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Crew Resource Management Training for Surgical Teams, A Fragmented Landscape

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OBJECTIVE: Medical Crew Resource Management (CRM) training courses are designed to increase patient safety by reducing the effects of human errors. These training courses are most popular in surgery and a wide range of medical CRM training courses for surgical teams is now available. However, the effects of these CRM training courses on patient outcomes are inconclusive. Although surgical teams feel the need to be trained in team collaboration skills, they are often puzzled about what criteria to apply when choosing a medical CRM training course. This study aimed to compare CRM training courses on didactic components and simulation-exercises to explore if these courses are interchangeable.

METHODS: In this qualitative study, semi-structured interviews were conducted among 10 main CRM training providers of surgical teams in the Netherlands.

RESULTS: Although a large variety was found in the content of CRM training courses, the most substantial differences were found in the simulation-exercises. Nine out of 10 trainers stated that standard simulation-exercises would be a step forward to ensure quality in CRM trainings. According to the trainers, the implementation of medical CRM can reduce human errors and as a result, preventable patient complications. They suggested a quality standard for CRM trainers in the medical field to ensure the quality of medical team training as a way to reach this.

CONCLUSIONS: Medical CRM training courses are diverse and noninterchangeable. Trainers expect that if CRM becomes part of surgical training and is embedded in operating theatre culture, it could be of great value for patients and professionals. (J Surg Ed 78:2102−2109. © 2021 The Authors. Published by Elsevier Inc. on behalf of Association of Program Directors in Surgery. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/))

KEY WORDS: Crew resource management, safety culture, patient safety, surgical training, professional education, interprofessional relations

COMPETENCIES: Interpersonal and Communication Skills

INTRODUCTION

Crew Resource Management (CRM) was developed in aviation by the National Aeronautics and Space Administration (NASA) after studying the occurrence of multiple airplane crashes.[1] Causes of these airplane crashes included, in many cases, human errors. Hence NASA developed team training to improve awareness to detect and to correct human errors before harm is done. In aviation, this training evolved in what is now called CRM training. CRM is based on a set of principles, for example, situational awareness, communication, leadership, self-awareness, adaptability, flexibility, and decision making. CRM aims to improve communication skills and behavior among team members and encourages sharing a mental plan of the procedure that is to be performed.[2] Since its introduction in aviation, CRM training has been widely

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applied in other sectors as well, including construction, ship handling, firefighting, and hospital medicine.

In 1999, the US Institute of Medicine (IOM) published the seminal patient safety report "To Err is Human".[3] It was shown that over 50% of the estimated 44,000 to 98,000 annual lethal medical errors in the United States were preventable due to human errors. CRM for health care was proposed to reduce this number, giving birth to a wide array of medical CRM training courses to reduce human errors. These courses have a multitude of names, for example, crisis resource management, human factor training, non-technical skill training or team training. All these courses aim to raise awareness for human factors and aim to increase non-technical skills to reduce the number of preventable medical errors.

In a more recent study, Makary and Daniel concluded that the annual preventable number of deaths caused by medical error presented in "To Err is Human" was underrated; they estimated that preventable medical errors were the third cause of death in the United States.[4] Although 15 years after the IOM report patient safety is improving, it improves slower than expected.[5] Patient safety is a universal problem.[6] Wagner and Zegers (2009) showed that 36.5% of adverse events in surgical departments in the Netherlands were highly likely to be preventable.[7]

In recent years, CRM training has increasingly become a subject of research, mostly in surgical departments and in the operating theatre.[8] There is no consensus on the effect on patient outcomes, but small differences have been reported in favor of CRM on the perception of safety by healthcare professionals and the overall satisfaction of participants from CRM trainings.[9–15] Furthermore, a recent study in the United States showed that implementation of a CRM program has a high return on investment.[16] Studies have shown a large variety in content and outcomes: some studies found a positive effect on patient outcomes, while others did not find an effect.[9,13,17–19] Could this be because there is a difference of views between CRM trainers?

Therefore, this study aims: 1) to compare and discuss the opinions of trainers of various medical CRM training methods. Are these methods interchangeable and what value do these methods represent for the operating team? And 2) to establish whether trainers find a standard desirable to ensure quality, and if so: who is best qualified to establish this standard.

METHODS

In this study, a qualitative study design with semi-structured interviews (Appendix) was used to interview trainers who teach medical CRM related training courses for the operating theatre.

Participants

To get multiple perspectives, purposive sampling was used, and ten CRM trainers from different backgrounds within the Netherlands were invited to participate in this study. All agreed to participate and were interviewed for this study between 2016 and 2017.

Data Collection

The semi-structured part of the interview (Appendix) consisted of questions related to four themes, based on literature concerning medical CRM.[8,20] The first theme, *Trainer Background*, focused on previous working experience of the trainer. This information was used to identify a possible relationship between trainer background and their training style. The second theme, *Training characteristics*, aimed to gather information on the medical CRM training: duration, participants, training components (theory, simulation/exercise, feedback/debriefing), any follow-up, costs. Moreover, it serves to identify CRM-related training programmes and compare medical CRM courses to these other CRM courses. The answers were compared to other currently available CRM training courses in healthcare and aviation. Thirdly, the theme *Existing Flaws* contained questions about perceived flaws in healthcare and existing medical CRM training courses. These questions aimed to establish what the trainers felt could be improved in the operating theatre and CRM training, prompted by their own experiences. In the fourth theme, *Future of medical CRM*, the trainers could share their views on the future direction of medical CRM training. A subsequent nonstructured part of the interview provided an opportunity to gather more in-depth information and questioned CRM trainers to react to and evaluate the opinions of the other trainers. Lastly, in this part of the interview, all participants were asked if they thought a standard in medical CRM training courses is desirable.

Data Analysis

The full interviews were minuted and responses were categorized in line with the afore mentioned themes. These results were analyzed and discussed until consensus was reached between two authors (WvG and JH).

RESULTS

Theme 1. Trainer Background

The CRM trainers interviewed (n = 10; 9 males, 1 female) had backgrounds in aviation, healthcare, armed forces, or a combination (Table 1). They had an average

TABLE 1. CRM Trainers' Characteristics

	n = 10
Male gender	9
Background of trainers	
Healthcare	5
Aviation	2
Military	1
Combination	2
Experience on average in years [range]	8.5 [2-16]
Employment	
Hospital-based	3
Private company	7

experience of 8.5 years in medical CRM training. Seven were employed by a private company and three by a university hospital in combination with clinical duties.

One example of fragmentation in CRM was the differences of opinion regarding the ideal trainers' background, identified in our study. Medically educated trainers assume that to ensure credibility, it is necessary that at least one of the trainers during CRM training comes from the same professional background as their target audience. However, trainers with an aviation background shared the opinion that only expertise in training nontechnical skills are essential during training and that a medical background is not necessary. Meanwhile, some trainers suggested that the increase in CRM trainers from aviation may be the result of a recent crisis in aviation employment. According to the majority of CRM trainers, this fragmentation might put the quality of CRM training in jeopardy.

Theme 2. Training Characteristics

Duration

Although there was a large variety of teaching methods, all medical CRM training courses focused on the core CRM principles: creating awareness for human factors and using this knowledge to enhance patient safety. The course duration of a CRM training varied from four hours on location in-situ to two full days at an external location. The majority of training courses took one full day.

CRM Training Participants

The medical teams mostly represented the target audience from *hot floors* like intensive care units, trauma centers, operating theatres and obstetrics. The group size ranged from 8 to 16 participants, representing the team members. Interestingly, all trainers considered a trainee group representing a team in the operating theatre as ideal, but this composition was seldom established in training groups. Anesthesiology professionals were over-represented, as CRM training with a focus on simulation is mandatory for anesthesiology residents in the Netherlands. The trainers experienced little resistance of participants to CRM during training, but if any, it was mostly from the older generation of healthcare professionals. *"Some resistance you only lose through retirement, I recognize this from aviation"* (Trainer 4).

Three Training Components of a Medical CRM Training

All medical CRM training courses could roughly be divided into 3 components: 1) theory, 2) simulation or exercise, and 3) feedback or debriefing. Figure 1 shows

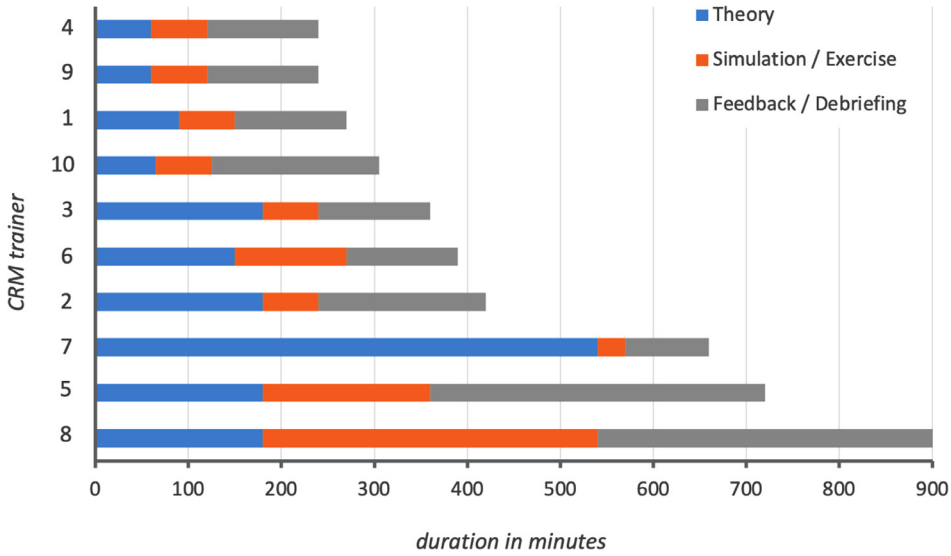

FIGURE 1. Total course duration and time distribution between different components of medical CRM courses (min).

an overview of the time distribution between these 3 components.

1) Theory was usually used to educate the participants about the theoretical framework of CRM. These theoretical sessions ranged from 45 minutes to 1.5 days, and interactive presentations were predominant. The mean duration of this part was 2.8 hours. To reduce the time of the presentation or lecture, some trainers asked their participants to do homework preceding the training. This homework usually pertained reading a book or completing an e-module about basic CRM principles.

2) Simulation/exercise for the team was used to practice the CRM principles in a controlled environment. In these sessions, trainers were using a multitude of methods to get the best results. Three out of 10 trainers were convinced that to get the best results the participants should go beyond their comfort zone. To establish this, they used a flight simulator or a control tower or both and had trainees face critical situations in which they needed to communicate with each other. The approach trainers applied most was the use of a simulation tailored to the medical (surgical) environment to practice the CRM principles, for example, by use of a medical manikin. Two different styles could be used in this part of the training:

   a) Simulation of an emergency in which the patient almost dies, aiming to increase the trainees' stress levels. Trainers claimed that only if the stress levels are high, trainees experience human limitations of communication.
   b) Simulation of a common procedure, representing routine team activities. Trainers executing this method argued that most preventable complications happen because of errors during routine procedures.

In addition, two trainers first used team exercises to practice CRM principles arguing that the participants first need to get familiar with basic CRM principles like situational awareness, leadership and decision making, before practicing on a dummy to simulate a real-life situation. *"It is dangerous to put untrained participants in a simulation. By doing this, one could provoke 'monkey see monkey do,' which is a lot different than creating real understanding of the communication principles in highly educated professionals"* (Trainer 7).

3) Feedback/debriefing on nontechnical skills was usually the most time-consuming component of a CRM training. Seven trainers used video recordings for feedback or debriefing.

Costs

The costs of a CRM training course varied from just above 100 euros to about 1000 euros per trainee. The hospital of the trainees almost always covered these costs. However, the net costs for the hospital are higher, considering that every trainee must be exempt from clinical duties during training.

CRM-Related Training Courses/Programmes

In addition to the CRM training course, some training agencies offered a full culture intervention programme to facilitate the implementation of CRM in the organization or the department. To reach its full potential, the trainers stated that CRM should be part of a hospital's culture. *"CRM is more than the training; training is just a small part of the intervention"* (Trainer 4).

All trainers recommended that after a CRM training course, a refresher course, once a year or once every three years, is needed to obtain the best results. However, refresher courses were rarely taken because most participants considered their CRM skills as adequate after just one training. In contrast, all trainers regarded a single training insufficient for the full effect of CRM training.

CRM for Healthcare Versus CRM in Other Fields

Concerning the difference between CRM for healthcare and aviation, the responses could be divided into three groups correlating with the trainers' backgrounds. Those from aviation pointed out that in any teamwork human factors and limitations are similar: *"There is no real need for medical knowledge, the human factors are the same"* (Trainer 8). However, these trainers considered the application of CRM in the aviation sector to be more experienced and professional. This is illustrated by Trainer 3: *"Healthcare is still unprofessional in how it treats CRM"*. One trainer with a military background stressed the differences between CRM in medicine and aviation: *"Healthcare and the armed forces are more similar than healthcare and aviation, since like a patient, an enemy is not fully predictable"* (Trainer 7). Trainers with a background in healthcare confirmed that healthcare is more complicated than aviation and, consequently, medical CRM training should be different: *"At the start of medical CRM training, expert trainers from aviation were necessary, but now healthcare must take over"* (Trainer 6).

Theme 3. Existing Flaws

One of the most common criticisms on teamwork in surgical departments was the existing top-down hierarchy. CRM trainers perceive this is as leading cause of disharmony in the operating theatre, that is potentially disastrous for team spirit and consequently, could be affecting patient safety. All trainers considered the current incident reporting systems in healthcare inadequate, overly focused on blaming. Trainers thought medical CRM training could improve safety in the operating theatre. In addition to a positive effect on patient safety, they appreciated that CRM would also improve the work environment in healthcare.

Theme 4. Future of Medical CRM

The trainers were unanimous that in the future CRM will be integrated in daily practice. While private companies dominate the Dutch medical CRM field, Trainer 9 (working as a hospital-based CRM trainer) anticipated that hospitals will take over from commercial parties, even though CRM training is still too expensive and challenging to organize at this moment. *"The ideal situation would be if healthcare would be self-sustainable concerning CRM and university medical centres would provide the manpower to ensure this. But we are not there yet, so there is [still] a need for the private sector"* (Trainer 9).

Standardization

All trainers except one expected that a standard for medical CRM would be a step forward to ensure quality. However, ideas about what this standard should include, varied between trainers. Although most trainers agreed on the need for a standard, there should be enough room for tailoring to the local context. To get the best results, trainers must be able to adapt a CRM training standard to the local context.

DISCUSSION

After recommendations in "To Err Is Human", CRM training became a topic of great interest in healthcare.[3] Simulation-based training with CRM principles has dominated the simulation training field and medical CRM is increasingly becoming a subject of research. However, a myriad of CRM training providers exists, and the possible effects on patients are unclear. This potential relation between CRM training and clinical outcomes has been studied in multiple departments in the last decade. Below, we will discuss these studies in the light of insights obtained in our study."

In surgery, Neily et al. (2010) studied the effect of CRM training on surgical outcomes in 108 Veterans Health Administration clinics.[17] They found a significant decrease in mortality of 18% compared to 7% in the control group. All clinics used a tailored version of CRM training consisting of 2 months of preparation, a 1-day conference, followed by one year with quarterly coaching interviews. Conversely, a similar study in France by Duclos et al. (2016) found no decrease in mortality after implementing CRM training to improve adherence to safety checklists.[18] Their CRM training consisted of two half-day sessions six months apart, in which the second session was tailored based on the information collected those six months. In obstetrics, CRM training of obstetric care teams showed no improvement in patient complications.[19] This study used a one day-training of CRM principles in a simulated environment. In the ICU, Haerkens et al. (2015) reported that CRM implementation was associated with reduced severe complications and mortality in critically ill patients.[13] Their intervention comprised a 2-day CRM training and an after-training follow-up in the implementation year. However, these conclusions were challenged by Kemper et al. in 2016, when they reported no improvement in patient outcomes, nor a change of healthcare professionals' behavior after 2 days of classroom-based training.[9]

This overview illustrates that no consensus has been reached on the effects of CRM on clinical outcomes. These divergent results reported in international literature could be explained by the diversity in CRM training formats as mentioned above, and of course, differences in study design. To our knowledge, our study is the first study that focusses on the CRM trainers' views as a possible cause for this diversity. This is a first step towards the introduction of a consensus standard for medical CRM training, which in summary can be defined as a set of conditions or the adoption of practices necessary to provide guidance and ensure safety in healthcare, developed by experts and based on current knowledge.[21,22] Ideally, this standard would be similar to the standard used in for example, the Advanced Trauma Life Support (ATLS) training. A standard would also serve as a uniform basis for future clinical research on the effect of medical CRM training on patient safety and outcomes.

Generally, healthcare professionals that completed CRM training perceive a better safety culture than those who did not.[9-12] A possible explanation for this could be an increased awareness of human factors as the most significant cause of medical errors.[3] The overall satisfaction of participants with CRM training, as found in the literature, is in line with the lack of resistance experienced by the interviewed trainers in this study.[13,14]

Potential of CRM

Although interprofessional education and teamwork are high on the agenda at medical and nursing schools, they are not yet prominently present in the curricula of students.[23] The majority of current generations of team members in the operating theatre are not educated in the topics of non-technical skills, human factors and teamwork. Curricular training in these topics has the potential to be of great value to improve teamwork and thus, patient safety. Teamwork and educating professionals about this subject were identified as a remaining challenge by the Lucian Leape Institute for improving patient safety.[24]

Lastly, few studies have been performed on the cost-benefit analysis of CRM implementation in the medical field. One study by Moffatt-Bruce et al. (2019) showed that the implementation of CRM in medicine has led to fewer avoidable patient harm, mostly from fewer medicine errors. This study estimated that this created a positive return on investment. Of course, controlling for confounding factors is very difficult in a large-scale study and further research on this subject is desirable.[16]

A Fragmented Landscape

To this day, there is still a growing interest in a field with many different players offering CRM training. Musson and Helmreich (2004) argued that healthcare professionals should take the lead in CRM-based training field activities.[25] So far, no consensus has been reached on what CRM training should include. This has led to a wide variety of CRM-based training courses that are dominated by private companies which are mostly supply-side rather than demand-orientated. The aim of every medical CRM training was the same: enhancing patient safety using CRM principles. However, the trainers' principles and *how* they addressed these CRM principles were reflected in the vast variety of CRM training courses.

This study showed that most diversity was observed in the total duration of the trainings and the simulation part of the training. The use of cockpits and control towers for medical CRM, expensive as these are, were considered a benefit by some trainers, but others expressed skepticism. The latter stated that even if it is *fun*, it is not comparable to daily practice. Following the Kirkpatrick training evaluation model, this kind of *fun* training would score high on level 1 (reaction) but low on levels 3 (behaviour) and 4 (results), meaning that what the participants would learn in these trainings would not be easily applicable in daily clinical practice.[26] Stevenson and Moore (2018) describe in their *Continuing Medical Education outcomes pyramid* what is needed for education to find its way to improvement in patient health (level 6): reaching competence (level 4) and impacting healthcare professionals' performance (level 5) are key.[27] One can conclude, that classic CRM training like flight simulation will most likely not affect patient or community health (level 6 of the pyramid), because of its inapplicability in clinical practice. This theoretic framework underlines our opinion that CRM courses tailored to the medical field are needed.

A Possible Way Forward

How can the quality of CRM training courses and trainers' professionalism be safeguarded? Establishing a standard for CRM trainers and/or their training methods might contribute to solving these problems and facilitate further research into the value of CRM more constructively. However, if a standard must be set, challenges and questions remain. Who is the best party to set this standard: the provider or the client? Should the standard comprise qualifications of the trainer or requirements for the training itself?

In contrast to the ATLS training format, which is standardized into detail, a medical CRM training should be tailored to some extent because every team is different. Standards for medical CRM trainers could therefore focus on the quality of the trainer instead of minimal course requirements. Client and provider could create a fitting format together, considering what is needed in a particular team and what can be provided by the trainer. On this basis, a feasible standard for the CRM trainers can be created and quality could be ensured, while the experience from the trainers is used optimally and the CRM training course is tailored to the needs of healthcare professionals.

Limitations and Strengths

One of the limitations of this study is the semi-structured interview approach, in which not every CRM trainer got the exact same questions. A strength of this research design was the room for constant comparison. Although the number of conducted interviews was small, it was representative, as all major players in the Dutch medical CRM field were included in the study. Another limitation of this study was that most trainers worked for commercial parties. Because they solely depend on the training market for their income, this could make them less critical to CRM in general. The high percentage of commercial trainers in this study was unavoidable because private companies dominate the medical CRM training market in the Netherlands.

CONCLUSION

For now, the CRM training courses are not regarded as interchangeable. The trainers involved in this study have serious concerns about the diversity and the quality of current medical CRM trainings. Based on literature and

perceptions of trainers, flight simulation seems unfit to effectuate CRM principles into daily care, but medical simulations are widely used. Generally, trainers believe that multiple CRM meetings are required to reach their full potential. They are convinced medical CRM has the potential to improve the teamwork of operating teams. Most trainers consider a consensus standard for medical CRM a rational way to ensure overall quality, although too much restriction is feared.

APPENDIX: STRUCTURED PART OF THE INTERVIEWS

Theme 1. Trainer Background

What is your professional background and education?

Where were you schooled to be a CRM trainer?

How long have you been active as a CRM trainer?

Theme 2. Training characteristics

Participants group

What does your normal participant group look like?

What does your ideal participant group look like?

What type of trainer is most favourable to train multi- and mono-disciplinary groups?

What type of trainer is most favourable to train trainers and a team?

What type of trainer is most favourable to train a single person?

Training

What is the aim and content of your training?

What is the most essential part of your training?

What are the differences and similarities between a medical and aviation CRM training?

Why should someone participate in your training?

After how much time do you recommend a refresher training?

Other trainers

What is your opinion on the other CRM trainers in the Netherlands?

In the Netherlands there a multiple forms of CRM training. In your opinion, what is the minimum requirement for a CRM training?

In your opinion, is a national standard for medical CRM training necessary?

What do you know about medical CRM training abroad?

Would you be willing to set a national standard with the other stakeholders?

Costs

How much does your CRM training cost?

In your opinion, who should pay for medical CRM training?

Theme 3. Existing flaws

In your opinion, what goes wrong in the today's operating theatre?

In your opinion, can CRM training be a remedy for this?

In your opinion, which effect on the reduction of mortalities and complication is possible with CRM?

In your opinion, how many hospitals are trained in the Netherlands?

Theme 4. Future of medical CRM

What do you envision for the future of medical CRM training?

Ending

Do you know other medical CRM trainers in the Netherlands?

At which hospitals in the Netherlands did you provide training?

DECLARATION OF INTEREST

None.

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