Practice variability in management of patient deterioration and fit with predefined procedures

Name: L. den Dekker
Student number: 5703999
Course Title: Research Internship
Status: Final report
Date**:** 19 June 2020
University: University Utrecht
Master Program: Clinical Health Sciences, Nursing Science
Supervisor: Prof. Dr. Lisette Schoonhoven
Lecturer: Rob Zwitserlood
Institute: Amphia Hospital Breda
Journal: Resuscitation
Number of words: 3795
Reference style: Vancouver
Number of words abstract: 298
Number of words Nederlandse samenvatting: 299

Abstract

Practice variability in the management of patient deterioration and fit with predefined procedures.

Background
Management of deterioration in patients on a general ward is a complex key safety and quality challenge in hospitals. Rapid Response Systems (RRS) have been implemented to improve the management of deterioration; however, the impact on improving patient safety has stagnated. To increase the understanding of the management of patient deterioration, insights into practice variability and fit with predefined procedures could be helpful.

Aim
The objective of this study is to describe practice variability in management of patient deterioration and rapid response team (RRT) activation by nurses and physicians in everyday practice and to compare this to predefined procedures, as described in protocols and guidelines for the detection of patient deterioration and RRT activation.

Method
A retrospective qualitative study was performed in a general hospital in the Netherlands. Practice variability is described based on written reports in patient files and RRT activations, and compared with predefined procedures, using the Functional Resonance Analysis Method (FRAM).

Results
In 40 cases, practice variability is shown in the use of vital parameters, worry, patient input, consultations with the ward physician and medical specialist, choices of treatment interventions, re-assessment, RRT activation and follow-up. Comparison with predefined procedures shows that the process in everyday practice is more complex and consists of more activities and aspects than the process in predefined procedures.

Conclusion
Everyday practice shows a lot of variability in the management of patient deterioration and RRT activation and a lack of fit with predefined procedures.

Recommendations
Future research should focus on identifying core activities to perform well in the management of patient deterioration and RRT activation for different patients and to give professionals the ability to succeed under variable conditions. The re-design and re-implementation of predefined procedures are needed to create documents that convey unambiguous statements about clinical actions and their timings.

Keywords: Deterioration, FRAM, Rapid Response System

Nederlandse samenvatting

Praktijkvariatie in management van patiënt verslechtering en overeenstemming met protocollen en richtlijnen.

Achtergrond
Management van verslechtering van patiënten, opgenomen op een verpleegafdeling in het ziekenhuis, is complex maar tegelijkertijd een kernaspect in kwaliteit en veiligheid. Rapid response systemen zijn geïmplementeerd om management van verslechtering te verbeteren, echter stagneert de impact op patiënt veiligheid. Om management van patiënt verslechtering beter te begrijpen kan inzicht in praktijkvariatie en overeenstemming met protocollen en richtlijnen behulpzaam zijn.

Doelstelling
Het doel van de studie is om praktijkvariatie, in management van patiënt verslechtering en rapid response team (RRT) activatie door verpleegkundigen en artsen, te beschrijven en dit te vergelijken met protocollen en richtlijnen over patiënt verslechtering en RRT activatie.

Methode
Een retrospectieve kwalitatieve studie is uitgevoerd in een algemeen ziekenhuis in Nederland. Op basis van patiënten dossiers en verslagen van RRT activatie, is praktijkvariatie beschreven en vergeleken met protocollen, gebruik makend van de 'Functional Resonance Analysis Method' of FRAM

Resultaten
In 40 gevallen wordt praktijkvariatie gezien in het gebruik van vitale parameters, input van de patiënt, consulatie van de afdelingsarts en medisch specialist, keuzes in behandelinterventies, herbeoordeling, RRT activatie en follow up. Vergelijking met protocollen en richtlijnen laat zien dat het proces in de dagelijkse praktijk complexer is en uit meer activiteiten bestaat dan beschreven in protocollen en richtlijnen.

Conclusie
De dagelijkse praktijk toont veel variatie in het management van patiënten die verslechteren en RRT activatie en een gebrek aan overeenstemming met protocollen en richtlijnen.

Aanbevelingen
Toekomstig onderzoek zou zich moeten richten op identificatie van kern activiteiten om management in patiënt verslechtering en RRT activatie goed in te richten en professionals de mogelijkheid te geven om succesvol te zijn in verschillende omstandigheden. Her-ontwerp en her-implementatie is nodig om protocollen en richtlijnen te creëren die ondubbelzinnige uitspraken doen over klinische en acties en hun timing en richtinggevend zijn om patiëntveiligheid te verbeteren in situaties van verslechtering

Sleutel woorden: patiënt verslechtering, FRAM, Rapid response systeem

Introduction

A key safety and quality challenge in healthcare is to ensure that deteriorating patients receive timely and appropriate care[1,2]. Approximately 3–9% of hospitalised patients suffer from deterioration[3,4]. As stated by Jones et al. (2013): "A deteriorating patient is one who moves from one clinical state to a worse clinical state which increases their risk of morbidity, including organ dysfunction, prolonged hospital stay, disability, or death."[4] Events such as intensive care unit (ICU) admission or cardiac arrest are often preceded by a worsening of vital signs[3,5,6]. The timely detection of deterioration on general wards, which would enable targeted management, might prevent transfer to the ICU, reduce morbidity, and improve survival rates[5,7,8].

To address deterioration in patients, Rapid Response Systems (RRS) have been implemented worldwide[7]. The RRS includes an afferent component and an efferent component[10,11]. Afferent activities involve the detection of deterioration and the call of a Rapid Response Team (RRT)[3,9]. In the efferent component, responses by multidisciplinary RRTs provide critical care resources and interventions at patients' current locations and admissions to the ICU[3,9,11]. The early warning score (EWS) is used to monitor worsening vital signs and plays an essential role in the detection of deterioration[7,11]. When the EWS rises above a pre-set level, an RRT should be activated[3,11]. Nurses and physicians are the primary healthcare professionals on general wards involved in the management of patient deterioration and RRT activation[9].

Despite the rising attention on deterioration in the literature and the widespread introduction of RRSs, clinical research shows delayed detection of deterioration, incomplete monitoring of EWS, non-adherence to EWS protocols, late activations of RRT, or completely missed deterioration leading to cardiac arrest[8,9,12]. A recent study showed that 35% of patient safety-related hospital death is related to the mismanagement of deterioration[13]. A review in Australia found that close to 50% of RRT activations are delayed[14].

Points at which the management of deterioration can fail have been identified, including inadequate monitoring of vital signs, failing to recognise early signs of deterioration, poor communication between nurses and physicians and between the general ward and the RRT, and inappropriate response to deterioration[1,9,17-20]. This shows that despite decades of attention, activity and investment, improvements in patient safety have stagnated[19].

Traditionally, research into deterioration has focussed on what goes wrong. This so-called 'Safety I approach' presumes that things go wrong because of identifiable failures or malfunctions of specific components[20]. However, the focus of safety research has recently shifted. This concept, called 'Safety II', assumes that 'things go wrong' and 'things go right' for the same basic reasons. Safety II defines 'safety' as the ability to succeed under variable conditions[20] such as differences between individual patients and flexibility in the interpretation of predefined procedures[21].

Insights in practice variability and the fit with predefined procedures could help increase the understanding of the management of patient deterioration. To date, no research has studied practice variability in the detection of deterioration and RRT activation.

Aim

The objective of this study is to describe practice variability in the management of patient deterioration and RRT activation by nurses and physicians in everyday practice on a general ward in a Dutch hospital and to compare this to predefined procedures, as described in protocols and guidelines for the detection of patient deterioration and RRT activation.

Method

Design
This study used a retrospective qualitative design and was conducted January–June 2020.

Population & domain
The population base of this study consisted of professionals who are involved in the treatment of deteriorating patients leading to RRT activation. This study was conducted in Amphia, a general hospital in the Netherlands. This 700-bed medical centre has approximately 250 RRT activations per year. Cases of patients 18 years or older were included if they deteriorated on the general ward and the RRT was activated. Cases were excluded if professionals activated the RRT from the COVID-19 cohort ward due to the changed RRT procedure for those patients.

Sampling
Purposive sampling was used to acquire a representative sample of practice variability[22]. We included cases from day-, night- and weekend shifts, on medical and surgical wards and with different outcomes such as ICU admission and treatment on the general ward.
The sample size was based on data saturation. Saturation indicates sampling to the point at which no new information is obtained[22,23]. 'Data saturation' is defined as two consecutive cases in which no new information arises[23]. How many cases we need to achieve saturation is unknown. We planned to purposefully select 50 cases from the ICU data system for RRT calls.

Functional resonance analysis method (FRAM)
FRAM helps model and understand complex, socio-technical systems[20]. The FRAM labels protocols and guidelines as 'work-as-imagined' and everyday practice as 'work-as-done'. It is a useful tool to describe practice variability and compare this with predefined procedures[24]. In a FRAM model, activities are called 'functions' and links are created between functions by identifying six aspects of them: input, output, preconditions, resources, controls and time factors[19] as shown in Table 1.

Table 1. approximately here

Data collection
The six local protocols of Amphia were selected as predefined procedures according to the management of patient deterioration and RRT activation.
Written reports from nurses and physicians about the treatment of deteriorating patients, EWS documented in patient files and files of RRT activations are used to describe current daily practices.

Case characteristics were retrieved from the patient files and reports of files of RRT activations included patients' age and gender, ward specialism, EWS score, caller, limitation of medical treatment (LOMT), outcome and shift.

Data analysis
Work-as-imagined
The protocols were read by the first researcher (LD) to familiarise themselves with the data and uploaded in NVIVO. The local protocol was read very carefully and actions for the

detection of deterioration and activation of RRT were identified[23]. After identifying the activities, functions that represent those activities were described, data about aspects of the functions were identified and a work-as-imagined model was created.

Work-as-done

Written reports, observation lists and files of RRT activations were organised and stored for each case in NVIVO. As a first step, the data of a case was read in-depth and functions in the detection of deterioration and activation of the RRT were identified. The second step was coding the data to identify input, output, precondition, resources, control and time of these identified functions. After identifying each function and its aspects, the 'FRAM visualiser' was used to model work-as-done for individual cases. Based on these individual models, an overall work-as-done model was created that represented the aggregated processes in RRT activation.

Practical support using FRAM was given by a quality officer with plenty of experience with FRAM.

Case characteristics were analysed using SPSS and presented in a table. Age was presented as mean with standard deviation. Categorical data are presented in percentages.

Variability

Variability is described based on the analysed differences between work-as-done and work-as-imagined.

Ethical issues

This study was conducted according to the principles of the Declaration of Helsinki[25] and according to the Medical Treatment agreement Act and General Data Regulation. This study (no. 20-099/C) is not applicable to the Medical Research Involving Human Subjects ACT as judged by the Medical Ethics Committee of the University Medical Centre Utrecht.

Recruitment and consent

Access to patient files and the use of patient data were obtained by a so-called 'no objection procedure' in Amphia. All patients in Amphia were informed with the folder 'welcome to Amphia' that it was possible that their medical data would be used for scientific research. Objections are possible and are registered in the EPD by the principal practitioner. As mentioned in the 'scientific research policy' of Amphia, a permanent employee of Amphia may view the electronic patient dossier in the context of retrospective file research under the condition that a research protocol is used that indicates what type of patient it concerns. The first researcher is a permanent employee of Amphia and the research protocol was approved by the local scientific commission.

Results

3.1 Case characteristics

In total, 40 cases were included to describe everyday practice based on RRT activation for January–April 2020. Table 1 shows the characteristics of those cases. Twenty-four (60%) were from a surgical ward and 16 (40%) were from a medical ward. The EWS score before RRT activation was 1–4 in 10 (28%) cases, 5–7 in 12 (33%) cases, and >7 in 14 (39%) cases. Most of the RRT activations occurred during the evening/night shift (26 (65%)). Sixteen patients (40%) were transferred to the ICU after RRT activation, 18 (45%) were treated on the ward, and four (10%) received palliative treatment. A third of the patients had a LOMT, two (10%) patients had a 'do not transfer to ICU' treatment order before RRT activation. In seven (17.5%) cases, advice to extend LOMT was given through the RRT.

Table 2 approximately here

3.2 Work-as-imagined

A work-as-imagined model was constructed that consisted of 12 functions (Figure 1), of which seven were foreground functions:

1. Standard monitoring of vital parameters
   Standard monitoring of vital parameters consists of measuring vital signs at admission and every eight hours thereafter if the EWS is 1–4. An EWS of 5–7 warrants monitoring of EWS every two hours. An EWS >7 is sufficient reason to activate the RRT team.
2. Worry
   In all cases when nurses worry, RRT must be activated and the attending physician should be informed.
3. Consulting attending physician
   The nurse should consult the attending physician (ward physician or medical specialist) in the case of an EWS of 1–4.
4. Consulting medical specialist
   The medical specialist as principal practitioner is the first point of contact for the general ward. If the EWS is 5–7, the principal practitioner should be consulted.
5. RRT activation
   On the general ward, the nurse confers—if necessary—about RRT activation with the attending physician. After that, the nurse or physician activates the RRT. The output of RRT activation is a diagnosis and treatment plan; admission to the ICU or follow-up on a general ward. The RRT consists of an intensivist, ward physician ICU and an ICU nurse. An aspect of time is that the RRT team must be on-site within 10 minutes and a diagnosis and treatment plan must be made within 30 minutes through dialogue with the principal practitioner.
6. Consulting the intensivist
   The intensivist is involved in the RRT team but could also be consulted separately by the medical specialist.
7. Follow-up through consulting intensive care nurse (CIV) When a patient remains on the ward after RRT activation, follow-up by CIV is described. The output is instruction, advice and support in the treatment of a deteriorating patient.

Figure 1 approximately here

3.3. Work-as-done

The work-as-done model (Figure 2.) is composed of seven foreground functions:

1. Monitoring of vital parameters

   Input for the monitoring of vital parameters is diverse, namely: standard monitoring, patient calls about a feeling of deterioration, clinical judgement of the nurse, physician instruction to more frequent monitoring, patients return to the ward after an intervention such as CT scan or an event such as where a patient is found to be unresponsive. Deviation of vital parameters could be detected, resulting in worry, direct RRT activation, consulting the ward physician or follow-up monitoring through the nurse.

   Preconditions are the ability to measure vital parameters. In some cases, accurate monitoring of vital parameters (particularly oxygen saturation and non-invasive blood pressure) was impossible due to poor circulation or low body temperature. Another precondition is the accurate entering of values in the observation list. In reports by nurses and physicians, other values are reported than those scored in the observation list.

2. Worry

   Physical assessment by the nurse or physician is input and a precondition to the reporting of worry. Worry is often described as increase of weariness, deterioration, impending exhaustion, or increase of breathlessness. Asking the patient how they feel is an aspect of control as the patient can confirm or alleviate the professional's worry. The output of worry could be RRT activation, follow-up monitoring, or consulting the ward physician.

3. Consulting the ward physician

   Work-as-done shows that the output of consulting the ward physician is physical assessment of the patient, RRT activation, treatment interventions or consideration by the medical specialist. In some cases, it is described that another specialism is consulted such as the pulmonary department in the case of respiratory problems.

4. Consulting medical specialist

   In some cases, the ward physician consulted a medical specialist for supervision. During the evening or night, the medical specialist is usually the back-up from home while a medical specialist is available during the daytime for physical assessment. Output is the advice to activate the RRT or treatment options.

5. Treatment interventions

   In some cases, nurses and physicians make rapid choices in treatment interventions and make appointments about communication and evaluate those interventions in a timely manner while other cases show cycles of interventions, consultations with medical specialist and other specialists and individual re-assessment by nurses and physicians without effective communication.

6. RRT activation

   The RRT is activated through the nurse, ward physician or medical specialist either in consultation with each other or independently. Other input for RRT activation is the patient review by the physician, with or without advice from the medical specialist. In some cases, the consulted specialism gives the advice to activate the RRT. In everyday practice, the full RRT team does not always arrive after activation. The most common output of RRT activation is ICU admission, advice for treatment interventions or palliative treatment. In the case of a 'do not transfer to ICU' order, output of RRT activation varies from leaving

without any advice to extended advice for treatment of deterioration, which was given in comparable cases.

7. Consulting the intensivist

The intensivist does not always immediately join the RRT to assess patients. If the output is a treatment plan on the general ward, the intensivist is only consulted by telephone. If acute interventions such as intubation or ICU admission needed, the assessment and agreement of the intensivist is a precondition.

8. Follow-up

Follow-up for patients who remained on the ward is in practice an agreement to re-call the RRT in the case of deterioration. In some cases, there was physical or telephone contact between the ICU and the ward about patient progress after RRT activation. One case described a re-assessment based on reports of persistently high EWS scores, the nurse's report of consistent deterioration and worry, the RRT team found the patient unresponsive.

Figure 2 approximately here

3.4 Variability

1. Monitoring of vital parameters

Vital parameters are monitored more frequently than described in work-as-imagined. EWS monitoring in work-as-imagined is based on previous values as in daily practice and varied input is reported. Work-as-imagined does not instruct monitoring after RRT activation. In practice, EWS monitoring before or after RRT activation varies from every two hours to every 15 minutes.

2. Worry

Work-as-imagined describes nurses' worry as criteria for RRT activation while in work-as-done, worry of nurses was reported but not used as the main reason for RRT activation. Work-as-imagined describes nothing about patients' worry or concern while patient worry played a role in several cases.

3. Consulting the ward physician

In work-as-imagined, the ward physician has a small role while the medical specialist is the first point of contact. This contrasts with work-as-done, where the ward physician is the first point of contact and has an important role in the detection and treatment of deteriorating patients. In the included cases, time to physical assessment and re-assessment varied.

4. Consulting medical specialist

The role of a medical specialist varies; for example, in neurology, the medical specialist is on duty in the evenings/nights and on weekends. In other specialisations, a ward physician is on duty with the backup of a medical specialist. It is not specified in work-as-imagined whether a medical specialist should be asked for advice prior to RRT activation.

5. Treatment interventions

Cases varied in the deployment and evaluation of treatment interventions. In work-as-imagined, up to and including an EWS of 7, the principal practitioner is allowed to deploy treatment interventions without including an aspect of time or reassessment.

6. RRT activation

Work-as-imagined gives an EWS >7 or worry as criteria for RRT activation, whereas RRT activations are based on more criteria in practice. In some cases, nurses and physicians used the EWS, their clinical judgement and the unsatisfactory effects of interventions against deterioration to activate the RRT team and communicate this with each other. Other cases with similar characteristics, i.e. show EWS >7, reports of worry, ongoing

deterioration, cycles of contact and re-contact with the ward physicians and medical specialist, yet struggle with timely RRT activation.
Work-as-imagined does not include instructions regarding RRT support for patients with a 'do not transfer to ICU' order in various work-as-done actions of the RRT. Work-as-imagined described who the members of the RRT team are with an aspect of time, work-as-done shows patient reviews with incomplete RRT team and arriving of members after 10 minutes.

7. Follow-up

As the protocol described the follow-up of patients who are not admitted to the ICU by the CIV in work-as-done, this is not performed in some cases where other opportunities of follow-up are described.

Discussion

Safety II states that things can go right or wrong for the same basic reasons. The core elements in the process of managing patient deterioration and RRT activation are the monitoring and use of vital parameters, worry, patients input, consultations with the ward physician and medical specialist, choices for treatment interventions, re-assessment and RRT activation and follow-up. This study shows a lot of practice variability in work-as-done, resulting in a lack of fit with the predefined procedures described in work-as-imagined. Most practice variability is shown in the following aspects: monitoring of vital parameters, worry, the roles of the ward physician and medical specialist and the response of the RRT team.

In this study, we found more frequent monitoring of vital signs than described in the protocol. This contrasts with findings of other studies, which reported partial adherence to the vital-signs monitoring protocol and no timely follow-up[26]. A potential explanation for this contrast could be that work-as-imagined in our study prescribed a lower monitoring frequency if the EWS is 5 – 7 than other studies[27]. Currently, there is no evidence in support of any specific minimum vital-sign monitoring frequency or how the observation frequency should increase when patients deteriorate[28]. EWS have a foreground function in the RRS while work-as-done showed that monitoring vital parameters was not always possible. As shown in work-as-done, optimal monitoring will likely depend not only upon vital parameters but also clinical states, patient feelings and nurse and physician insights.

Various cases have reported on nurses' worry resulting in an increase of observation frequency and follow-up without directly leading to RRT activation. This is in line with previous studies' findings that nurses' worry could be an early indicator of deterioration but is used inconsistently[29]. In work-as-done, input from the patients themselves is used in the detection of deterioration; this is not described in work-as-imagined. The roles of the patient and their family has been increasingly recognised as a key contributor in recognising and responding to deterioration as they can pick up on signs of physiological deterioration before this can be identified by staff or monitoring systems[30-32]. Therefore worry of patients should be rated in future research as a possible criterium for deterioration.

Variability in the role of the ward physician and medical specialist results in some cases in cycles of consultations, interventions and evaluations that hamper timely RRT activation.

However, other cases show effective consultations, timely interventions and evaluations and RRT activation in the case of acute deterioration or no improvement. Work-as-imagined has no time aspect, which is in contrast with the national guidelines that instruct that consultations by attending physicians must lead to treatment interventions within 30 minutes[33,34] and that these interventions must be evaluated after 60 minutes[33.34]. The RRT should then be activated in the case of unsatisfactory effects[33,34]. The role of the ward physician, time to assessment and re-assessment for different patients should be considered in work-as-imagined as described in the national guidelines.

This study showed that practice variability in incomplete RRT team responses is acceptable in some cases but has resulted in delayed treatment interventions in others. Previous studies lined up that a multidisciplinary RRT team led by an intensivist improved outcomes[12,35,36]. Therefore, all members of the RRT should immediately join in patient assessments to improve outcomes.

The follow-up of patients who stayed on the general ward after RRT activation varied and differed from work-as-imagined. In some cases, the presence or absence of follow-up made no difference in outcome; however, there were also cases in which the absence of follow-up led to serious adverse events. Patients triaged by the RRT to remain on the ward with abnormal vital signs had worse outcomes and could benefit from routine follow-up visits through a liaison nurse[37]. Therefore, patients with abnormal vital signs should receive follow-up as described in work-as-imagined.

This study has strengths and limitations. We visualised the process of patient deterioration in detail to describe practice variability and compare this with predefined procedures. No previous studies have focused on patient deterioration in such detail, which makes our results innovative and complementary. A specific strength of FRAM is its focus on activities that are responsible for the fact that clinical work usually goes right rather than specific situations in which things go wrong. We used purposive sampling to get a representative overview of practice variability; however, we only included cases of deterioration that led to RRT activations, which could result in a limited view missing cases of deterioration who recovered on the ward without RRT activation.
Moreover, real practice may still differ from the models developed in this study because we used patient files that could have incomplete information[38]. More complete information could be gained from direct observations and interviews[38]. We planned to do interviews to construct models of work-as-done but this was not possible due to the SARS-CoV-2 pandemic.

Re-design and re-implementation of predefined procedures are needed to improve the fit with everyday practice and to create documents that convey unambiguous statements about clinical actions and their timing. However, improving management in patient deterioration and RRT activation is not only a case of improving policy documents. This study showed that practice variability means that in some cases ‘things go right’ while in other ‘things go wrong’. Future research should focus on identifying core activities for different groups of patients to perform well in the management of patient deterioration and RRT activation and to give professionals the ability to succeed under variable conditions.

Conclusion
The results of this study show a lot of practice variability in everyday practice in the management of patient deterioration and RRT activation by nurses and physicians. The comparison with predefined procedures suggests a lack of fit between protocols and guidelines for the management of patient deterioration and everyday practice.

Reference list

1. National Patient Safety Agency (NPSA). Recognising and responding appropriately to early signs of deterioration in hospitalised patients. [Internet]. Available from: www.npsa.nhs.uk. [Accessed 26th November 2019].
2. Australian Commission on Safety and Quality in Health Care. Recognising and responding to acute physiological deterioration. [Internet]. Available from: https://www.safetyandquality.gov.au/our-work/recognising-and-responding-to-clinical-deterioration. [Accessed 26th November 2019].
3. Lyons PG, Edelson DP, Churpek MM. Rapid response systems. Resuscitation. 2018 May 16; 128:191-197
4. Jones D, Mitchell I, Hillman K, Story D. Defining clinical deterioration. Resuscitation. 2013 Aug 16; 84(8):1029–1034.
5. Petersen JA. Early warning score challenges and opportunities in the care of deteriorating patients. Dan Med J. 2018 February; 65(2): 1-13.
6. Andersen LW, Kim WY, Chase M, Berg KM, Mortensen SJ, Moskowitz A, et al. The prevalence and significance of abnormal vital signs prior to in-hospital cardiac arrest. Resuscitation. 2016 January 1; 98:112–117.
7. Smith MEB, Chiovaro JC, O'Neil M, Kansagara D, Quiñones AR, Freeman M, et al. Early warning system scores for clinical deterioration in hospitalized patients: A systematic review. Ann Am Thorac Soc. 2014 November 11; 11(9):1454-1465.
8. Vincent JL, Einav S, Pearse R, Jaber S, Kranke P, Overdyk FJ, et al. Improving detection of patient deterioration in the general hospital ward environment. Eur J Anaesthesiol. 2018 May; 35 (5): 325-333.
9. Chua WL, See MTA, Legio-Quigley H, Jones D, Tee A, Liaw SY. Factors influencing the activation of the rapid response system for clinically deteriorating patients by frontline ward clinicians: A systematic review. Int J Qual Health Care. 2017 December 1; 29(8): 981-998.
10. Wood C, Chaboyer W, Carr P. How do nurses use early warning scoring systems to detect and act on patient deterioration to ensure patient safety? A scoping review. Int J Nurs Stud. 2019 June; 94: 166-178.
11. Mcneill G, Bryden D. Do either early warning systems or emergency response teams improve hospital patient survival? A systematic review. Resuscitation. 2013 December; 84 (12):1652-1667.
12. Moreira AAS, Ramos RO, Ligório ABS, Junqueira KD, Corrêa KS. Rapid response team: What factors interfere with your performance? Invest Educ Enferm. 2018 May; 36 (2).
13. Donaldson LJ, Panesar SS, Darzi A. Patient-Safety-Related Hospital Deaths in England: Thematic Analysis of Incidents Reported to a National Database, 2010-2012. PLoS Med. 2014.
14. Jones D. The epidemiology of adult Rapid Response Team patients in Australia. Anaesthesia and Intensive Care. 2014 june 24; 11(6).
15. Odell M. Detection and management of the deteriorating ward patient: an evaluation of nursing practice. J Clin Nurs. 2015 Jan ;24(1–2):173–182.
16. Fuhrmann L, Lippert A, Perner A, Østergaard D. Incidence, staff awareness and mortality of patients at risk on general wards. Resuscitation. 2008 June; 77 (3):325-330
17. De Meester K, Van Bogaert P, Clarke SP, Bossaert L. In-hospital mortality after serious adverse events on medical and surgical nursing units: A mixed methods study. J Clin Nurs. 2013 Augustus;22 (15-16): 2308-2317
18. Van Galen LS, Struik PW, Driesen BEJM, Merten H, Ludikhuize J, Van Der Spoel JI, et al. Delayed recognition of deterioration of patients in general wards is mostly caused by human related monitoring failures: A root cause analysis of unplanned ICU admissions. PLoS One. 2016 Augustus 1;11(8).
19. Hollnagel E. FRAM: The Functional Resonance Analysis Method [Internet]. 2017: [Accessed on 24 November 2019]. Available from: https://functionalresonance.com/.

20. Hollnagel E, Wears RL, Braithwaite J. From Safety-I to Safety-II: A White Paper [Internet]. 2015: [Accessed on 27 November 2019]. Available from: https://www.england.nhs.uk/signuptosafety/wp-content/uploads/sites/16/2015/10/safety-1-safety-2-whte-papr.pdf
21. ZonMW, Nederlandse Federatie van Universitaire Medische Centra, Federatie medisch specialisten, Zorginstituut Nederland. Raport “begrippenkader gepaste zorg en praktijkvariatie”. [Internet]. 2015. Available from: file://Begrippenkader+Gepaste+Zorg+en+Praktijkvariatie.pdf. [Accessed 28 November 2019]
22. Polit DF, Beck CT. Nursing Research. 10th ed. Lippincott; Williams & Wilkins; 2012.
23. Holloway I, Wheeler S. Qualitative Research in Nursing and Healthcare. 3th ed. Oxford: Wiley-Blackwell; 2010.
24. Hollnagel E et. al. FRAM Handbook [Internet]. Available from: http://functionalresonance.com/how-to-build-a-fram-model/fram-handbook.html. [Accessed 29 November 2019]
25. World Medical Association. WMA Declaration of Helsinki- Ethical Principles [Internet]. Available from: https://www.wma.net/policies-post/wma-declaration-of-helsinki-ethical-principles-for-medical-research-involving-human-subjects/. [Accessed on: 26 November 2019]
26. Hands C, Reid E, Meredith P, Smith GB, Prytherch DR, Schmidt PE, et al. Patterns in the recording of vital signs and early warning scores: Compliance with a clinical escalation protocol. BMJ Qual Saf. 2013 September 1;22(9):719–726.
27. Freathy S, Smith GB, Schoonhoven L, Westwood G. The response to patient deterioration in the UK National Health Service — A survey of acute hospital policies. Resuscitation. 2019 June 1;139:152–158.
28. Smith GB, Recio-Saucedo A, Griffiths P. The measurement frequency and completeness of vital signs in general hospital wards: An evidence free zone? Int J Nurs Stud. 2017 September; 74.
29. Douw G, Huisman-de Waal G, van Zanten ARH, van der Hoeven JG, Schoonhoven L. Capturing early signs of deterioration: the dutch-early-nurse-worry-indicator-score and its value in the Rapid Response System. J Clin Nurs. 2017 September; 26 (17-18): 2605-2613.
30. World Health Organisation. Exploring patient participation in reducing health-care-related safety risks. Publ online [Internet]. Available from: http://www.euro.who.int/en/publications/abstracts/exploring-patient-participation-in-reducing-health-care-related-safety-risks. [Accessed on: 3 March 2020].
31. McKinney A, Fitzsimons D, Blackwood B, White M, McGaughey J. Co-design of a patient and family-initiated escalation of care intervention to detect and refer patient deterioration: Research protocol. J Adv Nurs. 2020 April 8.
32. Odell M, Gerber K, Gager M. Call 4 concern: Patient and relative activated critical care outreach. Br J Nurs. 2010 December 9; 19 (22):1390-1395
33. VMS veiligheids programma. Vroege herkenning en behandeling van de vitaal bedreigde patient [Internet]. Available from: www.vmszorg.nl. [Accessed on 26 November 2019]
34. National Institute for Health and Care Excellence. Overview | Acutely ill adults in hospital: recognising and responding to deterioration [Internet]. Available from: https://www.nice.org.uk/guidance/cg50. [Accessed on: 24 November 2019]
35. Al-Qahtani S, Al-Dorzi HM, Tamim HM, Hussain S, Fong L, Taher S, et al. Impact of an intensivist-led multidisciplinary extended rapid response team on hospital-wide cardiopulmonary arrests and mortality. Crit Care Med. 2013 February; 41 (2): 506-517.
36. Mitchell OJL, Motschwiller CW, Horowitz JM, Evans LE, Mukherjee V. Characterising variation in composition and activation criteria of rapid response and cardiac arrest teams: A survey of Medicare participating hospitals in five American states. BMJ Open. 2019 March 8;9(3).
37. Tirkkonen J, Kontula T, Hoppu S. Rapid response team patients triaged to remain on

ward despite deranged vital signs: missed opportunities? Acta Anaesthesiol Scand. 2017 November; 61 (10): 1278-1285.
38. Catchpole K, Neyens DM, Abernathy J, Allison D, Joseph A, Reeves ST. Framework for direct observation of performance and safety in healthcare. BMJ Quality and Safety. 2017 December 1; 26 (12): 1015-1021

Figures and tables

Table 1 Aspects of FRAM functions

Aspect	Description	Example for function [RRT activation]
Input (I)	What starts the function and what the function acts on or changes.	EWS > 7
Output (O)	The outcome or state change that emerges from a function.	Diagnosis and treatment plan
Precondition (P)	A condition that must be satisfied before a function can commence.	Contact with the medical specialist.
Resources (R)	Anything (people, information, materials) needed to carry out the function or that are consumed during the function.	Well-working instruments to measure vital parameters.
Control (C)	How a function is monitored or controlled, i.e. the work agreement.	Monthly feedback of RRT activations
Time (T)	Time constraints that may influence the function.	The RRT should arrive by the patients' side within 10 minutes.

Table 2 case characteristics

Total n = 40	**N (%)**
Age (mean ± s.d.)	69,5 (13,1)
Gender	
- Male	17 (43%)
- Female	23 (57%)
Ward specialism	
Medical	16 (40%)
Surgical	24 (60%)
EWS score before RRT (mean ± s.d.)	6,2 (3.0)
1–4	10 (28%)
5–7	12 (33%)
>7	14 (39%)
Caller	
Nurse	12 (30%)
Ward physician	16 (29%)
Medical specialist in training	6 (15%)
Medical specialist	4 (10%)
Other	2 (5%)

LOMT before RRT activation	
None	28 (70%)
DNR	6 (15%)
DNI / DNR	4 (10%)
DNI / DNR / do not transfer to ICU	2 (5%)
Outcome	
General ward	18 (45%)
ICU admission	16 (40%)
Palliative treatment	4 (10%)
Operating room	1 (2.5%)
Coronary care unit	1 (2.5%)
Shift	
Day (07:30-18:00)	14 (35%)
Evening/night (18:00-07:30)	26 (65%)
Weekend	10 (25%)

DNR: Do Not Resuscitate
DNI: Do Not Intubate
LOMT: Limitation of Medical Treatment
RRT: Rapid Response Team

Figure 1 'Work-as-imagined' model for the management of patient deterioration on the general ward

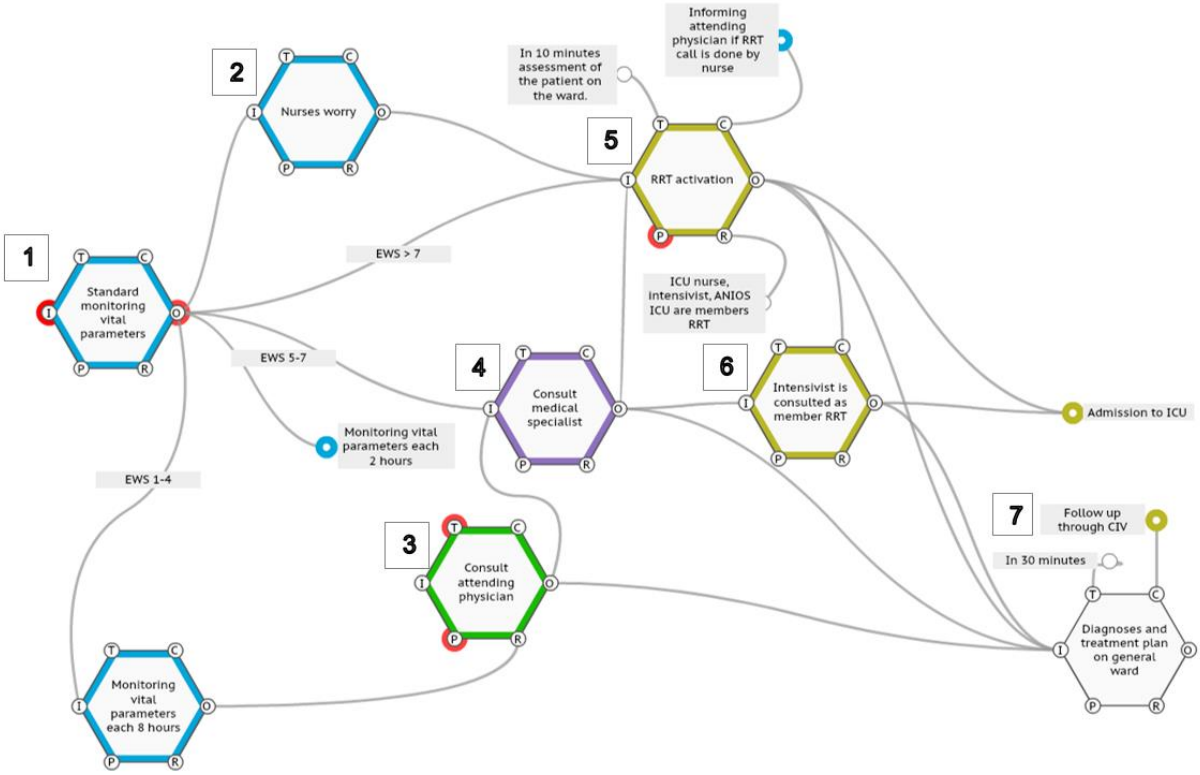

Figure 2 'Work-as-done' model for the management of patient deterioration on the general ward