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## ORIGINAL RESEARCH

### **The Use of Altered Rapid Response Calling Criteria in a Tertiary Referral Facility**

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7 **Title:** The Use of Altered Rapid Response Calling Criteria in a Tertiary Referral Facility  
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10  
11 **Abstract:**  
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13 **Purpose:** The purpose of this study was to examine the current utilisation of altered rapid  
14 response call criteria (ARRCC) at a tertiary hospital.  
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17 **Methods :** A retrospective review of all acute care admissions across 17 months was  
18 undertaken using the hospital administration system and electronic medical record to identify  
19 patients with ARRCC. In patients with altered criteria, the type of alteration, frequency of rapid  
20 response call, cardiac arrest, intensive care admission and death in hospital were identified.  
21 Comparisons were made using standard statistical methods.  
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23  
24 **Results :** Total hospital admissions numbered 45,912, with ARRCC used in 768 (1.7%) of  
25 these. Patients with an ARRCC during hospital admission were older (68.5 [55.5, 79.0] vs 59.0  
26 [43.0, 72.0] years,  $p < 0.001$ ) and had a significantly longer length of hospital stay (6.9 [3.0, 16.3]  
27 vs 2 [1, 5] days,  $p < 0.001$ ).  
28

29 Compared with the total group of patient admissions, patients with ARRCC more frequently  
30 triggered a rapid response team (9.0% vs 14.2%,  $X^2(1, n=46680) = 23.87, p < 0.001$ ), more  
31 frequently suffered a cardiac arrest (0.2 vs 0.9%,  $X^2(1, n=46678) = 20.34, p < 0.001$ ), more  
32 frequently died in hospital ( $p < 0.001$ ), and less frequently were discharged home ( $X^2(1,$   
33  $n=46680) = 43.91, p < 0.001$ ).  
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37 **Conclusion :** Patients with an ARRCC stayed longer in hospital and were at increased risk of  
38 cardiac arrest and death during hospitalisation. Further exploration of the role of ARRCC in  
39 facilitating individualised care to meet the needs and treatment goals of each patient in the  
40 acute hospital setting is required.  
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4 **Keywords:** Rapid response systems, early warning score, clinical deterioration.  
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7 **Introduction**  
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10 Since the 1990s rapid response teams (RRT) have been described as a strategy within the  
11 efferent arm of responding to patients with signs of clinical deterioration in the ward  
12 environment.<sup>1</sup> The parameters used to trigger the response of these RRT have also been  
13 examined in several studies.<sup>2,10</sup> Links between patient deterioration and alterations in pulse,  
14 respiratory rate, blood pressure, level of consciousness and oxygen saturations have been  
15 made.<sup>4,5,7</sup> Clinical deterioration may be preventable in many cases and can often be attributed  
16 to failure to recognise or appropriately respond quickly to this deterioration.<sup>11</sup> In response to  
17 this, the use of 'early warning scores' (EWS) or 'track-and-trigger systems' to identify patients  
18 and initiate appropriate response has been widely advocated.<sup>6,7</sup> The validity, reliability and  
19 utilisation of these tools have been challenged in the literature, with most recommendations  
20 highlighting the need for these tools to be used in conjunction with clinical judgement to  
21 appropriately detect the deteriorating patient and escalate care.<sup>3,9,10.</sup> Patients within hospital  
22 settings who have pre-existing chronic conditions which impact on their 'normal' baseline  
23 observations are one example of when this need for clinical judgment is paramount. In this  
24 group of patients generic scoring systems and escalation algorithms may not be appropriate. In  
25 an attempt to individualise track and trigger charts for patients, senior clinicians can choose to  
26 alter RRT criteria. Limited examination of the utilisation of altered RRT criteria or the outcomes  
27 for patients who have criteria altered during an acute care hospital admission has been  
28 conducted.  
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## Methods

### Study population

The study was undertaken in a 670 bed tertiary care hospital in Australia. At the time of the project there was no available literature or local data to provide guidance on the population of hospital admissions likely to have an altered rapid response calling criteria (ARRCC). During a 17month period (01/05/2015 – 01/09/16) all patients 18 years of age or greater who experienced an acute care admission for at least 24 hours were included. The sub-group of specific interest was those patients who received an ARRCC.

### Data collection

The electronic medical record was used to identify ARRCC and acute resuscitation plans. A review of 200 individual patient charts was undertaken and compared with the report generated from the electronic medical record to ensure use of the electronic medical record was an accurate method of categorising patients and collecting data for this study. Data extracted included the role of the clinician authorizing the change to criteria and whether there was a time frame associated with the ARRCC. ARRCC were defined as alteration in triggers for activating the rapid response team that deviated from standard hospital criteria which were:

- Heart Rate <40, >140 bpm
- Blood Pressure <90 mmHg
- Fall in Glasgow Coma Scale (GCS) >2 points
- Respiratory rate <8, >36 bpm
- Oxygen Saturations <90%
- Prolonged or repeated seizures
- Cardiac/Respiratory arrest.

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7 Other data extracted using the Performance Explorer Manager (Aginic, Brisbane) included age,  
8 gender, hospital admitting unit and ICU admission.  
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## 10 11 12 13 **Outcomes**

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15 Outcome data including death in hospital, hospital length of stay and discharge destination were  
16 also obtained from the electronic medical record.  
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## 22 **Ethical approval**

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24 Ethical approval was gained from the health service Human Research Ethics Committee. Any  
25 identifying data were stored separately to de-identified data. Documentation relating to this  
26 study was stored in a secure location and electronic data password protected. Individual patient  
27 consent was deemed not necessary.  
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## 35 **Statistical Analysis**

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37 Data were analysed as absolute values: categorical data are presented as n (%) and continuous  
38 data and are presented as median (IQR). Ordinal variables were assessed for normality, and  
39 comparison between median values was performed with a Mann-Whitney U-Test as all  
40 variables were non-parametric. Comparisons between two groups of categorical variables were  
41 made with the Chi-Square test of independence, and the authors have reported the test statistic  
42 (i.e. the strength of the association,  $X^2$ ), along with the degrees of freedom and significance  
43 level. When sample size was small (i.e.<10), Fischer's exact test was used to compare groups  
44 of categorical variables. All analysis was conducted with SPSS statistics 25.0 (IBM software). A  
45 p value <0.05 was considered significant in all analyses.  
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4 **Results**  
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7 A total of 45,912 acute care patients were admitted to the study hospital during the 17 month  
8  
9 study period. During this time 768 (1.7%) patients had ARRCC identified for them. Patients who  
10  
11 required ARRCC were older than those without an ARRCC and remained in hospital longer  
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13 (Table 1). Patients in the two groups were similar in gender. The majority of patients with  
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15 ARRCC were admitted to medical units (n= 544, 70.8%) followed by surgical (n=214, 27.9%)  
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17 and acute non-mental health bed under Psychiatry (n=10, 1.3%).  
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24 **Table 1: Patient demographics**  
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	Total Admissions n = 45912	With ARRCC n = 768	p Value
Age (years) – median (IQR), range	59.0 (43.0, 72.0), 18 – 107	68.5 (55.5, 79.0), 19 – 97	p<0.001 <sup>§</sup>
Male – n (%)	26900 (58.6%)	436 (56.8%)	
Hospital LOS median (IRQ), range	2 days (1 – 5), 1 – 297*	6.9 days (3.0 –16.3), 1 – 355	p<0.001 <sup>§</sup>
Acute Resuscitation Plan Present	**	204 (26.6%)	

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49 \*LOS data in the total admissions group was only available as whole numbers

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52 \*\*At the time of the study no data were available for hospital wide Acute Resuscitation Plans

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54 \$ Mann-Whitney U test

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56 # chi-square test  
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**Table 2: Hospital Outcomes**

	Total Admissions n = 45912	With ARRCC n = 768	p Value #
Rapid Response Team Call – n (%)	4163 (9.0%)	109 (14.2%)	p< 0.001
Intensive Care Admission – n (%)	2436 (5.3%)	29 (3.8%)	p= 0.06
Cardiac Arrest – n (%)	85 (0.2%)	7 (0.9%)	p< 0.001

#chi-square test

**Table 3: Discharge Outcomes**

	Total Admissions n = 45912	With ARRCC n = 768	p Value #
Home	40107 (86.8%)	604 (78.6%)	p< 0.001
Death in hospital	502 (1.1%)	73 (9.5%)	p< 0.001
Other Care facility.	3882 (8.4%)	75 (9.8%)	p= 0.18

# chi-square test

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4 ***Characteristics of ARRCC in the patients with alterations***  
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6 There was a total of 825 alterations in the calling criteria for 768 patients, as several patients  
7 had multiple criteria altered. In patients who had ARRCC documented, a majority had  
8 alterations to only one vital sign (n=728, 94.8%), while 29 (3.8%) had alterations to two vital  
9 signs, and 11 (1.4%) had  $\geq 3$  vital signs altered. Of these alterations, blood pressure was most  
10 common (n=304, 36.8%) followed by oxygen saturations (n=226, 27.4%), heart rate (n=198,  
11 24.0%), and respiratory rate (n=56, 6.8%).  
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22 A majority of alterations were documented by a registrar (n=554, 67.2%), followed by resident  
23 (n=99, 12.0%), intern (n=89, 10.8%) and consultant (n=64, 7.8%). Data were unavailable  
24 in 19 (2.3%) cases due to this not being recorded accurately within the electronic medical  
25 record.  
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33 ***Characteristics of patients with ARRCC who had a rapid response team triggered***  
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35 A total of 109 of the 768 patients with ARRCC had a rapid response team triggered (14.2%). Of  
36 these patients, 98 (90.0%) triggered a rapid response team only once, while 5 (4.6%) triggered  
37 rapid response teams twice, and 6 (5.5%) had  $\geq 3$  rapid response teams triggered during their  
38 admission.  
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46 There were a total of 148 different recorded triggers (in several cases there were multiple  
47 triggers for single rapid response team). The most common reason for rapid response team  
48 activation was blood pressure (n=50, 33.8%), followed by O<sub>2</sub> saturation (n=33, 22.3%),  
49 respiratory rate (n=27, 18.2%), then heart rate (n=18, 12.2%).  
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57 The timing of the alteration was compared with respect to the timing of the rapid response call.  
58 In 29 (26.9%) patients, the alteration was made prior to the rapid response team being  
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4 triggered, in 25 (32.4%) the alteration was made at the time of trigger by the rapid response  
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6 team and in 43 (39.8%), after the trigger. In 1 case, this was not able to be ascertained from the  
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8 medical record.  
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### 10 11 12 ***Comparisons between the total admissions and patients with ARRCC***

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15 Compared with the total admission group, patients with ARRCC triggered a rapid response  
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17 team call more frequently ( $X^2(1, n=46680) = 23.87, p < 0.001$ ), suffered a cardiac arrest more  
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19 frequently ( $X^2(1, n=46678) = 20.34, p < 0.001$ ), died in hospital more frequently (Fisher's exact  
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21 test  $p < 0.001$ ), and were less frequently discharged home ( $X^2(1, n=46680) = 43.91, p < 0.001$ ).  
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24 There was also a trend for patients with ARRCC to require an ICU admission less frequently  
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26 ( $X^2(1, n=46680) = 3.53, p = 0.06$ ).  
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### 34 **Discussion**

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39 Rapid response team calling criteria or triggers are based on physiological parameters which,  
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41 when abnormal, may predict cardiac arrest.<sup>12-18</sup> To better tailor this system to meet the needs of  
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43 patients with abnormal baseline physiology such as chronic airways disease or heart failure,  
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45 alterations may be utilised to adjust triggers for emergency response teams to prevent 'false  
46  
47 positive' calls.<sup>19</sup> In this study the utilisation and implications of ARRCC as part of the early  
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49 warning system to detect clinical deterioration were investigated. In understanding the manner  
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51 in which ARRCC is utilised in patient care there is opportunity to explore if alternative measures  
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53 such as goals of care discussions early in hospital admissions may improve care for this patient  
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4 The most common alterations to calling criteria were in relation to blood pressure, oxygen  
5 saturations and heart rate, and in almost all patients only a single physiological criterion was  
6 altered. Although this study was not designed to explore reasons behind clinician decision  
7 making that prompted an alteration of criteria, this was not an unexpected finding when  
8 considering common chronic disease states which may require alterations to criteria to  
9 individualise emergency response criteria to a pre-existing abnormal baseline.<sup>20</sup> In the  
10 subgroup of patients who had an ARRCC and who subsequently triggered an RRT (n= 109),  
11 only 26.9% of alterations were made prior to the RRT trigger. In the remaining 72.2% of  
12 patients, alterations were made either by, or after the RRT. These data suggest that while a  
13 majority of patients with alterations do not subsequently trigger an RRT, for the patients who do  
14 require a RRT review, there is a propensity to make alterations. This high proportion of  
15 alterations may be because this represents a subgroup of more unwell patients with abnormal  
16 'baseline' vital signs. This draws attention to the need for clinicians to consider the utilisation of  
17 ARRCC in practice. Although not within the scope of this study, ARRCC appears to be one  
18 strategy used by clinicians to individualise care; practices and rationale associated with use of  
19 ARRCC should be further explored.

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42 The majority of ARRCC were ordered by a registrar or consultant, however almost one quarter  
43 of alterations were ordered by interns or residents. This finding highlights a potential safety risk  
44 in this workflow. Literature suggests that a high proportion of junior medical officers would not  
45 escalate the care of a deteriorating patient and would be even less inclined to do so when busy  
46 or if the deterioration occurred after hours.<sup>21</sup> This raises a patient safety concern that criteria  
47 may be altered to avoid an RRT activation or medical escalation rather than a patient centric  
48 focus.<sup>19</sup> It should be noted that during the study it could not be reliably determined if senior  
49 medical advice had been sought prior to making this alteration by junior medical officers. Junior  
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4 medical officers ordering ARRCC has been previously reported in the limited literature regarding  
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6 the utilisation of ARRCC.<sup>19</sup>  
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11 One of aims of this study was to investigate the timeframes which ARRCCs were reviewed,  
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13 whether they remained in place or whether, and when, the alterations were cancelled. In the  
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15 charts reviewed in this study documentation indicating review of criteria could not be identified  
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17 within the electronic medical record therefore it could not be identified how this review process  
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19 occurred and how it was communicated at a local level to multidisciplinary clinicians. These  
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21 findings highlight the importance of clinical governance and workflow procedures to support the  
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23 care of the deteriorating patient. From both an accountability and patient safety perspective it is  
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25 imperative that senior medical staff from the primary care team be involved in aspects of  
26  
27 decision making regarding clinical deterioration management.<sup>22</sup> It is not unreasonable to assert  
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29 that this accountability should also extend to oversight of medical emergency call triggers which  
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31 aligns with research suggesting that attending physicians describe wanting a closer supervisory  
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33 relationship with junior medical officers.<sup>23</sup>  
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41 There is some evidence in the literature that senior physicians felt that triggering rapid response  
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43 teams resulted in junior medical staff not being adequately exposed to the decision-making  
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45 process within care of the deteriorating patient that is a requisite part of learning to be an  
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47 independent physician.<sup>24</sup> Alteration of criteria without senior medical engagement may represent  
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49 a missed learning opportunity for junior medical officers. It is also worth considering this  
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51 workflow from a broader team perspective. Shared mental models are crucial for effective and  
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53 safe patient care.<sup>25</sup> Alterations to calling criteria without senior medical engagement has the  
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55 potential to disrupt the multidisciplinary team's shared understanding of treatment plans for the  
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57 patient. Documents such as the Gosport report indicate that the authority gradient between  
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59 nurses and medical staff is still strong with nursing staff at multiple levels feeling unable or  
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4 unwilling to question medical decisions.<sup>26,27</sup> Despite efforts to reduce them, authority gradients  
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6 still exist within healthcare, both within professions and across disciplines.<sup>28</sup> It is not surprising  
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8 that authority gradients exist in health care given that many of the health care professions are  
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10 taught and practiced in largely hierarchical frameworks, both within and between the  
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12 professions. Consequently, breaking down these frameworks requires a consistent and multi-  
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14 dimensional approach to create new ways of working.<sup>29</sup> The utilisation of new technologies such  
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16 as the electronic record that provides clear documentation and ease of access to information  
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18 such as triggers for escalating care across disciplines is an example of this and highlights the  
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20 need for clear governance surrounding its use to ensure safe patient care. The effect of these  
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22 gradients is evident in RRT research revealing a reluctance of both ward nurses and junior  
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24 medical officers to initiate medical emergency calls or call for more senior help due to fear of  
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26 being criticised or appearing 'clinically inadequate'.<sup>30</sup> This again highlights the patient safety  
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28 concern relating to the practice of junior medical staff independently ordering ARRCC.  
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35 During the study period a small percentage of acute care patients admitted to hospital I received  
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37 ARRCC. Patients who received alterations during the study period were older, remained in  
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39 hospital longer, more frequently triggered an RRT call and died in hospital. These findings may  
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41 be attributed to the co-morbid state of these patients, although that relationship was not  
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43 explored in this study. Age, abnormal vital signs, RRT calls later in a hospital admission and  
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45 presence of a chronic condition have been associated with death in hospital after an RRT  
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47 activation.<sup>31,32</sup> RRT literature also suggests that up to one third of patients reviewed by rapid  
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49 response teams require end of life care.<sup>33</sup> There is a potential that alterations in calling criteria  
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51 may be being implemented in place of goals of care conversations and planning for end of life in  
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53 this group. From a broader perspective this appears to align with literature suggesting that  
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55 patients want to be partners in decision making, particularly for those who have a life limiting  
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57 illness where these conversations should occur in advance of a clinical deterioration.<sup>34,35,36</sup> If  
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4 this is the case, previously identified needs for improved end of life planning may potentially  
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6 have the additional benefit of reducing inappropriate alterations to calling criteria. In promoting  
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8 this discussion in the context of ARRCC it should be acknowledged that barriers to end of life  
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10 and limitation of care discussions are a complex and multifaceted challenge. <sup>37</sup>  
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## 15 16 **Limitations**

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19 The study was not without limitation. This was a retrospective single-centre study within a  
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21 tertiary hospital and may not be generalisable to all facilities. Data presented in this study were  
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23 collected across a 17 month period 2015-2016. Although this is now four years ago there  
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25 remains limited information outlining the use of ARRCC and therefore this paper contributes to  
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27 our understanding of how one sub-group of deteriorating patients are managed. Second,  
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29 although the utilisation of a digital medical record-based screening tool was effective in  
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31 identifying those patients who had an alteration recorded, the value of this system is dependent  
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33 on the accuracy of recording by clinicians. It has been noted that it was not within the scope of  
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35 this study to determine the reason for alteration of criteria, however given the increased risk of  
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37 rapid response calls and death in this patient group further understanding of the rationale for  
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39 alteration to criteria may have important patient safety implications.  
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## 46 47 **Conclusion**

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49 Early warning tools and rapid response teams have become common place in the recognition  
50  
51 and response to clinical deterioration in the acute hospital setting. <sup>1-10</sup> Descriptions of the  
52  
53 practice of altering criteria to trigger rapid response calls are limited. This study found patients  
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55 with an ARRCC had poorer outcomes than hospitalised patients in general. It was also found  
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57 that the majority of patients (72.2%) with ARRCC the alteration to the criteria occurred at the  
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time of or after a rapid response call. Future research surrounding this patient group may add to the effective management of clinical deterioration and potentially improve end of life care within the acute hospital setting.

**Disclosure**

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