Succeeding with Rapid Response Systems in Hospitals

A mixed methods research project

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Thesis submitted in fulfilment of
the requirements for the degree of
PHILOSOPHIAE DOCTOR
(PhD)

Faculty of Health Sciences
2023

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ISBN: 978-82-8439-188-5
ISSN: 1890-1387
PhD: Thesis UiS No. 720.

Safety is a dynamic non-event.
-Dynamic because processes remain within acceptable limits due to moment-to-moment adjustments and compensations by the healthcare workers.
-A non-event because safe outcomes are taken for granted and often go unrecognized.

(Karl Weick/Yadin David)

Acknowledgements

This PhD thesis was accomplished with the contribution, and support of many people. First, I would like to thank all the participants in Study 2. Your contributions with honest perspectives and valuable information have been essential for the results of this project.

My deepest gratitude goes to my primary supervisor, Britt Sætre Hansen. Your support, enthusiasm, and advice have been invaluable through both good and challenging times.

Sincere thanks go to my co-supervisors, Eldar Søreide and Bjørn Nedrebø for your invaluable input into my work. Thank you, Eldar for your work in the process of finding financial support for this project and for always cheering me on. Thank you, Bjørn for becoming a co-supervisor in the later stages of the PhD journey. Your expertise and opinions have been of great importance to this work.

I would like to thank Ken Hillman for your essential contributions to the systematic review and Kristian Strand and Jan Terje Kvaløy for your invaluable contributions to the mortality review-study. I would also like to thank my colleagues at UiS and SHARE Centre for Resilience in Healthcare for your warm welcome, encouragement, and friendship.

I am also grateful for the valuable feedback at my 50% seminar from Hege Ersdal and Doris Østergaard, and Karina Aase at my 90% seminar.

Thank you also goes to my good friends and colleagues at Stavanger University Hospital, especially all of you that work in MOBA. A special thanks to two of my nearest colleagues during this period, Øistein Mjelva and Anne Katrine Bergland. I am so grateful for your friendship and support.

Finally, my greatest gratitude goes to my family and friends, for all your support and love. My father, Torstein, thank you for your outstanding

support and engagement, even repeatedly reading and commenting on manuscripts! My late mother, Mary Ann, for all her love and unconditional support. I miss you! My sister, Line, thank you for your support and for always being there. And last, but not least, my children, Ida and Marius, and my husband Svein Tore, thank you for your love, patience, and support and for putting things into perspective!

This thesis has been language edited by OnLine English.

16.05.2023

Siri Lerstøl Olsen

Summary

Background: Modern hospital care is both advanced and complicated with multiple opportunities for medical errors including serious adverse events. Rapid Response Systems (RRSs) have been implemented in hospitals globally to prevent serious adverse events, such as cardiopulmonary arrest or death through systematic patient monitoring, early detection of deterioration (afferent limb), and timely response by competent personnel (efferent limb). An RRS also has two governance limbs, for ensuring resources (administrative limb) and follow up on quality (quality limb).

Although RRSs have been found to be effective in many hospitals, patients still experience omission events; lack of monitoring, delayed or missing recognition of deterioration, and delayed or lack of response to deterioration. The concept of the RRS constitutes the conceptual framework of this thesis. The overall aim of this PhD project was to increase the knowledge of how to prevent omission events in hospitals through succeeding with an RRS.

Methodology: This thesis uses a sequential mixed-methods design consisting of two qualitative studies and one quantitative study, and an integrated synthesis of their findings.

The first study, a systematic review, included 21 qualitative papers that presented perceptions of healthcare professionals from different parts of the world, regarding facilitators and barriers of a hospital RRS.

The second and third studies were both conducted in a Norwegian university hospital. In the second study, focus group interviews were conducted in two wards in the context of RRS simulation training, and separately in the intensive care unit to add the perspective of the efferent limb. Qualitative analyses were performed to provide an understanding

of how healthcare professionals manage the complexities of an RRS in daily practice as well as identifying its challenges.

In the third study a mortality review of diseased patients in two wards of a Department of Gastrointestinal Surgery were conducted. Quantitative analyses were performed to compare results from three time periods before- and after the implementation (2012) and further development (2016) of an RRS. Mortality rates for patients admitted to the study wards in the period of 2010–2019 are presented.

Finally, this thesis presents a qualitative synthesis integrating the results of the three studies, addressing a thesis research question of how hospital organisations with an RRS can better prevent omission events.

Results: *Paper I* highlights the importance of the administrative and quality improvement limbs. When these limbs were poorly connected to the operative limbs it led to unclear protocols, poor logistics, inconsistent education of healthcare professionals, and a lack of resources, including staff and beds. Furthermore, this paper emphasises the complexity of operating the afferent limb, ensuring regular monitoring, using scoring systems as intended in addition to managing a variety of documentation systems in busy hospital wards. Moreover, the paper reveals how the collaboration between the afferent and efferent limbs is vulnerable. Criticism and disrespectful behaviour down the hierarchy was frequently reported. This paper provides an international overview of barriers and facilitators of an RRS and influenced the aim, design, and research questions of Studies 2 and 3.

Paper II reports how healthcare professionals value combining a scoring system with clinical competence to discover deterioration. However, their ability to recognise deterioration was variable. Structured communication supported escalation when a patient was deteriorating, whereas variability in knowledge regarding the RRS and documentation routines impeded timely detection and escalation. Competing tasks, crowded units, and fear of criticism when calling the efferent limb from

the intensive care unit disrupted collaboration. This paper illuminates the value of simulation training to probe a hospital RRS and as an arena to improve consistent use of the RRS and interprofessional collaboration. These findings contributed to the development of the aim and design of Study 3.

Paper III reports how patient demographics did not change during the three time periods studied in the mortality review. After implementation and development of the RRS, there was a significant increase in documented vital signs, earlier documentation of limitations of medical treatment, an increase in reviews by healthcare professionals from the intensive care unit, without an increase in transfers to the intensive care unit, and a decrease in the number of patients experiencing omission events. This was associated with a significant decrease in in-hospital mortality, as well as 30-day mortality rates.

The integrated synthesis of the three studies underlines the need for hospital organisations to take overall responsibility for adequate resourcing. This includes competent personnel, necessary equipment, and comprehensive and user-friendly technological solutions for monitoring and documentation. Furthermore, the RRS protocol needs to be customised to the organisation. The trigger criteria and the structure of the efferent limb must be wisely chosen, and a clear RRS protocol is essential. Finally, hospital organisations need to ensure continuous follow up of quality and improvement. The chosen RRS structure, how it is used by healthcare professionals, and defined outcome measures should be continuously evaluated, and results fed back to healthcare professionals. Identified challenges need to be acknowledged and addressed.

Conclusions: Through studying the perceptions of healthcare personnel internationally and nationally, performing a mortality review and integrating the findings from the three studies, this thesis contributes to

increased knowledge on how to prevent omission events in hospitals through succeeding with an RRS.

This thesis demonstrates that leadership, taking the overall responsibility in the hospital organisation is essential to ensure adequate resources, including the alignment of workload and staffing, and providing user-friendly monitoring and documentation systems. Developing an environment where healthcare personnel can build competence in clinical evaluation and interprofessional collaboration is fundamental. Furthermore, a conscious choice of RRS structure, including trigger criteria, and efferent limb structures, described in a clear RRS protocols is needed. Continuous quality follow-up enabling improvements and adjustments of the RRS is warranted to prevent omission events, and thus minimise the occurrence of serious adverse events.

Papers included in the thesis

This thesis includes the following papers:

I. Siri Lerstøl Olsen, Eldar Søreide, Ken Hillman, Britt Sætre Hansen. Succeeding with rapid response systems - a never-ending process: a systematic review of how health-care professionals perceive facilitators and barriers within the limbs of the RRS. *Resuscitation*, 2019;144:75–90.

II. Siri Lerstøl Olsen , Eldar Søreide , Britt Sætre Hansen. We are not there yet: a qualitative system probing study of a hospital rapid response system. *Journal of Patient Safety*, 2022;18:722–9.

III. Siri Lerstøl Olsen, Bjørn Nedrebø, Kristian Strand, Eldar Søreide, Jan Terje Kvaløy, Britt Sætre Hansen. Reduction in omission events after implementing a rapid response system: a mortality review in a department of gastrointestinal surgery. *BMC Health Services Research*, 2023;23:179 https://doi.org/10.1186/s12913-023-09159-3.

Abbreviations

AEs	Adverse events
AI	Artificial intelligence
CASP	Critical appraisal skills programme
CCOT	Critical care outreach team
CI	Confidence interval
COREQ	Consolidated criteria for reporting qualitative research
DGS	Department of gastrointestinal surgery
EWS	Early warning score
EHR	Electronic health record
FGI	Focus group interview
GDP	Gross Domestic Product
HCA	Healthcare assistants
HCPs	Healthcare professionals (Refers to: Nurses, physicians, and healthcare assistants)
ICU	Intensive care unit
IAT	Intelligent Assessment Technology
LOMT	Limitations of medical treatment

MAELOR	Multidisciplinary audit and evaluation of outcomes of rapid response
MET	Medical emergency team
MERT	Medical emergency response team
MEWS	Modified early warning score
NEWS	National Early Warning Score
NEWS2	National Early Warning Score 2
OECD	The Organization for Economic Co-operation and Development
OM-chart	Observation- and medication chart
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
RQ	Research question
RRS	Rapid Response System
RRT	Rapid response team
SBAR	Situation–Background–Assessment–Recommendation

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Part I

1 Introduction

The primary goal of healthcare is to provide safe, high-quality patient care (1). Even so, patients globally are exposed to situations of potential harm (2) and in today's modern advanced hospitals, preventable adverse events (AEs) still happen (3). Harm to patients has a significant financial cost for healthcare systems and society (4). This thesis focuses on the concept of the Rapid Response System (RRS), developed to improve patient safety in hospitals with the ultimate goal being to prevent unnecessary deterioration of patients that can end in serious AEs such as long stays in the intensive care unit (ICU), cardiac arrest, and death (5).

The sections in this chapter will provide definitions regarding patient safety and patient harm used in this thesis, followed by a description of the concept of the RRS, its history, and the rationale for such overall systems in modern hospitals. Finally, the overall aim of the thesis together with objectives and research questions is presented.

1.1 *Patient harm*

Different terms are used to define and describe patient safety and patient harm. This thesis is based on the following terms and definitions:

- **Patient safety:** '*The absence of the potential for, or occurrence of, healthcare-associated injury to patients. Created by avoiding medical errors as well as taking action to prevent errors from causing injury*' (6).
- **Medical error:** '*Mistakes made in the process of care that result in, or have the potential to result in, harm to patients*' (6).
- **Adverse events:** '*Unintended injuries among hospitalised patients that result in disability, death or prolonged hospital stay, and are caused by healthcare management*' (7). Or as in the slightly broader definition by Institute of Healthcare

improvement: '*Unintended physical injury resulting from or contributed to by medical care that requires additional monitoring, treatment, or hospitalisation, or that results in death*' (8).

- **Near misses:** '*An occurrence of an error that did not result in harm*' (6).

Drawing on these definitions, a medical error incorporates the spectrum of events from AEs to near misses. These definitions make it clear that we are focusing on harm that arises from medical care rather than the result of medical illness and includes consequences for the patient with variable severity.

Medical errors can be divided into events of commission or omission (6, 9). *Commission events* mean that the event is a consequence of delivered care, evaluation, or treatment. An example can be a patient who experiences bleeding after a surgical procedure. In contrast, in *omission events*, the event is a consequence of not delivering adequate care at the right time or location (9). Here, an example can be the failure to monitor the patient after a surgical procedure and consequently not detecting that the patient is bleeding (Fig. 1).

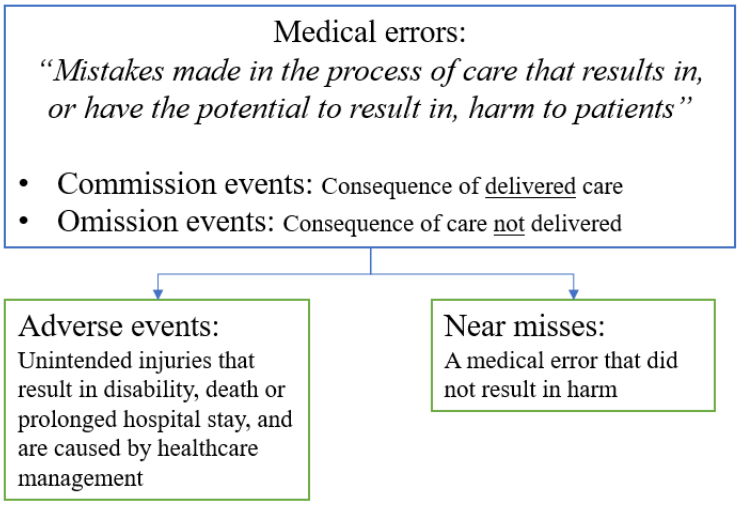

Figure 1: Definitions of patient harm.

1.2 The Rapid Response System (RRS)

This thesis is based on the concept of the RRS, as it was first defined at an international conference in 2005 (10) and further described in the Textbook of Rapid Response Systems, 2011 (5, 11).

The RRS provides a system to ensure monitoring, detection of early signs of deterioration, and providing skilled healthcare professionals (HCPs) to promptly care for the deteriorating patient (11). In other words, when a hospital succeeds with an RRS, the system elements are used as intended to prevent omission events such as failure to monitor the patient, failure to detect deterioration, and failure to respond to deterioration.

An RRS consists of four interconnected limbs (10, 11):

- *The afferent limb*: Responsible for the systematic monitoring of ward patients to detect patients deteriorating by predefined trigger criteria (single-parameter criteria or scoring systems).
- *The efferent limb*: The response team (RRT), consisting of personnel with experience and equipment to handle deteriorating patients.
- *The administrative limb*: Needed to oversee the system, provide resources, training, and education.
- *The quality improvement limb*: Responsible for collecting and reporting data and providing feedback to enable improvement of the system.

The concept of the RRS is further described in Section 2.3, Conceptual framework.

1.3 History and rationale for the RRS

The inception of the RRS started in the 1990s, initiated by critical care physicians in Australia and the United Kingdom interested in understanding what was happening to patients in general wards in the hours before serious AEs such as cardiac arrests and the need for ICU transfer (5). Early studies reported that when patients deteriorated, it was rarely sudden; there was potential room in time for the detection and prevention of AEs (12, 13). Knowledge of this window of opportunity and 'failure to rescue' (14) led to further research to establish usable criteria for ward staff to facilitate early detection of deterioration, and to give the staff power to summon critical care physicians to the patient's bedside (15).

The expected ultimate outcomes of the RRS were to prevent the need for ICU stay, shorten ICU stay length, prevent cardiac arrest, and reduce in-hospital mortality (5). Later, other possible positive impacts of the RRS have been recognised, such as the appropriate institution of limitations

of medical treatment (LOMT) (16), better education of ward staff in recognition of deterioration, and nurse and patient satisfaction (5).

During the late 1990s and early 2000s, different systems emerged, acting as RRSs to detect and respond to deteriorating patients. Various terms were used to describe what happened in the wards and the response team. The first international conference regarding the RRS was held in 2005 (10). This was a conference gathering together experts in patient safety, hospital medicine, critical care medicine, and medical emergency teams (METs) to analyse the state of knowledge on different RRSs at the time and develop consensus around the basic requirements for an RRS. The consensus also made recommendations on terminology.

The rationale for a hospital-wide RRS concept 30 years after its inception becomes apparent when looking at the challenges faced by complex hospital organisations (17, 18). Numerous HCPs act, often interdependently with each other and with technological solutions, to care for a great variety of patients. The repertoire for treatments of diseases and injuries is continuously expanding, providing multiple possibilities but also adding complexity (3).

Over the last decades, the population has been ageing. People live longer and thus need more healthcare interventions. These changes increase the demand on hospitals (19). High bed occupancy is associated with AEs (20), delayed transfers to the ICU for patients in need of critical care (21), and in-hospital mortality (22, 23). The number of physicians and nurses has increased in most Organization for Economic Co-operation and Development (OECD) countries in the past decade, but shortages persist (19). Different technological solutions for health information have been introduced into hospitals to improve patient care, but have also added to information complexity and may contribute to errors (24). Their value is also dependent on successful implementation (25).

Traditionally, hospitals operate in ‘silos’ (26) caring for patients based on the different specialities of medical conditions or injuries. In addition,

the possibility of delivering advanced care differs among departments. ICUs have highly complex equipment and personnel trained in caring for critically ill patients. In contrast, general wards employ experts in often more limited medical fields but with less equipment and personnel.

With advancing age comes more diseases and often problems that need experts from different fields. While patients in general wards might already be or become increasingly ill and in need of the expertise of intensive care personnel (27), ICU beds might already be full. The recognition of the need for a system across specialties and departments, focusing on the patient's needs, was central to the development of the RRS (28).

ICU-capacity strain is a well-known and debated issue (29, 30), challenging both patient care and ICU staff (31). The high variability of ICU capacity between hospitals (32) and the consequences of ICU-capacity strain have been highlighted during the current Covid-19 pandemic (32, 33).

The introduction of RRS into hospitals has not been without challenges (34). Several studies in the 1990s and early 2000s found a decrease in cardiac arrest and unexpected death (35, 36), but the quality of these studies was questioned because they were mostly performed in single hospitals, with before-and-after designs. Thus, the RRS effect on patient outcomes has been debated since its introduction (37, 38). Results from several single- and multicenter studies were eventually studied in systematic reviews and meta-analyses. Although the earliest studies drew conclusions with no or weak evidence (39, 40), recent meta-analyses, from 2013 (41), 2015 (42), and 2016 (43), found that RRS was associated with a reduction both in cardiac arrests and in-hospital mortality.

It is clear that not all hospital organisations realise the expected benefits of the RRS (41). Non-compliance with the recommended elements of the RRS protocol, such as failure to monitor (44) and delays in RRT

activation (45-47) are reported to affect a large number of patients. To understand better why some hospitals manage to use the RRS whereas others do not, researchers convey a need to explore why this is so, and searched for an understanding of local cultures and challenges within the system (41, 48, 49)

1.4 Aim, objectives, and research questions

To contribute to the field of RRS research, the overall aim of the PhD project, therefore, is: To increase the knowledge of how to prevent omission events in hospitals through succeeding with an RRS.

To address this aim, a mixed method study were performed (50) with three studies. Study 1 was performed to give an international perspective of facilitators and barriers to the RRS, informed by HCPs working within an RRS. Furthermore, Studies 2 and 3 were performed to study a Norwegian hospital RRS qualitatively and quantitatively. Finally, the findings were integrated into a qualitative synthesis in this thesis (See: 6 Synthesis of results across Studies 1–3).
Three objectives with research questions (RQs), guided the studies:

- Study 1: To improve our current understanding of the factors affecting the RRS.
  RQ: How do HCPs perceive potential facilitators and barriers within the limbs of an RRS?
- Study 2: To target a comprehensive understanding of how HCPs manage the complexities of RRS in daily practice as well as identifying its challenges.
  RQ1: How do HCPs describe the various elements of the RRS when it works well?
  RQ2: How do HCPs describe the remaining challenges that need to be addressed
- Study 3: To investigate whether implementing and developing an RRS in the Department of Gastrointestinal Surgery (DGS) was

associated with an overall temporal improvement and identifying needs for further improvement by studying patient monitoring, omission event occurrences, LOMT documentation processes, unexpected death and in-hospital and 30-day mortality rates.

2 Contextual background

This thesis combines an international perspective of the RRS (Study 1) with a Norwegian perspective (Studies 2 and 3). This chapter presents the background and setting for the three studies, followed by a presentation of the thesis' conceptual framework.

2.1 Study 1

The included papers in the systematic review represent studies from several countries, regions, and hospital systems. Although all studies were addressing RRS with at least an afferent and efferent limb, a diversity of RRS structures are represented (Table 1).

Table 1: The countries and RRS- structures in Study 1

Authors	Country/region	Description of the RRS
Astroth et al.	**USA:** Three medical/surgical units at a Midwestern community hospital. 155 beds.	Monitoring: Calling criteria, not further described. Response: RRT (Rapid Response Team), includes ICU nurses.
Benin et al.	**USA:** Yale-New Haven Hospital-academic hospital in Connecticut. 944 beds.	Monitoring: Trigger criteria, expecting the nurse to call RRT and primary team when the patient is triggering. The decisions could be made jointly. Response: Adult RRT from 2005, covering 43 units. RRT is composed of hospitalist physician, a critical care nurse, and a respiratory therapist.
Braaten J.	**USA:** acute care hospital, Colorado. 500 beds.	Established 2005: Monitoring: Calling criteria Response: RRT, with standardised policy. Not further described.
Chua et al.	**Singapore:** 1000 bed acute tertiary care public hospital in Singapore.	From 2009: Monitoring: Single-parameter MET-criteria. Including the 'worried' criteria. Response: ICU-based MET systems. Led by an ICU physician (ICU advanced trainee or registrar in respiratory and critical care medicine or internal medicine) supported by an ICU nurse and a respiratory therapist. Available accredited intensivist for an immediate consultation. Patients with abnormal vital signs but not reaching the MET-criteria: Nurses can initiate an ad hoc review by primary team doctors.
Currey et al.	**Australia/New Zealand** Participants attended the Australia and New Zealand Intensive Care Society Rapid Response Team conference in Melbourne 2014.	Does not describe the different RRS the participants work within. Refers to the consensus of an RRS with four limbs. These components reflect the Australian Commission for Quality and Safety in Healthcare

		national standard for recognising and responding to clinical deterioration in acute healthcare.
Douglas et al.	**Australia:** 929 bed hospital, Queensland.	Monitoring: A standardised observation and response chart. Single-parameter system, with 2 graded response categories, yellow: clinical review, orange: MERT review. Response: Medical emergency response team (MERT): Critical care expertise. Works alongside a code blue team.
Elliot et al.	**Australia:** 8 trial sites, acute healthcare facilities in Australia.	Monitoring: A standardised observation and response chart. A single-parameter system, with 2 graded response categories, yellow: clinical review, orange: MERT review. Response: MERT: Critical care expertise. Works alongside a code blue team.
Jeddian et al.	**Iran:** A tertiary teaching hospital, Iran-Teheran. 800 beds. 5 critical units: 54 beds.	Monitoring: Criteria Patient categorised as being high, moderate, and low risk by an outreach nurse. Response: critical care outreach team (CCOT). A supplementary service to 13 med.-surg. wards. Consisting of 6 nurses from ICU 24-hour service. Responsibility remained with the admitting physician.
Kitto et al.	**Australia:** Monash Australian hospital system. In four hospitals.	Monitoring: RRS Calling criteria, not further described. Response: RRS No specific description.
Leach and Mayo	**USA:** Large public tertiary care teaching hospital, California.	Monitoring: Calling criteria not described. Response: RRT nurse-led, including bedside nurse, respiratory therapist, primary physician intern, and resident. RRT-Nurses were exclusively hired for RRT, no other assignment that day. Responds to RRT calls, go around to identify RRT patients, involved also in cardiopulmonary arrests.
1. Mackintosh, Humphrey, Sandall 2. Mackintosh, Rainay, Sandall	**United Kingdom:** Two hospitals NHS, UK. Called Eastward and Westward.	Eastward: Monitoring: Early Warning Score (EWS), two wards piloting an intelligent assessment technology (IAT) and personal digital assistants. Response: Patients medical team, and on call team. Westward: Monitoring: EWS, escalation protocol Response: CCOT from 2001 with critical care nurse and physiotherapist. Operating on daytime, referring to a MET with an intensive care physician if concerned.
Massey et al.	**Australia:** Public teaching hospital, Queensland.	Monitoring: Single-parameter calling criteria. Response: MET A separate cardiac arrest team.
McDonnel et al.	**England:** District hospital in England (550 beds).	Monitoring: Two-tier track and trigger system—all patients monitored using two charts, the normal chart and if triggering a Patient at Risk chart. Response: CCOT. Not further described.
McGeughey et al.	**Northern Ireland:** 2 hospitals, 2 wards in each: 4 sites-one high-risk (med) and one low-risk (surg.) in each hospital.	Monitoring: EWS Response protocols and ALERT training—Response: Ward physicians/on call physicians.
Petersen et al.	**Denmark:** Urban hospital in the capital region of Copenhagen, Denmark.	Monitoring: EWS implemented since 2012. Response: From 2007: MET consisted of a senior registrar or staff specialist in anaesthesia and a specially trained ICU nurse. All staff allowed to call MET regardless of EWS.
Rihari-Thomas et al.	**Australia**: Academic health centre.	RRS in place for 5 years. Monitoring: A multitiered vital signs parameter track and trigger system. Response: Tier 1 clinical review. (The Unit RNs performing a thorough exam) Tier 2: RRT: in this case: The admitting medical team, and out of hours, the dedicated facility physicians.

		Tier 3 activate MET from ICU. Tier parameter criteria can be modified to create individual patient customisation.
Shapiro et al.	**USA:** from 18 hospitals in 13 states.	Monitoring: Objective criteria, and worried. Response: 18 hospitals with RRT—great variations in response teams. 9 hospitals viewed here as 'early robust adopters' (Hospitals where nurses were enthusiastic about RRS) 9 hospitals reluctant adopters (nurses not enthusiastic about RRS).
Smith DJ and Aitken LM	**England:** Tertiary referral hospital within central London.	Single-parameter track and trigger. Three vital signs that could trigger a response. Response: CCOT.
Stafseth et al.	**Norway:** Oslo University Hospital.	Monitoring: MEWS (Modified Early Warning Score), Using MEWS was voluntary. Response: Mobile Intensive Care Nurse.
Stewart et al.	**USA:** Acute care hospital in Pennsylvania, 242 beds.	Monitoring: MEWS was introduced in 2011. Response: Have a response team, not further described.

2.2 Studies 2 and 3

Studies 2 and 3 were conducted in Norway. In this section, a short description of the Norwegian healthcare system is given before a presentation of the local setting at the study hospital is provided.

2.2.1 Norwegian healthcare

Norway, with a population of approximately 5.4 million (51), has one of the world's highest Gross Domestic Product (GDP) per capita and a high per capita health expenditure. Most of the Norwegian health system financing comes from public funds. Reforms over the last years have focused on adapting to changing population health needs, including increasing use of e-health solutions and information and communication technologies (52).

Norway has a semi-decentralised health system. Four regional health authorities are responsible for the specialist care in 20 hospital trusts. Because of government efforts to improve resource allocation through a shift from inpatient to outpatient settings, the number of hospital beds has been declining. In 2017 there were 3.2 acute beds per 1000 inhabitants.

Although this number is higher than in other Scandinavian countries, the average bed occupancy rate is still high at over 80%, thus exceeding the average of the OECD- countries average of 75.7% (52).

The number of intensive care beds is of special interest when we study an RRS. Although there are some definitional differences in what is determined to be an intensive care bed, the OECD average in 2019 was 14.1 intensive care beds per 100,000 inhabitants. Norway lies far lower than this, at 5.4 beds per 100,000 inhabitants (19). Studies 2 and 3 were performed in a hospital with an intensive care bed capacity of 2.2.

In 2016, The Norwegian Patient Safety Program- 'In Safe hands'(53) included the topic of early detection to deterioration as one of seven target areas into its strategy. From 2020 the target area was continued as a national advice for implementing an RRS in all Norwegian hospitals from 2020 (54).

Recruiting competent nurses and physicians is a current challenge in all areas of healthcare, including within hospitals (55). Furthermore, like other OECD countries, Norway faces large demographic changes over the next 20 years (19). The ageing population will witness an increase in the number of persons over 80 years of age, with a concomitant increasing in the need for healthcare, while the working population that can provide the healthcare will decline. These demographic changes will challenge the entire healthcare system, both within hospitals and externally (55).

2.2.2 Local context

Studies 2 and 3 were conducted in a Norwegian university hospital. Implementation of the RRS at the hospital started in 2012 in two wards in the DGS and was inspired by the RRS model in current use at the Karolinska hospital in Sweden (56). The medical ward in Study 2 implemented the RRS in 2014.

The efferent limb has a two-tier approach. Tier one alerts the physician responsible for the patient, and tier two notifies a MET consisting of a nurse and physician from the ICU (Fig. 2).

Figure 2: The operative limbs of the RRS in Study 2 and 3 (Paper II).

The first RRS version (2012–2016) in the hospital had an afferent limb with a single-parameter trigger criteria (MET-criteria) (Fig. 3) and a rule that all patients should be monitored by vital signs at least every 12 hours. Enthusiastic anaesthesiologists, ICU nurses, surgeons, and ward nurses did a thorough job in the implementation phase. This RRS implementation team conducted focus group interviews (FGIs) to understand the current barriers to detecting and treating deterioration in the wards and prepared the wards for the implementation by providing education sessions for nurses and physicians and arranging simulation training sessions. They also updated the paper-based observation and medication chart (OM-chart) for vital signs documentation. During the first year, all MET calls were registered on paper charts and gathered for statistical analysis. This initial implementation was considered successful and the RRS concept was spread to other surgical wards during the next year.

MET- CRITERIA *Contact MET by calling XXX*	
ACUTE DETERIORATION OF	**VITAL SIGNS**
Ventilation	Respiratory frequency <8 /min Respiratory frequency >30/min O2 saturation <90% with supplementary O2
Circulation	Systolic blood pressure > 90 mmHg Pulse> 40/min Pulse >130/min
Neurology	Sudden unexpected change in consciousness
Other	If seriously alarmed about the patient's condition

- All patients not determined to be in the terminal phase, should have their vital signs measured every 12 hours.
- The patient's responsible physician is the first level of contact when the patient's condition is worsening.
- All Healthcare personnel can contact MET if triggering the MET criteria.
- Situation- Background- Assessment- Recommendation (SBAR) should be followed when making a MET call.

Figure 3: MET criteria (in use: 2012-2016)

In 2014, implementation started in the medical wards, and before 2016 all wards caring for adult patients (except the department of psychiatry) were expected to use the system. During the process of spreading the concept, it became apparent that the system was used in varying degrees in different departments and wards. Implementation in each department was conducted in slightly different ways, and the degree of physician involvement in educational settings was often low. The realisation of the need for follow-up and further development of the RRS for years to come led to a transformation of the RRS implementation team to the Hospital MET committee, incorporating the quality improvement limb, but also having responsibilities of an administrative limb.

A second version of the hospital RRS was developed in 2016, after the introduction of an electronic Observation-and-Medication chart (OM-chart) throughout the hospital. This provided an opportunity to develop the RRS further by changing from the MET criteria to an EWS incorporated in the electronic chart. The MET committee decided to work towards implementation of a National Early Warning Score (NEWS) (Fig. 4). This decision was based on current studies that suggested that NEWS was superior to other EWS in detecting deterioration (57). The purpose of incorporating NEWS in the OM-chart was to make deterioration more visible to the ward staff and to enable a clearer protocol for response (Fig. 5).

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
Consciousness Level				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.

Figure 4: NEWS, introduced from 2016.

Limitations of medical treatment should be evaluated within the first 24 hours		
NEW- score	**Vital sign frequency**	**Response/ Escalation**
0	Minimum of 2 x /24 hours	
1-4	Minimum of 3 x /24 hours (1 per shift)	Nurses can evaluate the need for more frequent vital sign measurements
5-6 or score of 3 or more in a single parameter	Hourly, or as instructed by physician. Document assessment and measures in 'NEWS response' in the OM-chart	Alert the responsible physician. Nurse and physician consider calling MET
≥ 7	Continuous monitoring until physician assessment. Document assessment and measures in 'NEWS response' in the OM-chart	Immediately alert responsible physician. Call MET if patient is not stabilised and the condition under control within 20 minutes
When seriously concerned about the patient, alert the responsible physician and/ or MET, regardless of NEW- score.		

Figure 5: NEWS response protocol.

When entering the patient's vital signs in the chart, a summary score was calculated automatically, and high scores were marked in colours. This development led to a new round of education sessions to train all nurses and physicians in the value of using NEWS, how to register the NEWS in the chart, and how to respond to high scores by using a NEWS-response protocol. The goal was also to be able to obtain reports of the use of NEWS and responses to high scores from this system. An example of the development of the OM-charts is presented in Appendix 7 (Supplementary file for Paper III).

The use of the RRS protocols was still inconsistent within and between departments. AEs with RRS protocol breaches were regularly reported

and discussed at quality meetings. The registration of MET calls on paper charts for quality improvement failed over time. In 2019, the MET committee initiated the process of implementing in situ simulations in the wards to increase focus and knowledge about deteriorating patients and the use of the RRS.

A reporting system from the electronic OM-chart was not available during the period of conducting the studies in this PhD project. The knowledge and experience of the RRS journey at the study hospital were essential for the formation of the PhD project.

3 The RRS as a conceptual framework

This thesis uses the four-limbed RRS (5, 10) (Fig. 6) as a conceptual framework. Seeing each of the four limbs as a concept, the four limbs and their interconnections constitute a conceptual framework by the following definition: 'a *network or a "plane" of interlinked concepts that together provide a comprehensive understanding of a phenomenon or phenomena*' (58). In hospitals, this conceptual framework is operationalised into a variety of RRSs described in protocols and procedures that should be followed in real life.

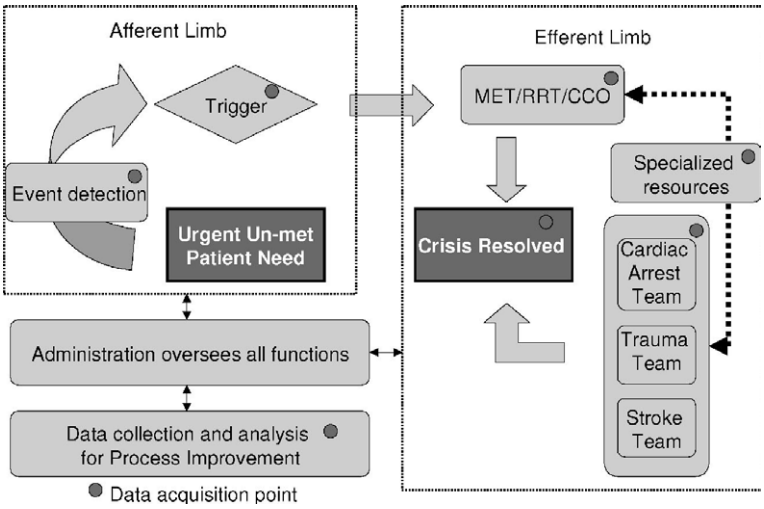

Figure 6: The concept of the RRS

An illustration of the four-limbed concept of the RRS (10). Medical Emergency Team (MET): often led by a physician from the ICU, Rapid Response Team (RRT): in Australia used synonymous with MET, but in the US often led by nurses. Critical Care Outreach (CCO): commonly used in UK, often staffed by ICU nurses.

Supported by meta-analyses (41-43), this thesis is based on the assumption that a four-limbed RRS in a hospital, used as intended, has the capacity to detect and timely manage deteriorating patients, thus preventing AEs such as cardiorespiratory arrest, unintended or prolonged ICU stays and reduce mortality.

By consensus, the term RRS describes a: '*whole system (and not just the individual components of the system) for providing a safety net for patients who suddenly become critically ill and have a mismatch of needs and resources*' (10). A hospital RRS must have the minimum of an afferent limb and an efferent limb available 24/7.

The afferent limb: This limb incorporates three interrelated activities: patient monitoring, detection of abnormalities, and triggering of a response if an abnormality is detected (59). Patient monitoring should constitute a clinical assessment of the patient at predefined intervals, including measures of a 'core set' of vital signs, heart rate, respiratory rate, temperature, pulse oximetry, and level of consciousness (59).

The efferent limb: Constitutes the provision of resources, both personnel and equipment needed to help a deteriorating patient. Different structures of the efferent limb exist in hospitals, with different descriptions. The term Medical Emergency Team is often applied to physician-led response teams with critical care expertise. RRT has often been used to describe a nurse-led team, with the possibility to call other resources if ICU-level care is warranted (5). In the UK, nurse-led response teams are often called critical care outreach (teams) (CCO(T)s). In this thesis, RRT is used to describe the various teams in the efferent limb.

The system also needs *governance limbs*, an *administrative limb* to oversee the planning, implementation, and maintenance of the RRS, and a *quality improvement limb* to collect and analyse data to support improvement (10). The inclusion of these governance limbs comes from acknowledging that the RRS functions within a wide system, spanning

from the level of the patients and HCPs to departments, hospitals, and institutions and up to the level of government (5).

4 Methodology

This chapter discusses the methodological approach in the thesis. It presents philosophical considerations, the chosen research design, the data collection methods, sampling and participants, analytical approaches, and ethical considerations. Finally, it considers the quality of the research and the researcher's role.

4.1 Philosophical considerations

The overall aim of this PhD project was to increase the knowledge of how to prevent omission events in hospitals through succeeding with an RRS. When studying an overall system such as an RRS, which is implemented into a complex hospital organisation, it is logical that multiple approaches are needed (60). Here, I have chosen to lean on the philosophy of pragmatism, supporting the mixing of qualitative and quantitative methods (60, 61).

The philosophy of pragmatism arose due to disagreement with the traditional assumptions in the late 19th century about what is knowledge, nature, and inquiry (62). Pragmatists argue that there is no incompatibility between quantitative and qualitative methods (63), and that the RQ is what should drive the design of the study(64). The pragmatic paradigm, or worldview (65), allows the researcher to focus on solving real word practical problems using the most appropriate methods. Furthermore, it supports using human experience as a means to build knowledge (66). The PhD project naturally follows the pragmatic paradigm because the overall aim has guided the choices of RQs, which in turn guided the use of both quantitative and qualitative methodological approaches.

4.2 Research design

Guided by the overall aim, this thesis uses a mixed methods design. Mixed methods design combines both qualitative and quantitative methods, integrating the findings (61). Mixed methods allow researchers to use the strength of both qualitative and quantitative methods to explore perspectives and uncover relationships that are relevant when studying trends and practices within the complex healthcare system (67) thus providing a more comprehensive picture than each method alone (68).

This thesis includes two qualitative studies and one quantitative study. They are connected in this thesis (See 6 Synthesis of Studies 1–3) using a sequential mixed-methods design (50). (Fig. 7). This design provides an opportunity to answer both exploratory and confirmative questions that can be both pre-planned and emerge during the studies. Conducting the studies sequentially provides dynamics to the research project as gained knowledge (inference (69)) can influence the next step in the research project.

This mixed method research project started with Study 1, creating an international foundation. The results and conclusions from this systematic review influenced the design and research questions of Study 2. Both Studies 1 and 2 influenced the aim and design of Study 3. Finally, the meta-inference of the three studies is conducted as an integrated synthesis in the thesis to address the overall aim of the thesis through addressing an overall thesis RQ. The thesis RQ was informed by the knowledge that was gained from all three studies.

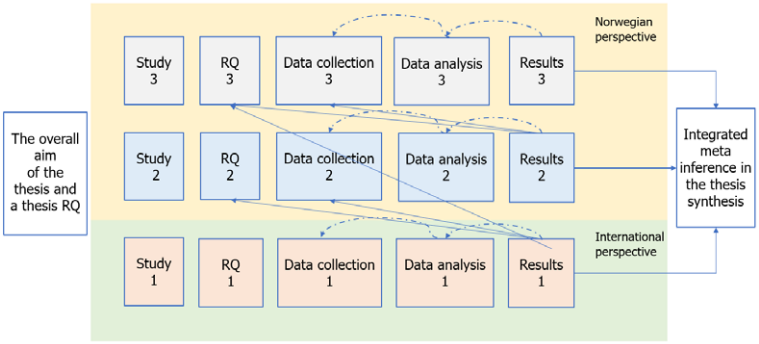

Figure 7: Overview over studies 1-3 and their integration.

A sequential mixed method design. The arrows illustrate how gained knowledge (inference) influences on the different steps within- and between the studies. The results of the three studies are finally integrated in this thesis` synthesis (50, 69).

4.2.1 Study 1, a systematic review

For Study 1, we conducted a systematic review of the literature to improve our current understanding of factors affecting the use of the RRS. Knowledge of struggles with RRS implementation locally and internationally (48), indicated a need to acquire increased knowledge, and we felt that healthcare personnel working in hospitals with an RRS in place would be an appropriate source of information. Thus, the RQ for this study was: 'How do healthcare professionals perceive potential facilitators and barriers within the limbs of an RRS?' The studies answering this RQ all used a qualitative approach. Qualitative methodology is appropriate when the aim is to increase our knowledge about human experiences, thoughts, expectations, motives, and attitudes (70). We used qualitative content analysis to synthesise the findings (71).

4.2.2 Study 2, focus group interviews

In Study 2, we observed in situ simulations and performed FGIs in connection with debrief sessions in a Norwegian hospital RRS to understand how the HCPs managed the complexities of the RRS and to identify current challenges. ICU personnel were interviewed in a separate FGI.

Two RQs were developed: how do HCPs describe the various elements of the RRS when it works well (RQ 1), and how do HCPs describe the remaining challenges that need to be addressed (RQ 2)?

FGIs are particularly well-suited when the aim is to learn about experiences, attitudes, and views in environments where many people interact (72). In the FGIs, we sought to use the value of interactions between the participants giving insight into a different character than in-depth individual interviews, namely the group dynamic between the HCPs in the wards (73). We synthesised the findings from the FGIs through a thematic analysis (74). We used the consolidated criteria for reporting qualitative research (COREQ) checklist (75) to ensure quality.

4.2.3 Study 3, mortality review and mortality rates

In Study 3, we wanted to evaluate whether the implementation and further development of an RRS in a Department of Gastrointestinal Surgery (DGS) in a Norwegian hospital was associated with an overall temporal improvement and to identify needs for further improvement. This was done by studying patient monitoring, omission events, documentation of limitation of medical treatment, unexpected death, and in-hospital and 30-day mortality rates.

First, we performed a mortality review of diseased patients in three time periods (P1 (2010–11), P2 (2014–15), and P3 (2018–19)) before and after RRS implementation (2012) and further development of the RRS (2016). Mortality review is found to be an appropriate method for

studying clinical practice and identifying quality gaps such as omission events (9, 76, 77). Second, we studied temporal trends in hospital admittances and in-hospital and 30-day mortality rates in the two study wards during the 10-year period covering P1, P2, and P3. Data collection Study 1

We reviewed the literature to systematically collect and synthesise original peer-reviewed literature to answer the question: 'How do healthcare professionals perceive potential facilitators and barriers within the limbs of an RRS?' (Paper I). The systematic review was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) statement (78) to ensure a transparent and systematic review.

4.2.4 Literature search

We searched EMBASE, MEDLINE, CINAHL, Epistemonikos, Cochrane, PsychInfo, and Web of Science for the period 2000–2017 and updated the search on March 20, 2019, to include more recent papers. An expert librarian assisted with the search. The search terms used were: 'rapid response team', 'medical emergency team', 'critical care outreach team', 'evaluate', 'implement', 'utilize', 'adopt', 'success', 'fail', and 'barrier' (Appendix I).

4.2.5 Eligibility criteria

Inclusion criteria were: Original peer-reviewed studies, in English, Norwegian, Danish, or Swedish, reporting on an RRS with at least an afferent and an efferent limb. Studies published before 2010 were excluded to be able to focus on the newest publications. We also excluded papers on paediatric RRS and RRS for subgroups (for example: pulmonary embolism RRT).

4.2.6 Study selection

The search identified 3024 items. We performed an initial screen to remove duplicates, then we read all titles and abstracts. We retrieved full-text papers if they appeared to address the research question and met the inclusion criteria, or if the title and abstract gave insufficient information to exclude the study.

We read full-text papers and excluded those that did not fulfil the inclusion criteria. We found four papers using multiple designs, and in these, we included only the qualitative component addressing the research question. Twenty-three papers were accepted for critical appraisal. To evaluate study quality and risk of bias, we used the Critical Appraisal Skills Programme (CASP) tool (79). We excluded two papers because of their low quality (Fig. 8).

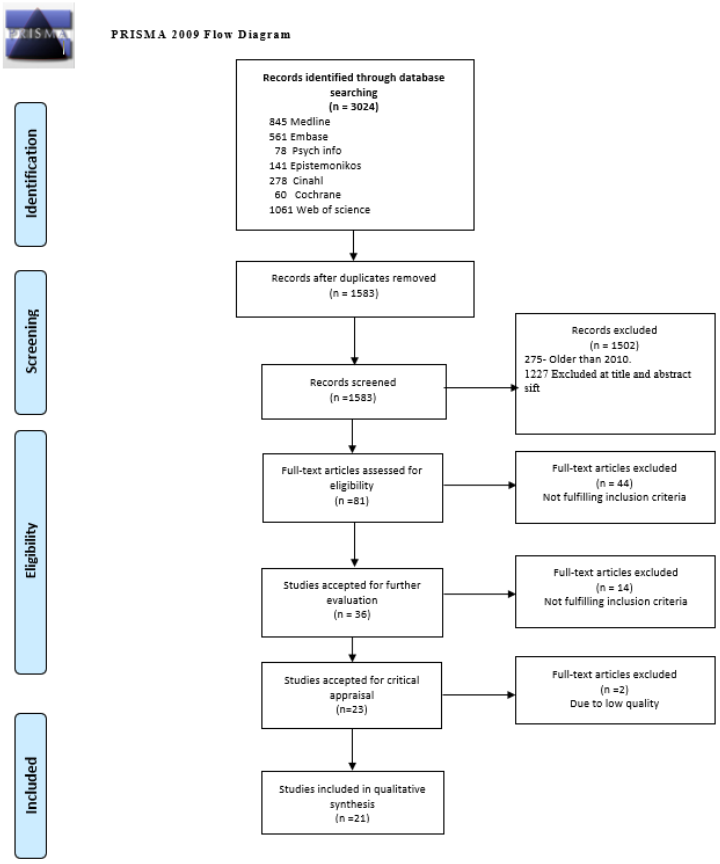

Figure 8: The PRISMA flowchart (Paper I).

4.3 Data collection Study 2

Data for Study 2 were gathered through six FGIs, in two wards (one medical and one surgical) and one in the ICU.

4.3.1 Setting

We conducted Study 2 in a Norwegian university hospital, with an established RRS. The setting is further described under Section 2 Contextual background.

Because of known AEs with evident RRS protocol breaches, the hospital's RRS committee initiated weekly in situ simulations to improve the use of RRS. The initiative started in one medical and one surgical ward (the study wards), initially focusing on the elements of the afferent limb and response from tier 1 (Fig. 2). In the wards, Train the Trainer EuSim level 1 facilitators planned and facilitated the simulations.

4.3.2 Sampling

Senior staff in the wards and in the ICU identified possible participants for the FGIs during the weeks before the study. At meetings in the wards, we verbally informed eligible participants about study purposes, that participation was voluntary, and that they were free to withdraw at any time. The ICU personnel received the same information when we met them for the interview. All participants signed written informed consent. There were four to five participants in each FGI. In each ward, two of the authors (SLO and BSH) observed three in situ simulations and conducted the debriefings as FGI (a total of six FGIs). SLO and BSH also conducted an FGI with participants from the ICU to include perspectives from tier 2 (Fig. 2, in chapter 2, Contextual background).

4.3.3 Sample characteristics

The participants in the FGI in the wards were nurses, HCAs, and physicians (medical physicians and surgeons) (Table 2). The physicians had different roles, ranging from interns to attending physicians, and the overall groups had a wide range of years in the profession, with a median of 4 years and a range of 4 months to 39 years. In the ICU, the participants were intensive care nurses and physicians (1 intensivist and 1 resident) with a median of 9.5 years in the profession (range 4–31 years).

Table 2: Participants in the FGIs (Paper II).

Inter - view no.	**Ward**	**Situation**	**Participants**	**grou p size**	**Time of experience in the profession:**
1–3	MED	Simulatio n scenario/ debrief	8 nurses 2 HCAs, 3 physicians.	4–5	4 mo – 39 years. (median: 4 y)
4–6	SURG	Simulatio n scenario/ debrief	9 nurses, 1 HCA, 3 physicians.	4–5	0.5 mo – 38 years. (median: 7 y)
7	ICU	Focus group interview	3 nurses, 2 physicians.	5	4 years – 31 years. (median: 9.5 y)

4.3.4 Development of interview guides

We developed two semi-structured interview guides, one for the wards and one adapted for the ICU personnel. The open-ended questions were sourced from the findings in Study 1 (Paper I).

4.3.5 Observing in situ simulations and conducting the interviews

Over a period of two months, BSH and SLO observed the six in situ simulations in the two wards, taking field notes. After the scenarios, all participants gathered in a quiet meeting room for the debrief session. The facilitators initiated the dialogue in the debriefs, focusing on the scenario, what happened, what worked well, and what could have been done differently. The scenarios elicited reflections and lively dialogues among the participants. Then, BSH and SLO continued with the interviews, following the semi-structured interviews guide.

The entire debriefs were conducted as FGIs and audio recorded. We also conducted one audio-recorded FGI in the ICU with nurses and physicians with MET experience, using an adapted interview guide. All participants contributed with reflections and dialogue around their experiences and views on the current RRS and provided ideas for further improvement. SLO transcribed all interviews verbatim.

4.4 Data collection Study 3

Study 3 took place in two wards of the DGS in a Norwegian university hospital, covering a population of approximately 400,000 inhabitants. Gastrointestinal surgical patients are vulnerable because of their illnesses and possible complications after surgery (80, 81).

4.4.1 Setting

The study department performs most types of gastrointestinal surgery, acute and elective, from hernia and cholecystectomy to colectomies, rectal resection, pancreas, and liver surgery, but not oesophagus surgery. The RRS implementation in the hospital started in these wards in 2012. (The setting is further described in 2 Contextual background).

4.4.2 Sampling

The sample of interest comprised all patients who died during hospital stay admitted to the two study wards during the years from 1 January 2010 until 31 December 2019. All deaths, year by year, provided the foundation to study temporal trends in in-hospital and 30-day mortality rates (Source: Regional Information Technology partner). For the mortality review, we chose to study the trajectory of the last hospital stay of patients who died during hospital admission in three time periods, (P1 (2010–11), P2 (2014–15), and P3 (2018–19)) before and after the implementation of RRS, to study the development over time (Fig. 8). The years of implementation were excluded to be able to study the system when one could expect it was in full use.

4.4.3 Eligibility criteria

All patients who died during admission in the three time periods (P1, P2, and P3) were identified, and their data were collected from the Norwegian electronic administrative and medical records system, and the hospital's electronic OM-chart. I retrieved all data for the patients manually by reviewing their patient records and charts and finding demographic data and clinical data describing their trajectory.

Cases where the patients were registered at one of the wards for <2 hours were excluded. All other cases underwent review. We then excluded cases when it was evident from the patient's admission record that all active treatment for the patient's illness was terminated, and thus it could be expected that the patient would die within a short time period (Fig. 9).

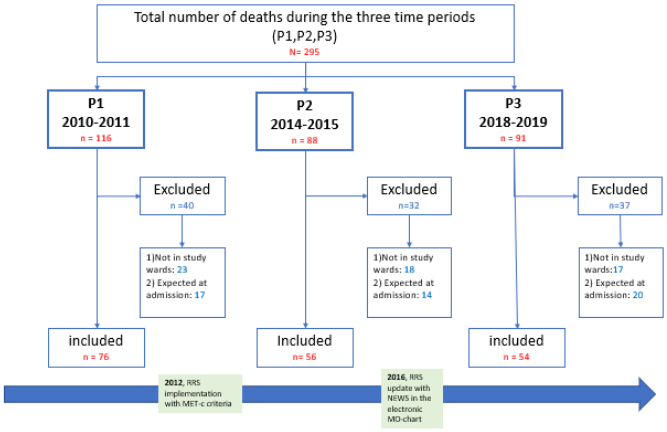

Figure 9: Inclusion of patients in the mortality review (Paper III).

4.4.4 The mortality review process

We established an interprofessional review group and a review method through two stages.

Stage 1: We established an agreement on criteria of what should be considered an omission event and piloted our review method. 'Failure to monitor' was concluded if there were considerably fewer vital signs records documented in the OM-chart than expected for a deteriorating patient. 'Failure to escalate' was concluded when there was a clear lack of escalation, from nurse to tier 1, or a clear delay or lack of ICU consultation (tier 2), including ICU transfer. Deaths were considered as unexpected when there was no sign of deterioration or a description of clinical deterioration in the patient's records within 24 h before death. This definition was inspired by Flaaten et al. (82).

We conducted two pilot rounds, refining our method by reviewing a total of 20 random patient records individually and as a group.

Stage 2: BSH and SLO reviewed all cases before BSN (experienced gastrointestinal surgeon) and KS (experienced intensivist) reviewed cases where the patient underwent surgery or had an ICU consultation or was transferred to the ICU. Cases found to be challenging, or where there were disagreements were reviewed again in the research group to reach a consensus. To ensure our method did not drift during the review period, we reviewed the earliest cases again at the end of the review period.

4.5 Data analysis

Different analysis methods were used in this PhD project. As the papers included in Study 1 all used a qualitative methodology, we performed a qualitative content analysis (71) to extract the data before organising the data according to the four limbs of the RRS concept. In Study 2, the qualitative interview data were analysed using thematic analysis (74), and in Study 3 we analysed the data using quantitative methods.

4.5.1 Analysis Study 1

The data extraction process involved several rounds of familiarisation with the content of all included papers, and comparison of their findings and discussion among the researchers. Following the concept of qualitative content analysis (71), we identified *meaning units* in the papers and thereby created *categories* of content-sharing commonality. Finally, we gathered the categories into *themes*. The four limbs of the RRS provided a framework to structure the findings (See results, in Fig. 9).

4.5.2 Analysis Study 2

In Study 2 we used the NVivo 12 pro software to organise the coding process and performed a thematic analysis (74). We repeatedly discussed and reflected upon the identified patterns of meaning and issues of interest in the data. We generated codes and searched for themes and

categories. Finally, we ended with three themes capturing the essential issues of the RQs (See 5.2 Results Study 2, Fig. 10).

4.5.3 Analysis Study 3

We performed the statistical analysis using IBM SPSS statistics for Windows version 26 and R version 4.1.2 (83).

To test for differences between the three time periods (P1, P2, and P3), chi-squared tests were applied for categorical data, with Monte Carlo simulation for data with expected cell counts less than 5. For continuous data, we used the Kruskal–Wallis test. We used a 5% significance level. When significant differences between periods were identified, a post hoc analysis comparing each pair of periods was done, using a Bonferroni adjustment for multiple testing. Poisson regression was used to test for temporal changes in in-hospital and 30-day mortality rates.

4.6 Ethical considerations

Ethical issues were considered in every part of this PhD project, following the Declaration of Helsinki (84).

Study 1 was a literature review; thus, it did not require ethical approval. In the evaluation of study quality, using the CASP checklist (85), we evaluated the ethical consideration of all included papers. Ethical considerations were handled differently in the studies, reflecting different regulations in different countries.

Study 2 was approved by the Hospital Data Protection Officer at the research department of the University Hospital (Reference number 17/2019) (Appendix IV). Because of Norwegian law, the study was not regulated by the Health Research Act (Regional Committee for Research Ethics in Norway). Participants in the study were identified by senior staff in the study wards during the weeks before the study. All

participants signed a written consent form and were informed that they could withdraw from the study at any time. (Appendix II and III)

Following Norwegian regulations, ethical approval for Study 3 was sought from the Regional Committee for Medical and Health Research Ethics for the Western Health region in Norway, REC-West. REC-West waived the need for informed consent because they considered the study a quality assurance project (reference number 28760) (Appendix V). The Hospital Data Protection Officer at the University Hospital Research Department approved the study (Reference number 25/2019) (Appendix VI)

4.7 Research quality

Throughout the PhD project, measures were taken to ensure the quality of the research. The quality of the two qualitative studies (Studies 1 and 2) and the synthesis in the thesis, was evaluated by considering their trustworthiness (86). In Study 3, reliability and validity were evaluated.

4.7.1 Trustworthiness of Studies 1, 2, and the integrated synthesis

Trustworthiness of qualitative research can be evaluated through the study's credibility, dependability, confirmability, and transferability (86, 87).

Credibility of a study refers to confidence in the data and in the data interpretation (88). In both qualitative studies, I have sought to provide credibility by having clear RQs, and by accurate description of the research process, including setting and data collection methods. In Study 1, this was done by following the PRISMA (78) statement. Furthermore, the CASP checklist (85) was followed to ensure the quality of included studies. In Study 2, the COREQ checklist was followed (75). Investigator triangulation was also a measure to enhance credibility(86).

Believability of the study results is central (88). The systematic review (Study 1) included several databases, and a broad spectrum of search words, to ensure that relevant literature was included to answer the research question properly. The thorough evaluation of eligible papers and the inclusion of 21 separate studies provided rich data material. The data analysis included familiarising with and comparing the papers, and then applying a structured approach using qualitative content analysis (71). Discussions within the research group led to agreement on categories and themes that covered the data material well.

In the FGIs (Study 2), information power (89) was sought. To ensure a variety of perceptions, we included HCPs with different professional qualifications, different genders, and years of experience in both a medical and a surgical ward, and the ICU. Semi-structured interview guides with open-ended questions allowed participants to answer freely, based on their own experience, and elicited discussion among participants, providing a rich data material. Thematic analysis (74) provided structure for the analysis. We had discussions within the research group during the analysis process, continuously moving back and forth between the text and the themes, before defining and naming themes and underlying categories. Credibility was also sought by presenting a variety of quotations that represented the diversity of the data embodied in the categories and themes.

To provide credibility in the integration of Studies 1–3 in the thesis, a clear synthesis RQ was developed, and I sought to describe accurately in the thesis how this synthesis was performed. Tables of excerpts are presented to clarify how the different papers have contributed to the themes and categories.

Dependability of a study refers to the reliability and stability of the data over conditions and time (88), and possible researcher-induced changes during the period of data collection and analysis (71). One should consider if the findings of the study could be repeated if the study was

performed in a similar context with similar participants (88). Although exact replications of qualitative results are not achievable, nor the goal, one can take into account, factors that can counteract design induced changes(86).

In the systematic review (Study 1), the strict systematics of the PRISMA statement, followed during the study and thoroughly described in the paper, enhance its dependability.

In Study 2, dependability was sought by ensuring consistency during the data collection period. The FGIs were all performed by the same researchers over a period of a few months. The same interview guide was used in the medical and surgical wards and a similar, but adapted, form was used in the ICU. We sought to be certain that all interview questions were covered in each interview. Furthermore, structured methods for analysis were used for both Study 1 and Study 2.

Dependability of the synthesis of Studies 1–3 was sought through a structured approach in the thematic analysis of the results of the three studies and providing excerpts of the findings. The thesis author has been the main researcher of all three studies and the integrated synthesis. This reduces the likelihood of researcher-induced changes.

Confirmability of qualitative studies refers to objectivity of the data (86). In the setting of interviews this means that the data should represent the experiences and views of the participants, rather than the researchers views (74). In both qualitative studies (Studies 1 and 2), confirmability was enhanced by having an interprofessional research group during the entire research process. Furthermore, we continuously discussed and reflected upon the researchers' presuppositions, trying to be inductively informed by the data and not by our beliefs and experiences.

Transferability refers to whether the findings can be transferred to, or be applicable to, any other patient group or context (88). The transferability of the findings in the studies and in the synthesis of the studies to other

settings is for the reader to decide (71, 86), based on their setting and possibilities. To facilitate the reader's ability to evaluate if the findings are transferrable to their context, I have tried to provide detailed information transparently on context, setting, participants, data collection, and data analysis.

The systematic review (Study 1) includes papers from many countries and settings. An overview of all studies and their available information on setting; country, region, hospital/ward size, participants, and RRS structure was provided. In addition, in Study 2, the method, setting, and participants are thoroughly described.

For the integrated findings in the thesis synthesis, I have sought to describe accurately how the three studies have been integrated to provide themes and categories. I have also discussed these findings in relation to recent studies to enhance actuality.

4.7.2 Reliability and validity of Study 3

Reliability refers to the stability of the measurements, that is that the score will be the same every time the measurement is repeated (90). To enhance inter-rater reliability in the mortality review, all patient records and charts were reviewed individually by two or more researchers. SLO and BSH reviewed all patient records, contributing to the consistency of the process. All cases involving surgery were additionally reviewed individually by BSN. Similarly, all cases involving ICU transfers or ICU personnel involvement were separately evaluated by KS. Finally, any cases lacking clarity or with any disagreements were reviewed by the research group a second time, to come to an agreement.

To reduce variation of our methods over time, the first records were reviewed again later in the process, assuring our measurement methods had not drifted (test–retest reliability ((90)). Small review groups, of five reviewers or less have been found to increase inter-rater reliability (91).

Validity refers to measurement accuracy, meaning the degree that the method measures what it is intended to measure (92). In Study 3, we wanted to study the process of patient monitoring, occurrences of omission events, and unexpected deaths in three separate time periods with different patients to compare the results. To increase content validity we needed a method that would reflect what we wanted to measure (92). We choose a patient record review method that would allow us to obtain information on omission events (9), not available from any registries and expected to be underreported in the hospital reporting system.

When studying the quality of patient care, as determined by quantifying AEs, patient record review is a common and accepted method. However, the validity of the method has not been established (91). To be sure that patient record reviews actually detect the events they are designed to detect, ideally, they would be referenced with clinical data registries or direct observations of patient care (91). Although ideal, this might not be feasible. Regarding the current study, no clinical data registries were available and direct observation of patient care over this period was not possible.

Intending to enhance study validity, the study group spent time establishing an agreement on criteria for deeming an event to be an omission. Furthermore, we reviewed the literature and discussed the relevant definition, and agreed upon what to deem an unexpected death. We tested the review method with our definitions on 20 random patient records and refined our definitions and methods. By including several professions and medical specialities in the research group, we intended to ensure a broad perspective when evaluating the occurrence of omission events.

Validity also refers to whether any reported changes between the three time periods are the result of the introduction and development of the RRS, or whether they are due to other confounding factors (87). To

enhance validity, background data for the patients were meticulously gathered. No significant differences between the three groups were found, increasing their comparability. Other interventions in the hospitals at the time could be confounding factors. Other than an increase in nursing staff at the introduction of the RRS in 2012, no other major changes were introduced in this period.

The number of patients in the study is limited, as only two wards in a single hospital were included. Increasing the number of patients could have contributed to making differences between the groups clearer. However, we intentionally included only the two wards, to avoid introducing confounding factors. Both wards admitted patients with gastrointestinal surgery issues, and both introduced the RRS at the same time. The years of inclusion was also limited to avoid the time periods of implementation of changes. We sought to have as few exclusion criteria as possible to include all eligible patients in the three time periods.

We present an association between the RRS and a decrease in in-hospital and 30-day mortality in the decade covering the three research periods. Controlling for all confounders for this result was not possible. Factors that could be confounders in this regard are described under limitations and include improvements in surgical techniques and earlier diagnosis due to better diagnostic imaging. To increase validity, however, we controlled for changes in patient age during the time period. We also found that the proportion of acute admissions did not change during this time.

External validity, or generalisability, is a relevant criterion for quality assessment (87). Study 3 was performed in two wards in a single hospital, and thus the generalisability may be limited. The method of the mortality review might well be relevant to study patient deterioration and omission events in other hospital wards. To make it possible for the reader to consider the relevance of the findings for their context, a rich

description of the setting was described in the paper, and diverse strengths and limitations of the study were considered. We followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) checklist for cohort studies to strengthen the quality of the Paper (93).

4.8 Researcher's role

In qualitative research, it is essential for the researcher to be reflective about their own role, presuppositions, and biases that follow their personal experiences and values because they might influence methods, analysis, and interpretation (71, 88) In all steps of the PhD project, I have reflected on my role as a researcher, and how my role as a physician with personal experiences working at the study hospital (Studies 2 and 3) might influence the research process and findings. During the research period, I have been a member of the RRS committee in the hospital and have thus been involved in the development of the hospital's RRS over time. In this role, I have educated young physicians and nurses about the RRS and its local protocol. I have also been part of a group contributing to the National advise from the Department of Quality Improvement and Patient Safety in the Directorate of Health, concerning the implementation of an RRS in all Norwegian hospitals (54).

By discussing with my co-researchers during the phases of each study and the synthesis, I have sought to minimise the influence of my preunderstandings. My role as a researcher, and how it might influence the study, differs somewhat in my three studies and their integration in this thesis.

In both Study 1 and Study 2, we sought to present the experiences and views from HCPs, providing meaningful categories and themes for clinical practice, with a low level of interpretation from us as researchers during the analysis. In Study 1, we analysed findings, and discussions already abstracted and interpreted by the original researchers. Being

aware of this, we still sought to stay cognisant of the presented data, abstracting the findings in the papers into categories before interpreting the categories into themes (94) related to the limbs and interconnections of the RRS.

In Study 2, I was involved in all phases of the project, planning the simulations, producing the interview guide, observing the simulations, and performing the interview in the debrief. I sought to be extra reflexive of my role as a researcher in this setting, staying open-minded and to look beyond my personal perceptions based on my experience. I wrote field notes during the observations, focused on open-ended questions to the participants, and the value of letting them discuss in the group. In addition, I had reflective discussions with my main supervisor who also participated in all interviews.

Study 3 is categorised as a quantitative study. However, I believe there is a need also to reflect on the researcher's role in this study due to the nature of data collection in the mortality review. The review process, the review teams' training and composition and the quality of documentation of patient records might all influence the detection of AEs (95). I also think it is of relevance to reflect upon other factors that might influence the researcher's judgements when studying patient records. Performing a patient record review means entering patient records and charts and reading the records day-by-day from both nurses and physicians, with descriptions of patient care within, and outside the focus of the study. As a researcher working at the hospital in question, being familiar with, and having opinions about the quality of documentation and evaluations made by clinicians was a factor I needed to be aware of. In addition, some of the HCP names were familiar and could have influenced my judgements.

To look beyond these issues, considerations and measures were taken. Having an interprofessional research group was one important strategy. The detailed discussions in the research group about the scope of the

review, definitions of omission events and unexpected death, was essential to keep the focus when patients' records were of poor quality or questions about clinical decisions came up. Independent reviews of many of the cases were another strategy. When discussing cases, information about the involved HCP was not available. Furthermore, to make sure we had not drifted in our method during the review process, we reviewed the first records one more time, at the end of the data collection period.

5 Results

In this chapter, I will present the results of Studies 1–3.

5.1 Results Study 1

The content analysis of the 21 included papers resulted in three themes with underlying categories, organised within the RRS conceptual model (Fig. 10).

<table>
<tr><td></td><td colspan="8">Administrative and Quality improvement limbs</td></tr>
<tr><td>Themes</td><td colspan="8">The barrier of disconnected leadership and a vague lines of responsibility</td></tr>
<tr><td>Categories</td><td colspan="2">The influence of leadership and vision</td><td colspan="2">Unclear protocols with lack of integration in handover processes</td><td>Inconsistent education</td><td colspan="2">Lack of equipment, personnel and integration with other hospital systems</td><td>The value of involvement and continuous follow-up</td></tr>
<tr><td></td><td colspan="6">Afferent limb</td><td colspan="2">The connection of the Afferent and Efferent limb</td></tr>
<tr><td>Themes</td><td colspan="6">The barrier of underestimating complexity</td><td colspan="2">The barriers lie in lack of trust and respectful behavior</td></tr>
<tr><td>Categories</td><td>The missing link between measuring and interpreting</td><td>Challenges in the use of observation and documentation systems</td><td>The value of knowing the patient</td><td>The complex intra-professional "knotworking" processes</td><td>The severity of clinical change</td><td>RRS protocol vs. reality</td><td>Lack of inter-professional trust and challenges of collaboration</td><td>Not knowing the patient</td></tr>
</table>

Figure 10: Results from Study 1 (Paper I).

5.1.1 ***The administrative and quality improvement limbs:*** *The barrier of disconnected leadership and vague lines of responsibility*

With five underlying categories, this theme highlights the importance of the governance limbs to succeed with a hospital RRS. Organisational leadership support was highlighted as essential for the RRS and conversely, poor leadership and lack of quality improvement follow up were linked to unclear protocols, poor logistics, inconsistent education, and lack of resources, including staff and beds. Furthermore, this led to informal triage of patients by the nurse and protocol breaches. The lack

of other structural systems in the hospital for discussing LOMT or establishing palliative care was also found to be a barrier to the RRS.

5.1.2 ***The afferent limb:*** *The barrier of underestimating complexity*

Six categories were interpreted into this theme, presenting the complexities in the elements of the RRS to the ward staff. Nurses worried about the solution of disconnecting the task of vital signs measurements and the interpretation by letting HCAs do the measurements, a solution chosen due to a lack of nursing staff. HCP-perceived scoring systems, such as EWS were valuable for detecting deteriorating patients and communicating about this between professions. However, they highlighted that the use of the documentation systems with manual vital signs entries that could be delayed or incomplete due to busy wards, and complexities related to the use of documentation systems were barriers to succeed with the RRS.

5.1.3 ***The connection of the afferent and efferent limbs:*** *The barriers lie in a lack of trust and respectful behavior*

Two categories merged into this theme, addressing the collaboration between the afferent and efferent limbs. Several of the papers reported how RRT members and physicians reprimanded or criticised ward nurses for calling the RRT, and junior physicians experienced criticism from senior staff. Ward nurses valued the cooperation with the nurse in the RRT and RRT members being supportive and caring, and giving positive feedback was a facilitator for RRT calls. Papers describe how familiarity in between RRT members, and between RRT and ward staff enhanced teamwork. as did familiarity between ward nurses and ward physicians. Having a nurse-led RRT could lower the threshold for escalation for junior physicians but could also be difficult to accept for senior

physicians. Clinical expertise, crisis management skills, and the ability to be a leader were considered key factors for the efferent limb. The quote by Douglas et al. (96) summarises the challenge in connecting the afferent and efferent limbs, stating that the success was '*depending entirely on the people within the team on that particular day*'.

To illustrate the importance of all four limbs of the RRS and highlight the importance of their interconnection, a figure of the RRS structure has been developed (Fig. 11), adapted from the findings of the first consensus conference regarding the RRS (10).

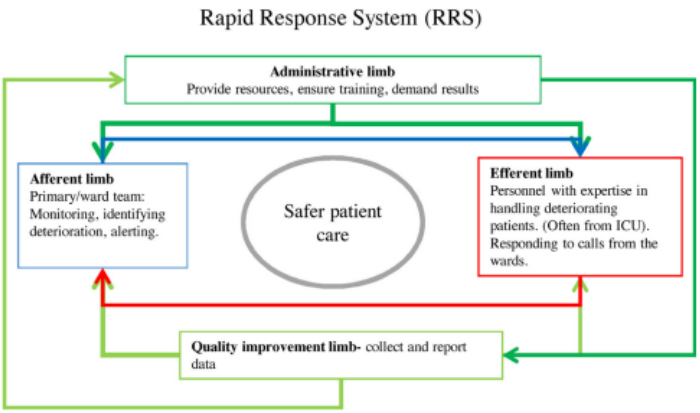

Figure 11: The four limbs of the RRS and their interconnections (Paper I).

5.2 Results Study 2

Thematic analysis identified three themes. Each theme had two underlying categories addressing the two RQs (Fig. 12).

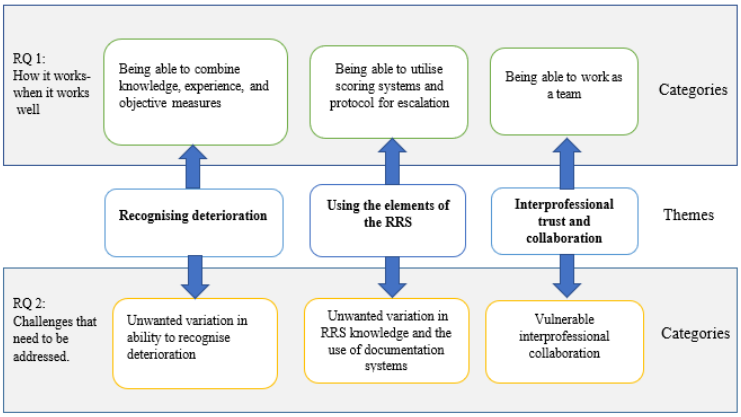

Figure 12: Results from Study 2 (Paper II).

5.2.1 Recognising deterioration

This theme highlights the importance of recognising that a patient is deteriorating. Participants described how they needed a combination of information in this process. Both the objectivity in the NEWS, with its underlying vital signs, and their knowledge and experience. Inexperienced staff were more dependent on the NEWS and needed to cooperate with staff with more experience. The interviews with the ICU staff uncovered unwanted variations between different departments in the ability to recognise deteriorating patients and suggestions for more proactive ICU staff in increasing the ward personnel's competence.

5.2.2 Using the elements of the RRS

This theme highlights the need for using the scoring system and the RRS protocol as intended. HCPs express how NEWS and the protocol provide structure, overview, and a sense of security. However, knowledge regarding the RRS elements varied among participants. This seemed to reflect the variability in their educational experience with the system. By

protocol, the response to high NEW-scores (red and orange) should be documented in the OM-chart under 'NEWS response'. This was valued by staff familiar with this function, but not known by all participants. The inconsistency in documentation routines led to challenges in finding important information and resulted in HCPs spending much time searching for information. A common documentation strategy was requested. The use of the communication tool, Situation–Background–Assessment–Recommendation (SBAR) (97) recommended in the protocol, was seen as a facilitator by HCPs for the escalation process when a patient deteriorated.

5.2.3 Interprofessional trust and collaboration

When a patient deteriorated, the nurses valued collaboration with other nurses. Ward personnel could describe positive experiences with the MET and collaboration around deteriorating patients. Even so, interprofessional collaboration was challenging. The HCPs in the ward and the ICU experienced the challenge of saturated units and several tasks at once competing for attention. Nurses described repeatedly struggling to get appropriate help for the patients, despite a clear RRS protocol. Nurses dreaded calling the MET, expecting resistance. The MET wanting the ward physician to be present at MET calls could be a struggle for the ward physicians, especially when they are busy on night shifts. MET calls were also challenging for ICU personnel because they also left other tasks in the ICU during the assessment of deteriorating ward patients. The need for more resources to cover all tasks, but also better attitudes towards collaboration was recognised. HCPs requested the need for interprofessional training and education. They believed in situ simulation could facilitate collaboration and shared situational awareness regarding deteriorating patients. We observed how the simulation and debrief sessions were an arena for clearing up any misunderstanding and providing feedback and support.

5.3 Results Study 3

Through a mortality review, we studied patient characteristics, findings related to patient monitoring, escalation of care, LOMT documentation, and the occurrence of omission events in the three time periods (P1, P2, and P3) (Table 3). In addition, we studied developments in hospital admissions and mortality rates in the decade covering P1–P3 (2010–2019) (Fig. 13).

5.3.1 Patient characteristics before and after RRS implementation and development

During the three time periods (P1, P2, and P3), the patient characteristics of the deceased patient did not differ regarding age, gender, comorbidity, (Updated Charlson comorbidity index (98)) admittance from home (with or without care), or institutions, type of hospital admittance (unplanned and planned), number of hospital admittances last year, and length of stay. Whether the patients had undergone surgery during the current stay, or needed reoperations were also unchanged during P1, P2, and P3.

5.3.2 Development in patient monitoring and care

We found a significant increase in documented vital signs sets after the introduction and development of the RRS (Table 3). None of the patients had a complete set of vital signs in P1 because the respiratory frequency was never documented. The number of ICU consultations significantly increased after introducing MET (P2 vs. P1 and P3 vs. P1), without an increase in ICU transfers. The number of patients having a LOMT documented did not change, however, the documentation occurred earlier during hospitalisation (P3 vs. P1).

We found a significant decrease in the number of patients considered to have one or more omission events during their hospital stay (P2 vs. P1 and P3 vs. P1) (Table 3). Fewer of the deceased patients had experienced

failure to monitor (P2 vs. P1 and P3 vs. P1) and failure to escalate (P1 vs. P3) Delayed surgery was infrequent in all periods, and the number was stable during P1, P2, and P3. Few deaths were deemed as unexpected. And there was no significant change after RRS implementation and development. Cardiac arrest alarms trended downwards during these periods without being statistically significant. There were no cardiac arrest alarms in the cases from 2019.

Table 3: Results from the mortality review (Paper III).

	P1	**P2**	**P3**	**Comparison between all periods, p-value**	**P1 vs. P2, p-value**	**P1 vs. P3, p-value**	**P2 vs. P3, p-value**
Number of patients	**76**	**56**	**54**				
***Number of complete vital signs sets/24 h/patient.** Median (Q1, Q3)	0 (0, 0)	2 (1, 2)	4 (3, 5)	**<0.001**	**<0.001**	**<0.001**	**<0.001**
***Number of simple vital signs sets/24 h/patient.** Median (Q1, Q3)	2 (1, 2)	2 (1, 2)	4 (3, 5)	**< 0.001**	**0.012**	**<0.001**	**<0.001**
LOMT documented N (%)	58 (76)	42 (76)	48 (89)	0.15			
****Days from admission to LOMT** Median (Q1, Q3)	8 (4, 16)	8 (1, 16)	3 (1, 10)	**0.011**	0.25	**0.003**	0.09

Cardiac arrest alarms N (%)	14 (18)	11 (20)	3 (6)	0.07			
ICU-consult in the wards (MET in Periods 2, 3) N (%)	9 (12)	17 (30)	18 (33)	**0.007**	**0.008**	**0.003**	0.738
ICU transfer N (%)	14 (18)	16 (29)	18 (33)	0.14			
Cases with one or more events of omission N (%)	30 (40)	11 (20)	6 (11)	**0.01**	**0.015**	**<0.001**	0.216
Types of omissions							
Failure to monitor N (%)	20 (26)	5 (9)	1 (2)	**<0.001**	**0.012**	**<0.001**	0.102
Failure to escalate N (%)	14 (18)	7 (13)	2 (4)	**0.043**	0.358	**0.012**	0.092
Delayed surgery N (%)	2 (3)	2 (4)	3 (6)	0.800¤			
Unexpected deaths N (%)	2 (3)	2(4)	0 (0)	0.455¤			

Comparing groups, statistics:
Continuous data: Kruskal–Wallis test. Categorical data: Chi-squared test. ¤Chi-squared test with Monte Carlo simulation. For the pairwise post hoc tests, p-values < 0.0167 are considered significant due to the Bonferroni correction.
Complete vital signs set: all vital signs (pulse, O_2 saturation, resp. frequency, blood pressure measured at the same period, counted during the first complete 24 h stay in the ward.
Simple vital signs set: Minimum one vital sign (pulse, O_2 saturation, resp. frequency, blood pressure measured, counted during the first complete 24 h stay in the ward.
*Only 173 patients were included due to two cases with missing charts and 11 patients with <24 h stay.
** of the 149 patients who had a documented LOMT.

5.3.3 Temporal trends in admissions and mortality rates

During the study period (2010–2019), the number of admittances to the two wards steadily increased with approximately 900 more admissions per year in 2019 vs. 2010. The proportion of planned admissions remained stable at 30%.

Both in-hospital and 30-day mortality rates in the two wards significantly decreased during this period, a trend that remained stable when adjusting for the patients' average age (Fig. 13).

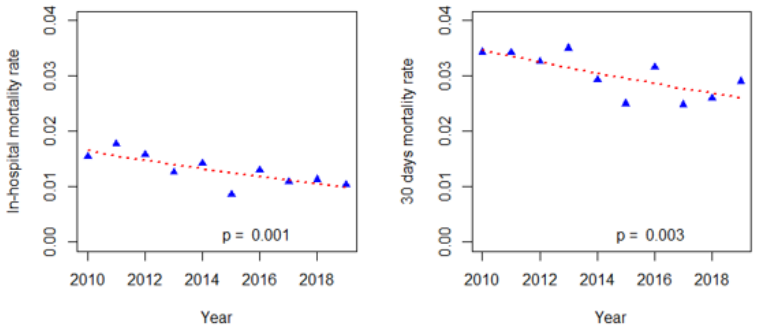

Figure 13: In-hospital- and 30-day mortality rates (Paper III).

In-hospital mortality rate (deaths/number of admittances): 0.95 (95% confidence interval [CI] 0.92–0.98) (p = 0.001), 30-day mortality rate (deaths within 30 days of admittance/number of admittances): rate ratio 0.97 (95% CI 0.95–0.99) (p= 0.003).

6 Integrated synthesis of Studies 1–3

This thesis uses a mixed methods design (See 4.2 Research design). A central aspect of mixed method is to incorporate two or more studies (strands) to answer one or several overall RQ, and this process (meta-inference) can be performed in different ways (69). To inform the overall aim of this PhD project, I choose to integrate the findings across the three included studies in a synthesis in this thesis, aiming to expand the gained knowledge beyond what is found in any one of the studies alone. This is possible because the mixing of findings provides an opportunity to explain, enhance, compare, and contrast findings (99). To structure the integration, a thesis RQ was developed: How can hospital organisations with an RRS better prevent omission events?

To address this thesis RQ, first, the quantitative findings were 'qualitized' (100). This allowed for integration with the qualitative findings in Papers I and II. Then, thematic analysis (74) was used to identify themes and underlying categories (Fig. 14) across the three studies. Excerpts from the three papers related to the themes and categories are presented in Tables 4-6 to provide transparency to the analysis.

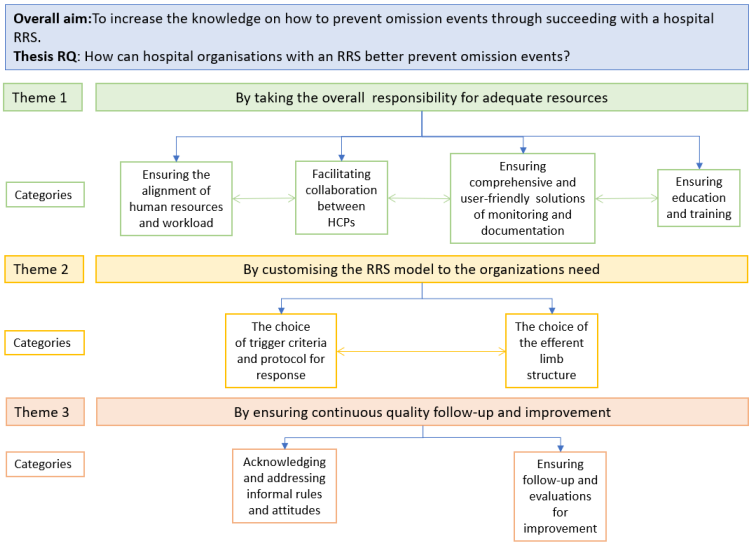

Figure 14: Results from the integrated synthesis.

6.1 Theme 1: By taking overall responsibility for adequate resources

The need for the hospital organisation to take overall responsibility to ensure adequate resources regarding personnel, equipment, and technical solutions is expressed both directly and indirectly in the studies. This includes ensuring that HCPs have competence regarding deteriorating patients and the RRS and collaboration skills. The four categories under this theme are interrelated. Improvements in one category may have a positive impact on the others. (Excerpts in Table 4).

6.1.1 Ensuring the alignment of human resources and workload

HCPs in the ward and ICU face several challenges when caring for deteriorating patients due to high workload and sparse human resources (Papers I and II). The introduction of an RRS is reported to increase workload (Paper I). In paper III the findings show a significant increase in documented vital signs and documentation and ICU consultations in the wards, and earlier decision makings on LOMT after the RRS introduction. HCPs having clinical knowledge and evaluation skills (Paper II) is highlighted. In busy periods, HCPs described how vital signs monitoring was given lower priority, and that they did not have time to 'lay their eyes on the patient' (Paper I). The strategy of having HCAs do the vital signs monitoring could make this a technical task because they lacked the competence to interpret the findings (Paper I).

In Paper II, ICU personnel describe their challenge of high workload and simultaneous tasks. They struggle to free their intensive care nurse from her assignments when responding to deteriorating patients and were concerned about the ICU physicians' workload. HCPs knowing that their colleagues in the ICU were busy, delayed calling about a deteriorating patient (Paper I). Nurses highlight the importance of working together in the wards to attend both to the deteriorating patient and to the needs of the ward's other patients (Papers I and II). When able to include EWS and RRT events in handover processes, working together is found to facilitate collaboration and patient flow (Paper I).

6.1.2 Facilitating collaboration between HCPs

High workload and the need for HCPs to attend to multiple tasks at the same time influenced the HCPs' ability to collaborate. In Paper II, this is clearly expressed by both ward and ICU personnel, describing how they often are already occupied when needing to attend to a deteriorating patient. This contributed to tension between professions. Paper I presents

multiple findings of criticism and negative attitudes between HCPs 'down the hierarchy', disrupting collaboration. The fear of calling the MET due to expecting a negative attitude is also found in Paper II. Nurses describe how they delay calling for help, afraid the 'patient is not sick enough' to validate the call or worry they might seem incompetent to the RRT (Paper I).

The value of committed leaders and a clear direction or 'mission' (Paper I) facilitates the RRS. Familiarity between nurses and physicians in the wards and with the RRS members promotes collaboration (Papers I and II). HCP also highlight the value of structured and clear communication, (Papers I and II) using tools like SBAR (Paper II).

6.1.3 Ensuring a comprehensive solution for monitoring and documentation

The hospital's solutions for how to monitor and document vital signs and clinical evaluation are important. The lack of equipment needed to monitor and detect deterioration challenges HCPs' ability to apply RRS protocols (Paper I). Although technological solutions with electronic OM-charts and electronic health records (EHRs) provide advantages for the HCPs in monitoring and detecting deterioration (Papers I-III) and communicating with other HCPs (Papers I and II), the findings in these studies highlight challenges to their use and usefulness. Delayed entry of vital signs into the system could delay the detection of deterioration. Because data entry takes time, loose notes were still in use, or documentation was not done (Paper I). The possibility of documenting information about deterioration and altered trigger criteria in different systems created confusion, information getting lost, and made HCPs use a disproportionate amount of time searching for information in the EHR (Paper II).

6.1.4 Continuous education and training

HCPs strongly expressed the need for education about deterioration and vital signs, about the RRS, and about teamwork (Papers I and II). Ward HCPs highlighted the need for confidence that the RRT provided expertise to the patient and that the team had a leader with good communication skills (Paper I). Joint education and training are advocated (Papers I and II). Simulation-based training is highlighted as a desired interprofessional activity in this regard (Papers I and II), because it provides an arena for aligning the RRS knowledge, gives positive feedback, clears up misunderstandings, and thus facilitates teamwork (Paper II).

Table 4: Integrated synthesis: Excerpts of findings for theme 1.

category	article	excerpt
Ensuring the alignment of human resources and workload	Paper I	HCPs described that the RRS increased workload, and staff shortages were seen as a barrier.
	Paper II	The ICU personnel, in turn, expressed how frustrating MET calls could be. They felt a need to accommodate for the lack of personnel and competence in the wards and reported discouragement when responding to a MET call when the ward physician was absent. When a patient deteriorated, nurses repeatedly struggled to get appropriate help for their patients.
	Paper III	Furthermore, we found a significant increase in the number of ICU consultations after introducing MET.
Facilitating collaboration between HCPs	Paper I	The process of deciding whether to activate the RRT were described by Kitto et al. as “knotworking”; nurses and physicians constantly collaborated vertically (with senior colleagues) and horizontally

		(between nurse and physician) to identify the appropriate place for the RRT. Multiple papers reported that ward physicians or RRT members reprimanded, criticized, or had a negative attitude toward a nurse who called the RRT.
	Paper II	The HCPs from the wards discussed how they dreaded calling the MET, expecting a negative tone and resistance.
Ensuring a comprehensive solution for monitoring and documentation	Paper I	The availability of real-time data via technological solutions facilitated the RRS by allowing doctors to access patient's vitals from other sites. The introduction of a chart with ranges rather than exact numbers resulted in double documentation or nurses having to estimate numbers when speaking with physicians32 posing as barrier.
	Paper II	The HCPs also described how the use of different documentation strategies within the electronic health record (EHR) created challenges.
	Paper III	RRS introduction significantly increased vital sign monitoring and documentation throughout the study time periods. None of the patients had a complete set of vital signs in P1 because the respiratory rate was not documented.
Continuous education and training	Paper I	Low priority of education regarding the RRS and management of deteriorating patients was a barrier while training was a facilitator, with an emphasis on joint training sessions between ward staff and the RRT and the use of simulation-based training.

	Paper II	Intensive care unit personnel (…) expressed their worry about the unwanted variations among wards, concerning their ability to recognize deterioration. Healthcare professionals who worked in the hospital during the initial phase of the RRS implementation had attended the relevant educational activities. However, HCPs employed more recently had rarely attended structured education and had to grasp the workings of the system individually.

6.2 Theme 2: By customising the RRS model to the organisation's needs

This theme underlines the fact that the chosen trigger criteria and efferent limb structures confer both advantages and disadvantages that need to be acknowledged and understood. The chosen structure needs a clear protocol. (Excerpts in table 5).

6.2.1 The choice of trigger criteria and protocol for response

HCPs appreciate the structure and security of track and trigger charts and EWS, which increase their awareness about deterioration and support escalation (Papers I and II). In paper III, introduction of an RRS (2012) with an updated paper chart and single-parameter criteria led to a significant increase in documented vital signs sets. Before the RRS, no patient had their respiratory frequency documented. The introduction of NEWS (2016) in electronic OM-charts and a more structured protocol for response further doubled the number of documented vital signs sets. Inclusion of a recommendation for considering whether a patient should have an LOMT led to earlier LOMT documentation for patients in the mortality review (Paper III).

The HCP perception of the trigger criteria as too sensitive could create alarm fatigue (Paper I). HCPs also report worry that scoring systems should replace clinician competence (Papers I and II). HCPs request that the calling criteria and response protocol are clear and agreed upon to help them operate the RRS (Papers I and II). In addition, they consider the protocol should incorporate HCP's clinical evaluation (Papers I and II). The clinical impression of deterioration, although subtle, should be considered. Nurses express the need to have the authority to use their clinical evaluation skills and to contact the RRT when the primary physician is unavailable (Papers I and II). The practice of adjusting the trigger criteria for individual patients is described as both positive and negative (Paper I).

6.2.2 The choice of the efferent limb structure

The findings of Papers I and II highlight the need for a conscious choice when it comes to structuring how the efferent limb should be organised and how it should be led. A system with a default direct contact from nurse to RRS seems to increase conflict between nurses and primary physicians (Paper I) and could lead to information about the patient being missed (Papers I and II). At the same time, having junior physicians as the first response limb could be a challenge for inexperienced physicians, leaving the nurse without help (Paper I). Choosing a nurse- or physician-led RRT needs consideration. A nurse-led RRT could lower the escalation threshold but may be reluctantly accepted by physicians (Paper I). Clear leadership of the RRT and the ability of the team to provide professionalism and support is warranted (Paper I).

Table 5: Integrated synthesis: Excerpts of findings for theme 2.

Category	Article	Excerpts
The choice of trigger criteria and protocol for response	Paper I	Confusion around when to call the RRT and their optimal response was a frequently reported barrier. Clearly defined documentation charts and protocols made staff more confident about seeking help.
	Paper II	Participants described how they recognised a deteriorating patient. They gave an overall clinical impression, calculated the NEWS value, and combined this information with their knowledge and experience regarding the patient's current diagnosis.
	Paper 3	RRS introduction significantly increased vital signs' monitoring and documentation throughout the study time periods. None of the patients had a complete set of vital signs in P1 because the respiratory rate was not documented.
The choice of structuring the efferent limb	Paper I	HCPs reported that in daytime, they preferred to call the primary team rather than the RRT because of their familiarity with the patient's condition. Nurses also reported a lower threshold for calling a nurse-led RRT than a physician-led RRT.
	Paper II	Furthermore, the ICU personnel described how having all the members (authors explanation: RRT personnel, ward physician, and nurse) present in the MET call as essential for effective patient management.

6.3 Theme 3: By ensuring continuous follow up of quality to improve

This theme captures the findings highlighting the importance of a solid quality limb. (Excerpts in table 6).

6.3.1 Acknowledging and addressing informal rules and attitudes

Informal rules of when it was acceptable not to monitor patients and amend the RRS protocol is reported. This could be when wards were busy, if the HCP did not agree with the parameters, or when patients continuously triggered a response (Papers I and II). This was expressed to undermine the RRS (Paper I) and needs to be recognised and addressed. Knowledge about intimidating behaviour should be immediately addressed (Paper I). The perceptions and commitment of the senior staff of the RRS are important. It was seen as a barrier when senior physicians worried that the RRS deskills junior doctors. On the other hand, seeing the RRT-calls as a learning opportunities facilitates the RRS (Paper I).

6.3.2 Ensuring follow-up and evaluations

HCPs report on the positive effect of being involved in continuous quality improvement, having local audits, and receiving positive feedback (Paper I). In Paper III, the mortality review provides a method for following the development of omission events to ensure that the RRS is utilised and to identify areas for improvement. Paper II highlights how the HCPs from different professions appreciate coming together to reflect and discuss how they work within the RRS. This provided an opportunity to enhance mutual understanding and uncover needs for improvement, such as common strategies for documentation of deterioration and management plans for the patient. In evaluations, other overall needs in the hospital organisation to facilitate the RRS can be

revealed. HCPs described how a hospital lacking a system of routines and culture for patients with palliative care needs is a barrier to discussing if a patient should have an LOMT (Paper I). Evaluation results need to be presented for the HCP for continuous improvement (Paper I).

Table 6: Integrated synthesis: Excerpts of findings for theme 3.

Category	Article	Excerpts
Acknowledging and addressing informal rules and attitudes	Paper I	Regarded as acceptable for nurses to falsify observations if they felt the patient was okay, to avoid having to explain why they did not react to an abnormal parameter.
	Paper II	Nurses described different strategies for patients who exhibited repeatedly high NEWS values without a defined response strategy. Some argued for following the protocol and notifying tier 1 immediately, whereas others argued for trusting their own assessment, not alarming anyone if they deemed the patient stable.
Ensuring follow-up and evaluations	Paper I	The availability of training, followed up by local audits and positive written responses were considered important components to succeed with the RRS.
	Paper II	Observations during the simulation sessions. Through these interactions, HCPs from different professions often cleared up misunderstandings and uncertainties, showed each other support, and gave each other positive feedback.
	Paper III	In the mortality review, we found a significant decrease in the number of patients considered to have one or more omission events during their hospital stay. The nature of the omissions changed during the study period, with fewer problems regarding monitoring and escalation.

7 Discussion

This PhD project presents increased knowledge on how to prevent omission events in hospitals with an RRS, using a mixed methods design. It is important to understand research findings in relation to previous and current related research (69). Although a large amount of research on how to structure, implement, and sustain an RRS existed before this PhD project started (101), the results of this thesis highlight that applying this knowledge in real-life settings is essential, and fully utilizing an RRS to prevent omission events, is demanding.

In the following sections, I will discuss the findings from this thesis' integrated synthesis in relation to recent literature.

7.1 Taking overall responsibility for adequate resources

The 24/7 operation of the RRS is dependent on the work of the HCPs in the wards and ICUs. This thesis finds that the operative limbs of the RRS often seemed left functioning on their own. However, as acknowledged at the first consensus conference regarding the RRS (10), they need support from the governance limbs. There is a need for the hospital organisation to take ownership and facilitate several underlying processes to enable the operative limbs of the RRS to prevent omission events, and thus prevent serious AEs.

Investment in structuring a solid RRS system has costs in personnel, including freeing them from clinical work as well as costs for education and training, quality work, equipment, and technology. However, an RRS has the potential to save costs in a longer perspective, by reducing ICU and hospital length of stay (102-104) and increasing patient throughput (104).

To prevent omission events, the thesis findings underline the need to ensure alignment of HCPs and workload in both the wards and the ICU. Several factors contribute to workload in healthcare, such as the number of admitted patients, severity of illness, and patient turnover (105). In this thesis, HCPs described how they struggled to manage competing tasks, and how a deteriorating patient took them away from other patients. ICU staff described how they had to leave ICU patients to tend to an RRS event in the ward. Furthermore, supporting the HCPs statements on how the RRS increased HCPs workload, this thesis also demonstrates how the introduction and development of an RRS increased both the volume of documented vital signs measures and bedside ICU evaluations.

When a patient deteriorates in a ward, the risk of AEs in other patients in the ward increases. This might be due to resources being allocated to the one deteriorating patient, illustrating the challenge of providing safety for all ward patients (106). A high workload for nurses is found to increase the amount of 'care left undone' (107), which again is found to be associated with mortality in post-operative patients (108).

Furthermore, staffing levels of registered nurses are reported to influence the rate of failure to monitor (109) and respond to deteriorating patients (110). The perception of high workload, challenging the RRS is also reported by RRT nurses(111) Staffing levels in the ICU are also found to affect mortality (112), underlining the importance of considering human resources in the ICU when establishing an RRS.

In addition this thesis pinpoints the increased vulnerability of patients during night shifts, with staffing being described as 'cut to the bone'. Delayed responses to deterioration are reported to be particularly challenging at night (109), and associated with worse patient outcomes (113-115). Staffing levels and skill mix at night might be an influencing factor (115).

Research is currently ongoing to find objective measures of workload, to provide better knowledge of when the workload becomes too high, endangering patient safety. This may help hospital organisations decide on adequate staffing levels and the need for resource allocation (116).

To align workload and working staff, the delegation of tasks from highly skilled personnel to personnel with less expertise is common (117). This thesis presents how nurses find it worrying to leave the vital signs measurements to HCAs because it leads to the decoupling of vital signs measurements from the interpretation and increases the nurse–patient divide.

Staff shortages in healthcare are a current and ever-increasing global issue (118). There is a need for interrogating what tasks can be performed by what group of health workers or machines. Task shifting may contribute to strengthening the healthcare system, but it requires planning, education, and training (117). Delegation of vital signs measurements requires a structure and clear line of responsibility from HCA to a registered nurse to increase safety (109). Future availability of continuous monitoring of high-risk ward patients, coupled with machine learning algorithms for deterioration may be a solution that will decrease workload and increase detection of deterioration (119).

Collaboration

The RRS concept is dependent on HCPs who collaborate within and between the afferent and efferent limbs. The identified challenges regarding collaboration in this thesis leave patients vulnerable to omission events. High workloads seem to be one of the factors that challenge collaboration. Thus, focus on a balance between workload and personnel may contribute to better collaboration. Furthermore, familiarity among nurses and physicians on the ward and with the ICU personnel might facilitate collaboration.

Although the value of familiarity to enhance collaboration has been confirmed in other studies (120, 121), it is challenging to ensure familiarity for HCPs working on different shifts, with rotating medical staff. The meeting between the RRT and ward personnel most often means new people gathering each time (120). Proactive rounding from ICU nurses might be valuable in this regard because it increases meeting points between wards, HCPs, and ICU (122).

In this thesis, we have used the umbrella term 'lack of interprofessional trust' to describe collaboration challenges within the RRS. The frequent finding of HCPs being reluctant to alert senior colleagues or the MET, of a deteriorating patient, due to fear of criticism or being seen as incompetent, implies 'low psychological safety' in the organisations. Psychological safety may be defined as '*people's perceptions of the consequences of taking interpersonal risks in a particular context such as a workplace*' (123). In a psychologically safe environment, individuals believe that it is safe to voice concern and speak up, without the risk of being rejected (124). Psychological safety is found to be essential for patient safety (125) but is often found to be lacking in healthcare teams (126).

In my opinion, the findings in this thesis underline the necessity of psychological safety to prevent omission events. Enablers of psychological safety are found at the levels of organisations, teams, and individuals (126). On the organisational level, this includes prioritising patient safety, focusing on improvement and learning, supporting speaking up and raising concerns, and facilitating familiarity across teams. Research is currently working on developing interventions that can effectively improve psychological safety (127, 128).

Furthermore, HCPs in this thesis describe how they value the structure of SBAR when communicating about a deteriorating patient. SBAR is often used in relation to the RRS (129). This structured communication tool has been shown to improve communication between physicians and

nurses (97), prevent communication errors (130), and is associated with improved patient safety (131). Connecting SBAR to RRS protocols and purposively using it in RRS simulation training may be a prudent measure to improve collaboration.

Documentation systems

The findings in this thesis reveal the time-consuming work HCPs are faced with, trying to manage a variety of documentation systems, often including both EHR and loose notes, with variable and inconsistent patient information. Having a robust system for user-friendly patient monitoring and documentation of vital signs and clinical assessment seems to be a necessity for preventing omission events. This thesis shows how going from a system without an RRS, with immature and unclear charts for vital signs documentation, to an RRS with updated paper charts and single-parameter criteria, and finally to NEWS incorporated in an e-OM-chart with colours and time stamps, were associated with increased vital signs documentation and fewer omission events in the study wards.

The importance of user friendliness, and the design of EHR (132) and monitoring equipment is reflected in other studies (109, 133). Decision support alarms in the EHR are associated with a reduction in hospital resuscitation and better patient outcomes (133). EHR usability is also linked to nurse (134) and physician burnout (135).

New technology represents multiple possibilities. Artificial intelligence (AI) linked to the EHR can assist in identifying patients at risk of deterioration (136, 137). Furthermore, continuous monitoring of medical and surgical ward patients vital signs, using wearable devices, has been found to reduce unplanned ICU transfers and RRT calls (123).

The field of developing and implementing technology to assist in monitoring and documentation is currently expanding (138-141). This will undoubtedly change the way HCPs work regarding patient monitoring, hopefully improving safety and reducing workload.

However, the clinical assessment, also include the face-to-face meeting between the HCP and the patient and must never be forgotten.

Education and simulation training

This thesis reveals how HCPs have variable knowledge regarding clinical deterioration and vital signs, the intention of the RRS, and how to collaborate using the elements of the RRS. These findings are consistent with recent studies (109, 120, 142). In this thesis, interprofessional meetings to reflect and discuss are reported to be infrequent in daily work, a finding confirmed in a recent study (143). The HCPs in this thesis request the possibility of interprofessional education and training to address these challenges. RRT nurses that frequently were involved in RRT calls reported it their critical care skills (111). Having RRT members without competing assignments in the ICU, can contribute to the education and support for the ward staff (144, 145).

Simulation based training is a recognised method to improve quality and safety in healthcare(146, 147). This thesis findings indicate that weekly in situ simulation training can improve collaboration because it elicits discussions that highlighted challenges and cleared up misunderstandings, such as the differences in the use of documentation systems. Less time spent trying to manage documentation systems with widespread or missing information might free up more time to care for patients. This might contribute to aligning workload and competent personnel. Interprofessional education and training sessions might also be an opportunity to increase familiarity between nurses and physicians in the ward and with the RRT members.

The value of regular in situ RRS simulation training was demonstrated over a three-year period in a paediatric hospital, with a significant decrease in days spent in the ICU and mortality (102). Calculations also provided evidence of a reduction in costs. The investment in freeing personnel and facilitators for the training sessions was far below the costs saved by reducing the use of intensive care beds.

7.2 Customising the RRS protocol to the organisation's needs

Different RRS models are currently in use globally (148). The findings in this thesis suggest that the choice of a scoring system, the efferent limb structure, and its leadership ought to be intentionally chosen, and thereby followed up to adjust for possible unwanted consequences.

Trigger criteria and monitoring frequency

This thesis presents how HCPs appreciate the ability of trigger criteria to increase their awareness of deterioration, providing structure and a sense of security. They request agreed-upon calling criteria and clear and consistent escalation protocols. Furthermore, the findings demonstrate both the positive effects and challenges of using NEWS incorporated into an electronic OM-chart.

A variety of trigger criteria, both single-parameter systems and EWS, are in use in hospitals today (148). However, the value of trigger criteria relies on compliance of the users (149). Standardised trigger criteria in a hospital have the ability to improve interprofessional collaboration, giving HCPs a common language (150).

In my opinion, choosing validated trigger criteria might facilitate its use. NEWS/NEWS2 is an example from the United Kingdom where it has been in use for a decade (151). A goal when developing NEWS was the standardisation of physiological criteria, leading to an agreed upon definition of 'what is deterioration' within and between hospitals. Large validation studies were conducted (57), and its performance has been compared with other single-parameter criteria and EWS (152).

No matter which criteria are used, the process of customising the trigger criteria for individual patients is a widespread practice (153) that needs to be carefully considered. In this thesis, it is described as both a barrier and facilitator for the RRS. Arguments for having to alter trigger criteria

for patients can be the presence of chronic diseases that impact vital signs, leading to triggering responses even in their most stable periods. Often only the criteria for a single parameter are adjusted (154). Alarm fatigue is a recognised challenge in hospitals (155), and nurses in this thesis report different responses to patients continuously triggering, alarming the physician to make them alter criteria, or just ignoring the trigger, trusting their own judgement. This behaviour of 'normalising the abnormal' and ignoring the NEWS protocol is confirmed in recent studies (109, 150).

Research has been performed to examine the safety of this practice (153, 154, 156), finding that the group of patients who have their criteria altered are vulnerable, have worse outcomes, and the practice does not lead to a reduction in RRT activations.

When considering this practice, it is important to recognise that trigger criteria do not replace clinical judgement, and do not work on their own (157). This thesis highlights how HCPs value the ability to use their clinical evaluation along with the scoring system. This is supported in reviews (157, 158) and a recent study (150). Nurses' 'worry' can indicate patient deterioration at a very early stage (159), before changes in vital signs. Clinical concern as an independent factor to escalate care is recommended in NEWS guidelines (151). Clearly including this element in the RRS protocol is found to give nurses the confidence to escalate care (160). I find it promising that an EWS including the possibility to let nurses adjust the score, adding or retracting points, due to clinical evaluation is recently developed, and found to be non-inferior to NEWS, in terms of all-cause mortality at 30 days (161).

The process of escalating care when worried about a patient with vital signs within normal ranges is reported to be a challenge (150, 158). If the psychological safety of the ward is low, I would expect that escalating care due to worry alone is a rare event. However, if HCPs feel

psychologically safe and are familiar with the physicians on call or RRT, it might have the opposite effect.

Instead of having to adjust for individual patients, for some patient groups, it might be safer to incorporate adjustments into the scoring system. NEWS2 included a separate score for O_2 saturation for patients with respiratory diseases and hypercapnia, to prevent life-threatening over-oxygenation. Incorporating such changes into the scoring system makes it feasible, although still challenging, to study the effect of such changes (162).

The intermittent nature of today's vital signs measurement means patients can deteriorate in between scheduled measurements (163). Vital signs not measured on time, or not completed, increase patient risk (164). A current review supports the implementation of continuously monitoring non-ICU patients (165). Furthermore, continuous monitoring in general wards might also be cost-effective (166, 167). Which patient groups will benefit from continuous monitoring needs to be established (119). Continuous monitoring of ward patients will probably become more common in the future as technology advances. How this is incorporated into RRS protocols—as it will impact on who, how, and when to respond—is of importance (168).

Considering a deteriorating patient's possibility to benefit from medical interventions including transfer to an ICU and knowing the patient's own preferences is important (169). RRTs are often involved in end-of-life care and LOMT discussions (170, 171). The evidence of RRT benefits in this regard is conflicting (172), and these evaluations should preferably be conducted in advance of deterioration, to reduce unnecessary RRT calls, burdensome and expensive interventions, and improve patient-centred care near the end of life (173, 174). A system in the hospital for ensuring that LOMT discussions and other elements of end-of-life care planning when indicated are recommended (175). As this thesis demonstrates, it can be incorporated into RRS protocols. Decision-

making processes regarding LOMTs are known to be challenging (176), thus training of HCPs regarding such decisions is advised (177).

This thesis does not cover the topic of patient and family-activated RRTs. This is recommended by the third international consensus conference on Rapid Response Systems (175), and also in the Norwegian national advice (54). Such an opportunity will provide another layer of safety for the patient and is found to increase patient and family satisfaction (175).

Efferent limb structure and leadership

There is a variety of efferent limb compositions. The literature describes one, two, and three tier (also includes a cardiac arrest limb) response limbs (178). Studies 2 and 3 in this thesis were performed in a hospital with a two-tier efferent limb, where the first tier is expected to be alarmed first, or at the same time as a MET call. According to a recent scoping review (178), the value of such pre-MET tiers is under-researched.

RRTs may be physician- or nurse-led (148). This thesis presents facilitators and barriers for both choices. To my knowledge, there is currently no clear evidence that one leader structure is better than the other (37, 42, 179, 180), but findings in this project suggest that the choice of team structure and how it is employed is important. Different structures lead to conflict on different levels and can involve nurses, ward physicians, and the MET. The potential for such conflict needs to be acknowledged and addressed in education and training sessions to prevent such challenges leading to omission events. A study protocol to further examine the structure of the efferent limb has been newly published (181).

A strategy for overcoming the barrier of the ward personnel manually alarming the efferent limb, including nurses' fear of criticism when making a 'wrong call', is the introduction of proactive rounding by nurses with ICU competence (122, 136, 144, 182, 183), reporting positive outcomes (122, 136). Using AI that analyses EWS and other

relevant information from the EHR to inform the ICU nurse of a patient triggering(136), might be a desired future solution.

7.3 Ensuring continuous follow up of quality for improvement

The need for a limb within the RRS with focus and competence to follow up and improve the system has been acknowledged and described at the first consensus conference on RRSs (10). This thesis confirms the importance of evaluations of RRS performance and follow up on informal rules and attitudes that lead to inconsistent use of the RRS. Audits with responses available for the HCPs and positive feedback loops are valued.

In my opinion, the many challenges faced by HCPs when operating the RRS highlight the importance of focusing on a solid quality limb. Ten quality metrics are recommended for hospitals to measure the function of the RRS and guide quality improvement (175). They include indicators of structure, process, and outcome.

Through data collection in this PhD project, my fellow researchers and I experienced how challenging it is to obtain data to follow RRS metrics. Data collection is dependent on the existing documentation systems and technological solutions in the hospital, their interaction, and possibilities for extracting and analysing the data. The identified differences in HCP documentation routines, what and where to document add to the complexity. This thesis demonstrates how patient record reviews are valuable to probe the RRS system, studying effects and revealing needs for improvement. Although the method is time-consuming, it can be used both prospectively and retrospectively, providing a rich amount of data. Improved availability of comprehensive patient-related data for analysis is warranted. Ongoing work in the field of healthcare data management suggests solutions in the future (184).

RRS events have the possibility to be used as sentinel events for learning and identification of the processes that lead to a high risk of deterioration (185). One suggested method for evaluating the RRTs is the multidisciplinary audit and evaluation of outcomes of rapid response (MAELOR) tool (186, 187). This method gives an overview of the hospital RRS outcomes and can identify departments and wards with a need for further improvement. Importantly, to understand the root causes of underperformance, other methods are needed. Such a system is described in a recent longitudinal study in a paediatric population. In that study, the authors describe a more overall continuous system for follow-up and evaluation of an RRS: By choosing to review a proportion of RRT events, they identified quality gaps that they were able to be systematically address and this led to improvements (188). The authors acknowledge that the success of their improvement system was dependent on commitment within the organisation.

The findings in this thesis illustrate how informal rules in the wards and HCP attitudes put patients in danger of omission events. Hospital organisations need to address this issue accordingly, with a continuous focus directed by the quality limb. A main goal should be building a culture in the organisation of 'no call is a wrong call', as highlighted in the longitudinal study by Acorda et al. (188). This thesis finds that in situ simulations can be an arena to identify and address such issues. The improvements found by Theilen et al. (102) after introducing weekly in situ simulation support this concept.

7.4 Methodological reflections

When studying a complex system such as an RRS, itself embedded within a complex hospital system, combining different methodologies and different research methods provides an opportunity to yield a more comprehensive picture. Although the three papers in this study are far from providing a view of all dimensions of the RRS, they contribute to the continuously expanding research field. Studying the RRS from

'within', through the view of HCPs and through patient records, provides a unique opportunity to increase our knowledge of the real world and its improvement needs to prevent patients from experiencing omission events. All three studies in this thesis have used investigator triangulation to strengthen rigour in the interpretation.

In Paper I, the systematic review sought to have a broad perspective, using multiple search words, and having few exclusion criteria to identify all relevant papers addressing the research question. A limitation with reviews is that the analysis is performed on already analysed data. Nevertheless, the included papers provide a rich amount of data, from different countries, hospitals, and RRS systems, providing a solid foundation for studying barriers and facilitators of the RRS. All the included studies used a qualitative methodology. Reflecting on the chosen review strategy, changing the wording of the research question to incorporate quantitative studies, such as surveys, could have given a mixed-methods review, and possibly some new elements to discuss.

Studies 2 and 3 were conducted in a single Norwegian university hospital. This gave the opportunity to study one RRS both qualitatively and quantitatively. However, such single-centre studies limit the transferability. Study 2 provided rich data material through lively discussions with focus groups in the wards and the ICU. It could have been an advantage to gather the ward personnel and ICU staff in the same focus groups, which could have revealed other dimensions regarding interprofessional collaboration. Establishing such comprehensive simulation scenarios involving both tiers 1 and 2 of the efferent limb is desired in the hospital. Even so, conducting the focus groups the way we did, made the HCPs freely reflect on the challenges related to collaboration between the wards and the ICU. The participants might not have spoken so freely about their negative experiences if they were in the same focus group.

In Paper III, the number of included patients may have led to an underestimation of some of the effects of the RRS. Expanding the time periods or incorporating other wards and departments could have been a possibility. Unfortunately, this would have introduced new biases of a different patient population, ward cultures, and other timings in implementation. A statistician was involved in both design and analysis of this study to enhance the quality of the method..

The work of thoroughly reviewing the trajectory of the last hospital stay of the deceased patients was time-consuming, and thus the number of records to be reviewed has a limit. The retrospective nature of this study, studying patient records going back years, has inherent limitations. The contexts around the patients' deaths are unavailable, and the quality of documentation may influence the findings. Conducting the review closer in time to the event might change the interpretation and provide better opportunities to understand how to improve. Although this approach has merit, it was not feasible during the tenure of this PhD project.

The research groups conducting Studies 2 and 3 represented different professions and specialities, providing a broad perspective. All researchers had a connection to the study hospital. This is both a limitation and a strength.

I find it interesting to reflect on the findings of these two Norwegian studies. Starting with Paper III, the findings mainly present positive outcomes of the RRS introduction and further improvement after the development of the system. The conclusion alone could have resulted in the department leaders being quite satisfied with the results. However, when combined with Paper II, it becomes evident that several improvement opportunities are present, requiring a continuous focus.

The thesis presents a sequential mixed-methods study, with the integrated findings of three consecutive conducted studies presented in this thesis. Several ways of conducting mixed-methods studies are available. The choice of the sequential design gave me the opportunity

of using the results and findings of the first- and later the second study to influence the aim and design of the next.

8 Conclusions

By studying the perceptions of HCPs internationally (Paper I) and nationally (Paper II) and by following the trajectory of patients dying in two hospital wards through a mortality review (Paper III), and finally integrating the findings from the three studies, this thesis contributes to increasing the knowledge on how to prevent omission events in hospital through succeeding with an RRS.

The findings of the integrated synthesis show that to better prevent omission events, hospital organisations need to take overall responsibility for adequate resources, aligning workload and staffing, ensuring that HCPs have clinical and collaboration competence, and providing comprehensive and user-friendly monitoring and documentation systems. Furthermore, there is a need to customise the RRS to the organisation's needs. Consciously choosing trigger criteria and efferent limb structures and being aware of the potential challenges of these choices, are essential. Finally, this thesis highlights the necessity of having a solid quality limb to follow up the RRS both quantitatively and qualitatively to ensure continuous improvement.

This thesis supports the use of simulation-based training as an arena for system probing, building competence in RRS knowledge and improving collaboration. Patient record reviews were also found to be a valuable method for evaluating omission events in an RRS hospital and provide an opportunity for finding arenas for improvement.

8.1 Implications for practice

Based on the findings in this thesis, the following section provides suggestions for clinicians, hospital organisations, and policy makers regarding better prevention of omission events in hospitals through succeeding with an RRS.

8.1.1 Implication for clinicians

The findings of the three themes in the thesis synthesis are of relevance to all clinicians in hospitals. Understanding the impact of their own clinical skills and their ability to collaborate with other healthcare personnel when a patient deteriorates might provide motivation to improve these competences. HCPs' commitment to learning about their hospital's RRS and protocol is essential. If the protocol is unclear, or the system is not used as intended, clinicians should report to their leaders. In addition, understanding the potential consequences of low psychological safety in the care of a deteriorating patient is essential. I believe all healthcare workers have a responsibility to contribute, as best they can, to provide an organisation where it is safe to speak up.

8.1.2 Implications for hospital leaders and policymakers

Hospital leaders on all levels need to contribute to facilitate the HCPs' ability to operate the RRS 24/7. Commitment to and support for the RRS are essential to encourage the HCPs to use the system.

Alignment of workload and competent personnel is of the essence to prevent omission events when patients deteriorate. I recognise that this is challenging in a time of global staff shortages in healthcare. Acknowledging this challenge and working together with clinicians to search for and develop strategies to handle this issue is of importance.

To facilitate interprofessional collaboration, university faculties and hospital leaders need to provide relevant education regarding clinical assessment, knowledge about the RRS and teamwork, and ensure arenas for interprofessional training (simulation training). It is crucial to build a culture where it is safe to speak up.

Ensuring that the hospital has high-quality monitoring and documentation systems is another challenge for hospital leaders.

Protocols for what and where to document essential information such as vital signs, their interpretations, and patient care plans might prevent omission events. This may also save HCPs time and frustration during their workday, helping to align workload and personnel, and possibly improve collaboration.

Hospital leaders need to make a conscious decision about their RRS structure, regarding the choice of trigger criteria, escalation protocol, and efferent limb structure. Possible challenges with the chosen structure should be acknowledged and through quality follow up the system can be adjusted as needed.

This thesis highlights the need for a strong quality limb, continuously working to follow up on the RRS. Leaders need to have knowledge about the performance and improvement needs of their RRS and have a system to enable feedback to clinicians. Quality metrics for the RRS have recently been recommended. Hospitals need systems that make these data easily available. This thesis presents how debriefing sessions in simulations training is a valuable arena for feedback from clinicians, and that patient record reviews are valuable when studying RRS performance and revealing quality gaps.

Quality improvement comes with a cost, and this needs to be acknowledged in budgets. Cost–benefit analyses for an RRS are very challenging due to complexity. Studies imply that there is an economic benefit of omission event prevention. Benefits such as patient and HCP satisfaction are equally important and may have implications for HCP job satisfaction and intentions of employees to remain employed, with positive implications for resource costs.

8.2 Suggestions for further research

The RRS is a complex system introduced into a complex hospital organisation. This thesis provides detailed information on the many

reasons why patients are still experiencing omission events in RRS hospitals, and suggestions for how hospital organisations can better prevent such omissions. This provides several possibilities for further research.

Aligning workload and available clinical competence

Hospitals are currently experiencing, and may face even greater, challenges regarding the alignment of workload and personnel. There is an urgent need to find sustainable ways to align tasks and available clinical competence. This provides opportunities for qualitative and quantitative research projects, to develop solutions and evaluate their consequences for patient monitoring, and HCPs' possibilities to detect and respond to deterioration.

Research to improve collaboration

Criticism and negative attitudes down the hierarchy are ongoing challenges for HCP collaboration. Low psychological safety in hospital wards seems to be an important factor. Ongoing research aims to find ways to increase psychological safety. I suggest that research should explore how regular RRS in situ simulations can influence psychological safety, and thus RRS collaboration. Furthermore, task shifting from one profession to another may influence HCP collaboration and should also be explored.

Research regarding monitoring and documentation systems

There is continuous ongoing development and research on technological solutions for patient monitoring systems, EHR and OM-charts. This influences the care of the deteriorating patient and the workday of HCPs. This provides opportunities for research projects to contribute to comprehensive and user-friendly solutions that improve care and workflow.

Research regarding the afferent and efferent limbs

As discussed in this thesis, different variations in trigger criteria, RRS protocols for a response, and efferent limb structure exist. I believe there is no one strict structure that fits all because it depends on the hospital organisation in question. However, finding the best solution for one hospital can be facilitated with quality improvement methods.

Further, research regarding trigger criteria/EWS is of relevance. For example, more research regarding incorporating clinical assessment in the EWS, as this might prevent alarm fatigue and highlight the value of clinical competence.

There is a need for more research to increase our understanding of how the efferent limb functions best. How the RRT works best at the deteriorating patient's bedside, in collaboration with the ward personnel, seems to be an under-explored field.

The value of mortality review as a method to study the RRS is presented in this thesis. Further research using patient record review on relevant patient groups such as post-operative patients or patients transferred to the ICU might give valuable insight when studying an RRS.

Research regarding the governance limbs

In this thesis, the importance of the governance limbs, the administrative limb and the quality limb are highlighted. I suggest it would be valuable with research projects to understand better how personnel work within and between these limbs, their challenges, and facilitators for supporting an RRS concept. This information would also be valuable for policy makers regarding the funding of quality improvement and patient safety measures in hospitals.

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Part II

Paper I

RESUSCITATION 144 (2019) 75 –90

Available online at www.sciencedirect.com

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Review

Succeeding with rapid response systems – a never-ending process: A systematic review of how health-care professionals perceive facilitators and barriers within the limbs of the RRS

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Abstract

Background: Meta-analyses show that hospital rapid response systems (RRS) are associated with reduced rates of cardiorespiratory arrest and mortality. However, many RRS fail to provide appropriate outcomes. Thus an improved understanding of how to succeed with a RRS is crucial. By understanding the barriers and facilitators within the limbs of a RRS, these can be addressed.

Objective: To explore the barriers and facilitators within the limbs of a RRS as described by health-care professionals working within the system.

Methods: The electronic databases searched were: EMBASE, MEDLINE, CINAHL, Epistemonikos, Cochrane, PsychInfo and Web of Science. Search terms were related to RRS and their facilitators and barriers. Studies were appraised guided by the CASP tool. Twenty-one qualitative studies were identified and subjected to content analysis.

Results: Clear leadership, interprofessional trust and collaboration seems to be crucial for succeeding with a RRS. Clear protocols, feedback, continuous evaluation and interprofessional training were highlighted as facilitators. Reprimanding down the hierarchy, underestimating the importance of call-criteria, alarm fatigue and a lack of integration with other hospital systems were identified as barriers.

Conclusion: To succeed with a RRS, the keys seem to lie in the administrative and quality improvement limbs. Clear leadership and continuous quality improvement provide the foundation for the continuing collaboration to manage deteriorating patients. Succeeding with a RRS is a never-ending process.

Keywords: Rapid response systems, RRS, RRS barriers, RRS facilitators, Healthcare professional perceptions, Deteriorating patients, RRS collaboration, RRS simulation, Succeding with RRS, Continous quality improvement

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https://doi.org/10.1016/j.resuscitation.2019.08.034

Received 22 May 2019; Received in revised form 15 August 2019; Accepted 24 August 2019

Introduction

The implementation of rapid response systems (RRS) to improve patient safety is strongly supported by quality improvement organizations such as the Institute of Healthcare Improvement,[1] and is recommended in international guidelines.[2–4] A successful RRS may be defined as a hospital-wide system that ensures observations, detection of deterioration, and tailored response to ward patients.[5,6] Time is essential, as delayed management has been associated with increase mortality.[7,8]

Two previous systematic reviews[5,9] have found moderate-strength evidence that implementation of RRS is associated with reduced rates of cardiac arrest and mortality. However, because many RRS fail to provide appropriate outcomes, there is debate about their effectiveness, and how to evaluate them.[10–13] Studies focusing primarily on outcomes often have limited assessment of the context, processes or mechanisms leading to those outcomes, and thus provide limited explanations of why RRS work or do not work in clinical practice.[14]

There is general consensus about what constitutes an RRS (Fig. 1), but great variation in how RRS components are constituted and operate.[9]

This highlights the need to identify the factors that contribute to their effectiveness in different operational contexts. If the RRS is not used as intended, expecting results is futile. Even if a hospital has officially implemented an RRS, compliance with the system may be low.[13,15] Cultural barriers may persist,[5] and understanding these is highlighted as essential.[16]

To improve our current understanding of the factors affecting the RRS we performed a systematic review based on the following question: "How do healthcare professionals perceive potential facilitators and barriers within the limbs of a RRS?"

Methods

The present systematic review was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement.[18] A broad search strategy was used to ensure inclusion of all relevant papers.

Search protocol and eligibility criteria

In October 2017 we systematically searched EMBASE, MEDLINE, CINAHL, Epistemonikos, Cochrane, PsychInfo, and Web of Science, for the period 2000–2017 and updated the search on March 20, 2019. The search terms used were: "rapid response team", "medical emergency team", "critical care outreach team", "evaluate", "implement", "utilize", "adopt", "success", "fail", and "barrier" (Appendix 1). An expert librarian assisted with this search.

Inclusion criteria

- Papers published from January 1, 2010–March 20, 2019.
- Original research
- Peer reviewed

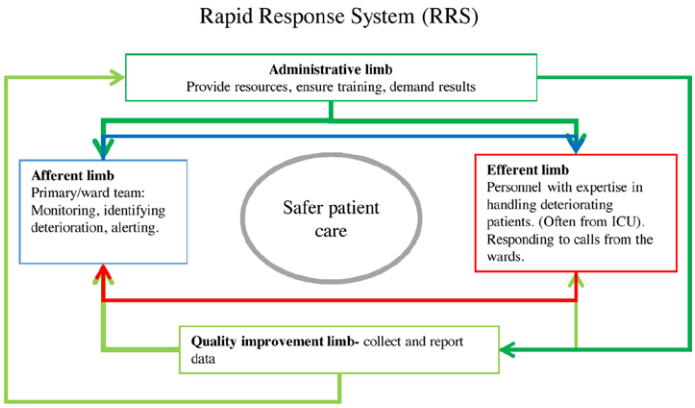

Fig. 1 – The structure of a Rapid response system (RRS), adapted from the findings of the first Consensus Conference of Medical Emergency Teams.[17]
The four limbs of the RRS[6]:
The afferent limb: the systematic process of monitoring patients and detect deterioration supported by predefined criteria.
The efferent limb: the response team with expertice in handling deteriorating patients. The team configuration most commonly used: Medical Emergency Teams (MET), often led by a physician from the ICU, Rapid Response Teams (RRT), in Australia used synonymous with MET, but in US often led by nurses. Critical Care Outreach Teams (CCO) most commonly used in UK, often staffed by ICU nurses.
The administrative limb: oversees the system. Ensure personnel and equipment resources, training and education.
The quality improvement limb: collect and report data, provide feedback and thereby improve the system.

- All study designs
- Languages: English, Norwegian, Swedish and Danish.
- RRS with at least an afferent and an efferent limb.

Exclusion criteria

- In consensus it was decided to exclude articles published before 2010, to focus on the newest publications.
- Articles on paediatric RRS and subgroups (example: pulmonary embolism RRT's, obstetric RRT's).

Study selection

We performed an initial screen of publications (3024) to remove duplicates, then read all titles and abstracts; full-text articles were retrieved if they appeared to meet the inclusion criteria and addressed the predefined review question. The full-text was also retrieved if the title and abstract gave insufficient information to allow immediate exclusion. Four papers used multiple designs, and only the qualitative component addressing the review question was included[19–22] (Fig. 2).

Data extraction

The data extraction process involved familiarization with and comparison of the included studies. The papers that addressed our research question used a qualitative approach, so we performed a qualitative content analysis[23] (Table 3). The findings were organized according to the four limbs of the RRS model (Fig. 1)

Quality and risk of bias

Study quality and risk of bias were evaluated using the Critical Appraisal Skills Programme (CASP) tool[24] (Table 1). Two papers were excluded because of low quality.

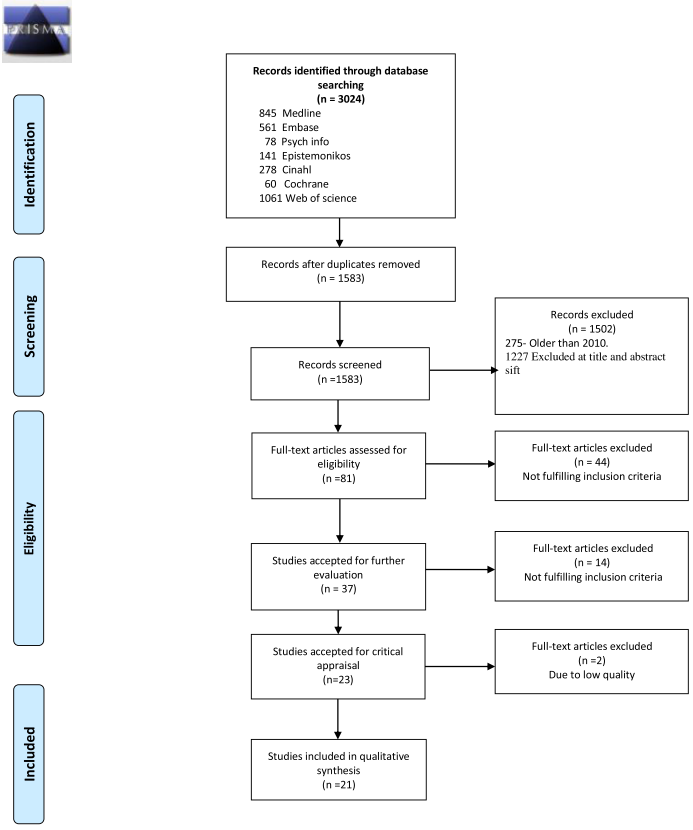

Fig. 2 – PRISMA flow chart.

Table 1 – Critical appraisal: critical appraisal skills programe (CASP) tool.

		Validity - is it worth continuing?						What are the results?			Will the results help locally?	
Journal	Author, year	CASP 1: Clear aim statement	CASP 2: Qualitative methodology appropriate	CASP 3 Appropriate research design to adress aims?	CASP 4: Appropriate recruitement strategy	CASP 5: Data collection to address research question	CASP 6: Consideratation of releationship between researcher and participants	CASP 7: Ethical considerations	CASP 8: Rigorous data analysis	CASP 9: Clear statement of findings	CASP 10: How valuable is the research	Comments
Journal of clinical nursing	Astroth et al., 2012	YES	YES	Yes	YES	Yes	NO	YES	Yes	YES	Valuable findings: addressing review question.	Cannot use the qualitative part on its own. It supplements the survey. Excluded
Americal Journal of Critical Care	Bagshaw et al., 2010	YES	Used as part of survey	Yes	Yes	Yes	NO	NO	NO	NO	Valuable findings: addressing review question.	
BMJ Quality and Safety	Benin et al.	YES	YES	YES	YES	YES	NO	YES	YES	YES	Valuable findings: addresing review question.	
The Americal Journal of Nursing	Braathen, J., 2015	YES	YES	YES	YES	YES	NO	Yes	Yes	YES	Valuable findings: addressing review question.	
Australian critical care	Curry et al., 2017	YES	YES	YES	YES	YES	NO	YES	YES	YES	Valuable findings: addressing review question.	
Journal of nursing care quality	Douglas et al., 2016	YES	Yes	Yes	YES	YES	Not relevant	YES	No	No	Valuable findings: addressing review question.	
BMJ Quality and Safety	Elliot et al., 2014	YES	YES	YES	YES	YES	NO	YES	YES	YES	Valuable findings: addressing review question.	
International Nursing Review	Jeddian et al. 2017	YES	YES	YES	YES	YES	NO	YES	YES	YES	Valuable findings: addressing review question.	
Journal of Interprofessional Care	Kitto et al., 2015	YES	YES	YES	YES	YES	NO	Yes	No	Yes	Valuable findings: addressing review question.	
Americal Journal of Critical Care	Leach LS, and Mayo AM. 2013	YES	YES	YES	YES	YES	NO	YES	YES	YES	Valuable findings: addressing review question.	
Social Science and Medicine	Mackintosh et al., 2014	YES	YES	YES	YES	YES	NO	YES	YES	YES	Valuable findings: addressing review question.	
BMJ Quality and Safety	Mackintosh et al. 2012	YES	YES	YES	YES	YES	No	YES	YES	YES	Valuable findings: addressing review question.	

Table 1 *(continued)*

		Valitidy - is it worth continuing?						What are the results?			Will the results help locally?	
Journal	Author, year	CASP 1: Clear aim statement	CASP 2: Qualitative methodology appropriate	CASP 3 Appropriate research design to adress aims?	CASP 4: Appropriate recruitement strategy	CASP 5: Data collection to address research question	CASP 6: Consideratation of releationship between researcher and participants	CASP 7: Ethical considerations	CASP 8: Rigorous data analysis	CASP 9: Clear statement of findings	CASP 10: How valuable is the research	Comments
Australian Critical Care	Massey et al., 2014.	YES	YES	YES	YES	YES	YES	YES	YES	YES	Valuable findings: addressing review question.	
Journal of Advanced Nursing	McDonnell et al. 2012	YES	YES	YES	YES	YES	NO	YES	Yes	YES	Valuable findings: addressing review question.	
Journal of Advanced Nursing	McGaghey et al., 2017	YES	YES	YES	YES	YES	NO	YES	YES	YES	Valuable findings: addressing review question.	
International Journal of Health Policy and Management	Rihari-Thom-as et al., 2017	YES	YES	YES	YES	YES	YES	YES	YES	YES	Valuable findings: addressing review question.	
Advanced Journal of Nursing	Shapiro et al., 2010	YES	YES	YES	YES	YES	NO	NO	YES	YES	Valuable findings: addressing review question.	
BMJ quality and safety	Shearer et al., 2012	YES	YES	YES	YES	NO	NO	Yes	NO	NO	Valuable findings: addressing review question.	The quality as a qualitative paper is not suffi-cient. Excluded.
Journal of Clinical Nursing	Smith D, Aitken LM, 2015	YES	YES	YES	YES	YES	NO	YES	Yes	Yes	Valuable findings: addressing review question.	
Intensive and Critical Care Nursing	Stafseth et al., 2016	YES	YES	YES	YES	YES	NO	YES	YES	YES	Valuable findings: addressing review question.	
Journal of Nursing Care quality	Stewart et al., 2014	YES	YES	YES	YES	YES	Yes	NO	YES	YES	Valuable findings: addressing review question.	
Australian Critical care	Chua et al., 2019	YES	YES	YES	YES	YES	YES	YES	YES	YES	Valuable findings: addressing review question.	
BMC Emergency medicine	Petersen et al., 2017	YES	YES	YES	YES	YES	YES	YES	YES	YES	Valuable findings: addressing review question.	

Results

We included 21 qualitative papers in the final review (Table 2). Different terms used to describe the efferent limb were standardised in this review as RRT.

Categories and themes that emerged in the analysis are presented in Table 3. Findings connected to the efferent limb were intertwined with the afferent limb, thus presented under the headline 'The connection of the Afferent and Efferent limb'. Key findings are presented in Table 4.

Administrative and quality improvement limbs

The barrier of disconnected leadership and vague lines of responsibility

The influence of leadership and vision

Organizational leadership support[14,25,26] and having a mission-driven organization[25] were described as essential: "*People who work in this hospital are really aware of our mission and they are committed to care for our patients and to our purpose*".[25] Conversely, poor governance associated with a lack of protocols or equipment, poor logistics and lack of commitment by senior staff and management were viewed as barriers.[27]

Unclear protocols with lack of integration in handover processes

Confusion around when to call the RRT and their optimal response[26–33] was a frequently reported barrier. By contrast, clear call-criteria, including the expectation that when in doubt, a call should be made, was described as a facilitator.[29] Normalization of breaches of RRS-protocol during busy periods were percieved to undermine the system.[34,35]

Cooperation and patient flow were facilitated by incorporating RRT events into the handover processes and daily use of early warning scores (EWS) in unit rounds.[22,28]

Inconsistent education

Low priority of education regarding the RRS and management of deteriorating patients[14,25,30] was a barrier while training was a facilitator,[25,27,36] with an emphasis on joint training sessions between ward staff and the RRT[35] and the use of simulation-based training.[25] Training in the use of EWS as early as in university was described as a facilitator.[36] Physicians worrying the system could deskill junior physicians was a barrier,[33,37] while viewing RRT calls as learning opportunities was a facilitator.[37,38]

Lack of equipment, personnel and integration with other hospital systems

HCP described that the RRS increased workload,[14,28,35,37,38] and staff shortages were seen as a barrier.[21,27–29,31,38] An example was too few RRT respondents: "*There is one [Registrar] in the whole hospital and there could be six [rapid response] calls at once, and how can they possibly get to six?*".[29] Nurses described applying an informal triage when wards were busy, allowing them to focus on sicker patients and reduce monitoring of other patients.[35] Not wanting to disturb a busy ICU-nurse or physician,[28,29] or knowing the ICU was

Table 2 – Included papers.

Author/ Journal	Year	Title	Aim/purpose	No of participants	Location/ hospital size	Study design	RRS model
Astroth et al./ Journal of Clinical Nursing	2013	Qualitative exploration of nurses decisions to activate rapid response teams	To identify barriers and facilitators to nurses' decisions regarding activation of rapid response teams (RRTs) in hospitals.	15 medical/surgical nurses	Three medial/surgical units at a Midwestern community hospital.155-beds.	Qualitative design; semi-structured individual interviews.	Monitoring: Calling criteria, not further described. Response: RRT (Rapid Response Team), includes ICU nurses.
Benin et al./ BMJ Quality and Safety	2012	Defining impact of a rapid response team: qualitative study with nurses, physicians and hospital administrators	To qualitatively describe the experiences of and attitudes held by nurses, physicians, administrators and staff regarding RRTs.	49 participants: 18 registered nurses, 8 administrators, 6 primary team senior attending physicians, 6 house staff members, 4 RRT attending physician, 4 RRT critical care (SWAT) nurses, 3 RRT respiratory technicians.	Yale-New Haven Hospital- academic hospital in Connecticut. 944 beds.	Qualitative design; semi- structured interviews.	Monitoring: Trigger criteria, expecting the nurse to call RRT and primary team when patient is triggering. The decisions could be made jointly. Response: Adult RRT from 2005, covering 43 units. RRT composed of hospitalist physician, a critical care "SWAT" nurse, and a respiratory therapist.
Braaten J./The American Journal of Nursing	2015	Hospital system barriers to rapid response team activation: a cognitive work analysis	To use cognitive work analysis to describe factors within a hospital system that shape medical- surgical nurses' RRT activation behaviour.	12 participants: medical/surgical nurses.	Medical-surgical units in acute care hospital, Colorado. 500 beds, non- for -profit, non- teaching hospital.	Qualitative design: 1) Document review, (RRT policy and protocols) 2) Individual interviews.	Established 2005: Monitoring: Calling criteria Response: RRT, with standardized policy. Not further described.

Table 2 *(continued)*

Author/ Journal	Year	Title	Aim/purpose	No of participants	Location/ hospital size	Study design	RRS model
Chua et al./ Australian Intensive Care	2019	A call for better doctor- nurse collaboration: A qualitative study of the experiences of junior doctors and nurses in escalation care for deteriorating ward patients	To explore the experiences of junior doctors and nurses in escalating care for clinically deteriorating ward patients in an acute hospital with a MET service and to understand the barriers surrounding the escalation of care.	24 participants: 14 nurses and 10 junior doctors.	1000 bed acute tertiary care public hospital in Singapore.	Qualitative design: Semi-structured individual interviews.	From 2009: Monitoring: Single parameter MET (Medical Emergency Team) criteria. Including the "worried" criteria. Response: ICU based MET systems. Led by ICU physician (ICU advanced trainee or registrar in respiratory and critical care medicine or internal medicine) supported by ICU nurse and a respiratory therapist. Available accredited intensivist for immediate consultation. Patients with abnormal vital signs but not reaching the MET criteria: Nurses can initiate an ad hoc review by primary team doctors.
Currey et al./ Australian Critical Care	2017	Critical care clinician perceptions of factors leading to Medical Emergency Team review	To explore perceptions of intensive care unit (ICU) staff who attend deteriorating acute care ward patients regarding current problems, barriers and potential solutions to recognising and responding to clinical deterioration that culminates in a Medical Emergency Team review.	207 respondents in 31 group surveys. 49% ICU nurses, 27,8% ICU educators or liaison nurses, 2,1% ICU medical registrars, 11,9%consultans,7,7% nurse managers.	Participants attended the Australia and New Zealand Intensive Care Society Rapid Response Team conference in Melbourne 2014.	Descriptive exploratory design: Group survey, open ended questions with written responses, qualitatively analysed.	Do not describe the different RRS the participants work within. Refers to the consensus of a RRS with four limbs. "These components reflect the Australian Commission for Quality and Safety in Healthcare (ACSQHC) national standard for recognising and responding to clinical deterioration in acute healthcare".
Douglas et al./ Journal of Nursing Care Quality *Qualitative part of study*	2016	Nursing and Medical Perceptions of a Hospital Rapid Response System -New Process But Same Old Game?	To explore and compare nursing and medical staff perceptions of MERT use at a large tertiary hospital with a mature RRS.	129 participants had open ended text contributions- 87 registred nurses and 87 medical staff.	929 bed hospital, teaching hospital, Queensland Australia	Qualitative design: Open ended questions in survey is qualitatively analysed.	Monitoring: A standardized observation and response chart. Single-parameter system, with 2 graded response-categories, yellow: clinical review, orange: MERT review. Response: MERT (medical emergency response team): Critical care expertise. Works alongside a code blue team.
Elliot et al./BMJ Quality and Safety	2014	Clinical user experiences of observation and response charts: focus group findings of using a new format chart	To report initial clinical user experiences and views following implementation of track and trigger charts in	44 focus groups with 218 clinical ward staff. (mostly nurses) Who had received training	8 trial sites, acute healthcare facilities in Australia.	Qualitative design; focus-group interviews.	Monitoring: A standardized observation and response chart. Single- parameter system, with 2 graded response-categories,

(continued on next page)

Table 2 *(continued)*

Author/ Journal	Year	Title	Aim/purpose	No of participants	Location/ hospital size	Study design	RRS model
		incorporating a track and trigger system	adult general medical- surgical wards	and used charts for 2-6 weeks.			yellow: clinical review, orange: MERT review. Response: MERT: Critical care expertise. Works alongside a code blue team.
Jeddian et al./ International Council of Nurses	2017	Implementation of a critical care outreach service: a qualitative study	To explore hospital staff perceptions of the perceived challenges and outcomes of the implementation of a critical care outreach service	24 persons: Focus groups of 21partic-ipants.(2 homoge-nous groups one with CCOT one with ward nurses) and 7 individual interviews. Participants: 6 CCOT members, 11ward head nurses, 5 ward nurses, 2 physicians.	Tertiary teaching hospital, Iran- Teheran. 800 beds. 5 critical units: 54 beds.	Qualitative design; focus-group interviews.	Monitoring: Criteria Patient categorized as being high, moderate and low risk by a outreach nurse. Response: CCOT (critical care outreach team): A supplementary service to 13 med- surg wards. Consisting of 6 nurses from ICU- 24 hour service. Responsibility remained with the admitting physician.
Kitto et al./ Journal of Interprofessional Care	2014	Rapid response systems and collective (in)competence: An exploratory analysis of intraprofessional and interprofessional activation factors	To explore the reasons why staff members do not activate the RRS.	10 focus groups across 4 hospital settings. Total: 27 doctors, 67 nurses.	Monash Australian hospital system. In four hospitals. Total of 2100 beds. 2 suburban hospitals, 1 elective centre, and 1 large teaching hospital	Qualitative design; focus-group interviews.	Monitoring: RRS Calling criteria, not further described. Response: RRS No specific description.
Leach, Mayo/ American Journal of Critical Care	2013	Rapid response teams: Qualitative analysis of their effectiveness.	To describe effectiveness of rapid response teams in a large teaching hospital in California. Investigating RRT performance in the context of organisational social processes.	17 participants: hospital leaders, RRT members, bedside nurses, physician leaders.	Large public tertiary care teaching hospital, California	Qualitative design; Semi-structured individual interviews.	Monitoring: Calling criteria not described Response: RRT- nurse-led, including bedside nurse, respiratory therapist, primary physician intern and resident. RRT-Nurses were exclusively hired for RRT, no other assignment that day. Responds to RRT calls, go rounds to identify RRT patients, involved also in cardiopulm arrests.
Mackintosh, Humphrey, Sandall/Social Science Medicine	2014	The habitus of 'rescue' and its significance for implementation of rapid response systems in acute health care	To explore the social and institutional processes associated with the practice of rescue, and its implications for the implementation and effectiveness of Rapid Response Systems (RRSs) within acute healthcare.	35 participants. doctors, ward nurses and critical care nurses, healthcare assistants, safety leads and managers.	Two hospitals NHS, UK. Called Eastward and Westward.	Qualitative design: Inidvidual interviews.	Eastward: Monitoring: EWS (Early Warning Score), two wards piloting an IAT (intelligent assessment technology) and PDA (personal digital assistants) Response: Patients medical team, and on-call team. Westward: Monitoring: EWS, escalation

Table 2 *(continued)*

Author/ Journal	Year	Title	Aim/purpose	No of participants	Location/ hospital size	Study design	RRS model
							protocol Response: CCOT from 2001 with critical care nurse and physiotherapist. Operating on daytime, referring to a MET with intensive care physician if concerned.
Mackintosh, Rainay, Sandall/BMJ Quality and Safety	2012	Understanding how rapid response systems may improve safety for the acutely ill patient: learning from the frontline	To explore the RRS used in the management of escalation on two large hospitals, understanding what works in what circumstances - and why.	35 participants. Interviews of doctors, ward and critical care nurses, healthcare assistants, safety leads and managers.	Two hospitals NHS, UK. Called: Eastward and Westward.	Comparative case study. Qualitative method with observations, interviews and data analysis. Focus in this review: The semi-structured individual interviews.	Eastward: Monitoring: EWS, two wards piloting an IAT (intelligent assessment technology) and PDA (personal digital assistants) Response: Patients medical team, and on-call team. Westward: Monitoring: EWS, escalation protocol Response: CCOT from 2001 with critical care nurse and physiotherapist. Operating on daytime, referring to a MET with intensive care physician if concerned.
Massey et al./ Australian Critical Care	2014	Nurses' perceptions of accessing a Medical Emergency team: A qualitative study	To explore nurses' experiences and perceptions of using and activating a MET, in order to understand the facilitators and barriers to nurse's use of the MET.	15 ward nurses	Public teaching hospital in Australia, Queensland.	Interpretive qualitative approach, in depth semi-structured interviews.	Monitoring: Single parameter calling criteria. Response: MET A separate cardiac arrest team.
McDonnel et al./Journal of Advanced Nursing	2012	A before and after study assessing the impact of a new model for recognizing and responding to early signs of deterioration in an acute hospital	To evaluate the impact of a new model for the detection and management of deteriorating patients on knowledge and confidence of nursing staff in an acute hospital.	15 nurses.	District hospital in England (550 beds) - on 12 wards: all inpatient areas: medicine, surgery, orthopaedics, gynaecology, stroke services.	A part of a mixed-method study: Qualitative design: Semi-structures interviews	Monitoring: Two-tier track and trigger system- all patients monitored using two charts- the normal chart- and if triggering- the PAR chart (Patient at Risk chart). Response: CCOT not further described.
McGeughey et al./Journal of Advanced Nursing	2017	Early warning systems and rapid response to deteriorating patient in hospital: A realist evaluation	To test the Rapid Response program theory against actual practice components of the RRS implemented to identify those mechanisms which have an impact on the successful achievement of	28 participants in individual interview (senior managers, managers, junior doctors, EWS and ALERT champions. 34 participants in focus group interviews (staff nurses, student nurses and	Northern Ireland. 2 hospitals, 2 wards in each: 4 sites- one high-risk (med) one low risk (surg) in each hospital.	Qualitative design; semi-structured individual interviews and focus-group interviews. (Part of a realist evaluation, also reviewing the litterature regarding RRS, and a document analysis)	Monitoring: EWS Response protocols and ALERT training- Response: Ward physicians/on call physicians.

(continued on next page)

Table 2 *(continued)*

Author/ Journal	Year	Title	Aim/purpose	No of participants	Location/ hospital size	Study design	RRS model
			desired outcomes in practice	healthcare assistants			
Petersen et al./ BMC Emergency Medicine	2017	Barriers and facilitating factors related to use of early warning score among acute care nurses: a qualitative study	To identify barriers and facilitating factors related to the use of the EWS escalation protocol among nurses.	18 nurses: 7 surgical and 11 medical.	Urban hospital in the capital region of Copenhagen, Denmark. 700 bed	Qualitative design; focus-group interviews.	Monitoring: EWS implemented since 2012. Response: From 2007: MET constituted of a senior registrar or staff specialist in anaesthesia and a specially trained ICU nurse. All staff allowed to call MET regardless of EWS.
Rihari-Thomas et al./ International Journal of Health Policy and Management	2017	Clinician Perspectives of Barriers to Effective Implementation of a Rapid Response System in an Academic Health Centre: A Focus Group Study	Aimed to explore and understand how doctors and nurses experience this system, and how and negotiate care for deteriorating patients within the RRS environment: Objectives 1) ascertain factors that affects implementation and ongoing effect of the RRS, and ascertain clinicians perception of its efficacy and utility when the initial tier of medical response is led by the patients admitting team.	34 participants: 21 physicians and 13 registered nurses	Australia, academic health centre.	Qualitative design; focus-group interviews.	RRS in place for 5 years. Monitoring: A multitiered vital sign parameter track and trigger system. Response: Tier 1 clinical review. (The Unit RNs- performing a thorough exam) Tier 2: RRT: in this case: The admitting medical team, and out of hours- the dedicated facility physicians. Tier 3 activate MET from ICU. *Tier parameter criteria can be modified to create individual patient customisation.
Shapiro et al./ American Journal of Nursing	2010	Rapid Response Teams Seen through the Eyes of the Nurse - How nurses who activate such teams feel about the experience and why it matters	Aim to report the impact of rapid response teams as seen through the eyes of the nurse.	56 staff nurses	from 18 hospitals in 13 states: USA. teaching and non-teaching, different settings(wards)	Qualitative design, focus groups	Monitoring: Objective criteria, and worried. Response: 18 hospitals with RRT- great variations in response teams. *9 hospitals- viewed here as “early robust adopters” (Hospitals where nurses were enthusiastic about RRS) *9 hospitals” reluctant adopters (nurses not enthusiastic about RRS)*.
Smith DJ, Aitken LM/ Journal of Clinical Nursing. *Qualitative part of study.*	2015	Use of a single parameter track and trigger chart and the perceived barriers and facilitators to escalation of a deteriorating ward patient: a mixed methods study.	To explore the barriers and facilitators percieved by the nursing staff relating to patient monitoring.	31 participants: 11 registred nurses, 7 pre registration nurses, 13 healthcare assistants. (from 4 wards)	Tertiary referral hospital within central London.	Qualitative design, Questionnaire with open ended questions: qualitatively analysed (As part of a mixed method study: Also includes a chart audit, results guiding the questionaire)	Monitoring: Single parameter track and trigger. Three vitals signs that could trigger response. Response: CCOT (Critical Care Outreach Team)
Stafseth et al./ Intensive and	2016	The experiences of nurses	To explore experiences of nurses	7 nurses.		Qualitative design; semi-structured	Monitoring: MEWS (Modified Early

Table 2 *(continued)*

Author/ Journal	Year	Title	Aim/purpose	No of participants	Location/ hospital size	Study design	RRS model
Critical Care Nursing		implementing the Modified early Warning Score and a 24-hour on-call Mobile Intensive Care Nurse: An exploratory study	implementing and using the MEWS and a mobile intensive care nurse (24/7- nursing support)		Oslo University Hospital, Rikshospitalet, Norway.	focus group interviews.	Warning Score), Response: MICN (Mobile Intensive Care Nurse) -Using MEWS was voluntarily.
Stewart et al./ Journal of Nursing Care Quality *Qualitative part of study*	2014	Evaluation of the Effect of the Modified Early Warning System on the Nurse-Led Activation of the Rapid Response System	To evaluate the use of MEWS as a framework in the decision-making-process for RRS activation by nursing.	11 nurses from 3 medical-surgical units.	Acute care hospital in Pennsylvania, 242 beds	Qualitative design; focus group interviews. (As part of a mixed methods study, also performed medical record review)	Monitoring: MEWS (Modified Early Warning Score) introduced in 2011. Response: Have an response team- not further described.

Table 3 – Categories and themes.

	Administrative and Quality improvement limbs							
Themes	**The barrier of disconnected leadership and vague lines of responsibility**							
Categories	*The influence of leadership and vision*	*Unclear protocols with lack of integration in handover processes*	*Inconsistent education*	*Lack of equipment, personnel and integration with other hospital systems*	*The value of involvement and continuous follow-up*			
	Afferent limb						**The connection of the Afferent and Efferent limb**	
Themes	**The barrier of underestimating complexity**						**The barriers lies in lack of trust and respectful behavior**	
Categories	*The missing link between measuring and interpreting*	*Challenges in the use of observation and documentation systems*	*The value of knowing the patient*	*The complex inter-professional "knotworking" processes*	*The severity of clinical change*	*RRS protocol vs. reality*	*Lack of inter-professional trust and challenges of collaboration*	*Not knowing the patient*

full could prevent nurses from activating the RRT.[30] HCP describe lacking a system to determine how and when additional resources could be provided.[35] Other barriers were not having hospital-wide systems for end-of-life-care decisions and planning,[27,38] pain management and palliative care services.[38]

Missing electronic tracking of vital signs and non-integration of monitoring with other infrastructure was a barrier.[27] As were poorly designed documentation-charts, the simultaneous use of multiple charts[27,32] and different scoring-systems within one hospital.[39] Unreliable, outdated, inefficient and poorly maintained equipment hindered the RRS.[21,27]

The value of involvement and continuous follow-up

The involvement of HCP in continuous quality improvement was described as a facilitator.[25] The availability of training, followed up by local audits and positive written responses were considered important components to succeed with the RRS,[29,34] as was a process for immediately addressing problems, such as the intimidation of nurses.[25] By contrast, conflict was created by audits focusing solely on nursing assignments and not on the behaviour of the responding physician.[34] EWS-audits lost their effect when staff did not receive feedback.[14]

The afferent limb

The barrier of underestimating complexity

The missing link between measuring and interpreting vital signs

Due to high workload, vital-sign measurements were made by the least-qualified; health-care assistants and students,[14,21,34] leading to an interval between the measurements and their interpretation.[21,34] This was considered to increase the distance between nurses and patients[14,21,34] and to reduce vital-sign monitoring to a technical task.[14] Although technology was seen as a solution to facilitate monitoring, the time spent "doing the vitals" was also seen as an important opportunity to observe and interact with patients.[35]

Challenges in the use of observation and documentation systems

HCP perceived track and trigger charts[20] and EWS[22,39] as valuable for increasing awareness about deteriorating patients, assisting physicians in prioritizing care[34,39] and to enhance intraprofessional communication.[22,36] Clearly defined documentation-charts and protocols made staff more confident about seeking help.[20,32,39] Ward staff reported using a combination of the call-criteria and their clinical judgement[14,33,40]: *"It should be an in-hand system, but it shouldn't be the system.*[14] It was a facilitator when nurses could

Table 4 – Summary table of key findings.

RRS limb	Facilitators	Barriers
Administrative and quality improvement limbs	Leadership support	Poor governance
	Shared mission	Lack of commitment
	Involvement of healthcare professionals	Unclear protocols
	Continuous quality improvement	Lack of staff
	Interprofessional training	Lack of equipment
		Poorly designed and integrated monitoring- and documentation systems
Afferent	Knowing the patient	High workload
	Clearly defined protocols	Disconnection between vital-sign measurements and interpretation
	Empowered nurses and physicians	The existing hierarchy
		Challenges in use of monitoring- and documentation systems
The connection between the afferent and efferent limb	Expertise	Reprimanding down the hierarchy
	Patient centered teamwork	Waiting for the patient to get worse

call the RRT based on clinical impression and concern[29] or if they felt the primary physician/on-call physician was not "doing their job", was inexperienced,[40] or unavailable.[29,33,37,40]

The availability of real-time data via technological solutions facilitated the RRS by allowing doctors to access patient's vitals from other sites. However, this technology could be a barrier if access was cumbersome in emergency situations; e.g. having to log on to a computer.[39] Delays of vital-signs entry into the electronic health records could delay the detection of clinical deterioration.[31]

Barriers were described in HCPs use of documentation systems,[22,27,28,32] for example: charts had incomplete dataset and incorrectly calculated EWS,[14,22] deliberately not documenting vitals in the electronic management system when wards were busy, seeing this as only a bureaucratic task[35] and documenting altered call-criteria for patients on loose notes.[28] The introduction of a chart with ranges rather than exact numbers resulted in double documentation or nurses having to estimate numbers when speaking with physicians[32] posing as barrier.

The customization by physicians of call-criteria for individual patients, was viewed as both a facilitator and a barrier.[19,22,28,32] One publication described how this practice had resulted in both inappropriate changes to avoid alarms and reluctance to change criteria resulting in unnecessary activation.[28]

The value of knowing the patient

Continuity of care and knowing the patient were perceived as important for the detection of subtle changes.[20] Nurses valued clinical intuition to monitor patients and take extra vital-signs when concerned, but resented being instructed to do so, without a good reason, by junior physicians.[35] Not having time to *"lay eyes on the patient"* was perceived as a barrier.[31] HCP worried focusing on EWS might mean overlooking cues such as blood results and overall clinical assessment[22,39] and decline in patient assessment skills.[19,32] HCP reported that in daytime, they preferred to call the primary team rather than the RRT because of their familiarity with the patient's condition.[40]

The complex inter-professional "knotworking" process

HCP believing that the RRT brought expertise and could expedite transfer of patients to higher-level care and improved patient outcomes30 facilitated the RRS. However, the nature of the detection/decision-making process differed between nurses (hierarchical and protocol-based) and physicians (autonomous).[19,27,33,34]

The process of deciding whether to activate the RRT, were described by Kitto et al.[33] as "knotworking"; nurses and physicians constantly collaborated vertically (with senior colleagues) and horizontally (between nurse and physician) to identify the appropriate place for the RRT. Physician autonomy could be a barrier to this process,[19,28,32,34] but when nurses could obtain help without seeking permission, the RRS was described as empowering.[29,37]

HCP described that calling the RRT could be a way of realigning the workload to ensure that other patients were not neglected.[29,35,37] Nurses reported that knowing they could get help from colleagues to care for other patients while attending a RRS event, was an important facilitator.[29,30]

The severity of clinical change

The perceived severity of a patients clinical condition influenced the likelihood of a RRT activation, with high EWS[35] or abrupt/serious changes being an acceptable trigger for RRT calls.[31,40] Physicians described the RRT as " . . . *the go-to team to provide urgent diagnosis and periarrest resuscitation* . . . " Being able to call the RRT when concerned was described as an important facilitator,[22,36] but subtle clinical changes often required navigation around system obstacles.[14,31,34,40] Nurses described being afraid the patient was not sick enough to require the call[26,30]; often waiting for "*it to get worse*", searching for support to validate clinical decisions[22,26,30,31] or using closer monitoring to find an objective trigger to justify a call.[14,31] In these situations, HCP highlighted the importance of communication, and the ability to articulate the exact patient problem clearly.[40]

RRS protocol vs. reality

Confusion and lack of clarity around protocols,[27,31,32] which introduced variations in response behaviour,[39] was reported as a barrier. Despite having a track and trigger system, escalation often went through the hierarchy of the system.[21,40]

Perceptions of the call-criteria influenced their usefulness.[14,19,26,28,30–32,35] Perceiving them as too sensitive[35] or non-specific[22,31] created alarm fatigue.[19,28,32] Nurses believing they could handle the situation themselves,[30,31,35] HCP finding EWS and their own clinical judgement conflicting[14,22] and disagreeing with the set parameters[26] were barriers. One publication described how it was

regarded as acceptable for nurses to falsify observations if they felt the patient was okay, to avoid having to explain why they did not react to an abnormal parameter.[32] Omission of monitoring at night because of nurses concern about sleep deprivation was also reported.[35]

The connection of the afferent and efferent limb

The barriers in lack of trust and respectful behaviour

The lack of interprofessional trust and challenges of collaboration

Multiple papers reported that ward physicians or RRT members reprimanded, criticized or had a negative attitude toward a nurse who called the RRT.[19,25–27,29–31,33,35,37,40] Nurses' believed that this behaviour might be caused by ward physicians feeling of failure if the nurse called the RRT directly: «*going over the head of the physician*".[25,29,31,37] This, provoked by physicians fear of being seen as clinically inept[28,40] or being ashamed to ask for help.[35]

Junior physicians described fearing criticism by senior staff for activating the RRT,[27,28,34,40] and had learned they should manage on their own.[34,40] Ward nurses were also concerned about being seen as incompetent by the RRT.[26,29–31] Perceiving RRT-calls as a failure disrupted the collaboration with the RRT.[25]

Ward nurses valued the RRT-nurse, regardless of "*their place in the RRT*".[29] Having a dedicated full-time RRT-nurse working next to the ward nurses[25] or doing rounds on units,[31] were described as facilitators. Nurses also reported a lower threshold for calling a nurse-led RRT, than a physician-led RRT.[36] One study reported that a nurse-led RRT supported junior medical staff and facilitated communication with more senior staff,[39] but another reported that physicians found nurse-led RRT difficult to accept.[38] RRT-members acting as mentors for ward nurses30 and providing education for all ward staff[34,37,38] facilitated the RRS.

Nurses were more inclined to reach out to physicians with whom they had a good relationship, and considered to be skilled.[35] RRT-calls were facilitated by supportive, professional and caring RRT-members,[30,35,36] who confirmed the nurses' findings, and gave positive feedback.[29,36] Conversely, differing task priorities between the RRT and the ward nurses were described as barriers.[38]

Familiarity within the RRT and between RRT-members and ward staff was reported to enhance teamwork, especially under time-pressure.[25] However, rotation and varied positions of ward physicians made it difficult for the RRT to establish effective relationships.[38]

Douglas et al.[19] stated that the effectiveness of an RRT was "*depending entirely on the people within the team on that particular day*". A key factor in the effectiveness of the efferent limb, was reported to be the clinical expertise and crisis management skills. An RRT leader that managed to be "*an information gatherer and willing to have a dialogue",* facilitated the function of the RRT.[25] By contrast, a lack of clear leadership could result in chaos.[26]

When junior doctors were the first tier of response, they reported feeling out of depth and anxious,[28] and nurses rarely found their contributions helpful.[35] The RRS effectiveness was further compromised if the junior doctors only reluctantly alerted the next tier (more senior specialist).[28]

Not knowing the patient

It was considered a barrier to the efferent limb that the RRT lacked detailed knowledge of the patient's medical history.[28,37,40]

Discussion

In this systematic review, we explored facilitators and barriers within the limbs of the RRS as reported by HCP working within the system.

Major findings

A major barrier to succeed with a RRS seems to be the disconnection of the administrative and quality improvement limbs from the operational afferent and efferent limbs. The operational limbs often seem to be left operating on their own, dealing with inadequate monitoring and documentation systems,[14,21,22,27,28,31,32,39] under-staffing[21,27–29,31,38] inconsistent RRS education[14,25,30] and unclear protocols.[27,31,32]

Our analysis further presents the complexity of operating within and between the operational limbs. HCPs interpretation of and confidence in the call-criteria1[4,19,22,28,30–32] and alarm fatigue[19,28,32] are barriers to be taken seriously. Interestingly, the possibility of customizing the call-criteria for an individual patient was described as both a facilitator and a barrier, perhaps underlining the complexity of this process.[19,22,28,32] Our findings imply that it is important to incorporate clinical judgement as a valid call-criterion for both nurses and doctors.[14,19,22,28]

Lack of inter-professional trust may be one of the core barrier for succeeding with a RRS. HCP rapport being criticized and reprimanded when trying to follow the patient-centered intention of the RRS.[19,25–31,33,34,37] The conflicts between nurses and ward physicians regarding alerting the RRT seem to be enhanced in protocols where RRT is expected to be alerted directly, bypassing the ward physician.[25,29,31,37] Involvement of the ward physician in RRT calls might reduce conflict and facilitate RRT activation. It might also counteract the barrier of physicians fearing that the RRT will interfere with treatment despite being unfamiliar with the patient`s medical history.[28,37,40]

The RRT structure in the reviewed papers varies greatly (Table 4). This review highlights the importance of the members` clinical expertise and ability to work together for the patient[25,28] and a belief in inter-professional training and education to improve collaboration.[25,36]

Comparison with previous studies

Incomplete implementation and sustainability of RRS remains a major issue.[13,41] In this review the barriers for activation of the efferent limb were frequent and in line with the finding described by Chua et al.[42] By using the RRS model (Fig. 1) in the analysing process, we found that root causes for major barriers and facilitators for RRS may lie within the administrative and quality improvement limbs. The importance of leadership, for successful system-wide implementation implies the involvement and alignment of leaders on all levels.[43,44] Disconnected leadership has been identified be a significant factor in health-care organizations struggling to improve quality.[45] Jones et al.[46] emphasised that an RRS needs to be part of the hospitals overall plan. A variety of approaches is available to assist the process of achieving successful implementation.[47,48] Successful systems engage in quality improvement which require commitment, focus on goals as well as on process, using data measurement and feedback.[2]

Regarding activation of the RRT, alarm fatigue is a known barrier.[41] Douglas et al.[19] found that increased familiarity, agreement, and perceived benefit of activation-criteria increases the frequency of RRT activation. The ongoing development of a validated scoring system such as National Early Warning Score (NEWS),[49] might help to overcome these barriers. The value of involving the primary team in RRT-calls[50,51] has also been demonstrated.

Previous research has highlighted inter-professional simulation-based training as a tool to improve both technical and non-technical skills.[52] Increased use of this approach might enhance the effectiveness of RRT in caring for deteriorating patients and breaking down silos between RRT and ward personnel.

By increasing the confidence and knowledge of nursing staff, training improves their ability to detect and handle clinical deterioration.[53] Wehbe-Janek et al.[54] suggested that a simulation-based training program could overcome system barriers and augment the use of RRT. Theilen et al.[55] demonstrated that regular in-situ simulation training of a paediatric RRT led to sustained improvement.

A RRS is a hospital-wide intervention with many interdependent parts and requires a complex chain of events to occur in a timely progression.

The health-care system is rapidly developing, continuously educating and employing new staff, integrating new technology and providing advanced care for patients with complex conditions. It is important to be aware that "*Any change in a work system element interact and produces changes elsewhere in the work system*".[56] Technological solutions to patient monitoring that alert staff and RRS-personnel of deteriorating patients,[57–60] could facilitate afferent limb, but their integration should be carefully tested in clinical practice.

We believe in increased involvement of HCP in the continuous follow-up on results and the process within and between the limbs of RRS. We suggest focus on inter-professional simulation-based training to improve communication and collaboration.

Areas for future research

To find the keys to succeed with a RRS, research should study the barriers and facilitators within the administrative and quality improvement limbs, as they should have the power and budget to provide a solid foundation for the operational limbs.

Continuously connected and involved administrative and quality-improvement limbs are essential to ensure the effectiveness of the operational limbs.[14,25,26] This work cannot be completed by a set date; it is a never-ending process.

Strengths and limitations

The strengths of this systematic review are its presentation of the perspectives of the HCP operating the RRS. It includes papers from 10 different nations, more than 20 hospital-systems and different professions, levels of experience and RRS structures, thus providing a broad picture of facilitators of and barriers to current RRS. Although there is great variation between health-care systems, we identified several common facilitators and barriers, which increases the transferability of the analysis.

Although the literature search aimed to be broad, the choice of search terms might have failed to identify papers with important additional insights. Because the studies included in the review were interview-based, sampled purposively or by convenience and always voluntary, inclusion bias may be an issue. As evident from the critical appraisal (Table 2), most researchers do not adequately consider their relationship with the participants. This is a weakness, because the results of interviews are influenced by the moderator. Ethical considerations were handled differently in the studies, reflecting different countries and regions with different rules and regulations.

Conclusion

In this systematic review, we explored facilitators and barriers, as described by HCP, within all limbs of the RRS and their interconnections. The keys to succeed with RRS seem to lie in the administrative and quality improvement limbs. Clear leadership, the availability of consistent education and training, equipment, personnel and clear protocols were essential for the operational limbs. Further, we found that continuous work to mitigate barriers and improve the system was of key importance. We suggest increased use of interprofessional simulation-based training to increase technical and non- technical skills, establish inter-professional trust and build support for the RRS. Hospital environments change continuously with the employment of new staff, integration of new technology, and provision of more advanced care. Thus, to succeed with a RRS is a never-ending process.

Conflict of interests

None.

Acknowledgements

Funding: University of Stavanger Research Fund, Safer Healthcare Grant.

The search strategy was assisted by an Expert librarian, Elisabeth Hundstad Molland, University of Stavanger, Norway.

To secure correct English spelling and grammar, the manuscript has been edited, using Online English editing services (www.oleng.com.au), expenses covered by the Safer Healthcare Grant.

Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.resuscitation.2019.08.034.

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Paper II

ORIGINAL ARTICLE

OPEN

We Are Not There Yet: A Qualitative System Probing Study of a Hospital Rapid Response System

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Objectives: The capability of a hospital's rapid response system (RRS) depends on various factors to reduce in-hospital cardiac arrests and mortality. Through system probing, this qualitative study targeted a more comprehensive understanding of how healthcare professionals manage the complexities of RRS in daily practice as well as identifying its challenges.

Methods: We observed RRS through in situ simulations in 2 wards and conducted the debriefings as focus group interviews. By arranging a separate focus group interview, we included the perspectives of intensive care unit personnel.

Results: Healthcare professionals appreciated the standardized use of the National Early Warning Score, when combined with clinical knowledge and experience, structured communication, and interprofessional collaboration. However, we identified salient challenges in RRS, for example, unwanted variation in recognition competence, and inconsistent routines in education and documentation. Furthermore, we found that a lack of interprofessional trust, different understandings of RRS protocol, and signs of low psychological safety in the wards disrupted collaboration. To help remedy identified challenges, healthcare professionals requested shared arenas for learning, such as in situ simulation training.

Conclusions: Through system probing, we described the inner workings of RRS and revealed the challenges that require more attention. Healthcare professionals depend on structured RRS education, training, and resources to operate such a system. In this study, they request interventions like in situ simulation training as an interprofessional educational arena to improve patient care. This is a relevant field for further research. The Consolidated Criteria for Reporting Qualitative Studies Checklist was followed to ensure rigor in the study.

Key Words: rapid response systems (RRS), healthcare professionals, in situ simulation, system probing, quality improvement, interprofessional collaboration, patient safety, leadership

(*J Patient Saf* 2022;00: 00–00)

Hospitals worldwide have implemented rapid response systems (RRSs) to improve care for deteriorating ward patients.[1] Over time, research on these has established an association with reducing cardiac arrest and hospital mortality.[2–4] By concept, an RRS consists of 4 interconnected limbs and works 24/7 to ensure systematic observations, early detection of deterioration, and timely, tailored response to deteriorating patients.[1,2,5] Naturally, hospitals around the world have structured these systems differently,[6] thus necessitating multiple evaluations and improvement strategies.[7,8] Nevertheless, whether an individual hospital's RRS manages to improve outcomes depends on various in-hospital facilitators and barriers.[5,9] These warrant local recognition and a comprehensive understanding to foster continuous quality improvement.[10]

Simulation training presents a feasible method for system probing to gather crucial information embedded within an institution's systems and culture.[11] We believe this is an underexplored opportunity for quality improvement for hospitals that intend on implementing or improving their RRS. Through the scenarios and debriefings, one can identify the efficacy of the system and the reasons for it, as well as the challenges that require focused attention. Hence, we decided to perform a qualitative study that probed our hospital's RRS. We used the debriefings of the RRS from in situ simulations as focus group interviews (FGIs).

We targeted a comprehensive understanding of how healthcare professionals (HCPs) manage the complexities of RRS in daily practice as well as identifying its challenges. Thus, we developed 2 research questions: How do HCPs describe the various elements of the RRS when it works well (research question 1), and how do HCP describe the remaining challenges that need to be addressed (research question 2)?

METHODS

Setting

We conducted the study in a Norwegian university hospital with an established RRS, adopted from the Karolinska University Hospital model in Sweden.[12] The local RRS is organized as a 2-tier system (Fig. 1), implying that staff attend most patients with signs of deterioration within tier 1. However, both nurses and physicians can call tier 2 when needed. Since 2017, we have been incorporating the first version of the National Early Warning Score (NEWS)[13] into the electronic observation and medical chart (OM chart), with an associated response protocol (Fig. 2). The "NEWS response" is an integrated functionality in the electronic OM chart that enables clinicians to document patient assessment and plans for management and acceptable individual vital signs. If this is done, the NEWS value will be highlighted in the OM chart, making it easy to see that there is information available if you click on it. Situation-Background-Assessment-Recommendation (SBAR)[14] is recommended to facilitate structured nurse-physician communication.

The RRS is an integrated part of the hospital's structure. Nevertheless, adverse events with evident RRS protocol breaches still occur, often describing challenges with interprofessional collaboration. Subsequent research has found that simulation training positively correlated with improved usage of the RRS.[15,16] Thus, in 2019, the hospital RRS committee initiated weekly interprofessional in situ simulation to improve the use of RRS. Initially, the focus centered on the "afferent limbs" approach to a deteriorating patient. The initiative started in 2 wards, 1 surgical (24 beds) and 1 medical (21 beds), with a plan to gradually have regular RRS-focused

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This study was funded by the University of Stavanger Research Fund: Safer Healthcare Grant.

The authors disclose no conflict of interest.

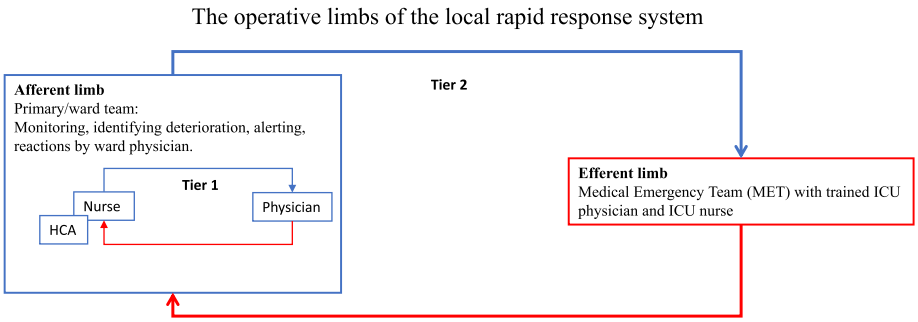

FIGURE 1. Illustrating the hospital arrangement of the operative limbs of the RRS. Afferent limb: the process of monitoring the patient and detection of deterioration by predefined criteria, including response by tire 1: responsible physician at the ward. SBAR is the recommended tool for communication. The responsibility for the patient lies within the afferent limb until a decision is made to move the patient to the ICU. Efferent limb: the MET from the ICU (physician and nurse), alerted by the afferent limb if the patient triggers the response criteria, and tire 1 response is not enough or not available.

simulations in all adult wards. Over time, we could include the "efferent limb" in 1 simulation session every month.

Participant Inclusion

The study followed the Helsinki Declaration. Because of Norwegian law, this study was not regulated by the Health Research Act (Regional Committee for Research Ethics in Norway). The Hospital Data Protection Officer at the Research Department of the University Hospital granted permission to perform the study (ID: 17/2019). The senior staff in the wards identified possible participants among the ward's nurses, physicians (medical physicians and surgeons), and healthcare assistants (HCAs) during the weeks before the study. We verbally informed all eligible participants at meetings in the wards about the study purposes, that participation was voluntary, and that they were free to withdraw at any time. The participants signed a written informed consent form. (For participant information, see Table 1.)

Data Collection

The Train the Trainer-EuSim level 1 facilitators[17] planned and facilitated the in situ simulations. (For scenario information, see Table 2.) First (emergency physician) and third (intensive care nurse [ICN]) authors observed 6 in situ simulation sessions of the RRS together and conducted the debriefings as FGI for 2 months. We arranged the debriefing/FGI immediately after the simulation scenarios in a quiet meeting room, lasting 45 to 50 minutes. We took field notes during the observations of the simulations and made audio recordings of all FGIs in their entirety. Facilitators started the dialogue in the FGI, letting the participants reflect on the scenario itself, which elicited further reflections and lively discussions among all participants regarding operating the RRS daily. The moderators then continued the FGI, following the semistructured interview guide (Box 1) with questions sourced from our past systematic review.[5] Hence, the RRS model (Fig. 1) was the framework for the scenarios and interview guide. To include some perspectives from tier 2 (Fig. 1), we arranged an additional FGI in the intensive care unit (ICU) with physicians and nurses experienced with the medical emergency team (MET; Table 1). We accomplished this with a customized interview guide (Box 1).

We transcribed the rich data material from the interviews verbatim and coded them into NVivo 12 pro software (https://www.qsrinternational.com/nvivo-qualitative-data-analysis-software/support-services/nvivo-downloads), and hence performed a thematic analysis.[18] To ensure trustworthiness, the research group continuously discussed and reflected on the identified patterns of meaning and issues of interest in the data. We generated codes and categories, searched for themes, and finally defined and named 3 themes that captured essential issues regarding the study

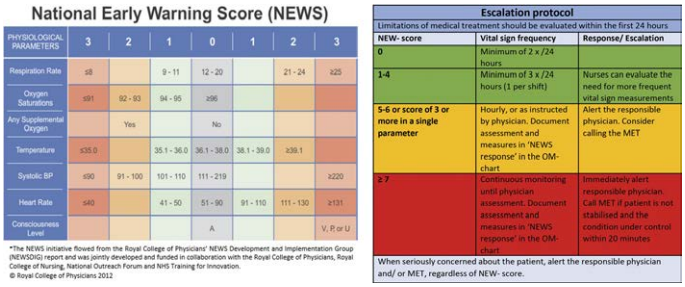

FIGURE 2. The established scoring system, NEWS, and the local escalation protocol (translated from Norwegian).

Box 1.

Interview guide: (a) Focus group interview in in situ simulation groups
***First debrief of the scenario: What happened, what worked well, what could have been done differently.**
What works well, challenges, and ideas for improvement are discussed through the following subjects:
- Do you have examples of managing deteriorating patients in the ward? Tell.
  - How do HCA, nurse, and physician cooperate in these situations?
- How and when is the scoring system NEWS used?
- Tell about how you were educated/informed about NEWS and MET.
- How and where do you document evaluations and measures taken regarding deterioration?
- How and when is SBAR communication used?
- How is MET used?
- Regarding all elements of the RRS, how can we further improve the system?

Interview guide: (b) Focus group interview with ICU personnel (experienced in MET calls)
What works well, challenges, and ideas for improvement are discussed through the following subjects:
- Tell about your experiences with handling deterioration patients in the ward.
- Regarding the scoring system NEWS:
  What do you know about the use of NEWS in the wards?
  What value does it have for the MET?
- How do you experience the communication when MET is called?
- How is MET utilized, by your experience?
- Tell about how you were educated/informed about NEWS and MET.
- How do you experience the cooperation between the ward personnel and MET?
- Do you have any thoughts about documentation?
- Regarding all elements of the RRS, how should we work to further improve the system?

objectives (COnsolidated criteria for REporting Qualitative research Checklist).

RESULTS

We identified 3 major themes, each of which had 2 underlying categories answering the 2 research questions (Fig. 3). For illustrating quotes, see Table 3.

Recognizing Deterioration (Theme 1)

Being Able to Combine Knowledge, Experience, and Objective Measures (Category 1)

Participants described how they recognized a deteriorating patient. They gave an overall clinical impression, calculated the NEWS value, and combined this information with their knowledge and experience regarding the patient's current diagnosis. Inexperienced HCPs elaborated on how they were more dependent on NEWS in their evaluation, valuing the support of the system. Moreover, participants reported a fear of relying solely on NEWS to recognize deterioration, highlighting the need for HCP with clinical knowledge and evaluation skills. Physicians saw increasing NEWS as an alarm; however, they highlighted the need to know the vital parameters behind the score for decision support.

Unwanted Variation in the Ability to Recognize Deterioration (Category 2)

Intensive care unit personnel, having experience on how the RRS functioned in different departments, expressed their worry about the unwanted variations among wards, concerning their ability to recognize deterioration. As suggestions for improvement, the ICU nurses discussed how they could be more proactive, thereby increasing ward personnel competence.

Using the Elements of the RRS (Theme 2)

Being Able to Use Scoring Systems and Protocol for Escalation (Category 1)

Overall, the HCPs expressed appreciation for the scoring system and escalation protocol, as they provided structure, overview, and a sense of security. The HCPs described how NEWS lowered their threshold for escalation, whereas physicians confirmed how worsening NEWS caught their attention.

By protocol, the NEWS response should include the acceptable physiological parameters of the individual patient and the strategies for management. This was not familiar for all participants, but HCPs, being aware of the functionality, valued how it simplified their work by highlighting essential information.

Furthermore, ward personnel reported how structured communication through SBAR facilitated the escalation process and simplified decision making for physicians, who were often in the middle of other tasks when receiving a call about a deteriorating patient.

TABLE 1. Participants in the In Situ Simulations and FGIs

Interview No.	Ward	Situation	Participants	Interview Group Size	Years in the Profession
1–3	Medicine	Simulation scenario/ debriefing	8 nurses ($N_{1–8}$ Med), 2 HCA ($HCA_{1–2}$ Med), 3 physicians: 1 intern, 1 resident, 1 attending ($P_{1–3}$ Med)	4–5	4 mo–39 y (median, 4 y)
4–6	Surgery	Simulation scenario/ debriefing	9 nurses ($N_{1–9}$ Surg), 1 HCA (HCA_1 Surg), 3 physicians: all residents in surgery ($P_{1–3}$ Surg)	4–5	0.5 mo–38 y (median, 7 y)
7	ICU	FGI	3 ICNs ($N_{1–3}$ ICU), 2 physicians: 1 intensivist and 1 resident in anesthesiology ($P_{1–2}$ ICU)	5	4–31 y (median, 9.5 y)
Authors			Author 1: MD, emergency physician, PhD candidate, Train the Trainer-EuSim level 1 facilitator. RRS committee member Author 2: anesthesiologist, professor. Author 3: ICN, professor. RRS committee member		

TABLE 2. Design and Conduction of the RRS In Situ Simulations

- We created patient cases based on real events. We used 3 different cases: a patient developing severe pancreatitis, a patient with bleeding after kidney biopsy, and a patient with chronic obstructive pulmonary disease exacerbation developing respiratory failure.
- HCP-simulated patients. We instructed them thoroughly on how to behave in the patient role.
- The scenarios took place in the wards, with all required equipment in its familiar places.
- Participants were told to use all equipment they naturally needed to examine the patient and plan further patient treatment.
- Because of the high patient bed occupancy rate, it was sometimes difficult to find an available patient room. This resulted in the scenarios taking place in the corridor behind screens or in exam rooms at times. Nevertheless, this did not change the scenarios or performance significantly.
- We created a test patient in the electronic OM chart, with vital parameters, EHR documents, and laboratory and radiology results to enhance the authenticity of the scenario.
- Every scenario involved a minimum of 1 nurse and 1 physician (Table 1). The session started with a brief, informing participants of the purpose of the simulation training, and the learning goals: evaluating and examining the patient using NEWS and clinical assessment, applying SBAR for communication, using the EHR and OM chart for documentation, and coming up with a plan for the patient.
- The cases started with the nurse and an HCA when present, getting a report of the case patient, and then going to see the patient, doing an initial evaluation. The physician was alarmed by a nurse in all scenarios, and the interprofessional team came up with a joint plan.
- The scenarios lasted 15–20 min, focusing mainly on the RRS elements within tier 1 (Fig. 1).
- The facilitator ended the scenario after an exam, the performance of initial stabilizing measurers, and development of a joint plan for further observations and actions, one of which included alarming the MET.

Unwanted Variation in RRS Knowledge and the Use of Documentation Systems (Category 2)

Knowledge regarding the RRS elements varied among participants, most likely reflecting their highly variable educational experiences regarding the system. Healthcare professionals who worked in the hospital during the initial phase of the RRS implementation had attended the relevant educational activities. However, HCPs employed more recently had rarely attended structured education and had to grasp the workings of the system individually. As a result, they requested collective interprofessional education to improve and align their RRS knowledge, highlighting in situ simulation as a desired educational arena.

The HCPs also described how the use of different documentation strategies within the electronic health record (EHR) created challenges. For instance, EHR notes often had no information about NEWS values and the related management plans, whereas the documentation of NEWS response varied among HCPs. This inconsistency in documentation routines led to challenges in finding important information for decision making, resulting in HCPs spending inordinate amounts of time searching through the EHR.

Nurses described different strategies for patients who exhibited repeatedly high NEWS values without a defined response strategy. Some argued for following the protocol and notifying tier 1 immediately, whereas others argued for trusting their own assessment, not alarming anyone if they deemed the patient stable. To improve patient care, nurses requested a common strategy for documenting structured plans for the patient. Both nurses and physicians then suggested consistency in the use of NEWS response, believing that it made plans readily available and could save time.

Interprofessional Trust and Collaboration (Theme 3)

Being Able to Work as a Team (Category 1)

The ward nurses highlighted the value of intraprofessional collaboration when having a deteriorating patient. Working together with another nurse ensured that they could perform tasks on time. The HCPs in the wards and the ICU could describe positive experiences with the MET, highlighting the importance of how this collaboration helped patients.

Vulnerable Collaboration (Category 2)

However, the FGIs uncovered collaboration challenges between the wards and the ICU. Saturated units and simultaneous vital tasks competed for HCPs' attention. Thus, despite the existing protocol clearly describing how staff should respond when a patient

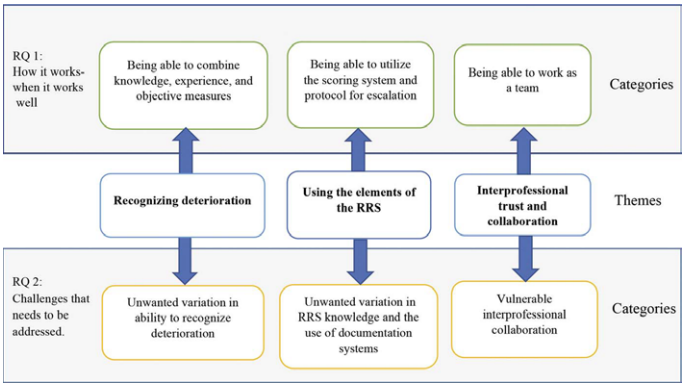

FIGURE 3. Themes and categories from thematic analysis.

TABLE 3. Illustrating Quotes

Recognizing deterioration	
Being able to combine knowledge, experience, and objective measures	"She didn't do very well. I checked the vitals; they were quite skewed. NEWS was red." (N_4-Med) "The vitals were not that skewed, but the diuresis reduced…They can deteriorate quite fast, these patients." (P_2-Surg) "For us newly educated nurses, I think it is nice to have such a tool (NEWS) with standardized measures, as it gives us a template for how to act. Our experience is limited, and we encounter new cases consistently." (N_4-Surg) "A weakness with scoring systems is that you can lean on them without re-evaluating the patient." (P_2-ICU) "I fear that NEWS can become a crutch, such that you stop doing good clinical evaluations and get tunnel vision. However, NEWS is great if you don't forget a comprehensive assessment." (N_4-Surg) "NEWS is good as a warning flag, (…) but I need more information. What has changed (…) I need to go through the numbers (of vital signs)." (P_2-Surg)
Unwanted variation in ability to recognize deteriorating	"There is a big gap between the wards, let's say…in some wards they lack competence on vital parameters. This can be quite frightening." (P_1-ICU) "I worry about the ward nurses. Too many nurses are inexperienced…some have only a few months of ward experience. We see the difference." (N_2-ICU) "We could have been used more actively in all departments, such as in basic nursing, teaching, and guidance." (N_2-ICU) "We (ICU nurses) should reach out to the ward nurses teaching tips and tricks." (N_3-ICU)
Using the elements of the RRS	
Being able to use the scoring system and protocol for escalation	"The system of doing observations has become very clear after the implementation of NEWS and MET." (N_7-Surg) "I think it (NEWS) provides a sense of security." (HCA_2-Med) "We are often the ones doing the vitals. We look at the last vitals and report the difference." (HCA_1-Med) "You can observe a trend, and then see how they are getting worse…before they really do, that is very…that is the real early recognition." (P_2-Med) "It's great (NEWS response). If it's used, you see it, and you can easily find the plan." (P_2-Med) "I have experienced its value. I had a patient with low saturation levels and was able to find out the measures that helped the patient last time, in the NEWS response. Then, I knew what could work, and it did." (N_4-Surg) "It's something to lean on when you talk to the physician. You have something specific; for instance, if NEWS has increased from orange 6 to red 8, you do not have to be afraid to call the physician." (N_5-Med) "I believe it helps. If a nurse comes and says, 'The patient is suddenly orange,' it is easy. Something has happened." (P_1-Med) "In general, the nurses have become great at using the SBAR, giving a clear picture about why they call." (P_2-Med) "Since you are on the other side of the call and do not know the patient, it is extremely valuable when you get an SBAR report like that. It is much better than simply stating, 'I have a deteriorating patient.'" (P_3-Med)
Unwanted variation in RRS knowledge and the use of documentation systems	"When we implemented NEWS, we were trained to do it." (N_7-Surg) "In the beginning, physicians received education during lunch meetings." (P_3-Med) "For my part, there hasn't been (education)." (P_2-ICU) "I wondered what it was: MET? I was just told that I can call the MET, but I did not know when to call, whom to call, and where to call." (N_4-Med) "The most important aspect relating to NEWS is the education about it." (N_4-Surg) "Everybody should be present and have the same education." (P_3-Surg) "I have actually asked for it (simulation training). I have worked here for several years, but I need it because you need to freshen up your knowledge…and you need reminders." (N_7-Surg) "Every time I attend any in situ simulation, I go home and think that now I have learned something." (P_3-Surg) "You learn so much more doing this (in situ simulation) than by reading on a paper what to do." (N_6-Med) "Some (physicians) think it is annoying that we call just because the score is red…but if there are no target measures and no plan…then we must call them." (N_5-Med) "The patient has a high NEWS over time, and if the NEWS is the same, you cannot call every time you get a high score…that is not possible." (N_1-Surg) "I do appreciate when there is a clear plan, including acceptable target measures for the vital signs of the patient, and information on how and when to act." (N_5-Med) "It's very convenient if you have a patient with COPD (chronic obstructive pulmonary disease);—this patient's O_2 saturation goals are…, and if they fall below this level, do this and this." (N_7-Surg) "We spend so much time searching through documents to check if anybody has made any decisions." (N_7-Med) "Often, I get a call from the ward, and the patient plan is hidden in the EHR somewhere; nobody has read it." (P_2-Med) "I feel in a way, if it is (NEWS response) going to work, then it's all or none." (N_7-Med) "If we could implement it (NEWS response) in daily work, it is a great tool, an aid to ensure effective clarifications. I believe that it can streamline communication." (N_6-Med)
Interprofessional trust and collaboration	
Being able to work as a team	"I have called the MET several times; it is excellent, you have someone to lean on. We can be a team, working together and planning together. We can improve the patient's situation together." (N6-Surg) "I experience that we are saving angels when we arrive. The nurses lower their shoulders, as they feel that finally somebody has come to offer support and suggestions, and that they are not alone anymore." (N_2-ICU) "I believe having an MET is reasonable. I have never attended an MET where I did not find our presence useful, whether or not the patient needed transfer to a higher level of care." (P_2-ICU)

(Continued next page)

TABLE 3. *(Continued)*

Vulnerable interprofessional collaboration	"I had a very ill patient in the ward…I had been working all night, trying to push for help, but none of the measures worked. The physician reply was: 'just wait and see.'" (N_7-Surg) "What is the result at 6 in the morning? Full speed to the ICU! That too, after we have argued all night!" (N_2-Surg) "It feels like the threshold to call (MET) is high. Like you are doing something that is not quite okay." (N_7–Med) "I have experienced three times; as a nurse, it is not for us to make the call. They (MET) tell you to go through the ward physician…and they hang up. Moreover, if the surgeon is operating, then…" (N_1-Surg) "I remember a very busy night shift, where the ICU physician told me off, saying that I should have been there by the patient bed while calling him. But how can I be everywhere at once?" (P_1-Surg) "My impression is that we often get called to help in a difficult situation, where the patient is not that critically ill, but the ward struggles with staffing, and we somehow should…" (N_2-ICU) "When we attend an MET call, and the ward physician is not present…we are not very happy." (P_1-ICU) "I worry about the increasing use of resources (for the ICU). Therefore, when the MET call comes, it is not always welcomed, because whatever plan you had for the day is shifted." (P_1-ICU) "When ward nurses call, we should be heard and respected for the knowledge we have." (N_2-Surg) "In my mind, the ICU physicians need to understand that we are alone at night." (P_1-Surg) "It is scary at night. Only two nurses (are present), and if you have two severely ill patients…" (N_6-Med) "Success factor: Staffing. There should be enough staffing in the ICU for both physicians and nurses to attend the MET call; this is a prerequisite for high quality." (P_1-ICU) "We should have the resources to attend when they call, and not be prevented by a filled-up ICU." (N_2-ICU) "It's not ideal, in any way… but we must stay positive and not let the fact that the ward physician cannot attend stop an MET call. Since then (at night) staffing levels are 'cut to the bone,' actually understaffed, we must limit the damage by compensating with those who are available, and actually can attend." (P_1-ICU) "Everybody needs this type of training (in situ simulation). We work in teams in our daily practice. Thus, it is important to train as teams." (N_6-Surg) "Yes, we should be involved (in the in-situ simulations) because I feel like a stranger when I come to the ward." (N_3-ICU) "The positive aspect of in situ simulations is how you start thinking differently, because you come together, reflect, and discuss." (N_7-Med) "It is quite rare that nurses and physicians get to give each other feedback…that is very useful with these simulations." (N_5-Med) "What is great about simulation training is the fact that you get to hear the opinions and experiences that other professions have…it is very useful to hear how they reason, because otherwise, you are not very conscious about it, being in your own bubble." (P_2-Surg) Dialogue: "What I find very important is your gut feeling." (P_3-Med)—"That is good to hear! It is greatly appreciated." (N_6-Med) Dialogue: "If a nurse treated the patient yesterday, and now today says, 'You know, he was not like this yesterday'… then we must come to evaluate." (P_1-Surg).—"That is so nice to hear you say! Not all physicians listen to that." (N_1-Surg)

deteriorated, nurses repeatedly struggled to get appropriate help for their patients. The HCPs from the wards discussed how they dreaded calling the MET, expecting a negative tone and resistance. Nurses reported that MET physicians instructed them not to contact the MET directly but rather to request the ward physician to make the call. This statement highlighted a significant concern at nightshifts in the surgical ward because the surgeon could have prior engagements at the operating theater. As a result, surgeons described feeling inadequate, having to be in several places at once. Nurses also reported how they wished ICU personnel were more respectful toward them while understanding their work situation. The ICU personnel, in turn, expressed how frustrating MET calls could be. They felt a need to accommodate for the lack of personnel and competence in the wards and reported discouragement when responding to a MET call when the ward physician was absent. They further elaborated on their struggles related to excusing the ICU nurse from other tasks and expressed concern about the ICU physicians' workload. Furthermore, The ICU personnel described how having all the members present in the MET call as essential for effective patient management. To accomplish this, they requested more resources and admitted a need for an attitude that supported collaboration.

To improve collaboration, both ward and ICU HCPs requested the opportunity to train together. They believed that in situ simulations would facilitate teamwork and increase shared situational awareness regarding the care for deteriorating patients. These statements corresponded with our observations during the simulation sessions. Through these interactions, HCPs from different professions often cleared up misunderstandings and uncertainties, showed each other support, and gave each other positive feedback.

DISCUSSION

Through system probing, this study aimed to provide insight into how HCPs managed the operational limbs of the RRS in daily practice, while revealing remaining challenges. The in situ simulations elicited open and lively discussions between professions regarding the system and prompted HCPs' requests for improvement. We believe that both the approach and results are relevant for all hospitals working to implement and improve their RRS.

The HCPs experienced that the NEWS worked well when combined with clinical knowledge and experience. Previous studies have reported this appreciation of Early Warning Scores[19,20] and the need to combine these scores with clinical judgment.[21] However, the appropriate use of NEWS and corresponding escalation protocol necessitate HCPs' sufficient education about the system. As revealed in this study, this was not the case for all HCPs, some of whom had to discover the system individually. According to our systematic review, uniform education of HCPs in a hospital regarding RRS remains a challenge all over the world.[5] The ICU personnel with extensive MET experience expressed concern about the unwanted variation among wards concerning the staff's

understanding of clinical deterioration. This underlines the importance of systematic interprofessional education.

The SBAR is known to improve nurse-physician communication[14,22] and was highly appreciated by all professions in the current study, as it facilitated timely decision making and teamwork. Meanwhile, HCPs experienced a time-consuming struggle due to inconsistency in the extent and location of the documented information. They requested consistency in documentation practice, as they needed readily available plans regarding the management of deterioration. They believed that it would buy time and reduce alarm fatigue. Locally, the NEWS response in the OM chart could satisfy this need, as it is easily available and visible. This challenge regarding documentation systems and routines is also consistent with the findings of previous studies.[5,23,24]

Central for an RRS is the connection between the 2 operational (afferent and efferent) limbs (Fig. 1), and this link's disconnection was a core barrier for succeeding with such a system.[5] Unfortunately, the current study is yet another example of how lack of interprofessional trust and fear of being criticized hinder the response to deteriorating patients.[24,25] It is worrisome that HCPs describe how they dread calling the MET, reporting stories of being dismissed or criticized. This is a sign of a system with low psychological safety, which counteracts the improvement of patient care.[26,27] Understanding the underlying causes for this patient safety breach is imperative. Through system probing, we revealed how conflicting interests between the ward and the ICU disrupted collaboration. These conflicting interests were normally due to high patient occupancy and high workload, with simultaneous tasks competing for the HCPs' attention. This fact should worry leaders in health care and health policymakers. The lack of staff, especially at night, requires urgent attention. Studies on RSS frequently report lack of personnel,[5] which is associated with increased in-hospital mortality.[28]

Interprofessional education that provides a shared understanding of why, when, and how to connect the operative limbs might improve the RRS. The HCP cannot address this issue on their own. As reported by HCPs in other studies,[25,29] the HCPs in our study requested more interprofessional arenas for evaluation, learning, and training. In situ simulation may meet this request because it has proven to increase nurses' knowledge and confidence regarding the management of deteriorating patients.[16,30] It also enhances cooperation and communication,[31,32] and improves situational awareness.[33] The structured debrief is of utmost importance, giving the HCP the opportunity to reflect, get feedback, discuss, and learn.[34] This use of facilitator-guided post event debrief has the ability to improve both individual and team performances.[35] In addition, we believe that in situ simulation can serve as an arena for building relationships within and between afferent and efferent limbs while highlighting the importance of all team members. Thus, it might increase psychological safety,[27] a factor essential for an RRS.

We believe that continuously working to overcome challenges within the RRS is essential to the improvement of the care of deteriorating patients in the wards. The opportunity and responsibility for providing time and resources for improvement of RRS lie within leadership at all hospital levels. The HCPs in all units must have the skills to detect deterioration and use the elements of the RRS, ensure consistency in documentation processes, and provide a foundation for interprofessional collaboration. In this regard, future research should further explore in situ simulation as an arena for system probing and interprofessional learning.

Strengths and Limitations

A strength of this study is that it presents the perspectives of HCPs from all professions involved in operating an RRS. Moreover, the detailed description of the study design, setting, and analysis, supported by quotations, has enhanced its transferability. However, not having the efferent limb as part of in situ simulation was a limitation. Thus, to obtain the perspectives of ICU personnel with MET experience, we conducted a separate FGI. However, having the ward and ICU personnel in separate FGIs might have encouraged the participants to talk more freely about negative issues. As with all single-center studies, the results could be different in other hospitals. Nevertheless, the findings are consistent with previously published studies, underlining how many strengths and challenges that hospitals worldwide need to recognize and address, concerning their respective RRS. In addition, this study illustrates the importance of local system probing to find what works locally and identify challenges and ideas for local improvement. Finally, the female researchers (MD and ICN) performing the FGIs were familiar with some of the participants, which may be both a strength and limitation of the study.

CONCLUSIONS

When it comes to succeeding with RRS, we are not there yet. Through system probing, we identified the merits of our RRS and revealed its current challenges. We must improve our instances of unwanted variations in HCPs' understanding of clinical deterioration, RRS education, and documentation routines, and address worrisome challenges regarding interprofessional collaboration. The participants in this study suggest that patient care improves when in situ simulations become a regular interprofessional educational arena. This is a relevant field for further research.

ACKNOWLEDGMENTS

We are grateful to the facilitators and participants for allowing us to use the in situ simulations as an arena for research. We are also thankful to the intensive care unit personnel for presenting their perspectives. To secure English language spelling and grammar, we used Editage (www.editage.com) for manuscript editing. The Safer Healthcare Grant covered the relevant expenses.

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Paper III

Olsen *et al. BMC Health Services Research* (2023) 23:179
https://doi.org/10.1186/s12913-023-09159-3

BMC Health Services Research

RESEARCH Open Access

Reduction in omission events after implementing a Rapid Response System: a mortality review in a department of gastrointestinal surgery

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Abstract

Background Hospitals worldwide have implemented Rapid Response Systems (RRS) to facilitate early recognition and prompt response by trained personnel to deteriorating patients. A key concept of this system is that it should prevent 'events of omission', including failure to monitor patients' vital signs, delayed detection, and treatment of deterioration and delayed transfer to an intensive care unit. Time matters when a patient deteriorates, and several in-hospital challenges may prevent the RRS from functioning adequately. Therefore, we must understand and address barriers for timely and adequate responses in cases of patient deterioration. Thus, this study aimed to investigate whether implementing (2012) and developing (2016) an RRS was associated with an overall temporal improvement and to identify needs for further improvement by studying; patient monitoring, omission event occurrences, documentation of limitation of medical treatment, unexpected death, and in-hospital- and 30-day mortality rates.

Methods We performed an interprofessional mortality review to study the trajectory of the last hospital stay of patients dying in the study wards in three time periods (P1, P2, P3) from 2010 to 2019. We used non-parametric tests to test for differences between the periods. We also studied overall temporal trends in in-hospital- and 30-day mortality rates.

Results Fewer patients experienced omission events (P1: 40%, P2: 20%, P3: 11%, P = 0.01). The number of documented complete vital sign sets, median (Q1,Q3) P1: 0 (0,0), P2: 2 (1,2), P3: 4 (3,5), P = 0.01) and intensive care consultations in the wards (P1: 12%, P2: 30%, P3: 33%, P = 0.007) increased. Limitations of medical treatment were documented earlier (median days from admission were P1: 8, P2: 8, P3: 3, P = 0.01). In-hospital and 30-day mortality rates decreased during this decade (rate ratios 0.95 (95% CI: 0.92–0.98) and 0.97 (95% CI: 0.95–0.99)).

Conclusion The RRS implementation and development during the last decade was associated with reduced omission events, earlier documentation of limitation of medical treatments, and a temporal reduction in the in-hospital- and 30-day mortality rates in the study wards. The mortality review is a suitable method to evaluate an RRS and provide a foundation for further improvement.

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Trial registration Retrospectively registered.

Keywords Rapid Response Systems, Mortality review, Health care improvement, Improvement, Patient safety, Adverse events, Omission events.

Background

Although most hospital deaths result from severe illness or injury, hospital mortality is still a quality indicator because some deaths may result from patient harm [1]. Patient harm or adverse events (AE) can be defined as "unintended injuries among hospitalised patients that result in disability, death or prolonged hospital stay, and are caused by healthcare management" [2]. The Global Trigger Tool is a commonly used tool to identify and report adverse events in hospitals [3]. Care not delivered, 'omission events', is found to be better detected by patient record reviews [4].

A voiced patient safety concern is the inadequate monitoring and follow-up of deteriorating patients in hospital wards [5]. Hospitals worldwide have implemented RRSs to remedy this. By concept, an RRS supports healthcare professionals in the early recognition of patient deterioration and securing prompt response by trained personnel evaluating and caring for the patient [6]. Thus, central to the RRS is to help prevent 'omission events', including failure to monitor the patients vital signs, delayed detection and treatment of deterioration and delayed ICU transfer. Recent systematic reviews [7–9] found moderate-strength evidence supporting the notion that implementing RRS is associated with reduced hospital cardiopulmonary arrests and hospital mortality.

Time matters when a patient deteriorates and increased time from deterioration to intervention (RRS activation and ICU transfer) has been associated with increased mortality [10], length of stay, and morbidity [10, 11]. However, several in-hospital challenges may prevent the RRS from functioning adequately [12–14]. Therefore, we must still work to understand and address barriers for timely and adequate responses in cases of patient deterioration.

When evaluating the care provided for deteriorating patients, it is also important to consider if the patient will benefit from available medical interventions or transfer to higher levels of care. Failing to make decisions regarding the limitation of medical treatment (LOMT) can lead to reduced quality of death [15]. RRS is associated with increased LOMT and end-of-life discussions [16] to prevent futile interventions in multimorbid, frail, and older patients [17]. This consideration should be built into a well-functioning RRS [18, 19].

Retrospective case record reviews, such as mortality reviews, represent a useful method for studying clinical practice. Event sequence in a deteriorating patient can be evaluated through the patient's clinical records and charts, helping to identify quality gaps, including omission events [4, 15, 20]. Therefore, we chose this method to study deceased patient trajectories in the Department of Gastrointestinal Surgery (DGS) before and after implementing our hospital RRS.

This study aimed to investigate whether implementing and developing RRS in the DGS was associated with an overall temporal improvement and identifying needs for further improvement by studying; patient monitoring, omission event occurrences, LOMT documentation processes; unexpected death and in-hospital- and 30-day mortality rates.

Methods

The STROBE -statement checklist for cohort studies was followed (Supplementary file 1.)

Setting

This study was conducted in a university hospital in Norway, covering a population of approximately 400,000 inhabitants. We chose the two wards (48 beds) of the DGS where RRS implementation was initiated; as this patient group is prone to succumb due to complications from their illnesses or the surgeries performed [21, 22]. The DGS performs most types of gastrointestinal surgeries (acute and elective), from hernia and cholecystectomy to colectomy, rectal resection, pancreas, and liver surgery, but not oesophageal surgery. The intensive care capacity of the hospital is 2,2 beds / 100 000 inhabitants, which is considered to be low in an international context [23].

Process of RRS implementation

Before 2012, the hospital had no clearly defined procedure for vital-sign monitoring or criteria for when the nurses should alert the surgeon on duty or contact the ICU staff directly. In 2012, starting with the DGS, the study hospital implemented a two-tier RRS (Fig. 1) inspired by the RRS model at the Karolinska University Hospital, Sweden [24]. From 2014 to 2015, the system was implemented throughout the hospital. An RRS committee led the work and introduced the standard of a minimum of twice daily vital sign measurements and single-parameter Medical Emergency Team criteria (MET-c) (Supplementary file 2), which could trigger an evaluation by the Medical Emergency Team (MET). The chart for documenting vital signs was improved (Supplementary File 3). Simultaneously, there was an increase

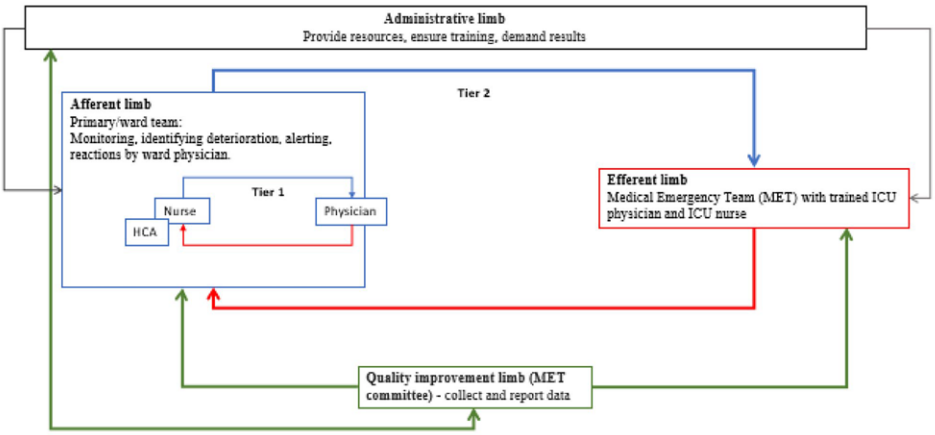

Fig. 1 Structure of the local RRS. The limbs of the Rapid Response System. Illustrating the hospitals arrangement of the operative limbs as a two tier system. Adapted from a systematic review [14]

from one to two nurses in both wards for the night shift. Otherwise, there was no increase in funding.

In 2016, the RRS was further developed. An electronic observation- and medication chart (OM-chart), incorporating the NEWS (Supplementary file 3), replaced the paper-based OM-chart and the MET-c. The MET committee developed a more explicit protocol that replied to the NEWS for responses and documentation (Supplementary file 2). This response protocol included the call to decide and document all patients' LOMT to prevent overtreatment, ensure better palliative care, and reduce unnecessary MET calls and ICU transfers. To facilitate LOMT decisions, the study wards incorporated LOMT assessments for all patients at a daily whiteboard meeting. This improvement of the RRS was carried out without increase in staff or additional funding.

Design

For the mortality review we chose to compare cases from three time periods Period 1 (P1), 2010/11; Period 2 (P2), 2014/15; Period 3 (P3), 2018/19). We excluded the RRS implementation period in 2012–2013 and the period of transition from single-parameter criteria to the National Early Warning Score (NEWS) in 2016/2017 (Fig. 2). For the overall mortality rates, we included all deaths in the DGS from 2010 to 2019.

Data collection

We collected the data from two main sources; from the electronic hospital administrative- and medical records to perform a mortality review and from the regional hospital administrative data to calculate mortality rates.

Inclusion and exclusion criteria

For the mortality review we identified patients who died during admission to the two study wards during the three time periods (P1–P3) from the Norwegian electronic administrative and medical records system (DIPS-EPJ). Patients registered in the ward for <2 h, were excluded. We also excluded cases from further analysis when it was evident from the admission record that all active treatments for the patient's illness were terminated; thus, the patient was expected to succumb within a short period (Fig. 1).

To calculate mortality rates in the study wards, we included all patients registered as admitted to the study wards.

The mortality review process

By reviewing electronic health records and OM-charts, one of the authors (SLO) retrieved the patients' demographic data and clinical trajectory during the hospital stay. Based on this information, an interprofessional group of reviewers, an anaesthesiologist and intensivist (ES, KS), a specialist in gastrointestinal surgery (BN), intensive care nurse (BSH), and internal medicine and emergency medicine physician (SLO) assessed the patients' clinical pathway for omission events.

We established the inter-professional review method (Fig. 3) by conducting two pilot rounds to ensure that all reviewers were trained to evaluate the records, and in agreement when defining omission events. Two researchers (SLO and BSH) reviewed all included cases before BN, and KS reviewed selected cases (all patients undergoing surgery or being transferred to the ICU). When the

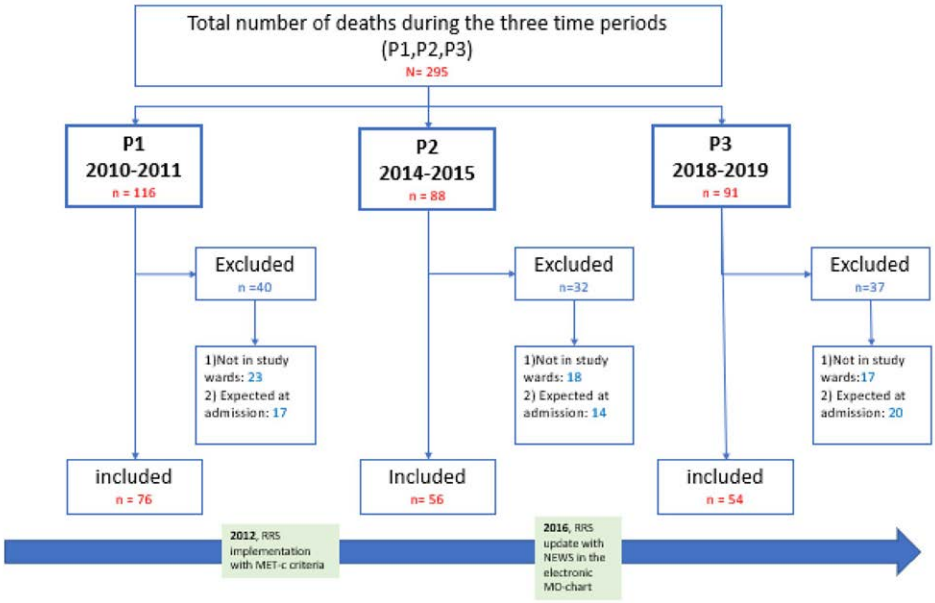

Fig. 2 Included patients in three time periods. Overview over included and excluded patients in the three periods (P1-P3). Illustrating when the RRS was implemented (2012) and updated (2016)

group found challenging cases or had disagreements, we reviewed the case again and discussed them until a consensus was reached. The earliest records were reviewed a second time late in the process to ensure that the method did not drift during the review period.

Definition of omission events and unexpected death

We considered a case to be 'failure to monitor' when there were considerably fewer vital sign sets documented than expected when the patient was deteriorating. Further, the case was considered to be 'failure to escalate' when there was a clear lack of escalation from the nurse to the patient's physician (tier 1) or a clear delay or lack of ICU consultation (MET in P2/P3) including delayed ICU transfer (tier 2). (Fig. 1) Inspired by Flaatten et al. [25], we considered deaths to be unexpected when there was no sign of deterioration in vital signs or description of deterioration in the patients' records within 24 h before death.

Administrative data collection

We retrieved data for all patients admitted to the two study wards annually from 2010 to 2019 from hospital administrative data (source: Regional Information Technology partner) to study the temporal trend in the number of admittances, and in-hospital and 30-day mortality rates.

Statistical analysis

We performed the statistical analysis using IBM SPSS statistics for Windows version 26 and R version 4.1.2 [26]. Chi-Squared tests were used to test for differences between the three time periods (P1-P3) for categorical data, with Monte Carlo simulation for data with expected cell counts less than 5. For continuous data we used the Kruskal Wallis test. We used a 5% significance level in all tests. When significant differences between periods were identified, post-hoc analysis comparing each pair of periods were done, using a Bonferroni adjustment for multiple testing. Poisson regression was used to test for temporal changes in mortality rates. (Tables 1 and 2).

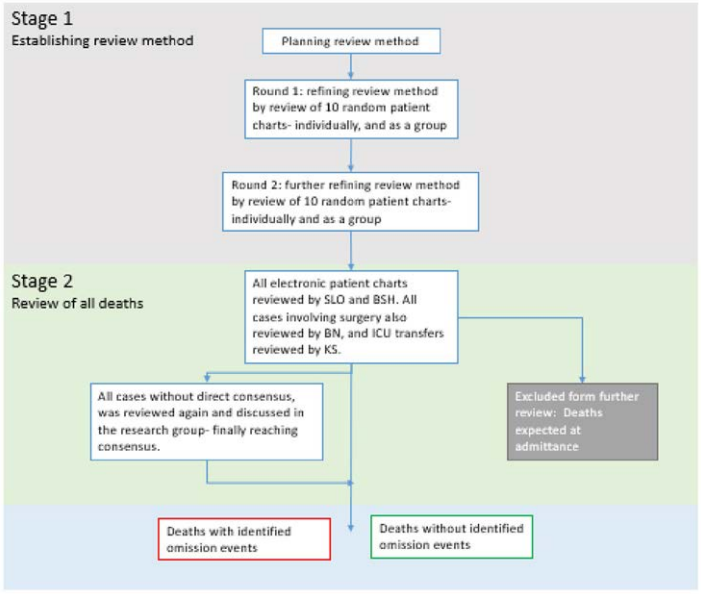

Fig. 3 The mortality review method. Through a two-stage retrospective record review process- the research group established the review method and reviewed all included deaths, identifying cases with and without omission events

Results

Mortality review

Patient characteristics

The socio-demographic characteristics and comorbidity [Updated Charlson Comorbidity Index (u-CCI) [27]] of the deceased patients did not differ in the three time periods, nor did the type of admittance and whether they underwent surgery during the hospital stay (Table 1).

Development in patient monitoring and care

RRS introduction significantly increased vital sign monitoring and documentation throughout the study time periods (Table 2). None of the patients had a complete set of vital signs in P1 because the respiratory rate was not documented. Furthermore, we found a significant increase in the number of ICU consultations after introducing MET. LOMT documentation occurred earlier during hospitalisation. We found a significant decrease in the number of patients considered to have one or more omission events during their hospital stay. The nature of the omissions changed during the study period, with fewer problems regarding monitoring and escalation. Delayed surgery and unexpected deaths were infrequent, and the number was stable during these periods. Cardiac arrest alarms trended downward during these periods without being statistically significant. There were no cardiac arrest alarms in the cases from 2019.

Temporal trends in admissions and hospital mortality rates

The total annual admittances to the two study wards increased steadily from 2,973 (2010) to 3,854 (2019). The proportion of planned admissions remained steady at approximately 30% during this period. In the same period, the in-hospital and 30-day mortality rates significantly decreased (Fig. 4). This decrease remained unchanged when adjusting for the average age of the patients.

Discussion

Summary of major findings

We found that implementing and further developing a university hospital RRS was associated with a temporal improvement in the ward care of patients in the DGS. There was increased systematic vital sign monitoring, earlier documented LOMT decisions, increased patient review by the ICU team, and decreased number of omission events. This was associated with a temporal decrease in the overall in-hospital- and 30-day mortality rates.

Table 1 Comparing patient characteristics

	P1	P2	P3	p-value
N	76	56	54	
Age Median, (Q1, Q3)	77 (64, 87)	78 (72, 83)	77 (70, 84)	0.90
Gender, male N (%)	39 (51)	30 (54)	30 (56)	0.89
u-CCI Median, (Q1, Q3)	2 (0, 6)	2 (0, 4)	2 (1, 4)	0.55
Admitted from N (%)				
Home without care	43 (57)	32 (58)	30 (58)	0.39*
Home with care	25 (33)	11 (20)	12 (23)	
nursing home-short time	4 (5)	6 (11)	4 (8)	
Nursing home-permanent	2 (3)	5 (9)	3 (6)	
Other institution	1 (1)	1 (2)	3 (6)	
Type of admittance N (%)				
Unplanned	69 (91)	55 (98)	52 (96)	0.16*
Planned	7 (9)	1 (2)	2 (4)	
LOS days hospital Median (Q1, Q3)	13 (6, 22)	14 (6, 24)	11 (6, 19)	0.76
LOS days study wards Median, (Q1, Q3)	12 (6, 21)	13 (6, 22)	11 (6, 19)	0.81
Number of Hospital admittances last 12 months Median, (Q1, Q3)	1 (0, 3)	1 (0, 3)	1 (0, 2)	0.48
Surgery performed N (%)	31 (41)	23 (41)	18 (33)	0.93
Reoperated one or more times N (%)	9 (29)	4 (17)	6 (33)	0.50*

Statistics:

Continuous data: Kruskal-Wallis test, Categorical data: Chi-squared test. *Chi-squared test with Monte Carlo simulation.

LOS = Length of stay, u-CCI = updated Charlson Comorbidity Index

Comparison with previous studies

We believe that establishing easily accessible and convenient systematic monitoring routines has created an important foundation for the RRS. Challenges in this fundamental limb of the RRS have been frequently reported in the literature [12, 14]. In an earlier study from this hospital, NEWS availability in the electronic OM-chart (P3) was reported to make deterioration easier to detect due to the series of time-registered measures highlighted in bright colours when vital signs deviate from normal [28]. However, ward patients are not continuously monitored; therefore, deterioration can occur between intermittent observations. International research regarding continuous vital sign monitoring outside the ICU to investigate whether this may improve patient outcomes and be cost-effective, is ongoing [29]. However, health care professionals (HCP) report worries about drawbacks, such as the potential for reduced patient contact and an increase in inappropriate escalations [30].

We found that failure to escalate seemed to decrease during the study period. We argue that this may be due to the increased availability and visibility of documented vital signs, especially during P3, and the establishment of a protocol for when to call the MET. However, this is an area for further improvement. We believe that timely escalations must be a focus for continuous attention to ensure sustainability due to many known challenges [14]. Alarm fatigue is a known challenge when monitoring patients with serious illnesses and abnormal vital signs over time [28, 31]. Furthermore, even when nurses or ward physicians recognise the deterioration, the ward-culture, and the HCPs earlier experiences of how they are treated by the MET during escalation may influence further action [14, 28]. Resources and ICU capacity are also known to influence HCP responses to patient deterioration [14, 28, 32].

The number of patients with LOMT did not change significantly during the study period, however, the LOMT was documented earlier in the patients' hospital stay. Timely decisions on which medical interventions are suitable for a severely ill patient might prevent futile and undignified resuscitation events, prevent costly overtreatment, and make room for appropriate palliative care [33]. We speculate that earlier LOMT documentation might have influenced the lower number of cardiac arrests found during P3 and might have prevented unnecessary MET calls. In addition, through the review process, we found an opportunity to improve the quality of death further through early decision-making and LOMT documentation.

Studies on hospital mortality often use the term unexpected mortality, frequently defined as patients dying without an LOMT decision [34–36]. With our definition of unexpected deaths, we found few cases that were considered unexpected, and a considerably higher number of patients that died without a written LOMT order. Hospital implementation of processes related to decision-making and LOMT documentation is known to vary [18]. The difference found in our study, illustrates the importance of considering how unexpected death is defined. If we had considered all cases in this study with no LOMT order as unexpected, we believe this would have represented the LOMT documenting custom in the department at the time rather than actual unexpected deaths. We argue that a mortality review is a relevant method to understand whether death is unexpected, providing crucial information about patient trajectory, deterioration context, and HCP considerations.

Implications for clinicians, hospital leaders and policy makers

To our knowledge, this is the first study on the impact of an RRS in the specific vulnerable population of gastrointestinal surgery patients. This study shows how an RRS can mature over time and gradually become more effective in its purpose, owing to continuous focus and development. We believe this study is unique in underlining how a retrospective patient record review can probe a hospital RRS, evaluate its impact, and identify strengths

Table 2 Development in patient monitoring, escalation, LOMT documentation and omission events

	P1	P2	P3	Comparison between all periods, p-value	P1 vs. P2, p-value	P1 vs. P3, p-value	P2 vs. P3, p-value
Number of patients	**76**	**56**	**54**				
***Number of complete vital sign sets/24 h/patient**. Median (Q1, Q3)	0 (0, 0)	2 (1, 2)	4 (3, 5)	**< 0.001**	**< 0.001**	**< 0.001**	**< 0.001**
***Number of simple vital signs sets/24 h/patient** Median (Q1, Q3)	2 (1, 2)	2 (1, 2)	4 (3, 5)	**< 0.001**	**0.012**	**< 0.001**	**< 0.001**
LOMT documented N (%)	58 (76)	42 (76)	48 (89)	0.15			
****Days from admission to LOMT** Median (Q1, Q3)	8 (4, 16)	8 (1,16)	3 (1, 10)	**0.011**	0.25	**0.003**	0.09
Cardiac arrest alarms N (%)	14 (18)	11 (20)	3 (6)	0.07			
ICU-consult in the wards (MET in period 2, 3) N (%)	9 (12)	17 (30)	18 (33)	**0.007**	**0.008**	**0.003**	0.738
ICU transfer N (%)	14 (18)	16 (29)	18 (33)	0.14			
Cases with one or more events of omission N (%)	30 (40)	11 (20)	6 (11)	**0.01**	**0.015**	**< 0.001**	0.216
Types of omissions							
Failure to monitor N (%)	20 (26)	5 (9)	1 (2)	**< 0.001**	**0.012**	**< 0.001**	0.102
Failure to escalate N (%)	14 (18)	7 (13)	2 (4)	**0.043**	0.358	**0.012**	0.092
Delayed surgery N (%)	2 (3)	2 (4)	3 (6)	0.800¤			
Unexpected deaths N	2 (3)	2(4)	0 (0)	0.455¤			

Comparing groups, statistics:

Continuous data: Kruskal-Wallis test. Categorical data: Chi-squared test. ¤Chi-squared test with Monte Carlo simulation. For the pairwise post-hoc tests, p-values < 0.0167 are considered significant due to the Bonferroni correction.

Complete vital sign set: all vital signs (pulse, O_2 saturation, resp. frequency, BP) measured at the same period, counted the first complete 24 h stay in the ward.

Simple vital signs set: Minimum one vital sign (pulse, blood pressure, resp. frequency, O_2 saturation) measured, counted on the first complete 24 h stay in the ward.

*Only 173 patients included, due to two cases with missing charts and 11 patients with < 24 h stay.

** of the 149 patients who had a documented LOMT.

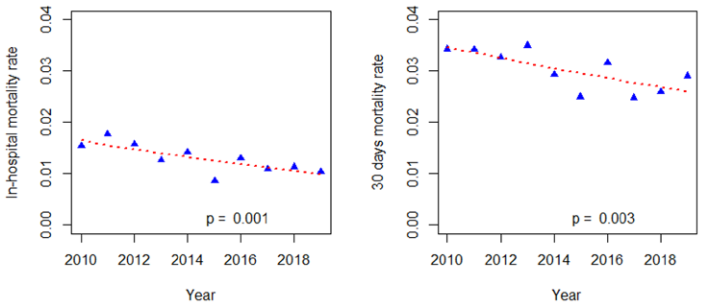

Fig. 4 Temporal trends in in-hospital and 30-day mortality rate. In-hospital mortality rate (deaths / number of admittances): rate ratio 0,95 (95% CI 0,92 – 0,98) (P = 0.001), 30-day mortality rate (deaths within 30 days of admittance/ number of admittances): rate ratio 0.97 (95% CI 0.95- 0,99) (P = 0.003)

and quality gaps, as omissions are not readily available for statistics.

Some hospitals have established a system for performing mortality reviews closer in time to the event to search for improvement opportunities [4]. The recommended quality metrics (including measurement of cardiac arrests and predictable cardiac arrests, timeliness of response and critical care interventions and timeliness of goals of care documentation) for evaluating RRS [37] require hospitals to obtain information embedded in charts and patient records, which is not easily available. Continuous work is required to provide automatic reports on the quality metrics. Valuable reports require data to be registered and made available for a reporting system. We believe retrospective record reviews are a valuable method to probe the hospital system, as they provide detailed information about the patients' trajectories, deterioration context, and healthcare personnel's considerations, invaluable for knowing where to put the effort to ensure continuous improvement. Nevertheless, studying all patient records and electronic OM-charts is time consuming. To make this method a sustainable tool in daily practice, there is a need to examine how patient clinical data can be made more easily accessible.

Strengths and limitations

Our study of hospital deaths and omission events was based on retrospective reviews of the hospital records, providing detailed information about the patients' current hospital stay trajectories. All patients were admitted to the same two wards of gastrointestinal surgery, contributing to homogeneity of the study population. We chose to study the population of these two wards only, as they introduced the RRS at the same time (2012) and started the changes in 2016 at the same time. The other wards in the hospital introduced the RRS at different time intervals. The study periods for the mortality review was also limited to avoid the year of implementation of changes. This increased the comparability, but also limited the number of eligible patients. Selection bias was limited due to few exclusion criteria.

After establishing a review method, the evaluations and conclusions were performed in a broad interprofessional consensus to limit the inter-rater disagreement. Two or more researchers with different clinical backgrounds studied all cases. A statistician (JTK) was included in the planning, analysis, and reporting of study findings. However, hindsight bias and subjectivity are limitations of this study. All researchers were at the time or earlier employed at the hospital, which might have made us more positive in our judgment than an external group would have been.

Additionally, this gave us an understanding of the context, increasing the consensus credibility. None of the reviewers currently worked in the study wards. One of the reviewers currently work in another hospital. To increase generalisability, the context, including the local RRS structure, patient cohorts and the study process is thoroughly described. The transferability is for the reader to decide.

Poor documentation of the clinicians' evaluations was evident, especially in P1, which might have influenced our conclusions. Conversely, clearer, and more complementary decision-making documentation in P3 made evaluation easier. The infrequent vital sign measures in P1, might have led us to miss cases that, in reality, should be determined as 'failure to rescue'. In this study, it was challenging to obtain information about the context (staffing, bed occupancy, and available ICU beds). If the patient record review was performed closer in time, it would have been possible to obtain more contextual information when the response to deteriorating patients was evaluated as delayed. Improvements in the availability of diagnostic imaging and surgical methods may have contributed to decreased mortality rates.

Conclusion

In this study, implementing and further developing an RRS led to a reduction in omission events such as failure to monitor and escalate care, earlier LOMT documentations and was associated with a temporal reduction in in-hospital and 30-day mortality rates. We found the interprofessional mortality review to be a suitable method to evaluate the RRS, providing a foundation for further improvement.

List of abbreviations

RRS	Rapid Response Systems
LOMT	Limitation of medical treatment
AE	Adverse events
ICU	Intensive care unit
MET	Medical emergency team
DGS	Department of Gastrointestinal Surgery
MET-c	Medical Emergency Team criteria
NEWS	National early warning score
OM-chart	Observation- and medication chart
DIPS-EPJ	The Norwegian electronic administrative and medical records system
P1-3	Period 1–3.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12913-023-09159-3.

Supplementary Material 1

Supplementary Material 2

Supplementary Material 3

Acknowledgements

We appreciate the help of the Regional Information Technology partner who provided administrative data for this study. To secure correct English spelling

and grammar, the manuscript has been edited, using Editage Author Service, Expenses covered by Safer Healthcare grant.

Author contribution
All authors were involved in the conceptualisation, methodology, writing and reviewing of the manuscript. SLO, BSH, KS, BN and ES were involved in the mortality review process, validation of the method, and consensus evaluation of the cases. SLO and JTK performed the statistical analysis. SLO prepared all figures and tables.

Funding
Safer Healthcare Grant (from the University Research Fund), covering salary for the PhD candidate (SLO) .

Data availability
The original data and material for the mortality review are not available due to the individual patients privacy. The administrative data sets could be available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
Ethical approval for this study was provided by the Regional Committee for Medical and Health Research Ethics for the Western Health Region in Norway (REC- West), (reference number 28760). REC- West, waived the need for informed consent as they considered the study a quality assurance project. The Hospital Data Protection Officer at the Research Department of the University Hospital approved the project (reference number 25/2019). The research project was performed in accordance with the Declaration of Helsinki.

Consent for publication
Not applicable.

Competing interests
The authors declare that they have no competing interests.

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Received: 12 September 2022 / Accepted: 7 February 2023
Published online: 21 February 2023

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Publisher's note

Appendices

Appendix I

Search Strategies for Study 1

Search Strategies for Study 1

Ovid MEDLINE(R) and Epub Ahead of Print, In-Process & Other Non-Indexed Citations and Daily 1974 to 2019 March 20, *searched on 20/03/2019*

1. Hospital Rapid Response Team/
2. ((rapid response adj (team* or system*)) or (medical adj (response or emergency) adj team*) or critical care outreach).tw,kf,kw.
3. (patient at-risk team* or emergency medical team*).tw,kf,kw.
4. 1 or 2 or 3
5. (evaluat* or implement* or success* or fail* or utiliz* or adopt* or barrier*).tw,kf,kw.
6. 4 and 5
7. limit 6 to (english or danish or norwegian or swedish)
8. limit 7 to yr=2000 -Current

Embase 1974 to 2019 March 19, *searched on 20/03/2019*

1. rapid response team/
2. ((rapid response adj (team* or system*)) or (medical adj (response or emergency) adj team*) or critical care outreach).tw,kw.
3. (patient at-risk team* or emergency medical team*).tw,kw.
4. 1 or 2 or 3
5. (evaluat* or implement* or utiliz* or utilis* or adopt*or success*or fail* or barrier*).tw,kw.
6. 4 or 5
7. limit to embase
8. limit 7 to (english or danish or swedish or norwegian)
9. limit 8 to yr= 2000 –Current

Web of Science Core Collection, searched on 20/03/2019

Search reads from bottom up

2 (#1) *AND* **LANGUAGE:** (English OR Danish OR Norwegian OR Swedish)
DocType=All document types; Language=All languages;

#1 TS=("rapid response team*" OR "rapid response system*" OR "Medical response team*"OR "medical emergency team*" OR "critical care outreach" OR "patient-at-risk-team*" OR "emergency medical team*") AND TS=(evaluat* OR implement* OR adopt* OR success* or fail* OR utiliz* OR utilis* or barrier*)
DocType=All document types; Language=All languages;

CINAHL via EBSCO searched on 20/03/2019

Search reads from bottom up

S6 S4 and S5

Limiters- Published Date: 20000101-20171031; Exclude MEDLINE records; Language: English, Danish, Norwegian, Swedish

S5 evaluat* or implement*or adopt* or utiliz* or utilis* or success* or fail* or barrier*

S4 S1 or S2 or S3

S3 "patient at-risk team*" or "emergency medical team*"

S2 (("rapid response" W0 (team* or system*)) or (medical W0 (response or emergency) W0 team*) or "critical care outreach"

S1 (MH "Rapid Response team")

Cochrane Library (all sections) searched via Wiley on 20/03/2019

#1 MeSH descriptor: [Hospital Rapid Response Team] this term only

#2 ("rapid response" next (team* or system*)):ti,ab,kw

#3 ((medical next (response or emergency) next team*) or "critical care outreach"):ti,ab,kw

#4 ("patient at-risk team*" or "emergency medical team*"):ti,ab,kw

#5 #1 or #2 or #3 or #4

#6 (evaluat* or implement* or adopt* or success* or fail* or utiliz* or utilis* or barrier*):ti,ab,kw

#7 #5 and #6 with Cochrane Library publication date Between Jan 2000 and Mar 2019

Epistemonikos, searched on 20/03/2019

(title:("rapid response team" OR "rapid response teams" OR "rapid response system" OR "rapid response systems" OR "medical response team" OR "medical response teams" OR "medical emergency team" OR "medical emergency teams" OR "critical care outreach" OR "patient-at-risk team" OR "patient-at-risk teams" OR "emergency medical team" OR "emergency medical teams") OR abstract:("rapid response team" OR "rapid response teams" OR "rapid response system" OR "rapid response systems" OR "medical response team" OR "medical response teams" OR "medical emergency team" OR "medical emergency teams" OR "critical care outreach" OR "patient-at-risk team" OR "patient-at-risk teams" OR "emergency medical team" OR "emergency medical teams")) AND (title:(evaluat* OR implement* OR adopt* OR utiliz* OR utilis* OR success* OR fail* OR barrier*) OR abstract:(evaluat* OR implement* OR adopt* OR utiliz* OR utilis* OR success* OR fail* OR barrier*))

PsychInfo, 1806- March week 3, searched at 02/03/2019

1 ((rapid response adj (team* or system*)) or (medical adj (response or emergency) adj team*) or critical care outreach).tw,id,hw.
2 (patient-at-risk team* or emergency medical team*).tw,id,hw.
3 1 or 2
4 (evaluat* or implement* or adopt* or success* or fail* or utiliz* or utilis*).tw,id,hw. (1050821)
5 3 and 4

Appendix II

Participant information and consent form (observation of simulations and FGI in study wards), Study 2

FORESPØRSEL OM DELTAKELSE I FORSKNINGSPROSJEKTET

SIMULERING: TIDLIG OPPDAGELSE OG HÅNDTERING AV PASIENT MED FORVERRET TILSTAND PÅ SENGEPOST-HVA ER FREMMERE OG HEMMERE FOR BRUK AV NEWS OG MIT PÅ SUS?

Dette er et spørsmål til deg om å delta i et forskningsprosjekt for å øke kunnskapen om hvordan vi kan lykkes med et system på sykehus for å tidlig oppdage og håndtere pasienter med forverret tilstand på sengepost. Ved Stavanger Universitetssykehus brukes NEWS (National Early Warning Score) for monitorering og som varslingskriterier med tilhørende protokoll for respons. SBAR (Situasjon- Bakgrunn- Aktuelt- Råd) anbefales som kommunikasjonsverktøy og Mobilt intensiv team (MIT) bestående av intensivlege og intensivsykepleier, er tilgjengelig 24/7 ved behov for tilsyn av pasient på sengepost. Internasjonalt kalles et slikt system for Rapid Response System (RRS), og Siri Lerstøl Olsen studerer disse systemene i et doktorgradsprosjekt (PhD) under tittelen: ***Aspects of implementation and sustainability of Rapid response systems in hospitals: What makes them successful?***

Sengepostene 3B og 6G starter høsten 2019 med simuleringstrening på sengepost, med fokus på tidlig oppdagelse og håndtering av pasient med forverret tilstand. Målet er å trene ansatte på å håndtere slike situasjoner gjennom å øke bevisstheten rundt og bruken av tilgjengelige systemer (NEWS, MIT, SBAR) for å sikre pasienten riktig hjelp raskt. Simulering er også en god metode til å få trene på samarbeid og kommunikasjon.

Simulering vil kunne bidra til å belyse hva som fungerer eller ikke fungerer i virkeligheten. Her kommer dette forskningsprosjektet inn. **For å lære mer om hva som funger bra i dagens system og hva som er barrierer, ønsker vi å observere flere simulerings-scenarier, samt intervjue deltakergruppen like i etterkant av treningen. Hensikten er ikke å adressere om du som ansatt gjør rett eller galt, men å lære hvordan man kan forbedre systemet lokalt på Stavanger Universitetssykehus og formidle denne kunnskapen videre til andre sykehus i inn- og utland som jobber med å etablere eller drive et RRS.** Vi ønsker å ha med deg som arbeider her på sengeposten som helsefagarbeider, sykepleier eller lege for å lære av dine erfaringer.

Tidlig oppdagelse av forverret tilstand på sengepost. Fremmere og hemmere for bruk av NEWS og MIT

HVA INNEBÆRER PROSJEKTET?

Forskningsprosjektet innebærer at to forskere, Siri Lerstøl Olsen og Britt Sætre Hansen, observerer simuleringstreningen. Underveis skrives observasjoner og kommentarer som dreier seg hovedsakelig om hvordan de involvere i scenariet handler, kommuniserer, resonnerer, og samhandler. Etter simuleringsscenariet er over, vil det være en debrief som er vanlig i simulering, for å samsnakke i gruppen om hvordan det gikk, hva man tenkte, erfarte og lærte. Denne debriefen blir utvidet til ca. 45 min og bli tatt opp på lydbånd. Det er fordi vi i tillegg til en debrief ønsker en gruppediskusjon om deres erfaringer med NEWS, MIT og SBAR brukt i hverdagen, hva dere opplever fungerer bra, og hva som fungerer mindre bra eller ikke i det hele tatt.

I prosjektet vil vi kun innhente og registrere opplysninger i forhold til ditt yrke/ stilling og antall års erfaring.

MULIGE FORDELER OG ULEMPER

Ved å delta i forskningsprosjektet får du mulighet til å bidra med dine erfaringer og synspunkt på systemet på sykehuset for å tidlig oppdage og håndtere pasient med forverret tilstand på sengepost. Dette er svært verdifull informasjon for å kunne forbedre systemet lokalt, og spre kunnskap til andre sykehus som jobber med slike system. Dine bidrag vil bli behandlet helt konfidensielt, og alle data som publiseres vil være avidentifisert.

FRIVILLIG DELTAKELSE OG MULIGHET FOR Å TREKKE SITT SAMTYKKE

Det er frivillig å delta i prosjektet. Dersom du ønsker å delta, undertegner du samtykkeerklæringen på siste side. Du kan når som helst og uten å oppgi noen grunn trekke ditt samtykke. Dersom du trekker deg fra prosjektet, kan du kreve å få slettet innsamlede opplysninger, med mindre opplysningene allerede er inngått i analyser eller brukt i vitenskapelige publikasjoner. Dersom du senere ønsker å trekke deg eller har spørsmål til prosjektet, kan du kontakte Siri Lerstøl Olsen, på telefon 40869842 eller mail: siri.l.olsen@uis.no.

Tidlig oppdagelse av forverret tilstand på sengepost. Fremmere og hemmere for bruk av NEWS og MIT

HVA SKJER MED OPPLYSNINGENE OM DEG?

Opplysningene som registreres om deg skal kun brukes slik som beskrevet i hensikten med prosjektet. Du har rett til innsyn i hvilke opplysninger som er registrert om deg og rett til å få korrigert eventuelle feil i de opplysningene som er registrert. Du har også rett til å få innsyn i sikkerhetstiltakene ved behandling av opplysningene.

Notater fra observasjoner vil ikke være knyttet til navn og person, men til yrke og års erfaring. Notatene vil bli skrevet over på data og lageret på kvalitetsserver.

Lydfilen fra intervjuet vil lagres innelåst i skap inntil den snares mulig transkriberes avidentifisert over på data. Da vil lydfilen slettes. Alle data vil bli håndtert konfidensielt. Observasjonene og fokusgruppeintervjuene vil bli brukt som data i en forskningsartikkel. Ingen personidentifiserbare data vil bli lagret eller gjengitt i artikkelen. Vi vil kun bruke yrke og antall år med erfaring for å skille ulike sitater. F. eks «(…) fungerer godt». (S.pl, 3 år) / «(…) svært tungvint» (Lege, 5 år). Dersom vi er i tvil om vi har forstått et utsagn riktig, kan du bli bedt om sitatsjekk.

Alle opplysningene vil bli behandlet uten navn og fødselsnummer eller andre direkte gjenkjennende opplysninger. En kode knytter deg til dine opplysninger gjennom en navneliste. Det er kun Siri Lerstøl Olsen og Britt Sætre Hansen som har tilgang til denne listen.

Opplysningene om deg vil bli anonymisert fortløpende og slettet fem år etter prosjektslutt.

GODKJENNING

Personvernombud ved Stavanger Universitetssykehus har gitt forhåndsgodkjenning for prosjektet.

Etter ny personopplysningslov har dataansvarlig, Stavanger Universitetssykehus, og prosjektleder Siri Lerstøl Olsen, et selvstendig ansvar for å sikre at behandlingen av dine opplysninger har et lovlig grunnlag. Dette prosjektet har rettslig grunnlag i EUs personvernforordning artikkel 6 nr. 1a.

Du har rett til å klage på behandlingen av dine opplysninger til Datatilsynet.

KONTAKTOPPLYSNINGER

Dersom du har spørsmål til prosjektet kan du ta kontakt med [Siri Lerstøl Olsen, tlf. 40869842. Mail: siri.l.olsen@uis.no

Personvernombud ved institusjonen er: Rafal Adnan Hashim Yeisen. E post: personvernombudet@sus.no

Tidlig oppdagelse av forverret tilstand på sengepost. Fremmere og hemmere for bruk av NEWS og MIT

JEG SAMTYKKER TIL Å DELTA I PROSJEKTET OG TIL AT MINE PERSONOPPLYSNINGER BRUKES SLIK DET ER BESKREVET

Sted og dato

Deltakers signatur

Deltakers navn med trykte bokstaver

Yrke/ antall års erfaring i profesjonen:

Appendix III

Participant information and consent form FGIs in ICU, Study 2

FORESPØRSEL OM DELTAKELSE I FORSKNINGSPROSJEKTET

TIDLIG OPPDAGELSE OG HÅNDTERING AV PASIENT MED FORVERRET TILSTAND PÅ SENGEPOST- HVA ER FREMMERE OG HEMMERE FOR BRUK AV NEWS OG MIT PÅ SUS?

Dette er et spørsmål til deg om å delta i et forskningsprosjekt for å øke kunnskapen om hvordan vi kan lykkes med et system på sykehus for å tidlig oppdage og håndtere pasienter med forverret tilstand på sengepost. Ved Stavanger Universitetssykehus brukes NEWS (National Early Warning Score) for monitorering og som varslingskriterier med tilhørende protokoll for respons. SBAR (Situasjon- Bakgrunn- Aktuelt- Råd) anbefales som kommunikasjonsverktøy og Mobilt intensiv team (MIT) bestående av intensivlege og intensivsykepleier, er tilgjengelig 24/7 ved behov for tilsyn av pasient på sengepost. Internasjonalt kalles et slikt system for Rapid Response System (RRS), og Siri Lerstøl Olsen studerer disse systemene i et doktorgradsprosjekt (PhD) under tittelen: ***Aspects of implementation and sustainability of Rapid response systems in hospitals: What makes them successful?***

Sengepostene 3B og 6G startet høsten 2019 med simuleringstrening på sengepost, med fokus på tidlig oppdagelse og håndtering av pasient med forverret tilstand. Målet er å trene ansatte på å håndtere slike situasjoner gjennom å øke bevisstheten rundt og bruken av tilgjengelige systemer (NEWS, SBAR, MIT). For å lære mer om fremmere og hemmere, har vi observert simuleringssesjoner og brukt debrief situasjonen til fokusgruppeintervjuer.

Vi ønsker nå mer kunnskap om intensivleger og intensivsykepleieres erfaringer med MIT systemet på SUS. Hva fungerer bra og hvorfor - og hva kan bli bedre?

HVA INNEBÆRER PROSJEKTET?

Siri Lerstøl Olsen (PhD kandidat/ Overlege), og Britt Sætre Hansen (Intensivsykepleier/ Professor og veileder) inviterer leger og sykepleiere ved 2M til fokusgruppeintervju. I prosjektet vil vi kun innhente og registrere opplysninger i forhold til ditt yrke/ stilling og antall års erfaring.

MULIGE FORDELER OG ULEMPER

Ved å delta i forskningsprosjektet får du mulighet til å bidra med dine erfaringer og synspunkt på systemet på sykehuset for å tidlig oppdage og håndtere pasient med forverret tilstand på sengepost. Dette er svært verdifull informasjon for å kunne forbedre systemet lokalt, og spre kunnskap til andre sykehus som jobber med slike system. Dine bidrag vil bli behandlet helt konfidensielt, og alle data som publiseres vil være avidentifisert.

FRIVILLIG DELTAKELSE OG MULIGHET FOR Å TREKKE SITT SAMTYKKE

Det er frivillig å delta i prosjektet. Dersom du ønsker å delta, undertegner du samtykkeerklæringen på siste side. Du kan når som helst og uten å oppgi noen grunn trekke ditt samtykke. Dersom du trekker deg fra prosjektet, kan du kreve å få slettet innsamlede opplysninger, med mindre opplysningene allerede er inngått i analyser eller brukt i vitenskapelige publikasjoner. Dersom du senere ønsker å trekke deg eller har spørsmål til prosjektet, kan du kontakte Siri Lerstøl Olsen, på telefon 40869842 eller mail: siri.l.olsen@uis.no.

HVA SKJER MED OPPLYSNINGENE OM DEG?

Opplysningene som registreres om deg skal kun brukes slik som beskrevet i hensikten med prosjektet. Du har rett til innsyn i hvilke opplysninger som er registrert om deg og rett til å få korrigert eventuelle feil i de opplysningene som er registrert. Du har også rett til å få innsyn i sikkerhetstiltakene ved behandling av opplysningene.

Notater fra observasjoner vil ikke være knyttet til navn og person, men til yrke og års erfaring. Notatene vil bli skrevet over på data og lageret på kvalitetsserver.

Lydfilen fra intervjuet vil lagres innelåst i skap inntil den snares mulig transkriberes avidentifisert over på data. Da vil lydfilen slettes. Alle data vil bli håndtert konfidensielt. Observasjonene og fokusgruppeintervjuene vil bli brukt som data i en forskningsartikkel. Ingen personidentifiserbare data vil bli lagret eller gjengitt i artikkelen. Vi vil kun bruke yrke og antall år med erfaring for å skille ulike sitater. F. eks «(…) fungerer godt». (S.pl, 3 år) / «(…) svært tungvint» (Lege, 5 år). Dersom vi er i tvil om vi har forstått et utsagn riktig, kan du bli bedt om sitatsjekk.

Alle opplysningene vil bli behandlet uten navn og fødselsnummer eller andre direkte gjenkjennende opplysninger. En kode knytter deg til dine opplysninger gjennom en navneliste. Det er kun Siri Lerstøl Olsen og Britt Sætre Hansen som har tilgang til denne listen.

Opplysningene om deg vil bli anonymisert fortløpende og slettet fem år etter prosjektslutt.

Tidlig oppdagelse av forverret tilstand på sengepost. Fremmere og hemmere for bruk av NEWS og MIT

GODKJENNING

Personvernombud ved Stavanger Universitetssykehus har gitt forhåndsgodkjenning for prosjektet.

Etter ny personopplysningslov har dataansvarlig, Stavanger Universitetssykehus, og prosjektleder Siri Lerstøl Olsen, et selvstendig ansvar for å sikre at behandlingen av dine opplysninger har et lovlig grunnlag. Dette prosjektet har rettslig grunnlag i EUs personvernforordning artikkel 6 nr. 1a.

Du har rett til å klage på behandlingen av dine opplysninger til Datatilsynet.

KONTAKTOPPLYSNINGER

Dersom du har spørsmål til prosjektet kan du ta kontakt med [Siri Lerstøl Olsen, tlf. 40869842. Mail: siri.l.olsen@uis.no

Personvernombud ved institusjonen er: Rafal Adnan Hashim Yeisen. E post: personvernombudet@sus.no

Tidlig oppdagelse av forverret tilstand på sengepost. Fremmere og hemmere for bruk av NEWS og MIT

JEG SAMTYKKER TIL Å DELTA I PROSJEKTET OG TIL AT MINE PERSONOPPLYSNINGER BRUKES SLIK DET ER BESKREVET

Sted og dato

Deltakers signatur

Deltakers navn med trykte bokstaver

Yrke/ antall års erfaring i profesjonen:

Appendix IV

Approval from Hospital Data protection Officer, Study 2

Stavanger Universitetssjukehus
Helse Stavanger HF

Personvernombudet

Til
Siri L. Olsen

Intern ID	Elements	Saksbehandler:	Dato:
17/2019		Personvernombud: Rafal Yeisen	08.08.19

Tilbakemelding på melding om behandling av personopplysninger i forbindelse med prosjektet: "SIMULERING: TIDLIG OPPDAGELSE OG HÅNDTERING AV PASIENT MED FORVERRET TILSTAND PÅ SENGEPOST-HVA ER FREMMERE OG HEMMERE FOR BRUK AV NEWS OG MIT PÅ SUS?".

Viser til innsendt meldingskjema med vedlegg om behandling av personopplysninger vedrørende ovennevnte prosjektet.

Formålet med prosjektet

Sengepostene 3B og 6G starter høsten 2019 med simuleringstrening på sengepost, med fokus på tidlig oppdagelse og håndtering av pasient med forverret tilstand. Målet er å trene ansatte på å håndtere slike situasjoner gjennom å øke bevisstheten rundt og bruken av tilgjengelige systemer (NEWS, MIT, SBAR) for å sikre pasienten riktig hjelp raskt. Simulering er også en god metode til å få trene på samarbeid og kommunikasjon. Formålet med dette prosjektet er å lære mer om hva som funger bra i dagens system og hva som er barrierer.

Behandlingsgrunnlag

Prosjektet er basert på samtykke, og har behandlingsgrunnlag i personvernforordning artikkel 6 nr.1 bokstav a.

Personvernombud tilrår at prosjektet kan gjennomføres under forutsetning av følgende:

1. Prosjektet godkjennes av klinikksjef før oppstart.
2. Prosjektet skal ikke behandler pasientopplysninger.
3. Data lagres avidentifisert på helseforetakets Kvalitetsserver. For å få tildelt plass på Kvalitetsserveren må saksnummer på denne godkjenningen (under Intern ID) fylles ut i søknadsskjemaet og selve godkjenningsbrevet må også legges ved. Annen lagringsform forutsetter godkjenning av personvernombudet.
4. Koblingsnøkkel som kobler avidentifiserte data med personopplysninger lagres enten elektronisk på tildelt område på Kvalitetsserveren eller nedlåst på prosjektleders kontor og skal slettes ved prosjektslutt 01.09.2024.
5. Informasjonsskriv/ samtykke som skal benyttes må inneholde tilstrekkelig informasjon tilknyttet til de registrerte rettigheter jmf personopplysningsloven, kapittel III Den registrertes rettigheter.

6. Informasjonsskriv/ samtykke som skal benyttes må inneholde PVO kontaktinformasjon.
7. Data slettes eller anonymiseres (ved at krysslisten slettes) ved prosjektslutt 01.09.2024. Når formålet med registeret er oppfylt sendes melding om bekreftet sletting/anonymisering til personvernombudet.

Personvernombud har, ut over det som er angitt over, ingen innvendinger til at prosjektet gjennomføres. Det forutsettes at prosjektet gjennomføres som beskrevet og i henhold til personvernforordninger samt øvrige relevante lover og forskrifter.

Med vennlig hilsen

Rafal Yeisen
Personvernombud

Appendix V

Response from REC-WEST- Study 3

Region:	Saksbehandler:	Telefon:	Vår dato:	Vår referanse:
REK sør-øst B	Ingrid Dønåsen	22845523	25.09.2019	28760
			Deres referanse:	

Siri Lerstøl Olsen

28760 Implementering av system for tidlig oppdagelse av forverret tilstand: læring gjennom mortalitetsanalyser

Forskningsansvarlig: Helse Stavanger HF - Stavanger universitetssjukehus

Søker: Siri Lerstøl Olsen

Søkers beskrivelse av formål:

Dette prosjektet søker å forstå hvordan implementering av et system for tidlig oppdagelse av forverret tilstand (Internasjonalt kalt Rapid response systems) har bidratt til å forbedre monitorering av innlagte pasienter, og håndtering ved tegn til forverring i klinisk tilstand ved gastrokirurgiske sengeposter. Vi vil se etter styrker og aktuelle forbedringsområder. Dødsfallene vil bli kategorisert i henhold til system fra Mayo klinikken; forventet/ eller uventet- med eller uten forbedrings- potensiale. Metoden vil være retrospektiv med journalgjennomgang av alle dødsfall knyttet til gastrokirurgiske sengeposter fra og med 2010 til og med 2018. Denne vurderingen gjøres som konsensus i en gruppe med leger og sykepleier. Numeriske data vil presenteres som tidsserier, og forbedringsområder vil diskuteres opp mot gjeldende forskningslitteratur.

REKs vurdering

Vi viser til søknad om forhåndsgodkjenning av ovennevnte forskningsprosjekt, mottatt til fristen 11.06.2019. Søknaden ble behandlet av Regional komité for medisinsk og helsefaglig forskningsetikk (REK sør-øst B) i møtet 21.08.2019. Vurderingen er gjort med hjemmel i helseforskningsloven § 10.

Gammelt referansenummer for denne saken før ny saksportal i REK var 2019/1199

Prosjektet omhandler implementering, bruk og forbedringspotensiale for et system for tidlig oppdagelse av forverret tilstand (Rapid response systems). Komiteen anser prosjektet slik det er fremlagt i søknad og protokoll som forskning på helsetjenesten, ikke på helse og sykdom som sådan. Prosjektet faller dermed utenfor helseforskningslovens virkeområde, jf. §§ 2 og 4 bokstav a.

Ettersom prosjektet ikke anses som kvalitetssikring er det imidlertid innenfor REKs mandat å vurdere søknad om fritak fra samtykkekravet, herunder dispensasjon fra taushetsplikten, i prosjektet, jf. forskrift av 2.7.2009 nr. 989,*Delegering av myndighet til den regionale komiteen for medisinsk og helsefaglig forskningsetikk etter helsepersonelloven §29 første ledd og forvaltningsloven § 13d første ledd*. Komiteen er av den oppfatning at de samme vurderinger skal gjøres her, som ved vurdering av fritak av lovpålagt taushetsplikt etter helseforskningsloven §§ 15, 28 og 35. Relevante skjønnsmomenter i vurderinger foretatt etter helseforskningslovens bestemmelser er anvendt i komiteens vurdering av denne saken.

Alle pasientene som skal inkluderes i prosjektet er avdøde og det er dermed ikke mulig å innhente samtykke fra dem. Komiteen anser at prosjektet har vesentlig samfunnsnytte og at deltakernes velferd og integritet er ivaretatt. Vilkårene for fritak fra samtykkekravet, herunder dispensasjon fra taushetsplikten, anses således som oppfylt.

Komiteen gjør oppmerksom på at REKs myndighet er begrenset til å vurdere om vilkårene for å gi dispensasjon fra taushetsplikt er oppfylt. Behandlingsgrunnlaget for opplysningene må forankres i egen institusjon.

Vedtak

Godkjent

Forskningsprosjektet faller utenfor helseforskningslovens virkeområde, jf. §§ 2 og 4 bokstav a.

Med hjemmel i helsepersonelloven § 29 første ledd, jf. forskrift av 2.7.2009 nr. 989, Delegering av myndighet til den regionale komiteen for medisinsk og helsefaglig forskningsetikk etter helsepersonelloven § 29 første ledd og forvaltningsloven § 13d første ledd, har komiteen besluttet å gi fritak fra lovpålagt taushetsplikt.
Dispensasjonen fra taushetsplikt innebærer at opplysninger kan innhentes som beskrevet i søknaden uten hinder av taushetsplikt.
Dispensasjonen fra taushetsplikt gjelder til 20.06.2023.

Komiteens avgjørelse var enstemmig.

Klageadgang
REKs vedtak kan påklages, jf. forvaltningslovens § 28 flg. Eventuell klage sendes til REK sør-øst B. Klagefristen er tre uker fra mottak av dette brevet. Dersom vedtaket opprettholdes av REK sør-øst B, sendes klagen videre til Den nasjonale forskningsetiske komité for medisin og helsefag for endelig vurdering, jf. forskningsetikkloven § 10 og helseforskningsloven § 10.

Ragnhild Emblem
Professor, dr. med.
Leder REK sør-øst B

Ingrid Dønåsen
Rådgiver

Kopi sendes:
Stavanger universitetssjukehus HF ved øverste administrative ledelse: post@sus.no

Appendix VI

Approval from Hospital Data protection Officer, Study 3

Stavanger Universitetssjukehus
Helse Stavanger HF

Personvernombudet

Siri Olsen

Intern ID	Elements	Saksbehandler:	Dato:
25/2019		Personvernombud Rafal Yeisen	31.10.2019

VURDERING FRA PERSONVERNOMBUDET – «Implementering av system for tidlig oppdagelse av forverret tilstand: læring gjennom mortalitetsanalyser».

Det vises til innsendte dokumenter, herunder meldeskjema, variabelliste og REK vedtak.

REK har vurdert prosjektet til å være «annen type forskning», dvs forskning som faller utenfor helseforskningsloven. De registrerte er døde, og prosjektet er følgelig ikke samtykkebasert.

I henhold til Lov om behandling av personopplysninger § 9 andre ledd påhviler det prosjektet å rådføre seg med personvernombudet. Selv om det er en rådføringsplikt, vil ansvaret for at personvernet er tilstrekkelig ivaretatt i prosjektet påhviler prosjektansvarlig og virksomheten.

Personvernombudet har vurdert prosjektet, og tilrår at prosjektet gjennomføres i samsvar med innsendte opplysninger og dokumenter.

Personvernombudet har gjort følgende vurdering av prosjektet;

Prosjektets behandlingsgrunnlag;

Personvernforordningen får ikke anvendelse på personopplysninger om avdøde personer, jf fortalen i forordningen artikkel 27. Det kan fastsettes regler om behandling av personopplysninger om avdøde personer i nasjonal rett.

Personvernombudet vurderer at prosjektet har lovlige behandlingsgrunnlag i nasjonal rett jf Lov om behandling av personopplysninger § 9. Videre at samfunns interessen i at behandlingen av personopplysninger finner sted, *klart* overstiger ulempen for den registrerte. Personvernombudet vurderer videre at databehandlingen er omfattet av nødvendige og tilstrekkelige garantier.

REK innvilget dispensasjon fra taushetsplikten etter helsepersonelloven § 29 første ledd i vedtak av 25.09.19. Dispensasjonen fra taushetsplikt gjelder til 20.06.2023.

Formål

REK har vurdert prosjektet til å være forskning som faller utenfor helseforskningsloven. Personvernombudet er enig i det.

Prosjektet søker å forstå hvordan implementering av et system for tidlig oppdagelse av forverret tilstand (Internasjonalt kalt Rapid response systems) har bidratt til å forbedre monitorering av innlagte pasienter, og håndtering ved tegn til forverring i klinisk tilstand ved gastrokirurgiske sengeposter. Vi vil se etter styrker og aktuelle forbedringsområder. Dødsfallene vil bli kategorisert i henhold til system fra Mayo klinikken; forventet/ eller uventet- med eller uten forbedrings- potensiale. Metoden vil være retrospektiv med journalgjennomgang av alle dødsfall knyttet til gastrokirurgiske sengeposter fra og
med 2010 til og med 2018. Denne vurderingen gjøres som konsensus i en gruppe med leger og sykepleier. Numeriske data vil presenteres som tidsserier, og forbedringsområder vil diskuteres opp mot gjeldende forskningslitteratur.

Personvernombudet vurderer at prosjektet har et samfunnsmessig viktig og godt formål. Videre at formålet er tilstrekkelig klart definert og avgrenset, jf personvernforordningen artikkel 5 nr 1 b).

Ivaretakelse av personvernet

Personvernombudet ber prosjektleder å ta hensyn til krav om dataminimering, riktighet, integritet, lagringsbegrensning, og konfidensialitet ved behandling av innsamlede data.

Sluttvurdering

Personvernombudet har ingen innvendinger til at prosjektet gjennomføres slik den er beskrevet i dokumenter og opplysninger som er fremlagt.

Videre forutsettes det at prosjektet gjennomføres ihht Lov om behandling av personopplysninger, helseregisterloven, dødsårsaksregisterforskriften og annen relevant lovgivning.

Til slutt forutsettes det også at data lagres på Helse Stavanger HF sin forskningsserver.

Personvernombud

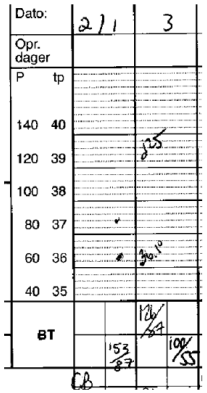
Rafal Yeisen

Appendix VII

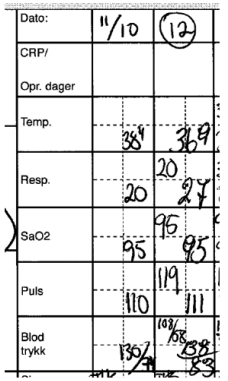
OM-Charts in the Norwegian study Hospital (Supplementary file, Paper III)

Examples of the charts with documented vital signs used in the three time periods

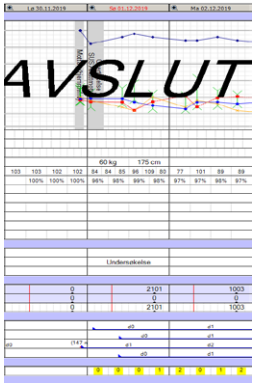
P1



P2



P3



Supl. File 3: Development of patient OM-chart. In **P1**, no room for respiratory frequency documentation. In **P2**, new charts developed when the MET- c criteria was implemented. In **P3**, NEWS is incorporated in the chart. All vital signs are documented both in the top of the chart, and in the bottom as NEW -score. By clicking on the numbers, detailed information about time for registration and all vital sign values are available.