Rapid response systems. Recognition and management of the deteriorating patient
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Chapter 1

Introduction and outline of thesis
Introduction

All nurses and physicians know at least one or two anecdotal cases in which a patient (nearly) died or experienced any other kind of serious adverse event (AE) which was (potentially) avoidable. 1 For a long time, clinical deterioration was assumed to be sudden and unpredictable, therefore not perceived to be avoidable. It has now been clearly defined that most major AEs including (unexpected) death are preceded by changes in vital signs as early as 8 to 24 hours prior to the actual occurrence of the AE. 2-6 Cardiac arrests (CA) and unplanned ICU admissions are major AEs and are generally associated with death. 7-9 As stated above and according to international literature, the majority of AEs are potentially avoidable. 10,11 Data from the Netherlands show an identical picture and over 1735 patients die annually of potentially avoidable causes. 12 In 2008, the Dutch Inspectorate of Healthcare together with other partners launched a program to reduce harm to hospitalized patients in ten different areas. 13 The third area that was stipulated was enhanced quality of care for the deteriorating patient on nursing wards. Implementation of a Rapid Response System (RRS) was imperative and hospitals will be held accountable for failure of detection and treatment of the deteriorating patient. Interestingly, although the first description of this system shows enhanced survival of patients seen by an ICU based Rapid Response Team (RRT) 14, evidence regarding the effectiveness of RRS remains unclear. 15

RRSs have been designed to protocolize, facilitate and structure the assessment and management of deteriorating patients by ward staff. The system is build up from three separate components. 16 The primary component of the system is the afferent limb which aims at the early recognition of the deteriorating patient by measurement of their vital parameters. 17 To aid in this processes, Track and Trigger (TT) systems have been developed. Generally, two kinds of systems are present. Single parameter systems detect patients at risk based on abnormality of one single parameter. The other kind of system is an aggregated system which relies on a sum score based on multiple parameters and there respective abbreviations from normality. 18 One regularly used multi-parameter TT is the Modified Early Warning Score (MEWS) which relies on 8 parameters and also includes whether the nurse is worried about the patient clinical condition. 19 Although no comparative trials have been performed between these two kinds of TTs, the multiple parameter system is believed to be superior. 20 Upon reaching a predefined threshold, the nurse should escalate care and activate the efferent limb. The efferent limb primarily consists of the RRT. In general, although dependent on country, this consists of ICU staff including a physician and a nurse which is called to a patient. 21,22 A slightly different protocol is maintained in some countries, including the Netherlands, in which the primary responsible physician is notified prior to the RRT. 23,24 Finally, an educational and feedback system completes the system ensuring continued registration of clinical endpoints including feedback loops and education to the care providers. 25-27
Although this system has high face validity and the general perception is that it’s very likely to be effective in clinical practise, implementation is hampered by the contradicting reports regarding effectiveness. Research into these kinds of systems is complex and difficult because it addresses multiple organisational levels and is built up from a number of components, which may act both independently and inter-dependently. The single largest study performed, the MERIT study which was a multi-center cluster randomized trial held in Australia, failed to show significant effects of the introduction of a RRS. In contrast, a stepped wedge controlled trial held in the United Kingdom did show significant effects after introduction of a RRS on hospital mortality. Multiple post-hoc analyses of the MERIT identified significant implementation defects and contamination of the placebo hospitals in the trial. More interestingly, the dose of RRT calls was directly correlated with reduction of AEs including unexpected death. These findings indicated that effectiveness should be correlated to implementation and foremost to afferent limb failure. Delayed detection of a deteriorating patients results in system malfunction and increased mortality. This has led to new and interesting research opportunities not only to elucidate the effectiveness issue, but also to zoom in on factors that cause this delay. Some of these factors are known from earlier research and include the level of knowledge of the health care professionals, monitoring of vital signs, apparent compliance problems upon identifying a sick patient and failure to appreciate clinical urgency. Hierarchical and traditional organizational factors may directly impact patient safety and delay in recognition and treatment.

The situation in the Netherlands in 2008 in which mandatory introduction of RRS in all hospitals in the Netherlands was present, led to a unique opportunity to conduct research regarding the identification of deteriorating patients and Rapid Response Systems (RRS). This thesis is an effort to contribute to this growing body of knowledge on factors that are associated with the effectiveness of RRSs to prevent major AEs in patients on general hospital wards. For this purpose, we introduced a RRS in twelve Dutch hospitals using a uniform implementation strategy with consecutive introduction of the afferent and, in a second phase, the efferent limb. To further elucidate factors that influence implementation and effectiveness of these systems, additional research has focused specifically on the afferent limb and factors associated with delayed recognition and compliance issues as this is likely to contribute or mask possible effectiveness of the system.
Outline of the thesis

This thesis describes, in two parts, the evidence underlying tools that were implemented to enhance the quality of care and early recognition of deteriorating patients on nursing wards compared to the period in which these were not available.

Part 1 retrospectively describes the care that was provided to patients that experienced a major AE and the perception of the quality of care by the involved health care providers. Because awareness of deteriorating patients on nursing wards and also how vital signs were measured was unknown, this data provides insight into the hiatus that needs to be overcome if change is to be adapted. In association with this theme, a systematic review analysing prognostic models for the prediction of mortality among elderly ICU patients was performed. Because this particular population represents the majority of patients being admitted to ICU, this review was designed to investigate if clinically validated models are present for risk stratification and possible clinical decision making for admission to ICU.

Building on these findings, part 2 focuses on earlier recognition and management of the deteriorating patient after (components of) a RRS were implemented. As unequivocal scientific evidence regarding effectiveness of RRS is absent, the multi-center COMET (Cost and Outcome analysis of Medical Emergency Teams) trial was conducted to contribute data for sustained and possibly improve long-term implementation in (Dutch) hospitals. To better explain and interpret these outcomes, separate studies describe adherence to RRS and its specific components such as the MEWS protocol and protocolized measurements of vital signs and MEWS on clinical outcome.

Part 1: The deteriorating patient on the general ward

In chapter 2, a retrospective cohort of patients experiencing a severe AE (cardiopulmonary arrest, unplanned ICU admission, emergency surgery and death without a Do Not Attempt Resuscitation (DNAR) order) from either a surgical or internal nursing wards were included. In this cohort, the frequency, degree of documentation and systematic manner of vital signs measurements was studied in the 48 hours prior the event. The MEWS was applied to this set of data to determine possible usefulness in earlier recognition of these patients. To further elucidate factors associated with a possible delayed recognition and response in deteriorating patients, chapter 3 focuses on the perception of the quality of care provided to patients experiencing a cardiopulmonary arrest or unplanned ICU admission. In a cross-sectional study, all care-providers (nurses and physicians) from the internal wards taking care for these patients were questioned using a structured quantitative questionnaire. The results of these two studies are helpful
in providing insight and evidence as to how health care professionals judge and review their own provided (quality) of care in the hours prior a major AE.

In a systematic review described in chapter 4, the current literature was analyzed for papers describing the development and/or validation of models predicting mortality in elderly patients who were admitted to ICU. Clinical capabilities and possible clinical usage was investigated. These findings may identify suitable models for early risk assessment and provide clinical decision rules in determining possible ICU admission.

**Part 2: Rapid Response Systems.**

Employing a nationwide questionnaire, perception of potential usage and effectiveness of RRS was investigated. Although implementation of RRS in the Netherlands is mandatory, content of the RRS limbs is not regulated. Chapter 5 provides insight on how Dutch hospitals have implemented and what their opinion is regarding RRSs.

To ascertain the effectiveness of the afferent limb (MEWS and SBAR instruments one year after implementation) in more detail, the recognition of a deteriorating patient was compared between trained and non-trained nurses. Chapter 6 describes the outcomes of this quasi randomized trial in comparing time of recognition, adherence to protocol and notification of the physician between these groups.

In Chapter 7, nursing wards were randomized to measure the MEWS at least three times daily or only if one or more vital signs were abnormal. In this quasi-randomized study, the two arms were compared for degree of implementation and differences in subclinical endpoints including delay in recognition of the deteriorating clinical state. These three studies provide insight into the implementation of a RRS in one (academic) hospital. The following two chapters describe the effort invested in a large multicenter trial investigating the effectiveness of a Rapid Response System.

The COMET study rationale and design is described in chapter 8. In this before-after design, the afferent limb (MEWS and SBAR instruments) was implemented followed by the introduction of the RRT. The primary outcome was the incidence of the composite endpoint of either cardiopulmonary arrest, unplanned ICU admission or death. Using a generalized linear mixed model (GLMM), the primary outcome and the individual endpoints were compared between the phases. The outcome of the trial is described in chapter 9. Primary comparisons were made between the before (5 months) and the last 5 months of the RRT phase. After careful correction for multiple confounders including, gender, age, individual hospital, and urgency of admissions, while simultaneously accounting for clustering of admissions within hospitals, the incidence of the endpoints were compared. Despite the lack of randomization which was impossible due to the mandatory nature of RRSs in the Netherlands, these findings are likely to significantly contribute to the body of knowledge concerning clinical effectiveness of RRSs.
Reference List


