ORIGINAL RESEARCH

Impact of skill mix variations on patient outcomes following implementation of nursing hours per patient day staffing: a retrospective study

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Abstract

Aims. This article is a report of a study of the association between skill mix and 14 nursing-sensitive outcomes following implementation of the nursing hours per patient day staffing method in Western Australian public hospitals in 2002, which determined nursing hours by ward category but not skill mix.

Background. Findings from previous studies indicate that higher nurse staffing levels and a richer skill mix are associated with improved patient outcomes. Measuring skill mix at a hospital level for specific staffing methods and associated nursing-sensitive patient outcomes are important in providing staffing for optimal patient care.

Design. The research design for the larger study was retrospectively analysing patient and staffing administrative data from three adult tertiary hospitals in metropolitan Perth over 4 years.

Methods. A subset of data was used to determine the impact of skill mix on nursing-sensitive outcomes following implementation of the staffing method. All patient records (N = 103,330) and nurse staffing records (N = 73,770) from nursing hours per patient day wards from October 2002–June 2004 following implementation were included.

Results. Increases in Registered Nurse hours were associated with important decreases in eight nursing-sensitive outcomes at hospital level and increases in three nursing-sensitive outcomes. The lowest skill mix saw the greatest reduction in nursing-sensitive outcome rates.

Conclusions. The skill mix of nurses providing care could impact patient outcomes and is an important consideration in strategies to improve nurse staffing. Levels of hospital nurse staffing and skill mix are important organizational characteristics when predicting patient outcomes.

Keywords: healthcare quality, health policy, nurse, nurses, patient outcomes, skill mix, staffing
Introduction

The nurse hours per patient day (NHPPD) staffing method was introduced in the Western Australian (WA) public sector in March 2002 and it remains in effect today. This method used a ‘bottom up’ approach to classify each hospital ward into one of seven categories using characteristics such as patient complexity, nursing intervention levels, the presence of a high dependency unit, the emergency/ elective patient mix and patient turnover. Once wards were classified, average NHPPD values were prescribed for each ward. Shift-to-shift variations in nursing hours were still possible under the method as it focussed on average hours for a ward or unit over time (Twigg & Duffield 2009).

Evaluation of the NHPPD staffing method found important decreases in the rates of nine nursing-sensitive outcomes when examining hospital-level data following its implementation. These were mortality, central nervous system complications, pressure ulcers, deep vein thrombosis, sepsis, ulcer/gastritis/upper gastrointestinal bleed shock/cardiac arrest, pneumonia and average length of stay (Twigg & Duffield 2009, Twigg et al. 2011). At the ward level, important decreases in the rates of five nursing-sensitive outcomes; mortality, shock/cardiac arrest, ulcer/gastritis/upper gastrointestinal bleed, length of stay and urinary tract infections (UTIs) were found.

In its order to implement NHPPD, the Australian Industrial Relations Commission, however, was silent on nursing skill mix. Since the order was given in 2002, a systematic review identified higher Registered Nurse (RN) staffing as an important determinant of patient safety (Kane et al. 2007a). It suggested that the proportion of total nursing hours provided by RNs (skill mix) should have been included in the staffing method. The purpose of this article is to report on the association between skill mix, defined as the proportion of total nurse hours provided by RNs (Needleman et al. 2002) and nursing-sensitive outcomes following implementation of the NHPPD staffing method.

Background

Several studies have explored the relationship between skill mix and patient outcomes. A review of the quality of care for the treatment of acute medical conditions in hospitals in the USA examined quality of care for acute myocardial infarction, congestive heart failure and pneumonia (Landon et al. 2006). This study found that higher RN staffing patterns were associated with higher quality of care. In contrast, increased licensed practical nurse staffing was associated with lower quality of care. RN hours and the proportion of RNs were also found to have an important inverse relationship with the incidence of pneumonia (Cho et al. 2003). An increase of one RN hour resulted in a 0.23% decrease in the risk of pneumonia and a 10% increase in the proportion of RNs was associated with a 9.5% drop in the risk of pneumonia.

The growing body of evidence was mostly produced in the USA and was less accepted outside the USA healthcare system until several international studies were published. Estabrooks et al. (2005) examined 18,142 patient outcomes from 49 acute care hospitals in Alberta, Canada and found mortality varied significantly across hospitals. Age and patient co-morbidities explained 44.2% of the variation in mortality and four nursing characteristics explained a further 36.9%. The four nursing characteristics were: nurse education – hospitals with a higher proportion of baccalaureate-prepared nurses were associated with lower rates of 30-day mortality; skill mix – hospitals with a higher proportion of RNs compared to non-RNs were associated with lower rates of 30-day mortality; employment status – hospitals with a higher proportion of casual and temporary nurses were associated with higher rates of 30-day mortality; and nurse–physician relationships – hospitals with higher scores on collaborative nurse–physician relationships were associated with lower rates of 30-day patient mortality. Higher percentages of RN staff, higher percentages of baccalaureate-prepared nurses and higher nurse reported adequacy of staffing and resources were also associated with lower 30-day mortality rates in medical patients in Canada (Tourangeau et al. 2007). A higher proportion of RNs in the staff mix was associated with lower medication error rates and lower wound infection rates (Hall et al. 2004). These studies support the USA findings and give additional evidence that baccalaureate-prepared nurses and a higher proportion of RNs are associated with improved patient outcomes (Hall et al. 2004, Estabrooks et al. 2005, Tourangeau et al. 2007).

In Australia, a study in Queensland surveyed 2800 nurses with a response rate of 53%. The study showed that over 50% of aged-care nurses, 32% of nurses working in the public sector and 30% of nurses working in the private sector...
identified difficulties in meeting patient needs because of insufficient staffing levels and a poor skill mix (Hegney et al. 2003). More recently, a large New South Wales study (Duffield et al. 2007) undertaken over 5 years examined 80 hospitals and 286 wards to determine the association of nursing workload and skill mix with patient outcomes. This study found that a higher proportion of RNs was associated with important decreases in pressure ulcers, gastrointestinal bleeding, sepsis, shock, physiological/metabolic derangement and pulmonary failure. In contrast, this same study found increased rates of deep vein thrombosis with improved skill mix. It could be argued that this finding may relate to better assessment and detection with a richer skill mix. Skill mix was more critical than hours of care in regard to improvements in nursing-sensitive outcomes (Duffield et al. 2007).

Finally, a recent comprehensive systematic review found that every additional RN full time equivalent per patient day was associated with a 16% reduced risk of mortality in surgical patients (Kane et al. 2007a). One additional RN hour per day was also associated with reductions in hospital-acquired pneumonia (4%), pulmonary failure (11%), failure to rescue in surgical and medical patients (1%) and deep vein thrombosis in medical patients (2%). On the other hand, every additional patient per RN per shift was associated with a 7% increase in pneumonia, a 53% increase in pulmonary failure and a 17% increase in medical complications (Kane et al. 2007a). This systematic review suggests that the association between skill mix and patient outcomes is an international phenomenon and policy should give consideration to skill mix when mandating nursing hours.

The study

Aim

The aim of the study was to determine any association between skill mix and patient outcomes following implementation of the NHPPD staffing method in three adult tertiary hospitals in Western Australia.

Design

The research design was an interrupted time series using retrospective analysis of patient and staffing administrative data.

Participants and data collection

The study was set in the capital city of Perth, WA and the sample consisted of all multi-day patient separations and all patient days related to those separations in three adult tertiary teaching hospitals. Details of the study setting, data sources and procedures, data inclusion and exclusion criteria and measurement of patient outcomes have been published previously (Twigg et al. 2011). This component of the larger study involved the analysis of a retrospective cohort of all multi-day stay patients admitted to the study hospitals following implementation of the NHPPD staffing method over 20 months (October 2002–June 2004) utilizing hospital morbidity data to identify nursing-sensitive outcomes.

Study variables

Nursing-sensitive outcome variables

The nursing-sensitive outcome variables were: (1) central nervous system (CNS) complications; (2) wound infections; (3) pulmonary failure; (4) UTI; (5) pressure ulcer; (6) pneumonia; (7) deep vein thrombosis; (8) ulcer/gastritis/upper gastrointestinal bleed; (9) sepsis; (10) physiological/metabolic derangement; (11) shock/cardiac arrest; (12) mortality; (13) failure to rescue; and (14) length of stay. Failure to rescue was defined as death of a patient who experienced a hospital-acquired complication. Surgical wound infections, pulmonary failure and physiological/metabolic derangement were examined only for surgical patients.

Predictor variable

The predictor variable of interest in this aspect of the study was skill mix. Skill mix was defined as the proportion of total nurse hours provided by Registered Nurses expressed as a percentage. Changes in rates of nursing-sensitive outcomes following implementation of the NHPPD staffing method were examined to determine if skill mix had a statistically significant association.

Ethical considerations

The study was approved by the ethics committees of the university and the hospitals.

Data analysis

In preparation for inferential analysis a time series data file was created containing the incidence rate of nursing-sensitive outcomes for each of the three tertiary hospitals (Twigg et al. 2011). Each time period was one calendar month. SPSS for Windows Graduate Student Version, Rel, 15.0.0 2006; SPSS Inc., Chicago, IL, USA was used for data analysis and the significance level was set at 0.05. A regression approach was used to analyse the time series. The basic goal of the
when rates trend up, then down, then up again (or changes in a trend that followed a parabolic shape, that is, 
vice versa). In addition, a squared term for time (time 
point). This assumes equal differences between the rates for consec-
tive time points. In addition, a squared term for time (time 
period squared) was included to also allow modelling of 
changes in a trend that followed a parabolic shape, that is, 
when rates trend up, then down, then up again (or vice versa).

To account for cyclical fluctuations in the incidence of nurse 
sensitive outcomes such as pneumonia, which occurs more 
frequently in winter, a categorical variable called season was 
also included in the regression model. December, January and 
February were allocated to the summer season. March, April 
and May were allocated to the autumn season. June, July and 
August were allocated to the winter season. September, 
October and November were allocated to the spring season. 
Adjusting by season is well established in the analysis of case 
mix data where patient numbers and severity of illness varies 
across seasons. As there was no important interaction 
between skill mix and NHPPD (total hours) and total 
patients and total hours were significantly correlated, the 
variable total hours was not included in the final modelling.

Results for separate hospitals were obtained by including in 
the model a categorical (or dummy) variable for hospital with 
an interaction term for hospital and skill mix. To allow 
different trend lines (or curves) for each hospital, models also 
included interaction terms between hospital and time period 
and hospital and time period squared. This method used all 
the data, which provides a more powerful analysis than a 
stratified analysis where each hospital is analysed separately.
The rate ratios (RR) indicated changes in the rates of nursing-
sensitive outcomes 1–13 associated with a 1 percentage-point 
increase in skill mix, net of other predictors in the model. For 

nursing-sensitive outcome 14, length of stay, Generalized 
Linear Models were used with the same covariates to 
determine the mean changes in average length of stay 
associated with a 1 percentage-point increase in skill mix.

In keeping with other studies, the analysis of nursing-
sensitive outcomes was undertaken in three groupings: all 
patients (Needleman et al. 2002), the subset of medical 
patients (Tourangeau et al. 2007) and the subset of surgical 
patients (Aiken et al. 2003). Previous studies (Needleman 
et al. 2001) identified two methods for adjusting for patient 
characteristics or risk factors that might influence the 
complication rates. The simplest method was to stratify all 
hospitals into groups with similar case mix and then analyse 
each group. The second more complicated method was to 
develop a measure of individual patient risk, then aggregate 
the risk of patients in each hospital, to estimate an expected 
rate of complications in each health service. The expected 
rate of complications would then be incorporated into the 
analysis to adjust for case mix differences across hospitals. In 
this study, however, the first method was used as the case mix 
data from the study hospitals were similar and they were 
routinely grouped together for comparative purposes.

Validity and reliability

All data were collected and recorded by the Department of 
Health, WA, independent of the researchers. As secondary 
data is reliant on the accuracy of the coding from the medical 
record, it is subject to error. Studies of secondary case mix 
data in WA, however, found such data have very high levels 
of accuracy and reliability (Brameld et al. 1999, Teng et al. 
2008).

Results

Patient demographic data

All multi-day stay patients from the NHPPD multi-day ward 
categories A, B C and D in the three adult teaching hospitals 
were included (52 wards). There were 103,330 patients post 
implementation of the NHPPD staffing method; gender 
ranged between 50.5–54.4% male and 49.5–45.9% female; 
19.9–28.2% were admitted electively and 71.8–80.1% were 
admitted as emergencies. Age ranged from 18 to 106 and the 
average was between 58.91 and 62.71 years. The Diagnostic 
Related Group (DRG) cost weights, a relative measure of the 
average cost of care for patients in a DRG, were similar 
across hospitals. A summary of the patient demographics can 
be found in Table 1. Given the similarities in the gender 
proportions, mean ages and DRG cost weights between
The impact of skill mix changes on nursing-sensitive outcomes following implementation of the NHPPD staffing method

The extent to which nursing-sensitive patient outcomes were associated with skill mix following implementation of NHPPD in three adult tertiary hospitals is presented in Table 3. As there are 14 outcomes that are considered to be potentially associated with nursing (Needleman et al. 2001) and it is possible that the sensitivity of these outcomes may be different in medical and surgical settings, all results are presented.

In Hospital 1 the rate of pneumonia increased significantly for all patients with each percentage-point increase in skill mix. There were no important changes for the other 13 nursing-sensitive outcomes. In Hospital 2 skill mix was significantly associated with six nursing-sensitive outcomes. Rates of pneumonia, deep vein thrombosis, shock/cardiac arrest and failure to rescue decreased significantly in the all patients’ analyses with each percentage-point increase in skill mix. However, the rate of urinary tract infection increased significantly as the skill mix percentage increased. In medical patients the rates of deep vein thrombosis and shock/cardiac arrest also decreased significantly when the skill mix percentage increased. In surgical patients the rates of pneumonia and sepsis decreased significantly as the skill mix percentage increased. For the other eight nursing-sensitive outcomes there were no important changes.

Skill mix was significantly associated with five nursing-sensitive outcomes for Hospital 3. The rates of pressure ulcer, gastritis and upper gastrointestinal bleeds decreased in all patients with each percentage-point increase in skill mix. In medical patients, rates of pressure ulcer, pneumonia, gastritis and upper gastrointestinal bleeds and mortality decreased significantly with each percentage-point increase in skill mix. However, the rate of shock/cardiac arrest in medical patients increased significantly with every percentage-point increase in skill mix. There were no important trends for the remaining nine nursing-sensitive outcomes.

Discussion

This study found that skill mix was significantly associated with several nursing-sensitive outcomes following implementation of the NHPPD staffing method. As the hospitals had different levels of skill mix (Table 2), it is not surprising that the study did not find consistently important results across hospitals. Nonetheless, increases in skill mix were associated with important decreases in the rates of eight nursing-sensitive outcomes: pressure ulcer, pneumonia, deep vein thrombosis, ulcer, gastritis and upper gastrointestinal bleeds, sepsis, shock/cardiac arrest, mortality and failure to rescue in the three hospitals. On the other hand, there were significantly increased rates of three nursing-sensitive outcome indicators: urinary tract infections at Hospital 2, pneumonia at Hospital 1 and shock/cardiac arrest at Hospital 3.

Patients in Hospital 2, which had a post-implementation average skill mix of 81.5%, experienced improvements in five nursing-sensitive outcomes. Patients in Hospital 3, with an average skill mix of 84.1%, experienced improvements in four. These improvements are in contrast to Hospital 1 (skill mix 88.5%) where nursing-sensitive outcomes did not improve significantly. This suggests that a skill mix of between 88% and 90% may be an appropriate target in terms of future policy development. That is, a richer RN skill mix may reduce several adverse events, including failure to rescue.

Table 1 Patient demographic variables post implementation NHPPD staffing method.

<table>
<thead>
<tr>
<th>Patient records</th>
<th>Gender</th>
<th>Admission type (%)</th>
<th>Mean age</th>
<th>Elective</th>
<th>Emergency</th>
<th>DRG cost weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hospital 1</td>
<td>Male</td>
<td>Female</td>
<td>50.5</td>
<td>49.5</td>
<td>62.71</td>
<td>28.2</td>
</tr>
<tr>
<td>Hospital 2</td>
<td>52.2</td>
<td>47.8</td>
<td>61.64</td>
<td>28.4</td>
<td>71.6</td>
<td>2.63</td>
</tr>
<tr>
<td>Hospital 3</td>
<td>54.1</td>
<td>45.9</td>
<td>58.91</td>
<td>19.9</td>
<td>80.1</td>
<td>3.04</td>
</tr>
</tbody>
</table>

Table 2 Mean skill mix percent following implementation of the NHPPD staffing method.

<table>
<thead>
<tr>
<th>Hospital</th>
<th>Post implementation</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hospital 1</td>
<td>88.5</td>
<td>87.5–89.8</td>
</tr>
<tr>
<td>Hospital 2</td>
<td>81.5</td>
<td>78.5–83.5</td>
</tr>
<tr>
<td>Hospital 3</td>
<td>84.1</td>
<td>79.9–88.7</td>
</tr>
</tbody>
</table>
Table 3 Rate ratios (95% confidence interval) comparing the effect of skill mix following implementation of NHPPD for nursing-sensitive outcomes 1–13 and changes in average length of stay for nursing-sensitive outcome 14 for hospitals all, medical and surgical patients.

<table>
<thead>
<tr>
<th>Patient Outcome Description</th>
<th>Hospital 1</th>
<th>Hospital 2</th>
<th>Hospital 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>CNS complications (NSO 1)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All</td>
<td>0.83 (0.57, 1.21)</td>
<td>0.88 (0.74, 1.04)</td>
<td>0.94 (0.89, 1.00)</td>
</tr>
<tr>
<td>Medical</td>
<td>0.89 (0.57, 1.39)</td>
<td>0.91 (0.75, 1.09)</td>
<td>0.95 (0.89, 1.01)</td>
</tr>
<tr>
<td>Surgical</td>
<td>0.70 (0.34, 1.45)</td>
<td>0.80 (0.51, 1.25)</td>
<td>0.91 (0.79, 1.04)</td>
</tr>
<tr>
<td>Surgical wound infections (NSO 2)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surgical</td>
<td>1.15 (0.89, 1.49)</td>
<td>0.98 (0.84, 1.13)</td>
<td>1.02 (0.98, 1.06)</td>
</tr>
<tr>
<td>Pulmonary failure (NSO 3)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surgical</td>
<td>0.74 (0.51, 1.08)</td>
<td>0.88 (0.71, 1.09)</td>
<td>0.95 (0.89, 1.01)</td>
</tr>
<tr>
<td>Urinary tract infections (NSO 4)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All</td>
<td>1.02 (0.92, 1.12)</td>
<td>1.07** (1.02, 1.13)</td>
<td>0.99 (0.97, 1.00)</td>
</tr>
<tr>
<td>Medical</td>
<td>1.02 (0.92, 1.12)</td>
<td>1.07 (0.99, 1.15)</td>
<td>0.99 (0.97, 1.01)</td>
</tr>
<tr>
<td>Surgical</td>
<td>1.00 (0.83, 1.22)</td>
<td>1.10 (0.99, 1.23)</td>
<td>0.97 (0.94, 1.01)</td>
</tr>
<tr>
<td>Pressure ulcer (NSO 5)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All</td>
<td>0.95 (0.72, 1.24)</td>
<td>1.08 (0.94, 1.23)</td>
<td>0.98 (0.92, 1.03)</td>
</tr>
<tr>
<td>Medical</td>
<td>0.96 (0.68, 1.36)</td>
<td>1.03 (0.89, 1.20)</td>
<td>0.91** (0.86, 0.97)</td>
</tr>
<tr>
<td>Surgical</td>
<td>0.92 (0.59, 1.42)</td>
<td>1.08 (0.87, 1.32)</td>
<td>1.04 (0.97, 1.12)</td>
</tr>
<tr>
<td>Pneumonia (NSO 6)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All</td>
<td>1.16* (1.01, 1.33)</td>
<td>0.90** (0.85, 0.97)</td>
<td>0.98 (0.96, 1.00)</td>
</tr>
<tr>
<td>Medical</td>
<td>1.18 (0.97, 1.43)</td>
<td>0.92 (0.84, 1.01)</td>
<td>0.96* (0.93, 0.99)</td>
</tr>
<tr>
<td>Surgical</td>
<td>1.13 (0.92, 1.40)</td>
<td>0.88** (0.80, 0.97)</td>
<td>1.00 (0.96, 1.03)</td>
</tr>
<tr>
<td>DVT (NSO 7)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All</td>
<td>1.01 (0.76, 1.34)</td>
<td>0.81** (0.70, 0.93)</td>
<td>0.96 (0.91, 1.02)</td>
</tr>
<tr>
<td>Medical</td>
<td>1.11 (0.79, 1.57)</td>
<td>0.80* (0.68, 0.95)</td>
<td>0.99 (0.92, 1.06)</td>
</tr>
<tr>
<td>Surgical</td>
<td>0.83 (0.50, 1.36)</td>
<td>0.83 (0.63, 1.05)</td>
<td>0.91 (0.83, 1.01)</td>
</tr>
<tr>
<td>Ulcer/Gastritis/UGI bleed (NSO 8)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All</td>
<td>0.92 (0.73, 1.17)</td>
<td>0.95 (0.84, 1.08)</td>
<td>0.95* (0.90, 0.99)</td>
</tr>
<tr>
<td>Medical</td>
<td>0.98 (0.73, 1.23)</td>
<td>0.97* (0.84, 1.13)</td>
<td>0.93* (0.88, 0.99)</td>
</tr>
<tr>
<td>Surgical</td>
<td>0.72 (0.44, 1.19)</td>
<td>0.91 (0.89, 1.21)</td>
<td>0.96 (0.87, 1.06)</td>
</tr>
<tr>
<td>Sepsis (NSO 9)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All</td>
<td>0.94 (0.78, 1.13)</td>
<td>0.89 (0.79, 1.00)</td>
<td>0.98 (0.95, 1.02)</td>
</tr>
<tr>
<td>Medical</td>
<td>0.92 (0.67, 1.26)</td>
<td>0.95 (0.81, 1.13)</td>
<td>0.96 (0.96, 1.01)</td>
</tr>
<tr>
<td>Surgical</td>
<td>0.99 (0.76, 1.30)</td>
<td>0.83* (0.71, 0.98)</td>
<td>1.01 (0.96, 1.06)</td>
</tr>
<tr>
<td>Physiological/Metabolic derangement (NSO 10)</td>
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</tr>
<tr>
<td>Surgical</td>
<td>0.99 (0.82, 1.21)</td>
<td>1.08 (0.95, 1.22)</td>
<td>1.01 (0.98, 1.05)</td>
</tr>
<tr>
<td>Shock/Cardiac arrest (NSO 11)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All</td>
<td>0.76 (0.50, 1.16)</td>
<td>0.73** (0.60, 0.88)</td>
<td>1.02 (0.95, 1.09)</td>
</tr>
<tr>
<td>Medical</td>
<td>0.69 (0.38, 1.24)</td>
<td>0.66** (0.50, 0.87)</td>
<td>1.10* (1.00, 1.22)</td>
</tr>
<tr>
<td>Surgical</td>
<td>0.84 (0.46, 1.55)</td>
<td>0.78 (0.59, 1.04)</td>
<td>0.95 (0.86, 1.06)</td>
</tr>
<tr>
<td>Mortality (NSO 12)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All</td>
<td>0.92 (0.82, 1.03)</td>
<td>0.97 (0.92, 1.03)</td>
<td>0.98 (0.96, 1.00)</td>
</tr>
<tr>
<td>Medical</td>
<td>0.94 (0.83, 1.06)</td>
<td>0.97* (0.91, 1.03)</td>
<td>0.98* (0.96, 0.99)</td>
</tr>
<tr>
<td>Surgical</td>
<td>0.83 (0.64, 1.07)</td>
<td>0.99 (0.86, 1.13)</td>
<td>0.98 (0.94, 1.03)</td>
</tr>
<tr>
<td>Failure to rescue (NSO 13)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All</td>
<td>0.91 (0.73, 1.13)</td>
<td>0.88* (0.79, 0.99)</td>
<td>0.99 (0.96, 1.04)</td>
</tr>
<tr>
<td>Medical</td>
<td>0.95 (0.72, 1.25)</td>
<td>0.88 (0.77, 1.00)</td>
<td>1.00 (0.95, 1.05)</td>
</tr>
<tr>
<td>Surgical</td>
<td>0.83 (0.58, 1.18)</td>
<td>0.91 (0.75, 1.10)</td>
<td>0.99 (0.73, 1.05)</td>
</tr>
<tr>
<td>Average length of stay (NSO 14)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All</td>
<td>0.11 (0.02, 0.51)</td>
<td>−0.03 (−0.23, 0.17)</td>
<td>−0.03 (−0.10, 0.04)</td>
</tr>
<tr>
<td>Medical</td>
<td>0.03 (0.04, 0.41)</td>
<td>0.01 (−0.21, 0.22)</td>
<td>−0.05 (−0.13, 0.04)</td>
</tr>
<tr>
<td>Surgical</td>
<td>0.36 (0.14, 0.86)</td>
<td>−0.07 (−0.31, 0.18)</td>
<td>0.01 (−0.09, 0.10)</td>
</tr>
</tbody>
</table>

NSO, nursing-sensitive patient outcome.

*P ≤ 0.05, **P ≤ 0.01 and ***P ≤ 0.001.
What is already known about this topic

• Higher nurse staffing levels and a richer skill mix have been associated with improved patient outcomes.
• In light of the evidence, some Australian states and jurisdictions have legislated or mandated nurse staffing.
• The available evidence does not give specific guidelines for nurse staffing, either in terms of the amount of care required or skill mix of the nurses providing care at a unit level.

What this paper adds

• The effect of skill mix at a hospital level following implementation of the nursing hours per patient day staffing method is variable depending on ward type and patient characteristics.
• In acute care, a relatively small increase in skill mix is associated with important improvements in some nursing-sensitive outcomes.
• Increases in skill mix are associated with improved patient outcomes even at higher skill mix concentrations.

Implications for practice and/or policy

• Nursing skill mix can have a major impact on some patient outcomes and hence should be considered when devising staffing methods, particularly where new models of care propose used less skilled patient care workers.
• A skill mix of between 88% and 90% Registered Nurses may be an appropriate target in future policy development.
• Additional research is needed to determine skill mix ratios that meet the requirements of specific ward types and patient characteristics.

Although these findings support earlier work undertaken in Australia and overseas (Aiken et al. 2003, Cho et al. 2003, Hall et al. 2004, Estabrooks et al. 2005, Duffield et al. 2007, Mark et al. 2007, Thungjaroenkul et al. 2007, Tourangeau et al. 2007), they also extend and expand the skill mix argument. Findings show that a relatively small (1 percentage-point) increase in skill mix is associated with important improvements in some nursing-sensitive outcomes. The RN provides surveillance of patients and the resultant early detection and rescue from complications are critical in improving patient outcomes (Aiken et al. 2002). These findings suggest that relatively small increases in skill mix may continue to benefit patients in acute care. A very recent study (Needleman et al. 2011) also identified that changes in skill mix on a shift by shift basis can be important to patient outcomes.

The findings raise questions in regard to the argument that the benefits of increased RN staffing diminish as the hours of care increase (Mark et al. 2007, Sochalski et al. 2008). These authors found hospitals with initial lower RN staffing levels were more likely to demonstrate improvement in patient outcomes when compared to hospitals with higher RN staffing levels (Sochalski et al. 2008). One question that arises is whether hospitals with higher RN staffing levels already had better patient outcomes and then demonstrated further improvements with further gains in RN staffing. The pre-existing benefit of improved outcomes cannot be easily measured. Although these approaches give estimates of the marginal value of adding another nurse, this marginal approach underestimates the average value per nurse added (Dall et al. 2009). The Dall et al. study identified that the benefits of additional RN staffing changed little between low and high nurse hours per patient day hospitals. It suggests that there are only modest variations in staffing levels across hospitals once adjustments are made for case mix (Dall et al. 2009). In the NHPPD study, increases in skill mix continued to benefit patients at higher skill mix than those previously reported. This finding, combined with the evidence in the literature (Kane et al. 2007a), has important implications for policy development, especially in WA where the NHPPD staffing model is still in effect. It is also pertinent more widely throughout Australia as new models of care aim to maximize the use of less skilled workers to assist in patient care (Productivity Commission 2005). Using fewer skilled workers is not congruent with evidence to hand (Estabrooks et al. 2005, Tourangeau et al. 2007, Duffield et al. 2011). The association with improved patient outcomes evident in the literature supports the notion that policy should maximize the RN nursing workforce to improve skill mix.

Limitations of the study

The sample in this study was limited to the three adult tertiary teaching hospitals in Western Australia as these hospitals received 88.9% of the staffing increases under the NHPPD staffing method. This represented 36–39% of the states multi-day patient separations during the study period. These hospitals were similar in nature, had similar infrastructure and with similar nursing support and commitment to teaching and research (Health Reform Committee 2004). Hence, this lack of variation may have limited the ability of
our study to assess the effect of skill mix. Another limitation of the study was that adjustment for patient characteristics was only undertaken in identifying nursing-sensitive outcomes. Although there were similar case mix weights in the study hospitals, adjustment for patient risk using a more complex individual measure aggregated by the hospital would have strengthened the study.

Conclusion

In conclusion, the findings of this Australian study add further evidence to a recent systematic review that found levels of RN staffing in hospitals remain the most persistent and prominent nursing organizational characteristics for predicting patient outcomes (Kane et al. 2007b). This study suggests that the skill mix of nurses could have a major impact on some patient outcomes and is an important consideration in developing staffing methods. However, the findings of this study were not consistent across all nursing-sensitive outcomes or across all hospitals with their different levels of skill mix. There is a need for additional large scale studies that focus on ward types and patient characteristics.

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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_author.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.

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