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Clinical practices in the escalation of care for the deteriorating patient: a multicentre study

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Abstract

Background: Rapid response systems (RRSs) have been introduced to assist in the effective management of deteriorating patients. Optimal system performance requires adequate staffing levels and compliance with the escalation protocol. Delay and failures in activation of the rapid response team (RRT) are directly correlated to adverse outcomes. The current study analyses clinical practice and adherence to the RRS protocol in the Netherlands in correlation with demographic data from the hospitals.

Methods: A multicentre cross-sectional survey using a vignette-based questionnaire was employed. Healthcare providers on the included medical and surgical wards participated. A descriptive analysis was performed on the data from the questionnaires and correlated to RRT activations and nurse-to-patient ratios.

Results: The response rate was 31% (n=654). During the day shift, a ratio of 5-8:1 (patient-to-nurse) was reported in 52-60% of the hospitals. During evening shifts, 20-34% reported ratios of more than 8:1, and overnight, at least 84% reported even higher ratios. More than 50% of nurses perceived their workload to be 'fairly heavy'. In contrast, 55-66% of the registrars perceived their workload to be 'fairly heavy' whereas consultants deemed work to be balanced. Upon detection of a deteriorating patient, nurses called the doctor in 88-90% of cases. The RTT was activated in 90% of cases.

Conclusion: Compliance with RRS processes is reported to be high. Nurses reported significant workloads and high patient-to-nurse ratios. These ratios are likely to affect the ability to escalate care and provide optimal management for the deteriorating patient.

Introduction

In analogy with trauma care and the 'golden hour' concept, early and effective management of the deteriorating patient on the nursing ward is likely to reduce patient morbidity and mortality.[1] The most recent systematic review has shown positive outcomes after introduction of a rapid response system (RRS).[2] Two randomised trials, however, were unable to provide conclusive evidence regarding effectiveness of a rapid response team (RRT).[3,4] A Dutch national multicentre before-after RRT implementation study observed significant reduction in cardiopulmonary arrest rates and a trend towards reduced in-hospital mortality.[5]

Implementing an RRS can be considered a 'complex intervention', which is challenging to study because of numerous confounders.[6] The number of RRT calls has been used as a proxy for system performance. In analogy with pharmacology, 'RRT dose' is related to outcome, and delayed activation of the RRT is directly correlated to increased mortality.[7]

Multiple factors/confounders have been implicated in delays occurring within the system. This includes failure to appreciate clinical urgency, failure to recognise early signs of deterioration and adequacy of escalation of care and management of the patient.[8,9] Nurses are considered an integral link within the system, as they are at the forefront of care and the first to recognise patient deterioration. Evidence indicates that a high patient-to-nurse ratio is associated with poor outcome and is likely related to nurses' ability to recognise and act on deterioration in a timely manner.[10,11]

The goal of the present cross-sectional study was to gain insight into potential areas for improvement of the so-called 'afferent arm' (deterioration detection and activation) of the RRT. All hospitals in the Netherlands operate an RRS since mandatory implementation in 2008. Using a vignette-based survey tool we focused on themes including willingness to escalate, compliance with RRS escalation protocols, nurse staffing, perceived workload and general satisfaction with the RRS.

Methods

Study design

We designed a vignette-based questionnaire based on a fictitious deteriorating patient to analyse current practices regarding escalation of care. A total of nine hospitals in the Netherlands participated in this study: two university and seven large teaching hospitals. All hospitals had a mature, i.e. well-established, RRS in place. Per hospital, two medical and two surgical nursing wards were included.

Participants

Each hospital assigned a coordinator to facilitate data extraction, survey distribution and completion of surveys. Respondents were nurses and physicians (registrars and consultants were studied separately) aged 18 and above. All the healthcare providers who had worked on the ward in the previous six months were invited to participate. In order to maximise the number of participants, a link to the survey was sent in a personal email. In case of erroneous inclusion, participants were able to exclude themselves and were subsequently removed from the database.

Definitions, data collection and survey content

The RRS was implemented in the nine Dutch hospitals as described previously. In short, recognition of deterioration was based on the Modified Early Warning System (MEWS) using a score exceeding a threshold value of 3 as evidence of possible deterioration. Upon reaching a positive/critical MEWS of 3, the nurse is expected to escalate to the in-charge registrar or consultant of the parent team. Within a maximum timeframe of 1.5 hours, the parent team is expected to have seen and managed the patient. In case of refractory deterioration, the RRT should be activated. Within the context of the management of the parent team, consultation of the consultant (if the registrar is first responder), a referral to other specialties or direct RRT activation are all deemed appropriate interventions.

The questionnaire started with the basic demographics of the respondent. The vignette was subsequently introduced and with the enfolding deterioration, details regarding escalation and management of the patient and overall compliance with the protocol were explored. As three different categories of respondents were present, slight modifications of the questionnaires were developed, tailored to each respective caregiver group. Patient ratios focused on the responsibility for the number of patients per healthcare provider. Differentiation per type of shift was performed for a more comprehensive insight into staffing 24/7.

For 2016, data on monthly RRT activation rates (RRT calls per 1000 admissions) were collected at the ward level. Admissions with one or more overnight stays were included. With the time stamp of the RRT call, out of hours (between 18:00 and 08:00 and during weekends) activations could be calculated.

Data analysis and statistics

Normally distributed continuous variables are expressed as means with standard deviations and not normally distributed variables as medians and interquartile ranges. Categorical variables are expressed as numbers and percentages. To test two or more independent groups of not normally distributed continuous variables, the Mann-Whitney U and Kruskal-Wallis test, respectively, were used. For comparison of categorical variables, the $\chi 2$ test or Fisher/McNemar testing was employed where appropriate. For all comparisons, a sta¬tistical significance was defined at $p<0.05$. All data were entered into a Microsoft Access database and the analyses were performed using SPSS version 25.0 (Chicago, Illinois, USA).

Ethics

This study conforms to the 1975 Declaration of Helsinki (revised in 2008). The medical ethics committee of the University of Amsterdam approved the study and a provided a waiver. Formal written consent was not deemed necessary and responding to the survey was deemed sufficient.

Results

Respondent characteristics

In total, 2278 respondents were approached for this study. Of these, 146 respondents indicated that they had not been active on the nursing ward and were subsequently excluded, leaving 2132 eligible respondents. The response rate was 30.7% (n=654). Response rate for nurses was 30%, for registrars 26% and 33% for the consultants. Response rates varied by hospital and respondent group. In the nurse and registrar groups, most respondents were female (nurses: >90% female; registrars: >60% female). Consultants were 40% female in the surgical and 56% in the medical groups, respectively *(table 1).*

Table 1. Demographics of respondents
P values: *< 0.05; **<0.001; #<0.05; ## <0.0001
Education: low = pre-vocational (VMBO)/practical; high = higher nursing school/university/PhD

		Nurse		Registrar		Consultant	
		Surgical	Medical	Surgical	Medical	Surgical	Medical
Gender, female n(%)		173 (90) *	149 (90) *	27 (61)	63 (64)	36 (40)	36 (56)
Age in years, n(%)	**20 - 29**	70 (37)	75 (46)	26 (59)	51 (52)	16 (18)	3 (5)
	30 - 49	82 (43)	67 (41)	18 (41)	47 (48)	52 (58)	42 (66)
	>50	40 (21)	23 (14)	0	1 (1)	22 (24)	19 (30)
Work experience in years	**0 - 10**	104 (54)	102 (62)				
	11 - 20	42 (22)	30 (18)				
	>21	46 (24)	33 (20)				
	<1			9 (21)	19 (19)		
	1 - 5			30 (68)	70 (71)		
	6 - 10			5 (11) *	10 (10) *		
	0 - 5					31 (34)	21 (33)
	6 - 10					20 (22)	11 (17)
	>11					39 (43)	32 (50)
Nurse education	**Low**	37 (20)	35 (21)				
	High	114 (59)	95 (58)				
	Other	41 (21) *	35 (21) **				

Table 2. Patient-to-nurse ratios on surgical and medical nursing wards
Data are shown as percentages from the median and the interquartile range. A working day was defined as a day between Monday and Friday

Number of patients per nurse			1 - 4	5 - 8	>8
Day shift	**Working day**	**Surgical**	27 (5 - 71)	67 (29 - 93)	0 (0 - 6)
		Medical	42 (23 - 91)	58 (9 - 77)	0 (0 - 0)
	Weekend	**Surgical**	28 (4 - 73)	72 (41 - 86)	4 (0 - 6)
		Medical	23 (0 - 70)	64 (30 - 75)	0 (0 - 21)
Evening shift	**Working day**	**Surgical**	0 (0 - 6)	83 (29 - 89)	12 (7 - 71)
		Medical	0 (0 - 0)	84 (78 - 92)	14 (0 - 17)
	Weekend	**Surgical**	0 (0 - 6)	82 (29 - 91)	12 (6 - 71)
		Medical	0 (0 - 3)	83 (74 - 92)	17 (0 - 25)
Night shift	**Working day**	**Surgical**	0 (0 - 0)	3 (0 - 17)	96 (80 - 100)
		Medical	0 (0 - 0)	3 (0 - 8)	97 (92 - 100)
	Weekend	**Surgical**	0 (0 - 0)	0 (0 - 27)	94 (71 - 100)
		Medical	0 (0 - 3)	4 (0 - 8)	95 (92 - 100)

Patient ratios and workload

Table 2 shows reported nurse staffing ratios, expressed as the number of patients cared for by one nurse, both during day shifts and weekend shifts. Within the Netherlands, wards consist of 20 to 30 patients. Generally, during day shifts (weekdays and weekends), nurses were responsible for 5-8 patients (55% surgical and 52% medical during weekdays and 60% and 55% during weekend daytime shifts). This increased during evening shifts, when 64-74% (interval represents spread between hospitals) of nurses reported having to manage between 5-8 patients. All differences observed between shifts of nurses were statistically significant ($p<0.0001$) (day versus evening, day versus night and evening versus night).

Differences were present between hospitals regarding nurse staffing between daytime shifts during weekdays and weekends. University hospitals were able to reduce their patient-to-nurse ratio compared with non-academic hospitals. Fifty percent of nurses from these university hospitals reported that they were responsible for 5-8 patients (data not shown). Between 84% and 86% of nurses were expected to manage more than eight patients during night shifts irrespective of the type of ward without significant differences between hospitals (typically two nurses caring for 30 patients at night). The reason why this ratio is lower is not known, i.e., absolute increases in the number of nurses and/or reduction in the absolute number of patients compared with other hospitals.

Most surgical registrars (44%) reported managing 16-20 patients, whereas most medical registrars (55%) managed 11-15 patients during day shifts. During off-hours shifts (both weekend and evening/night shifts) most registrars reported being responsible for over 50 patients (48% of surgical registrars and 40% of medical registrars). For consultants, a similar pattern was observed. During day shifts, 41% of surgical consultants supervised 16-20 patients versus 55% of consultants required to supervise 11-15 patients ($\chi 2$ $p<0.0001$%). During off-hours shifts, most consultants were required to supervise the care of over 75 patients (data not shown).

Table 3 indicates the perceived workload for nurses was heavy, irrespective of shift and specialty (50-55%). Registrars perceived their workload as 'balanced' during day shifts (64% surgical and 81% medical), which increased during off-hours shifts to at least 'fairly heavy' in 66% (surgical) and 55% (medical). Perceived workload was significantly increased among all groups of healthcare providers comparing daytime versus shift work. However, it was only within the group of medical registrars that this difference fell short of significance ($p=0.075$). A similar correlation was found comparing the group of doctors (registrars and consultants) versus nurses. Nurses perceived their workload to be significantly higher than doctors (data not shown).

Ward management and escalation of care

Table 4 analyses the management of a patient during subsequent stages of deterioration. In the Netherlands, a two-tier system is employed in which the ward team is primarily responsible for the clinical management. The first question analysed a patient with a critical MEWS. The majority of nurses (88% surgical and 90% medical) called their registrar/consultant. Of the medical registrars, 87% would contact their supervisor after assessment, whereas 64% of the surgical registrars acted similarly.

Table 3. Perceived workload amongst healthcare providers on surgical and medical wards / Workload and appreciated workload among healthcare workers
Data are shown as the percentages from the median and the interquartile range (IQR)

Perceived workload			Light	Moderately light	Balanced	Fairly heavy	Too heavy
Nurse	**Daytime**	**Surgical**	0 (0 - 0)	0 (0 - 6)	41 (36 - 55)	57 (39 - 59)	0 (0 - 6)
		Medical	0 (0 - 0)	0 (0 - 0)	50 (35 - 62)	50 (36 - 65)	0 (0 - 5)
	Shift	**Surgical**	0 (0 - 0)	0 (0 - 0)	46 (33 - 53)	55 (43 - 61)	0 (0 -6)
		Medical	0 (0 - 0)	0 (0 - 0)	45 (36 - 57)	46 (42 - 54)	4 (0 - 7)
Registrar	**Daytime**	**Surgical**	0 (0 - 0)	0 (0 - 14)	57 (50 - 67)	29 (17 - 33)	0 (0 - 0)
		Medical	0 (0 - 0)	0 (0 - 8)	82 (69 - 87)	9 (0 - 25)	0 (0 - 0)
	Shift	**Surgical**	0 (0 - 0)	0 (0 - 0)	29 (17 - 43)	67 (50 - 83)	0 (0 - 0)
		Medical	0 (0 - 0)	0 (0 - 0)	33 (10 - 55)	47 (35 - 70)	0 (0 - 0)
Consultant	**Daytime**	**Surgical**	0 (0 - 0)	0 (0 - 11)	60 (50 - 70)	25 (13 - 30)	0 (0 - 0)
		Medical	0 (0 - 0)	7 (0 - 17)	67 (50 - 75)	19 (0 - 22)	0 (0 - 0)
	Shift	**Surgical**	0 (0 - 0)	13 (0 - 17)	50 (40 - 50)	40 (0 - 50)	0 (0 - 0)
		Medical	0 (0 - 11)	0 (0 - 17)	60 (50 - 69)	0 (0 - 31)	0 (0 - 0)

Table 4. Ward management of deteriorating patients
Statistical analyses represent differences between the respective surgical and medical group. *p=0.007; **p=0.009; ***p=0.004; ****p=0.009
MEWS = Modified Early Warning System; RRT = rapid response team

		Nurse		Registrar		Consultant	
		Surgical	Medical	Surgical	Medical	Surgical	Medical
1. Who do you call with a patient with a critical MEWS?	**Nurse**	12 (6)	6 (4)				
	Registrar	166 (87)	147 (89)	8 (18)	6 (6)	20 (22)	9 (14)
	Consultant	1 (1)	1 (1)	28 (64)	86 (87)	21 (23)	14 (22)
	RRT	0	3 (2)	3 (7)	5 (5)	21 (23)	19 (30)
	Consultation			3 (7)	0	15 (17)	10 (16)
	Other	13 (7)	8 (5)	2 (5)	2 (2) *	13 (14)	12 (19)
2. I feel no threshold to escalate to the higher echelon as described in the above question	**Fully agree**	49 (26)	72 (44)	4 (9)	38 (38)	23 (26)	13 (20)
	Agree	104 (54)	71 (43)	25 (57)	50 (51)	34 (38)	22 (34)
	Neutral	21 (11)	14 (9)	12 (27)	8 (8)	12 (13)	12 (19)
	Disagree	17 (9)	6 (4)	3 (7)	3 (3)	16 (18)	13 (20)
	Fully disagree	1 (1)	2 (1) **	0	0 ***	5 (6)	4 (6)
3. After initial management, the patient doesn't improve immediately, the next person I call is:	**Nurse**	8 (4)	5 (3)	0	0	0	0
	Registrar	152 (79)	126 (76)	0	0	10 (11)	6 (9)
	Consultant	8 (4)	12 (7)	25 (57)	64 (65)	23 (26)	7 (11)
	RRT	24 (13)	22 (13)	10 (23)	30 (30)	37 (41)	28 (44)
	Referral			4 (9)	0	8 (9)	13 (20)
	Other	0	0	5 (11)	5 (5) ****	12 (13)	10 (16)
4. The patient is getting sicker despite adequate treatment. The RRT should be called at this time.	**Fully agree**	96 (50)	92 (56)	25 (57)	47 (48)	51 (57)	36 (56)
	Agree	79 (41)	59 (36)	16 (36)	41 (41)	31 (34)	23 (36)
	Neutral	15 (8)	11 (7)	2 (5)	9 (9)	6 (7)	4 (6)
	Disagree	2 (1)	3 (2)	1 (2)	2 (2)	1 (1)	1 (2)
	Fully disagree	0	0	0	0	1 (1)	0

The surgical registrars referred more directly to the RRT (7 versus 5%), consulted other specialties (7 versus 0%) or communicated with a colleague (18 versus 6%) compared with their medical counterparts. Thresholds for escalation were generally low (question 2). Question 3 referred to the situation in which a patient does not respond to initial treatment, but according the RRS can still be managed by the ward team. Registrars escalate to the consultant in 57% versus 65%, and consultants refer to the RRT in 41% versus 44%, respectively.

When analysing interaction effects between respondents in relation to questions 1 and 3, none of the registrars that initially called another registrar within the same specialty (question 1) subsequently alerted the RRT upon deterioration. These registrars subsequently primarily called their consultant (question 3; 75 versus 83%). For consultants, of those who initially called another consultant within the same specialty, 33 versus 36% subsequently alerted the RRT.

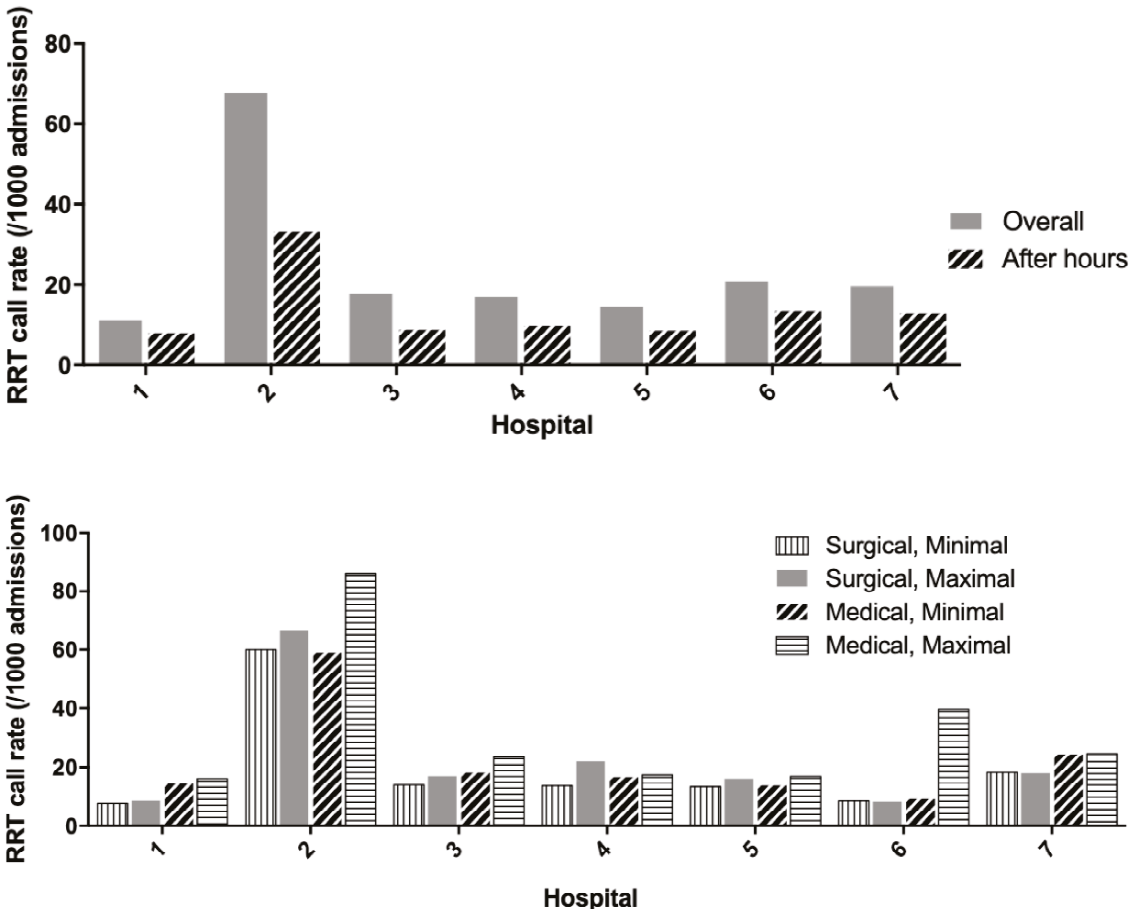

Figure 1. RRT activation rates (as per 1000 admissions). The top panel shows the average number of RRT calls during 2016 and the average number during after-hours. The bottom panel indicates the minimal and maximal average utilisation of the RRT per specialty

RRT activation rates

RRT activation rates were analysed for seven of the nine hospitals (*figure 1*). Two hospitals were unable to provide data on the monthly admissions and RRT calls. The average RRT activation rate per hospital over 2016 varied between 12 to 68 per 1000 admissions. All hospitals showed lower call rates after hours (18:00-08:00) and during 24-hour weekend days (8 to 33 per 1000 admissions) which was comparable with about two-thirds of total RRT calls. *Figure 1* (upper panel) shows the average number of RRT calls per hospital. Hospital 2 had the highest RRT call rates (surgical 64, medical 73 and after hours 60 and 59 per 1000 admissions, respectively) compared with the other hospitals. In the other six hospitals, RRT call rates were similar and ranged between 8 and 25/1000 admissions. After hours, this ranged between 7 and 16 per 1000 admissions. The lower panel in *figure 1* indicates the highest and lowest average RRT call rate per specialty on a monthly basis. Irrespective of specialty, hospital 2 had the highest utilisation of RRT services. Minimal average use was 7.5/1000 admissions and highest 86/1000.

Discussion

After mandatory introduction of RRS in the Netherlands in 2008, mortality and patient harm significantly decreased.[5] The current study shows that the reported uptake of RRS is high and escalation of care is appropriate within the two-tier system. The main outcomes of the study point towards increased patient-to-nurse ratios in the majority of studied hospitals with over 84% of nurses taking care of more than eight patients, and often up to 15 patients, during night shifts.

The physical and mental strain of work is deemed relatively balanced by both nurses and registrars but increasing to higher workloads during shift (i.e. off-hours) work. Self-reported adherence to escalation of care is high despite the workload, although RRT activations reflect an almost 50% reduction of after-hours RRT activation rate (8-33/1000 versus 12-68/1000 admissions). Interestingly, the hospital with the highest nurse staffing also showed the highest rate of RRT activation. Unfortunately, within the current study, we were unable to correlate RRT activation rates with clinical outcome.

Statistically significant differences in RRT call rates were observed between hospitals (two hospitals were unable to provide the data). Hospital 2 showed consistently higher activation rates together with generally lower patient-to-nurse ratios compared with the other hospitals. The number of RRT activations per 1000 admissions has been designated as 'RRT dose' and increasing 'the dose' is directly related to better outcomes. In this context, a dose of over 40 per 1000 admissions is deemed optimal.[12] The degree to which this can be extrapolated to the Dutch situation is not precisely known, because case-mix, trigger and activation protocols for RRTs are different and therefore care should be taken with these extrapolations.

As an RRS is built from multiple components, focusing solely on the efferent arm is an atomistic approach. Before the escalation to the RRT, a multitude of processes occur. Therefore, the effectiveness of the entire system is influenced by many factors and each step is as important as the previous one. As previously shown, delayed recognition of deterioration and activation of the RRT is associated with poor clinical outcome.[13] Potential causes for system delays have been attributed to impaired recognition, failure to escalate, lack of clinical urgency and monitoring failures.[9,14,15] As also observed in our study, diurnal patterns have been observed for RRT activation rates. Activation rates out of office hours are lower compared with daytime and are associated with significant clinical burden.[16,17] Unfortunately, our study was not designed to analyse correlation of RRT activation rates with clinical outcome. Interestingly, higher patient-to-nurse ratios at night may be an important aspect which may be related to reduced recognition of deteriorating patients and thus declining activation rates at night.
The landmark study by Aiken et al. in 2002 reported that in hospitals with high patient-to-nurse ratios, surgical patients had increased (risk-adjusted) 30-day mortality and failure-to-rescue rates. After adjustment, each additional patient per nurse increased the likelihood of death within 30 days of admission by 7% (OR 1.07, 95% CI 1.03-1.12).[10] A second study by the same group identified a correlation between the degree of education of nursing staff and clinical outcome in nine European countries.[18] Later published studies have shown similar outcomes, adding to the burden of evidence.[19] Through which specific interaction this occurs, remains unknown. One possibility, tightly linked to the failure-of-rescue principle and described in the above papers is the late detection of complications and clinical deterioration.[20,21] Therefore, increased patient-to-nurse ratios could impede appropriate and timely response and have previously been shown to be linked to monitoring failures.[15]

After appropriate triggering, adequate escalation and management is required. As described previously, ward teams have an opportunity to manage their patients after which RRT can be activated. Inefficiency in management and inappropriate escalation has been referred as 'clinically futile cycles'.[22] This concept refers to periods in which patient adverse events occur not because of ignorance or inability, but solely because healthcare providers apply unwritten rules and cultural practices delaying effective and efficient care. Examples of these were shown in this study *(table 4)* in which the RRT is not always called, especially by registrars and consultants who do not appropriately escalate in the first place. This circular way of thinking and acting prevents staff from effectively managing the clinical problem, with a potential delay or absence of RRT activation. Reasons for this futility remain not fully elucidated and in accordance with Shearer et al., a small subset of healthcare providers still revert to either a colleague or consultation of another 'organ' specialist.[23]
Overall, and within the context of this study, there has never been a reliable comparison of the 'dose' of the RRT between various hospitals, countries or hospital cultures. As seen in the current study, only one of the hospitals (hospital 2) is subsequently deemed 'mature' (i.e. well-established) although cardiac arrest rates in all these hospitals decreased significantly after introduction of RRS (data not shown).[24]

The current study has limitations due to its retrospective nature (RRT activation rates) and the utilisation of a questionnaire. With RRT activation data from only seven hospitals, it was not feasible to perform regression analysis to explore possible correlation between questionnaire results and activation rates. Secondly, although the questionnaire was anonymous and we assured respondents that their responses could not be traced back to a person or department, responder bias remains a potential confounder. Overall, the response rate was just under 31%, which is reasonable considering the large group of people who were potential subjects. It is worth considering that our main objective was to reach out to all healthcare providers who may have worked on the wards rather than looking at a single well-defined group, but this may have decreased our response rate. Thirdly, as the objective of the questionnaire was to measure compliance with the RRS protocol (which could be easily deducted from the questionnaire and case vignettes), reporting bias is possible as respondents could have been more inclined to provide the 'desired' answer.
Adequate management for a deteriorating patient relies on synchronisation of a multitude of factors and the different healthcare providers working in unison. It is impossible to include all of the potential confounders as one would need to have detailed information on the adequacy of triggering systems,[25] adequacy of measurement of vital signs (continuous versus intermitted non-invasive measurements)[26] and adequacy of medical management initiated by the teams.[27] Hence, our focus was on the general process and not to specific factors relating to potential delays.

Conclusion

This study has shown successful implementation of RRS in the Netherlands. Self-reported compliance with the required steps in the escalation protocol is high, and the RRT activation rates as part of the two-tier system seem adequate. The RRT should not evolve into a rescue mechanism which compensates for system failures.[28] Future studies should focus on factors responsible for differences in activation rates, futility in escalation and assess if lower activation rates during nights and weekends are related to outcome and how to improve this situation.

Disclosures

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