School of Nursing and Midwifery, Edith Cowan University, Joondalup, WA 6027, Australia. Email: g.evans@ecu.edu.au
[2]Sir Charles Gairdner Hospital, Hospital Ave, Nedlands, WA 6009, Australia.
[3]Director, Centre for Health Services Management, Faculty of Nursing, Midwifery and Health, University of Technology, Sydney, NSW 2007, Australia. Email: christine.duffield@uts.edu.au
[4]Corresponding author. Email: d.twigg@ecu.edu.au

Abstract. The National Safety and Quality Health Service Standards requires health service compliance by 2013 and covers several areas including governance arrangements, partnerships with consumers and eight key clinical processes. Nurses in Australia comprise 62% of the hospital workforce, are the largest component and hence play a critical role in meeting these standards and improving the quality of patient care. Several of the standards are influenced by nursing interventions, which incorporate any direct-care treatment that the nurse performs for a patient that may be nurse or physician initiated. The ability for nurses to undertake these interventions is influenced by the hours of care available, the skill mix of the nursing workforce and the environment in which they practice. Taking into consideration the predicted nursing shortages, the challenge to successfully implement the National Safety and Quality Health Service Standards will be great. This paper examines the role of nursing in the delivery of the National Standards, analyses the evidence with regard to nursing-sensitive outcomes and discusses the implications for health service decision makers and policy.

What is known about the topic? The National Safety and Quality Health Service Standards have been endorsed for implementation by the Australian Health Ministers. Compliance with the National Safety and Quality Health Service Standards is required by Health Services in 2013. Nurses play a critical role in providing high-quality patient care and meeting accreditation standards. A decline in nursing standards is associated with inadequate staffing levels and skill mix and a lack of effective leadership and results in an increase in patient mortality.

What does this paper add? The role of nurses in achieving compliance with the standards is discussed. We demonstrate that the capacity for nurses to undertake interventions is influenced by prevailing workforce characteristics. Significant nursing shortages have been identified as possible challenges to successfully implementing the National Safety and Quality Health Service Standards.

What are the implications for practitioners? Practitioners need to review nursing hours of care, skill mix and the practice environment as part of the actions required to achieve the National Quality and Safety Standards. The Australian Commission on Safety and Quality in Health Care has the opportunity to take the lead by including such indicators in the measurement of hospital performance.

Received 3 December 2012, accepted 19 May 2013, published online 21 August 2013

Introduction

Health service accreditation has become a leading driver of quality and safety in the healthcare sector as a means of monitoring and promoting healthcare performance against optimal standards.[1] However, due to a lack of evidence, the capacity of accreditation to provide high-quality and safe patient care is contested.[2]

In the Australian context, a critical component of the Health Services Safety and Quality Accreditation Scheme is the National Safety and Quality Health Service Standards. These standards were approved by Australian Health Ministers in September 2011 and require Health Service compliance by 2013. The standards cover several areas including governance arrangements, partnerships with consumers and eight key clinical processes.[3] Although the Standards do not link specifically to the contribution of any particular health discipline, there is no denying the fact that nurses comprise around 62% of the Australian hospital clinical workforce.[4] As a consequence, it is likely

that they will play a critical role in meeting these standards and improving the quality of care. Importantly, several of the standards are nursing-sensitive, that is, the standards are sensitive to nursing care and care delivered collaboratively with other clinicians.[5] The capacity for nurses to undertake interventions and provide quality care is influenced by the hours of care available, the skill mix of the nursing workforce (that is, the proportion of the hours of care provided by registered nurses) and the environment in which they practice. These characteristics are associated with changes in the rates of adverse events.[6–8] Given the predicted extensive shortage of nurses[9] there will be great challenges to the successful implementation of the National Safety and Quality Health Service Standards. This paper examines the role of nursing in the delivery of the National Standards, analyses the evidence with regard to nursing-sensitive outcomes, especially those also identified as a standard in the National Safety and Quality Health Service Standards, and discusses the implications for health service policy and decision makers.

National Safety and Quality Health Service Standards

The National Safety and Quality Health Service Standards were developed with the goal of protecting the public from harm and improving the overall quality of health care.[3] The first two standards provide an overarching governance framework and recognise the importance of engagement with consumers. The remaining eight standards focus on specific clinical outcomes and take a systems approach to the prevention of adverse events and include;

> 'preventing and controlling healthcare associated infections, medication safety, patient identification and procedure matching, clinical handover, blood and blood products, preventing and managing pressure injuries, recognising and responding to clinical deterioration in acute health care and preventing falls and harm from falls.'[3] (p.3)

Each standard has criteria identifying key components of the Standard and then identified actions designed to achieve the Standard. For example, the Preventing Falls and Harm from Falls standard identifies criteria around governance, risk assessment, introduction of prevention strategies and engagement of consumers by identification of the risks and prevention strategies. Required actions are then identified such as appropriate policies and data monitoring, provision of appropriate equipment, utilisation of best-practice risk-assessment tools to comprehensively assess risk, implementation of prevention and harm minimisation care plan and care plan development with the patient and carers.[3] These Standards have become a part of the process of accreditation for health services and are an important barometer for the quality of healthcare that will be provided in this country.

Role of nurses and nursing in patient safety

Several seminal reports that have recently emanated from the United States have begun to articulate the importance of nurses and nursing care in patient safety. One of the first and arguably most significant was published by the USA Agency for Healthcare Research and Quality, titled *Keeping Patients Safe: Transforming the Work Environment of Nurses*.[10] It identified several threats to patient safety, including inadequate training and insufficient supervision, inadequate workforce deployment, poor work and equipment design, poorly structured operations and inadequate and poorly maintained equipment. More importantly, the report identified that nurses, as the largest component of the workforce, play a central role in patient safety as they provide the most direct care, observe for clinical changes and initiate rescue activities, and coordinate and integrate care services from multiple providers. The importance of nurses to patient safety is further highlighted in data from the Joint Commission on the Accreditation of Healthcare Organisations database on sentinel events.[10] Nineteen percent of total errors reported over a 7-year period, 1995–2002, identified nurse staffing levels as a causal factor. Other factors included inadequate staff orientation and training and a breakdown in communication.

Important though these reports are, they do not explicitly articulate the role that nurses play in patient safety. However, over the past decade there has been a growing body of national and international research that is doing so. There is now increasing acceptance that several nursing-sensitive outcomes get to the essence of how nurses impact patients' safety and health status. Known variously as nursing-sensitive patient outcomes, or nursing/nurse-sensitive outcomes, these are outcomes that, as mentioned earlier, are influenced by care provided by nurses and other clinicians.[5] Nursing-sensitive outcomes were first developed by Needleman, Buerhaus, Mattke, Stewart and Zelevinsky,[11] who developed cohorts of patients using a combination of International Classification of Diseases-9 codes, diagnosis-related groups and major diagnostic categories, presence of a surgical procedure and age. Each algorithm specified an inclusion and exclusion criterion that was specific to the adverse outcome, identifying only patients who experienced a truly preventable adverse outcome rather than one associated with the disease process. For example, the deep vein thrombosis (DVT)/pulmonary embolism (PE) algorithm specified that discharge records with a secondary diagnosis of DVT or PE qualified as a nursing-sensitive patient outcome; however, discharge records with a primary diagnosis of DVT or PE did not qualify. The specific nursing-sensitive outcomes developed were central nervous system complications, DVT or PE, decubitus ulcer (pressure injuries), gastrointestinal bleeding, sepsis, shock or cardiac arrest, urinary tract infection, failure to rescue, physiologic or metabolic derangement, pneumonia, pulmonary failure, wound infections, mortality and length of stay (Table 1).

Multiple studies have now used some or all of these outcome measures to examine the impact that nursing staff numbers (related to the hours of care patients receive) and mix (proportion of care provided by registered nurses) have on patient outcomes, resulting in their international acceptance as reliable measures of nursing-sensitive outcomes.[12–15] These outcome measures have also been used in Australia.[7,16,17] Consistently the results are the same – the more hours of care patients receive the better their outcomes. Higher nursing hours is associated with lower pressure-ulcer rates, medication errors, injuries, falls and length of stay.[18–20] More importantly, when registered nurses provide this care, patient outcomes are even better[21] with a 3–12% reduction in adverse outcomes with higher registered nurse staffing levels[18].

A review of more than 100 peer-reviewed papers supports an association between lower nurse staffing and poorer patient outcomes in hospitals.[22] Lower registered nurse staffing levels are

Table 1. Nursing-sensitive patient outcomes included in the study
Adapted from Needleman *et al.*[11]

Item	Detail
Central nervous system complications	Complications such as confusion or delirium. Nurses intervene to create a supportive environment, such as structuring sleep patterns.
Deep vein thrombosis/ pulmonary embolism	Thromboses are frequently related to periods of immobility. Early and frequent mobilisation of patients is an important nursing activity.
Decubitus ulcer (pressure injury)	Decubitus ulcers are caused by prolonged pressure on skin areas, usually due to immobility. Mobilisation and positioning of patients are central nursing activities.
Ulcer/gastritis/gastrointestinal bleeding	In most cases, gastrointestinal ulcerations and bleeding are stress-related complications in hospital patients. Nursing plays a role in relieving psychological stress and detecting ulcers at an early stage.
Pneumonia	Two key risk factors for hospital-acquired pneumonia are prolonged immobility, which leads to inadequate ventilation of parts of the lungs, and inappropriate or failure to perform pulmonary hygienic techniques. Nursing care influences both risk factors.
Sepsis	Sepsis, defined as life-threatening and systemic infection, can result when a hospital-acquired infection is left untreated. The two most frequent hospital-acquired infections (urinary tract infection and pneumonia) are considered to be nursing-sensitive.
Shock/cardiac arrest	Both pulmonary failure and cardiac arrest are endpoints to a continuous deterioration in a patient's status. Nurses play an important surveillance role.
Urinary tract infection	Urinary tract infection is a frequent complication in hospitalised patients, particularly those with indwelling urinary catheters. Infection can result from inattention to sterile techniques when placing indwelling urinary catheters or from inadequate attention to time consuming toileting programs for incontinent patients.
Failure-to-rescue	Defined as mortality of patients who experienced a hospital-acquired complication, studies have shown failure-to-rescue is related to hospital quality and nursing. The underlying rationale is that excellent care is more likely to prevent patients with complications from dying.
Physiologic/metabolic derangement[A]	Imbalances in electrolytes and blood sugar levels are very common in hospital patients. Given the central role of nurses in patient monitoring and reporting abnormal laboratory values to the treating team, slight imbalances can be detected quickly and corrected in a timely manner in well staffed hospitals.
Pulmonary failure[A]	Both pulmonary failure and cardiac arrest are endpoints to a continuous deterioration in a patient's status.
Surgical wound infection[A]	Because nurses are responsible for pre-operative preparation of patients, which includes skin cleansing and administration of antibiotics, surgical wound infections could be influenced by the quality of nursing care.
Mortality	Several studies have related mortality to nurse staffing patterns in hospitals.
Length of stay	Nurses play an important role in discharge planning. They can ensure that patients are not discharged prematurely or kept in the hospital for too long thus exposing them to hospital acquired complications.

[A]Only evaluated in surgical patients.

associated with an increase in adverse events such as falls, urinary tract infections, pressure injuries, nosocomial infections and failure-to- rescue.[18] However, increased failure to rescue, patient mortality, respiratory tract infections and decreased quality of care have been significantly related to high nursing workloads.[20]

A comparative study conducted by Twigg *et al.*[17] found variations in nursing-sensitive outcomes associated with changes in skill mix (proportion of registered nurse hours). By increasing registered nurse hours an associated decrease in the rates of eight nursing-sensitive outcomes was identified. Patients in hospitals with an average skill mix of 81.5–84.1% experienced improvements in four or five nursing-sensitive outcomes. In contrast to this the hospital with the highest skill mix of 88.5% did not have any improvements in nursing-sensitive outcomes. The authors suggested that for determining policy around nurse staffing levels, a skill mix of between 88 and 90% would be appropriate.

Studies have also linked the nursing work environment to improved patient outcomes. An empowering work environment was found to influence nurses' ability to practise professionally and therefore provide safe quality care.[23,24] The hospital work environment has been found to influence mortality when estimated separately and jointly with registered nurse staffing and a more educated workforce.[6] Australian work found that care deteriorated when nurses perceived an unsafe work environment and where resources such as leadership and ancillary staff were lacking, resulting in tasks being left undone, especially the comforting and teaching tasks, and overtime increased.[7] Strong evidence exists that workforce staffing and the design of workflow affect the number of errors and patient safety outcomes.[25]

Role of nursing and nurses with the National Safety and Quality Health Service Standards

Nurses can play a significant role in patient safety and importantly, in this country, to the successful implementation of the National Safety and Quality Health Service Standards. With the exception of the Governance standard, the remaining nine National Safety and Quality Health Service Standards primarily require practice change at the ward or unit level where nurses are the primary caregivers 24 h per day, 7 days per week. Importantly, several of the National Safety and Quality Health Service Standards also include nursing-sensitive outcomes and therefore successful implementation would be influenced by the number, skill mix and practice environment in which nurses work.

For example, the actions required to prevent and manage pressure injuries and prevent falls and harm from falls are primarily nursing functions in acute care. The ability to utilise

the screening tool to identify at-risk patients and implement best-practice plans to minimise the risk and document these activities is influenced by the number of nurses on the shift, the educational preparation of those nurses and their work environment. If showering and other activities that enable inspection and maintenance of skin integrity are routinely done by non-qualified staff, then the time available to registered nurses to assess skin integrity is far less. Equally, if there are fewer nurses on duty then less time is available to educate the patient and carers about the risk of pressure injuries or falls and the plan developed to minimise the risk. If the nursing workforce is inadequate then the incidence of pressure injuries and falls will increase.[18–20] Similarly, for nurses to manage blood transfusions, administer medications and accurately record in the patient clinical record adverse reactions to blood or blood products or medications requires sufficient resources.

In addition, the National Safety and Quality Health Service Standard 9 recognises that unexpected death and cardiac arrest are often preceded by observable abnormal clinical changes.[3] The early identification and actioning of patient deterioration reduces adverse events and minimises the interventions required to stabilise patients. Nurses are critical to this process of early recognition and action in the ward environment. When nurses do not have sufficient staffing numbers and expertise, early detection does not occur resulting in failure-to-rescue or inability to save a life following a complication. Multiple studies identify increases in failure- to-rescue when nursing resources are inadequate.[8,26–28]

There have been several strategies aimed at enhancing the surveillance role of nurses by freeing time to provide care. For example, introduction of the Assistant in Nursing role in acute care in Western Australia was undertaken to complement the existing nursing workforce. By providing an unregulated worker to work alongside the nurse, more nursing resources are available to the ward as other nurses are no longer called away from their duties to assist a colleague with patients requiring high levels of physical care.[29] Several hospitals in Australia have now adopted this initiative.[30] Another example is the UK National Health Service Productive Ward initiative aimed at improving ward processes and environments to help nurses spend more time on patient care thereby improving safety and efficiency.[31] However, Stafford hospital in the UK found evidence that an unacceptable standard of nursing care was prevalent throughout the hospital with healthcare support workers (or Assistants in Nursing) providing the most intimate and vital care to patients at their most vulnerable. In this instance neither the patients nor the public were provided adequate protection from those who were unfit to perform this role, contributing to high patient mortality.[32]

Much of the healthcare reform is focussed on reducing hospital bed days (and cost) by reducing length of stay, more community care and different models to manage chronic diseases.[31] These changes have also increased job opportunities for nurses especially in advanced practice roles[33] often removing them from the ward environment. This 'shift' in staffing will exacerbate the current and projected workforce shortages, which will impact negatively on the provision of care 24/7 at the bedside, which drives the primary need for a hospital admission and care.[34]

Impact of nursing workforce shortages

The importance of nurses in the achievement of the National Safety and Quality Health Service Standards is clear but will not be without challenges. There have been significant and prolonged shortages in the nursing workforce in this country and, unfortunately, recent evidence suggests this will continue. A Health Workforce Australia report[9] identified a projected shortage of 20 079 nurses in 2016 increasing to 109 490 in 2025. Should Australia aim to have less reliance on migration and achieve medium self-sufficiency in its nursing workforce, the shortage in 2025 would increase to 129 818 nurses. Nursing shortages have the potential to result in less hours of care provided to patients by a qualified (regulated) workforce, which will result in an increase in adverse events rather than the desired decrease resulting from implementation of the new Standards. One example from Ontario, Canada found that medical and surgical units with a lower proportion of regulated nursing staff (registered nurses or registered practical nurses) to unregulated staff had higher rates of medication errors and wound infections.[35]

Strategies are available to healthcare services to mitigate the impact of the nursing workforce shortages. The Health Workforce Australia report[9] suggests that if retention was improved by sustaining nurse exit rates at the 2% found during the Global Financial Crisis the total nursing workforce shortage would fall to 25 000 in 2025. This equals a reduction in projected shortages of over 100 000 nurses, a significant change. A major strategy available to improve nurse retention is improving the practice environment in which nurses work, which is more effective than increasing recruitment or salaries.[36] Naude and McCabe[37] found that several factors motivated nurses to remain in a hospital. Supportive or friendly staff, supportive or effective management and a good physical environment with adequate equipment improved job satisfaction and enhanced retention. These factors relating to the work environment were critical in nurses' decisions about whether or not they stayed at that hospital.[37] Clarke and Aiken also found that health services that managed staffing effectively, invested in nursing education and implemented strategies to create positive work environments had more satisfied nurses.[38] Effectively managing nurse staffing, nurse education and the practice environment provide three options to improve nurse retention and minimise the risk of adverse events for patients.[6]

The nurse's role in surveillance and rescue of patients from harm in the goal of reducing preventable adverse events can only be realised if there are sufficient nurses to provide appropriate care. The US leads in this regard as policies are being put in place to improve patient safety by reporting nurse staffing, skill mix and patient outcomes. At least 14 states in the US have enacted mandated nurse staffing in some form[39] by requiring hospitals to be accountable for implementing nurse staffing plans with input from direct care nurses, legislating or regulating to mandate specific nurse-to-patient ratios or requiring facilities to release staffing levels to the public and/or a regulatory body.[39] In Australia, no such policies have been put in place. There is opportunity for the Australian Commission on Safety and Quality in Health Care to take the lead in this regard and include nursing hours of care, skill mix and measures of the practice environment as valuable indicators by which hospital performance could be assessed. Studies have shown that a higher registered nurse

staffing level or more nurse hours per patient day have the potential to reduce hospital costs[40] through improved patient outcomes, such as decreased rates of pressure ulcers, urinary tract infections and length of stay.[41] Two Australian studies also identified a reduction in failure-to-rescue, surgical wound infection, pulmonary failure, ulcer, gastritis, upper gastrointestinal bleed and cardiac arrest as a result of increased nursing hours of care.[7,42]

Conclusion

Strategies focussed on integration of the quality and safety agenda, nurse staffing and the practice environment have the potential to make significant inroads into the reduction in adverse events. There are several strategies that can be implemented, such as the addition of support roles that will improve productivity and free up time to provide more care and increasing nurse retention to increase workforce capacity. These strategies coupled with the initiatives being progressed through the National Safety and Quality Health Service Standards provide a real opportunity to reduce adverse events and improve the quality of care in the Australian healthcare system. Any strategy that will ensure patients are kept safe and adverse events are reduced will ultimately also impact on efficiencies in the healthcare system, providing further benefits.

Competing interests

No conflict of interest has been declared by the authors.

References

1 Hinchcliff R, Greenfield D, Moldovan M, Westbrook JI, Pawsey M, Mumford V, *et al.* Narrative synthesis of health service accreditation literature. *BMJ Qual Saf* 2012; 21(12): 979–91. doi:10.1136/bmjqs-2012-000852

2 Greenfield D, Braithwaite J. Health sector accreditation research: a systematic review. *Int J Qual Health Care* 2008; 20(3): 172–83. doi:10.1093/intqhc/mzn005

3 Australian Commission on Safety and Quality in Health Care. National safety and quality health service standards. Sydney: Australian Commission on Safety and Quality in Health Care; 2011. Available at http://www.safetyandquality.gov.au/wp-content/uploads/2011/09/NSQHS-Standards-Sept-2012.pdf [verified 12 September 2012]

4 Australian Institute for Health and Welfare. Australian hospital statistics 2010–11. Canberra: AIHW; 2012. Available at http://www.aihw.gov.au/publication-detail/?id=10737421633&tab=2 [Verified 10 September 2012]

5 Given B, Beck S, Etland C, Gobel BH, Lamkin L, Marsee VD. Nursing-sensitive patient outcomes – description and framework. Pittsburgh: Oncology Nursing Society; 2004. Available at http://www.ons.org/Research/NursingSensitive/Description [verified 6 September 2012]

6 Aiken LH, Clarke SP, Sloane DM, Lake ET, Cheney T. Effects of hospital care environment on patient mortality and nurse outcomes. *J Nurs Adm* 2008; 38(5): 223–9. doi:10.1097/01.NNA.0000312773.42352.d7

7 Duffield C, Diers D, O'Brien Pallas L, Aisbett C, Roche M, King M, *et al.* Nursing staffing, nursing workload, the work environment and patient outcomes. *Appl Nurs Res* 2011; 24: 244–55. doi:10.1016/j.apnr.2009.12.004

8 Needleman J, Buerhaus P, Mattke S, Stewart M, Zelevinsky K. Nurse-staffing levels and the quality of care in hospitals. *N Engl J Med* 2002; 346(22): 1715–22. doi:10.1056/NEJMsa012247

9 Health Workforce Australia. Health workforce 2025 – doctors, nurses and midwives. Vol. 1. Adelaide: Health Workforce Australia; 2012.

10 Page A, ed. Keeping patients safe: transforming the work environment of nurses. Washington DC: National Academies Press; 2004.

11 Needleman J, Buerhaus P, Mattke S, Stewart M, Zelevinsky K. Nurse staffing and patient outcomes in hospitals. Boston: Harvard School of Public Health; 2001.

12 Aiken LH, Cimiotti JP, Sloane DM, Smith HL, Flynn L, Neff DN. Effects of nurse staffing and nurse education on patient deaths in hospitals with different nurse work environments. *Med Care* 2011; 49(12): 1047–53. doi:10.1097/MLR.0b013e3182330b6e

13 Rafferty AM, Clarke SP, Coles J, Ball J, James P, McKee M, *et al.* Outcomes of variation in hospital nurse staffing in English hospitals: cross-sectional analysis of survey data and discharge records. *Int J Nurs Stud* 2007; 44: 175–82. doi:10.1016/j.ijnurstu.2006.08.003

14 Tourangeau AE. Nursing skill mix and experience reduce patient mortality. *Hosp Q* 2002; 5(3): 19–20.

15 McCloskey BA, Diers DK. Effects of New Zealand's health reengineering on nursing and patient outcomes. *Med Care* 2005; 43(11): 1140–6. doi:10.1097/01.mlr.0000182549.85761.cd

16 Twigg D, Duffield C, Bremner A, Rapley P, Finn J. The impact of the nursing hours per patient day (NHPPD) staffing method on patient outcomes: a retrospective analysis of patient and staffing data. *Int J Nurs Stud* 2011; 48: 540–8. doi:10.1016/j.ijnurstu.2010.07.013

17 Twigg D, Duffield C, Bremner A, Rapley P, Finn J. Impact of skill mix variations on patient outcomes following implementation of nursing hours per patient day staffing: a retrospective study. *J Adv Nurs* 2012; 68: 2710–2718. doi:10.1111/j.1365-2648.2012.05971.x

18 Stanton MW. Hospital nurse staffing and quality of care. Research in action. 2004. Available at http://www.ima.org.il/Ima/FormStorage/Type7/ahrq58.pdf [Verified 5 September 2012]

19 Kane RL, Shamliyan TA, Mueller C, Duval S, Wilt TJ. Nursing staffing and quality of patient care. Evidence report/technology assessment no. 151. Rockville, MD: Agency for Healthcare Research and Quality; 2007. Available at http://www.ahrq.gov/downloads/pub/evidence/pdf/nursestaff/nursestaff.pdf [verified 11 March 2008]

20 Pearson A, O'Brien-Pallas LL, Thomson D, Doucette E, Tucker D, Wiechula R, *et al.* Systematic review of evidence on the impact of nursing workload and staffing on establishing healthy work environments. *Int J Evid-Based Healthc* 2006; 4: 337–84. doi:10.1111/j.1479-6988.2006.00055.x

21 Kane RL, Shamliyan TA, Mueller C, Duval S, Wilt TJ. The association of Registered Nurse staffing levels and patient outcomes. *Med Care* 2007; 45(12): 1195–1204. doi:10.1097/MLR.0b013e3181468ca3

22 Clarke SP. Nurse staffing in acute care settings: research perspectives and practice implications. *Jt Comm J Qual Improv* 2007; 33(11): 30–44.

23 Spence Laschinger HK, Almost J, Tuer-Hodes D. Workplace empowerment and magnet hospital characteristics: making the link. *J Nurs Adm* 2003; 33(7/8): 410–22. doi:10.1097/00005110-200307000-00011

24 Upenieks V. What's the attraction to magnet hospitals? *J Nurs Manage* 2003; 34(2): 43–4. doi:10.1097/00006247-200302000-00014

25 Clancy CM, Farquhar MB, Sharp BA. Patient safety in nursing practice. *J Nurs Care Qual* 2005; 20(3): 193–7. doi:10.1097/00001786-200507000-00001

26 Aiken LH, Clarke SP, Cheung RB, Sloane DM, Silber JH. Educational levels of hospital nurses and surgical patient mortality. *J Am Med Assoc* 2003; 290(12): 1617–23. doi:10.1001/jama.290.12.1617

27 Aiken LH, Clarke SP, Sloane DM, Sochalski JA, Silber JH. Hospital nurse staffing and patient mortality, nurse burnout, and job dissatisfaction. *JAMA* 2002; 288(16): 1987–93. doi:10.1001/jama.288.16.1987

28 Esparza SJ, Zoller JS, White AW, Highfield MEF. Nurse staffing and skill mix patterns: are there differences in outcomes? *J Healthc Risk Manag* 2012; 31(3): 14–23. doi:10.1002/jhrm.20092

29 Government of Western Australia Dohnam. Assistant in nursing (acute care) traineeship. Duties and competencies of the qualified acute care AIN. Western Australia: Government of Western Australia, Department of Health Nursing and Midwifery; 2013.
30 Department of Health NSW. Employment of assistants in nursing (AIN) in NSW health acute care. NSW: Department of Health; 2010.
31 National Health Service. Rapid impact assessment of the productive ward: releasing time to care. Coventry, UK: NHS Institute of Innovation and Improvement; 2011.
32 Francis R. Report of the Mid Staffordshire NHS Foundation Trust public inquiry. London: United Kingdom NHS; 2013.
33 Duffield C, Gardner G, Chang AM, Catling-Paull C. Advanced nursing practice: a global perspective. *Collegian* 2009; 16: 55–62. doi:10.1016/j.colegn.2009.02.001
34 Diers D, Potter J. Understanding the unmanageable nursing unit with case mix data: a case study. *J Nurs Adm* 1997; 27(11): 27–32. doi:10.1097/00005110-199711000-00007
35 McGillis Hall L, Doran D, Pink G. Nurse staffing models, nursing hours, and patient safety outcomes. *J Nurs Adm* 2004; 34(1): 41–5. doi:10.1097/00005110-200401000-00009
36 Hayes LJ, O'Brien-Pallas L, Duffield C, Shamian J, Buchan J, Hughes F, *et al.* Nurse turnover: a literature review. *Int J Nurs Stud* 2006; 43(2): 237–63.
37 Naude M, McCabe R. Magnet hospital research pilot project conducted in hospitals in Western Australia. *Contemp Nurse* 2005; 20(1): 38–55. doi:10.5172/conu.20.1.38
38 Clarke SP, Aiken LH. An international hospital outcomes research agenda focussed on nursing: lessons from a decade of collaboration. *J Clin Nurs* 2008; 17: 3317–23. doi:10.1111/j.1365-2702.2008.02638.x
39 American Nurses Association. Nurse staffing plans and ratios. Silver Spring: American Nurses Association; 2009. Available at http://www.nursingworld.org/mainmenucategories/ANAPoliticalPower/State/State-LegislativeAgenda/StaffingPlansandRatios_1.aspx [verified 3 February 2012]
40 Titler M, Dochterman J, Kim T, Kanak M, Shever L, Picone DM, *et al.* Cost of care for seniors hospitalized for hip fracture and related procedures. *Nurs Outlook* 2007; 55(1): 5–14. doi:10.1016/j.outlook.2006.06.006
41 Thungjaroenkul P, Cummings GC, Embleton A. The impact of nurse staffing on hospital costs and patient length of stay: a systematic review. *Nurs Econ* 2007; 25(5): 255–65.
42 Twigg D, Geelhoed EA, Bremner A, Duffield C. The economic benefits of increased levels of nursing care in the hospital setting. *J Adv Nurs* 2013; doi:10.1111/jan.12109

JAN JOURNAL OF ADVANCED NURSING

ORIGINAL RESEARCH

The economic benefits of increased levels of nursing care in the hospital setting

Diane E. Twigg, Elizabeth A. Geelhoed, Alexandra P. Bremner & Christine M. Duffield

Accepted for publication 19 January 2013

Correspondence to D.E. Twigg:
e-mail: twigg@ecu.edu.au

Diane E. Twigg PhD RN RM
Professor of Nursing and Head of School
School of Nursing and Midwifery, Edith Cowan University, Joondalup, Western Australia, Australia
and Sir Charles Gairdner Hospital, Perth, Western Australia, Australia

Elizabeth A. Geelhoed PhD MPH BEc
Professor
School of Population Health, The University of Western Australia, Perth, Australia

Alexandra P. Bremner BSc(Hons) PhD
Assistant Professor
School of Population Health, The University of Western Australia, Perth, Australia

Christine M. Duffield PhD RN
Professor and Associate Dean (Research)
Director Centre for Health Services Management, Faculty of Nursing, Midwifery and Health, University of Technology, Sydney, Sydney, New South Wales, Australia

TWIGG D.E., GEELHOED E.A., BREMNER A.P. & DUFFIELD C.M. (2013) The economic benefits of increased levels of nursing care in the hospital setting. *Journal of Advanced Nursing* 69(10), 2253–2261. doi: 10.1111/jan.12109

Abstract

Aim. To assess the economic impact of increased nursing hours of care on health outcomes in adult teaching hospitals in Perth, Western Australia.

Background. Advancing technology and increased availability of treatment interventions are increasing demand for health care while the downturn in world economies has increased demand for greater efficiency. Nurse managers must balance nurse staffing to optimize care and provide efficiencies.

Design. This longitudinal study involved the retrospective analysis of a cohort of multi-day stay patients admitted to adult teaching hospitals.

Methods. Hospital morbidity and staffing data from September 2000 until June 2004, obtained in 2010 from a previous study, were used to analyse nursing-sensitive outcomes pre- and post-implementation of the Nurse Hours per Patient Day staffing method, which remains in place today. The cost of the intervention comprised increased nursing hours following implementation of the staffing method.

Results. The number of nursing-sensitive outcomes was 1357 less than expected post-implementation and included 155 fewer 'failure to rescue' events. The 1202 other nursing-sensitive outcomes prevented were 'surgical wound infection', 'pulmonary failure', 'ulcer, gastritis', 'upper gastrointestinal bleed', and 'cardiac arrest'. One outcome, pneumonia, showed an increase of 493. Analysis of life years gained was based on the failure to rescue events prevented and the total life years gained was 1088. The cost per life year gained was AUD$8907.

Conclusion. The implementation of the Nurse Hours per Patient Day staffing method was cost-effective when compared with thresholds of interventions commonly accepted in Australia.

Keywords: cost-effectiveness, health policy, healthcare quality, nurses, patient outcomes, staffing

Introduction

This article discusses the economic benefits of increased levels of nursing care and reports the findings of a study that assessed the cost-effectiveness of increased nursing care on health outcomes. It builds on previous analysis (Twigg *et al.* 2011, 2012) by examining the cost-effectiveness of the staffing method and by 'incorporating a more complex individual measure of patient risk aggregated by hospital' (Twigg *et al.* 2011). To date an economic evaluation has not been undertaken in an Australian setting.

Background

The recent downturn in world economies has increased pressure on public and private health services to increase efficiency in an environment where advancing technology and increased availability of treatment interventions are increasing the demand for health care. Seventy-two percent of the recurrent cost per 'case-mix-adjusted' separation is staff related (medical and non-medical labour) (Australian Institute for Health & Welfare 2010) and as nursing is the largest workforce in health, nurse managers are increasingly forced to make difficult decisions. Nurse managers must decide the number and mix of nursing staff needed to optimize safe patient care within the limitations of budgetary constraints (Twigg & Duffield 2009). In a recent report, the Australian Nursing Federation (2009) observed that excessive workloads are common in the Australian healthcare setting. Nursing workloads and patient outcomes are inextricably linked (Aiken *et al.* 2002). Simply put: 'If there are not enough nurses, the workload for each nurse is increased' (Australian Nursing Federation 2009). Inadequate time reduces nurses' ability to deliver adequate patient care and forces nurses to leave work undone which directly has an impact on patient outcomes (Kalisch 2006, Duffield *et al.* 2011).

Higher nurse staffing levels and a richer skill mix [a higher proportion of registered nurse (RN) hours] have been linked with improved patient outcomes in many studies (Aiken *et al.* 2003, 2002, b, Rafferty *et al.* 2007, Tourangeau *et al.* 2007, Kane *et al.* 2007). Fifteen states and one district in the USA have enacted regulations or legislation aimed at improving nurse staffing. California was the first state to do so in 1999 and numerous studies about the impact of these changes have been undertaken (Donaldson & Shapiro 2010). A synthesis of these studies found that the nurse-to-patient ratio fell and the nursing hours per patient day increased. However, the authors did not establish any significant impact on patient safety indicators (Donaldson & Shapiro 2010) although they noted that adverse outcomes did not increase despite the case-mix index suggesting a sicker patient group. On the other hand, Aiken *et al.* (2010) found the mandated ratios in California were associated with lower mortality when compared with two states (Pennsylvania and New Jersey) without legislation. The continuous (24 hour 7 days a week) surveillance provided by RNs is key to early detection and prompt intervention for deteriorating patients (Aiken *et al.* 2002, b, Estabrooks *et al.* 2005). Nurses also have the capacity to proactively minimize adverse events and subsequent negative patient outcomes (Aiken *et al.* 2003). This function, however, depends on adequate nurse staffing levels in terms of both the volume of nursing and the mix of nurses (Aiken *et al.* 2003, Needleman *et al.* 2011).

Two Australian studies found similar results (Duffield *et al.* 2011, Twigg *et al.* 2011). The first study, undertaken in New South Wales found a higher proportion of RNs was associated with a statistically significant decrease in pressure ulcers, gastrointestinal bleeding, sepsis, shock, physiologic/metabolic derangement, pulmonary failure, and failure to rescue (Duffield *et al.* 2011). The same study found increased rates of deep vein thrombosis with improved skill mix (Duffield *et al.* 2011). The second study, undertaken in Western Australia (WA) over 4 years, evaluated implementation of the Nurse Hours per Patient Day (NHPPD) staffing method (Twigg *et al.* 2011). Twigg *et al.* (2011) found decreased rates of nine nursing-sensitive outcomes (NSOs), including mortality, at hospital level and significant decreased rates of five NSOs at ward level, following implementation of NHPPD.

This research evidence has put hospitals on notice to implement appropriate nurse staffing levels and a better skill mix (Clarke & Aiken 2006) as illustrated by the mandated staffing changes described previously. However, budgetary constraints and the labour market often limit the ability of hospitals to implement higher levels of nurse staffing and administrators have expressed concerns about the cost implications (Needleman & Buerhaus 2003). In response, several papers modelled the potential impact of fewer or additional nursing hours, given the association with NSOs. Many have argued that significant financial savings are to be gained by improving nurse-to-patient ratios (Rothberg *et al.* 2005, Needleman *et al.* 2006, Newbold 2008). Needleman *et al.* (2006) used data from the landmark 2002 study of 799 hospitals to argue the economic and social case for increasing nurse staffing levels. They found improving the RN mix (higher proportion of RN hours) to the 75th percentile while maintaining the total hours of care resulted in significant cost savings via reductions in length of stay and/

or adverse outcomes. Although increasing total hours of care (RNs and licensed practical nurses) to the 75th percentile produced a larger reduction in length of stay, improvements in adverse outcomes were not so great and did not offset the increased hours of care. Needleman *et al.* (2006) estimated 6700 inpatient deaths could be avoided by increasing nursing staffing, mostly by a richer RN mix.

Newbold (2008) used production theory techniques to suggest staffing profiles that maximized patient outcomes and minimized costs. Reinterpreting Aiken *et al.*'s (2003) data, Newbold (2008) suggested increasing the number of graduate RNs as a percentage of the workforce was the most cost-effective way to improve patient outcomes. Thungjaroenkul *et al.* (2007) found that the proportion of RNs (skill mix) was inversely related to costs. More recently, Weiss *et al.* (2011) found that units with higher RN non-overtime staffing had lower odds of readmission. Their projected total savings was $409·59 per hospitalized patient per standard deviation increase in RN non-overtime staffing. For the 16 units studied, this represented US$11·64 million total savings.

Staffing at the nurse-to-patient level has also been examined from the context of a patient safety intervention (Rothberg *et al.* 2005). Rothberg *et al.* estimated that decreasing the patient-to-nurse ratio from 8:1–4:1 would reduce patient mortality and cost US$136,000 per life saved. This cost compares favourably to, for example, thrombolytic therapy in acute myocardial infarction at US $182,000 per life saved (Catillo *et al.* 1997 cited in Rothberg *et al.* 2005) or routine cervical cancer screening at US $432,000 per life saved (Charny *et al.* 1987 cited in Rothberg *et al.* 2005). This is supported by another study (Dall *et al.* 2009) that found the economic value of each additional full time RN ranged from US$58,100 to US$62,500 because of an associated reduction in nosocomial complications and therefore reduced medical costs. These analyses (Rothberg *et al.* 2005, Needleman *et al.* 2006, Dall *et al.* 2009, Weiss *et al.* 2011) indicate there is also an economic argument to improve nurse staffing.

The study

Aims

The aim of this study was to assess the cost-effectiveness of increased nursing hours of care on health outcomes of patients in adult tertiary teaching hospitals following a direction from the Australian Industrial Relations Commission to implement the Nurse Hours per Patient Day staffing method (Australian Industrial Relations Commission 2002). Specifically, the study:

- Assessed the net cost of intervention by comparing the costs of increased nursing staff with the savings in terms of reduced nursing-sensitive outcomes.
- Evaluated the cost per life year gained of increased nursing hours on mortality outcomes.

Data were obtained in 2010 from a previous Australian study (Twigg *et al.* 2011) that demonstrated an association between improved health outcomes and increased hours of nurse staffing following implementation of the NHPPD staffing method (Twigg & Duffield 2009). The study was set in Perth, the capital city of WA, which is the largest state in Australia. The population of WA was 2,317,100 in 2010, with over 1·2 million residing in metropolitan Perth (Australian Bureau of Statistics 2010). The three metropolitan adult tertiary teaching hospitals have a total of 1449 beds, which give 'a comprehensive range of clinical services including trauma, emergency (except obstetrics), critical care, and acute medical and surgical services' (Twigg *et al.* 2011). For the purposes of this study we have assumed that when the observed number of NSOs varied from the expected number, the primary reason for the difference was the NHPPD, however, other factors may also have contributed.

Design

This longitudinal study involved the retrospective analysis of a cohort of all multi-day stay patients (medical and surgical) admitted to the three teaching hospitals for more than 24 hours from September 2000–June 2004.

Sample

Data comprised 22 months prior to implementation of the NHPPD staffing method (pre-implementation), 6 months transition (data not included), and 22 months following implementation of the NHPPD staffing method (post-implementation). Rates of 13 NSOs were calculated using the hospital morbidity data associated with each of these admissions. NSOs were defined as a 'variable patient or family caregiver state, condition, or perception responsive to nursing intervention' (Mass *et al.* 1996, Johnson & Lass 1997, Irvine *et al.* 1998). The specific NSOs included in this study were based on the Needleman *et al.* (2002) study and comprised: central nervous system complications, deep vein thrombosis/pulmonary embolus, pressure ulcers, gastrointestinal bleeding, pneumonia, sepsis, shock/cardiac arrest, urinary tract infection, failure to rescue, physiologic/metabolic derangement, pulmonary failure, wound infections, and mortality.

The sample also included nursing hours in the three adult tertiary hospitals' NHPPD wards. In Australia, an RN is defined as a nurse who is on the register maintained by the Nursing and Midwifery Board of Australia (NMBA) to practise nursing. Currently, RN education is a minimum 3-year degree from a tertiary education institution (Australian Institute for Health & Welfare 2008). Australia's Enrolled Nurses (ENs) are also registered by the NMBA. Their minimum educational requirement is a 1-year diploma from a higher education institution (Australian Institute for Health & Welfare 2008). ENs are similar to the US and Canadian licensed practical or vocational nurses, who undertake a 12–18 month training programme emphasizing technical tasks and skills (Page 2004).

Data collection

Patient data were sourced from patient discharge abstracts from September 2000–June 2004 extracted from the hospitals' morbidity systems. Data were identified for inclusion based on the process described in Tourangeau and Tu (2003) and were used to develop the risk adjustment model.

Ethical considerations

This study was granted Research Ethics Committee approval by the Human Research Ethics Committee of Edith Cowan University and the Human Research Ethics Committee of the study hospitals.

Data analysis

All analyses were conducted using PASW version 18 Release 18·0·2.

Pre- and post-implementation comparisons

Comparisons of patient characteristics pre- and post-implementation were undertaken using chi-squared tests (gender, indigenous status, country of birth, season of admission, referral source, major diagnostic category, care type) and two sample independent *t*-tests (age, DRG cost weight).

Individual patient risk adjustment

For each of the 13 categorical NSOs, a multivariable logistic regression model was fitted to the pre-NHPPD intervention data. The models were adjusted for the following patient and admission characteristics: age, gender, age gender interaction, indigenous status, country of birth, season of admission, referral source, major diagnostic category, care type, and Diagnostic Related Group cost weight. These models were applied to patients in the postimplementation period and the predicted probabilities from these models were used to calculate the expected frequency of each NSO post-implementation. The difference between the expected and observed frequencies of each NSO for the post-implementation period was calculated and the significance of this difference was tested using chi-squared analysis. The only NSOs included in the economic analysis were those that demonstrated statistical significance ($P < 0{\cdot}004$, based on the Bonferroni correction for multiple comparisons to reduce the probability of false positives; i.e. testing 13 outcomes $0{\cdot}05/13 = 0{\cdot}0038$) (Hair *et al.* 2010 p. 437).

Measurement of costs – nursing variables

The cost of the intervention comprised increased hours of nursing staff following implementation of the NHPPD staffing method. Staff records ($n = 140{,}060$) were used to collect nursing hours over the study period. Total numbers of nursing hours provided by RNs and ENs were collected for the pre-implementation period (22 months) and the post-implementation period (22 months). Hourly rates for RNs and ENs were based on total annual salaries (including on-costs such as annual leave) and an average 40 hour working week. Staff data were sourced from the Department of Health Western Australia Human Resource Data Warehouse. Nursing variables included in the database were skill mix percent, total nursing hours, and total RN hours. Only productive hours (nursing hours of care excluding annual leave sick leave and workers compensation) were included. Three adult acute hospitals, 52 wards, and the associated nurse hours for each ward were included. The hourly cost was based on the average nursing costs for each hospital.

Cost savings were based on the net reduction in NSOs (refer to Table 1 for listing of NSOs.) The cost of NSOs prevented was taken as an average cost and based on a published cost of an adverse event for a multiple day admission corrected for age and comorbidity (Ehsani *et al.* 2006). All costs were referenced to a single calendar year using health index deflators.

Measurement of NSOs and cost-effectiveness

Nursing-sensitive outcomes were assessed, as previously described. The outcome for life years gained was based on pre- and post-intervention differences in 'failure to rescue'. Future life years gained were discounted at 3% to reflect time preference, that is, benefits sustained currently have greater value than those in the future. The cost of the

intervention as described above was compared with the net number of NSOs averted to establish the total net cost, which was compared with the net number of discounted life years gained to establish the cost per life year gained.

Validity and reliability

This study used data previously collected by hospitals in WA and recorded in their hospital morbidity databases. Although secondary data from medical records may be subject to coding error, validation studies confirm the accuracy and reliability of WA hospital morbidity data (Brameld *et al.* 1999, Teng *et al.* 2008). For example, Teng *et al.* (2008) found the positive predictive value of case-mix coding of heart failure as the principal diagnosis was 99·5% when compared with the medical chart diagnosis. Sensitivity analysis was used to validate the robustness of the cost-effectiveness ratio by testing levels of uncertainty in the analysis.

Results

Patient demographics

Characteristics of the patient population were similar across the three hospitals and were consistent for both the pre- and post-implementation periods of analysis (patient population 107,253 compared with 107,026). While there was a significant difference in age (60·3 pre- and 60·8 post-implementation) (*t*-test $P < 0·001$), this difference was not considered clinically relevant. The increase in Diagnostic Related Group cost weight between the pre- and post-implementation period was also significant (*t*-test $P < 0·001$), suggesting increased patient complexity post-implementation (Table 2).

Nursing hours

Nursing hours increased by 590,568 hours in the post-implementation period, comprising 409,987 more RN hours

Table 1 Nursing-sensitive outcomes observed and expected frequencies.

Nursing-sensitive outcome	Pre/Post-intervention	*n* =	Observed number of outcome (frequency)	Expected number of outcome (frequency)	Difference between expected and observed frequencies		*P* value
1	Pre	107,253	497				
CNS complications	Post	108,224	489	486	−3	Increase	0·923
2*	Pre	42,417	909				
Surgical wound infection	Post	43,749	857	1002	145	Decrease	0·001
3*	Pre	42,417	491				
Pulmonary failure	Post	43,749	398	571	173	Decrease	<0·001
4	Pre	107,253	4685				
Urinary tract infection	Post	108,224	4906	5039	133	Decrease	0·172
5	Pre	107,253	709				
Pressure ulcer	Post	108,224	885	778	−107	Increase	0·008
6	Pre	107,253	2686				
Pneumonia	Post	108,224	3326	2833	−493	Increase	<0·001
7	Pre	107,253	606				
Deep vein thrombosis	Post	108,224	622	628	6	Decrease	0·864
8	Pre	107,253	1308				
Ulcer/gastritis/UGI bleed	Post	108,224	827	1368	541	Decrease	<0·001
9	Pre	107,253	994				
Sepsis	Post	108,224	1220	1099	−121	Increase	0·012
10*	Pre	42,417	1245				
Physiologic/metabolic derangement	Post	43,749	1319	1344	25	Decrease	0·623
11	Pre	107,253	623				
Shock/cardiac arrest	Post	108,224	303	646	343	Decrease	<0·001
12	Pre	107,253	3522				
Mortality	Post	108,224	3479	3617	138	Decrease	0·096
13	Pre	107,253	1243				
Failure to rescue	Post	108,224	1160	1315	155	Decrease	0·002

Pearson chi-squared tests were used to determine differences between expected and observed frequencies.
*Analysis completed on surgical patients only.

Table 2 Patient demographics for pre- and post-intervention.

	Gender			Diagnostic related group cost weight
	Male	Female	Mean age (years)	
Pre-intervention	52·7%	47·3%	60·31	2·10
Post-intervention	52·5%	47·5%	60·82*	2·16*

*t-test $P < 0·001$.

and 180,580 more EN hours. Agency hours, which included RN and EN hours, reduced by 21,333 hours (refer Table 3). Across all hospitals the skill mix [RNs/(RNs + ENs)] changed very little, but decreased slightly from 87% pre-implementation to 85% post-implementation. Hence, cost-effectiveness was calculated assuming no change in skill mix and based on costs incurred and life years gained.

Cost-effectiveness

The total number of NSOs prevented was 1357 including 155 'failure to rescue' events and 1202 other NSOs comprising 'surgical wound infection', 'pulmonary failure', 'ulcer, gastritis, upper gastrointestinal bleed', and 'cardiac arrest' (refer to Table 4). One NSO, pneumonia, showed an increase of 493. Net cost was estimated based on 1202 NSOs averted (savings) and 493 NSOs having incurred an additional cost. Other NSOs did not demonstrate difference at the 0·004 significance level (Table 1).

Analysis of life years gained was based on the 155 failure to rescue events prevented post-intervention. The average age of all inpatients who experienced a failure to rescue event was 73·8 years and the average life expectancy for Australians was 81·5 years in 2008 (OECD 2011), therefore the total life years gained was 1240. To adjust for future benefits (time preference), life years were discounted at 3%, so that total life years gained became 1088 years.

Total nursing hours increased by 590,568 hours (refer to Table 3); costing AUD$16,833,392 based on proportional contribution of RNs and EN average salary costs. As previously reported (Twigg & Duffield 2009), when the staffing method was introduced the increases were achieved by increasing nursing numbers rather than a reliance on agency nurses or overtime. The cost per adverse event was AUD$10,074 (Ehsani *et al.* 2006) and the total cost averted was AUD$7,142,466 (for four NSOs averted and one NSO increased), leading to a net intervention cost of AUD $9,690,926. The cost per life year gained was AUD$8907.

Sensitivity analysis

Our cost of the NSO prevented was taken from published work and corrected for age and comorbidity, however, sequelae of adverse events frequently depend on the original cause of admission and we were unable to validate this figure directly. If we underestimated the cost of an adverse event by 50%, (assume NSO cost of AUD$15,000) then the cost per life year gained becomes AUD$5697. Conversely, if we overestimated the cost of a NSO by approximately the same amount so that the cost was AUD$5000, then the cost per life year gained becomes AUD$12,213 (discounted).

Our cost-effectiveness ratio may overestimate in that not all NSOs occur in different patients and the cost per NSO prevented is potentially less when more than one NSO occurs in the same patient. To test the impact of repeat events we analysed frequency data to estimate the number of events in the same individual. The data suggest that up to 25% of events occurred in the same individual. If only 75% of NSOs prevented are considered to lead to resource savings, then cost per life year gained becomes AUD $14,064 (discounted), suggesting that the result is only

Table 4 Summary of nursing-sensitive outcomes prevented.

Nursing-sensitive outcome	Number of nursing-sensitive outcomes prevented
Surgical wound infection	145
Pulmonary failure	173
Ulcer, gastritis, upper gastrointestinal bleed	541
Shock, cardiac arrest	343
Failure to rescue	155
Total	1357

Table 3 Nursing hours by pre/post-intervention in all hospitals.

	RN hours	Other hours	Agency hours*	Total hours
Pre	3,466,811·84	494,672·22	464,322·82	3,961,484·00
Post	3,876,798·96	675,253·03	442,990·14	4,552,052·00
Difference	409,987·12	180,580·81	−21,332·68	590,568·00

*Agency hours were excluded in the analysis of nursing hours.

What is already known about the topic?

- Higher nurse staffing levels and a richer skill mix have been associated with improved patient outcomes.
- Internationally, improved nurse staffing levels have been associated with economic benefits.
- The available evidence does not examine the economic impact of increased nursing hours in the Nurse Hours per Patient Day staffing method.

What this paper adds

- Increased nursing hours in acute hospitals resulting from using the Nurse Hours per Patient Day staffing method was considered cost-effective when using accepted thresholds for life years gained.
- The Nurse Hours per Patient Day staffing method was associated with avoidance of specific nursing-sensitive outcomes, which demonstrates parallel improvements in the quality of care.

Implications for practice and/or policy

- Investment in increased nursing hours via the Nurse Hours per Patient Day staffing method has proven a cost-effective initiative with clinical benefits.
- Further research is needed to better the cost-specific nursing-sensitive outcomes and determine the economic benefits of nurse staffing changes at ward level.

moderately sensitive to several repeat events in the same individual. When analysis included only NSOs prevented (i.e. excluding the increased pneumonia events), the net cost of the intervention became AUD$12,108,948 and the cost per life year gained was AUD$4324.

Discussion

A reasonable threshold for cost-effectiveness in Australia is $30–60,000 per life year gained (Eichler *et al.* 2004), hence the implementation of the NHPPD staffing method was cost-effective under all scenarios. These results are in keeping with the findings in the literature (Rothberg *et al.* 2005, Dall *et al.* 2009) and suggest increasing nurse staffing is a cost-effective patient-safety intervention. Furthermore, these results fall within the cost-effectiveness thresholds of the USA, the UK, and Sweden suggesting broader application that of Australia (Eichler *et al.* 2004). In addition, the implementation of the NHPPD staffing method was associated with the avoidance of 1202 other NSOs (surgical wound infection, pulmonary failure, ulcer, gastritis, upper gastrointestinal bleed, and cardiac arrest) demonstrating parallel improvements in the quality of care. The significant increase in the pneumonia rates is an anomaly that cannot be easily explained. Pneumonia is susceptible to severe fluctuations according to influenza prevalence but we were unable to ascertain whether this was the cause for the increase. However, one of the three hospital's senior managers advised that a focus on coding pneumonia as a complication had occurred during the study period (T. Basile, personal communication, 2012) suggesting that the increase in pneumonia may have been related to a change in data capture. These results suggest the increased expenditure on nursing salaries was justified from a cost-effective threshold even though the business case for increased nurse staffing could not be made on the basis of cost savings. That is, the intervention is a cost-effective expenditure compared with other accepted health interventions although financial returns in averted illness do not exceed the financial investment in nurse salaries. This raises the question: What is the community prepared to pay for quality health care (Needleman *et al.* 2006)?

Limitations

There were some limitations to this study. Agency hours were not included in the analysis as they represented <10% of all RN and EN nursing hours. The study was unable to control for variation in the staffing levels of other disciplines or for variation across hospitals, which may have masked benefits since they were averaged across hospitals. The study did not take into account changes in treatments or medications that may also have contributed to changes in NSOs. The study was also unable to control for secular trends, however, over the study period health services were relatively static as a major review and planning process for the future of health services was underway (Health Reform Committee 2004). The data did not have sufficient detail to undertake a probabilistic sensitivity analysis, however, elementary sensitivity analysis was undertaken to determine the effect of variation in the variables. Finally, an average cost for NSOs was used as costing data on specific nurse sensitivity outcomes was unavailable.

Conclusion

This study demonstrates that the investment in the increased nursing hours associated with the implementation of the NHPPD staffing method has been a cost-effective initiative based on the accepted Australian threshold. The findings of this study are timely as the Council of Australian Governments has established Health Workforce Australia to examine several

matters including a National Training Plan with a goal of self-sufficiency in the supply of doctors, nurses, and midwives by 2025 (Health Workforce Australia 2012). Better costing of specific NSOs would strengthen future research examining the economic benefits of changes in staffing methods and hours of care. In addition, this study has focused on the changes in NSOs across adult acute hospitals in WA. Staffing decisions occur at the ward level and larger national studies examining the economic benefits of staffing changes at a detailed ward level would further refine the evidence to support the allocation of scarce nursing resources.

Acknowledgements

The authors thank Judith Pugh PhD RN, from the School of Nursing and Midwifery at Edith Cowan University, for proof reading and administrative support in manuscript preparation.

Funding

This research was funded by an Edith Cowan University Collaborative Grant with industry partners Sir Charles Gairdner Hospital Nursing Service and the Western Australian Department of Health, Nursing and Midwifery Office. The funding amount was AU$37,899.

Conflict of interest

No conflict of interest has been declared by the authors.

Author contributions

All authors meet at least one of the following criteria (recommended by the ICMJE: http://www.icmje.org/ethical_1author.html) and have agreed on the final version:

- substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data;
- drafting the article or revising it critically for important intellectual content.

References

Aiken L.H., Clarke S.P., Sloane D.M., Sochalski J. & Silber J.H. (2002) Hospital nurse staffing and patient mortality, nurse burnout and job dissatisfaction. *Journal of the American Medical Association* 288(16), 1987–1993.

Aiken L.H., Clarke S.P., Cheung R.B., Sloane D.M. & Silber J.H. (2003) Educational levels of hospital nurses and surgical patient mortality. *Journal of the American Medical Association* 290(12), 1617–1623.

Aiken L.H., Sloane D.M., Cimiotti J.P., Clarke S.P., Flynn L., Seago J.A., Spetz J. & Smith H.L. (2010) Implications of the California nurse staffing mandate for other states. *Health Services Research* 45(4), 904–921.

Australian Bureau of Statistics (2010) *Australian Demographic Statistics*, Dec 2010 Vol. 2011. Australian Bureau of Statistics, Canberra.

Australian Industrial Relations Commission (2002) *Exceptional Matters Order*. Vol. 2009, Sydney.

Australian Institute of Health and Welfare (2008) *Nursing and midwifery labour force 2005*. National Health Labour Force Series no. 39 Cat. no. HWL 40. AIHW, Canberra.

Australian Institute of Health and Welfare (2010) *Hospital Performance: Cost per Casemix-Adjusted Separation*, Vol. 2011. Australian Institute of Health and Welfare, Canberra.

Australian Nursing Federation (2009) *Ensuring quality, safety and positive patient outcomes: Why investing in nursing makes $ence*. Australian Nursing Federation, Melbourne.

Brameld K.J., Thomas M.A., Holman C.D., Bass A.J. & Rouse I.L. (1999) Validation of linked administrative data on end-stage renal failure: application of record linkage to a 'clinical base population. *Australian and New Zealand Journal of Public Health* 23(5), 464–467.

Clarke S.P. & Aiken L.H. (2006) More nursing, fewer deaths. *Quality and Safety in Health Care* 15, 2–3.

Dall T.M., Chen Y.J., Seifert R.F., Maddox P.L. & Hogan P.F. (2009) The economic value of professional nursing. *Medical Care* 47(1), 97–103.

Donaldson N. & Shapiro S. (2010) Impact of California mandated acute care hospital nurse staffing ratios: a literature synthesis. *Policy Politics, & Nursing Practice* 11(3), 184–201.

Duffield C., Diers D., O'Brien Pallas L., Aisbett C., Roche M., King M. & Aisbett K. (2011) Nursing staffing, nursing workload, the work environment and patient outcomes. *Applied Nursing Research* 24, 244–255.

Ehsani J.P., Jackson T. & Duckett S. (2006) The incidence and cost of adverse events in Victorian hospitals 2003–2004. *Medical Journal of Australia* 184(11), 551–555.

Eichler H.G., Kong S.X., Gerth W.C., Mavros P. & Jönsson B. (2004) Use of cost-effectiveness analysis in health-care resource allocation decision-making: how are cost-effectiveness thresholds expected to emerge? *Value in Health* 7, 518–528.

Estabrooks C.A., Midodzi W.K., Cummings G.G., Ricker K.L. & Giovannetti P. (2005) The impact of hospital nursing characteristics on 30-day mortality. *Nursing Research* 54(2), 74–84.

Hair J.F., Black W.C., Babin B.J. & Anderson R.E. (2010) *Multivariate Data Analysis*. Pearson, Upper Saddle River, NJ.

Health Reform Committee (2004) *A Healthy Future for Western Australians: Report of the Health Reform Committee*. Department of Health, Perth.

Health Workforce Australia (2012) *National Training Plan Methodology Paper*, Vol. 2012. Health Workforce Australia, Adelaide.

Irvine D., Sidani S. & McGillis Hall L. (1998) Linking outcomes to nurses' roles in health care. *Nursing Economics* 16(2), 58–64, 87.

(Johnson M. & Lass M., eds) (1997) *Nursing Outcome Classification (NOC)*. Mosby, St. Louis MO.

Kalisch B.J. (2006) Missed nursing care: a qualitative study. *Journal of Nursing Care Quality* 21(4), 306–315.

Kane R.L., Shamliyan T.A., Mueller C., Duval S. & Wilt T.J. (2007) The association of Registered Nurse staffing levels and patient outcomes. *Medical Care* 45(12), 1195–1203.

Mass M., Johnson M. & Moorhead S. (1996) Classifying nursing-sensitive patient outcomes. *IMAGE: Journal of Nursing Scholarship* 28(4), 259–301.

Needleman J. & Buerhaus P. (2003) Nurse staffing and patient safety: current knowledge and implications for action. *International Journal for Quality in Health Care* 15(4), 275–277.

Needleman J., Buerhaus P., Mattke S., Stewart M. & Zelevinsky K. (2002) Nurse-staffing levels and the quality of care in hospitals. *New England Journal of Medicine* 346(22), 1715–22.

Needleman J., Buerhaus P.I., Stewart M., Zelevinsky K. & Mattke S. (2006) Nurse staffing in hospitals: Is there a business case for quality? *Health Affairs (Project Hope)* 25(1), 204–211.

Needleman J., Buerhaus P., Pankratz S., Leibson C.L., Stevens S.R. & Harris M. (2011) Nurse staffing and impatient hospital mortality. *The New England Journal of Medicine* 364(11), 1037–1045.

Newbold D. (2008) The production economics of nursing: a discussion paper. *International Journal of Nursing Studies* 45(1), 120–128.

OECD (2011) *Society at a Glance 2001: OECD Social Indicators*. OECD Publishing, Paris.

Page A. (ed.) (2004) *Keeping Patients Safe: Transforming the Work Environment of Nurses*. National Academies Press, Washington DC.

Rafferty A.M., Clarke S.P., Coles J., Ball J., James P., McKee M. & Aiken L.H. (2007) Outcomes of variation in hospital nurse staffing in English hospitals: cross-sectional analysis of survey data and discharge records. *International Journal of Nursing Studies* 44, 175–182.

Rothberg M.B., Abraham I., Lindenauer P.K. & Rose D.N. (2005) Improving nurse-to-patient staffing ratios as a cost-effective safety intervention. *Medical Care* 43(8), 785–791.

Teng T.-H.K., Finn J., Hung J., Geelhoed E. & Hobbs M. (2008) A validation study: how effective is the Hospital Morbidity Data as a surveillance tool for heart failure in Western Australia. *Australian and New Zealand Journal of Public Health* 32(5), 405–407.

Thungjaroenkul P., Cummings G.G. & Embleton A. (2007) The impact of nurse staffing on hospital costs and patient length of stay: a systematic review. *Nursing Economics* 25(5), 255–265.

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

Tourangeau A.E., Doran D.M., Hall L.M., O'Brien Pallas L., Pringle D., Tu J.V. & Cranley L.A. (2007) Impact of hospital nursing care on 30-day mortality for acute medical patients. *Journal of Advanced Nursing* 57(1), 32–44.

Twigg D. & Duffield C. (2009) A review of workload measures: a context for a new staffing methodology in Western Australia. *International Journal of Nursing Studies* 46, 131–139.

Twigg D., Duffield C., Bremner A., Rapley P. & Finn J. (2011) The impact of the nursing hours per patient day (NHPPD) staffing method on patient outcomes: a retrospective analysis of patient and staffing data. *International Journal of Nursing Studies* 48, 540–548.

Twigg D., Duffield C., Bremner A., Rapley P. & Finn J. (2012) Impact of skill mix variations on patient outcomes following implementation of nursing hours per patient day staffing: a retrospective study. *Journal of Advanced Nursing* 68(12), 2710–2718.

Weiss M.E., Yakusheva O. & Bobay K.L. (2011) Quality and cost analysis of nurse staffing, discharge preparation and postdischarge utilization. *Health Services Research* 46(5), 1473–1494.