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Are service and patient indicators different in the presence or absence of nurse practitioners? The EDPRAC cohort study of Australian emergency departments

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ABSTRACT

Objectives To evaluate the impact of nurse practitioner (NP) service in Australian public hospital emergency departments (EDs) on service and patient safety and quality indicators.

Design and setting Cohort study comprising ED presentations (July 2013–June 2014) for a random sample of hospitals, stratified by state/territory and metropolitan versus non-metropolitan location; and a retrospective medical record audit of ED re-presentations.

Methods Service indicator data (patient waiting times for Australasian Triage Scale categories 2, 3, 4 and 5; number of patients who did not-wait; length of ED stay for non-admitted patients) were compared between EDs with and without NPs using logistic regression and Cox proportional hazards regression, adjusting for hospital and patient characteristics and correlation of outcomes within hospitals. Safety and quality indicator data (rates of ED unplanned re-presentations) for a random subset of re-presentations were compared using Poisson regression.

Results Of 66 EDs, 55 (83%) provided service indicator data on 2 463 543 ED patient episodes while 58 (88%) provided safety and quality indicator data on 2853 ED re-presentations. EDs with NPs had significantly (p<0.001) higher rates of waiting times compared with EDs without NPs. Patients presenting to EDs with NPs spent 13 min (8%) longer in ED compared with EDs without NPs (median, (first quartile–third quartile): 156 (93–233) and 143 (84–217) for EDs with and without NPs, respectively). EDs with NPs had 1.8% more patients who did not wait, but similar re-presentations rates as EDs with NPs.

Conclusions EDs with NPs had statistically significantly lower performance for service indicators. However, these findings should be treated with caution. NPs are relatively new in the ED workforce and low NP numbers, staffing patterns and still-evolving roles may limit their impact on service indicators. Further research is needed to explain the dichotomy between the benefits of NPs demonstrated in individual clinical outcomes research and these macro system-wide observations.

Strengths and limitations of this study

► To our knowledge, this is the first study internationally to compare at a systems level the differences in service and patient safety and quality indicators for emergency departments (EDs) with nurse practitioner (NPs) on the service team and EDs without NPs.

► This large national study included data for over two million ED patient presentations collected prospectively.

► The study investigated NP service by collecting data at the system rather than individual NP level; this is a study strength and a departure from the prevailing approach to NP research.

► This was an observation study, thus there was no random allocation of NP implementation.

► Data custodians from two jurisdictions were unable to provide service indicator data, and one of these jurisdictions did not provide safety and quality data.

INTRODUCTION

Emergency departments (ED) are the safety net of healthcare providing care to patients with life-threatening conditions through to non-urgent clinical conditions regardless of financial status.[1] Worldwide, EDs are overcrowded because of increased health service demand, access block[2] and increasing presentations with complex care needs.[3 4] This overcrowding results in increased patient suffering, increased waiting times, patients leaving without being seen, decreased quality of services and undesirable impact on ED staff[5 6] and adverse patient outcomes.[5 7]

In response to the risk to patient safety and quality, health service managers have implemented workforce reforms. The use of nurse practitioners (NPs) in the ED has been one

of the most frequently adopted workforce solution internationally.[8] The NP role originated in the USA to meet demand for primary care services.[9 10] The UK has seen an increase in NPs in the ED, both in numbers and scope of practice.[11] In Australia, emergency NP service is a relatively new nursing model of care, and previous work from our team demonstrated that EDs employ the highest proportion of Australian NPs.[12 13] The ED NP role was initially developed to address the management of patients presenting to EDs with minor illness or injury.[14] However, the dynamic and flexible nature of the NP role[14] extends to complex and in-depth management of patients. There are differences between NPs in the UK and Australia, notably the absence of formal regulation of the UK NP title,[11] making international comparisons of the role difficult. Despite the rapid uptake of the NP role, research evaluating this service model around patient safety and quality outcomes is lacking.

In addition to the use of NPs to combat ED overcrowding and increasing ED attendances for low complexity problems,[3 4] fast track units have been created in many countries.[9 15] These functionally distinct units within EDs allow low-acuity patients to be streamlined from triage and seen separately.[16] Research from both Australia and UK show that NPs are a suitable staffing choice for fast track areas.[16–18]

Research to date has focused on service and clinical outcomes of individual NP roles without acknowledging that the strategy of implementing the NP role in ED is an innovation aimed at system improvement.[19] A new evaluation approach is needed, acknowledging that addition of NPs (both emergency specialist NPs and NPs from other specialties) to the ED clinical team is complex, with service consequences that extend beyond the individual clinician. Implementation of the NP role in EDs has met with challenges.[9 20] Unclear expectations including blurring of NP responsibilities and role boundaries with other nursing and medical staff often leads to confusion about the role.[20] EDs in Australia and internationally now employ NPs as part of their health service delivery team,[11 21] therefore high-quality multi-site research using appropriate inquiry approaches to comprehensively evaluate the effectiveness of NP service in EDs is warranted.[22]

This research aimed to compare service and patient safety and quality indicators for EDs with NPs on the service team and EDs without NPs. For the first time in Australia, research has examined the direct and/or systems impact of NP service on ED outcomes.

METHOD

This study involved a cohort of ED patients and a nested retrospective medical record audit to compare service and quality indicators in Australian public hospital EDs with and without NPs. Data from three sources were used: (1) a national survey on hospital and ED characteristics (previously reported),[21] (2) ED administrative data measuring service indicators of the ED episodes and (3) data abstraction from patient medical records to assess rates of unplanned patient re-presentation. The study was undertaken from July 2013 to June 2014.

Hospital eligibility and recruitment

All 155 Australian public hospitals providing 24-hour medical and nursing staff emergency services and reporting ED data to the Australian Institute of Health and Welfare identified from the MyHospitals website (https://www.myhospitals.gov.au) as in June 2012 completed a national telephone survey on ED organisation, staffing and service models.[21] A random sample of 66 of the 155 hospitals who participated in the survey, stratified by state/territory (geographical/jurisdictional units) and location (metropolitan/non-metropolitan) provided data on ED presentations. Data custodians from each hospital or health department were approached for access to administrative data.

Patient eligibility

Study participants were all patients in Australasian Triage Scale (ATS) categories 2, 3, 4 and 5 (*The ATS is a rating scale ensuring that patients are seen according to their clinical urgency. The maximum wait time indicator for each category is: 1: immediate; 2: 10 min; 3: 30 min; 4: 1 hour; 5: 2 hours.*)[23] who presented to participating EDs during the study period. Category 1 patients were excluded because, in addition to small numbers, NPs rarely initiate or manage treatment for this cohort in hospital EDs that met the study inclusion criteria.

Data collection

The hospital survey[21] collected data on a range of characteristics related to hospitals (location: state/territory; type: major referral, urban district, regional and ED size: categorised as small (<30 000 episodes per year), medium (30 000–60 000 episodes), large (>60 000 episodes); ED services (fast track, rapid assessment team, short stay/sub-acute care, aged care liaison as described previously[21]; and nursing (nurse educator, clinical nurse consultant, enrolled nurse), medical (staff specialists, registrars, residents/interns) and allied health (access to radiology) workforce factors. These variables were considered to be important ED features likely to be associated with ED management and clinical care. EDs were categorised based on presence or absence of NPs on the ED service team including NPs who serviced a specific population such as aged care or mental health.[21] Data on NP characteristics were limited to those relating to the NP service model, other variables of education and experience are standardised across Australia. In order to gain authorisation as a NP in Australia the nurse must demonstrate to the registering authority a minimum 3 years' experience as a senior clinician and completion of a board-accredited NP masters' degree.[24]

Service indicator data were collected prospectively from routinely collected computerised hospital administrative data over a 12-month period, from July 2013 to

June 2014, to capture the effects of seasonal variation on demand for ED services. Patient-level data obtained were: medical record number, date of birth, sex, date and time of presentation, date and time seen by an ED clinician, date and time the patient left ED, whether or not the patient was seen by a clinician and whether or not they completed their treatment, presenting condition, ATS category, mode of transport to ED and final diagnosis as determined by national coding processes.[25] Three service indicators were measured from administrative data: (1) patient waiting times for ATS categories 2, 3, 4 and 5; (2) number of patients who 'did not wait' (DNW), defined as patients who did not wait to be seen by clinical staff (doctor or nurse) or patients who had been seen but left before completion of treatment; and (3) overall length of stay in ED for patients who were not admitted, transferred or left without being seen or before completion of treatment. Length of time in the department for admitted patients is influenced by factors beyond the ED such as the availability of hospital beds, thus non-admitted patients are a more appropriate population in which to measure length of ED stay.

The safety and quality indicator measured in this study was the rate of unplanned ED re-presentations within 48 hours. This variable identified accuracy and appropriateness of clinical care and data were readily available. Patients who re-presented to the same ED within 48 hours of their initial presentation were identified over a 3-month period from 1 July to 30 September 2013 from computerised ED data systems. A random sample of 50 of these re-presenting patients were selected for each ED using random number generating software and a retrospective medical record audit undertaken by trained research nurses. Notes for the initial presentation and reasons for re-presentations were reviewed and the re-presentation was classified as unplanned if the second visit was for an unrelated cause, or there was no indication that patient had been asked to reattend in the initial visit; re-presentations where the patient had been requested to return for follow-up, or if their condition worsened or further developed were not classified as unplanned.

Sample size

Calculation of sample size was informed by national data including published and unpublished local data and based on 80% power and a 5% significance level. An intraclass correlation of 0.02 was used to estimate the design effect due to correlation of measures within hospitals. The outcome 'proportion of patients seen on time' required the largest sample size and was therefore used to estimate the sample size required. The total sample size required to detect a 5% difference in this outcome (from both NP and non-NP EDs combined) for ATS 3 and ATS 4 triage categories was estimated to be 744 916 and 939 104 patients, respectively. Assuming a 1:1 ratio of NP to non-NP EDs, the number of EDs needed was 56 (based on the larger of these two sample size estimates).

Data analysis

Data were analysed using Stata V.13 and 14. Data checks and exploratory data analyses were undertaken to check for out of range or unusual/illogical values. For service indicator outcomes, univariable associations were initially examined using two-way tables and univariable logistic regression for the DNW outcome and univariate Cox proportional hazards regression for patient waiting time, and length of stay. Multiple regression models were generated including core covariates of interest: presence or absence of NP; hospital location; hospital type; ED size; patient age category, patient sex and ATS category (2, 3, 4 or 5, where ATS-specific models were not generated). Due to possible multi-collinearity, correlations among arrival mode and other hospital-level variables, nursing workforce variables, medical workforce variables and access to radiology were assessed and relevant (non-correlated) variables were then added individually, and retained in the model if the p value for the Wald test assessing their association with the outcome was ≤0.1. As waiting times for ED patients vary according to their triage category, separate models were generated by triage category for this outcome.

Given the potential for NPs to have greater impact in less urgent presentations, models were also generated with an interaction term for NP by ATS category, however as none of these interactions were statistically significant only the main effects models are reported. Analyses adjusted for correlation of observations within hospitals using the Huber-White (sandwich) (cluster) variance estimate. Sensitivity analysis was undertaken on the DNW outcome for the subgroup of patients who did not wait to be seen by clinical staff (ie, defining patients who had been seen but left before completion of treatment as having waited).

The safety and quality indicator outcome (rates of unplanned re-presentations within 48 hours) was considered at the ED level. The overall rate of re-presentation was calculated as number of re-presentations divided by the total number of ED presentations. The proportion of unplanned re-presentations was based on the subgroup of re-presenting patients whose records were reviewed and calculated as number of unplanned re-presentations divided by the sum of number of planned and unplanned re-presentations. The overall rate of unplanned re-presentations was calculated as overall rate of re-presentation multiplied by proportion of unplanned re-presentations.

In assessing the service indicator outcomes, a significance level of p<0.01 was used to take some account of the large number of observations (ED presentations), while a significance level of p<0.05 was used for the safety and quality indicator outcome, which was based on a subsample of ED presentations.

Patient and Public involvement

Patients were not involved in the design and conduct of this study, however there was extensive involvement of industry partners in this study. This team of health service leaders

(see acknowledgements) collaborated with the study team in setting project goals, confirming feasibility of study design and establishing project deliverables. When the project was in progress the industry partners formed joint membership of the project advisory committee, received progress reports and provided feedback. On completion of the project, the study findings were discussed with industry partners to inform health service policy and workforce planning in emergency services across Australia.

RESULTS

Of the 155 Australian public hospital EDs that met the eligibility criteria, 135 (87%) provided survey data; while 61 of the 66 asked to provide ED data consented and had ethical approval to participate in the study. Of the 66 hospitals, 55 (83%) provided service indicator data on 2 463 536 ED patient episodes from July 2013 to June 2014 while 58 (88%) provided safety and quality indicator data on 2853 ED patient re-presentations from July to September 2013. Of the 2900 re-presentations selected for this component of the study, 47 patient records could not be located.

Service indicator data could not be obtained from Western Australia and Northern Territory because data custodians were unable to provide access to data despite the study obtaining Human Research Ethics Committee (HREC) approval. However, the Western Australian Department of Health data custodian did provide safety and quality indicator data on re-presentations which were included in analyses.

Demographic characteristics of EDs and emergency episodes

Characteristics of the 61 Australian EDs recruited to participate in the study are presented in table 1. Approximately a third of EDs were located in New South Wales, half were from regional or rural locations with 25% described as urban district and 27% as major referral metropolitan EDs.

Just over half of EDs (n=33; 55%) employed NPs, of which 15 (45%) employed fewer than two NP full-time equivalent (FTE) and 18 (55%) employed ≥2 NP FTE. Thirteen EDs employed NPs restricted to treating patients in triage categories urgent to non-urgent (ATS categories 3–5), while in the remaining EDs, NPs also covered emergency (ATS category 2) patients. All EDs employed registered nurses, 38% also employed clinical nurse consultants and 73% employed nurse educators.

There were similar numbers of male and female patients presenting to ED during the study period. Patient age was bimodal with peaks for infants aged between 0 and 4 years and for adults from 20 to 40 years. School age children (5–19 years) were under-represented compared with adults. The majority of ED episodes were classified as urgent (ATS category 3: 38%) or semi-urgent (ATS category 4: 41%). Over 30% (n=763 944) of presentations were for patients diagnosed with infectious diseases or injury (table 2).

Patient waiting times

Factors associated with waiting times of patients in EDs for each ATS category are shown in table 3 (also see online

Table 1 Characteristics of hospital emergency departments (n=61)*

Characteristic	n (%)
State strata	
NSW	22 (36)
VIC	15 (25)
QLD	13 (21)
WA	6 (10)
SA/TAS/ACT	5 (8)
ACEM classification	
Major referral	16 (27)
Urban district	15 (25)
Major regional/rural	29 (48)
ED size (number of presentations)	
<35 000	18 (33)
35 000–<50 000	18 (33)
50 000+	19 (35)
Nurse practitioner in ED	33 (55)
ED nurse practitioner FTE	
No NP	27 (45)
NP <2 FTE	15 (25)
NP ≥2 FTE	18 (30)
Triage category services by NP	
No NP	27 (48)
NP 1–5	8 (14)
NP 2–5	8 (14)
NP 3–5/4–5	13 (23)
Other clinical positions	
Nurse educator	44 (73)
Clinical nurse consultant	23 (38)
Enrolled nurse	49 (82)
Staff specialists	50 (83)
Registrars	46 (77)
Residents/interns	51 (85)
Service operation models	
Access to radiology	39 (65)
Fast track	45 (75)
Rapid assessment team	25 (42)
Short stay/sub-acute care	40 (67)
Aged care liaison	40 (67)

Numbers may not add to total sample size due to missing data.
*Only 55 hospitals provided service indicator data.
ACEM, Australian College for Emergency Medicine; ACT, Australian Capital Territory; ED, emergency department; FTE, full-time equivalent; NP, nurse practitioner; NSW, New South Wales; QLD, Queensland; SA, South Australia; TAS, Tasmania; VIC, Victoria; WA, Western Australia.

supplementary file). EDs with NPs had significantly higher median waiting times (p<0.001) compared with EDs without NPs for all ATS categories with the exception of ATS category 5. Median waiting times were longer in Queensland for all ATS categories (from 8 to 47 min)

Table 2 Characteristics of emergency department patient presentations (n=2 463 543)

Characteristic	n (%)
Sex	
Male	1 236 316 (50)
Female	1 227 220 (50)
Age group	
0–4	261 511 (11)
5–9	114 538 (5)
10–14	108 599 (4)
15–19	168 420 (7)
20–29	377 320 (15)
30–39	307 969 (13)
40–49	266 846 (11)
50–59	237 614 (10)
60–69	215 492 (9)
70–79	192 395 (8)
80+	212 832 (9)
Triage category	
Emergency (2)	306 399 (12)
Urgent (3)	936 106 (38)
Semi-urgent (4)	1 017 746 (41)
Non-urgent (5)	203 285 (8)
Final primary diagnosis	
Infectious/injury/external	763 944 (31)
Circulatory/respiratory	304 380 (12)
Skin/subcutaneous/musculoskeletal	189 591 (8)
Endocrine/nutrition/metabolism	164 962 (7)
Health status/health services	144 820 (6)
Genitourinary	143 103 (6)
Mental/behavioural	88 634 (4)
Eye/adnexa/ear/mastoid	51 444 (2)
Pregnancy/childbirth/perinatal/congenital	46 287 (2)
Nervous system	39 727 (2)
Neoplasms/blood	23 262 (1)
Other clinical/laboratory/unknown	503 382 (20)

compared with other jurisdictions. For ATS categories 3 and 4, male patients were significantly more likely to be seen before female patients, however the difference in median waiting time was small at 1 min. While EDs with fast track had longer median waiting times compared with those without fast track, the difference was significant for ATS category 3 only (p<0.01). Results for Cox proportional hazards models for each ATS category are provided in table 3.

Patients who did not wait

A total of 63 366 (2.6%) patients did not wait to be seen. Patients in EDs employing NPs had higher odds of not

waiting (OR: 1.8 95% CI 1.4 to 2.2; p<0.001) compared with EDs without NPs (table 4). Female patients had higher odds of waiting compared with males. The odds of not waiting increased with increasing ATS category (decreasing level of urgency). For additional results for other covariates (hospital location, ED size and diagnostic group) see online supplementary file.

Length of stay in ED for non-admitted patients

Of the 1 470 304 patients not admitted following their ED presentation, 826 024 attending EDs with NPs spent a median of 156 min in ED compared with a median length of stay of 143 min for 644 280 patients from EDs without NPs (HR 0.87, 95% CI 0.81 to 0.95, p=0.001). Patients in Queensland spent the shortest time in the ED. Male patients were significantly more likely to be discharged sooner than female patients (HR 0.94, 95% CI 0.94 to 0.95, p<0.001) (table 5). Length of stay decreased with decreasing level of urgency (higher ATS category). Increasing age was associated with longer time in the ED for discharged patients with children spending a median of approximately 2 hours in the ED increasing in a linear fashion to patients aged over 80 years who spent over 3.5 hours in ED.

Model also adjusted for hospital type and diagnostic group; an HR of <1 indicates that patients in this group are less likely to be discharged, compared with the reference group.

Rates of unplanned re-presentation

EDs with NPs did not differ in rates of unplanned re-presentations compared with EDs without NPs. Significant reductions in the rates of unplanned re-presentations were seen in EDs with fast track (IRR 0.74, 95% CI 0.60 to 0.92, p=0.006) and those with aged care liaison models (IRR 0.72, 95% CI 0.54 to 0.96, p=0.023), with a marginally non-significant increase in re-presentations associated with the presence of a Nurse Educator (IRR 1.22, 95% CI 0.99 to 1.50, p=0.060) (see online supplementary file).

DISCUSSION

Notably, this study is novel in Australia and globally in its systems-level comparison of differences in both service and patient safety and quality indicators for EDs with and without NPs on the clinical team. Our results showed that EDs with NPs had lower performance for three routinely measured ED service indicators. There were longer waiting times in EDs with NPs for patients allocated ATS categories 2, 3 and 4. While this difference is statistically significant, the clinical significance is not established, given the small magnitude of difference. The difference in waiting times was not significant for ATS category 5; these patients are more likely to be seen by an NP[21] so would be more likely to have shorter waiting times. EDs with fast track had longer patient waiting times for ATS category 3 and EDs with NPs had higher odds of patients

Table 3 Selected factors associated with waiting times for emergency department patients: results of survival analysis stratified by triage category (n=2 308 470)

	ATS category 2 (maximum wait time for medical assessment and treatment: 10 min)			ATS category 3 (maximum wait time for medical assessment and treatment: 30 min)			ATS category 4 (maximum wait time for medical assessment and treatment: 1 hour)			ATS category 5 (maximum wait time for medical assessment and treatment: 2 hours)		
	Median (Q1–Q3) (min)	HR (95% CI)	P value	Median (Q1–Q3) (min)	HR (95% CI)	P value	Median (Q1–Q3) (min)	HR (95% CI)	P value	Median (Q1–Q3) (min)	HR (95% CI)	P value
NP status												
Without NPs*	6 (2–10)	1		21 (10–40)	1		29 (13–61)	1		26 (10–62)	1	
With NPs	7 (4–13)	0.79 (0.70 to 0.88)	<0.001	26 (12–57)	0.75 (0.67 to 0.83)	<0.001	38 (16–82)	0.74 (0.67 to 0.82)	<0.001	29 (12–67)	0.88 (0.79 to 0.97)	0.012
State												
QLD*	8 (4–19)	1		36 (16–81)	1		47 (19–93)	1		35 (14–77)	1	
NSW	8 (5–12)	1.51 (1.31 to 1.73)	<0.001	21 (12–37)	1.65 (1.44 to 1.89)	<0.001	29 (14–60)	1.50 (1.32 to 1.71)	<0.001	26 (11–59)	1.35 (1.16 to 1.57)	<0.001
VIC	4 (1–8)	2.12 (1.83 to 2.46)	<0.001	18 (8–38)	1.65 (1.44 to 1.90)	<0.001	30 (12–69)	1.38 (1.21 to 1.57)	<0.001	27 (10–64)	1.16 (0.98 to 1.37)	0.094
SA/TAS/ACT	5 (1–9)	1.66 (1.43 to 1.94)	<0.001	23 (11–52)	1.24 (0.95 to 1.63)	0.114	34 (15–77)	1.14 (0.92 to 1.41)	0.241	33 (13–78)	1.01 (0.77 to 1.34)	0.934
Gender												
Male*	7 (3–11)	1		23 (11–48)	1		33 (14–71)	1		28 (11–65)	1	
Female	7 (3–12)	0.96 (0.95 to 0.97)	<0.001	24 (12–51)	0.96 (0.96 to 0.97)	<0.001	34 (14–73)	0.98 (0.98 to 0.99)	<0.001	28 (11–65)	1.00 (0.99 to 1.01)	0.743
Mode of arrival												
Ambulance*	7 (3–11)	1		21 (10–45)	1		34 (14–74)	1		38 (14–86)	1	
Private/public transport/ police	7 (4–12)	0.93 (0.89 to 0.97)	<0.001	25 (12–53)	0.86 (0.81 to 0.90)	<0.001	33 (14–72)	0.99 (0.94 to 1.05)	0.755	28 (11–64)	1.25 (1.19 to 1.31)	<0.001
Patient fast track												
No fast track*	5 (2–10)	1		18 (9–33)	1		28 (12–65)	1		24 (10–57)	1	
Fast track	7 (3–12)	0.91 (0.79 to 1.06)	0.234	25 (12–53)	0.82 (0.72 to 0.94)	0.005	35 (15–74)	0.95 (0.85 to 1.07)	0.410	29 (12–66)	0.92 (0.82 to 1.03)	0.147
Rapid assessment team												
No rapid assessment team*	7 (3–12)	1		21 (11–40)	1		31 (14–65)	1		28 (12–64)	1	
Rapid assessment team	7 (3–12)	1.13 (1.00 to 1.27)	0.046	27 (12–63)	0.89 (0.78 to 1.01)	0.068	37 (15–82)	0.94 (0.84 to 1.06)	0.322	27 (10–66)	1.02 (0.91 to 1.14)	0.716

Models also adjusted for hospital type, hospital size, age group and diagnostic group; a HR of <1 indicates that patients in this group are less likely to be seen, compared to the reference group.
*Reference group.
ACT, Australian Capital Territory; ATS, Australian Triage Scale; ED, emergency department; NP, nurse practitioner; NSW, New South Wales; QLD, Queensland; SA, South Australia; TAS, Tasmania; VIC, Victoria.

Table 4 Factors associated with not waiting for completion of treatment (n=2 446 935)

	n	%	OR (95% CI)	P value*
NP status				
Without NPs†	47 289	4.5	1	
With NPs	87 638	6.3	1.78 (1.42 to 2.23)	<0.001
Hospital type				
Major referral†	45 477	5.0	1	
Urban district	35 454	6.7	1.55 (1.11 to 2.16)	0.010
Major regional/rural	53 996	5.4	0.9 (0.60 to 1.37)	0.639
Rapid assessment team				
No rapid assessment team†	71 554	5.4	1	
Rapid assessment team	63 373	5.7	1.26 (1.00 to 1.58)	0.049
Radiology				
No radiology†	40 315	4.9	1	
Radiology	94 612	5.8	1.33 (0.99 to 1.78)	0.060
Age group				
0–4	17 204	6.6	1	
5–9	6583	5.8	0.82 (0.78 to 0.86)	<0.001
10–14	4818	4.5	0.63 (0.58 to 0.68)	<0.001
15–19	12 040	7.2	0.82 (0.72 to 0.94)	0.004
20–29	30 277	8.1	0.86 (0.73 to 1.01)	0.058
30–39	22 279	7.3	0.78 (0.66 to 0.94)	0.007
40–49	16 844	6.4	0.74 (0.62 to 0.89)	0.001
50–59	11 874	5.0	0.61 (0.51 to 0.73)	<0.001
60–69	6871	3.2	0.39 (0.33 to 0.46)	<0.001
70–79	3890	2.0	0.25 (0.22 to 0.29)	<0.001
80 +	2247	1.1	0.13 (0.11 to 0.16)	<0.001
Sex				
Male†	68 175	5.6	1	
Female	66 752	5.5	0.79 (0.75 to 0.85)	<0.001
Triage category				
Emergency (2)†	4284	1.4	1	
Urgent (3)	34 178	3.7	2.32 (1.97 to 2.74)	<0.001
Semi-urgent (4)	75 182	7.4	5.43 (4.40 to 6.71)	<0.001
Non-urgent (5)	21 283	10.6	4.76 (3.08 to 7.37)	<0.001

Model also adjusted for state, hospital size and diagnostic group.
*P values from Wald test.
†Reference group.
NP, nurse practitioner.

not waiting for treatment completion compared with EDs without NPs.

The trend, nationally and internationally, of a high uptake of NP service in the ED setting[8 12 13] was supported and possibly influenced by early single site audit studies that reported NPs having a positive effect on service indicator data.[26–28] EDs employed NPs in order to improve existing poor performance on service indicators. That these assumptions were not supported by the study findings can possibly be explained by the effect of reverse causation. That is, the existing poor performance on service indicators was the cause for EDs to employ NPs. In other words, poor performance was the cause, not the effect, of NP service.

Consistent with expectations, patients who arrived by ambulance had shorter waiting times for ATS categories 2 and 3, and patients with more urgent triage categories had greater length of stay than less urgent categories. Elderly patients who are likely to have more comorbidities than the young, spent longer time than other groups in the ED.

Table 5 Factors associated with length of stay in emergency department for discharged patients (n=1 470 308)

	Median (min)	Q1–Q3 (min)	HR (95% CI)	P value*
NP status				
Without NPs†	143	84–217	1	
With NPs	156	93–233	0.87 (0.81 to 0.95)	0.001
State				
QLD†	135	80–206	1	
NSW	159	93–233	0.77 (0.69 to 0.86)	<0.001
VIC	150	90–228	0.83 (0.74 to 0.93)	0.001
SA/TAS/ACT	160	98–244	0.8 (0.67 to 0.94)	0.007
Gender				
Male†	142	85–218	1	
Female	159	94–234	0.94 (0.94 to 0.95)	<0.001
Age group				
0–4†	125	77–190	1	
5–9	120	75–183	0.97 (0.95 to 1.00)	0.086
10–14	123	78–187	0.91 (0.87 to 0.96)	<0.001
15–19	143	87–216	0.78 (0.73 to 0.83)	<0.001
20–29	149	89–223	0.76 (0.71 to 0.82)	<0.001
30–39	154	91–229	0.74 (0.68 to 0.79)	<0.001
40–49	159	94–235	0.70 (0.65 to 0.76)	<0.001
50–59	164	97–240	0.68 (0.63 to 0.73)	<0.001
60–69	175	106–255	0.65 (0.60 to 0.70)	<0.001
70–79	193	118–283	0.61 (0.56 to 0.66)	<0.001
80 +	222	143–328	0.55 (0.51 to 0.60)	<0.001
Triage category				
Emergency (2)†	191	130–276	1	
Urgent (3)	180	115–253	1.06 (1.01 to 1.11)	0.012
Semi-urgent (4)	138	83–214	1.33 (1.25 to 1.41)	<0.001
Non-urgent (5)	95	52–157	2.01 (1.88 to 2.16)	<0.001
ED size				
<35 000†	129	74–205	1	
35 000–<50 000	137	82–212	0.96 (0.83 to 1.11)	0.580
50 000+	169	105–239	0.7 (0.6 to 0.81)	<0.001
Mode of arrival				
Ambulance†	208	138–306	1	
Private or public transport/police	139	83–213	1.46 (1.43 to 1.50)	<0.001
Liaison models aged				
No liaison aged care†	144	85–225	1	
Liaison aged care	152	91–228	1.19 (1.06 to 1.34)	0.002

Model also adjusted for hospital type and diagnostic group; an HR of <1 indicates that patients in this group are less likely to be discharged, compared with the reference group.
*P values from Wald test.
†Reference group.
ACT, Australian Capital Territory; NP, nurse practitioner; NSW, New South Wales; QLD, Queensland; SA, South Australia; TAS, Tasmania; VIC, Victoria.

Our safety and quality indicator of unplanned re-presentations showed no difference between EDs with and without NPs. However, when comparing re-presentations according to service models, EDs with fast track had a significantly lower rate, on average 25%, of unplanned re-presentations. Our results are in part supported by

previous research where individual NP care was the explanatory variable. A well-powered, Australian randomised controlled trial comparing emergency NP care with traditional care found no significant differences between groups for the same service indicators of waiting times, numbers of patients who did not wait and ED length of stay.[29] However, results showed a significant difference in 'time to analgesia' in favour of NPs when compared with ED doctors.[30] Similarly, Roche et al[19] found no significant difference between NP and traditional care on service indicators of waiting time and length of stay in rural EDs. For patients presenting to these rural EDs with undifferentiated chest pain however, NPs had a higher proportion of diagnostic accuracy of ECG interpretation, higher proportion of guideline adherence for high-risk patients and patients had 2.4 times lower odds of an unplanned re-presentation within 7 days when compared with the standard care model. These and other studies[17 18 20] indicate that the impact of NPs when compared with traditional care on service indicators is inconclusive and varies across settings. However, research on the influence of NP service on patients' clinical outcomes and quality of care is consistently shown to be equivalent or superior in comparison to traditional ED care.

The Emergency Department Nurse **Prac**titioner (EDPRAC) national survey study showed that Australian EDs with NPs average two NP FTE nationwide,[21] numbers insufficient to staff the 24 hours ED service time frame. These NP numbers and staffing patterns when compared with the scope of medical staffing (an average of ~46 medical staff FTE nationwide across 24 hours) are likely too small to have a clinically significant effect on service indicators in either direction. Furthermore, alternative influences related to EDs that employed NPs need to be taken into consideration, such as the level of health service planning and historical hospital performance on service indicators before including NPs in the team. Data on these variables were not collected. Within the timeframe of this study, the majority of NPs were in the early phases of their career (≤5 years post-endorsement NP experience) and therefore may not have worked to their full scope of practice.

Ultimately, our research raises questions about optimum deployment of the NP service model in EDs. While NPs may be a suitable choice for managing patients in ED fast track areas, the impact of their service may not have been appropriately captured by the routinely collected service indicators we measured which are multifactorial. Drivers other than ED staffing that impact on all service indicators include patient characteristics, non-urgent patient visits and hospital bed shortages.[31] Evaluation of emergency NP service requires further consideration of which service indicators appropriately measure the safety and quality of patient care.

There are notable strengths to our study. This large exploration of ED service included data for over 2 million ED patient presentations. The study covered all jurisdictions in Australia (except Western Australia and Northern Territory) with data collected over a 12-month timeframe. Data from the EDPRAC survey provided essential information to adjust for hospital and team characteristics in the statistical models used in this study. Our research also departed from the prevailing approach to investigating NP service by taking measurement at the system rather than individual NP level. Implementation of the NP role in complex systems such as hospitals may have impacted on our findings given the multifaceted interactions between the NP role and the hospital system.[32]

A limitation of the study relates to the quality of ED performance data particularly when jurisdiction-level data are aggregated and reported at national level. All reported data showed differences in waiting times for all ATS categories but data custodians in some jurisdictions restricted our access to some of the data categories or declined to supply data despite HREC approval. Australian research has shown that ED performance data is subject to manipulation and fine-tuning[33 34] which further compromises data integrity. Examination of the study findings raises questions about the strength of the causal link between NP service and the study outcomes. This, in part, can be attributed to inherent limitations of observational studies where there is minimal control over variables and consistency of intervention across multiple sites. Accordingly, reverse causation as discussed above could not be ruled out in this study design. Not-withstanding these limitations the findings and ensuing questions provide important foundation knowledge for formulation of hypotheses for subsequent experimental studies on the issues identified.

Overall, our study results show that on a systems level, prevailing NP staffing patterns have little or no effect on improvement of currently measured service indicators. The optimum number of emergency NPs relative to medical and nursing staffing, ED size and workload is unknown. If NPs are to be an effective ED workforce strategy, then further research to determine optimum ED skill mix and staffing ratio is warranted. Furthermore, an examination of the rationale for employing NPs in EDs may reveal variables that differentiate them from hospitals that do not employ NPs. Our results highlight the need for further consideration of the measurement of ED performance generally and in the context of team configuration, including the focus of NP service and the quality of service indicator data. Further research is also needed to examine the influence of NP care across all ED acuity levels on patient and service outcomes including staffing patterns in fast track service models.

At the time of our study, the majority of Australian NPs worked in EDs. Importantly, the NP role and scope of practice have since diversified with the validation of other NP specialty areas aside from the ED.[35] Our findings therefore represent a measure of one model of NPs and should not be generalised to all NPs.

CONCLUSION

This study is innovative in its examination of ED NP service at a national level and has revealed new knowledge about

Australian ED services. While this research has provided statistically reliable results relating to the influence of ED team configuration with and without NPs, these findings should be treated with caution. NPs are a relatively new inclusion into the ED workforce, and their numbers and roles are still being defined; our result may in part reflect the lack of critical mass of NP numbers per ED. Prevailing ED staffing models that include NPs have scant influence on the traditional service indicator metrics studied in this research raising questions about the need for more honed measures to evaluate ED NP service. Further research is needed to explain the dichotomy between the benefits identified in individual clinical outcomes NP research[36] and these macro system-wide observations.

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