RESEARCH ARTICLES

Examining the impact of rapid response team nursing models on patient outcomes: A single-centre retrospective observational study

AUTHORS

CLINTON FILDES RN, MN, GradDipNg(CritCareNurse), BN [1,2,3]

REBECCA MUNT RN, PhD, Grad Cert Edn (Higher Ed), Honours (Nursing), BN [4,5]

DIANE CHAMBERLAIN RN, PhD, MPH (Epi), MN (Critical Care), BSc, GCHEcon [6]

CORRESPONDING AUTHOR

CLINTON FILDES Clinical and Health Sciences, City East Campus, University of South Australia, Adelaide, SA, Australia. Ph: +61 8 8302 7879, E: clinton.fildes@unisa.edu.au

1 Clinical and Health Sciences, University of South Australia, Adelaide, SA, Australia
2 Rosemary Bryant AO Research Centre, University of South Australia, Adelaide, SA, Australia
3 Central Adelaide Local Health Network, Adelaide, SA, Australia
4 South Australia Health & Medical Research Institute, Adelaide, SA, Australia
5 Adelaide Nursing School, University of Adelaide, Adelaide, SA, Australia
6 Caring Futures Institute in the College of Nursing and Midwifery, Flinders University, Adelaide, SA, Australia

ABSTRACT

Objectives: To determine whether rapid response team (RRT) end-of-call patient outcomes differ between a dual-role intensive care unit (ICU)/RRT nursing model and a partially dedicated RRT nursing model, to report any associations between ICU adverse events and RRT calls, and to describe RRT call characteristics.

Background: ICU nurses commonly staff RRTs but juggling simultaneous ICU and RRT duties may compromise patient safety and care.

Methods: A single-centre retrospective cohort study compared all ward-based RRT calls during two equivalent eight-month periods at a large Australian adult teaching hospital: January–August 2017 (non-dedicated model) and January–August 2018 (partially dedicated model). Data was obtained primarily from the RRT database. Descriptive statistics and binomial proportion tests compared call characteristics. Unadjusted logistic regression examined associations between nurse role (dual or dedicated) and end-of-call outcomes: remained on ward, transferred, or died (primary outcome = death; secondary = transfer).

Results: Of the 6,955 RRT calls analysed, the proportion attended by dual-role ICU/RRT nurses fell markedly after two dedicated nurses were introduced, down from 39.4% (1366/3466) in 2017 to 11.6% (403/3489) in 2018 ($\chi^2(2) = 838.4$, $p < 0.001$). Across both periods, dual-role nurses still managed 1,769 calls (25%). RRT calls attended by dual nurses carried more than threefold higher odds of death (odds ratio [OR]: 3.015 [95% CI: 1.796–5.061], $p < 0.001$), double the odds of any transfer off the ward (OR: 2.027 [95% CI: 1.756–2.340], $p < 0.001$), and 43% higher odds of ICU transfer specifically (OR: 1.428 [95% CI: 1.148–1.776], $p = 0.001$). The pattern of RRT trigger reasons changed significantly between 2017 and 2018, with fewer calls for cardiac

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arrest or low oxygen saturation and more calls initiated because staff were "worried," among other shifts (χ^2 (15) = 61.95, p < 0.001). No statistically significant associations could be demonstrated between ICU-recorded adverse events and RRT call characteristics; nevertheless, exploratory trends in the data suggest possible links that require further research.

Conclusions: The dual ICU/RRT nursing model was associated with poorer patient outcomes, including higher mortality and more frequent transfers. In contrast, the partially dedicated RRT nursing model was associated with more favourable outcomes.

Implications for Clinical Practice: The findings suggest that dedicated RRT nursing staff may improve patient outcomes by reducing the dual nurses' workload, highlighting the importance of workload management in RRT staffing. Further studies are warranted to explore these results in other settings.

What is already known about the topic?

- Rapid response teams often rely on ICU nurses, who bring expertise in advanced assessment to support acutely deteriorating patients in general hospital wards.
- In some hospitals, nurses undertake dual roles, providing both patient care in the ICU and attending RRT calls.

What this paper adds

- A focused comparison of RRT patient outcomes between dedicated RRT nurses and dual ICU/RRT nurses.
- Dedicated RRT nurses were associated with a significant reduction in in-hospital arrests and RRT patient mortality, compared with the dual ICU/RRT model, highlighting how nursing can contribute to potential improvements in patient outcomes.

Key words: Critical Care Nursing; Health Care Rationing; Hospital Rapid Response Team; Intensive Care Units; Workforce.

INTRODUCTION

Rapid response teams (RRTs) are now an established element of acute-care hospitals and form the efferent limb of a broader rapid-response system that encompasses physiological detection and escalation processes (afferent limb), institutional patient-safety governance, and an oversight committee.[1] The principal mandate of the RRT is to deliver immediate, specialist care to ward patients who manifest early signs of clinical deterioration. Landmark observational studies have shown that physiological derangement frequently precedes in-hospital cardiac arrest, indicating that timely activation of an RRT can avert preventable deaths.[2-4]

RRTs are usually multidisciplinary and, in larger institutions, routinely include intensive care unit (ICU) clinicians, particularly nurses.[5] Many of the earliest teams evolved from traditional cardiac-arrest services and were introduced with minimal additional resources.[5] Consequently, ICU nurses are often required to interrupt bedside responsibilities to attend RRT activations (hereafter "RRT calls", also termed medical-emergency-team (MET) calls in some jurisdictions). Such redeployment has several potential ramifications.[6] First, it may compromise the mandated 1:1 ICU nurse-to-patient ratio, thereby increasing workload and the likelihood of missed care.[7,8] Second, accumulating evidence links frequent work interruptions to a higher incidence of medication and procedural errors among ICU nurses.[9] Insufficiently resourced RRTs may therefore jeopardise both ward-level and ICU-level patient safety, leading to issues such as medication delays, ventilator weaning delays, and unplanned ICU transfers.[6]

The present study compares two nursing configurations for RRT coverage at a large metropolitan teaching hospital: a non-dedicated model in 2017 and a partially dedicated model introduced in 2018 (Figure 1). In both years, four ICU nurses were assigned to the RRT service; however, in 2017, all four nurses balanced routine ICU duties or equipment management with RRT attendance, whereas in 2018, two nurses were rostered exclusively to the RRT around the clock, supported by two on-shift ICU nurses for overlapping calls. The number of medical staffing attending was unchanged (Supplementary Material). Using routinely collected RRT database records, we examine whether reallocating nursing resources in this manner influenced RRT call characteristics, end-of-call patient outcomes, and ICU adverse-event rates.

AIM

To evaluate whether end-of-call patient outcomes differ between rapid response activations covered by dual-role ICU/RRT nurses and those managed by dedicated RRT nurses.

OBJECTIVES

1. Compare patient outcomes: death during the call, transfer to higher-acuity care, or ward retention between the two nursing models.
2. Characterise RRT activations by trigger, timing, responder mix, and scene-time metrics.
3. Examine associations between ICU-level adverse events and the frequency of RRT calls.

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METHODS

STUDY DESIGN AND SETTINGS

This single-centre retrospective cohort study examined ward-based patients who experienced deterioration events requiring RRT attendance. The study took place at a large adult metropolitan teaching hospital in Australia, using data from 1 January to 31 August 2017 and from 1 January to 31 August 2018 (inclusive). The age of the data is unavoidable, due to delays resulting from the study's unfunded nature and the COVID-19-related clinical redeployment of author one, although the study captures key insights into the transition to a dedicated RRT nursing service. To minimise seasonal variation in hospital presentations, two eight-month periods (January–August) were compared using an Interrupted Time Series (ITS) design. Time-series analysis was selected for three principal reasons. First, because the staffing redesign occurred at a single, well-defined moment, treating the hospital as its own control strengthens causal inference in the absence of randomisation. Second, by modelling both the baseline level and the underlying trajectory before the intervention, the method disentangles the intervention's impact from secular and seasonal patterns that would otherwise blur a simple pre-versus-post comparison. Third, the technique leverages the data's fine-grained chronological detail, capturing every monthly observation, thereby increasing statistical power and enabling detection of both abrupt (level) and progressive (slope) changes. The September–December period, which aligned with the implementation of the new RRT nursing model, was excluded to maintain focus on trends within comparable seasonal windows, ensuring consistency in hospital activity patterns across both periods.

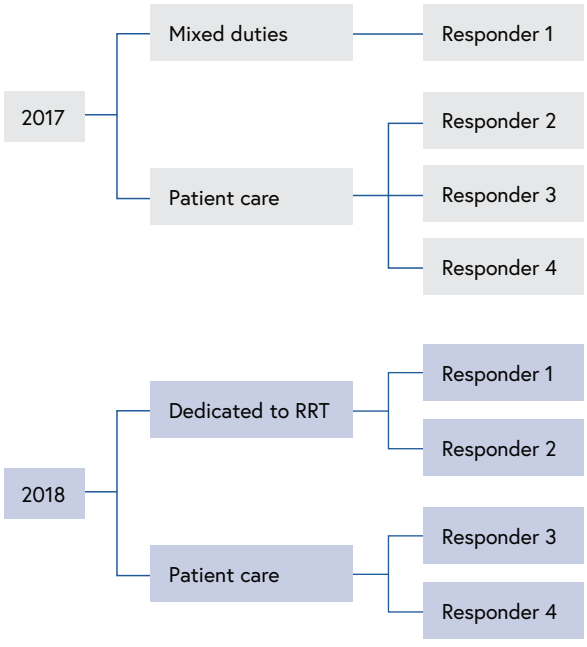

FIGURE 1. RRT NURSING MODEL IN 2017 AND 2018

PARTICIPANTS

All ward-based hospital inpatients who experienced at least one RRT call within the previously specified timeframe were included. The unit of analysis was the individual RRT call, which was matched to its patient episode through a unique database identifier and timestamp, enabling the retrieval of patient demographics, end of call outcomes, and the nursing staff assigned to the call.

SAMPLE SIZE

A total of 6,955 RRT calls were analysed (2017: 3,466; 2018: 3,489).

DATA COLLECTION AND MANAGEMENT

Three routinely collected hospital databases were queried with permission from the respective data custodians: (1) the local COMET (core outcome measurement and evaluation tool) ICU activity database; (2) the SA Health safety learning system (SLS) database, which captures staff reported adverse events; (3) the RRT database, where all RRT calls are transcribed from paper forms (written by nurses) into the database (by an administrative officer).

The ICU admissions database was used to obtain activity data for the study periods, totalling 4,792 admissions (n = 2,398 in 2017; n = 2,394 in 2018). The SLS database showed that ICU staff recorded 811 adverse events during the study (n = 342 in 2017; n = 469 in 2018). An adverse event was defined as any occurrence during healthcare that could have, or did, result in unintended psychological or physical harm to a patient or staff member.[10] After COMET data extraction, the data were viewed in Microsoft® Excel® spreadsheets, then manually reviewed, screened, cleaned, and coded.[11] Errors or outliers identified during the review were addressed with the data custodian. Due to missing data from the RRT database, 264 of 6,955 RRT calls had an unknown nurse responder status. These calls were still included in the analysis. Data were coded (scale, ordinal, nominal) and entered into IBM SPSS Statistics for Windows (Version 28) for analysis.[12]

STATISTICAL ANALYSIS

Descriptive statistics were conducted on the demographic data to summarise key characteristics of the study population. Demographic characteristics and reasons for RRT calls were compared between the two years using a binomial proportions test. Statistical significance was defined as a p-value < .05. Patient RRT call outcomes (either: (1) remained in the ward, (2) transferred to another location, or (3) death during the RRT call) were analysed using logistic regression, with dual ICU/RRT nurse status as the dependent variable. Both significant and insignificant outcomes were included in the individual binomial logistic regression analysis for transparency. Given the exploratory nature of the analysis and the limited available data, the analysis was unadjusted for factors such as age or severity of illness. The exposure of

interest was the nursing model, dual-role nurses compared with coverage by partially dedicated RRT nurses. The primary outcome was death during the RRT episode; secondary outcomes were transfer to any higher-acuity location and scene-time duration.

ETHICS STATEMENT

This study was classified as low and negligible risk. Ethical and governance approval was granted by the local health network (#13893). To protect confidentiality and minimise potential biases, identifiable data related to staff and/or patients were not extracted, ensuring privacy and maintaining objectivity in the analysis.

RESULTS

CHARACTERISTICS: RRT CALLS

Over the 16-month study window, the RRT attended 6,955 calls, 3,466 in January-August 2017, and 3,489 in the corresponding months of 2018, equating to 1.45 and 1.46 calls per ICU admission, respectively. Introduction of two partially dedicated RRT nurses in 2018 sharply reduced dual-role coverage: dual ICU/RRT nurses attended 1,366 calls (39.4%) in 2017 but only 403 calls (11.6%) in 2018, a 71 % fall that was highly significant ($X^2(2) = 838.4$, $p < .001$). Overall, dual-role nurses still managed one-quarter of all activations (25.4%) during the study. Patient ages ranged from 3 to 104 years, with a mean age of 67 years (SD 19) and a median age of 71 years (IQR 57–82). Occasionally, the team must treat a visiting child, so a few database records show an age of three years, even though we are an adult hospital. The incidence of RRT in-hospital arrests (cardiac and respiratory arrests) decreased significantly from 57 (1.6%) in 2017 to 33 (0.9%) in 2018 ($X^2(1) = 6.65$, $p = .01$). Furthermore, in-hospital mortality among patients who received an RRT call fell from 44 deaths (1.3%) in 2017 to 20 deaths (0.6%) in 2018 ($X^2(1) = 9.245$, $p = .002$) (Table 1).

TRIGGERS FOR RRT ACTIVATION

Systolic blood pressure (SBP) <90 millimetres of mercury (mmHg) remained the most frequent cause of RRT calls in both years, accounting for 25.8% of calls in 2017 and 25% in 2018. Between 2017 and 2018, significant differences were observed in the frequency of RRT calls for the following reasons: "cardiac arrest" ($p = 0.048$), "O_2 saturations <89%" ($p = 0.001$), "unexpected or uncontrolled seizure" ($p = 0.032$), and "worried" ($p < 0.001$) (Table 2).

RRT CALL DURATION

From 2017 to 2018, both the mean and variability of RRT scene times increased. This rise in mean scene time, coupled with a broader range and greater variance, indicates that RRT calls were longer and more variable in 2018 (Table 3). Dedicated RRT nurses exhibited shorter and less variable call times, with a narrower range and fewer extreme values, compared to dual ICU/RRT nurses. Dual nurses had slightly longer calls on average, with greater variability and more frequent outliers, as indicated by higher skewness and kurtosis values (Table 4).

RRT TIME AND ADVERSE EVENTS

Monthly interrupted time-series plots suggested that periods of intense dual-role activity coincided with more ICU adverse events, whereas lighter dual-role workloads aligned with fewer events (Figure 2). However, the correlation between the two series ($r = -0.483$) was not statistically significant ($p = 0.58$), precluding firm inferences about temporal coupling.

TABLE 1. DEMOGRAPHIC INFORMATION: PATIENT CHARACTERISTICS AND RRT ACTIVITY

Variable	Overall 2017 & 2018	2017	2018	Test statistic (df)	*p*
Patient characteristics					
Median patient age, years (IQR)	71 (57–82)	72 (57–83)	69 (56–81)		
Mean patient age, years (SD)	67 (19)	68 (18)	66 (19)		
ICU activity					
Total admissions to the ICU, *n*	4792	2398	2394		
RRT activity					
Total RRT calls, *n*	6955	3466	3489		
RRT calls attended by ICU nurses, *n* (%)[a]	1769 (25.4)	1366 (39.4)	403 (11.6)	$X^2(2) = 838.4$	**< .001**
RRT calls triggering ICU/HDU admission, *n* (%)[b]	418 (8.7)	213 (8.9)	205 (8.6)	$X^2(1) = 0.15$	.70
RRT calls for in-hospital cardiac arrest outside ICU, *n* (%)[a]	90 (1.3)	57 (1.6)	33 (0.9)	$X^2(1) = 6.65$	**.01**
RRT calls in which death was recorded, *n* (%)[a]	64 (0.9)	44 (1.3)	20 (0.6)	$X^2(1) = 9.245$	**.002**

a) Percentage of all RRT calls in the given study period, 2017 or 2018.
b) Percentage of all ICU/HDU admissions in the given study period.

Note (1): significance level: .05
Note (2): The data for 2017 and 2018 includes only the period of study Jan–Aug, inclusive, of each year.

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TABLE 2. THE DISTRIBUTION OF REASONS FOR RRT CALLS, WITH A COMPARISON OF COLUMN PROPORTIONS

Reason for RRT call	2017		2018	
	n	*n* %	*n*	*n* %
Respiratory Arrest	10	0.3	3	0.1
Cardiac Arrest	**47**(.048)	1.4	30	0.9
Threatened Airway	38	1.1	31	0.9
Significant Bleeding	20	0.6	29	0.8
Respiratory Rate <7	13	0.4	17	0.5
Respiratory Rate >30	375	10.8	339	9.7
O_2 Saturation <89%	**486**(.001)	14.0	397	11.4
Pulse Rate <40	59	1.7	60	1.7
Pulse Rate >140	326	9.4	377	10.8
SBP >200 mmHg	255	7.4	275	7.9
SBP <90 mmHg	893	25.8	873	25.0
Level of Consciousness / Sedation	467	13.5	453	13.0
Unexpected or Uncontrolled Seizure	**105**(.032)	3.0	77	2.2
Worried	347	10.0	**502**(< .001)	14.4
Unattended MDT Review	10	0.3	17	0.5
≥3 Observations in Red Zone	15	0.4	9	0.3

Note (1): significance level: .05
Note (2): Pearson $X^2(15) = 61.95$, $p < .001$, indicating the pattern of RRT triggers changed between 2017 and 2018.

p-values represent two-sided tests comparing 2017 and 2018.
The value is placed beside the year with the larger column proportion, with the p-value show in brackets.

TABLE 3. DESCRIPTIVE STATISTICS OF RRT SCENE TIME (MINUTES) IN 2017 AND 2018

	2017	2018
Sum all RRT call time	122433	134438
Mean (Std. Error)	35.32 (.439)	38.53 (.508)
95% Confidence Interval for Mean • Lower Bound • Upper Bound	 34.46 36.18	 37.54 39.53
Median	30	30
Standard Deviation	25.824	30.006
Interquartile Range	24	28
Range (min–max)	265 (0–265)	278 (2–280)
Variance	666.885	900.38
Skewness (Std. Error)	2.308 (.042)	2.432 (.041)
Kurtosis (Std. Error)	8.771 (.083)	9.101 (.083)

TABLE 4. DESCRIPTIVE STATISTICS OF RRT SCENE TIME (MINUTES) IN 2017 AND 2018, SEPARATED BY NURSE RESPONDER ROLE

	2017		2018	
	Mixed duties	Dual ICU/RRT	Dedicated RRT	Dual ICU/RRT
Total minutes at RRT calls, minutes (%)[a]	67,792 (53.4)	48,026 (39.2)	115,043 (85.6)	16,404 (12.2)
Mean (Std. Error)	35.61 (.592)	35.16 (.705)	38.12 (.535)	40.70 (1.587)
Median	30	30	30	32
Standard Deviation	25.84	26.06	29.382	31.863
Interquartile Range	23	23	27	29
Range (min–max)	236 (2–238)	265 (0-265)	246 (2-248)	247 (4-251)
Variance	667.719	679.132	863.301	1015.263
Skewness (Std. Error)	2.145 (.056)	2.589 (.066)	2.259 (.045)	3.073 (.122)
Kurtosis (Std. Error)	6.818 (.112)	11.851 (.132)	7.395 (.089)	14.340 (.243)

a) Percentage of all time (minutes) spent at RRT calls in the given study period (total 2017 = 122433; 2018 = 134438), acknowledging missing data.

TABLE 5. LOGISTIC REGRESSION FOR DUAL ICU/RRT NURSES (NURSES ON PATIENT CARE) AND RRT CALL OUTCOMES

RRT Patient Outcome	*p*-value	Odds ratio*	95% CI for Exp(B)	
(Variable)	(Sig.)	[Exp(B)]	Lower	Upper
Left in the ward	<.001	0.472	0.41	0.543
Transferred out of the ward	<.001	2.027	1.756	2.34
Transferred to the ICU/HDU	0.001	1.428	1.148	1.776
Died during the RRT call	<.001	3.015	1.796	5.061

*Odds ratios are unadjusted.
CI = confidence interval

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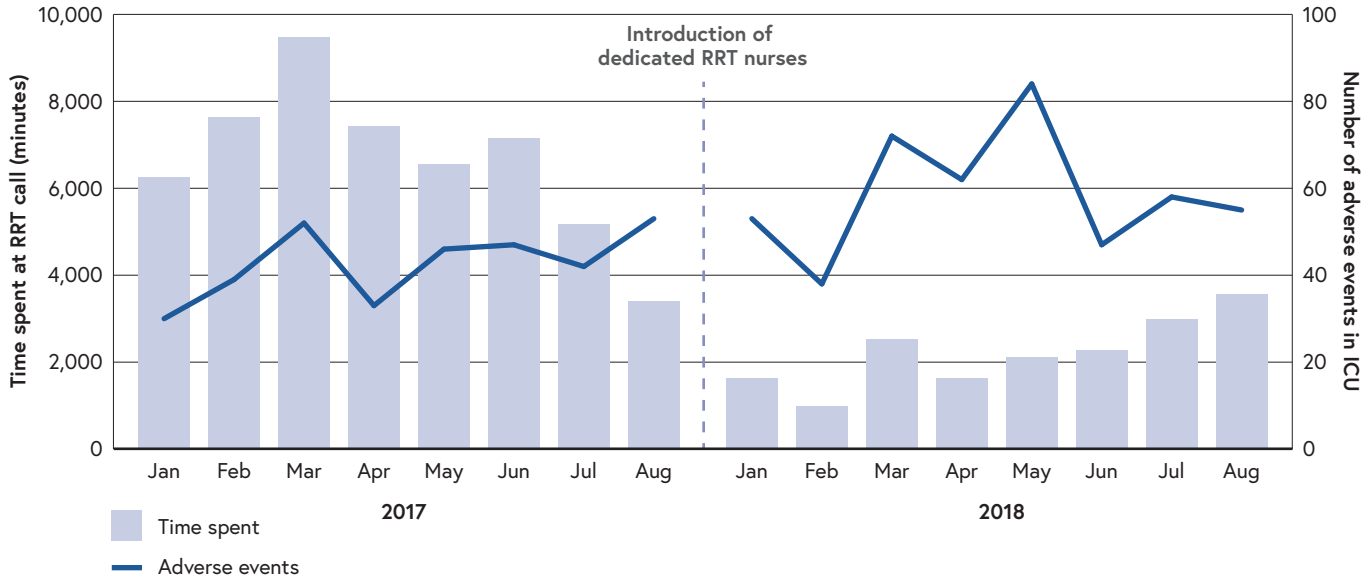

FIGURE 2. INTERRUPTED TIME-SERIES GRAPH OF ADVERSE EVENTS AND DUAL ICU/RRT NURSE ACTIVITY AT RRT CALLS

PATIENT RRT CALL OUTCOMES

After each RRT call, the nurse documented one of the three available patient outcomes on the medical record form: (1) remained in the ward, (2) transferred to another location, or (3) death during the RRT call. Unadjusted population-averaged logistic regression showed that dual-role coverage was associated with substantially poorer end-of-call outcomes, compared with calls handled by dedicated nurses (Table 5). RRT calls attended by dual nurses carried more than threefold higher odds of death (odds ratio [OR]: 3.015 [95% CI: 1.796–5.061], $p < 0.001$), double the odds of any transfer off the ward (OR: 2.027 [95% CI: 1.756–2.340], $p < 0.001$), and 43% higher odds of ICU transfer specifically (OR: 1.428 [95% CI: 1.148–1.776], $p = 0.001$). Calls that resulted in transfer lasted longer (mean 50 minutes) than those that did not (mean 35 minutes); whereas, calls ending in death were shorter (mean 30 minutes, compared to mean 37 min for non-fatal outcomes) and occurred predominantly after hours (66% between 20:00–08:00 hours).

DISCUSSION

This retrospective, single-centre study demonstrates that reallocating two ICU nurses to a partially dedicated RRT was associated with clinically meaningful improvements in ward patient outcomes, possibly due to improved nurse workloads. Compared with calls attended by dedicated RRT nurses, those covered by dual-role ICU/RRT nurses carried more than threefold higher odds of death during the call and around double the odds of transfer to another care area, including the ICU. In parallel, the incidence of non-ICU in-hospital arrests fell from 1.6% to 0.9% and RRT-recorded deaths halved after the staffing change. Although causal inference is limited by the study's observational design, the magnitude and direction of these associations are consistent with a large body of international evidence linking excessive nurse workload to excess mortality and longer length of stay.[13-15]

High nurse workload, as seen in the dual ICU/RRT nursing model, is a well-established risk factor for adverse patient outcomes. Recent studies across multiple countries have consistently shown that increased nurse workload is linked to higher patient mortality and unfavourable outcomes.[13-15] Aiken et al., examined the relationship between nurse staffing and patient outcomes in Chile, and Lasater and Aiken et al., explored the impact of high nurse workloads on patient outcomes and length of stay in Illinois, United States.[13,14] In another study, Lasater and Sloane et al. focused on the effects of nurse staffing and sepsis bundles on patient outcomes in New York, United States.[15] Despite differences in research focus, these studies highlight the critical role of nurse staffing and workload in determining patient outcomes. Similarly, the dual ICU/RRT nursing model, which often involves a heavier workload and competing responsibilities for nurses, may contribute to poorer patient outcomes by limiting the ability to provide timely, specialised care during RRT calls, and is not reflective of staffing practices in top-performing hospitals, where dedicated RRT teams are associated with better patient outcomes and improved safety.[16,17] Building on Aiken et al.'s recommendations, improving nurse staffing levels could enhance patient outcomes, with the costs of additional nurses potentially offset by these benefits.[13] Similarly, Lasater, Sloane et al., demonstrated that adequate nurse staffing positively impacts patient outcomes, reinforcing the need for minimum safe staffing standards.[15]

INTERPRETATION IN THE CONTEXT OF PREVIOUS WORK

High-performing hospitals typically deploy dedicated, multidisciplinary RRTs with protected staffing, a practice associated with rapid scene arrival, shorter intervention times and lower cardiac-arrest rates.[16,17] By contrast, the dual-role model studied here forced ICU nurses to suspend 1:1 ICU assignments each time an RRT call arose, breaching Australian and United Kingdom ICU safe-staffing recommendations and potentially exposing both ICU and ward patients to harm.[7,8,18] The observed reduction in arrests and RRT deaths following implementation of the dedicated nursing model is plausible; nurses relieved of conflicting demands can respond more promptly, remain for the full duration of deterioration management, and avoid cognitive overload that predisposes to error.

Two significant improvements in patient outcomes were observed following the introduction of dedicated RRT nurses: a reduction in non-ICU in-hospital arrests (IHAs) and a decrease in deaths during RRT calls. These findings align with previous literature that identifies nurse workload as a key determinant of patient outcomes.[13-15] For instance, Lasater, Sloane et al., demonstrated that nurse workloads significantly impact mortality rates, with each additional patient per nurse associated with a 12% increase in in-hospital mortality odds compared to other factors.[15] In our study, the reduction in IHAs and deaths in 2018 could be attributed to the introduction of dedicated RRT nurses, who focused solely on RRT duties, without the added responsibility of ICU patient care. This model likely facilitated more comprehensive investigations into patient deterioration and enabled timely, proactive interventions, potentially improving patient outcomes. Scene-time analyses support this explanation.

MECHANISTIC CONSIDERATIONS

Calls involving dual-role nurses, in 2018, were usually longer and displayed greater variance than those managed by dedicated staff, suggesting that task switching and competing priorities impeded efficient care delivery. Moreover, most RRT deaths occurred during off-hours, precisely when ICU staffing reservoirs are thinnest, underscoring the vulnerability of dual-role systems to diurnal workload variations. Building on recent findings by Griffiths et al., the use of temporary staff to mitigate low nurse staffing numbers and having appropriately qualified, senior nursing staff was shown to only partially address the associated risks, highlighting the need for sustainable, long-term solutions to ensure patient safety.[19] This further underscores the importance of establishing comprehensive workforce standards and guidelines for RRT nurses in Australia, informed by ongoing research and expert consultation, to ensure sufficient staffing and mitigate the risks associated with high nurse workload.

RRT CASELOAD VS ICU DEMAND

In 2018, dedicated nurses responded to 88% of RRT calls and dedicated more time per call compared to 2017. Despite the longer call durations in the 2018 data, there was no increase in ICU admissions, suggesting that the increased focus on RRT duties did not result in greater ICU demand. The ratio of RRT calls to ICU admissions we calculated were nearly double those reported in an earlier Australasian multi-centre study (0.73), highlighting the notably high RRT caseload in relation to ICU admissions and the increasing demand for RRT services over time.[5] Elliott et al., (similar RRT, tertiary hospital) likewise stressed that maintaining a multi-tier RRT requires recurrent funding and that dedicated RRT personnel cannot be double-rostered to ICU duties, noting that the associated RRT staffing costs are 'not insignificant'.[20] However, evidence shows that investing in the nursing workforce both improves patient outcomes and reduces overall costs.[13] Our study suggests a similar trend, where investment in RRT nursing resources may have helped optimise ICU bed management, reduce unplanned admissions, and improve patient outcomes.

SAFETY AND QUALITY IMPLICATIONS OF DUAL ICU/RRT STAFFING

In terms of the relationship between dual ICU/RRT nurse activity and adverse ICU events, Figure 2 visually suggested that periods of increased dual nurse activity coincided with a rise in adverse ICU events. While this correlation was not statistically significant in our study, it may still hold clinical relevance. One possible explanation is that the increased use of dual ICU/RRT nurses reduces the staffing levels in the ICU, potentially compromising the quality of care. This is consistent with concerns raised in the Australasian RRT guidelines, which caution that inadequate resourcing of the rapid-response system may have adverse effects on ICU care by preventing proper clinical handovers or removing necessary staff from direct ICU patient care.[21] By comparison, the United Kingdom's guidelines for the provision of intensive care services, developed for a public health system similar to Australia's, are less prescriptive about RRT staffing resourcing but emphasise core elements such as having a rapid-response capability (i.e. arrive quickly to the ward area), robust track-and-trigger systems, and a patient-safety culture.[18]

During peaks in RRT demand, dual-role ICU/RRT nurses were pulled from their 1:1 ICU assignments for extended periods, up to 251 minutes. These long interruptions risk eroding ICU care quality; Santomauro et al., found that ICU nurses who experienced increased interruptions during medication administration were more prone to errors.[9] Other studies likewise show that understaffing compromises patient outcomes.[13-15] Taken together with our data, the evidence suggests that adequate, dedicated staffing, for both the RRT and ICU, is important to safeguard patients and minimise risk.

STRENGTHS AND LIMITATIONS

Key strengths include the natural "step-change" in staffing that created a quasi-experimental comparison, a large consecutive sample of 6,955 calls, and an interrupted time-series approach that minimised seasonal bias. Nevertheless, several limitations temper interpretation. First, as a retrospective, observational cohort study, it cannot establish absolute causal relationships between dual ICU/RRT nurse roles and RRT call outcomes. Second, the RRT database contained no patient-level covariates; thus, illness severity, comorbidity, and end-of-life decisions could not be adjusted for. Third, the single-hospital setting and eight-month windows constrain generalisability and preclude assessment of long-term sustainability; additionally, there was missing data, and the age of the data is acknowledged as a limitation. Finally, exploratory correlations between dual-nurse workload and ICU adverse events did not reach statistical significance ($r = -0.48$, $p = 0.58$), highlighting the need for larger, multicentre evaluations.

IMPLICATIONS FOR POLICY AND PRACTICE

Despite these caveats, the data adds to a growing consensus that diverting on-shift ICU nurses to ward emergencies jeopardises patient safety. Health-service managers should weigh the downstream costs of adverse events against the comparatively modest expense of rostering dedicated RRT nurses; economic analyses elsewhere suggest the investment is likely to be cost-neutral or cost-saving.[13-15]

FUTURE RESEARCH

Prospective, multisite studies with risk-adjusted outcomes are warranted to confirm these findings and to delineate the optimal skill-mix, seniority and training requirements for dedicated RRT nurses. Incorporating patient-reported outcome measures and economic endpoints would further inform policy decisions. Establishing national workforce standards for RRTs analogous to ICU staffing guidelines could provide a pragmatic framework for resource allocation.

CONCLUSION

Within the constraints of an unadjusted, single-centre analysis, the transition from a dual-role to a partially dedicated RRT nursing model coincided with fewer in-hospital arrests, fewer RRT deaths and markedly lower odds of adverse end-of-call outcomes. These results reinforce international evidence that excessive nurse workload compromises patient safety and support the adoption of protected, dedicated nursing roles within rapid-response systems. Hospitals with similar RRT demands in Australia, Canada, and the United Kingdom, and other comparable health systems, may benefit from investing in dedicated RRT nursing staff to alleviate the burden on ICU nurses and improve patient care.

Data availability statement: Restrictions apply to the availability of the data which were used for this study. The data that supports the findings of this study were taken from three different government departmental databases and are not publicly available.

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REFERENCES

1. Devita MA, Bellomo R, Hillman K, Kellum J, Rotondi A, Teres D, et al. Findings of the first consensus conference on medical emergency teams. *Crit Care Med*. 2006;34(9):2463-78. Available from: https://doi.org/10.1097/01.ccm.0000235743.38172.6e
2. Schein RMH, Hazday N, Pena M, Ruben BH, Sprung CL. Clinical antecedents to in-hospital cardiopulmonary arrest. *Chest*. 1990;98(6):1388-92. Available from: https://doi.org/10.1378/chest.98.6.1388
3. Wilson RM, Runciman WB, Gibberd RW, Harrison BT, Newby L, Hamilton JD. The quality in Australian health care study. *Med J Aust*. 1995;163(9):458-71. Available from: https://doi.org/10.5694/j.1326-5377.1995.tb124691.x
4. Franklin C, Mathew J. Developing strategies to prevent in hospital cardiac arrest: analyzing responses of physicians and nurses in the hours before the event. *Crit Care Med*. 1994;22(2):244-7. Available from: https://doi.org/10.1097/00003246-199402000-00014
5. Jones D, Pilcher D, Boots R, Carter A, Turner A, Hicks P, et al; Joint College of Intensive Care Medicine and Australian and New Zealand Intensive Care Society Special Interest Group on Rapid Response Systems; ANZICS Centre for Outcome and Resource Evaluation. Resource use, governance and case load of rapid response teams in Australia and New Zealand in 2014. *Crit Care Resusc*. 2016;18(4):275-82. Available from: https://doi.org/10.1016/S1441-2772(23)00804-9
6. Fildes C, Munt R, Chamberlain D. Impact of dual intensive care unit and rapid response team nursing roles on service delivery in the intensive care unit. Critical Care Nurse. 2022 Oct 1;42(5):23-31. Available from: https://doi.org/10.4037/ccn2022540
7. Australian College of Critical Care Nurses (ACCCN). Workforce Standards for Intensive Care Nursing. Melbourne. ACCCN Ltd. ISBN 9 780646 960739. 2016 [cited 2024 May 15]. Available from: https://acccn.com.au/publications/workforce-standards-2016/

8. College of Intensive Care Medicine. IC-1 Minimum Standards for Intensive Care Units. 2016 [cited 2024 Dec 17]. Available from: https://cicm.org.au/common/Uploaded%20files/Assets/Professional%20Documents/IC-1-Minimum-Standards-for-Intensive-Care-Units.pdf
9. Santomauro C, Powell M, Davis C, Liu D, Aitken LM, Sanderson P. Interruptions to intensive care nurses and clinical errors and procedural failures: A controlled study of causal connection. *J Patient Saf*. 2021;17(8): e1433-e1440. Available from: https://doi.org/10.1097/PTS.0000000000000528
10. SA Health; Government of South Australia. Patient incident management and open disclosure policy directive (V2.3). 2020 May 15 [cited 2024 Jan 15]. Available from: https://www.sahealth.sa.gov.au/wps/wcm/connect/89e269804e341fb5b45ffcc09343dd7f/Directive_Patient+_Incident_Management+_and+_Open_Disclosure_Policy_v2.3_15.05.2020.pdf
11. Microsoft Corporation. Microsoft Excel. Version 14.7.1. Redmond, Washington: MS Corp.
12. IBM Corp. IBM SPSS Statistics for Windows. 28.0.1.0 (142) ed. Armonk, NY: IBM Corp, Released 2021.
13. Aiken LH, Simonetti M, Sloane DM, Cerón C, Soto P, Bravo D, et al. Hospital nurse staffing and patient outcomes in Chile: a multilevel cross-sectional study. *Lancet Glob Health*. 2021;9(8):e1145-e1153. Available from: https://doi.org/10.1016/S2214-109X(21)00209-6
14. Lasater KB, Aiken LH, Sloane D, French R, Martin B, Alexander M, et al. Patient outcomes and cost savings associated with hospital safe nurse staffing legislation: an observational study. *BMJ Open*. 2021;11(12):e052899. Available from: https://doi.org/10.1136/bmjopen-2021-052899
15. Lasater KB, Sloane DM, McHugh MD, Cimiotti JP, Riman KA, Martin B, et al. Evaluation of hospital nurse-to-patient staffing ratios and sepsis bundles on patient outcomes. Am J Infect Control. 2021;49(7): 868-873. Available from: https://doi.org/10.1016/j.ajic.2020.12.002
16. Dukes K, Bunch JL, Chan PS, Guetterman TC, Lehrich JL, Trumpower B, et al. Assessment of Rapid Response Teams at Top-Performing Hospitals for In-Hospital Cardiac Arrest. *JAMA Intern Med*. 2019;179(10):1398–1405. Available from: https://doi.org/10.1001/jamainternmed.2019.2420
17. Nallamothu BK, Guetterman T, Harrod M, Kellenberg JE, Lehrich JL, Kronick SL, et al. How Do Resuscitation Teams at Top-Performing Hospitals for In-Hospital Cardiac Arrest Succeed?: A Qualitative Study. *Circulation*. 2018:138(2):154-163. Available from: https://doi.org/10.1161/CIRCULATIONAHA.118.033674
18. The Faculty of Intensive Care Medicine. Guidelines for the provision of intensive care services. Version 2.1. 2022 [cited 2025 Jul 9]. Available from: https://www.ficm.ac.uk/standardssafetyguidelinesstandards/guidelines-for-the-provision-of-intensive-care-services
19. Griffiths P, Saville C, Ball J, Culliford D, Jones J, Lambert F, et al. Nursing Team Composition and Mortality Following Acute Hospital Admission. *JAMA Netw Open*. 2024; 7(8):e2428769. Available from: https://doi.org/10.1001/jamanetworkopen.2024.28769
20. Elliott R, Martyn L, Woodbridge S, Fry M, Foot C, Hickson L. Development and Pragmatic Evaluation of a Rapid Response Team. Critical Care Nursing Quarterly. 2019:42(3):227-234. Available from: https://doi.org/10.1097/cnq.0000000000000263
21. Boots R, Carter A, Erickson S, Hawker F, Jones D, Nicholls M, et al; College of Intensive Care Medicine of Australia and New Zealand; Australian and New Zealand Intensive Care Society. Joint position statement on rapid response systems in Australia and New Zealand and the roles of intensive care. 2016 [cited 2024 Dec 17]. Available from: https://cicm.org.au/common/Uploaded%20files/Assets/Professional%20Documents/IC-25-Joint-ANZICS-and-CICM-Rapid-Response-Systems-Position-Statement.pdf