Implementing change in health services: the case of rapid response systems

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Abstract: Rapid response systems (RRSs) have been introduced in hospitals to prevent delays in medical management of care for patients whose clinical status deteriorates unexpectedly. An RRS consists of three limbs and its implementation affects the entire hospital organisation. This paper aims to provide insights into the approaches used by Dutch hospitals for RRS implementation and the factors influencing the approaches chosen. Starting from a conceptual framework emphasising the importance of the process, content and context for innovation implementation, our qualitative study shows the breadth of approaches used in practice. In-depth insights into the implementation process, content and context – as well as the relationships between them – extend existing theory on RRS implementation and will help hospitals tailor their implementation approach to organisational characteristics.

Keywords: rapid response system; RRS; healthcare innovation; implementation strategy; qualitative research; healthcare organisation.

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1 Introduction

Over the last century, thorough thinking about process and system design has greatly improved the responsiveness, flexibility and efficiency of manufacturing and services. It has been recognised that similar ways of thinking about and delivering healthcare services would be extremely valuable for quality improvement (Walley, 2003; Morton and Cornwell, 2009). To arrive at desired changes, application of comprehensive concepts such as focused factories (e.g., Casalino et al., 2003; Hyer et al., 2009) and total quality management (Øvretveit, 2000; Shortell et al., 2000; Gregori et al., 2009) have been emphasised by academics and hospitals. However, successful implementation of new concepts is a prerequisite if improvements in process and patient outcomes are to be achieved. Research has shown that the implementation of comprehensive concepts requires more than just a focus on the *contents* of the concept itself (i.e., what the concept encompasses and its objectives). The *process* of implementation (i.e., how change is achieved, what activities are done and by whom) and the *context* of the organisation (internal and external factors such as culture and politics that influence change) also have to be taken into account (Pettigrew and Whipp, 1993).

One concept that aims to improve the quality of care delivered by hospitals is the rapid response system (RRS). This is a hospital-wide care system focusing on providing appropriate care to ward patients whose vital functions (heart rate, respiration rate, consciousness) deteriorate unexpectedly. RRSs are built around a specialised team of caregivers – the rapid response team – that can be called to the hospital wards in acute situations to treat patients suffering from clinical deterioration (Winters et al., 2007). The team is complemented by different types of procedures, for example for early recognition of clinical deterioration on hospital wards. Through early recognition of deteriorating patients and the provision of immediate and suitable care to these patients, the RRS aims to reduce unplanned intensive care unit (ICU) transfers, cardiopulmonary resuscitation (CPR) and possible deaths of these patients.

RRSs have been implemented in Australia, the UK and the USA (Winters et al., 2007; Jones et al., 2011) and they are now becoming common in Scandinavian countries and the Netherlands. Despite conflicting evidence about RRS effectiveness (Chan et al., 2008, 2010), its introduction has been driven by the belief that an RRS prevents serious adverse events after sudden alterations in vital signs in hospital ward patients, thus making the hospital a safer environment for patients (Jones et al., 2011). This, however, requires implementation of the concept and compliance with its way of working on all hospital wards (Jones et al., 2011).

A complete RRS comprises three main components (Winters et al., 2007; Jones et al., 2011). The first is the efferent limb, a rapid response team (RRT) that is often set up at the ICU. This team can be called by hospital wards when a patient's vital functions suddenly deteriorate. The team responds to calls by sending appropriate personnel and equipment to the ward. The second component is the afferent limb, which is designed to identify clinical deterioration in patients on the wards and trigger a response. It includes procedures for early recognition of patient deterioration through evaluation of vital signs (such as heart rate, respiration rate or consciousness) and the criteria for calling the RRT to be used by ward nurses. The third component provides a hospital-wide feedback loop, which includes the collection of data and analysis of events where the RRT was called in. Reviewing data on RRT calls and their outcomes might permit strategies to be developed that prevent clinical deterioration of patients and optimise care provision on hospital wards, thus allowing for continuous improvement of the care system (Jones et al., 2011). The implementation of an RRS will therefore influence many aspects of the hospital organisation, from the ICU to the wards and from operational to strategic levels.

Several success factors have been identified for the hospital context in which the RRS is to be implemented, such as hospital management support (DeVita et al., 2005) and having the right RRT leader (Jones et al., 2009). Given the content of the RRS, it has been recognised that hospitals with a teaching status choose different setups for their RRS compared to non-teaching hospitals, as hospitals tailor their RRS to meet the burden of events (more versus less complex patients) and incorporate the most appropriately trained personnel available (Jones and Bellomo, 2011). Teaching and university hospitals tend to set up a comprehensive system that is active 24/7 to meet the needs of their complex patients and because they have highly trained (ICU) staff available. Smaller general hospitals may not have these kinds of facilities or have less complex patients and therefore choose a simpler team construction, daytime activation only, or restrict the number of wards to which RRT service is available.

Despite existing knowledge about RRS content and some insights into contextual factors, a comprehensive picture of the implementation process of RRSs and why hospitals choose their particular implementation approach is currently not known (DeVita and Hillman, 2011). Klein and colleagues (Klein and Knight, 2005; Klein and Sorra, 1996) emphasise that implementation is the crucial stage that moves from the decision to adopt an innovation on to the routine use of that innovation in practice. While innovation adoption has been widely studied, the implementation process has been less studied (Klein et al., 2001). Fixsen et al. (2005) call for studies that can increase knowledge about the process of implementation and offer practical guidance for both policy makers and service providers. To this end, they suggest the use of field-based approaches.

In response to the literature gaps identified by Klein and colleagues (Klein and Knight, 2005; Klein et al., 2001; Klein and Sorra, 1996) and Fixsen et al. (2005), this study aims to explore the concept of the RRS from the point of view of an implementation process. Using qualitative research reflecting on actual practice in Dutch hospitals let us increase knowledge about the process of implementation in real-life contexts. To guide data collection and analysis, we focused particularly on the implementation process in relation to the content of the innovation and the context in which the implementation process was taking place (Pettigrew and Whipp, 1993). To this end, the research question addressed by means of semi-structured interviews is "*What approaches do hospitals follow when implementing RRSs and how do context, content and process factors influence the approach chosen?*"

2 The process of innovation implementation in healthcare

Innovation in care contexts has been defined as "a novel set of behaviours, routines and ways of working that are directed at improving health outcomes and that are implemented by planned and coordinated actions" (Greenhalgh et al., 2004). Innovations can be characterised by different degrees of newness for the context in which they are implemented, such as being new to the world, new to the industry or market, or new to the firm (e.g., Garcia and Calantone, 2002). 'New to the world' implies that something has been completely newly invented and never been used before, such as the World Wide Web or the discovery of penicillin. 'New to the industry or market' means that an innovation has been used in other sectors but it is newly introduced in the sector being focused on, such as the introduction in hospitals of crew resource management, which was originally developed in the airline sector. 'New to the firm' implies that an organisation is embracing a new way of working that might have proven itself already in other organisations in the same sector. Examples are the implementation of focused patient processes developed by, e.g., the Shouldice hospital for patients suffering from an external abdominal hernia or integrated care processes developed by Mayo Clinics, or the implementation of a RRS in hospitals. In this paper, we are focusing on the last of the three, i.e., new to the firm.

Implementation of an innovation in an organisation is the process of gaining targeted employees' appropriate and committed use of an innovation (Klein and Sorra, 1996; Klein and Knight, 2005). The implementation process consists of various stages (e.g., Klein and Sorra, 1996; Greenhalgh et al., 2004; Hansen and Birkinshaw, 2007; Simpson and Flynn, 2008). In early stages of the implementation process, an innovation is *adopted*, i.e., a decision is made to adopt the innovation. Users are trained and the first actions are taken to introduce and use the innovation (Simpson and Flynn, 2008). In later stages of the implementation process, further actions are taken to spread the use of the innovation with the final aim of sustaining or 'routinising' the innovation (Simpson and Flynn, 2008). This means that the innovation is embedded in the organisation and put into practice by targeted users in a consistent manner (Greenhalgh et al., 2004).

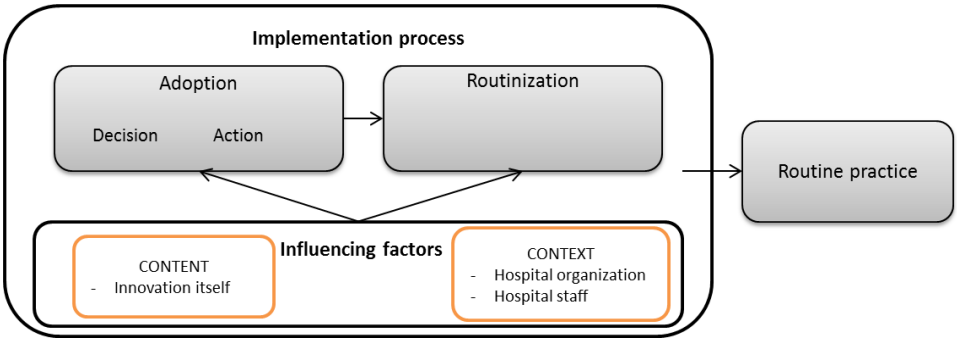
In order to *adopt* an innovation within an organisation, various success factors have been identified in the literature that are related to the innovation itself, to the organisation in which the implementation is implemented and to the staff and professionals working in the organisation. As regards the innovation itself, its perceived quality and utility and the perceived possibility of adapting an innovation to the specific setting that it will be implemented in are crucial to innovation adoption (Simpson and Flynn, 2008). In terms of the staff, appropriate skills and abilities are required (Simpson and Flynn, 2008; Greenhalgh et al., 2004; Klein and Knight, 2005). At the organisational level it has been recognised that a supportive package of implementation practices is required, including resources (both time and money), training and a plan of action for implementation (Greenhalgh et al., 2004; Klein and Knight, 2005), as well as leadership support (Simpson and Flynn, 2008).

To achieve *routinisation*, staff need to be motivated and have the skills to use the innovation (Greenhalgh et al., 2004). To this end, the innovation itself has to be perceived as being effective and feasible (Simpson and Flynn, 2008) and empirical evidence and feedback has to be communicated among staff involved to prove the value of an innovation. At the organisational level, the availability of resources has been identified as being important for routinisation (Greenhalgh et al., 2004; Simpson and Flynn, 2008).

In order to achieve innovation adoption as well as routinisation multiple factors are therefore involved that concern the *content*, i.e., the innovation itself (utility, adaptability, effectiveness and feasibility), as well as the *context*, i.e., staff having to work with the innovation (skills, motivation, communication) and the organisation in which the innovation is to be implemented (resources, training, leadership).

The process of innovation as depicted in the previous sections, including the adoption and routinisation phases and the content and context related factors influencing these phases of the implementation process, is summarised in Figure 1. This figure was adapted from Simpson and Flynn (2008) and will be used as a framework for focusing and organising the data collection and analysis in the remainder of this paper.

Figure 1 Framework for innovation implementation (see online version for colours)



As yet, not much has been written about RRS adoption and routinisation. DeVita and Hillman (2011) identified that there is no strong data for defining particular strategies for RRS implementation; only the experiences of individual hospitals have been described. These experiences pointed to the importance of the use of data about the effectiveness of the RRS in the routinisation phase (DeVita and Hillman, 2011), for example, thereby confirming Simpson and Flynn (2008) in this specific context. Following the general insights on the implementation process that have been identified in various healthcare contexts (Greenhalgh et al., 2004; Simpson and Flynn, 2008), we posit that the process for RRS implementation also consists of various stages, in which adoption of the RRS is followed by its routinisation. In addition, we posit the importance of the innovation contents and implementation context in addition to the implementation process. In the remainder of this paper, we will shed further light upon the process of RRS implementation (including influencing factors) by using semi-structured interviews and thematic analysis, thereby working towards a more detailed understanding of the framework as presented in Figure 1 in the light of RRS implementation.

3 Methodology

The Netherlands has 91 hospitals: eight university hospitals with a teaching function, 27 teaching hospitals and 56 general hospitals without a teaching function (Dutch Hospital Data, 2012). Patient safety and quality improvement have been a major focus of the sector for years. Hospital associations, in collaboration with the Dutch government,

introduced a nationwide Hospital Patient Safety Programme in 2008 to give more impetus to this trend. As part of this programme, all Dutch hospitals have been advised to implement an RRS (VMS, 2008). The advice was to set up a system containing an afferent, efferent, and feedback limb and a general blueprint was given for the content of each limb. In addition, a generic roadmap for preparing for implementation was provided, which included *inter alia* the advice to set up an implementation team and define a plan for communication and training about the RRS. The generic roadmap did not however give advice on the steps to be taken during actual implementation or on the exact content of each limb.

To shed light upon the way in which the Dutch hospitals implemented their RRS, a qualitative study design was used. This study was part of an overall evaluation study of the complete Hospital Patient Safety Programme. For this overall study, 19 hospitals were randomly selected, stratified by location and teaching status (teaching: eight, non-teaching: 11). These hospitals were approached for an interview about RRS implementation. As one non-teaching hospital had not started its RRS implementation yet, 18 semi-structured interviews were conducted by trained interviewers. These were guided by a topic list based on available literature on the implementation of organisation-wide change (i.e., focus on innovation adoption and routinisation including the innovation content, process and context) (e.g., Pettigrew and Whipp, 1993; Greenhalgh et al., 2004) and RRS in particular (e.g., Jones et al., 2011). The topic list contained questions such as "What are the contents of the afferent, efferent and feedback limbs and how are they organized?", "How did you organize and address the implementation of the entire system?", "What factors concerning the hospital as a whole influenced the implementation?" etc.

In all hospitals, one interview was conducted. The contact person at each hospital was asked for the most appropriate person to interview, namely the one with the most knowledge or most closely involved with the RRS of the hospital. In ten hospitals the interview was conducted with the project leader for RRS implementation (mainly the ICU doctor) and in eight hospitals in combination with a second (and sometimes third) person involved in implementation (mainly an ICU nurse or quality officer). Data collection took place from December 2011 to May 2012. Table 1 shows an overview of the hospitals included in this research, stating some general characteristics for each (location, size, teaching status, etc.), the year in which the RRS was started and the number and type of interviewees.

The interviews were transcribed. Data was first analysed per hospital by means of thematic analysis. To explore approaches to RRS implementation, including the various stages of the implementation process, influencing factors and perceived effects of implementation, we followed a systematic data reduction process: reading of transcripts, codification of segments, generation of themes and categories, and identification of relationships (Miles and Huberman, 1994). Process descriptions were created for each hospital including both early and later stages of implementation and we created thematic conceptual matrices for factors perceived as helping and hindering during the adoption and routinisation phases. Common themes and working practices were identified from the within-case analyses, which led to the cross-case analysis providing insights into how (different types of) Dutch hospitals deal with RRS implementation.

Table 1 Hospital characteristics and number (type) of interviewees

Hospital	*Location in the Netherlands*	*Teaching status**	*No. of beds*	*No. of sites with beds*	*ICU level***	*RRS adoption decision*	*# (type) interviewees*
1	West	TH	483 + 170	2	3	2004	1 (ICU doctor/project leader)
2	West	NTH	627[a]	2	2	2008	1 (ICU doctor/project leader)
3	West	TH	881	2	2	2009	2 (head of quality office and quality officer/project leader)
4	West	TH	881[a]	1	3	2002	1 (ICU doctor/project leader)
5	West	TH	555	1	3	2008	1 (ICU doctor/project leader)
6	East	NTH	300	1	2	2009	2 (ICU nurses/project leaders)
7	North	TH	580	1	3	2006	1 (ICU doctor/head of ICU)
8	South	TH	715	1	3	2012	1 (project leader/ICU nurse)
9	West	NTH	455	1	2	2009	1 (quality officer/ICU nurse)
10	South	NTH	364 + 396	2	1	2009	3 (ICU doctor, 2 ICU nurses)
11	South	NTH	667	1	2	2009	2 (ICU doctor and cardiologist/project leader)
12	East	NTH	297	1	1	2008	1 (Emergency care doctor/ project leader)
13	South	TH	696	1	3	2009	1 (project leader)
14	North	NTH	392 + 653	2	2	2009	3 (ICU nurse team leader and ICU nurses)
15	South	NTH	207 + 276	2	1	2009	2 (ICU doctor and quality officer)
16	North	TH	1,339	1	3	2011	1 (head of ICU)
17	West	NTH	350[a]	2	1	2010	2 (ICU doctor and head of ICU
18	North	NTH	339	1	1	2009	2 (head of ICU/project leader and quality officer

Notes: *TH = teaching hospital, NTH = non-teaching hospital
**ICU level 1 = lowest level ICU with ICU doctor reachable 24/7;
ICU level 2 = mid-level ICU with 24/7 availability of ICU doctor;
ICU level 3 = highest level ICU with 24/7 exclusive availability of ICU doctor
[a]Unknown per site

4 Results

The within-case analysis of each hospital, including implementation organisation, implementation process, the perceived promoting and hindering factors during adoption and routinisation and the perceived outcomes of the RRS, is summarised in Appendix A (hospitals are indicated by numbers 1 to 18). In this section, we present our cross-case findings. First, a description of the implementation process is provided. Thereafter, we shed light upon the contents of the implementation, the context of implementation and the relationships between these concepts. Where possible, we point out the relationship between hospital characteristics as described in Table 1 and the implementation approach chosen.

4.1 The process of RRS implementation

In the majority of the hospitals (12 out of 18), the ICU took the initiative/decision to set up the RRS. In the other six hospitals, the initiative/decision was taken by top management or the quality office. Four of these hospitals were non-teaching hospitals. In all hospitals, implementation was organised by assigning a team responsible for RRS implementation. In nine hospitals, this implementation team was composed entirely of professionals working at the ICU. In the other nine hospitals, the implementation team consisted of healthcare professionals working at different parts of the hospital. From the five hospitals with a small level 1 ICU (Table 1), four organised a hospital-wide implementation team. Table 2 shows a matrix with the decision making unit and accompanying implementation team organisation for each hospital. Interviewees in the hospitals with an ICU implementation team indicated that it was important that those with the most knowledge about a subject should be responsible for executing related tasks, in this case the implementation and setup of the RRS. In the hospitals with a hospital-wide implementation team, interviewees emphasised the importance of the scope of the improvement project; those who would be affected by the project should be involved in its execution. Because the RRS is capable of improving the entire hospital system, it could not be considered as '*just an ICU toy*' (hospital 1) and professionals and managers representing various hospital entities had been involved to work together towards a safer hospital.

In each hospital, the implementation team implemented an RRS that contained an afferent limb (i.e., monitoring procedures to recognise deteriorating patients and criteria for calling the RRT), an efferent limb (i.e., the rapid response team including appropriate professionals and equipment) and a feedback limb (i.e., overall evaluation and analysis of calls with the aim of continuous improvement of the RRS) (Jones et al., 2011), as advised by the National Patient Safety Programme (VMS, 2008). During the implementation process, the implementation teams took various steps to finally implement the RRS. These steps are summarised in Table 3, which suggests that two approaches to RRS implementation can be discerned: a stepwise approach and a non-stepwise approach. In the five hospitals with the non-stepwise approach, the adoption phase consisted of the assignment of the implementation team. After that, the RRS was implemented on all hospital wards at once (after training the hospital personnel) to achieve routinisation. The hospitals that followed this approach were all non-teaching hospitals that considered themselves as small. They reasoned that the size of their hospital or respective sites made

it possible to monitor and steer the implementation process quite easily without first having to pilot it.

Table 2 Initiative taken and implementation team composition

		Initiative taken by	
		ICU	*Top management/quality office*
Implementation team composition	ICU only	2, 3, 5, 6, 11, 14	9, 10, 13
	Hospital-wide	1, 4, 7, 8, 12, 17	15, 16, 18

Table 3 Steps in the implementation process

Step in process	*Hospitals*	
ADOPTION	*Stepwise approach*	*Non-stepwise approach*
Decision making/initiative taking	All sites	
Assignment of implementation team	All sites	
Training of pilot wards	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 13, 15, (16)	
Pilot in one/small number of wards	1, 2, 3, 4, 5, 6, 7, (8), 9, 10, 13, (15), (16)	
ROUTINISATION	*Stepwise approach*	*Non-stepwise approach*
Training in all hospital wards	All sites (except hospital 9)	
Implementation on all wards at once		11,12, 14, 17,18
Gradual implementation on trained wards	1, 2, 3, 4, 5, 6, 7, 9,10, 13, (15)	
Afferent limb implemented	1, 2, 3, 4, 5, 6, 7, 9,10, 13	
Efferent limb implemented	1, 2, 3, 4, 5, 6, 7, 9,10, 13	
Feedback limb implemented	1, 3, 7, 13	
Feedback limb under construction	2, 5, 6, 9	
No feedback limb yet	4, 10, 15	
Not any limb yet	8, 16	
Looking for improvements/to-do's in system	All sites	
In afferent limb	1, 2, 3, 4, 7. 9, 11, 12, 13, 14, 18	
In efferent limb	18	
In feedback limb	4, 5, 6, 9, 10, 15, 17	

Notes: No operational RRS: 8, 15, 16
(n): action planned but not operationalised yet

The stepwise approach to implementation was followed by 13 project teams. This approach consisted of various steps in both the adoption and routinisation phase, starting with a pilot in one or a few wards during the adoption phase, followed by gradual unrolling of the RRS to achieve routinisation. In all but one (hospital 9) of these hospitals, training of hospital ward nurses and doctors was a prerequisite for the implementation of the RRS on a particular ward; the RRT and accompanying procedures were only operationalised on a ward when 60–100% of the medical staff had been trained in these procedures.

In addition to focusing on one ward at a time, the stepwise approach also focused on one RRS limb at a time. All hospitals first focused on the implementation of the RRT and the early recognition procedures, i.e., the efferent and afferent limbs. In this way, the hospitals aimed to get the system up and running and provide hospital professionals with a means to provide better care to critically ill patients in hospital wards. The feedback component, required to complete the RRS and allow for continuous improvement, was implemented in a second stage, as can be seen in Table 4 where the rows on gradual implementation of the RRS on trained wards shows that many hospitals are lacking a (fully functioning) feedback limb. As one interviewee put it, "*Once the team and accompanying procedures were more or less functioning, we developed further towards a rapid response system, including continuous training and evaluation*" (hospital 3). In general, the setup of the RRT and introduction of the recognition procedure were perceived as relatively simple; interviewees indicated that hospitals had ample experience with implementing new procedures. Setting up a new care team had been experienced before. Implementation of the feedback limb, however, was perceived as far more complex. Because the feedback limb served to continuously improve the RRS and the hospital care system as a whole, interviewees felt that its implementation envisioned a large change encompassing the entire hospital at both the operational and managerial levels.

To routinise the RRS and embed its functioning, continuous training of ward personnel, analysis of RRT calls and structural feedback reports to wards and management were mentioned as primary points for improvement, along with improvements in the afferent limb. Hospitals that had already routinised the feedback limb mentioned different points for improvement, mainly focusing on further improvement of patient monitoring to aim for still earlier recognition of deterioration.

In summary, two different approaches were followed by hospitals in RRS implementation, a stepwise or a non-stepwise approach. Stepwise indicates that a distinction was made between various activities undertaken in the adoption and routinisation phase of implementation and also that the content of the RRS limbs was implemented one at a time.

4.2 The content of RRS being implemented

Even though each implementation team implemented an RRS consisting of an afferent, efferent and feedback limb, as advised by the National Patient Safety Programme, the content of the limbs appeared to differ among hospitals. Interviewees in 12 hospitals indicated that the content of the RRS had been adapted to the local situation. The afferent limb was adapted in eight hospitals, the efferent limb in seven and the feedback limb in three. Table 4 shows for each hospital what adaptations were made in which limb and why. From this table, it can be seen that there is a clear relationship between the limb being adapted and the reason given for this by the interviewees. Adaptations in the *afferent limb* were all related to professional and patient characteristics. Professional characteristics (e.g., existing knowledge on wards, division of tasks and responsibilities) influenced the type and number of triggers included in the early warning procedure, and the thresholds set within this early warning procedure. Patient characteristics, such as the risk of the patient deteriorating, influenced the way in which the early warning procedure was adapted to suit different wards.

Table 4 Adaptations made to content of the RRS

Hosp.	*Adaptation made*	*Limb affected*			*Influencing factors*				*Reason for adaptation*
		A	*E*	*F*	*Org*	*Prof*	*Pat*	*Other*	
1	A&E doctor was given a role in the RRT to make sure 24/7 availability in the smallest site.		x		x				*Organisation* (site): the hospital has two sites, in both of which 24/7 availability of the RRT has to be secured.
2	Afferent, efferent and feedback limbs adapted to include acute wards that were advised to be excluded by the Dutch national programme.	x	x	x		x			*Professionals*: knowledge on acute wards about deteriorating patients turned out to be not as high as was expected, so wards are included in the RRS.
4	Early warning procedure was tuned to patient characteristics on different wards and to workability / efficiency of the procedure	x				x	x		*Patient*: patients were taken as starting point for way in which early warning procedure is used on each ward; procedure has to fit the characteristics of the patients on that ward and is not standardised throughout the hospital
									Professionals (efficiency): procedure of monitoring the patient adapted so it would take the wards less time
	Many more outcomes were added to evaluate the functioning and effectiveness of the RRS			x				x	*Vision on safety*: the hospital values more outcome indicators than advised to evaluate the RRS
6	The early warning procedure to detect deteriorating patients was tuned to patient characteristics at different wards. In addition, acute wards, outpatient clinics and hospital visitors were included in the RRS.	x					x	x	*Patient*: patients were taken as starting point for way in which early warning procedure is used on each ward, procedure has to fit the characteristics of the patients on that ward and is not standardised throughout the hospital
									Vision on safety: as anyone in the hospital might suffer from deterioration and should be treated for that, procedures were widened as to include all hospital wards, outpatient clinics and even hospital visitors

Table 4 Adaptations made to content of the RRS (continued)

Hosp.	*Adaptation made*	*Limb affected*			*Influencing factors*				*Reason for adaptation*
		A	*E*	*F*	*Org*	*Prof*	*Pat*	*Other*	
7	Early warning procedure was adapted to include gut feeling of nurses as a trigger	x				x			*Professionals*: based on internal patient file review, gut feeling of nurses appeared to be important for signalling deterioration, it was therefore included in the early warning procedure
	Responsibility for deteriorating patient after RRT call was adapted to divide responsibilities and keep ward doctors responsible for their own patients								*Professionals*: To make sure doctors would keep and live up to their responsibilities for individual patients, the division of responsibilities in RRS was adapted as to make sure the ICU doctor would not be responsible all by him/herself.
9	High threshold set in early warning procedures	X				x			*Professionals*: ICU doctor and ICU nurses already had an advisory function before the RRS was implemented. To be able to keep these tasks, a high threshold was built in the procedures for monitoring the patient and calling the RRT.
10	Low threshold set in early warning procedures	X				x			*Professionals*: to make sure all professionals would act in all cases and degrees of deterioration, a very low threshold was built into the procedures for monitoring the patient and calling the RRT
	RRT adapted to ensure 24/7 availability in both hospital sites		x		x				*Organisation* (site): two hospital sites do not both have 24/7 availability of doctors, so at each site the afferent and efferent limbs look slightly different in order to ensure 24/7 availability
11	Early warning procedure was adapted to include gut feeling of nurses as a trigger	x				x			*Professionals*: a 'softer' early warning trigger (the gut feeling of the nurses) that was perceived as important by the professionals was added to the early warning procedure

Table 4 Adaptations made to content of the RRS (continued)

Hosp.	*Adaptation made*	*Limb affected*			*Influencing factors*				*Reason for adaptation*
		A	*E*	*F*	*Org*	*Prof*	*Pat*	*Other*	
12	Two early warning procedures were developed to fit patient characteristics for high and low risk; separate calling procedures were made as well: for low risk, only the EC doctor is called in, for high risk, complete RRT is called.	x					x		*Patients*: hospital adapted the procedure to fit characteristics of high and low risk patients. Low risk: light procedure, high risk: heavy procedure.
	A&E ward doctor leads the RRT to ensure 24/7 availability of the team.		x		x				*Organisation* (size): small hospital that does not have 24/7 availability of ICU doctor.
14	Two RRT's were set up to ensure 24/7 availability in both sites		x		x				Organisation (sites): two RRT's to ensure 24/7 availability for all patients in the hospital
17	Early warning procedure was adapted to give more attention to respiration rate as a trigger	x				x			*Professionals*: professionals were not paying enough attention to measuring respiration rate as an indicator for patient decline. This trigger was therefore made more important, to make sure everyone would focus on it.
	RRT organised such as to fit two sites of the hospital		x		x				*Organisation* (sites): the hospital has two sites. To make sure the RRT is available 24/7 on both, internal medicine nurses have been given a role besides the ICU nurses.
18	RRT organised to ensure 24/7 availability of the RRT		x		x				*Organisation* (size): the hospital is small and has an ICU doctor is not available 24/7. The EC doctor was therefore given a role in the RRT at night.
	Extensive evaluation procedure developed to encourage routinisation			x				x	*Vision on safety*: each morning, all team leaders come together for a brief RRS meeting in which patients are discussed who scored >3 points in the early warning system and the way they were treated for real-time evaluation. Team leaders give feedback to their nurses.

Adaptations to the *efferent limb* were all related to organisational characteristics (hospital size, number of sites). Small hospitals in particular adapted the composition of the RRT to ensure 24/7 availability. Hospitals with more than one site set up a second rapid response team (often including an emergency care doctor instead of an ICU doctor) to make sure all patients could be taken care of.

A fourth influencing characteristic was identified, namely the way in which the hospital as a whole looked upon safety issues and aimed to organise its processes and procedures around that. This influenced the outcome measures taken into account or the way in which evaluations were conducted. In one hospital, its vision on safety influenced its afferent procedure to include not only patients but all people present in the hospital, including professionals and visitors.

Of the hospitals that had not made any adaptations (as yet), three (8, 15, 16) had an RRS that was currently not operational. Because the RRS was designed only on paper, these hospitals had not been able to experience its functioning. The RRS of one of the other three hospitals that did not make any adaptations (3, 5, 13) was taken as the example by the Dutch Hospital Patient Safety Programme. The blueprint of the RRS that was advised to all Dutch hospitals was based on this RRS.

In summary, we identified factors related to the hospital organisation, to professionals, patients and to the safety vision as influencing the adaptation of the efferent, afferent and feedback limbs. Different types of contextual factors therefore appear to influence what parts of the RRS content were adapted and how.

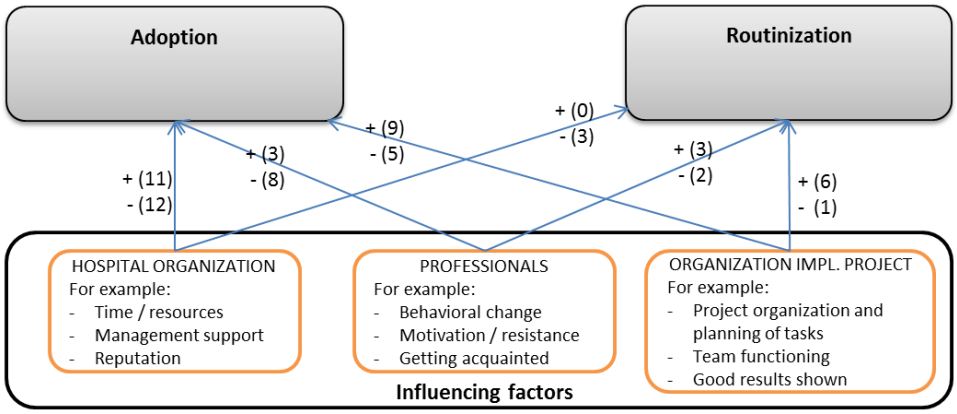
4.3 Influencing factors in the implementation context

In addition to the effect of the context on content, we aim to shed light upon context-related factors and their influence on the process of RRS implementation. The interviewees all mentioned various factors that were helping or hindering the implementation of the RRS either in the adoption or routinisation phase (see Appendix A).

Context factors were divided into the categories of *hospital organisation*, *professionals*, *patients* and *safety view*, since these categories were shown to be relevant in the previous section. No promoting or hindering factors appeared to be related to patients or safety view. However, a different category, both promoting and hindering implementation, was identified, being the organisation of the implementation *project* for RRS implementation. Figure 2 shows what type of contextual factors were perceived as helping (+) or hindering (–) by what number of hospitals in what phase of the implementation process (adoption versus routinisation). Appendix B gives detailed information on the promoting and hindering factors and by how many hospitals they were perceived.

Overall, hospital organisational factors and professional factors were more often perceived as hindering than helping, both in the adoption and in the routinisation phase. Factors related to the organisation of the implementation project were more often perceived as promoting than as hindering, both in the adoption and in the routinisation phase. In addition, the interviewees mentioned more factors affecting the adoption phase than the routinisation phase. This might also be due to the rather early stage of implementation that most of the hospitals were still in.

Figure 2 Promoting and hindering factors in RRS implementation (see online version for colours)



Notes: +(n) = number of hospitals perceiving facilitating factor in this category.
–(n) = number of hospitals perceiving hindering factor in this category.

The adoption phase was mostly affected by hospital organisational factors. Among others, these included the size of the hospital, availability of time and resources, and management support. In 12 hospitals, these had been perceived as hindering; the most prevailing hindering factor was perceived lack of time and/or resources (seven hospitals). Interviewees from 11 hospitals mentioned the adoption phase had been facilitated by factor related to the hospital organisation. The most prevailing facilitating factor was support from the hospital board (eight hospitals), followed by ICU reputation and availability of time and resources (both three hospitals). Eight hospitals perceived one or more factors related to professionals as hindering the adoption phase, such as resistance among doctors (eight hospitals), and the behavioural changes required (three hospitals). Three hospitals perceived professionally related factors as a help during RRS adoption; all three mentioned motivation of professionals on hospital wards as facilitating change. Factors related to the organisation of the implementation project were perceived as hindering RRS adoption by five hospitals and helping it by nine. Hindering factors concerned, e.g., having no formal project organisation or delays because of too many discussions and meetings with wards. Examples of promoting factors were an inspiring/motivating implementation team (four hospitals), a hospital-wide implementation team, or commitment created by meetings with wards (both two hospitals).

With respect to routinisation, three hospitals perceived hospital organisational factors as hindering (mainly lack of time and resources), none perceived these factors as promoting, two perceived professionally related factors as hindering (behavioural change required), and three perceived professional related factors as facilitating (professionals getting used to the system). Factors related to the organisation of the project were perceived as facilitating in six hospitals and hindering in one, which lacked a formal project organisation. The most important facilitating factor was communication of good evaluations and results of the adoption phase (five hospitals, four of them teaching hospitals). The outcomes of measurements made during the pilot and early implementation phase motivated nurses and convinced doctors of the value of the RRS which promoted routinisation.

Availability of resources is mentioned in literature as influencing both adoption and routinisation of any innovation (Greenhalgh et al., 2004; Klein and Knight, 2005; Simpson and Flynn, 2008). Availability of resources was mentioned in seven hospitals as a hindrance and in three hospitals as a help to RRS implementation. Table 5 shows the availability of resources per hospital and per limb. In teaching hospitals, resources were often made available for the evaluation limb (hospitals 1, 3, 4, 7, 13) and for training (hospitals 4, 5, 7, 8, 13) in terms of time, money and back-office support. In non-teaching hospitals, if resources were made available, this was mainly for the efferent component to make sure that the RRT was able to come with personnel and equipment when a call was made (2, 6, 10, 14). Except for hospital 16, the hospitals where no resources were made available were all non-teaching hospitals.

Table 5 Availability of resources per limb

Part of RRS	*Hospitals*
Afferent	4, 5, 7, 8, 11, 13, 18
Efferent	2, 4, 6, 10, 11, 13, 14
Feedback	1, 3, 4, 7, 11, 13
None	9, 12, 15, 16, 17

4.4 Perceived effects of the RRS

A summary of the perceived effects of RRS implementation for all hospitals is given in Table 6. The effect perceived most often was the value of the RRS to nurses. Twelve interviewees described how the fact that the afferent component includes procedures for measure a patient's vital signs made nurses feel more empowered, as the measurements gave them a means of confirming their feeling that the patient was deteriorating. "*Nurses now have a tool available that lets them make their gut feeling concrete*" (hospital 15). Five interviewees pointed out that better communication between nurses and doctors resulted from these procedures, because nurses informed doctors about the patient's situation for each vital sign measured, thereby communicating in a more standardised way. "*The measures made available by the scoring system help them [the nurses] communicate on an equal level with the doctor*" (hospital 4). Better communication, learning opportunities, and likely reduction of CPRs were all perceived by hospitals with only one site. One hospital perceived a negative effect, namely that nurses felt intimidated sometimes by the RRT when they took over the deteriorating patient.

With respect to outcome measures, interviewees indicated that they experienced more RRT calls over time (a sign of better embedding in the system). One hospital (2) had fewer RRT calls over time; however the initiating doctor was consulted personally more often. Also, interviewees indicated fewer CPRs and shorter ICU stays because deteriorating patients were recognised earlier and action was taken earlier. It should be noted that the outcomes in most hospitals were based mostly on feelings; the numbers of RRT calls and the period over which it had been operational were too low/short to produce statistically significant results.

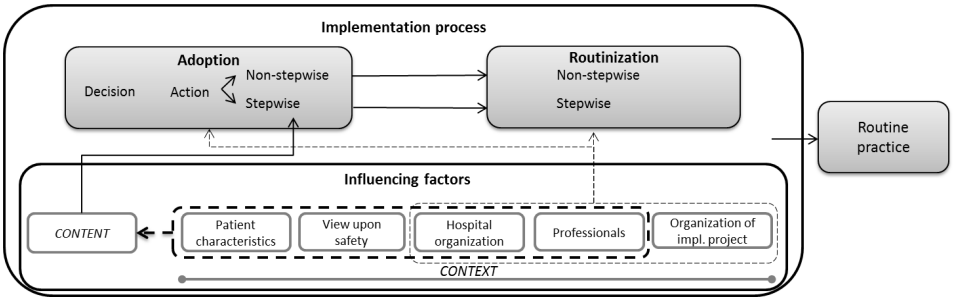
Table 6 Perceived effects of the RRS being implemented

Perceived effects – descriptive	
Nurses feel empowered	1, 3, 4, 5, 6, 7, 9, 10, 11, 14, 15, 17
Better doctor-nurse communication	4, 5, 6, 7, 9
Likely reduction of CPRs	4, 6, 7, 9
Training and learning possibilities for nurses	7, 9, 12
Patients get to ICU earlier	14
Nurses feel intimidated	18
Perceived effects – numerical	
More (fewer) RRT calls	1, (2), 4, 5, 9
Fewer CPRs	1, 3, 10
Shorter ICU stays	7

In summary, this section provided detailed insights into the process, content and context of RRS implementation. In addition, the interviews revealed interrelationships between process, content and context of RRS implementation. After the decision to adopt the RRS, two types of implementation processes were identified, stepwise and non-stepwise. The second of these was mainly followed by small hospitals. Content of the RRS influenced the stepwise implementation process, providing the order in which parts of the RRS were implemented. In addition, content of the RRS was adapted for various factors related to the hospital context. More specifically, which components of the RRS content were adapted (efferent, afferent or feedback) was directly related to contextual factors concerning the organisation, professionals, patients and vision on safety respectively. The context also influenced the implementation process. Contextual factors related to hospital organisation and professionals were mainly perceived as hindering, whereas factors related to the organisation of the implementation project were more often perceived as facilitating the adoption and routinisation of RRS implementation.

Based on our findings, we adapted and tuned the framework for innovation implementation, as developed in the theoretical section of this paper (see Figure 1), to a framework reflecting RRS implementation (see Figure 3). In essence, Figure 3 shows the relationships between innovation content, innovation context and the process of implementation that were experienced by the hospitals in our study. Various factors that were related to the innovation context can influence the process of RRS implementation as well as the adaptations made to the RSS content. The content itself influences the implementation process, but only the stepwise version. The greater emphasis on the fact that innovation content and innovation context are not independent concepts influencing the process of implementation, means that the adapted framework reflects the complex reality of innovation implementation better.

Figure 3 Framework for RRS implementation



5 Discussion and conclusions

This paper aimed to provide insights into how hospitals implement their RRS and how the approach chosen is determined. The implementation process is seen as the key stage between the decision to adopt an innovation and its routine use in practice (Klein and Knight, 2005; Klein and Sorra, 1996). However, there are currently no in-depth insights into this process (Fixsen et al., 2005; Simpson and Flynn, 2008). Gaining meaningful insights into the implementation process and offering practical guidance to hospitals would not have been possible if we examined the innovation process in isolation. In this study, the innovation content, implementation context and implementation process (Pettigrew and Whipp, 1993) were studied together through semi-structured interviews. This approach provided insights that go well beyond the experiences of single organisations, which are what have mainly been presented in the literature so far (DeVita and Hillman, 2011). It adds both breadth and depth to current literature. The approaches taken by 18 hospitals revealed great diversity in implementation processes, contents and contexts. At the same time, we were able to zoom in on these three elements, thereby revealing relationships between them. Previous research has presented the content and context as independent concepts that both influence the process of implementation [see Figure 1, representing the view of Klein et al. (2001; Klein and Knight, 2005; Klein and Sorra, 1996), Simpson and Flynn (2008)]. Our study has shown that these concepts are interrelated, in the sense that the implementation's context also influences the content of the innovation being implemented. Additionally, we were able to distinguish various types of contextual factors that influence either the implementation process, the innovation content, or both. This study adds depth to insights into implementation of innovations in healthcare contexts. The framework developed points out the relationships between content, context and the process of implementation. It can be used as a starting point for future research focusing on greater understanding of these relationships and working towards a theory for the implementation of system-wide innovations in healthcare settings and elsewhere.

As for innovations in general, the implementation process for an RRS consists of two stages, adoption and routinisation (e.g., Klein and Sorra, 1996; Greenhalgh et al., 2004; Simpson and Flynn, 2008). Within those stages, our data revealed two approaches for designing the implementation process. The non-stepwise approach was followed only by smaller, non-teaching hospitals. The stepwise process was followed by all hospital types

and focused on ward-by-ward implementation as well as limb-by-limb implementation of the RRS. Implementation of the feedback limb was seen as far more difficult or radical than the afferent and efferent limbs; implementation approaches were adjusted accordingly. Previous research into innovation implementation has identified that an innovation can be incremental or radical and that the implementation process chosen should be contingent upon how the innovation is characterised by its users (Rogers, 1995). Our study implies that an innovation (the RSS) can not only be categorised as incremental or radical as a whole, but also that elements within it can be seen by the organisation as either incremental (the afferent and efferent limb) or radical (the feedback limb). This might have motivated many of the hospitals to split the simpler (incremental) changes from the more complex (radical) ones during implementation, thus resulting in a stepwise implementation process.

The content of the RRS was adapted or 'localised' in two-thirds of the hospitals. This finding is in accordance with Greenhalgh et al. (2004) and Simpson and Flynn (2008), who state that many innovations, require adapting to the local situation. However, those studies do not go into the reasons for adapting an innovation. Our study found that contextual factors related to the organisation, professionals, patients and safety provided grounds for content adaptation. Moreover, direct relationships appeared between the contextual reasons provided and the parts of the content adapted (with the efferent limb adapted for organisational factors, the afferent limb for professional and patient-related factors and the feedback limb for factors related to views on safety).

When abstracting these insights towards a broader perspective on the localisation of innovations, this might imply that the core of an innovation (here, the RRT or efferent limb) would most likely be adapted to comparatively fixed parameters of the organisation in which the innovation is being implemented (size, site, resources). The procedures and working instructions of how to deal with the innovation core (here, the afferent limb or early recognition procedures) will mainly be adapted for those who are affected by the innovation, in this case both professionals and patients. The fit between the innovation and the organisational system as a whole seems to be affected by relatively intangible concepts such as vision, culture or climate. These ideas provide an interesting starting point for future research into the adaptation or localisation of innovation content. They should be examined in more detail both within healthcare and elsewhere.

As explained above, contextual factors influence innovation content as well as the innovation process. Some of the factors facilitating or hindering the process of RRS implementation are in accordance with the findings of other authors (Greenhalgh et al., 2004; Simpson and Flynn, 2008). These mainly concerned organisational and staff-related factors. In addition, this study revealed that the setup of the innovation project has a major influence on the process, mainly in terms of facilitating it, whereas organisational and staff-related factors were more often perceived as hindrances.

One context-related factor that has already received attention in the literature on RRS implementation is the type of hospital (teaching or non-teaching). Jones and Bellomo (2011) put forward the idea that non-teaching hospitals might set up simpler structures for implementing the RRS because of their limited resources and lower-risk patients. The non-teaching hospitals included in our study, however, tended to design more complex structures for the efferent limb (the RRT) in order to ensure 24/7 availability of the team. They therefore adapted the content of the RRS to work towards the aim of having the RRS available for all patients around the clock and did not take their limited hospital resources as starting point.

The aim of this study was to relate hospital characteristics to the implementation approaches chosen. We were however unable to derive a clear pattern from the interviews. This implies that innovation implementation processes were largely customised in each hospital to suit the content, context and process factors at stake in that particular situation. Some points that our study did reveal were that the management tends to take the decision to adopt in non-teaching hospitals, with a non-stepwise process most likely to be chosen for the implementation; that hospitals with a small ICU tend to put together a hospital-wide implementation team; that small hospitals tend to adapt the efferent limb of the RRS more often; and that teaching hospitals tend to measure and use the outcomes of the adaptation phase more often in order to facilitate the routinisation phase of the implementation. Studies based on quantitative designs might in future provide more insights into relationships between hospital characteristics (or combinations thereof) and the approaches to innovation implementation.

Further opportunities for future research would lie in a more detailed study of the benefits or effects of the RRS. Existing studies have not shown consistent results in that regard (Chan et al., 2008) and many hospitals in this study were only able to describe the perceived effects. Quantifying the effects would also allow cost-benefit analysis that could be based on the cost calculations made by Edelson and Bellomo (2011). In addition, future research might focus on benefits perceived by the implementation team versus benefits perceived by professionals on the wards who were not part of the implementation team. For the purposes of this study, we chose to interview only people who were closely involved in RRS implementation. However, as all hospital staffs are involved in the routinisation of the RRS, it will be useful to broaden the research scope.

RRSs are being introduced in many countries (Jones et al., 2011). Based on our findings, we would advise hospitals to follow general guidance on RRS content, but adapt it to fit the local hospital setting. With respect to the implementation process, a stepwise process helps separate the more incremental changes from more radical changes in the organisation and makes the implementation easier to handle. However, for smaller hospitals, it might save time and resources to implement the RRS in the whole hospital at once. For people studying organisational design and engineering, our research provides insights in greater depth and examples that can be used for more efficient and effective implementation of quality-related concepts. We hope that this paper will provide a starting point for future research into system improvements in the healthcare sector.

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Appendix A

Table A1 Within-case analysis of RRS implementation

Hospital #	*Organisation of implementation project*	*Implementation process description*	*Resources available for RRS implementation*	*Promoting factors perceived in implementation*	*Hindering factors perceived in implementation*	*Perceived effects of RRS implementation*
1	Hospital-wide implementation team. Responsibilities shared between ICU and rest of hospital in implementation. Hospital-wide embedding in separate safety	ICU took initiative. Pilot followed by gradually unrolling RRT and procedures on hospital wards. Training as prerequisite for implementation on ward; system adapted to two hospital sites. Evaluation and feedback loop organised. RSS is now operational and routinised. Continuous improvement focuses on afferent limb.	For feedback limb (FTE for evaluation and analysis)	*Adoption:* Reputation of the ICU, hospital-wide team, drive in implementation team *Routinisation:* Stepwise approach to continuous improvement led by clear focus	*Adoption:* - *Routinisation:* Behavioural change required on wards	Nurses feel empowered More RRT calls, fewer CPRs
2	ICU implementation team. ICU responsible for implementation	ICU took initiative. Pilot followed by gradually unrolling RRT and procedures on hospital wards. Training as prerequisite for implementation on ward; system adapted to include acute wards. RSS is now operational and routinised, feedback limb underdeveloped. Continuous improvement focuses on afferent limb and embedding	For efferent limb (RRT tools)	*Adoption:* Small organisation, short lines Good information provision to ward personnel *Routinisation:* -	*Adoption:* No time and hardly resources available *Routinisation:* Cost cuts in wards so nurses have less time for patient monitoring	Fewer RRT calls

Table A1 Within-case analysis of RRS implementation (continued)

Hospital #	*Organisation of implementation project*	*Implementation process description*	*Resources available for RRS implementation*	*Promoting factors perceived in implementation*	*Hindering factors perceived in implementation*	*Perceived effects of RRS implementation*
3	ICU implementation team. ICU responsible for implementation. Embedding at ICU, currently developing to hospital-wide in safety committee	ICU took initiative. Pilot followed by gradually unrolling RRT and procedures on hospital wards. Training as prerequisite for implementation on ward. RSS is now operational and routinised. Continuous improvement focuses on afferent limb	For feedback limb (FTE for evaluation and analysis)	*Adoption:* ICU-led initiative, ICU has most knowledge *Routinisation:* Adoption phase showed good results, helped to encourage wards to use RRS	*Adoption:* Few resources *Routinisation:* Behavioural and cultural change required: nurses do not dare to communicate with doctors as equals	Nurses feel empowered and safer Fewer intubations and CPRs
4	Hospital-wide implementation team. Shared responsibilities in implementation. Hospital-wide embedding in safety committee	ICU took initiative. Pilot followed by gradually unrolling RRT and procedures on hospital wards. Training as prerequisite for implementation on ward; afferent system adapted to patient characteristics. Afferent and efferent limbs are operational, feedback limb under construction. Improvement focuses on afferent limb and embedding of feedback limb	For efferent, afferent and feedback limbs: FTE, tools, ICT, etc.	*Adoption:* Hospital took part in larger study on RRS which had implementation plans etc.; Commitment created in meetings and content discussions, implementation team took account of wards' wishes; ICU doctors as champions, hospital board gave support and resources *Routinisation:* Involvement of ward leaders; Nurses experienced positive RRS results	*Adoption:* Discussions and meetings to create commitment took quite some time *Routinisation:* -	Nurses feel empowered; better nurse-doctor communication. More RRT calls, likely fewer CPRs

Table A1 Within-case analysis of RRS implementation (continued)

Hospital #	*Organisation of implementation project*	*Implementation process description*	*Resources available for RRS implementation*	*Promoting factors perceived in implementation*	*Hindering factors perceived in implementation*	*Perceived effects of RRS implementation*
5	ICU implementation team. ICU responsible for implementation	ICU took initiative. Pilot followed by gradually unrolling RRT and procedures on hospital wards. Training as prerequisite for implementation on ward. RSS is now operational and routinised, feedback limb underdeveloped	For afferent limb (training of ward personnel)	*Adoption:* Enthusiastic and inspiring chair of implementation committee *Routinisation:* Nurses and doctors experienced positive results from RRS, this created motivation	*Adoption:* Resistance among doctors *Routinisation:* -	Nurses feel empowered; better nurse-doctor communication More RRT calls
6	ICU implementation team. ICU responsible for implementation	ICU took initiative. Pilot followed by gradually unrolling RRT and procedures on hospital wards. Training as prerequisite for implementation on ward; system adapted to patient characteristics and to include acute wards. RSS is now operational and routinised, feedback limb underdeveloped. Continuous improvement focuses on afferent limb	For efferent limb (FTE for RRT)	*Adoption:* Good communication to wards, implementation team showed effort to become familiar with ward personnel *Routinisation:* Adoption phase showed good results, encouraged wards to use RRS	*Adoption:* Little time and resources *Routinisation:* Financing structure in hospital: ICU transfer of patient costs ward money which prevents doctors from calling RRT	Nurses feel empowered, better nurse-doctor communication CPRs likely reduced

Table A1 Within-case analysis of RRS implementation (continued)

Hospital #	*Organisation of implementation project*	*Implementation process description*	*Resources available for RRS implementation*	*Promoting factors perceived in implementation*	*Hindering factors perceived in implementation*	*Perceived effects of RRS implementation*
7	Hospital-wide implementation team. Shared responsibilities in implementation	ICU took initiative. Pilot followed by gradually unrolling RRT and procedures on hospital wards. Training as prerequisite for implementation on ward. System adapted to desired influence of professionals: keep ward doctors responsible for own patients and afferent limb includes gut feeling of nurses as trigger. RSS is now operational and routinised. Continuous improvement focuses on afferent limb	For afferent limb (training of ward personnel) and feedback limb (FTE for evaluation and analysis)	*Adoption:* Motivation among nurses Enthusiastic and inspiring chair of implementation committee *Routinisation:* Doctors experienced positive results from RRS, which created motivation	*Adoption:* Resistance among doctors Hardly any resources Lack of training capacity slowed down implementation speed *Routinisation:* -	Nurses feel empowered; better nurse-doctor communication; learning curve for ward nurses Shorter length of ICU stay, likely fewer CPRs.
8	Hospital-wide implementation team. Shared responsibilities in implementation	ICU took initiative. Pilot followed by gradually unrolling RRT and procedures on hospital wards. Training as prerequisite for implementation on ward. RSS is not currently operational	For afferent limb (training of ward personnel)	*Adoption:* Support of hospital management Large hospital, plenty of personnel for implementation *Routinisation:* -	*Adoption:* Lack of training capacity will likely slow down implementation speed *Routinisation:* -	RRS not operational; expectations are empowerment for nurses and better nurse-doctor communication

Table A1 Within-case analysis of RRS implementation (continued)

Hospital #	*Organisation of implementation project*	*Implementation process description*	*Resources available for RRS implementation*	*Promoting factors perceived in implementation*	*Hindering factors perceived in implementation*	*Perceived effects of RRS implementation*
9	ICU implementation team. No responsibilities assigned. No embedding arranged	Board took the initiative. Pilot followed by gradually unrolling RRT and procedures on hospital wards; system adapted to low-threshold system to fit professional influence wanted. Afferent and efferent limbs are operational and routinised, feedback limb underdeveloped. Improvement focuses on afferent limb (training) and feedback limb	No	*Adoption:* Willingness of ICU and wards to implement *Routinisation:* -	*Adoption:* Lot of pressure from hospital board but no time and resources available No formal project organisation *Routinisation:* No formal project leader, informally involved doctors have too many other tasks	Nurses feel empowered; better nurse-doctor communication; learning curve for ward nurses More RRT calls, likely fewer CPRs
10	ICU implementation team. ICU responsible for implementation. Hospital-wide embedding in safety committee	Safety committee took the initiative. Pilot followed by gradually unrolling RRT and procedures on hospital wards. Training as prerequisite for implementation on ward; system adapted to high-threshold system to fit professional influence wanted and adapted to two hospital sites. Afferent and efferent limbs are operational, feedback limb under construction. Improvement focuses on embedding the feedback limb	For efferent limb (design of procedures and project plans)	*Adoption:* Management support: they made time available Nurses and doctors in the whole hospital were motivated. *Routinisation:* -	*Adoption:* Hospital merger and complicated hospital structure slowed down implementation process Various visions on RRS form slowed down implementation *Routinisation:* -	Nurses feel empowered Few RRT calls, fewer CPRs (10%)

Table A1 Within-case analysis of RRS implementation (continued)

Hospital #	*Organisation of implementation project*	*Implementation process description*	*Resources available for RRS implementation*	*Promoting factors perceived in implementation*	*Hindering factors perceived in implementation*	*Perceived effects of RRS implementation*
11	ICU implementation team. ICU responsible for implementation	ICU took initiative. No pilot. RRS implemented at once on all hospital wards. Training as prerequisite for implementation on ward; afferent limb includes gut feeling of nurses; adapted to professional influence wanted. RSS is now operational and routinised. Continuous improvement focuses on afferent limb (training and communication)	For design of afferent, efferent and feedback limbs	*Adoption:* Support from board of hospital, they made available time and resources and feel very much involved *Routinisation:* -	*Adoption:* ICT had to be adapted for scoring system, this took time and slowed down implementation *Routinisation:* Not enough formation to operate RRT, took time to arrange this	Nurses feel empowered
12	Hospital-wide implementation team	ICU took initiative. No pilot. RRS implemented at once on all hospital wards. No formal training, only informational talks. Formal training sessions currently set up. Calling procedure adapted to hospital requirements for low and high risk patients RRS is operational. Not routinised yet because of lack of training. Improvement focuses on afferent limb (training, communication, early warning procedure)	No	*Adoption:* *Routinisation:* Doctors perceive little extra workload, which makes acceptance easier Professionals get more acquainted with the system because it has been operational for some time.	*Adoption:* Lot of resistance from doctors because of extra workload Little knowledge about the system since no formal training was given Small hospital, so wards tend to call a specialist directly *Routinisation:* -	Nurses feel they can recognise deteriorating patients better

Table A1 Within-case analysis of RRS implementation (continued)

Hospital #	*Organisation of implementation project*	*Implementation process description*	*Resources available for RRS implementation*	*Promoting factors perceived in implementation*	*Hindering factors perceived in implementation*	*Perceived effects of RRS implementation*
13	ICU implementation team. ICU responsible for implementation	Hospital board/management took initiative. Pilot followed by gradual implementation on hospital wards: afferent limb introduced six months before efferent limb. Feedback limb introduced later. Training as prerequisite for implementation on wards. RRS is now operational and routinised. Continuous improvement focusses on afferent limb (training)	FTE for afferent, efferent and feedback limbs: ICU nurses were freed from daily tasks	*Adoption:* Hospital took part in larger study on RRS which had implementation plans etc.; *Routinisation:* -	*Adoption:* Afferent limb was introduced 6 months before efferent limb. as there was nowhere to go when a deteriorating patient was signalled, the afferent limb was hardly used *Routinisation:* -	Both nurses and doctors perceive existence of RRS as positive
14	ICU implementation team. No-one responsible for implementation	ICU took initiative. No pilot. RRS implemented on all wards at once. Training as prerequisite for implementation of RRS. Procedure adapted for the two sites of the hospital. RRS is operational and routinised, except for feedback limb. Continuous improvement focuses on afferent limb (awareness for and use of recognition procedure)	Only resources to buy mobile monitoring device to equip RRT (efferent limb)	*Adoption:* Motivated ICU implementation team *Routinisation:* Doctors gradually get used to the RRT	*Adoption:* No support from management No project leader/no-one responsible for implementation Lack of support from medical doctors: both ICU and others. *Routinisation:*	Nurses feel empowered Patients get to ICU earlier

Table A1 Within-case analysis of RRS implementation (continued)

Hospital #	*Organisation of implementation project*	*Implementation process description*	*Resources available for RRS implementation*	*Promoting factors perceived in implementation*	*Hindering factors perceived in implementation*	*Perceived effects of RRS implementation*
15	Hospital-wide implementation team. Shared responsibilities for implementation; quality officer has final responsibility	Management took initiative. Pilot followed by gradual implementation on hospital wards. Training as prerequisite for implementation of RRS At time of interview, pilot was being evaluated. RRS operational on surgical ward and to be implemented on other wards. On surgical ward, improvement focuses on feedback limb (more structural feedback)		*Adoption:* Support from top management Hospital-wide project structure *Routinisation:* -	*Adoption:* Training of doctors is difficult *Routinisation:* -	Nurses feel empowered – they have a tool through which to express their feelings
16	Hospital-wide implementation team	Management took initiative. Pilot is planned. Training as prerequisite for implementation of RRS. No RRT yet Improvement focuses on introduction of RRT and organisation of the feedback limb	-	*Adoption:* Support from top management As a teaching hospital: easy to organise training. *Routinisation:* -	*Adoption:* The system encompasses the entire hospital, it is difficult to get wards and departments together, it takes time to move things forward The hospital is organised in relatively independent departments that have their own resources, strategy and responsibilities. This hampers the organisation of an RRS in which all have to work together.	Not applicable: no system yet

Table A1 Within-case analysis of RRS implementation (continued)

Hospital #	*Organisation of implementation project*	*Implementation process description*	*Resources available for RRS implementation*	*Promoting factors perceived in implementation*	*Hindering factors perceived in implementation*	*Perceived effects of RRS implementation*
16					Because it is a large hospital: difficult to get to know everyone involved quickly, slows things down; Hospital with complex patients: each ward has its own way of dealing with deteriorating patients, not willing to change their current way of working Too little communication about the RRS and accompanying procedures *Routinisation:* -	
17	Hospital-wide implementation team. Shared responsibilities for implementation	ICU took initiative. No pilot; implemented at once on all hospital wards. Training as prerequisite for implementation Afferent limb adapted to give more attention to trigger concerning respiration. Efferent limb adapted to two sites. RRS is now operational and will be evaluated soon. Continuous improvement focuses on feedback limb (RRS coordinator for analysis)	No resources available	*Adoption:* Support from top management *Routinisation:* Professionals get used to the new system and therefore tend to use the procedures more often.	*Adoption:* Some wards and doctors perceive the RRS as additional work instead of as an improvement tool. *Routinisation:* Not everyone is able to see the hospital as a system and think and act that way. Small ICU with minimal capacity. This might hamper routinisation	Nurses feel empowered

Table A1 Within-case analysis of RRS implementation (continued)

Hospital #	*Organisation of implementation project*	*Implementation process description*	*Resources available for RRS implementation*	*Promoting factors perceived in implementation*	*Hindering factors perceived in implementation*	*Perceived effects of RRS implementation*
18	Hospital-wide implementation team. Shared responsibilities for implementation	Quality office took initiative. No pilot; implemented at once on all hospital wards. Training as prerequisite for implementation. Efferent limb adapted because of small ICU (no ICU doctor in house 24/7) and feedback limb adapted to encourage routinisation. RRS is implemented and now being routinised. Continuous improvement focuses on efferent limb (communication by the RRT) and the afferent limb (keep attention to early warning procedure)	Resources for training	*Adoption:* Small size of hospital enabled quick implementation Professionals in the whole hospital (doctors and nurses) were motivated Support from top management *Routinisation:* -	*Adoption:* - *Routinisation:* -	Nurses feel sometimes intimidated by the RRT when the RRT takes over the patient

Appendix B

Table A2 Promoting and hindering factors perceived during the implementation process

Type of factor perceived	*Category of factor perceived*	*Detailed description of reasons/factors perceived*	*Hospitals perceiving this factor in the adoption phase of implementation*	*Hospitals perceiving this factor in the routinisation phase of implementation*
Promoting factors	Hospital organisation	Reputation of ICU	1, 3, 4	
		Size of organisation	2, 18 (small), 8 (large)	
		Support of board	4, 8, 10, 11, 15, 16, 17, 18	
		Availability of resources/time	4, 10, 11	
		Type of hospital: teaching (easy to organise training)	16	
			5 factors	
			11 unique hospitals	*0 hospitals*
	Professionals	Motivation among nurses/wards/ICU personnel	7, 9, 18	
		Doctors perceive little extra workload		12
		Professionals get more acquainted/used to the system		12, 14, 17
			1 factor	*2 factors*
			3 unique hospitals	*3 unique hospitals*
	Patients	-	-	-
	Safety view	-	-	-
	Other: organisation of the implementation project	Adoption phase showed good results, motivated wards		3, 4, 5, 6, 7
		Hospital-wide implementation team	1, 15	
		Stepwise approach to continuous improvement led by clear focus		1
		Good information provision to ward personnel	2, 6	
		Hospital took part in larger study on RRS, which provided work plans etc.	4, 13	
		Commitment created by meetings and taking account of the wards' wishes	4, 6	
		Involvement of ward leaders		4
		Inspiring/motivated (chair of) implementation team	1, 5, 7, 14	
			5 factors	*3 factors*
			9 unique hospitals	*6 unique hospitals*

Table A2 Promoting and hindering factors perceived during the implementation process (continued)

Type of factor perceived	*Category of factor perceived*	*Detailed description of reasons/factors perceived*	*Hospitals perceiving this factor in the adoption phase of implementation*	*Hospitals perceiving this factor in the routinisation phase of implementation*
Hindering	Hospital organisation	No/little time/resources available	2, 3, 6, 7, 8, 9, 12	2, 11
		Internal finance structure: wards pay for patient transfer to ICU		6
		Merger slowed down	10	
		Complicated structure slowed down	10, 16	
		Adaptations in ICT required	11	
		No management support	14	
		Hospital size	16 (large)	
		ICU size	17 (small)	
			7 factors	*2 factors*
			12 unique hospitals	*3 unique hospitals*
	Professionals	Behavioural change required on wards	12, 16, 17	1, 3
		Resistance among doctors	5, 7, 12, 14, 15, 16, 17	
		Different visions on RRS	10	
		Little knowledge about RRS, because there was no training	12	
		Inability to see hospital as a system	17	
			5 factors	*1 factor*
			8 unique hospitals	*2 unique hospitals*
	Patients	-	-	-
	Safety view	-	-	-
	Other: organisation of the implementation project	Discussions and meetings to involve wards took time	4, 16	
		No formal project organisation	9, 14	9
		Afferent limb introduced too early, when no efferent limb was available	13	
		Too little involvement and communication about RRS	16	
			4 factors	1 factor
			5 unique hospitals	1 unique hospital