Composition, hours, shapes and forms of RRS : what works best?

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26th, April 2019

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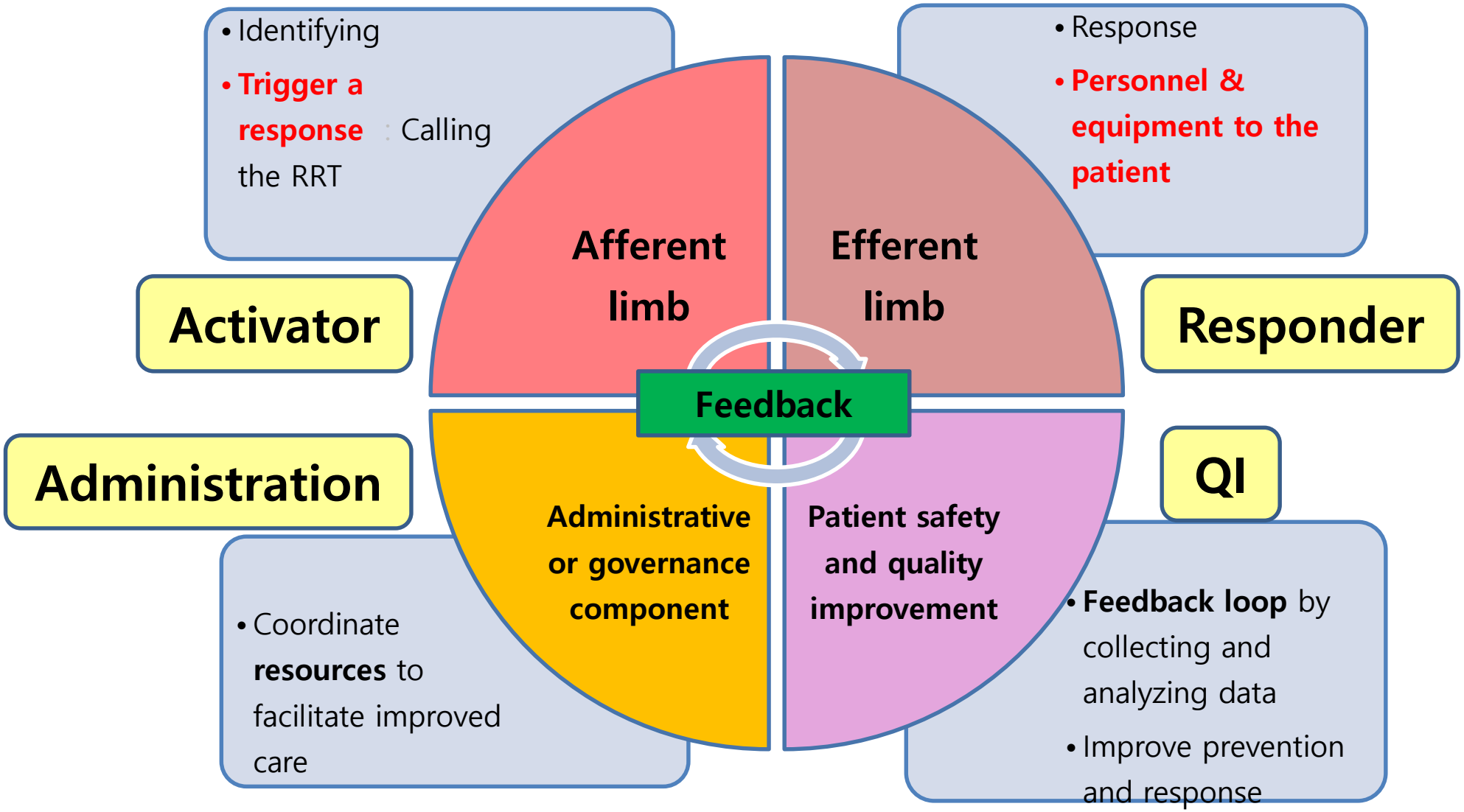
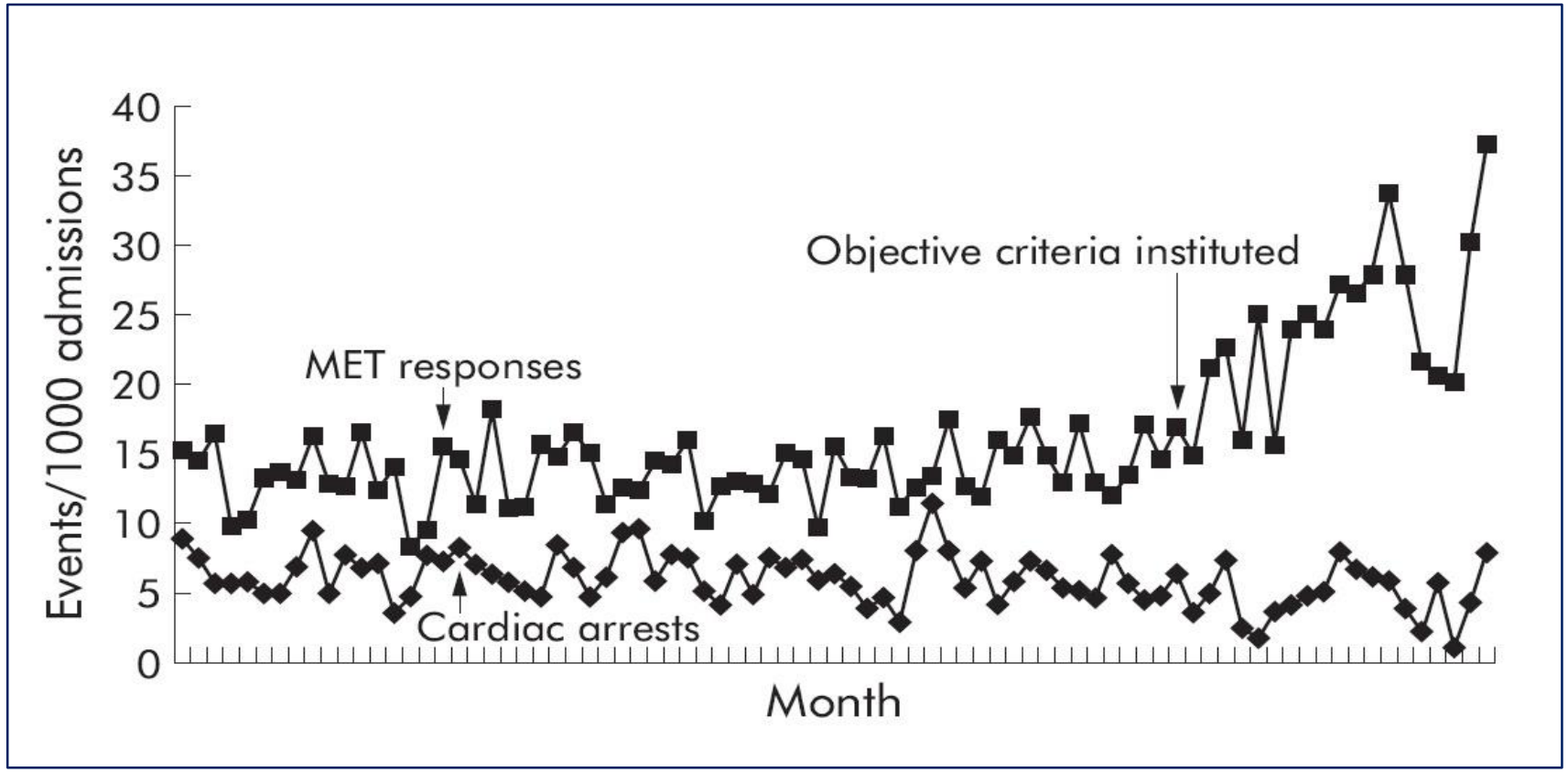
Components of RRS



N Engl J Med 2001;345:1368-77.

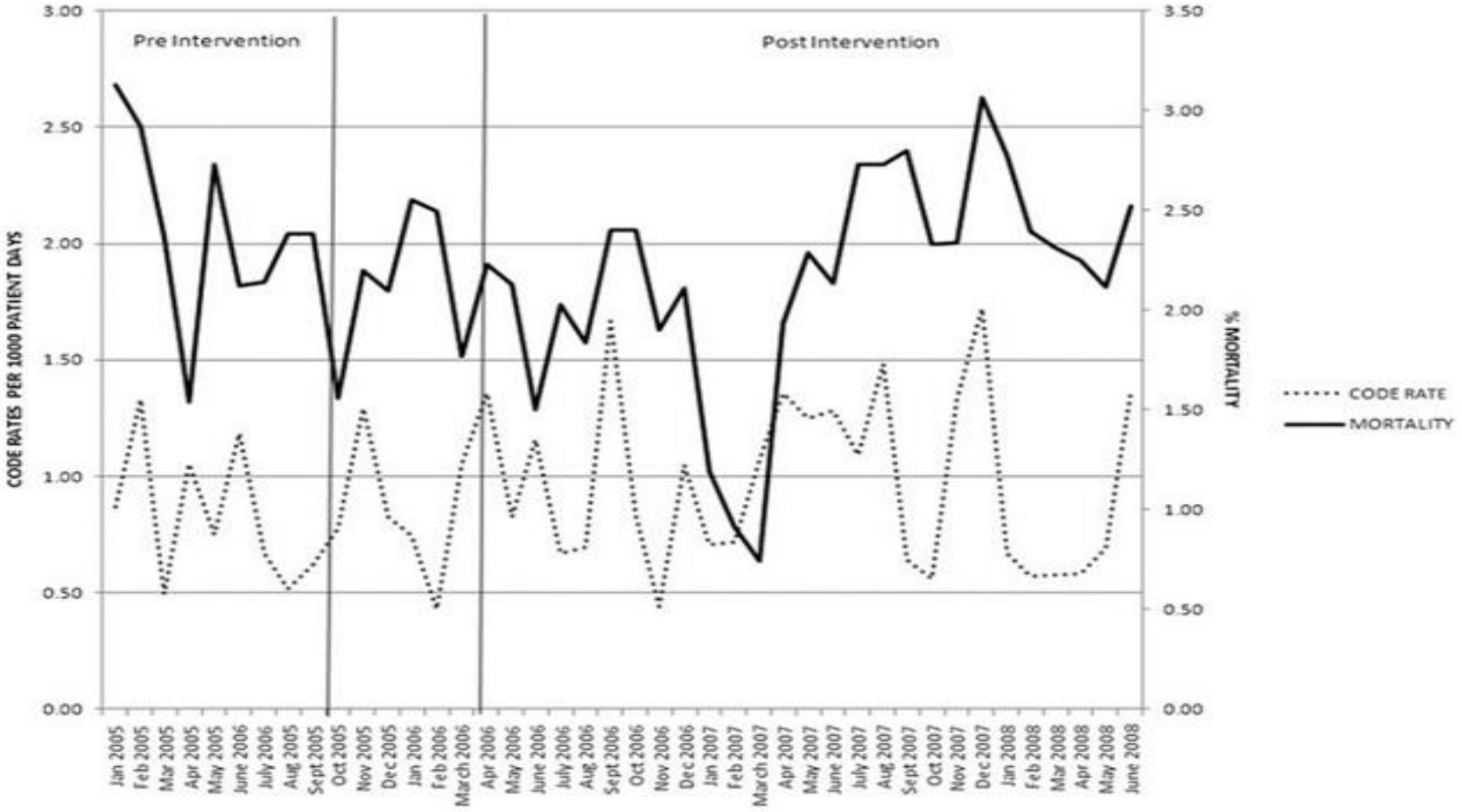
“Effectiveness of RRS”



MET responses from 13.7 to 25.8 per 1000 admissions ($p<0.001$) after activation
Coincident 17% decrease in the incidence of CPRs from 6.5 to 5.4/1000 admissions ($p = 0.016$)

Qual Saf health Care 2004;13:251-254

Does RRS really improve patient outcomes?



Shiwan K. Shah , et al. Chest 2011; 139(6):1361–1367

Difficult to prove the efficacy of RRS

Randomized Controlled Trial	Cluster randomization
• The most rigorous study design • The advantage of excluding potential bias due to heterogeneity and time trends • Two RCTs to estimate the effects of an RRs – Cluster randomization at ward or hospital level	• Ward level: bias due to heterogeneity in standard of care, patient groups, ward staffing ratios and ward staff expertise • Hospital level: heterogeneity of RRSs

Randomization on a patient level ?????

Open access Research

BMJ Open

Characterising variation in composition and activation criteria of rapid response and cardiac arrest teams: a survey of Medicare participating hospitals in five American states

Oscar J L Mitchell,[1] Caroline W Motschwiller,[1] James M Horowitz,[2] Laura E Evans,[3] Vikramjit Mukherjee[3]

- Acute care hospitals in New York, New Jersey, Rhode Island, Vermont, and Pennsylvania.
- Teaching and community hospitals as well as hospitals from rural, urban and suburban areas.

Mitchell OJL, et al. BMJ Open 2019;9:e024548.

Table 1 Characteristics of participating hospitals

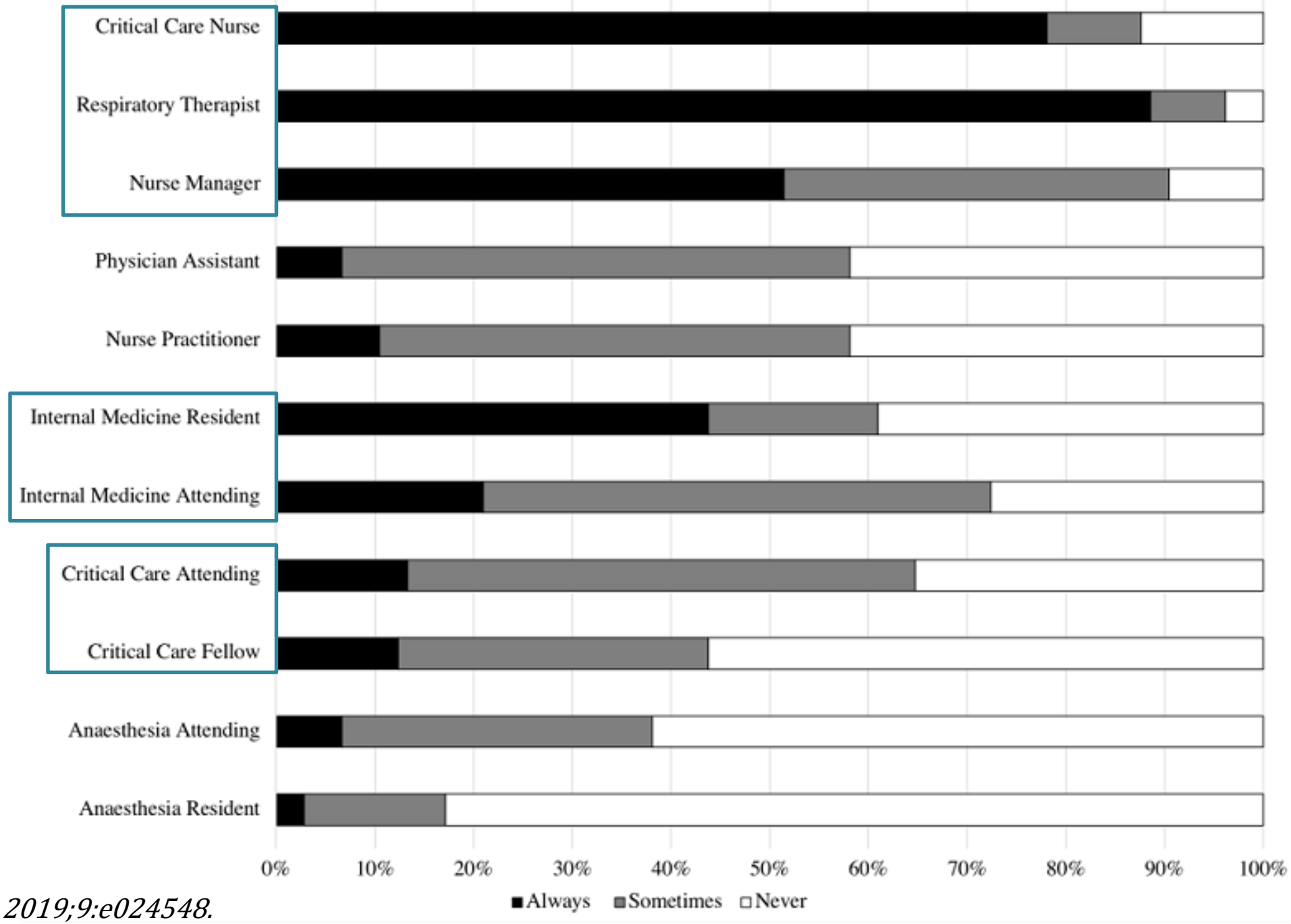
Characteristics of participating hospitals	n	Percentage
University affiliation	107 surveys	
Yes	59	55
No	48	45
Financial structure		
Private	54	50
Public	53	50
Inpatient beds		
0–500	72	67
>500	35	33
ICU beds		
0	2	2
1–20	50	47
21–50	31	29
>50	24	22
ACGME training programme present		
Internal medicine residency	69	64
Anaesthesia residency	39	36
Critical care fellowship	51	48

Table 2 RRT characteristics, including availability of RRT, activation criteria, mechanism of dispatch, and variation in individual team members

RRT characteristics	n	Percentage
24 hours RRT	104	99
RRT calling criteria		
Clinical concern	100	95
Vital sign	81	77
EWS	62	59
RRT called over		
Overhead	75	71
Pager	71	68
Phone	24	23
Pager and overhead	49	47
RRT team members change		
Daily	73	70
Weekly	15	14
Monthly	4	4
Rarely	13	12

Mitchell OJL, et al. BMJ Open 2019;9:e024548.

RRT Composition varied widely with most hospitals



Mitchell OJL, et al. BMJ Open 2019;9:e024548.

Physician present in the RRT

- Always had a physician : 67 hospitals (64%)

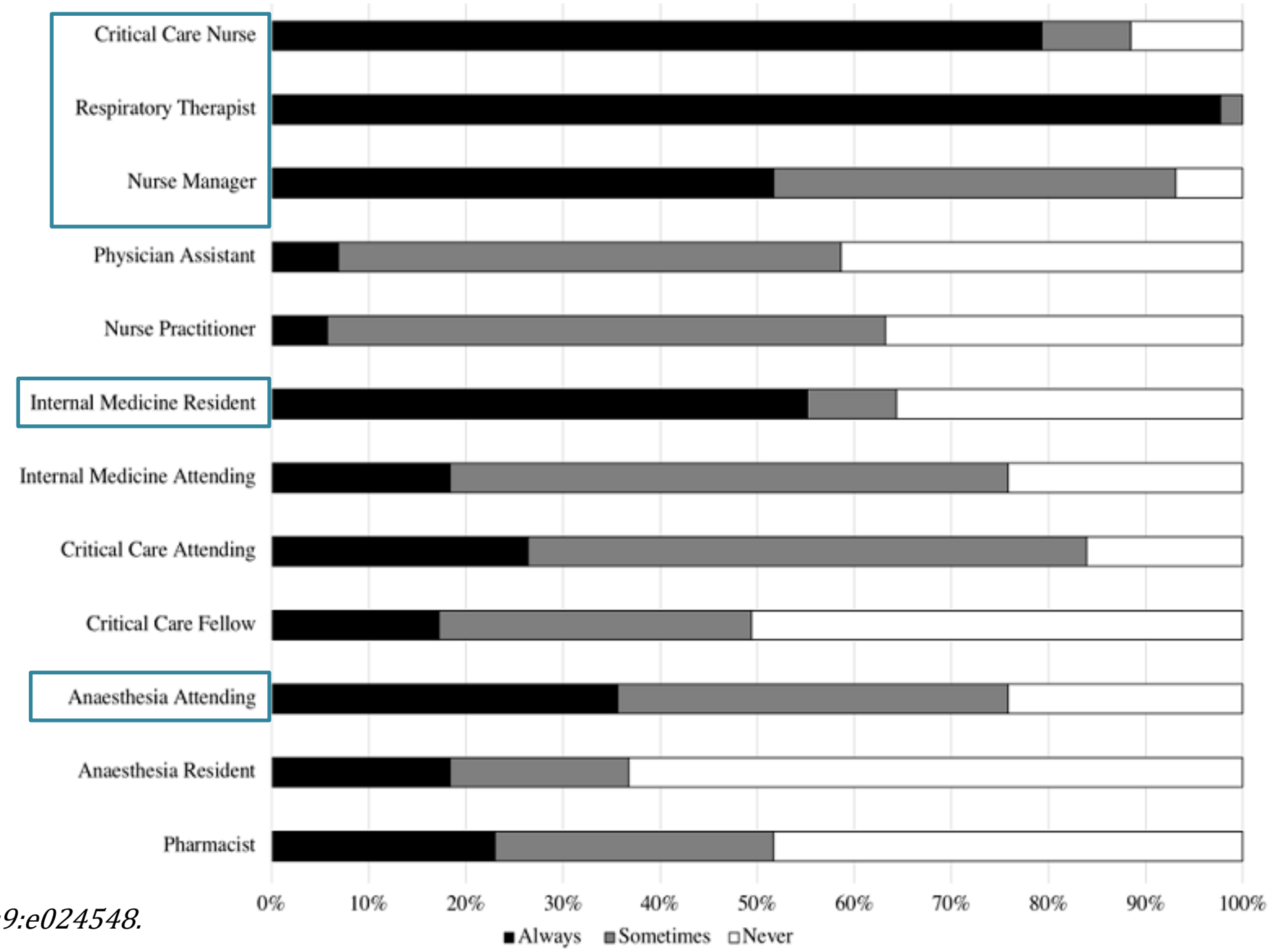
- Attending physicians
  - always part of the RRT in 40 hospitals (38%)
  - occasionally present in 56 hospitals (53%)
  - never present in 9 hospitals (9%)

- Critical care physicians (attending or fellow)
  - always attended RRT activations in 20% of hospitals
  - never attended in 25%

Mitchell OJL, et al. BMJ Open 2019;9:e024548.

Cardiac Arrest Teams

-81% hospitals dedicated CAT



Mitchell OJL, et al. BMJ Open 2019;9:e024548.

Leadership

- Senior physicians(attending) were slightly more likely to lead cardiac arrests
  - 31 % RRT *vs.* 40 % CAT
- Critical care attendings
  - 10% RRT *vs.* 20% CAT

Table 3 Individual who was reported to usually lead the RRT and cardiac arrest team by specialty and training level

Team leader by specialty	Rapid response		Cardiac arrest	
	n	Percentage	n	Percentage
Internal medicine				
NP/PA	11	10	5	6
Resident	35	33	33	38
Attending	22	21	18	21
Critical care				
Fellow	5	5	6	7
Attending	10	10	17	20
Nurse	13	12	2	2
Anaesthesia				
Resident	0	0	0	0
Attending	0	0	0	0
Other				
Family medicine resident	3	3	1	1
ED physician	1	1	1	1
Variable providers	5	5	4	5

31% of RRTs 40% of CAT

Mitchell OJL, et al. BMJ Open 2019;9:e024548.

Wide heterogeneity & Rapid team turnover

- Largest study to date in the USA

- 70% - change members daily
- RRT composition - RT (89%), CCN(78%), physicians(64%), nurse managers(51%) being the most likely to attend
- Lack of senior supervision of RRT and CAT
- Teams were frequently led by trainee physicians, often without senior supervision

→ Mixed results seen in studies of RRTs

Mitchell OJL, et al. BMJ Open 2019;9:e024548.

- IHI defines an RRT as ‘a team of clinicians who bring critical care expertise to the bedside’.

- In practice the composition of each RRT likely varies by hospital, based on local resources and requirements.

- Effectiveness of an RRT might be intrinsically linked to its composition, as provider expertise possibly influences the ability to promptly stabilize, resuscitate and triage a deteriorating patient.

Mitchell OJL, et al. BMJ Open 2019;9:e024548.

RRT actions

- The most commonly reported interventions include administering supplemental oxygen or intra-venous fluids, suctioning patients' upper airways, securing intravenous access, and ordering basic investigations (ECG, arterial blood gases, chest X-ray).

Ian A. Scott, 2015 Royal Australasian College of Physicians

Interventions	Total	Medical service (n = 138)	Surgical service (n = 322)	*P* value
Recommendation				< 0.001
A: ICU admission	246 (53.5)	79 (57.6)	178 (52.0)	
B: Borderline intervention	178 (38.7)	39 (28.0)	145 (42.4)	
C: Consultation only	19 (4.1)	8 (5.9)	12 (3.5)	
D: DNR	17 (3.7)	12 (8.5)	7 (2.0)	
Minor intervention (B, C)	196 (42.4)	48 (34.7)	146 (45.3)	0.045
Major intervention (A, D)	264 (57.4)	90 (65.3)	176 (54.7)	
Specific interventions				
Respiratory support				
Lung care and low flow oxygen titration	383 (83.3)	76 (55.1)	307 (95.3)	0.001
High flow nasal O_2 apply	10 (2.2)	6 (4.3)	4 (1.2)	0.012
Portable ventilator apply	4 (0.9)	3 (2.2)	1 (0.3)	0.054
BiPAP apply	3 (0.7)	2 (1.4)	1 (0.3)	0.163
Order diagnostic studies				
Laboratory studies	363 (78.9)	53 (38.4)	310 (96.3)	< 0.001
Imaging studies	335 (72.8)	46 (33.3)	289 (89.8)	< 0.001
Electrocardiogram	173 (37.6)	13 (9.4)	160 (49.7)	< 0.001
On-site cardiac evaluation	156 (33.9)	2 (1.4)	154 (47.8)	< 0.001
Drug and fluid management				
Drug adjustment	266 (57.8)	55 (39.9)	211 (65.5)	0.004
Fluid resuscitation	232 (50.4)	41 (29.7)	191 (59.3)	0.001
Transfusion	28 (6.1)	1 (0.7)	27 (8.4)	0.003
Transfer monitoring	181 (39.3)	36 (26.1)	145 (45.0)	0.023
Consultation to other specialties	122 (26.5)	5 (3.6)	117 (36.3)	< 0.001
Procedure				
Intubation	74 (16.1)	24 (17.4)	50 (15.5)	0.145
Central line insertion	10 (2.2)	1 (0.7)	9 (2.8)	0.464
Emergent arrangement				
Emergency embolization arrange	9 (2.0)	4 (2.9)	5 (1.6)	0.192
Emergency operation arrange	7 (1.5)	3 (2.2)	4 (1.2)	0.380
Others	55 (12.0)	9 (6.5)	46 (14.3)	0.090

YJL et al. Korean Med Sci 2017; 32: 688-694

Original research

Association between implementation of an intensivist-led medical emergency team and mortality

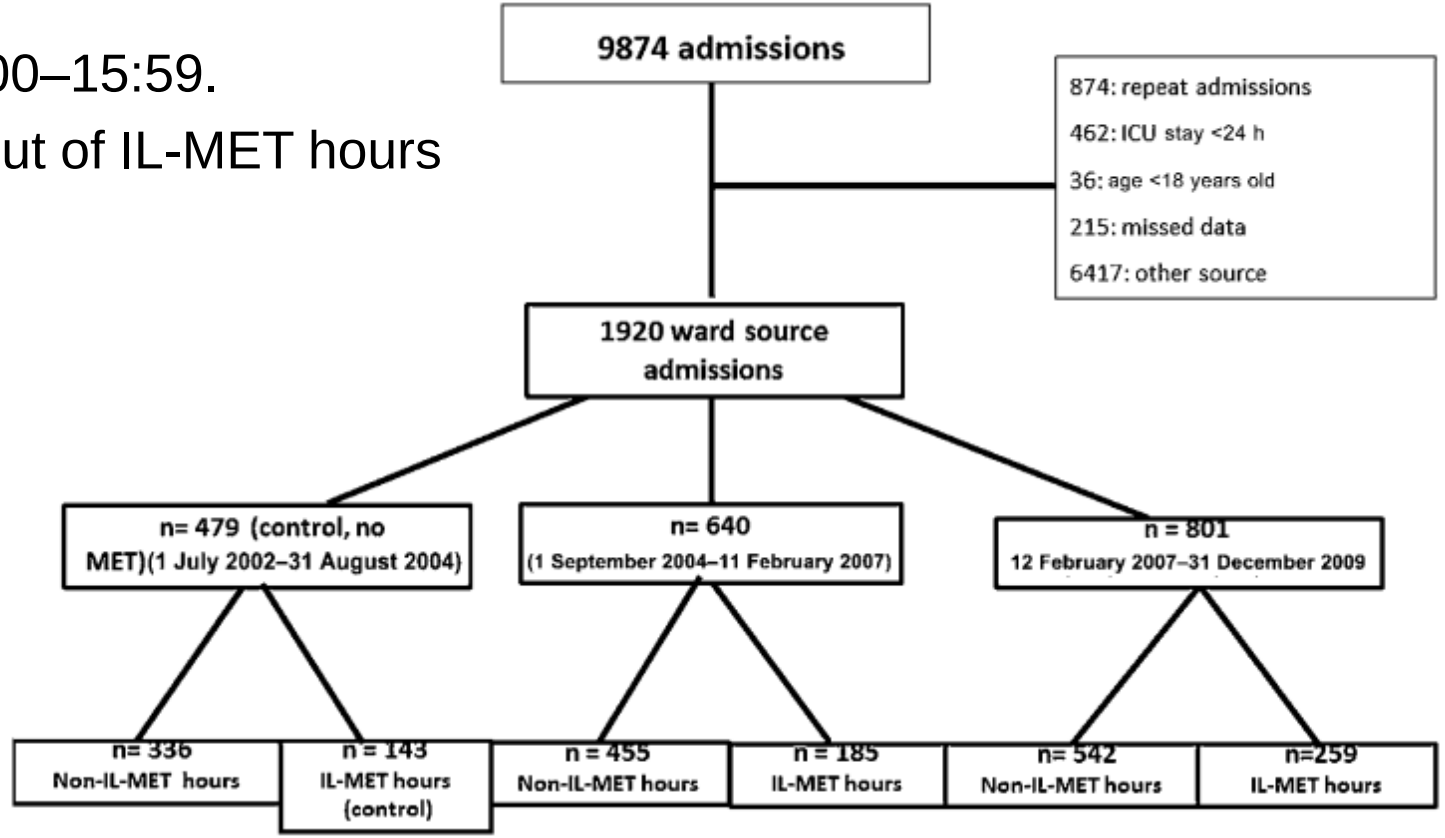
Constantine J Karvellas,[1] Ivens A O de Souza,[1,2] R T Noel Gibney,[1] Sean M Bagshaw[1]

- University of Alberta Hospital
- The aim of this study was to examine a dedicated IL-MET responding to rapid response calls and to assess the impact on clinical outcomes, most notably in-hospital mortality and length of stay

BMJ Qual Saf 2012;21:152 159.

- Period 1 (2002.7~ 2004.8): no MET
- Period 2 (2004.9 ~ 2007.2): partial MET
  (no dedicated intensivist)
- Period 3 (2007.2 ~ 2009.12): hospital-wide IL-MET
  (dedicated intensivist-led MET)

- IL-MET hours: Monday to Friday 8:00–15:59.
- Non-IL-MET hours: all other times out of IL-MET hours



BMJ Qual Saf 2012;21:152 159.

Table 2 Baseline characteristics of the study patients at intensive care unit (ICU) admission

Baseline characteristics	Period 1 (control) (N=479)			Period 2 (N=640)			Period 3 (N=801)			
	Non-IL-MET hours (N=336, 70%)	IL-MET hours (N=143, 30%)	p*	Non-IL-MET hours (N=455, 71%)	IL-MET hours (N=185, 29%)	p*	Non-IL-MET hours (N=542, 68%)	IL-MET hours (N=259, 32%)	p*	p**
Men, n (%)	206 (61)	79 (55)	0.21	266 (58)	114 (62)	0.46	318 (59)	151 (58)	0.92	0.74
Age years, mean (SD)	59 (16)	62 (16)	0.12	60 (16)	61 (15)	0.34	60 (16)	62 (16)	0.16	0.81
APACHE II, mean (SD)	23 (9)	22 (9)	0.80	24 (9)	24 (8)	0.83	24 (8)	24 (8)	0.69	**0.009**
Comorbidities, n (%)										
None	174 (51.8)	66 (46.2)	0.26	253 (55.6)	109 (58.9)	0.44	294 (54.2)	147 (56.8)	0.50	**0.09**
One	141 (42.0)	67 (46.9)	0.99	153 (33.6)	61 (33.0)	0.42	195 (35.9)	92 (35.5)	0.44	**0.02**
Two or more	21 (6.3)	10 (6.9)	0.99	49 (10.8)	15 (8.1)	0.42	53 (9.9)	20 (7.7)	0.44	**0.02**
Comorbid condition, n (%)										
Immunosuppression	47 (14.0)	23 (16.1)	0.55	62 (13.6)	29 (15.7)	0.50	91 (16.8)	29 (11.2)	0.04	0.86
Haematological cancer	22 (6.6)	10 (7.0)	0.86	28 (6.2)	9 (4.9)	0.53	49 (9.0)	19 (7.3)	0.42	0.24
Metastatic cancer	17 (5.1)	4 (2.8)	0.27	10 (2.2)	4 (2.2)	0.97	17 (3.1)	12 (4.6)	0.29	0.49
Hepatic failure	24 (7.1)	10 (7.0)	0.95	46 (10.1)	11 (5.9)	0.09	53 (9.8)	25 (9.7)	0.96	0.11
Chronic renal failure	29 (8.6)	11 (7.7)	0.73	48 (10.6)	12 (6.5)	0.11	42 (7.8)	21 (8.1)	0.86	0.75
Congestive heart failure	15 (4.5)	11 (7.7)	0.15	18 (4.0)	11 (5.7)	0.27	7 (1.3)	1 (0.4)	0.23	**<0.001**
Chronic lung disease	27 (8.1)	17 (11.9)	0.18	35 (7.7)	16 (8.7)	0.69	40 (7.4)	21 (8.1)	0.72	0.32
Routine cardiac surgery	1 (0.3)	0	0.51	4 (0.9)	2 (1.1)	0.81	1 (0.2)	2 (0.8)	0.20	0.61
AIDS	1 (0.3)	1 (0.7)	0.53	1 (0.2)	1 (0.5)	0.51	3 (0.6)	2 (0.8)	0.71	0.63
Primary ICU diagnosis, n (%)										
Respiratory	161 (47.9)	65 (45.5)	0.62	201 (44.2)	75 (40.5)	0.40	204 (37.6)	112 (43.2)	0.13	**0.007**
Gastrointestinal	43 (12.8)	16 (11.2)	0.62	52 (11.4)	19 (10.3)	0.67	70 (12.9)	28 (10.8)	0.39	0.96
Trauma	10 (2.9)	2 (1.4)	0.31	27 (5.9)	6 (3.2)	0.16	17 (3.1)	12 (4.6)	0.29	0.27
Sepsis	27 (8.0)	12 (8.4)	0.89	55 (12.1)	26 (14.1)	0.49	93 (17.2)	42 (16.2)	0.74	**<0.001**
Neurological	34 (10.1)	20 (14.0)	0.22	35 (7.7)	15 (8.1)	0.85	35 (6.5)	20 (7.7)	0.51	0.006
Cardiovascular	40 (11.9)	17 (11.9)	0.99	52 (11.4)	30 (16.2)	0.10	88 (16.2)	37 (14.3)	0.48	0.07
Metabolic	5 (1.5)	2 (1.4)	0.94	9 (2.0)	2 (1.1)	0.42	11 (2.0)	0	0.02	0.89
Renal	7 (2.1)	4 (2.8)	0.63	18 (3.9)	5 (2.7)	0.44	13 (2.4)	4 (1.5)	0.43	0.84
Haematological	3 (0.9)	3 (2.1)	0.27	2 (0.4)	6 (3.2)	0.004	11 (2.0)	4 (1.5)	0.64	0.39
Other	6 (1.8)	2 (1.4)	0.76	4 (0.9)	1 (0.5)	0.66	0	0		

Table 3 Mortality, lengths of stay and necessity of mechanical ventilation differences between intensivist-led medical emergency team (IL-MET) hours and non-MET (non-IL-MET) hours during all three study periods

Baseline characteristics	Period 1 (N=479)			Period 2 (N=640)			Period 3 (N=801)			
	Non-IL-MET hours (N=336, 70%)	IL-MET hours (N=143, 30%)	p*	Non-IL-MET hours (N=455, 71%)	IL-MET hours (N=185, 29%)	p*	Non-IL-MET hours (N=542, 68%)	IL-MET hours (N=259, 32%)	p*	p**
ICU mortality, n (%)	70 (20.8)	18 (12.59)	0.03	78 (17.1)	37 (20.0)	0.39	100 (18.5)	44 (17.0)	0.61	0.86
Hospital mortality, n (%)	104 (30.9)	44 (30.77)	0.97	143 (31.4)	64 (34.6)	0.44	195 (35.9)	78 (30.1)	0.10	0.24
ICU length of stay, days (IQR)	5 (2–10)	5 (2–9)	0.92	5 (2–9)	5 (3–10)	0.44	5 (2–11)	5 (3–9)	0.87	0.20
Hospital length of stay, days (IQR)	25 (13–47)	26 (13–54)	0.53	25 (14–51)	28 (14–52)	0.43	28 (14–55)	29 (15–55)	0.53	0.06
Mechanical ventilation, n (%)	240 (71.4)	100 (69.9)	0.74	308 (67.7)	137 (74.1)	0.11	395 (72.9)	200 (77.2)	0.19	0.19

Period 1 (1 July 2002–31 August 2004): no medical emergency team (MET); period 2 (1 September 2004–11 February 2007): partial MET coverage (no dedicated intensivist); period 3 (12 February 2007–31 December 2009): hospital-wide dedicated intensivist-led MET (IL-MET). IL-MET hours: Monday to Friday, 8:00–15:59; non-MET hours: all other times out of IL-MET hours. p*=comparison between IL-MET hours and non-IL-MET hours; p**=comparison between period 1 and period 3.

BMJ Qual Saf 2012;21:152 159.

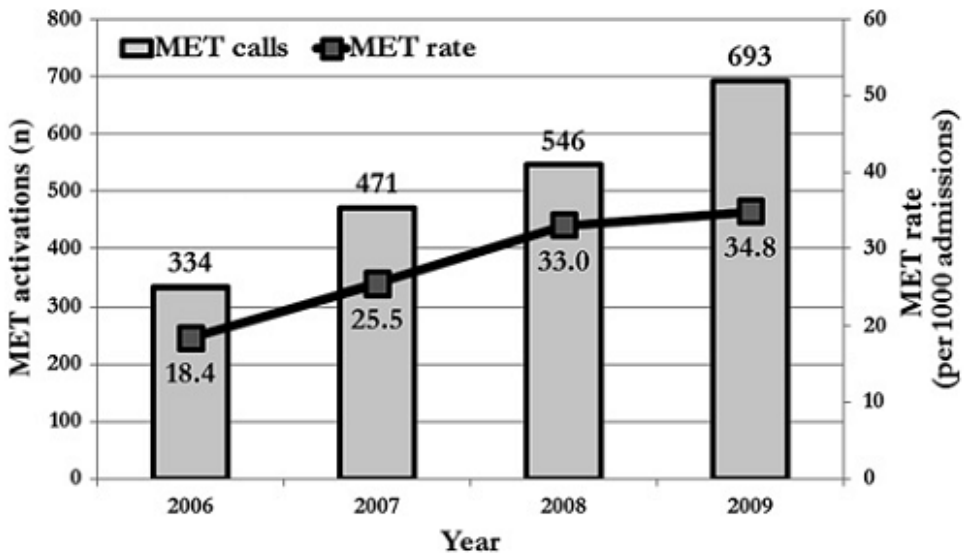


Figure 3 Total Number of medical emergency team (MET) activations (n) and MET activation rate (per 1000 admissions) between 2006 and 2009.

Table 4 Multiple variable logistic regression analysis showing the association of in-hospital mortality with APACHE II, age, medical comorbidity, use of mechanical ventilation and admission during the intensivist-led MET (IL-MET) hours for all three study periods and from 1 January 2008 to 31 December 2009

Predictor variables	OR (95% CI)	p Value
1 July 2002–31 August 2004		
Admission during IL-MET hours	0.97 (0.61 to 1.54)	0.90
APACHE II	1.09 (1.06 to 1.13)	<0.001
Age	1.00 (0.99 to 1.02)	0.65
Mechanical ventilation	1.02 (0.61 to 1.69)	0.94
At least one comorbidity	1.62 (0.98 to 2.45)	0.04
1 September 2004–11 February 2007		
Admission during IL-MET hours	1.19 (0.80 to 1.77)	0.39
APACHE II	1.10 (1.07 to 1.13)	<0.001
Age	1.02 (1.00 to 1.03)	0.002
Mechanical ventilation	1.46 (0.92 to 2.31)	0.11
At least one comorbidity	1.39 (0.92 to 2.09)	0.11
12 February 2007–31 December 2009		
Admission during IL-MET hours	0.73 (0.51 to 1.03)	0.07
APACHE II	1.11 (1.08 to 1.13)	<0.001
Age	1.01 (1.00 to 1.02)	0.008
Mechanical ventilation	1.33 (0.88 to 2.00)	0.18
At least one comorbidity	1.43 (1.01 to 2.02)	0.04

period 1 (pre-introduction of MET)

period 2 (non-IL MET)

period 3 (hospital wide IL MET)

- Implementation of an IL-MET did not appear to significantly reduce the rate of in-hospital mortality or lengths of stay.

BMJ Qual Saf 2012;21:152 159.

Sustained effectiveness of a primary-team–based rapid response system*

Michael D. Howell, MD, MPH; Long Ngo, PhD; Patricia Folcarelli, RN, PhD; Julius Yang, MD, PhD; Lawrence Mottley, MD; Edward R. Marcantonio, MD, SM; Kenneth E. Sands, MD, MPH; Donald Moorman, MD; Mark D. Aronson, MD

- Objective: whether a RRS that relied on a patient's usual care providers, not a critical-care–trained RRT, would improve patient outcomes
- An interrupted time-series analysis of over a 59-month period
- Specifically, we did not add clinical staff or use an ICU-based RRT, but instead focused on systematic detection of decompensations and notification of patients' usual care providers

Crit Care Med 2012; 40:2562–2568

All providers who participate in the patient's care in our new system were the same providers responsible for the patient's care already. However, in the previous system, the floor's senior nurse, respiratory therapist, and the attending physician participated in care on an as-needed basis when patient acuity was high, but exact criteria were not specified.

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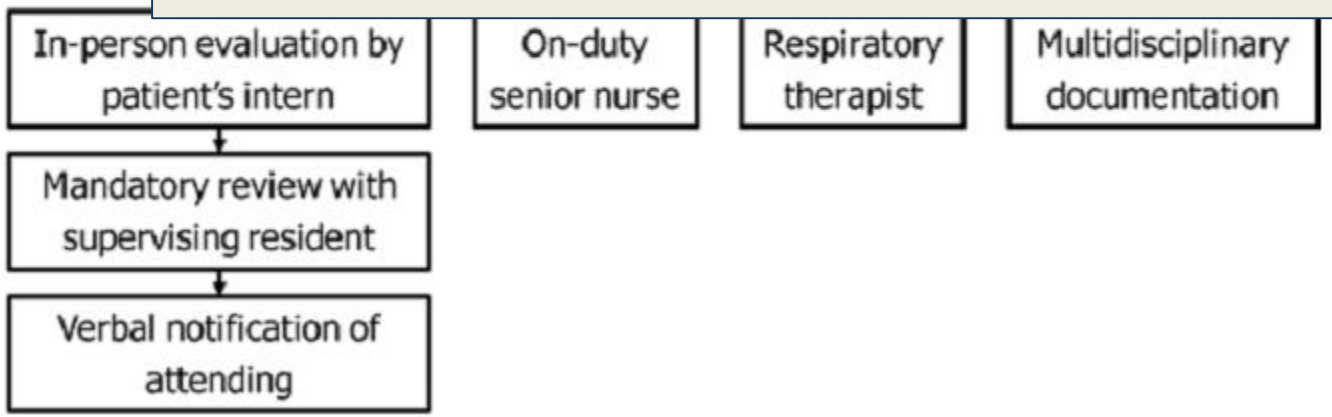
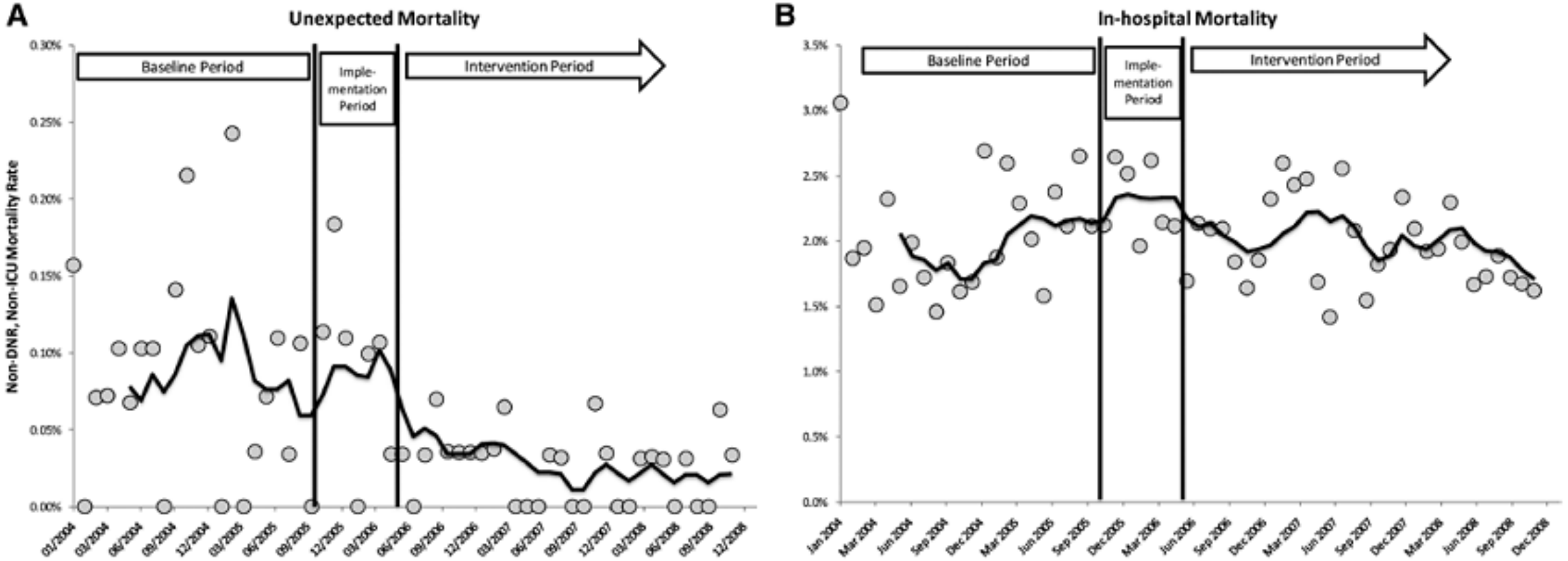


- ✓ the baseline period (22 months)
- ✓ the implementation period (6 months)
- ✓ the intervention period (31 months)

Figure 1. Clinical pathway for monitoring and responding to inpatients with acute decompensations.

Crit Care Med 2012; 40:2562–2568

The intervention period was associated with a lower risk of unexpected mortality



ICU = intensive care unit; DNR=do-not-resuscitate

Figure 2. Unadjusted mortality rates. *A*, The risk of unexpected mortality over time. *B*, overall in hospital mortality rates over time. Curves are a 6-month moving average.

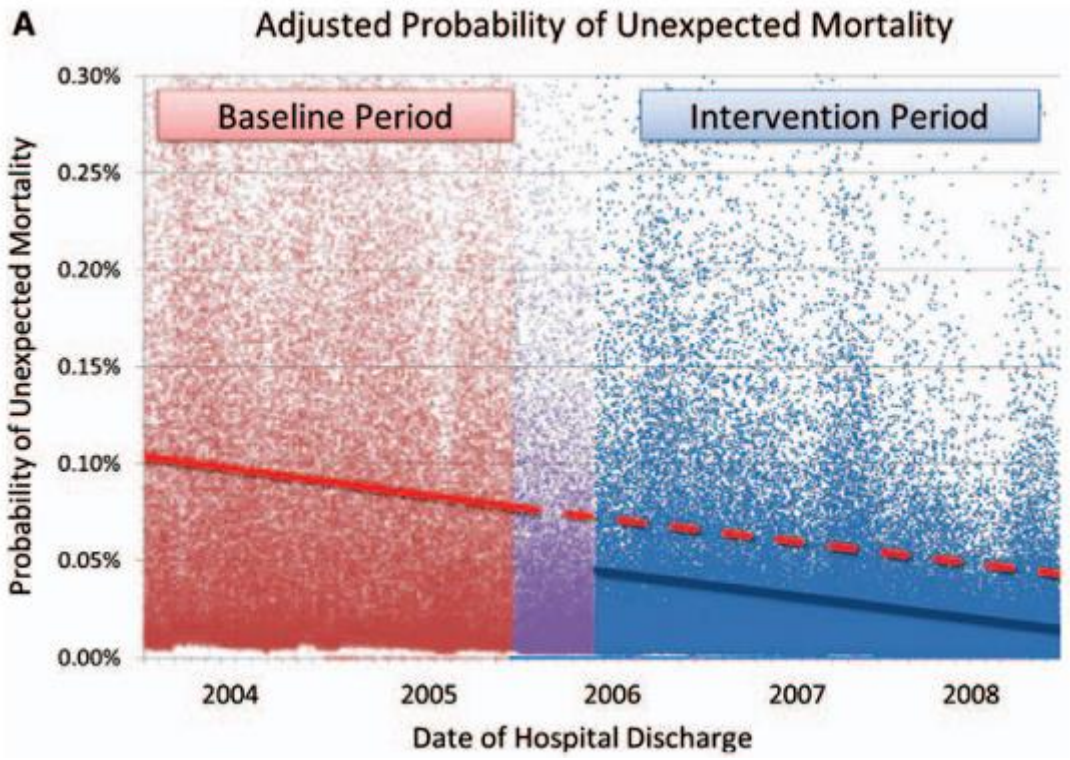
Crit Care Med 2012; 40:2562–2568

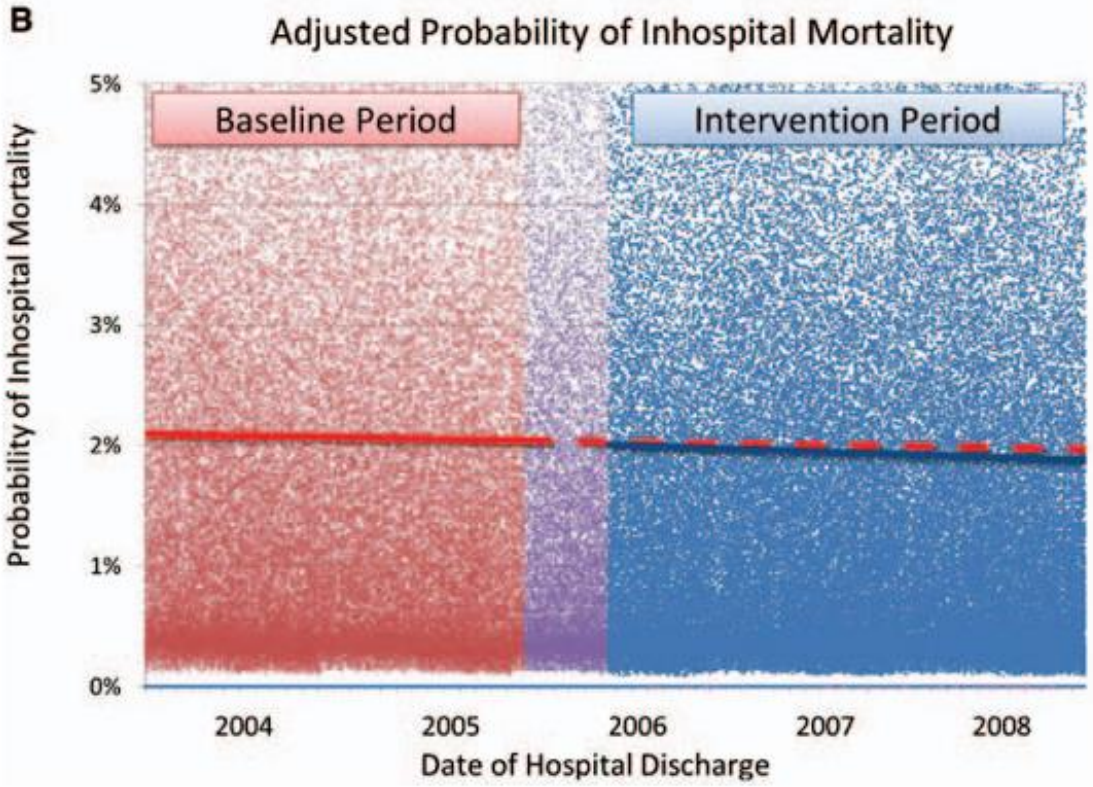
Table 2. Adjusted odds ratio for death before and after the intervention for unexpected (non-do-not-attempt resuscitation, non-intensive care unit) mortality

	Adjusted Odds Ratio	*p*
Intervention period	0.2 (0.11–0.37)	<.0001
Charlson Comorbidity Index (per point increase)	1.56 (1.37–1.77)	<.0001
Case mix (per point increase)	1.12 (1.07–1.17)	<.0001
Age (per year increase)	1.04 (1.02–1.05)	<.0001
Gender (female vs. male)	0.69 (0.46–1.04)	.08
Race		
Asian	0.58 (0.08–4.19)	.6
Black	0.84 (0.39–1.82)	.7
Hispanic	0.81 (0.2–3.3)	.8
Other	1.4 (0.78–2.5)	.3
White	1.0	—
Season		
Spring	1.3 (0.71–2.4)	.4
Summer	1.01 (0.56–1.81)	.99
Fall	0.9 (0.47–1.71)	.7
Winter	1.0	—
Intensive care unit bed ratio		
Lowest	0.65 (0.21–2.03)	.5
Second lowest	0.73 (0.32–1.69)	.5
Third lowest	0.95 (0.42–2.15)	.9
Highest	1.0	—

Crit Care Med 2012; 40:2562–2568

The intervention period was associated with a lower risk of unexpected mortality





Interrupted time-series analyses to evaluate whether time trends might account for the observed effects

Crit Care Med 2012; 40:2562–2568

For Clinicians and Policymakers

- Without a dedicated ICU-based team, organizing the detection of and response to acute clinical decompensations reduces unexpected mortality.
- This approach requires no additional clinical staffing, preserves provider continuity, and respects traditional tenets of medical education.

➢ Ongoing discussions about intensivist manpower shortages

➢ It may be that intensivists' time is better spent with the critically ill, in the ICU, rather than serving as part of rapid response teams.

Crit Care Med 2012; 40:2562–2568

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The role of the primary care team in the rapid response system☆,☆☆,★,★★

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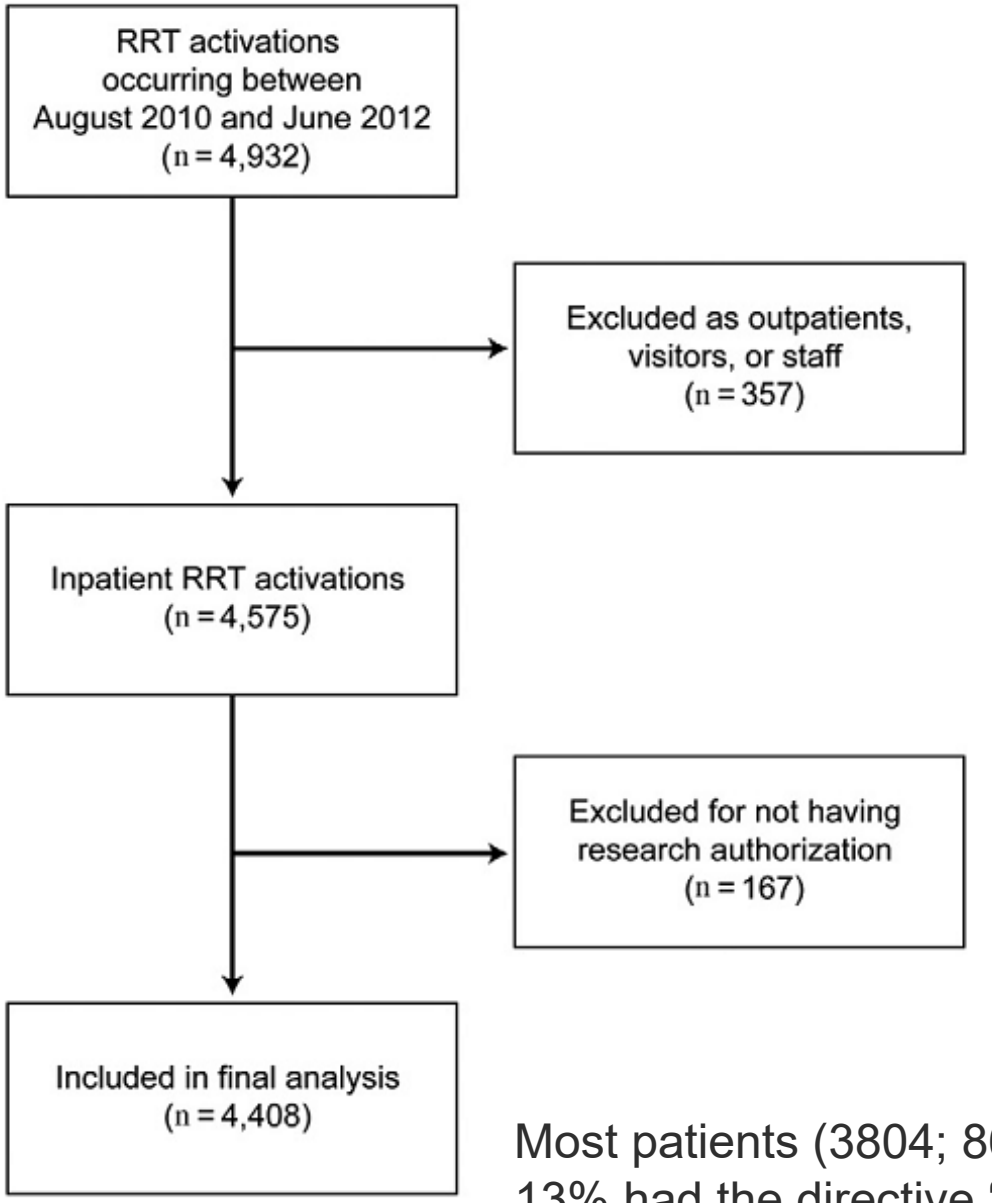
[c] Department of Anesthesiology, Mayo Clinic, Rochester, MN

- Combination of retrospective chart review and prospective survey-based evaluation
  - Retrospective evaluation contained assessment of all RRTs
  - 2010.8~ 2012.6 chart review, primary team involvement
  - Post-RRT survey for prospective use
  - Primary team's involvement in decision making and the overall subjective quality of the interaction with primary service

Journal of Critical Care 30 (2015) 353–357



- Efferent RRS arm
  - Critical care fellow, Critical care nurse, ICU-based RT
  - Supervised by a staff-level in-house intensivist
- Afferent component of the RRS
  - Bedside care providers

Most patients (3804; 86.2%) were considered a “full code,”
13% had the directive “DNR/DNI”

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Table 1

Activation characteristics when primary team present vs absent from retrospective data set

Variable[a]	Overall (n = 4423)	Primary team present[b] (n = 3616)	Primary team not present[b] (n = 166)	*P*
Age, median (IQR), y	65.0 (54.0-76.0)	65.6 (54.0-76.0)	63.7 (53.0-74.6)	.24
Male sex	2231 (50.4)	1770 (49.0)	91 (54.8)	.14
Median (IQR) time to RRT, d	3 (1-7)	3 (1-7)	3 (1-6)	.96
Surgical service[c]	1627 (48.0)	1299 (47.0)	120 (82.0)	<.01
Code status[d]	604 (13.5)	511 (14.1)	7 (4.2)	<.01
Code status changed during RRT activation	321 (7.2)	275 (7.6)	4 (2.4)	.01
Patient transfer to ICU	1508 (58.6)	2136 (59.1)	75 (45.2)	<.01

In the retrospective series, an attempt was made to contact the primary service before or during the RRT activations in 96.4% of cases.

The primary service was more likely to be contacted (odds ratio [OR], 3.57 [95% confidence interval {CI}, 1.57-8.14]; $P < .01$) and present (OR, 3.97 [95% CI, 2.48-6.34]; $P < .01$) if the patient was not full code.

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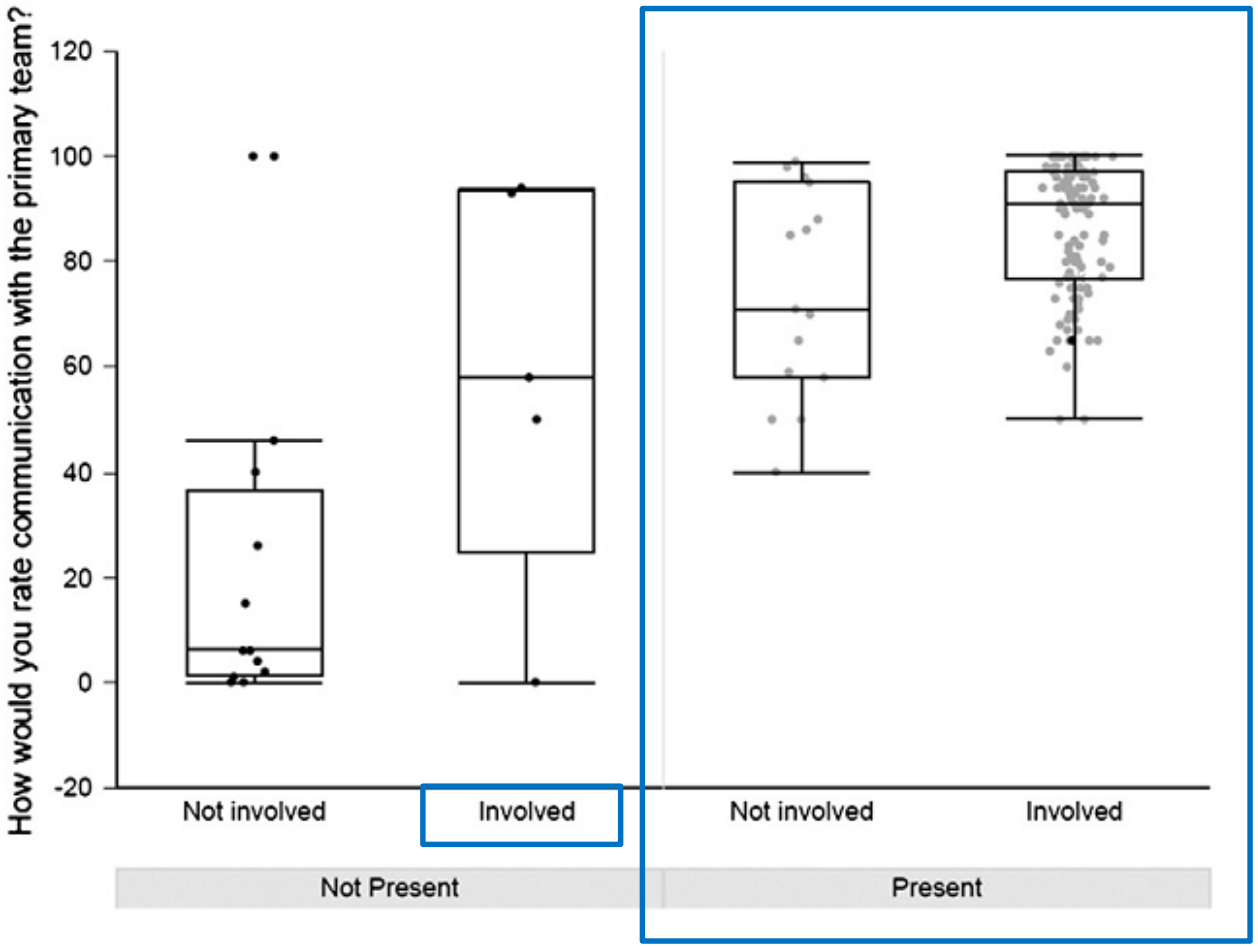

- Subjective quality of communication with primary service during RRT intervention
- Graph shows a trend toward better ratings when the primary service is present and more involved in shared decision making.

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Reasons for the primary service not being present

- 37%- resolution of the RRT evaluation before arrival
- 21%- primary team home call
- 16%- not contacted before or at time of RRT activation
- Surgical services were less likely to be contacted pre-RRT (OR [IQR], 0.21 [0.08-0.53]; $P = .01$) and less likely to be physically present (OR [95% CI], 0.11 [0.05-0.28]; $P < .01$).

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- This study's available data show that active primary team involvement influences the process of care associated with RRT activation(ICU transfer, DNR changed).
- Introduction of the RRT without the primary service brings an opinion based on limited information.
- The data are suggestive that the primary team's involvement in collaboration with the RRT is beneficial in facilitating discussions of goals of care.

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Contents lists available at SciVerse ScienceDirect

Resuscitation

journal homepage: www.elsevier.com/locate/resuscitation

Clinical paper

Differences in outcomes between ICU attending and senior resident physician led medical emergency team responses☆

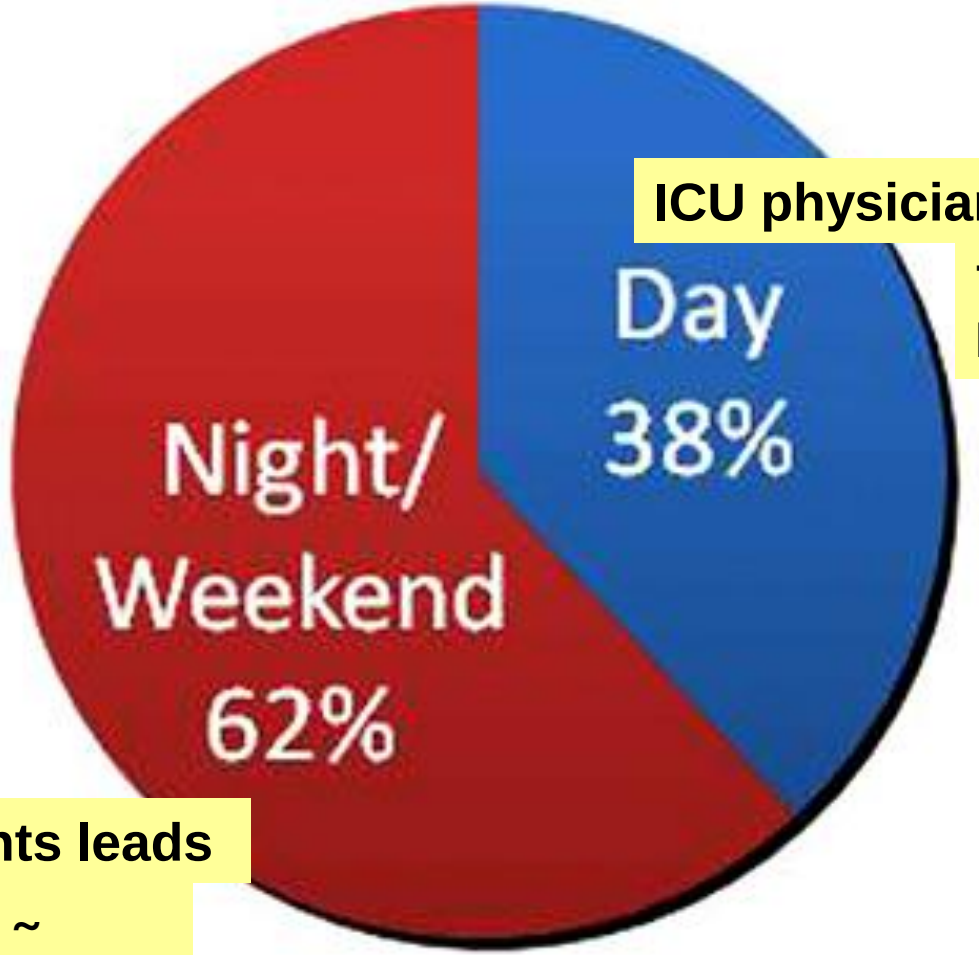
David S. Morris, William Schweickert, Daniel Holena, Robert Handzel, Carrie Sims, Jose L. Pascual, Babak Sarani*

2150 Pennsylvania Ave, NW, Suite 6B, Washington DC, 20037, United States

- A retrospective study of the RRS database at a single, academic hospital was performed from July 1, 2006 to May 31, 2010.

Resuscitation 83 (2012) 1434-1437

Rapid Response Distribution



ICU physician leads

7A ~ 5P
Mon~Friday

Residents leads

5P Fri ~
7A Mon

Fig. 1. Percentage of rapid response calls in each cohort.

Table 1
Criteria for rapid response activation.

Respiratory
Rate < 8 or >32 breaths/min
Oxygen saturation <85%
Acute increase in oxygen need by 50%
Dyspnea
Cardiac
Rate < 40 or >140 beats/min
Systolic blood pressure < 80 or >200 mmHg
Diastolic blood pressure > 110 mmHg
New onset chest pains
Neurologic
Seizure
Acute change in mental status
Miscellaneous
Uncontrolled bleeding
Inability to contact house-officer after 2 pages
Nurse concern/discretion
Physician concern/discretion

The nurse to patient ratio is constant during all shifts.

Resuscitation 83 (2012) 1434-1437

Triggers for MET activation varied by time period

	Day, *N* (%) 534 (38)	Night/W, *N* (%) 870 (62)	OR	95% CI	*p*
Respiratory	215 (40%)	443 (51%)	1.54	1.25–1.92	<0.001
Cardiovascular	284 (53%)	484 (56%)	1.10	0.89–1.37	0.37
Neurologic	254 (48%)	366 (42%)	0.80	0.65–0.99	0.04
Staff concern alone	10 (2%)	31 (4%)	1.94	0.94–3.98	0.07

Resuscitation 83 (2012) 1434-1437

Interventions during RRS activation

	Day, *N* (%) 534 (38)	Night/WE, *N* (%) 870 (62)	OR	95% C.I.	*p*
Echocardiogram	11 (2)	4 (<1)	0.22	0.07–0.69	0.01
Diuretics	26 (5)	69 (8)	1.68	1.06–2.68	0.03
Bronchodilators	13 (2)	63 (7)	3.13	1.71–5.74	<0.001
Supplemental O_2	331 (62)	599 (69)	1.34	1.07–1.68	0.01
Chest radiography	154 (29)	344 (40)	1.61	1.27–2.02	<0.001
Central venous line placement	64 (12)	160 (18)	1.65	1.21–2.25	0.002
Peripheral IV placement	176 (33)	330 (38)	1.24	0.99–1.55	0.07
Urinary catheter placement	16 (3)	45 (5)	1.76	0.98–3.15	0.05
Intubation	50 (9)	95 (11)	1.18	0.82–1.70	0.36
Transfer to ICU	306 (57)	494 (57)	0.96	0.78–1.21	0.82

Similar outcomes – intensivists or residents

- Progression to cardiopulmonary arrest following RRS activation was not significantly different between the two periods (1.8% D vs. 2.4% NW, $p = 0.4$).
- Death during a RRS event was distinctly rare and did not differ significantly between the two groups (0.2% D vs. 0.8% NW, $p = 0.81$).
- Beyond the immediate results of the RRS activation, we found that unadjusted in-hospital mortality did not differ between D and NW periods (27% D vs. 26% NW, $p = 0.64$).

Resuscitation 83 (2012) 1434-1437

Impact of MET trigger and timing on mortality

	OR	95% CI	p
Night or weekend	0.87	0.68–1.11	0.26

- A resident-led MET in such a model may enable more efficient use of attending physician time and resources.
- Attending physicians may be able to assume a more advisory role with residents leading the team in most instances.
- A prospective study is needed to determine optimal staffing and resource allocation of RRS.

Resuscitation 83 (2012) 1434-1437

Resource use, governance and case load of rapid response teams in Australia and New Zealand in 2014

The Joint College of Intensive Care Medicine and Australian and New Zealand Intensive Care Society Special Interest Group on Rapid Response Systems, and ANZICS Centre for Outcome and Resource Evaluation

- RRTs are a mandatory element of Australian national health care policy
- To assess the clinical activity, funding, staffing and governance of RRTs
- 165 (79.7%) hospitals participated survey
- RRTs - 149 of 165 hospitals (90.3%)

  - 138/143 (95.5%) Australian, 11/22 (50%) New Zealand hospitals

Crit Care Resusc 2016; 18: 275-282

ICU staffs' involvement is common

- ICU staff participated in 147/148 RRTs (99.3%)
  - both medical and nursing staff (76.2%)
  - medical staff only (10.2%)
  - nursing staff only (6.8%)

- Isolated ICU nursing involvement was more common
  - in smaller ICUs (P = 0.005)
  - in rural/regional and metropolitan hospitals (P = 0.04)
  - in New Zealand (P = 0.006)

Crit Care Resusc 2016; 18: 275-282

Table 1. Differences in hospital characteristics, by rapid response team funding type

Hospital characteristic	Not funded	Partially funded	Fully funded	*P*
ICU level,* *n* (%)				
1 (*n* = 14)	13 (92.9)	1 (7.1)	0	
2 (*n* = 59)	47 (79.7)	2 (3.4)	10 (16.9)	0.004
3 (*n* = 73)	43 (58.9)	17 (23.2)	13 (17.8)	
Classification, *n* (%)				
Metropolitan (*n* = 26)	14 (53.8)	3 (11.5)	9 (34.6)	
Rural/regional (*n* = 33)	29 (87.9)	2 (6.1)	2 (6.1)	< 0.001
Tertiary (*n* = 41)	20 (48.4)	14 (34.1)	7 (17.1)	
Private (*n* = 46)	40 (87.0)	1 (2.2)	5 (10.9)	
Jurisdiction, *n* (%)				
Australia (*n* = 135)	99 (73.3)	18 (13.3)	18 (13.3)	0.012
New Zealand (*n* = 11)	4 (36.4)	2 (18.2)	5 (45.5)	
Median hospital beds (IQR)	220 (155–344)	480 ((327–669)	417 (211–530)	< 0.001
Median available ICU beds (IQR)	10.0 (6.0–14.0)	17.5 (10.8–25.3)	13.5 (9.3–15.8)	< 0.001
Median ICU admissions (IQR)	357 (157–694)	1565 (614–2165)	903 (446–1786)	< 0.001

ICU = intensive care unit. IQR = interquartile range. * College of Intensive Care Medicine grading.

RRT funding type

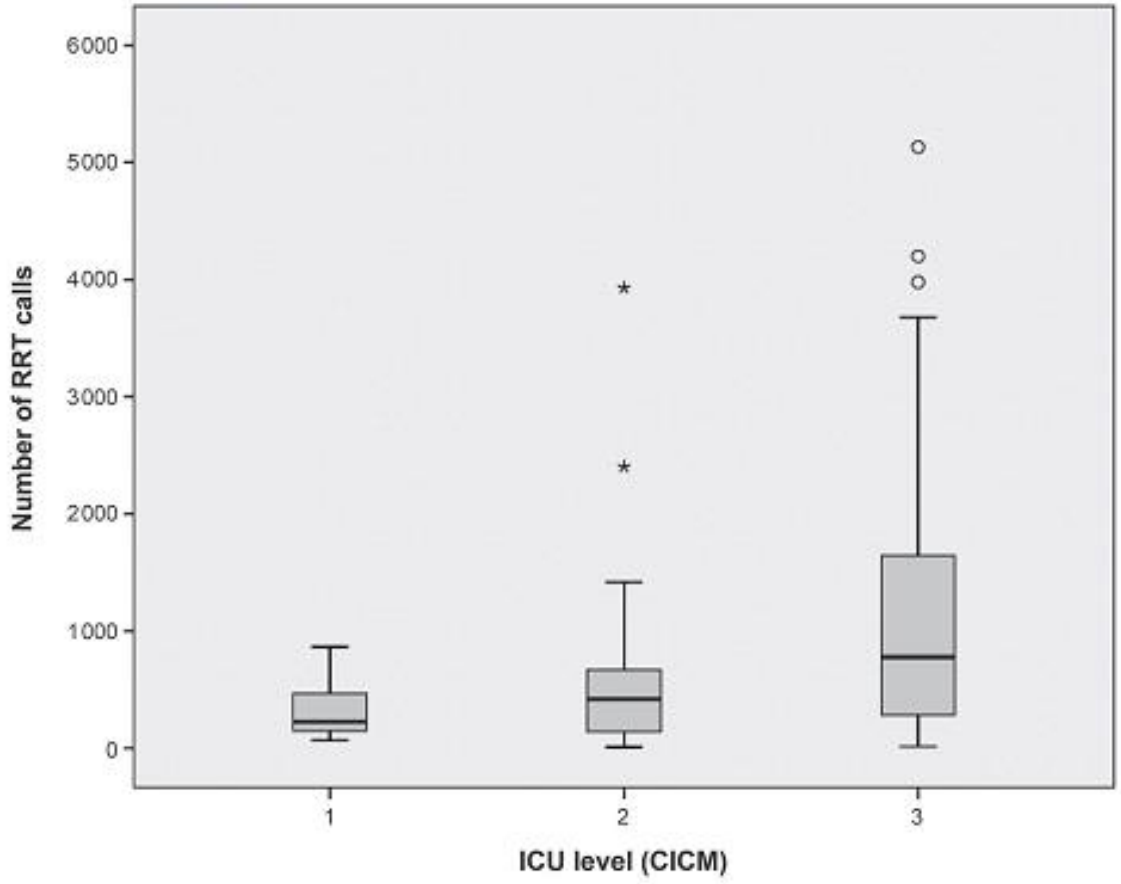
- Not funded - 103/146 hospitals (70.6%)
- Partially funded - 20/146 hospitals (13.7%)
- Fully funded - 23/146 hospitals (15.7%)

Funding levels were greater for higher levels of ICU and ICUs with higher bed numbers, and were lowest in rural/regional and private hospitals.

Although New Zealand hospitals were less likely to have an RRT, their RRT services were more likely to be funded.

Crit Care Resusc 2016; 18: 275-282

Figure 1. Box and whisker plot showing number of annual RRT calls, by ICU level



RRT = rapid response team. ICU = intensive care unit. CICM = College of Intensive Care Medicine.

Table 3. Differences in hospital characteristics, by presence of dedicated outreach specialist

Hospital characteristic	No dedicated specialist	Dedicated specialist	*P*
ICU level,* *n* (%)		(9.7%)	0.269
1 (*n* = 14)	13 (92.9)	1 (7.1)	
2 (*n* = 59)	54 (94.7)	3 (5.3)	
3 (*n* = 73)	64 (86.5)	10 (13.5)	
Classification, *n* (%)			
Metropolitan (*n* = 25)	24 (96.0)	1 (4.0)	
Rural/regional (*n* = 34)	31 (91.2)	3 (8.8)	0.012
Tertiary (*n* = 41)	32 (78.0)	9 (22.0)	
Private (*n* = 45)	44 (97.8)	1 (2.2)	
Jurisdiction, *n* (%)			0.259
Australia (*n* = 134)	120 (78.7)	14 (10.3)	
New Zealand (*n* = 11)	11 (45.5)	0 (9.1)	
Median hospital beds (IQR)	252 (160–414)	400 (216–548)	0.083
Median available ICU beds (IQR)	11.0 (7.3–15.0)	19.0 (5.8–21.2)	0.11
Median ICU admissions (IQR)	876 (543–1349)	1341 (687–1944)	< 0.001
RRT call:ICU admission ratio	0.52 (0.23–1.02)	0.87 (0.60–1.71)	0.089

ICU = intensive care unit. IQR = interquartile range. RRT = rapid response team. * College of Intensive Care Medicine grading.

Crit Care Resusc 2016; 18: 275-282

Table 4. Differences in hospital characteristics, by ICU management of RRT

Hospital characteristic	Not managed by ICU	Managed by ICU	*P*
ICU level,* *n* (%)		83%	0.045
1 (*n* = 15)	2 (13.3)	13 (86.7)	
2 (*n* = 59)	5 (8.5)	54 (91.5)	
3 (*n* = 73)	18 (24.7)	55 (75.3)	
Classification, *n* (%)			0.001
Metropolitan (*n* = 26)	2 (7.7)	24 (92.3)	
Rural/regional (*n* = 36)	4 (11.1)	32 (88.9)	
Tertiary (*n* = 40)	15 (37.5)	25 (62.5)	
Private (*n* = 45)	4 (8.9)	41 (91.1)	
Jurisdiction, *n* (%)			0.346
Australia (*n* = 136)	22 (16.2)	114 (83.6)	
New Zealand (*n* = 11)	3 (27.3)	8 (72.7)	
Median hospital beds (IQR)	362 (170–607)	250 (160–390)	0.08
Median available ICU beds (IQR)	13.0 (8.5–19.0)	11.0 (6.0–15.0)	0.112
Median ICU admissions (IQR)	1039 (596–1708)	831 (543–1360)	0.286
RRT call:ICU admission ratio	0.51 (0.26–0.83)	0.57 (0.24–1.03)	0.17

ICU = intensive care unit. RRT = rapid response team.
IQR = interquartile range. * College of Intensive Care Medicine grading.

RRT oversight

- ICU provided oversight of the RRT in 122/147 instances (83%).
- ICU staff were more likely to provide oversight of the RRT in level 1 and level 2 ICUs than in level 3 ICUs, and less likely to provide such oversight in tertiary ICUs.

Crit Care Resusc 2016; 18: 275-282

- RRTs in Australia and New Zealand for the 2013–14 financial year and obtained a 79.7% response rate.
- Although the ICU provided oversight of the RRT in 80% of cases, and con
ser
- In a ted in the RRT and ICU nurses functioned without ICU medical input primarily in rural/regional areas. Only about 10% of ICUs had dedicated medical staff for this service.

Need to improve the resources allocated to such rapid response services and for training of ICU registrars who participate in an RRT.

Crit Care Resusc 2016; 18: 275-282

Afferent Limb

- Activators can be everyone in hospital

- Calling
- EMR screening

- Single parameter trigger
- Aggregated risk score based trigger
  - NEWS, MEWS, e-CART, SiEWS, AI based

Triggering system

- An EWS would have high specificity and sensitivity, ensuring correct identification of ‘at risk’ patients whilst avoiding excessive workload, ‘alarm fatigue’ and staff desensitization – issues that can compromise quality of care and patient safety.

Sensitivity and specificity of commonly utilized RRS activation criteria are too low

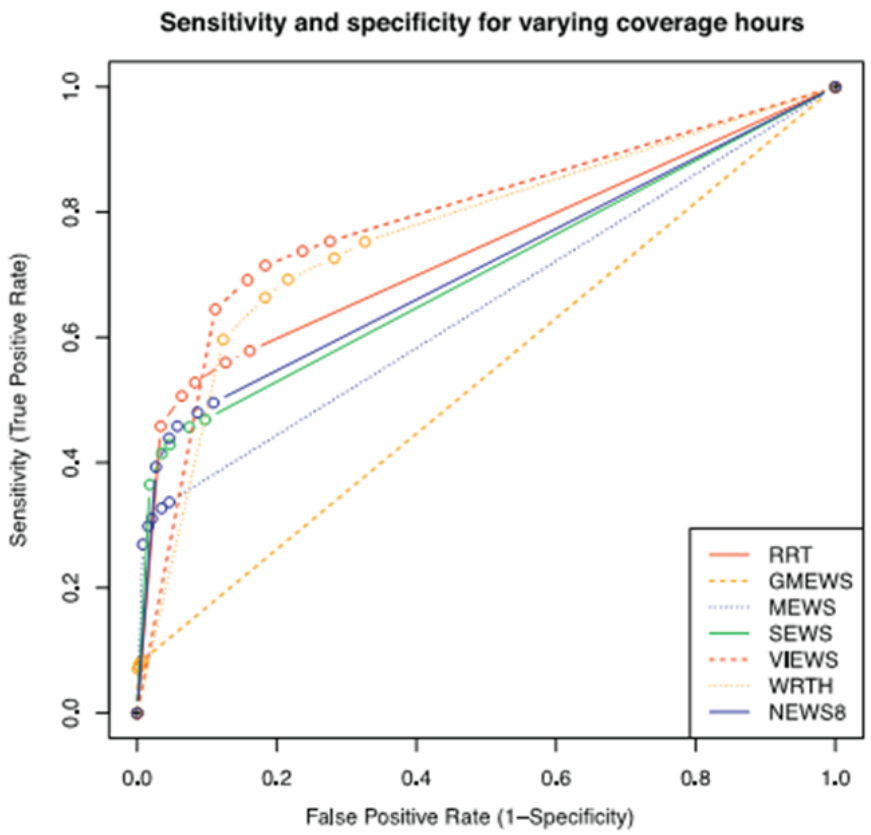


Fig. 1. RRT0: study institution's Rapid Response Team calling criteria. WRTH, Worthing.

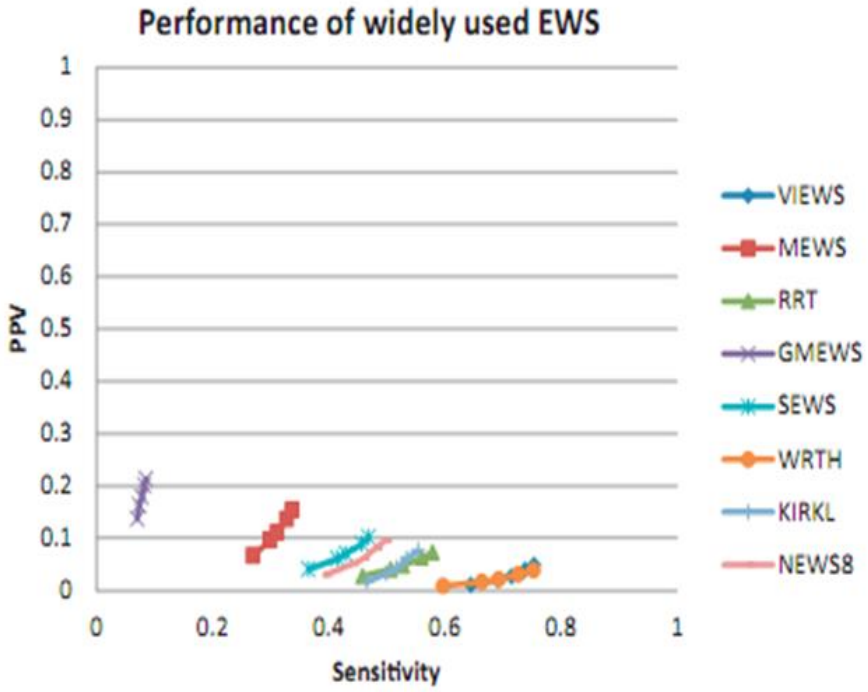


Fig. 2. RRT: study institution's Rapid Response Team calling criteria. PPV, positive predictive value.

Kim WY et al. PLos One 2015;10(6):e0130523

RESEARCH ARTICLE

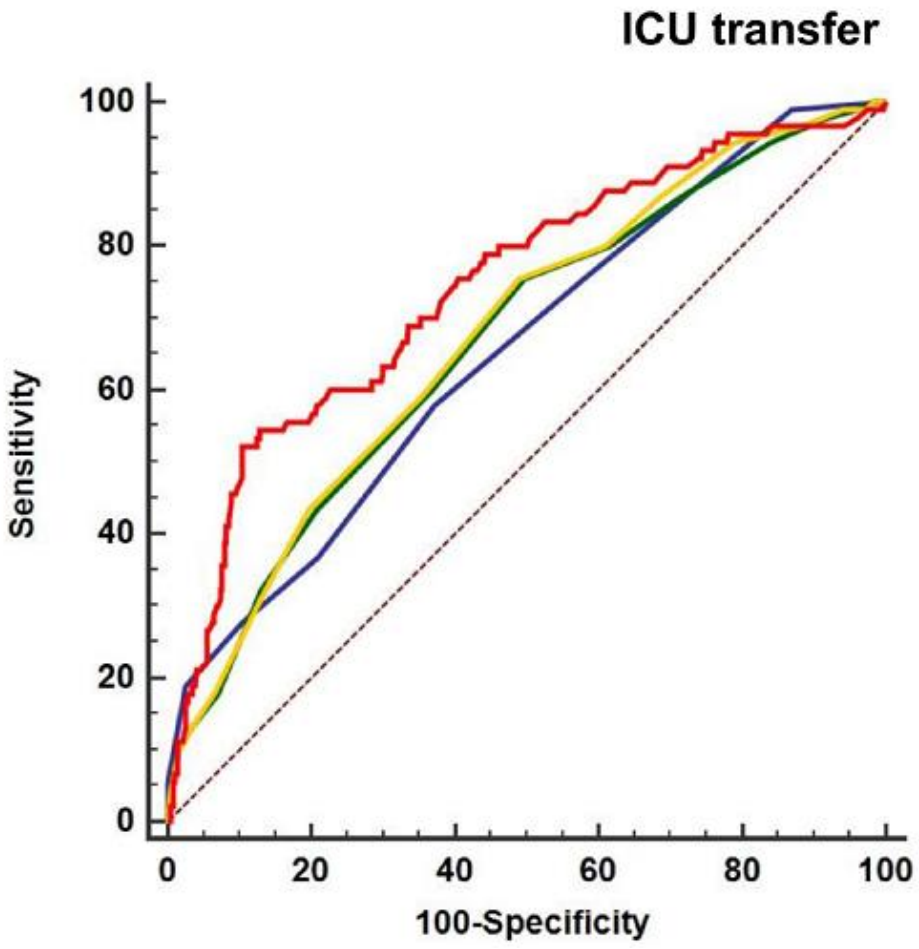
Evaluation of the SpO_2/FiO_2 ratio as a predictor of intensive care unit transfers in respiratory ward patients for whom the rapid response system has been activated

Won Gun Kwack[1,2], Dong Seon Lee[3], Hyunju Min[3], Yun Young Choi[3], Miae Yun[3], Youlim Kim[1,2], Sang Hoon Lee[1,2], Inae Song[4], Jong Sun Park[1,2], Young-Jae Cho[1,2], You Hwan Jo[5], Ho Il Yoon[1,2], Jae Ho Lee[1,2], Choon-Taek Lee[1,2], Yeon Joo Lee[1,2]*

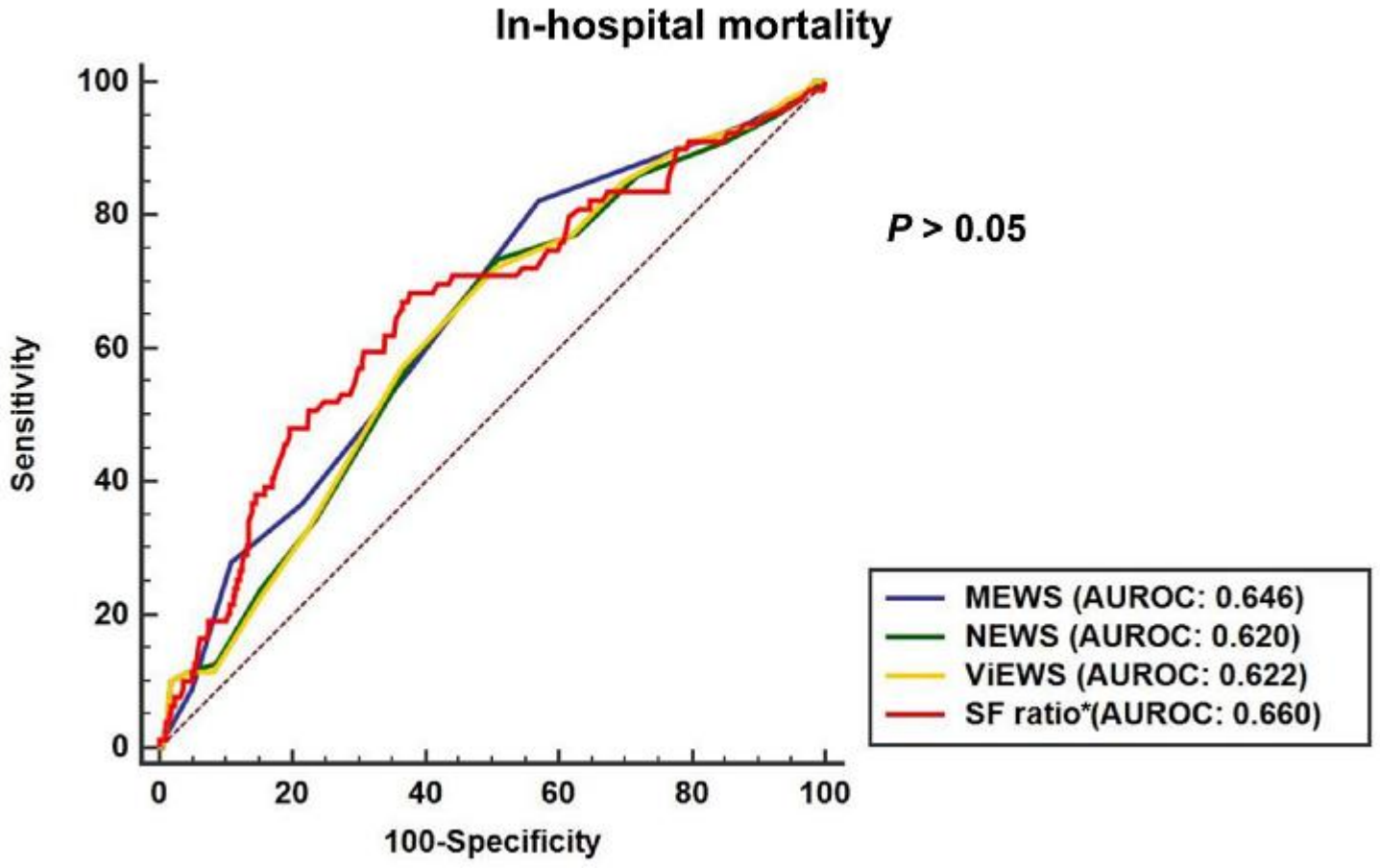
Table 4. Predictive values for intensive care unit transfers.

Variables	Sensitivity	Specificity	PPV	NPV	PLR	NLR
SF ratio* ≤ 170†	52.2 (41.4–62.9)	89.6 (86.0–82.5)	55.3 (44.1–66.1)	88.4 (84.7–91.5)	5.0 (3.5–7.2)	0.53 (0.3–0.7)
SF ratio ≤ 200	54.4 (43.6–65.0)	83.8 (79.1–87.0)	46.7 (36.9–56.7)	88.3 (84.5–91.5)	3.38 (2.5–4.6)	0.54 (0.4–0.7)
SF ratio ≤ 250	65.6 (54.8–75.3)	67.7 (62.7–72.5)	33.3 (26.4–40.8)	88.9 (84.6–92.3)	2.03 (1.6–2.5)	0.51 (0.4–0.7)
SF ratio ≤ 300	78.8 (69.0–86.8)	53.8 (48.6–59.0)	29.8 (24.1–36.1)	91.3 (86.7–94.7)	1.71 (1.5–2.0)	0.39(0.3–0.6)

PLoS ONE 13(7): e0201632



***P* < 0.05**
- SF ratio* vs. MEWS
- SF ratio vs. NEWS



***P* > 0.05**

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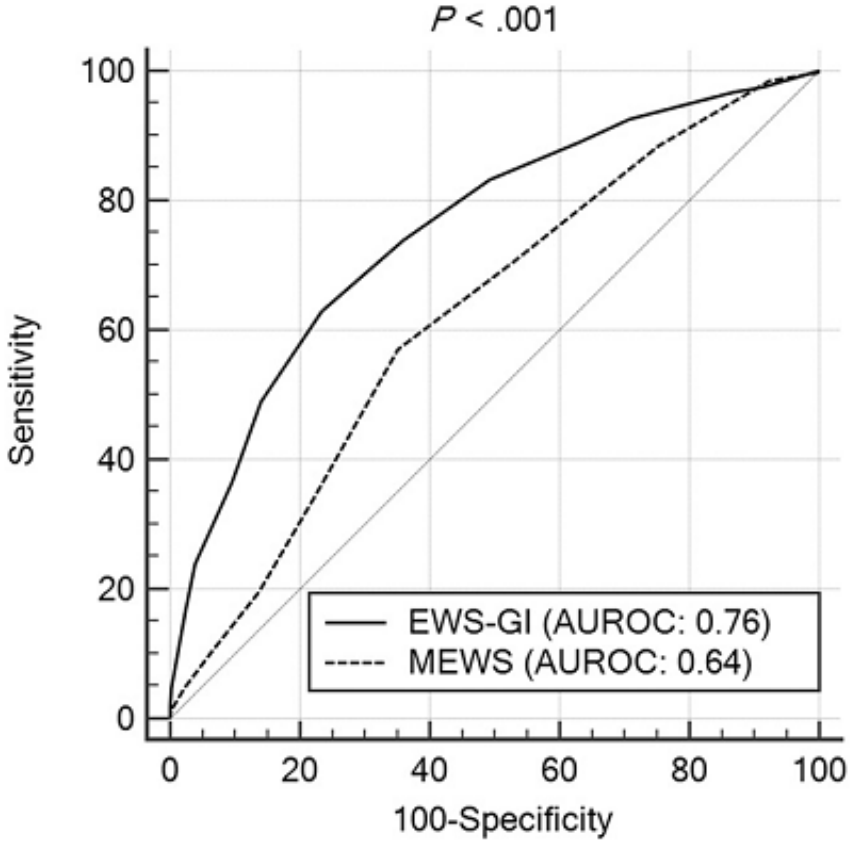
Outcomes/Predictions

Table 2
Factors included in the EWS-GI.

	Multivariate analysis for prediction of ICU transfer		EWS-GI calculation[a]
	Adjusted OR (95% CI)	*P*	Simplified weight
Heart rate ≥ 105 bpm	1.42 (1.03–1.94)	0.03	1
Respiratory rate ≥ 26 bpm	1.54 (1.12–2.13)	0.008	2
ACDU score ≥ 1	2.42 (1.77–3.30)	<0.001	2
SpO_2/FiO_2 ratio < 240	2.12 (1.54–2.92)	<0.001	2
Creatinine ≥2.0 mg/dL	1.94 (1.37–2.76)	<0.001	2
Total bilirubin ≥9.0 mg/dL	1.57 (1.11–2.22)	0.01	2
Prothrombin time ≥ 1.5 (INR)	1.91 (1.37–2.66)	<0.001	2
Lactate ≥3.0 mmol/L	1.98 (1.45–2.70)	<0.001	2



Journal of Critical Care 40 (2017) 213–217

Contents lists available at ScienceDirect

Resuscitation

journal homepage: www.elsevier.com/locate/resuscitation

Rapid response systems

Aggregate National Early Warning Score (NEWS) values are more important than high scores for a single vital signs parameter for discriminating the risk of adverse outcomes☆

Stuart Jarvis[a,b], Caroline Kovacs[a], Jim Briggs[a], Paul Meredith[c], Paul E. Schmidt[c], Peter I. Featherstone[c], David R. Prytherch[a,c], Gary B. Smith[d,*]

[a] Centre for Healthcare Modelling and Informatics, University of Portsmouth, Portsmouth, UK
[b] Department of Health Sciences, University of York, York, UK
[c] Portsmouth Hospitals NHS Trust, Portsmouth, UK
[d] School of Health & Social Care, University of Bournemouth, Bournemouth, UK

Portsmouth Hospitals NHS Trust (PHT) Computerized hospital records of all discharged adult patients
April 2010 ~ May 2011

Data acquisition

Resuscitation 87 (2015) 75–80

National Early Warning Score (NEWS)*

PHYSIOLOGICAL PARAMETERS	3	2	1	0	1	2	3
Respiration Rate	≤8		9 - 11	12 - 20		21 - 24	≥25
Oxygen Saturations	≤91	92 - 93	94 - 95	≥96			
Any Supplemental Oxygen		Yes		No			
Temperature	≤35.0		35.1 - 36.0	36.1 - 38.0	38.1 - 39.0	≥39.1	
Systolic BP	≤90	91 - 100	101 - 110	111 - 219			≥220
Heart Rate	≤40		41 - 50	51 - 90	91 - 110	111 - 130	≥131
Level of Consciousness				A			V, P, or U

*The NEWS initiative flowed from the Royal College of Physicians' NEWS Development and Implementation Group (NEWSDIG) report, and was jointly developed and funded in collaboration with the Royal College of Physicians, Royal College of Nursing, National Outreach Forum and NHS Training for Innovation

Chart 4: Clinical response to the NEWS trigger thresholds

NEW score	Frequency of monitoring	Clinical response
0	Minimum 12 hourly	• Continue routine NEWS monitoring
Total 1–4	Minimum 4–6 hourly	• Inform registered nurse, who must assess the patient • Registered nurse decides whether increased frequency of monitoring and/or escalation of care is required
3 in single parameter	Minimum 1 hourly	• Registered nurse to inform medical team caring for the patient, who will review and decide whether escalation of care is necessary
Total 5 or more Urgent response threshold	Minimum 1 hourly	• Registered nurse to immediately inform the medical team caring for the patient • Registered nurse to request urgent assessment by a clinician or team with core competencies in the care of acutely ill patients • Provide clinical care in an environment with monitoring facilities
Total 7 or more Emergency response threshold	Continuous monitoring of vital signs	• Registered nurse to immediately inform the medical team caring for the patient – this should be at least at specialist registrar level • Emergency assessment by a team with critical care competencies, including practitioner(s) with advanced airway management skills • Consider transfer of care to a level 2 or 3 clinical care facility, ie higher-dependency unit or ICU • Clinical care in an environment with monitoring facilities

For NEWS, the RCPL recommends escalation of care to a doctor at NEWS values of 5 or greater, and also when 3 points are awarded for any single vital sign.

Chart 4: Clinical response to the NEWS trigger thresholds

NEW score	Frequency of monitoring	Clinical response
0	Minimum 12 hourly	• Continue routine NEWS monitoring
Total 1–4	Minimum 4–6 hourly	• Inform registered nurse, who must assess the patient • Registered nurse decides whether increased frequency of monitoring and/or escalation of care is required
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Total 5 or more Urgent response threshold	Minimum 1 hourly	• Registered nurse to immediately inform the medical team caring for the patient • Registered nurse to request urgent assessment by a clinician or team with core competencies in the care of acutely ill patients • Provide clinical care in an environment with monitoring facilities
Total 7 or more Emergency response threshold	Continuous monitoring of vital signs	• Reg me sho • Em car wit • Cor clin or 1 • Clir mo

Aggregate NEWS value of 3 with a component score of 3 is treated the same as an aggregate NEWS value of 5.

However, our data reveal that, for all outcomes, the latter indicates significantly higher risk – typically around four times the risk.

	Odds ratio, compared to NEWS = 5 (95% CI)		
	Death	Cardiac arrest	Unantic
Triggering combinations of NEWS			
5	1.00 (0.72–1.29)*,**	1.00 (0.59–1.44)**	1.00 (0.
4 (includes a component = 3)	0.53 (0.25–0.85)	0.66 (0.17–1.26)	0.46 (0.
3 (includes a component = 3)	0.26 (0.12–0.42)	0.24 (0.00–0.55)	0.23 (0.
Non-triggering combinations of NEWS			
4 (no component = 3)	0.38 (0.22–0.56)*	0.43 (0.14–0.74)	0.45 (0.
3 (no component = 3)	0.20 (0.12–0.28)	0.21 (0.07–0.36)	0.22 (0.

Chart 4: Clinical response to the NEWS trigger thresholds

NEW score	Frequency of monitoring	Clinical response
0	Minimum 12 hourly	• Continue routine NEWS monitoring
Total 1–4	Minimum 4–6 hourly	• Inform registered nurse, who must assess the patient • Registered nurse decides whether increased frequency of monitoring and/or escalation of care is required
3 in single parameter	Minimum 1 hourly	• Registered nurse to inform medical team caring for the patient, who will review and decide whether escalation of care is necessary
Total 5 or more Urgent response threshold	Minimum 1 hourly	• Registered nurse to immediately inform the medical team caring for the patient • Registered nurse by a clinician or in the care of ac • Provide clinical c monitoring facili
Total 7 or more Emergency response threshold	Continuous monitoring of vital signs	• Registered nurse medical team co should be at lea • Emergency asse care competenc with advanced c • Consider transfe clinical care facil or ICU • Clinical care in a monitoring facilities

An aggregate NEWS value of 4 with no component scoring 3 (which would not trigger escalation) also indicates higher risk than an aggregate NEWS value of 3 with a component scoring 3 (which would trigger escalation) for all outcomes, although the differences are not significant. These findings imply that the RCPL guidance should be reviewed.

	Odds ratio, compared to NEWS = 5 (95% CI)	
	Death	Cardiac arrest
Triggering combinations of NEWS		
5	1.00 (0.72–1.29)*,**	1.00 (0.59–1.44)**
4 (includes a component = 3)	0.53 (0.25–0.85)	0.66 (0.17–1.26)
3 (includes a component = 3)	0.26 (0.12–0.42)	0.24 (0.00–0.55)
Non-triggering combinations of NEWS		
4 (no component = 3)	0.38 (0.22–0.56)*	0.43 (0.14–0.74)
3 (no component = 3)	0.20 (0.12–0.28)	0.21 (0.07–0.36)

* A significantly ($p < 0.05$) higher risk than the value immediately below.
** A significantly higher risk than the value two places below.

Triggering criteria	Number of escalations/day	Number of detected deaths/day	Number of detected cardiac arrests/day	Number of detected unanticipated ICU admissions/day	Number of detected adverse outcomes/day
Trigger only on aggregate NEWS ≥ 5	220	2.24 (94.6%)	0.35 (87.3%)	0.78 (92.2%)	2.99 (93.6%)
Trigger on aggregate NEWS ≥ 5 and any single component score of 3	307	2.30 (96.9%)	0.37 (92.4%)	0.80 (95.1%)	3.08 (96.3%)

40%

detection of 3.0% more

Aggregate National Early Warning Score (NEWS) values are more important than high scores for a single vital signs parameter for discriminating the risk of adverse outcomes.

Using t (with differing numbers of observations per episode — a more realistic situation)

workload would increase by 40% from 220 to 307 escalations per day with only a small increase in detected adverse outcomes from 2.99 (93.6% of adverse outcomes) to 3.08 (96.3%).

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journal homepage: www.elsevier.com/locate/resuscitation

Clinical pap

Successf rapid response team in an adu

Cynthia Ge udyka, Moeen K. Panni*

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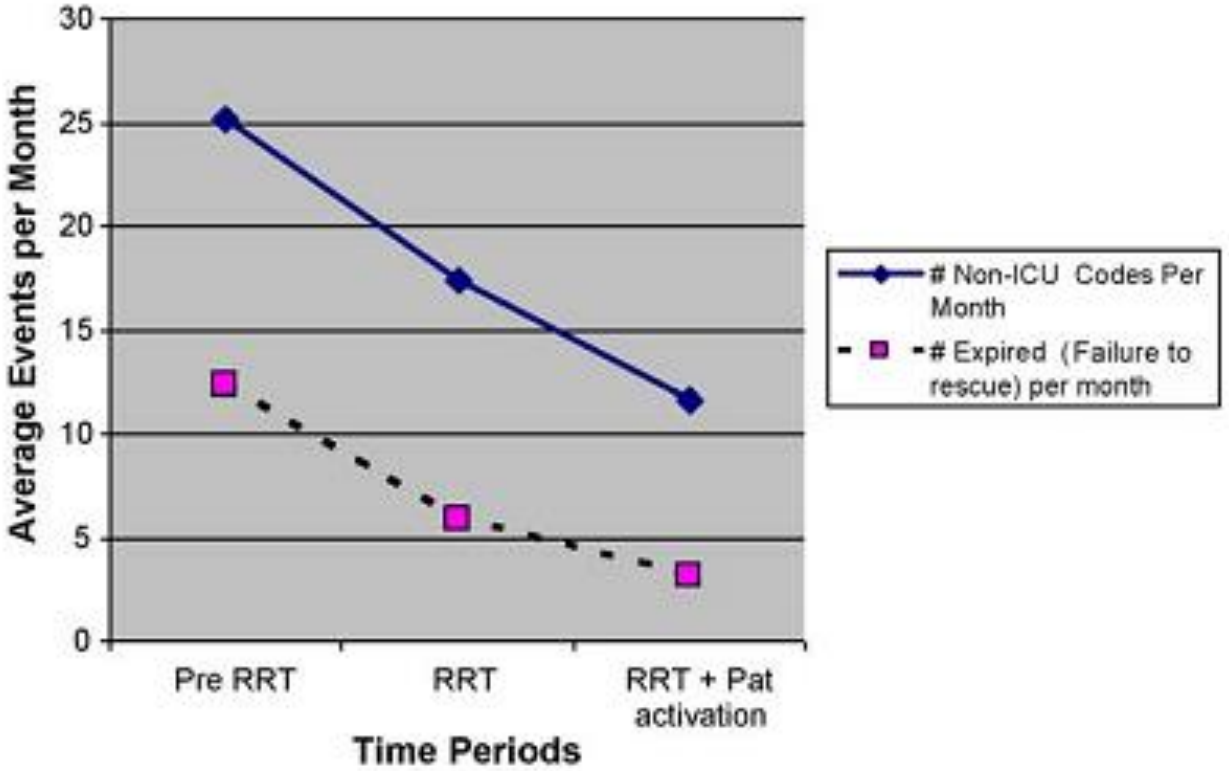
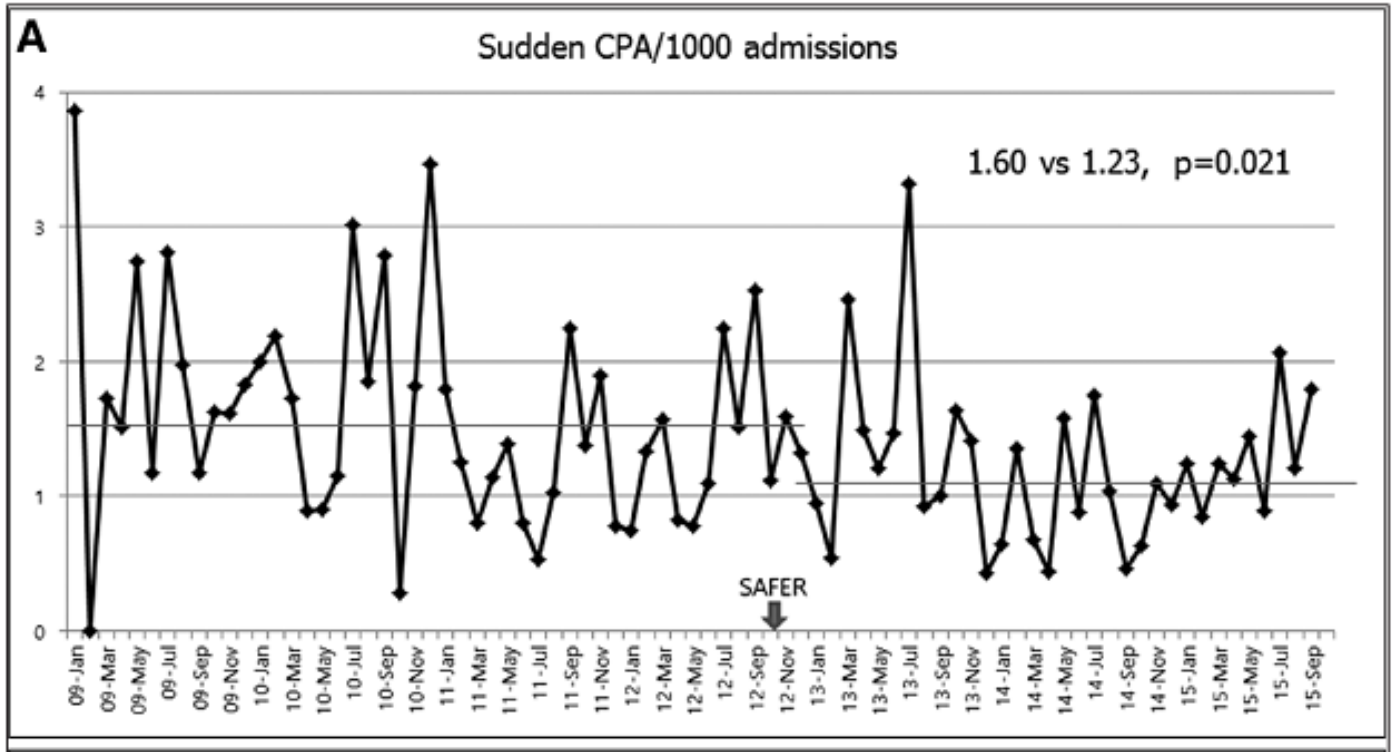
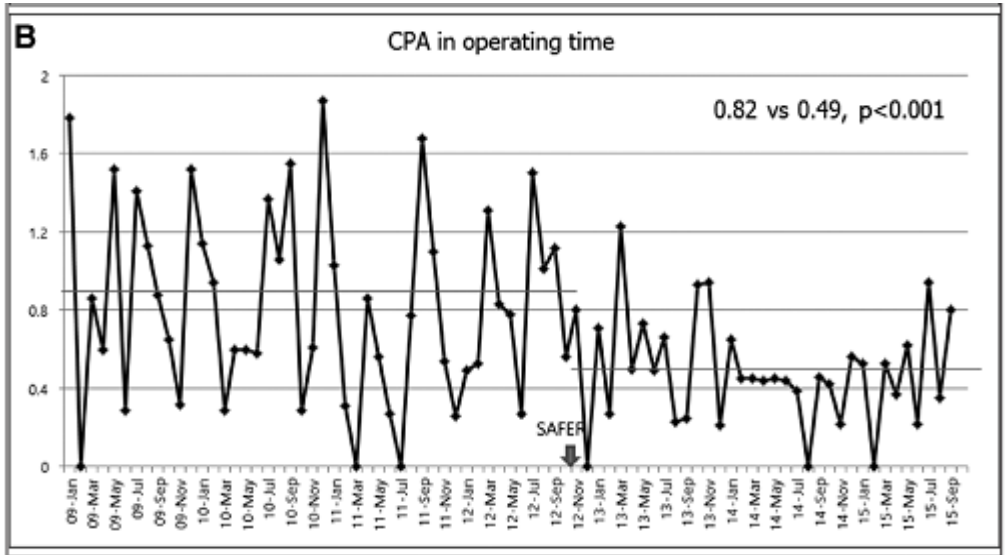


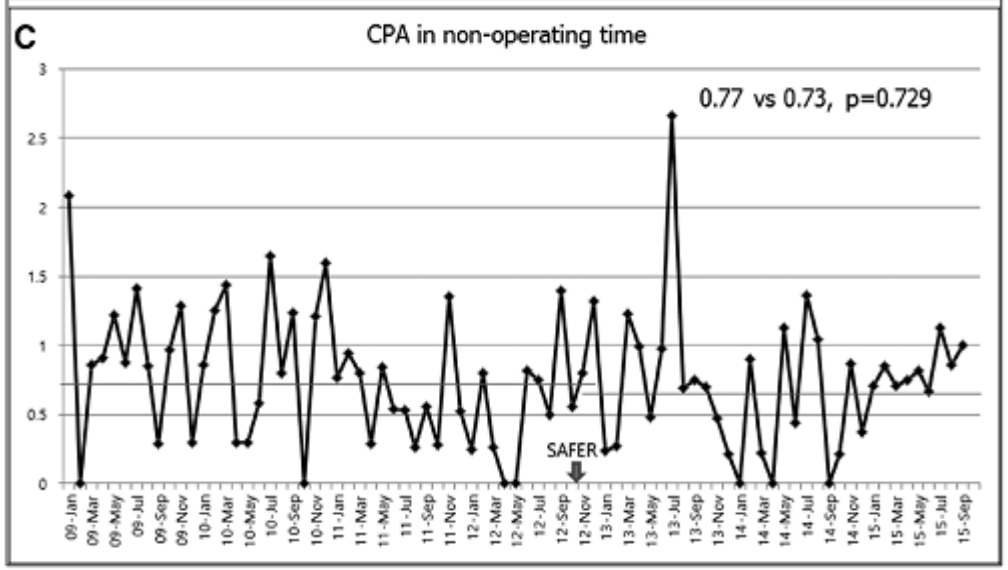
Fig. 1. Photograph showing six members of the RRT team and Cynthia Gerdik (front row – second from left), Director of Critical-Care Nursing, who spearheaded the entire program.

Effectiveness Analysis of a Part-Time Rapid Response System During Operation Versus Nonoperation

Youlim Kim, MD[1–3]; Dong Seon Lee, RN[2]; Hyunju Min, RN[2]; Yun Young Choi, RN[2]; Eun Y
Inae Song, MD, PhD[2,4]; Jong Sun Park, MD, PhD[1–3]; Young-Jae Cho, MD[1–3]; You Hwan Jo,
Ho Il Yoon, MD, PhD[1,3]; Jae Ho Lee, MD, PhD[1,3]; Choon-Taek Lee, MD, PhD[1,3];
Sang Hwan Do, MD, PhD[2,4]; Yeon Joo Lee, MD[1–3]







Crit Care Med 2017; 45:e592–e599

Summary -1

- Considerable heterogeneity among RRTs
  - Team members
  - ICU-based rapid response team
  - Patient's usual care providers
  - Senior resident led team
  - Various EWS, different threshold single criteria
  - Part time RRS, full time RRS

Summary -2

- While there has been broad adoption of the RRT model, there is no clear guideline-based ‘best practices’ statement regarding team composition, dynamics or activation criteria, which may contribute to the variability in the effectiveness reported by single-center studies of RRTs.

신속대응 시스템 시범사업 수가

분류	운영시간	수가 (입원환자 1인, 1일)	전담인력		장비
			의사	간호사	
1군	365일 24시간	1,260원	전담 1명	전담 9명	4종
2군	주5일 16시간이상	610원	-	전담 5명	4종
3군	주5일 8시간이상	310원	-	전담 2명	2종

전담전문의 – 1군

- 전담전문의는 중환자의학 세부전문의로서 1일 주간(day time) 8시간 이상, 1주간(week) 5일 이상 신속대응팀에 배치 되어야 하며, 한 달 이상 연속하여 근무하여야 함
- 대체인력은 전담인력과 동일한 자격을 가진 자로, 전담인력의 근무조건을 준수하되, 대체전문의는 중환자의학 세부전문의 수련과정에 있는 전문의를 포함
- 대체는 내과, 마취통증의학과, 신경과, 신경외과, 외과, 흉부외과, 응급의학과 전문의 중에 가능

담당전문의- 2군, 3군

- 신속대응팀 업무를 지원하는 담당전문의는 내과, 신경과, 외과, 신경외과, 흉부외과, 마취통증의학과, 응급의학과 전문의로 구성하여야 함

- 담당전문의는 신속대응팀에 상주하지 않으나, 신속대응팀 의료진 호출시 업무 지원이 가능하여야 함

- 근무표

Thank you for your attention !