CHAPTER 1

General introduction
GENERAL INTRODUCTION

“We are humans; Humans err. I’ve made mistakes and will make mistakes in the future. That is not terrible. People should learn from their mistakes and the environment should prevent further escalation.” This is a quote of His Majesty Willem-Alexander, King of the Netherlands, from an interview preceding his investiture on the 30th of April 2013 [1]. It underlines that everybody can make mistakes, even a king. The importance is how the error is handled by the erroneous persons and their environment.

Errors also occur in the Intensive Care Unit (ICU), some with severe consequences for patients. There is increasing evidence that these errors can be counteracted by training healthcare providers in the use of non-technical skills, such as communication, leadership and teamwork [2,3]. Crew resource management (CRM) is a team training that aims to help participants develop their non-technical skills. This thesis describes the evaluation of the implementation, effectiveness and cost-effectiveness of a classroom based CRM training in the Intensive Care Unit (ICU).

Patient safety in the Intensive Care Unit

Errors in healthcare can result in adverse events. An adverse event is defined as ‘an unintended injury that results in temporary or permanent disability, death or prolonged hospital stay, and is caused by healthcare management rather than by the patient’s underlying disease process’ [4]. Adverse events are a serious cause of harm and even deaths [5-8].

The risks, potential harm and costs of adverse events for patients in ICUs are larger than in other hospital departments [9,10], making improvement of patient safety in ICUs all the more important [11]. Patients in the ICU frequently suffer from severe multiple-system illnesses that threaten vital functions. These vital functions are necessary to stay alive, such as the functioning of the heart and lungs. Treatment of ICU patients requires more testing, monitoring, and decisions than the treatment of patients in any other setting within healthcare [12]. Moreover, due to the complex and instable nature of ICU patients, their care often requires high-risk decisions within a limited timeframe, based on incomplete data, by staff with varying levels of critical care training [13].

Results of a Dutch record review study revealed that 9.4% of all patients admitted to the ICU experienced one or more adverse events, which is far above the average of a hospital [5.7%; 5]. Of these adverse events 50% were considered highly preventable. Similarly, other studies have shown that 0.8 to 1.7 adverse events occur per patient-day in the ICU [13,14].
From a systems perspective, adverse events are a consequence of a combination of active and latent failures. Active failures are unsafe acts or omissions of frontline staff, such as action slips, cognitive failures, or violations, which result in immediate adverse consequences [14]. Latent failures are the “resident pathogens” within a system [15] creating the conditions in which unsafe acts are more likely to occur [14]. Lawton et al. [16] classified frequently reoccurring latent conditions based on their proximity to the active failure. Most proximal are situational factors (e.g. characteristics of the task and, team composition), followed by local working conditions (e.g. supervision, management and workload), organizational factors (e.g. policies, procedures and training), and external factors (e.g. design of equipment). Communication and safety culture can be found in all ‘layers’ around the active failure.

The distinction between active and latent failures signifies that adverse events are not merely, if at all, a consequence of clinical incompetence. In fact, a lack of non-clinical, or non-technical, skills is increasingly recognized as an important underlying cause of adverse events [17,18]. Non-technical skills are ‘the cognitive, social and personal resource skills that complement technical skills and contribute to safe and efficient task performance’ [19]. Examples of non-technical skills are task management, teamwork, situation awareness and leadership [2,20]. Roughly, it can be argued that non-technical skills organize the latent conditions, whereas clinical skills guide the active part.

Non-technical skills are of particular importance in the Intensive Care Unit, where complex care for vulnerable patients is provided by multiple professionals [21,22]. ICU teams have to respond 24/7 to acute situations in changing multidisciplinary compositions, under high levels of time pressure, and with high stake outcomes [13]. Under these circumstances, the chances of errors increase [23]. Studies have shown that poor non-technical skills lead to poor teamwork resulting in critical incidents in the ICU [24,25] or failure to follow protocol [26,27].

**Crew resource management (CRM)**

Both national and international health authorities have advocated CRM as a method to improve non-technical skills, especially in acute care departments, such as departments of emergency care, surgery and intensive care [7,28,29]. CRM, which has its roots in aviation and other high-risk industries [30], was developed in the early 1980’s as a response to the finding that unsafe flight conditions were frequently the result of failures in pilots’ non-technical skills rather than a lack in technical knowledge [17]. It has been shown that CRM can effectively improve safety in a variety of professional domains besides aviation, such as nuclear power and offshore oil production [31,32]. It is plausible that the general principles of CRM can be used in the ICU as well, because the ICU shares characteristics
with workplaces where CRM has been proven to be effective, such as high-stake outcomes, complex actions, and high time pressure [33].

CRM aims to increase participants’ understanding of how certain threats, such as miscommunication, can develop [34] as well as to provide tools and skills to respond to such threats. CRM is based on the premise that human error is avoidable, but can never be eradicated. Starting point is familiarizing participants with human factors and the limitations of human performance [34]. By doing so, CRM raises awareness of, and creates a shared perspective on, the threats and opportunities in daily work processes. This alters how participants perceive their working situation, the so called situational awareness. Situational awareness is defined as the perception and comprehension of information from the environment, and the usage of this information to guide future behaviour [35] and is considered to play a key role in CRM [36]. Based on the concept of situational awareness, CRM teaches to optimally use all available information and other resources, in the environment, to overcome the human limitations.

The available resources in the environment can be everything: Colleagues; Physical aspects; Available technology; Memory. Each resource provides bits of information that together construct the situational awareness of an individual. Wrong or flawed information leads to a suboptimal situational awareness, which in turn misguides behaviour that could lead to errors.

Applying non-technical skills stimulates the gathering of information and improves the quality of this information, thereby optimizing situational awareness. This can take many forms, of which the use of a checklist or debriefing are frequently applied examples [37]. It is important that participants think of their own solutions. Therefore, participants are stimulated to assess and think about personal and peer behaviour.

In short, CRM is directed at increasing awareness of human limitations and enhancing the use of non-technical skills in order to improve situational awareness and, as a result, reduce adverse events.

**Research aims**

It can be argued that the results regarding the effectiveness of CRM in the present literature are inconclusive due to design and methodological limitations. Furthermore, the costs and implementation of CRM training have not been considered up to date. Therefore the following research aims with subsequent research questions were formulated:
1. Develop a sound study design with according instruments to evaluate CRM:
   a. What should a design to assess the effectiveness and cost-effectiveness of CRM look like?
   b. What instruments should be developed in order to assess the effects and cost-effectiveness of CRM?

2. Study the implementation of CRM:
   a. What are the barriers and facilitators for following up on CRM initiatives developed during the training?
   b. What strategies are applied to implement CRM?

3. Assess the effects, costs and cost-effectiveness of CRM:
   a. What is the effectiveness of CRM regarding the reaction, attitude, behaviour and organization of the participants?
   b. What are the costs and the cost-effectiveness of CRM in comparison with usual practice?

Although CRM training is a relatively new phenomenon, it is more and more applied in health care in an attempt to improve patient safety by better use of non-technical skills [38]. This is reflected by the increasing number of publications about the effectiveness of CRM in health care settings. Three systematic reviews on CRM and team training were published in 2010, of which 47% of all included studies (total of 57) were published less than five years ago [39-41].

During the design of this thesis in 2009, the results of the existing effect studies were promising but still limited. For instance, Rabol and colleagues [39] showed that classroom-based CRM training consistently lead to positive first reactions and a change in attitude that favours CRM principles [42,43]. Similarly, the study of Haller [44] showed that participants were very satisfied about CRM and had a better understanding of teamwork and shared decision making. However, the results are less conclusive with regard to the question whether CRM changes actual behaviour. For instance, McCulloch and colleagues [45] found an increase in the use of non-technical skills for nurses, but not for anaesthetists and surgeons. More recent reviews of CRM combined with simulation [46,47] or for paramedics [48] show similar results.

There are several reasons for the inconsistent. For one, it can be argued that these results are partly caused by weak study designs. Most of the studies evaluate the effect of CRM within six months [39], which is a relatively short period for an innovation to be completely adopted and to become part of the daily routine [49]. In addition, most evaluations rely on a pre- and post-training comparison, but do not include a control
Finally, in some studies the trained and non-trained participants were not separated in data gathering.

Another possible explanation for the abovementioned mixed results might be lying in validity issues in the assessment of non-technical skills. Non-technical skills are broad concepts that capture a wide range of aspects, each of which can be relevant depending on the situation. Furthermore, most non-technical skills are in part automatic and consist routine behaviour, of which people have no realistic perception to what extent they use them. Most studies rely on self-reported questionnaires to measure non-technical skills [39] or use proxy measures, for instance the reporting of incidents by staff [50]. Although these outcomes are relevant, they are not a reflection of the actual display of a non-technical skill. Observations are probably the best way to assess behavioural change, as it measures behaviour as it actually occurs. However, observations have hardly ever been used in controlled or before and after studies.

The Kirkpatrick evaluation framework for organizational training programmes [51] is recommended to evaluate the effectiveness of CRM [39]. The framework distinguishes four levels of evaluation: 1) reaction; 2) learning; 3) behavioural change; 4) organisational impact. It is widely applied [52], as it allows for a systematic and multilevel evaluation, while at the same time organising it in a simple and understandable manner [37,53].

Besides the design and methods used in CRM-effectiveness research, the way in which CRM is implemented might also be an important determinant of the effects of CRM, though neglected in the present literature. The critical role of appropriate implementation of new ideas is increasingly recognized by researchers in healthcare [54]. Without a proper implementation even the best interventions will struggle to have effect [55]. The attention for implementation in CRM literature is still limited. Moreover, there is a tendency to perceive CRM as a button that can be pushed to attain certain outcomes, for instance the application of a checklist [50] or the use of antibiotic administration [56]. This perspective ignores the process of implementing CRM and the question why people do or do not adopt CRM.

Finally, despite the growing body of literature about the effectiveness of classroom based CRM, the cost and subsequent cost-effectiveness have, to date, not been investigated. Cost-effectiveness has been a neglected field in quality improvement research in general [57]. Monetary costs are of particular importance for the ICU as the cost of one bed day is four times as high as the average bed day on a regular Dutch hospital ward [58], making a prolonged stay as a result of an adverse event a costly concern. By analysing the cost-effectiveness, it will be more clear what effects can be
achieved against which costs. This is important in the context of improving quality, while simultaneously saving money [59].

Outline of the thesis
This thesis starts with a description of the design of this study (Chapter 1). To properly assess some of the constructs of this design an observation instrument was developed that measures explicit professional oral communication to assess non-technical skills (Chapter 2) and a questionnaire that assesses perceived and enacted behaviour that optimizes situational awareness (Chapter 3). We then investigated the implementation of CRM. First we wanted to know which factors before and after the training determined the actual implementation of the plans of action which were developed during the training (Chapter 4). Second we studied the implementation strategies at all three intervention sites (Chapter 5). Finally, we set out to evaluate the effect of the training in terms of reaction, attitude, behaviour, and organization (Chapter 6) and costs (Chapter 7).

REFERENCES


