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The impact of adding assistants in nursing to acute care hospital ward nurse staffing on adverse patient outcomes: An analysis of administrative health data

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ABSTRACT

Objectives: The aim of this study was to assess the impact of adding assistants in nursing to acute care hospital ward nurse staffing on adverse patient outcomes using administrative health data.
Design: Logistic regression modelling was used with linked administrative health data to examine the association between seven adverse patient outcomes and use of assistants in nursing utilising a pre-test/post-test design. Outcomes included were in-hospital 30-day mortality, failure to rescue, urinary tract infection, pressure injury, pneumonia, sepsis and falls with injury.
Setting: Eleven acute care metropolitan hospitals in Western Australia.
Sample: Patients were retained in the dataset if they spent any time on a medical, surgical or rehabilitation ward during their admission and excluded if they only spent time on other ward types, as the outcomes used in this study are only validated for these patient populations. There were 256,302 patient records in the total sample with 125,762 in the pre-test period (2006–2007) and 130,540 in the post-test period (2009–2010).
Results: The results showed three significant increases in observed to expected adverse outcomes on the assistant in nursing wards (failure to rescue, urinary tract infection, falls with injury), with one significant decrease (mortality). On the non-assistant in nursing wards there was one significant decrease (pneumonia) in the observed to expected adverse outcomes and one significant increase (falls with injury). Post-test analysis showed that spending time on assistant in nursing wards was a significant predictor for urinary tract infection and pneumonia. For every 10% of extra time patients spent on assistant in nursing wards they had a 1% increase in the odds of developing a urinary tract infection and a 2% increase in the odds of developing pneumonia.
Conclusion: The results suggest that the introduction of assistants in nursing into ward staffing in an additive role should be done under a protocol which clearly defines their role, scope of practice, and working relationship with registered nurses, and the impact on patient care should be monitored.

What is already known about the topic?

- The use of assistants in nursing in acute care settings has increased in recent times due to shortages of registered nurses, cost containment priorities and changes in the scope of registered nurse practice.
- Changing the nursing skill mix by reducing registered nurse hours of care has been shown to impact adversely on patient outcomes, however the impact of adding assistants in nursing to the existing ward staffing complement has not been studied.
- The use of assistants in nursing is contentious, with varying levels of support among nurses and policy makers.

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What this paper adds

- This is the first study of the relationship between adverse patient outcomes and the use of assistants in nursing in an additive rather than substitutive role.
- This study demonstrated an association between the proportion of time that patients spent on wards where assistants in nursing were employed and increased odds of two adverse patient outcomes – urinary tract infections and pneumonia.
- This study also demonstrated that when comparing the observed to expected adverse patient outcomes following the implementation of assistants in nursing to the acute care wards, there were more increases in adverse outcomes on assistant in nursing wards compared to wards where they were not employed, and more decreases in adverse outcomes on wards where assistants in nursing were not employed compared to the wards where they were employed.

1. Background and introduction

Assistants in nursing (AINs) were introduced into the health workforce to work alongside registered or licenced nurses. AINs have various designations including health care assistant (United Kingdom (UK) and Australia (AU)), patient care assistant (AU), certified nursing assistant, unlicensed assistive personnel (United States (US)), assistant practitioner, healthcare support worker, nursing auxiliary and nursing aide (UK). For this paper the term AINs will be used. AINs have always been part of the health system, although their use, both in terms of numbers and settings, has increased in recent times (Duffield et al., 2014; Kessler et al., 2012). The main drivers for this increase have been a shortage of registered staff, cost containment, the loss of student nurses in hospitals, changes in the scope of registered nurse (RN) practice toward increased technical skills and specialist nursing roles, and increasing amounts of paperwork (Kessler et al., 2012). It is thought that AINs can adequately perform duties not requiring the level of education and skill of the RN thereby giving RNs more time for performing nursing care that requires a higher level of expertise (Duckett et al., 2014; Jenkins and Joyner, 2013; Kessler et al., 2012; Skills for Health, 2011; Spilsbury et al., 2011). In practice, this has often resulted in nurses spending less time in direct patient care and more time on care planning and paperwork, often to the dissatisfaction of nursing staff (Munn et al., 2013; Spilsbury et al., 2011).

Although AINs have been established in long term care settings for many years in Western Australia (WA), where this study was conducted, they were not employed in acute care settings. In 2008, the WA Department of Health Nursing and Midwifery Office, in conjunction with hospital Directors of Nursing and Chief Executives, introduced AINs into acute care settings in a complementary rather than a substitutive role, providing a unique opportunity to evaluate this model. The role of the AIN was to carry out basic patient care tasks in accordance with their skills and competencies under the direction of the RN (ANF, 2011). AINs had a list of duties they were deemed able to perform, and this constituted their scope of practice (WA Department of Health, 2008a,b). Duties included assisting with patient meals, mobility, toileting and activities of daily living, taking patient observations such as pulse and temperature, blood glucose monitoring and patient surveillance. Individual hospitals determined the way in which AINs were introduced; some hospitals assigned them to specific wards while others employed them across a number of wards.

The AINs were additional to the usual ward staffing allocation as determined by the Nursing Hours per Patient Day (NHpPD) model. This model was introduced into WA hospitals in 2002 in order to manage the nursing workload and ensure adequate staffing. In this model each ward is assigned to a category (A–D) dependent on the complexity and diversity of patients and the nursing tasks required to care for them. Each category is allocated a staffing level per occupied bed day. The required staffing is then determined by multiplying the occupied bed days by the category staffing level to give the hours per day and wards are expected to staff at this level (Twigg and Duffield, 2009; Twigg et al., 2011). AINs work alongside the two levels of nurses in the WA nursing structure, RNs and enrolled nurses (EN). Wards are staffed with a mix of RNs and ENs depending on the clinical profile of the ward. RNs hold a three-year undergraduate degree and are registered to practice. The EN, who works under the supervision of the RN, possesses an 18-month Diploma of Nursing from an accredited training organisation in the Vocation Education and Training sector and is also registered to practice. In contrast, AINs either receive 18 weeks of training provided by the Department of Health which includes seven weeks of theory and an eleven week clinical placement or have achieved a six-month Certificate III qualification through a Registered Training Organisation prior to commencement of employment.

The use of unregulated staff such as AINs is contentious, with varying levels of support among nurses and policy makers (Kessler et al., 2012). The potential for role blurring, lack of understanding about the respective roles of AINs and RNs, inadequate supervision of AINs, inappropriate delegation of tasks and boundary rivalry is high between these two groups (Bach et al., 2012; Kessler et al., 2012). Unlike the health care professionals with whom they work AINs are not regulated, often have minimal educational preparation for their roles, and there is no standardisation in the level of education required for the role (Duffield et al., 2014). In the UK, there have been recent high profile cases in which a diluted skill mix, that is, a lower than expected ratio of registered to unregistered staff, was implicated in significant failures in patient safety in various National Health Service (NHS) trusts (Francis, 2010; Healthcare Commission, 2007). While health care assistant recruitment, training and education were subsequently reviewed, options for regulation were not included in the terms of reference (Cavendish, 2013). Others have called for AINs to be regulated, for example the Royal College of Nursing (RCN) and the Australian Nursing Federation (ANF) have issued position statements calling for registration (ANF, 2011; Duffield et al., 2014; Mason, 2013; RCN, 2007). However, this remains contentious as regulation would increase costs and reduce the flexibility with which AINs can be utilised (Kessler et al., 2012; Mason, 2013).

The two RN/AIN staffing models that currently exist in the workplace are the substitutive model and the supportive or complementary model. The substitutive model replaces skilled RNs with AINs (Health Policy Solutions, 2011), which decreases skill mix and results in fewer RN hours of patient care (Blegen et al., 2008; Duffield et al., 2014; McKenna et al., 2004; Roche et al., 2012). Changing the skill mix has been found to adversely impact patient outcomes, with studies showing that a poorer skill mix is associated with increased adverse outcomes for patients (Blegen et al., 1998; Needleman et al., 2002; Roche et al., 2012; Sovie and Jawad, 2001; Tourangeau et al., 2002; Thungjaroenkul et al., 2007; Twigg et al., 2011). For example, lower AIN staffing has been associated with decreased mortality (Griffiths et al., 2016).

The supportive or complementary model uses AINs as additional help and support to RNs, therefore maintaining the nursing hours of care available for patients (Carrigan, 2009; Health Workforce Australia, 2011; Roche et al., 2012). As such, this model directly addresses problems such as excessive workloads that have hampered RNs' capacity to provide quality nursing care, which can lead to hurried or incomplete nursing care and an increased risk of errors (Duffield et al., 2011a,b) . The impact on patient outcomes of the complementary model requires testing, as there are no research studies that have evaluated this model.

2. Research aim

The aim of this study was to assess the impact of adding AINs to acute care hospital ward nurse staffing on adverse patient outcomes using administrative health data. We hypothesised that the addition of AINs to existing ward staffing would decrease adverse patient outcomes due to the additional help that they could provide to regulated staff on the ward.

3. Conceptual framework

The conceptual framework used for this study was the Patient Care System Model (PCDM) (O'Brien-Pallas et al., 2004). This framework includes input factors (characteristics of patients, nurses and systems) and throughput factors (changes to patients' conditions and nursing activities), which influence output factors (patient, nurse and system outcomes) (Meyer et al., 2009; O'Brien-Pallas, 2002; O'Brien-Pallas et al., 2011).

4. Method

This study used a quasi-experimental pretest-posttest control group design. All multi-day admissions (408,707 records) to hospitals in the Perth metropolitan area between January 2006 and December 2010 were obtained through the WA Data Linkage Unit (WADLU). Patient data collected for this study included demographic data, International Classification of Diseases (ICD) diagnosis and procedure codes, and event data, that is, patient ward movements during their hospital stay, including time and date of ward transfer. This data collection period included two years prior to the introduction of AINs into the system (2006–2007) and two years following the introduction of AINs (2009–2010). Data from 2008, seen as the implementation year, were excluded from the analysis.

Patients were retained in the dataset if they spent any time on a medical, surgical or rehabilitation ward during their admission and excluded if they only spent time on other types of wards, as the outcomes used in this study are only validated for these patient populations. Using the ICD codes and syntax previously developed by Needleman et al. (2002), McCloskey (2003) and Twigg et al. (2011), the presence of seven adverse patient outcomes that are sensitive to the quality of nursing care was determined for each patient record. These outcomes, identified from a comprehensive literature review and indicator testing process, were failure to rescue (death in patients with complications), 30-day mortality (death in hospital within 30 days of admission), falls with injury, and hospital-acquired urinary tract infection (UTI), pressure injury, pneumonia, or sepsis (Twigg et al., 2015).

The retained wards were classified as an AIN or non-AIN ward by examining the staffing data for the post-test period. The monthly AIN hours were plotted for each ward. If the AIN hours were greater than 30 h per month for at least three months between January 2009 and December 2010 then the ward was classified as employing AINs. The final dataset included 33 AIN wards and 31 non-AIN wards. Fig. 1 shows the spread of the hours worked by AINs on the 33 AIN wards by month. There was a large variation in the number of hours worked by AINs on the study wards. Across all the wards the mean hours worked per month was 279 h (SD 323 h). The median hours worked was 158 with a minimum of 0 h and a maximum of 1652 h.

Fig. 2 shows the skill mix distribution across the two types of wards. This represents the RN work hours divided by the total work hours for each ward for each month of the post-test period. This represents the ratio of RNs to ENs as these are the only two types of nurses employed in WA hospitals. AIN hours were not included in this calculation as they were additional to the usual ward staffing. The median was 87% RNs ($M = 85$, $SD = 11$) with a range of 51%–100% for the non-AIN wards and median of 77% ($M = 75$, SD = 11) with a range of 40%–98% for the AIN wards indicating the percentage of RNs employed was much higher on non-AIN wards than AIN wards. Data were not normally distributed. An independent samples Mann-Whitney U test showed a significant difference between the skill mix percent of the two groups ($p < 0.001$).

Even though the skill mix of the two ward types differed it remained at similar levels across the pre-test and post-test periods for both ward types. For the AIN wards the mean skill mix increased from 71% pre-test to 75% post-test. On the non-AIN wards the mean skill mix increased from 82% to 85% across the two periods. This indicated that both ward types experienced a similar small improvement in mean skill mix over the two time periods.

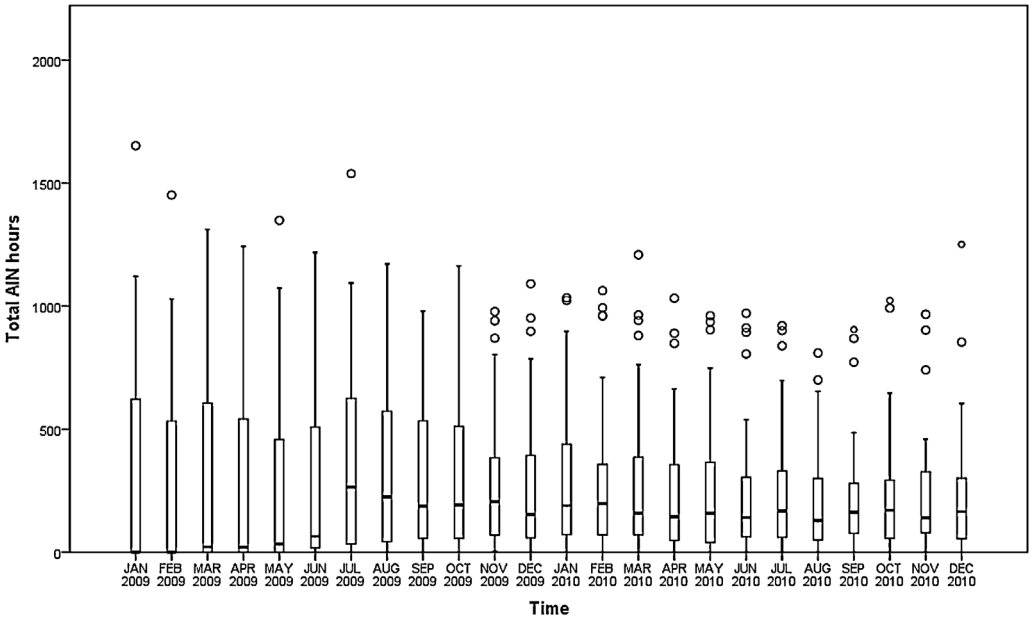

Fig. 1. AIN hours on the AIN wards by month (post-test period).

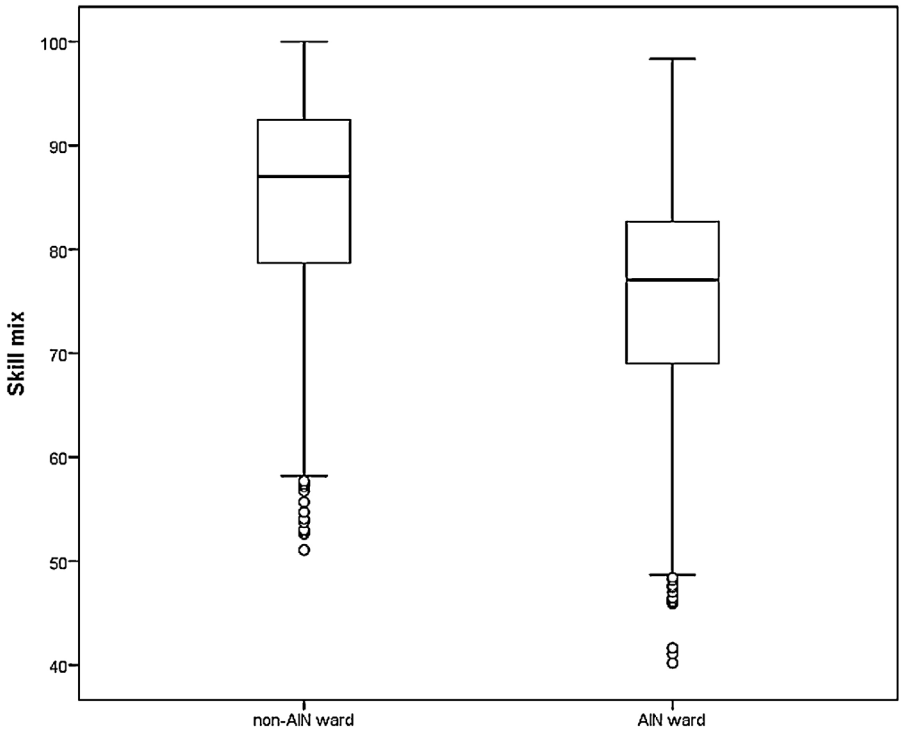

Fig. 2. Skill mix on the study wards (post-test period).

The significance of these differences was tested using a paired samples *t*-test. This change was statistically significant, however, not considered to be clinically significant.

The NHpPD ratings for the AIN wards compared to the non-AIN wards is included in Table 1. At the end of 2009, 78% of AIN wards (data missing for six wards) and 83% of non-AIN wards (data missing for two wards) were on or above the set NHpPD staffing target for their wards (Nursing and Midwifery Office, 2010), indicating that the majority of both types of wards were staffed at the appropriate level during the study period according to the NHpPD methodology.

5. Data analysis

There were two parts to the data analysis, a pre-test/post-test within ward-type (AIN wards and non-AIN wards) and a post-test only between ward-type analyses. For the first analysis the pre-test and post-test data were modelled to determine the numbers of adverse patient outcomes before and after the introduction of AINs for each ward-type adjusting for patient characteristics. The second analysis examined the post-test data of patients who spent time in AIN wards compared to those who did not.

As patients move wards during their hospital stay, for the pre-test/post-test analysis the proportion of time out of the total length of stay that the patient was on the AIN wards and the non-AIN wards was calculated. These proportions were then applied to the patient outcome numbers for failure to rescue, 30-day mortality, urinary tract infection, pressure injury, pneumonia, sepsis and falls with injury to obtain the observed patient outcome numbers by ward type (AIN/non-AIN).

Each patient record was assigned to one of two data phases based on their admission date; the pre-test phase included admissions from 2006 to 2007 before the introduction of AINs and the post-test phase included admissions from 2009 to 2010 after the introduction of AINs. For AIN wards and non-AIN wards separately models were developed for the pre-test data and used to predict the patient outcome numbers for the post-test period, to estimate what would have happened if patient samples had been the same in the two phases. Stepwise logistic regression models were run with each patient outcome as the dependent variable and patient and hospital characteristics as the independent variables. These variables were derived from a previous study in this area (Twigg et al., 2013). The independent variables were group (medical or surgical admission), age, gender, season (of admission), Indigenous status, source of referral to the hospital (home, nursing home/hostel, other hospital, other), Diagnosis Related Group (DRG) cost weight (a measure of the resource use of each patient), age squared, peer group of the hospital (type of hospital), length of stay, elective or emergency admission, Charlson comorbidity index, and DRG cost weight by age, and gender by age interactions. These variables were retained in all of the models because they were significant in at least two of the models. This was done to allow the AIN variables to be directly compared across the different patient outcome models because each model was adjusted for the same patient and hospital characteristics.

The probabilities of the patient acquiring each outcome were predicted using the models. The predicted probabilities were weighted by the proportion of time the patient spent on AIN and non-AIN wards. This gave expected probabilities of each patient acquiring the outcome by ward type (AIN/non-AIN). The means of these expected probabilities were then calculated for each

Table 1
Nursing Hours per Patient Day (NHpPD) rating of included wards.

Category	NHpPD	AIN wards		Non-AIN wards	
		n	%	n	%
A	7.5	2	6.1	6	19.4
B	6.0	15	45.4	15	48.4
C	5.75	8	24.2	5	16.1
D	5.0	8	24.2	5	16.1
Total		33		31	

outcome and multiplied by the numbers of patients in the cohort of the post-test data to obtain the expected number of outcomes for the post-test phase based on the patient characteristics of the pre-test phase. Differences between the expected and observed frequencies of each outcome for the post-test phase were calculated and the significance of this difference was tested using the chi-square test.

For the post-test analysis a variable was created to indicate the proportion of patient length of stay on an AIN ward. This variable was then added as an independent variable to logistic regression models to determine the association between this variable and the outcome after adjusting for other patient and hospital characteristics. The adjustment variables were the same as those that were included in the pre-test/post-test analysis with the addition of a variable indicating the number of ward changes a patient had during their hospital stay and one that indicated the proportion of time the patient spent on low skill mix wards to control for this known association with poorer patient outcomes (Needleman et al., 2002). A low skill mix ward was defined as one where the proportion of RNs in the overall ward staffing complement was less than 72.87%, the lowest quartile of skill mix proportions identified from the staffing data.

6. Ethics approval

This project was granted ethical approval from the Department of Health and Edith Cowan University Human Research Ethics Committees.

7. Results

After applying the data exclusions there were 256,302 patient records in the total sample, with 125,762 in the pre-test period (2006–2007) and 130,540 in the post-test period (2009–2010). These records were drawn from eleven hospitals in the Perth metropolitan area. An overview of the sample with respect to the variables used in the regression modelling is given in Table 2. The samples were similar across the pre-test and post-test periods.

7.1. Pre-test/post-test within ward-type analysis

The unadjusted NSO rate per 1000 bed-days was calculated for each NSO and represented as a time series (Figs. 3–9). The fitted line shows the changes in NSO rates for each ward type over the time period. Thirty-day mortality and urinary tract infections rates showed similar patterns across the period. Failure to rescue rates decreased more on the non-AIN wards than on the AIN wards, while pressure injury and pneumonia rates decreased on the non-AIN wards but increased on the AIN wards. The sepsis and falls with injury rate increased more on the AIN wards than on the non-AIN wards. There were no NSOs for which the AIN rate showed an improvement over the non-AIN rates.

The results from the pre-test/post-test analysis (Table 3) showed that there were three significant increases in adverse outcomes on the AIN wards (failure to rescue, UTI, falls with injury) when comparing the observed to expected number of outcomes, with one significant decrease (mortality). The other adverse

Table 2
Overview of sample.

		Pre-test	Post-test
		Mean (SD)	Mean (SD)
Age (years)		63.6 (19.8)	63.4 (20.0)
DRG cost weight		2.3 (2.9)	2.3 (3.1)
Length of stay (days)		8.1 (9.8)	7.8 (9.5)
		Frequency (%)	Frequency (%)
Group	Surgical	80,605 (64.1)	86,543 (66.3)
	Medical	45,157 (35.9)	43,997 (33.7)
Gender	Male	64,043 (50.9)	67,682 (51.8)
	Female	61,719 (49.1)	62,858 (48.2)
Season	Autumn	31,613 (25.1)	32,704 (25.0)
	Winter	32,326 (25.7)	33,646 (25.8)
	Spring	32,108 (25.5)	34,180 (26.2)
	Summer	29,715 (23.6)	30,010 (23.0)
Indigenous status	Not ATSI	120,813(96.1)	124,883(95.7)
	ATSI	4,949 (3.9)	5,657 (4.3)
Source of referral	Home	92,752 (73.8)	96,034 (73.6)
	Nursing home/hostel	4,137 (3.3)	4,366 (3.3)
	Hospital	28,503 (22.7)	29,609 (22.7)
	Other	370 (0.3)	531 (0.4)
Hospital peer group	A1	94,826 (75.4)	96,168 (73.7)
	B1	17,406 (13.8)	21,208 (16.2)
	C1	8,258 (6.6)	8,373 (6.4)
	D2/E2	5,272 (4.2)	4,791 (3.7)
Admission type	Elective	40,555 (32.2)	38,387 (29.4)
	Emergency	85,207 (67.8)	92,153 (70.6)
Charlson Comorbidity Index	None	81,840 (65.1)	90,207 (69.1)
	One	16,338 (13.0)	14,600 (11.2)
	Two or more	27,584 (21.9)	25,733 (19.7)

Group: surgical = operation date within 2 days of admission, medical = no operation date or operation date >2 days after admission. Indigenous status: ATSI = Aboriginal or Torres Strait Islander. Hospital peer group: A1 = principal referral hospital, B1 = large hospital, C1 = medium hospital, D2/E2 = sub-acute and non-acute hospitals.

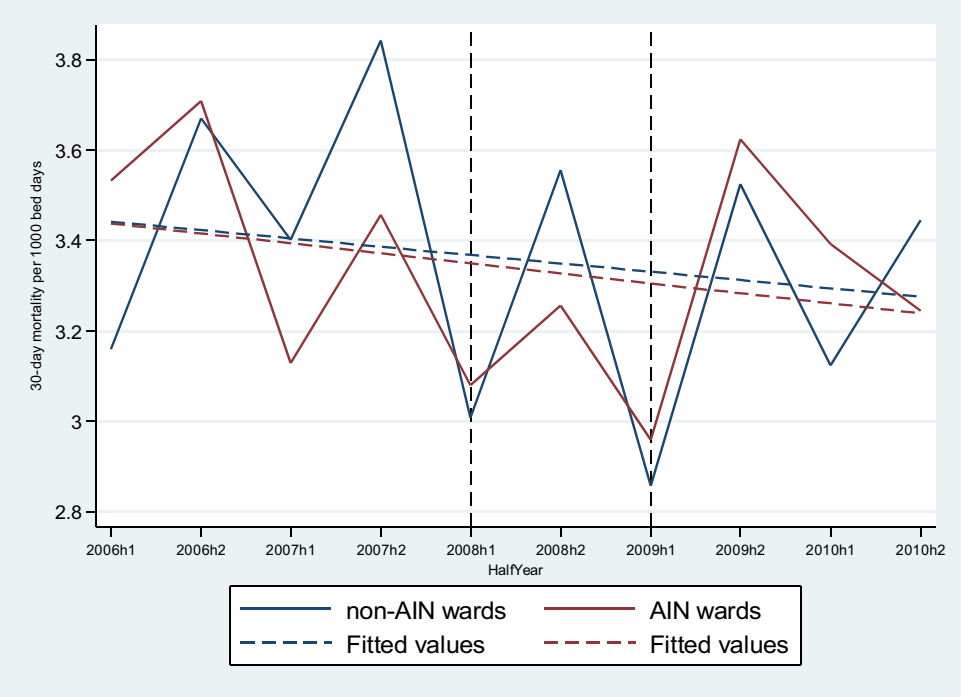

Fig. 3. 30-day mortality rates.

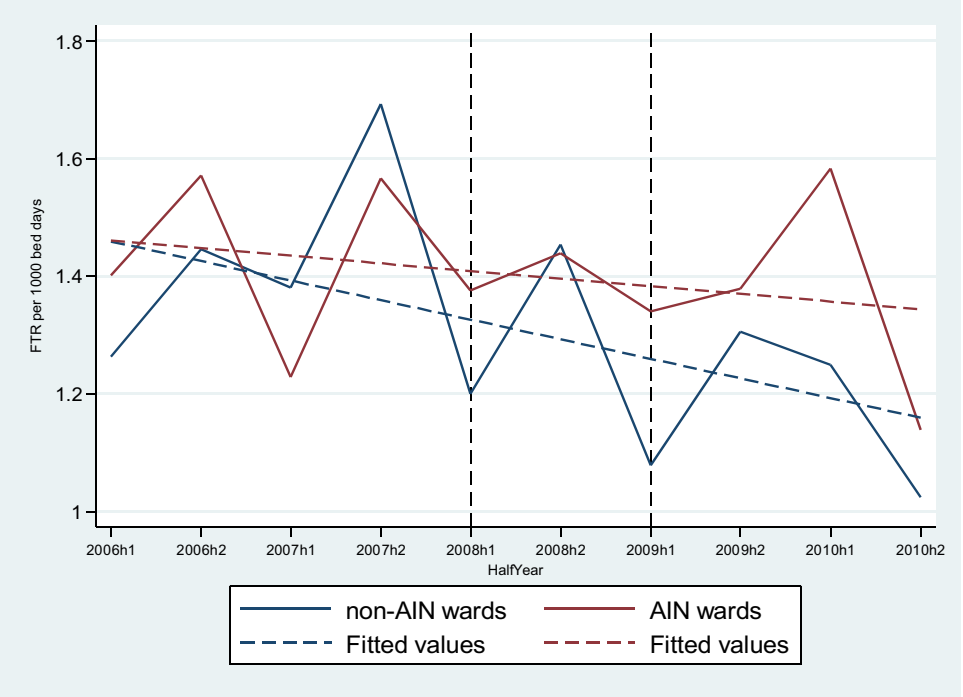

Fig. 4. Failure to rescue rates.

outcomes also increased on these wards; however these results were not statistically significant. On the non-AIN wards there was one significant decrease (pneumonia) in the observed to expected adverse outcomes and one significant increase (falls with injury), with three other non-significant increases and two non-significant decreases in adverse outcomes.

7.2. Post-test between ward-type analysis

For the post-test analysis the variable of interest was whether patients had spent time on AIN wards during their hospital stay. After adjusting for patient and hospital characteristics results showed that spending time on AIN wards was a significant

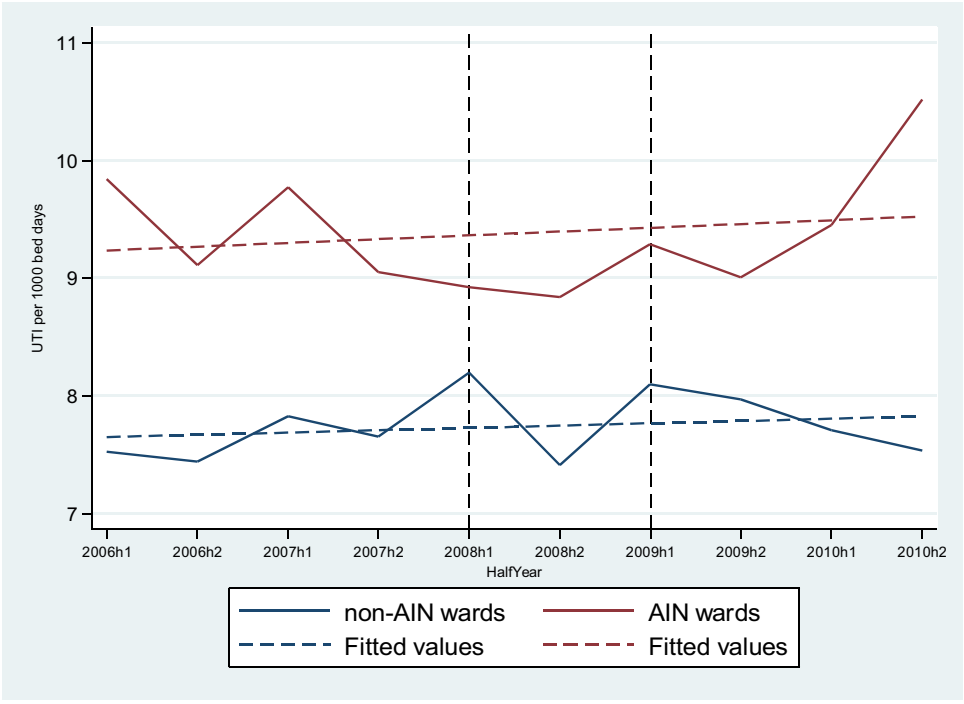

Fig. 5. Urinary tract infection rates.

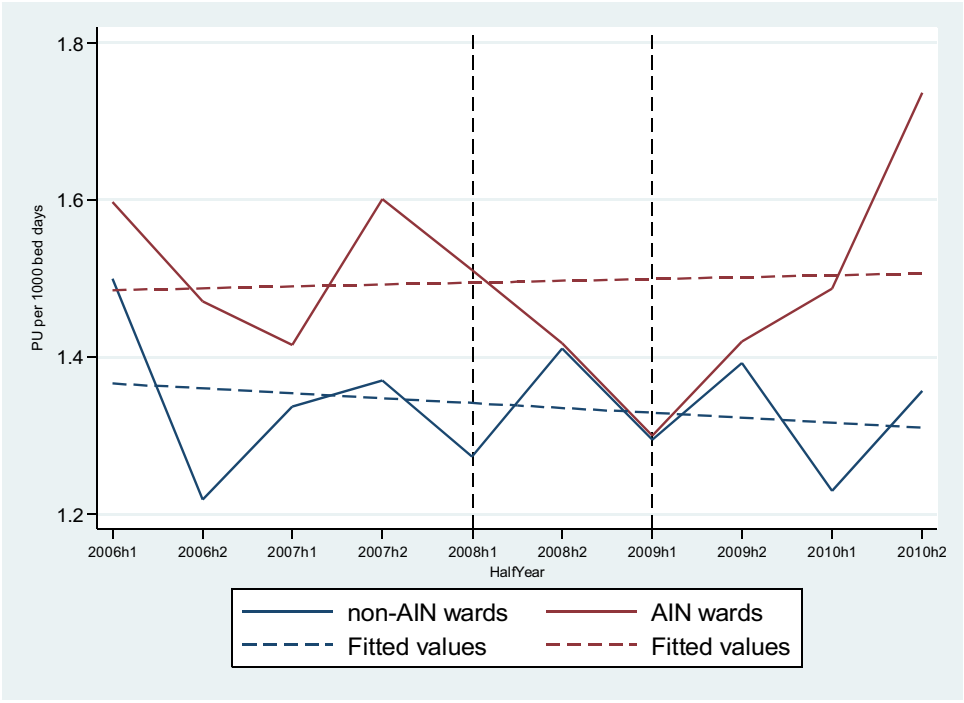

Fig. 6. Pressure injury rates.

predictor for UTI and pneumonia. For every 10% of extra time patients spent on AIN wards they had a 1% increase in the odds of developing a UTI and a 2% increase in the odds of developing pneumonia. Spending time on low skill mix wards was an important adjustment variable and was a significant predictor for UTI, pressure injury, sepsis and falls with injury. For every 10% of extra time patients spent in low skill mix wards they had a 3% increase in the odds of developing a UTI, a 6% increase in the odds of developing a pressure injury, a 5% increase in the odds of having a fall with injury and a 1% decrease in the odds of developing sepsis (see Table 4).

8. Discussion

To-date, there is no published research regarding the association between adverse patient outcomes and the **addition** of

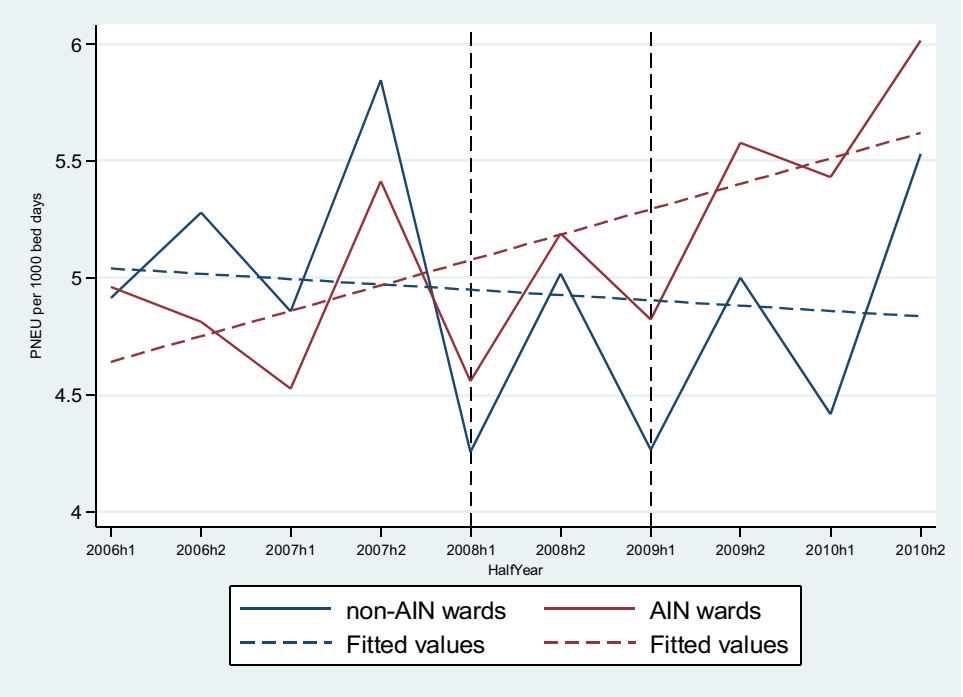

Fig. 7. Pneumonia rates.

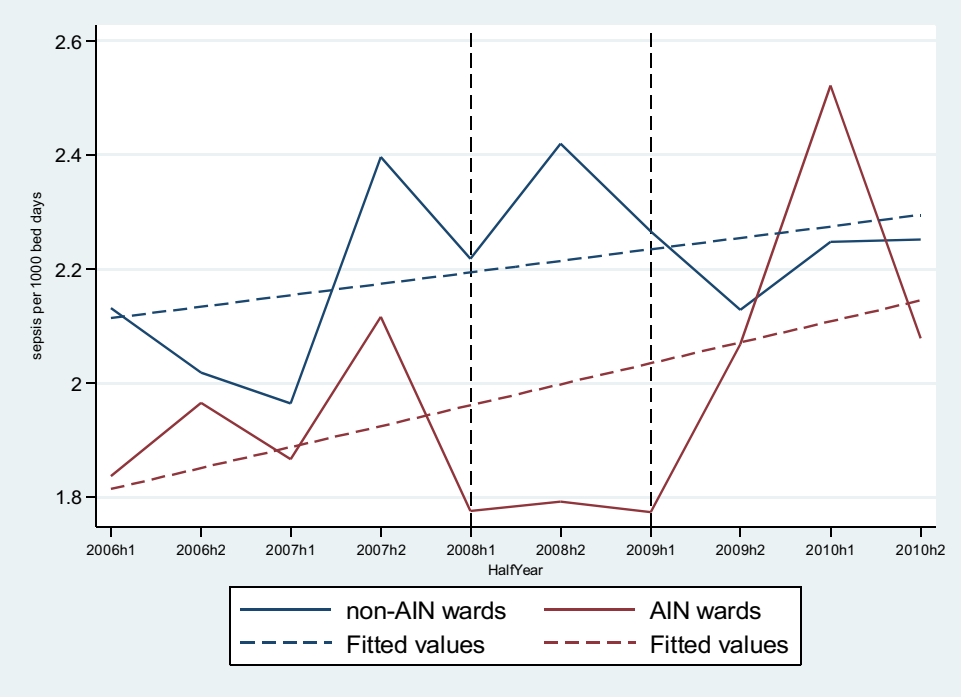

Fig. 8. Sepsis rates.

unregulated staff such as AINs in acute care hospitals to support rather than replace RNs (Duffield et al., 2014). Logically, maintaining the skill mix combined with enhanced resources should improve patient outcomes. We hypothesised that the addition of AINs to existing ward staffing would decrease adverse patient outcomes due to having another person on the ward to help the regulated nurses. Contrary to expectations, in this study, the odds for two of the outcomes, after adjustment for patient and hospital characteristics, were increased for patients who spent more of their hospital stay on AIN wards. Additionally, there were no decreases in the odds ratios for patients who spent more time on AIN wards, indicating that adding AINs to the staffing complement as an extra resource did not improve the quality of care provided to patients. Nursing surveillance is known to keep patients safe (Dresser, 2012), however, effective surveillance depends upon nurses having the knowledge, expertise and experience that

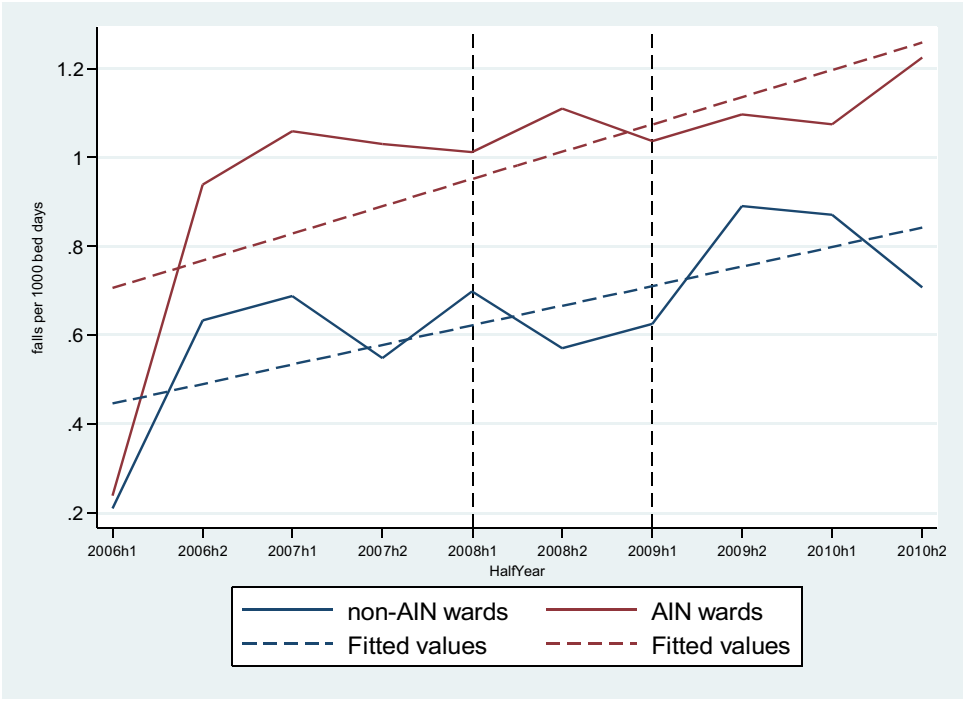

Fig. 9. Falls with injury rates.

Table 3
Pre-test/post-test within ward-type analysis.

Patient outcome	Observed Frequency	Expected Frequency	Difference (Observed-expected)	Increase/decrease	*p* value
All AIN wards					
Failure to rescue	485	417	68	Increase	0.018
Mortality	1122	1230	−108	Decrease	0.024
Urinary tract infection	4025	3821	204	Increase	0.017
Pressure injury	633	623	10	Increase	0.777
Pneumonia	2112	1992	120	Increase	0.056
Sepsis	807	783	24	Increase	0.544
Falls with injury	504	339	165	increase	<0.001
All non-AIN wards					
Failure to rescue	461	406	55	Increase	0.052
Mortality	1244	1238	6	Increase	0.903
Urinary tract infection	3426	3467	−41	Decrease	0.614
Pressure injury	599	603	−4	Decrease	0.908
Pneumonia	1972	2186	−214	Decrease	0.001
Sepsis	962	945	17	Increase	0.695
Falls with injury	376	265	111	Increase	<0.001

enables them to detect cues, recognise patterns, differentiate, and anticipate problems. It is possible that delegating basic patient care tasks to AINs reduces the opportunity for ongoing monitoring, assessment and evaluation by RNs, and that important cues are not recognised by the AINs.

When comparing the observed to expected patient outcomes following the introduction of AINs to the staffing complement there were three significant increases in adverse outcomes on the AIN wards (failure to rescue, UTI, falls with injury), with one significant decrease (mortality). The other adverse outcomes also increased on these wards, however these results were not statistically significant. On the non-AIN wards there was one significant decrease (pneumonia) in the adverse outcomes and one significant increase (falls with injury), with three of the other adverse outcomes increasing and two decreasing. These data indicate that there was no clear pattern when comparing the observed to expected outcomes following the implementation of AINs, although there were more increases in adverse outcomes on AIN wards compared to non-AIN wards, and more decreases in adverse outcomes on non-AIN wards compared to AIN wards. The time series graphs also showed there was no benefit from adding AIN resources to the wards. This is an unexpected finding as the AINs were additional to the usual staffing level and therefore the hours of care available for patients was increased. The majority of the wards in this study were staffed to the appropriate level under the NHpPD methodology and there were no clinically significant changes in skill mix across the pre and post periods for the two ward types used in this study. The reason for this finding is unclear and was not able to be investigated within the study methodology. The authors are not aware of any general policies or health system changes occurring during the study period that would have affected AIN wards differently to the non-AIN wards.

Although not the primary variable of interest, this study demonstrated the importance of including skill mix when

Table 4
Post-test between ward-type analysis.

Patient outcome	Outcome frequency (%)	c-statistic (%)	% Correctly Classified	Variable	Odds Ratio	95% CI	*p* value
Failure to Rescue	1196 (12.6)	72	87.4	AIN time	1.00	(0.98, 1.02)	0.975
				low skill mix	0.99	(0.96, 1.01)	0.211
Mortality	2891 (2.2)	84	97.8	AIN time	0.99	(0.98, 1.00)	0.276
				low skill mix	0.99	(0.98, 1.01)	0.247
UTI	8469 (6.5)	78	93.4	AIN time	1.01	(1.00, 1.01)	0.035
				low skill mix	1.03	(1.02, 1.04)	<0.001
Pressure injury	1451 (1.1)	84	98.9	AIN time	1.00	(0.99, 1.02)	0.761
				low skill mix	1.06	(1.04, 1.07)	<0.001
Pneumonia	5001 (3.8)	78	96.1	AIN time	1.02	(1.02, 1.03)	<0.001
				low skill mix	0.99	(0.98, 1.00)	0.168
Sepsis	2207 (1.7)	81	98.3	AIN time	1.01	(1.00, 1.02)	0.143
				low skill mix	0.98	(0.96, 0.99)	0.006
Falls with injury	976 (0.8)	81	99.3	AIN time	1.01	(1.00, 1.03)	0.116
				low skill mix	1.05	(1.03, 1.07)	<0.001

Odds ratio is for each 10% increase in time spent on AIN wards or low skill mix wards. n = 130,540 for all outcomes except failure to rescue where n = 9,499.

modelling the association between patient outcomes and other staffing variables. The association between poorer skill mix and increased adverse patient outcomes has also been identified in a previous study in the WA context (Twigg et al., 2011) and in numerous international studies (Blegen et al., 1998; Needleman et al., 2002; Sovie and Jawad, 2001; Tourangeau et al., 2002; Thungjaroenkul et al., 2007). Proportion of time spent on low skill mix wards was an important predictor of adverse patient outcomes with three of the outcomes having increased odds when patients spent more time on low skill mix wards. The finding that spending time on low skill mix wards was protective for developing sepsis is difficult to explain. In the case of UTI the proportion of time spent on AIN wards and the proportion of time spent on low skill mix wards were both significant predictors for developing the outcome. The results indicate that adding AINs to wards that already have a lower skill mix requires careful consideration as both of these variables were separately associated with increased adverse outcomes for patients.

Although adding AINs to the wards did not reduce the number of RNs it still functionally decreased the skill mix. This study demonstrated that improving patient outcomes is not just about adding more staff and supports the literature regarding the importance of skilled nursing care in promoting the health of patients. A number of reviews and meta-analyses of the extensive literature on this topic (for example Kane et al., 2007; Lang et al., 2004; Lankshear et al., 2005; Thungjaroenkul et al., 2007; Unruh, 2008) have confirmed a clear association between nurse staffing levels, skill mix and the outcomes of care. However, this evidence has not translated into consistent decisions to improve nursing variables within the acute care environment. The main reasons for this appear to be firstly, a lack of trust in the research evidence because it is not based on randomised controlled trials, and secondly, the significant cost drivers aimed at reducing the nursing budget, which is the most expensive component of hospitals. The research evidence on the cost effectiveness of improving nurse staffing is currently inconclusive and so the hypothesis that nurses save hospitals money due to the avoided costs from improving patient outcomes cannot yet be substantiated (Twigg et al., 2016). This study serves as a reminder that diluting the skill mix may be detrimental to the quality of care and should be implemented only with careful consideration. The anecdotal evidence provided in the Francis (2010) review indicated the grave consequences that can ensue from poorly planned staffing decisions. If *adding* AIN resources did not improve patient outcomes but was, instead, associated with poorer patient outcomes then *replacing* skilled nursing staff with AINs seems undesirable.

As this was not a randomised controlled trial there are other explanations for the results that need to be considered. This study cannot be considered a natural experiment as patients and AINs were not assigned randomly to wards. Patients were assigned to wards based on their clinical profile and/or bed availability and AINs were assigned to wards based on perceived need, for example they were assigned predominately to wards where there was an increased demand for basic care, although there was no specific policy covering their deployment and they were assigned in different ways in different settings. Although there was a clear guideline detailing the scope of practice and tasks that AINs were able to perform there was no specific implementation plan. It is not known what measures were taken by hospitals to ensure that AINs were integrated into the ward environment or that issues of communication, delegation and accountability between AINs and other nursing staff were discussed and organised. It is known that there was a high level of turnover among nursing leaders in the State at that time and this may have impacted on the change management process (Duffield et al., 2011a,b).

Additionally, the AINs practised differently within individual ward areas. For example, in some areas AINs were used to assist staff with the care of all patients, in some they were assigned to only one patient for a shift, and in others they were allocated to a group of patients. This lack of consistency may have contributed to the poorer results for patients who spent time on AIN wards and to the variability in the findings, as these process-type variables mediate between structure (presence of AINs) and patient outcomes as described by Donabedian (1966, 1988). It was not possible to capture these process variables within the regression models. Even though the modelling strategy controlled for many obvious patient characteristics there may be are other characteristics of the patients, the wards or the utilisation of AINs that were not accounted for within the modelling that may explain some of these results.

9. Limitations

A limitation of the modelling strategy used for the pre-test/post-test analysis is the precision with which the number of outcomes for each ward type could be determined. Patients move through a number of hospital wards within each admission and the actual date that an adverse outcome occurred during the patient's hospital stay is not available in administrative datasets. Therefore a proportion of each outcome was attributed to the AIN or non-AIN wards dependent on the patient's length of stay in each of these type of wards rather than a direct attribution of the outcome to the type of ward on which it occurred. This would have either underestimated or overestimated the actual number of outcomes for each ward type.

Another limitation of the study is in determining exposure to AIN resources. Hospitals were free to introduce AINs as required; there were no designated AIN wards. We determined exposure to AIN resources by examining the staffing data to see where and how AINs were utilised. There was wide variation in the way AINs were deployed across the health system. Some wards employed AINs consistently while others occasionally added AIN resources. We therefore determined a cut off point for allocating a ward to the AIN group. This meant that some patients on non-AIN wards may still have been exposed to AINs and some patients on AIN wards may not have been. It was not possible to determine which patients had been cared for by AINs, limiting the ability to draw any causal conclusions.

10. Conclusion

The results raise a number of issues about the introduction of AINs into the ward system in an additive model as the data do not support any beneficial effect on patient outcomes. Potentially, adding AIN resources may have had a detrimental effect on patient outcomes, although due to limitations in the study design it is not possible to determine a causal pathway. This has implications for settings where AINs have been substituted for RNs as the potential impact on adverse patient outcomes is increased. As outlined, AINs were introduced without any specific policy directive for their use and were deployed in varying ways within the health services. If AINs are added to the staffing complement it should be done under a protocol which clearly defines their role, scope of practice, and working relationship with RNs, and the impact on patient care should be monitored. Due to the increased odds of patients developing an adverse outcome when spending time on AIN wards and low skill mix wards, careful consideration needs to be given to the environment into which AINs are introduced, particularly if they are introduced into wards that already have a lower skill mix and/or poor work environment. As mentioned a lower skill mix has been identified in the literature as being associated with poorer patient outcomes, and the addition of less skilled workers will potentially compound this effect.

11. Recommendations

The research methodology used for this study indicates an association between AIN use and poorer patient outcomes rather than establishing a causal relationship, therefore further research using different methodologies is warranted. Conducting a study in which AINs are randomised to wards with a standard protocol for their utilisation and management, then comparing outcomes between control and comparison wards would provide a useful research methodology. Using data collection methods which allow the occurrence of an adverse outcome to be linked to the ward on which it occurred would also improve the rigour of this type of research. Although more research is needed to confirm the findings from this study, the authors recommend that hospitals exercise caution in changing the ward skill mix either by substituting AINs for RNs or by adding AIN resources to wards as the impact on patient care may not be positive. If AINs are implemented system wide there should be a planned change process that includes clear implementation guidelines and training in delegation, accountability and team building. There needs to be ongoing monitoring of the quality of care delivered by AINs to ensure they are practising within their scope of practice and working effectively with RNs. Maintaining a sufficient level of RNs on the ward to provide appropriate supervision for AINs is also important for the quality of patient care as well as for reducing costs from increased adverse outcomes. Good communication, appropriate delegation and supervision of AINs is vital to preserve quality patient outcomes

Conflicts of interest

None to declare.

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Author contributions

The authors' responsibilities were as follows—All authors: were responsible for the project conception; all authors: developed the research plan; HM and LG: prepared the data and conducted the data analysis; HM: prepared the manuscript; DT, CD, JP, LG & MR: critically reviewed the manuscript; DT and HM: had the primary responsibility for the final content; and all authors: read and approved the final manuscript.

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