

MARCUS RALL ⁽¹⁾

(1) Center for Patient Safety and Simulation
 Dep. of Anesthesiology and Intensive Care Medicine
 University Hospital Tuebingen
 Tuebingen, Germany

Saturday May 28, 2005

PETER DIECKMANN ^(1,2)

(2) Institute of Work Psychology
 Swiss Federal Institute of Technology (ETH)
 Zurich, Switzerland

14:00-14:45

Room R

*General principles of managing critical situations
 and preventing errors in anesthesia and intensive care medicine*

ERRORS IN MEDICINE, PATIENT SAFETY AND HUMAN FACTORS

“Safety is a dynamic non-event” [1]

Safety Culture is “A collection of characteristics and attitudes in an organization, promoted by its leaders and internalized by its members, that makes safety an overriding priority” [2]

Patient safety in developed countries is good, but not good enough. According to the IOM-Report “To err is human”, between 44,000 and 98,000 people die from medical errors each year in the US [3]. Many more are damaged by medical errors. These numbers are similar for other countries. Many of these outcomes are not due to inadequate medical knowledge but to problems in transforming that knowledge into meaningful clinical actions under the real world conditions of patient care [4]. In complex working systems like anesthesia decisions have to be made under conditions of uncertainty and time pressure. Working in multiprofessional teams requires coordination and communication skills which are not taught in medical school. Up to 70% of all errors can be attributed to human factors. It is time for medicine to acknowledge this and to adopt strategies to prevent those human errors harming patients. One way of reducing human factor errors is the CRM (Crisis Resource Management) concept.

WHAT IS CRM?

Crisis Resource Management (CRM) was introduced in aviation and has proved successful in many other industries. Gaba and colleagues transferred and adapted CRM to medicine and called it Anesthesia Crisis Resource Management [4]. CRM aims to coordinate, utilise and apply all available resources to optimise patient safety and outcomes. Resources include all people involved with all their skills, abilities and attitudes – as well as their limitations, in addition to equipment. CRM begins before the crisis. All the principles that help in dealing with an acute crisis also help avoid the crisis in the first place. CRM is about capturing errors as soon as possible and minimizing the negative consequences of errors which have already occurred. Gaba, Howard and Fish developed key points of CRM for anesthesia and these were recently updated [5].

TABLE 1: CRM KEY POINTS⁵

1.	Know the environment
2.	Anticipate and plan
3.	Call for help early
4.	Exercise leadership and followership
5.	Distribute the workload
6.	Mobilize all available resources
7.	Communicate effectively
8.	Use all available information
9.	Prevent and manage fixation errors
10.	Cross (double) check
11.	Use cognitive aids
12.	Re-evaluate repeatedly
13.	Use good teamwork
14.	Allocate attention wisely
15.	Set priorities dynamically

(from Rall M, Gaba DM: Human Performance and Patient Safety, in Miller 6th edition 2005)

HOW TO APPLY KEY POINTS OF CRM

CRM key points are designed to focus your attention on factors which might improve patient safety. As you read through these principles you may think them trivial. Our experience with simulator training shows that applying these principles during routine work and especially during crises makes differences which are far from trivial. For each of these principles, think them through and ask yourself for each key point:

- How does it apply to your job and work environment (colleagues and organisation)?
- Which problems have you experienced in your work related to the key points?
- Which problems have you observed in other people's work?
- How could you improve that using the key point?
- How did you apply the key point so far?
- How could you improve your ability to use this key point?
- What problems or obstacles could you face in your real world?

CRM IN ACTION - THE CRM KEY POINTS

1. KNOW THE ENVIRONMENT!

Ideally crisis management begins before the crisis starts. One of the prerequisites of crisis resource management is to *know your resources*. Resources are *personnel* and *equipment* (software and hardware). It is important to know who can be asked for help, who is available at the different times (days, nights, weekends), how to find those helpers quickly and how long it will take before effective help is available. For equipment you need to know not only *what* you have and *where*, but also *how* to operate it. Think about infrequently used equipment and check it regularly. This can be done when reviewing possible crisis situations.

Remember: *Knowing the technical, human and organisational environment can help to reduce a lot of stress in crises. In critical situations it can make the difference between losing or saving a patient's life.*

2. ANTICIPATE AND PLAN

Anticipation is key for goal-oriented behaviour. Consider the requirements of a case in advance, think of what could be difficult and plan ahead for each possible difficulty. Also expect the unexpected! Be prepared. Mentally stay ahead of the game. Good pilots say "Always fly ahead of your plane!"

Remember: *Anticipation helps to avoid surprises. During crises you don't want surprises. Planning ahead takes out a lot of stress in those hot moments of excitement.*

3. CALL FOR HELP EARLY

Knowing your own limitations and calling for help is the sign of a strong character and competent person. Trying alone or toughing it out is dangerous for the patient and inappropriate. In an emergency or even a suspected emergency, you should call for help early rather than late. Help needs time to arrive. In a crisis there may be too much for the team on scene to handle alone. Make sure to know in advance who and how to call and how to use the help when it arrives.

Remember: *Calling for help early is not a sign of low self-confidence; it shows your respect and sense of responsibility for your patient's safety. "Heroes" are dangerous.*

4. EXERCISE LEADERSHIP AND FOLLOWERSHIP

A team needs a leader. Someone has to take command, distribute tasks and collect all the information. You need to get some insight into what it means to lead a team. Leadership is not about knowing more than everybody else, doing everything alone or putting other people down. Leadership is about coordinating and planning using clear communication. Followership means being a good and important team member; listening to what the team leader says, doing what is needed. It does not mean shutting off your own brain. Be assertive if you think the team leader makes wrong decisions. It is your responsibility to make sure the leader is aware of your concerns. If there are team problems discuss them – but after the event.

Remember: *Concentrate on what is right, not who is right. The team consists of leaders and followers. The leader's job is to coordinate and integrate, but all are equally responsible for the patient's well-being. The patient should never suffer from your team problems.*

5. DISTRIBUTE THE WORKLOAD

One of the main tasks of a team leader is the distribution of workload. Someone needs to define the tasks, check that they are properly carried out and that everything fits together. If possible the team leader should remain free of manual tasks in order to observe, gather information and delegate tasks. Team members should also actively look for things which need to be done. It is not a good team, if the team leader has to direct every team action.

Remember: *You can not and should not do it all alone. As a leader distribute and coordinate tasks, as a team member offer ideas and tasks and do what needs to be done.*

6. MOBILIZE ALL AVAILABLE RESOURCES

Think of everyone and everything that could help you to deal with the problem at hand. That includes people and technology embedded in the organizational processes. On the human side your knowledge and skills and your knowledge of your strengths and weaknesses are your most important resource. Resources are there to be used. It is foolish to manage a crisis alone when there are colleagues in the lounge drinking coffee, or to struggle with infusions when the level-one device is unused in the storage room.

Remember: *After a crisis you often realize that there were precious resources available if only you had mobilized them. This can be personnel (numbers and qualifications) or extended monitoring and equipment.*

7. COMMUNICATE EFFECTIVELY

Communication is key in crisis situations. Good team work depends on *everybody being on the same page*. Communication ensures that everybody knows what is going on, what needs to be done and what is already done. Communication can be difficult sometimes. Saying something is only communication if the message is received (see Table 2).

Remember: *Communication is important for both the sender and receiver of a message, no matter whether they lead or follow. Address people directly. Acknowledge what you heard and confirm when you have completed a task.*

TABLE 2: COMMUNICATION FLOW – CLOSE THE LOOP (FROM [5])

<ul style="list-style-type: none">• Meant is not said• Said is not heard• Heard is not understood• Understood is not done
--

8. USE ALL AVAILABLE INFORMATION

Medicine is complex because you have to integrate information from many different sources. Every bit of information can help you to understand your patient's status better and arrive at the correct diagnosis. Complete the picture by correlating all these different sources: clinical impression, patient's vital signs, information available from relatives (e.g. about drug therapy and coexisting diseases). Make yourself aware of vital sign trends.

Remember: *When treating or diagnosing a patient you have to consider all information sources available. The key is to integrate bits of information in your mental picture of the patient. Humans tend to seek (only) for confirming information. Deliberately seek out information which does not fit to your picture.*

9. PREVENT AND MANAGE FIXATION ERRORS

All human action is based on mental models of the current situation. If your model of the situation is not correct, neither will your actions be. Fixation errors stem from faulty but consistent models of a situation. This may mean sticking to a diagnosis - *This and only this* - not taking into account the (correct, but rare) alternative. It might mean neglecting one (maybe most severe) diagnosis - *Everything but this*. Or it might mean that you do not recognize the need to act in emergency mode - *Everything is OK*.

One principle of managing fixation errors is to get a new view on the situation, not biased by faulty previous assumptions. Try to get a second opinion from somebody not involved – take care not to tell them too much about your own view so you will not “infect” them. Deliberately change perspectives (physically or mentally) and try to look for information not fitting your picture of the situation. Step back and look at the situation as a whole as if you were entering the room for the first time. Imagine what one of your most respected colleagues would do in this situation.

Remember: *Fixation errors are errors in your mental model of the patient and the situation. So they are hard to catch and come in different styles. Knowing the enemy already helps to respond. Always rule out the worst case.*

10. CROSS (DOUBLE) CHECK

Cross checking means correlating what you know from different sources. Does the artefact in the ECG show up in the pulse oximetry too? Our memory fools us sometimes and always tries to make things fit consistently. Maybe it is not an artefact. Double checking is about making sure that what you remember you perceived is what you actually perceived. Sometimes the mind plays tricks - you think you did something but maybe you did not, because you just thought you did it. Or maybe you thought you stopped the infusion, but you turned it wide open. Touch devices to make sure they are in the desired state.

Remember: *Always think about errors – both your own and others (To err is human). Rechecking might help you to catch these errors. Correlate results and perform plausibility checks. Read the vital signs monitor with your fingertips. Eyes are sometimes faster than the brain.*

11. USE COGNITIVE AIDS

Cognitive aids come in different forms but serve similar functions. The big strength of humans – but also their big weakness – is that they tend to take short cuts, do not think systematically and are flexible. “What helps most of the time” will produce errors when things need to be done in a definite order without missing anything. That is why we design cars but robots build them the same way over and over again. Using checklists, common in other industries, might help to not forget important steps in diagnosis or treatment. If machines do maths better than us – why not let them do it? Calculating dosages using a calculator is less error prone than using your head. Looking up dosages or other information shows responsibility not a lack of knowledge. Calling hotlines (poisoning, malignant hyperpyrexia) is also a responsible action.

Remember: *Never feel bad looking something up, even if you knew it before. Check yourself. Have important information on paper. Don't be cool – be good. It might be a life and death decision!*

12. RE-EVALUATE REPEATEDLY

Acute medicine is dynamic. What is correct now might be wrong in the next minute. Every piece of information might change a situation. Some parameters might also change slowly over time. Subtle changes are hard to perceive. So do not hesitate to follow a dynamic situation by dynamic decision making – do not stick to choices you made if the situation changes. Use trend monitoring whenever possible in order to detect slowly falling blood pressure. Keeping track of trends is difficult for the human mind. Let technology help you.

Remember: *Be aware of dynamically changing situations. What is this patient's main problem and what most endangers his life? Be in doubt, try to correlate all information. Establish a habit of rechecking your mental model regularly.*

13. USE GOOD TEAMWORK

Not all team work is good work and good team work is hard work. Coordination of a team begins before it gathers. If all members know the tasks to be done and their roles during these tasks, coordination is easier. Short briefings at the beginning of a task are common in aviation and are time well spent. During a crisis there is often much tension within a team. Even though it is not a common part of current clinical practice, a debriefing provides a tremendous learning opportunity.

Remember: *Dream teams are made, not born! Respect the team members and their weaknesses. Team players should think about what the other person will need next. Work hand in hand, not on demand. Try to reach this flow-state of team work.*

14. ALLOCATE ATTENTION WISELY

As our attention is very limited and humans are not good at multi-tasking you need to allocate your attention repeatedly. Two principles might be helpful. First, it is reasonable to develop the rhythms you use for allocating your attention. The ABC-sequence is based on this principle. If you manage to keep to this rhythm you are less likely to miss important details. The second principle is to alternate between focusing on details and focusing on the big picture. Whenever you need to focus on a detail (e.g. a difficult intubation) try to force yourself to go back to the big picture and to re-evaluate your patient's overall status. Try not to get distracted, interrupt long procedures and check the patient.

Remember: *You can't concentrate on two tasks at the same time. Make sure you concentrate on the most important information. Situation awareness allows you to distinguish between important and less important information. Allocate your attention actively. Have others check certain aspects for you while you are doing other tasks.*

15. SET PRIORITIES DYNAMICALLY

Dynamic situations demand dynamic measures. Don't stick to your "decisions" – they are often based on uncertain and incomplete information. Make (purposeful) preliminary decisions. What was right might be wrong now and vice versa. Having a solution does not mean you have the best solution. However, one priority remains – ensuring stable vital signs at all time. Even if you do not know why your patient is sick, take care of the vital signs and don't get lost in difficult differentials whilst the patient stops breathing.

Remember: *After having re-evaluated a situation it might be necessary to define new priorities and goals. Try not to stick to your initial decision - no matter how hard it was to make it. Let your team know your priorities and ask for their view!*

HOW CAN CRM-SKILLS BE LEARNED AND TAUGHT?

THEORY

The CRM Key Points mentioned above often seem obvious, maybe even trivial. They are, but using and applying them is not. To improve your CRM-competence you should try to reflect on these principles as close to your working environment as possible. Whenever you have dealt with unexpected events take a few minutes afterwards and try to analyse them by going through the key points. More theoretical background on the principles can be found in the book by Gaba, Howard and Fish [6] as well as in related safety literature [7-16].

PRACTICE

All around the world there is an increasing number of simulation centres [17] in which you can learn the CRM key points hands-on. Combined with theory you work through relevant scenarios in highly realistic environments. During video assisted debriefings you can discuss how the CRM principles can help you to make patients safer. Many of these centres also offer mobile training, meaning that they can bring the simulator and everything needed (e.g. audio-/video equipment) to your facility and train your staff on site. The Society in Europe for Simulation Applied to Medicine SESAM provides links and information [18]

(<http://www.uni-mainz.de/FB/Medizin/Anaesthesie/SESAM/welcome.html>).

HOW CAN CRM-SKILLS CONTRIBUTE TO PATIENT SAFETY?

Although 70% of all errors in medicine are attributable to human factors, there is no formal training to improve that. CRM is not yet a standard part of medical training and there is no clear cut evidence that it improves patient outcome. Large numbers would be needed for such a study. Nevertheless CRM training is an integral and accepted part of training in aviation, nuclear power and other industries in which human errors can lead to catastrophic events. There is no reason to assume that doctors are less error prone or would benefit any less from human factor based CRM training.

In order to improve patient safety CRM key points and their application must be supported by the decision makers and accompanied by organisational improvements. Only if hospitals and other health care organisations provide such a framework can the individual health care worker effectively improve patient safety.

The following citation speaks for itself and makes the message clear:

“...no industry in which human lives depend on the skilled performance of responsible operators has waited for unequivocal proof of the benefits of simulation (or CRM) before embracing it... Neither should anesthesiology (health care)”[19]

David Gaba, *Anesthesiology* 76:491-494, 1992

LITERATURE

1. Maurino de, Reason J, Johnston N, Lee rb. *Beyond Aviation Human Factors*. Aldershot: Ashgate, 1995.
2. Columbia Accident Investigation Board. *Columbia Accident Investigation Board Report Vol 1*. 2003.
3. Kohn LT, Corrigan JM, Donaldson MS. *To Err is Human - Building a Safer Health System*. Washington: National Academy Press, 1999.
4. Gaba DM, Fish KJ, Howard SK. *Crisis management in anesthesiology*. New York: Churchill Livingstone, 1994.
5. Rall M, Gaba D. Human Performance and Patient Safety. In Miller R, ed. *Miller's Anesthesia*, pp 3021-72. Philadelphia: Elsevier Churchill Livingstone, 2005.
6. Gaba DM, Fish KJ, Howard SK. *Crisis Management in Anesthesiology*. New York: Churchill Livingstone, 1994.
7. Reason JT, Carthey J, de Leval MR. Diagnosing “vulnerable system syndrome”: an essential prerequisite to effective risk management. *Qual. Health Care* 2001;10 Suppl 2 :ii21-ii25.
8. Reason J. Human error: models and management. *West J. Med.* 2000;172:393-6
9. Reason J. *Managing the Risks of Organizational Accidents*. Aldershot: Ashgate, 1997.
10. Reason J. *Human error*. Cambridge: 1994.
11. Helmreich RL. On error management: lessons from aviation. *BMJ* 2000;320:781-5.
12. Helmreich RL. Managing human error in aviation. *Scientific American*. 1997;276:62-7.
13. Wiener, E., Kanki, B., and Helmreich, R. *Cockpit Resource Management*. 1993. San Diego, Academic Press.
14. Fletcher GC, McGeorge P, Flin RH, Glavin RJ, Maran NJ. The role of non-technical skills in anaesthesia: a review of current literature. *Br.J. Anaesth.* 2002;88:418-29.
15. Flin R, Salas E, Strub M, Martin L. *Decision Making Under Stress*. Aldershot: Ashgate, 1997.
16. Flin R. *Sitting in the Hot Seat*. Chichester: John Wiley+Sons, 1996.
17. Rall M, Gaba D. Patient Simulators. In Miller R, ed. *Miller's Anesthesia*, pp 3073-104. Philadelphia: Elsevier Churchill Livingstone, 2005.
18. Rall M., Moenk S, Mather S, Rettedal A, Glavin R.J. SESAM - The Society in Europe for Simulation Applied to Medicine. (Editorial). *Eur.J. Anaesthesiol.* 2003;20:763.
19. Gaba DM. Improving anesthesiologists' performance by simulating reality(editorial). *Anesthesiology* 1992;76:491-4.

LINKS

<http://www.npsf.org/>
www.patientsafety.gov (VA)
<http://www.jcaho.org/>
www.npsa.nhs.uk
<http://anesthesia.stanford.edu/VASimulator>
www.medizin.uni-tuebingen.de/ps/english