

CREW RESOURCE MANAGEMENT

Practical Points for Improving Patient Safety in Theatre.

M Gunning

Moderator: N Rorke



UNIVERSITY OF
KWAZULU-NATAL

INYUVESI
YAKWAZULU-NATALI

School of Clinical Medicine
Discipline of Anaesthesiology and Critical care

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CREW RESOURCE MANAGEMENT

INTRODUCTION

The CMSA Portfolio of Learning for the Fellowship in Anaesthetics of The College of Anaesthetics of South Africa¹ lists 'Professional Attributes' as one of 13 modules that must be completed over the course of the 48-month Registrar Training Program.

The listed aims for the registrar in this particular module include becoming an effective communicator, a collaborator in the multidisciplinary healthcare team, and manager. While these personal qualities and patient care aims are assessed at the end of each clinical block using the green registrar evaluation forms², these non-technical skills (NTS) are not formally taught at present during registrar training.

Crew Resource Management (CRM) was developed by the National Aeronautics and Space Administration, or NASA, in 1979 to provide structured teaching of these principles in order to improve flight safety. This concept was adopted by the healthcare sector and a number of courses have been developed similarly in an attempt to improve patient safety.

DEFINITIONS

Crew Resource Management (**CRM**) - *A management system, which makes optimum use of all available resources- equipment, procedures and people - to promote safety, reduce error, avoid stress and enhance the efficiency of flight operations. The course focuses on improving communication, leadership style and decision making skills.*³

Non-Technical Skills (**NTS**) – *Interpersonal and cognitive skills, rather than psychomotor skills, considered essential for safe and effective teamwork. This includes being a good leader with excellent decision-making and task management skills, an effective communicator, or a good follower (team member).*⁴

ANAESTHETICS AND AVIATION

There are a number of striking similarities between the Anaesthetic and Aviation environments. Firstly, the safety of passengers and patients is paramount. The Induction, Maintenance and Emergence phases of an anaesthetic mirror Take Off, Cruise and Landing in aviation. Both sectors make use of emergency drills and management algorithms in times of crisis. More than two thirds of air crashes, and similarly medical errors, have been attributed to human error due to a breakdown in NTS, rather than technical error.⁵

Both flight crew and medical teams must interact with technology in complex and often highly pressurized environments.

In medicine, the field of anaesthetics is unique due to the intensity of time pressure, the ever-changing environment and the degree of uncertainty. Protocols can be used to decrease pressure in emergency situations, to simplify management into an A-B-C type approach.

In England, doctors wishing to work on-board medical aircraft must first complete the HEMS Crew Course (HCC) which includes certification in CRM.³ Similarly, Human Error and Patient Safety (HEAPS) training in Australia and Team Oriented Medical Simulation (TOMS) courses have been developed for the medical field.

Anaesthetic *Crisis* Resource Management (ACRM)⁶, and Anaesthetic Non-Technical Skills (ANTS) are examples of courses that have been specifically designed to teach CRM principles to anaesthetic crews.

HUMAN FACTORS APPROACH

A large percentage of critical incidents are as a result of human error, and every incident has a human factor. CRM training specifically aims to reduce the impact of human error, but while NTS are becoming mandatory training worldwide, it still not universally taught as part of the medical curriculum.⁷ Anaesthetic mortality has reduced from 1-2 deaths per 3000 cases, to 1-2 in 20000 over the past 30 years.⁸

This is thought to be due to advances made in patient monitoring and medical equipment, as well as improved medical understanding of human physiology, which ultimately has resulted in better patient care. Mistakes can be classified into preventable or unpreventable, and the majority of preventable mistakes are as a result of human error.

These mishaps now commonly occur during the maintenance phase of an anaesthetic during periods of decreased vigilance. Good documentation is therefore essential for two reasons: firstly, real-time record-keeping means increased vigilance on the part of the anaesthetist. Secondly, accurate and timeously completed medical records avoid an inevitable under-reporting bias of critical incidents.

MEDICAL MISTAKES: “PRIMUM NON NOCERE”

The Hippocratic oath sworn by physicians includes the principle ‘First do no harm’. To err is human however, and there has been a paradigm shift to understanding that medical mistakes are inevitable and not necessarily as a result of incompetence.

Atul Gawande, did much to dispel the commonly held public perception that only 'bad' doctors make mistakes and that good doctors are infallible, in his book 'Complications'.⁹ Errors occur in 5-15% of all hospital admissions worldwide, and 45% of these occur in the operating theatre¹⁰, and the majority of these errors are primarily human error as previously explained.

It is essential to appreciate that operating theatres constitute a high-risk environment, and their inherent risk is compounded by high patient turnover and time pressure. Mandela said "Our greatest triumph is not in never falling, but in rising every time we fall."

Anaesthetic and Surgical crews are on the same healthcare team. Safety issues should be raised without the need to point a finger at any one individual, and positive steps must be taken to improve team training to reduce the likelihood of the error recurring.

Preventable Anaesthetic Accidents

Common human errors in theatre:	Common Equipment malfunctions*:
Hand washing failure	Undetected circuit disconnection
Circuit connection error	Gas supply problem
Airway mismanagement	Monitoring device
Inadvertent gas flow change	Anaesthetic Machine and ventilator error
Fluid mismanagement/ hypovolaemia	Laryngoscope failure
IV line disconnection	Syringe swap*(Operator errors)

Adapted from 'Preventable anaesthesia mishaps: a study of human factors'.¹¹

Drug Errors:

It is estimated that an alarming 20% of drug doses given to hospitalized patients are in fact incorrect.¹⁰ As anaesthetists, drug errors are frequently due to 'syringe swap'.

To combat this, the label on any drug ampoule (not the box) or syringe should be read carefully before a drug is drawn up or injected, and ideally checked with a second person (challenge and response).

Emergency drugs should be pre-prepared and commonly used drugs pre-drawn. Syringes should always be labelled, ideally with colour-coded labels, and standard drug concentrations should be used.¹²

RISK MANAGEMENT

In order to attempt to prevent errors occurring, it is important to understand the extent and nature of the risk. In risk management terms, medical errors are referred to as Serious Untoward Incidents (SUI). When a SUI occurs, a thorough incident report should be filed.

Following this, a root cause analysis should be performed to identify the causative factors which resulted in the error. These factors should be tabled at regularly held risk meetings, and recorded in a risk register, to ensure that the information can be retained within the system and disseminated to all the team members.

If a problem area is identified due to repeated errors, a Standard Operating Protocol (SOP) can then be developed to specifically address the issue. Risk committee members should impartially review complications, ensure physician compliance with the protocols, and monitor quality indicators through regular audit.

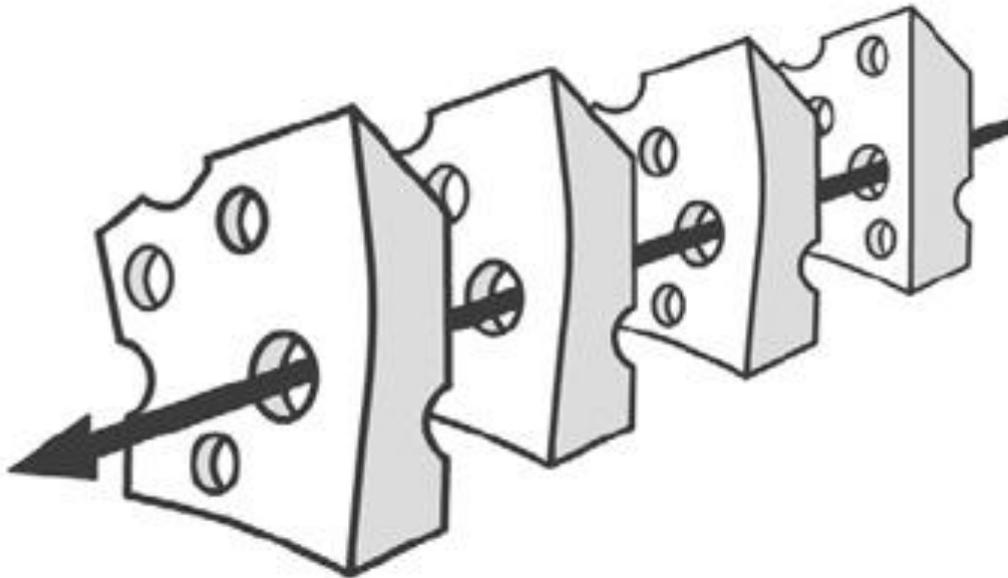
Human error and equipment misuse in Anaesthetics

Factor	Example
Inadequate preparation	No machine check, no pre-med, haste and/ or carelessness
Inadequate experience or training	Unfamiliarity with technique or equipment
Environmental conditions	Noise, temperature, poor communication with other crews
Physical and emotional	Fatigue, stress, personal problems

Anaesthetic Complications, Chapter 46, Clinical Anesthesiology, Morgan and Mikhail 4th ed.

SWISS CHEESE MODEL

James Reason described the 'Swiss Cheese Model' sequence of events that occur which lead to an incident occurring.¹³ This so called 'mishap chain' is a series of coincidental circumstances, misjudgements and technical errors, which occur on the background of latent flaws in the system. A systems failure is often at the root of the problem, and if this is correctly addressed, then the error can be prevented entirely from reoccurring.



'Vigilance' is the motto of the American Society of Anesthesiologists (ASA), and it goes without saying that one should never leave an anaesthetised patient unattended. Despite vigilance mishaps do occur, but if detected early a SUI can be avoided through damage control.

It is essential to call for help early, and consider working through the problem using a decision making tool such as 'DORDAR', commonly used in the aviation industry (expanded below). It is also vital to document these so called 'near misses' so that steps can be taken to avoid the same mistake from repeating in the future.

DORDAR Dynamic Decision Making Tool

D	Diagnose the problem: red flags?
O	Options?
R	Risk benefit consideration
D	Decide
A	Action
R	Reassess

CRM CONCEPTS: "Safety is no accident"

Good CRM is an attitude. It is beyond the scope of this booklet to cover all aspects of CRM, but an awareness of the following key CRM ideas is invaluable:

Key CRM Concepts

Leadership: SHELL model
HALT before handover
Diplomacy and Command Gradient
Risk shift
Communication
Bandwidth and nametags
Checklists and cross-checking
Confirmation Bias
Task fixation
Briefing and debriefing

The **SHELL Model** attempts to define the relationship between human factors and the anaesthetic environment, and how they intersect.¹⁴ The **Software** refers to anaesthetic guidelines and SOPs. **Hardware** is the anaesthetic drugs and equipment.

The **Environment** includes all aspects of the operating theatre, such as lighting, noise and temperature. Central **Liveware** refers to the clinical lead, or anaesthetist, and peripheral **Liveware** includes assistants (crewmembers), and other team members. Each component must be considered and a systems fault in any one can ultimately result in a SUI.

Handover periods are well known to be high-risk times, and are therefore commonly staggered between the members of the healthcare team (for example, Doctors and Nurses), to avoid compromising patient safety. Handover protocols vary widely between units, but one recommendation to reduce errors is to use the **HALT** system before starting the process.¹⁵

Those about to receive the handover are asked if they are **Hungry, Angry, Late** or **Tired**? Hunger causes distraction, and anger frequently results in miscommunication. Proper preparation is essential and should not be rushed.

Fatigue severely impairs concentration, response times and mood; a guideline for working night shifts advocated napping at work, whilst being aware of the pitfalls of sleep inertia and incurring a sleep debt.¹⁶ (Ideally doctors should sleep 1 hour for every 2 hours spent awake on a night shift to repay the sleep debt).

The concept of a **command gradient** is of particular importance in the South African operating theatre environment, and clearly exists between specialist anaesthetists and trainee anaesthetic assistants. Steep hierarchies however prevent safety concerns from team members from getting full and appropriate attention.

It is therefore critical that we 'flatten the hierarchical pyramid'. Pyramids exist both within the anaesthetic crew, and the healthcare team as a whole. It is important to acknowledge cultural differences, specifically with regards to what is deemed a culturally appropriate way to interact with authority or leadership figures.

One technique is to ask questions from the team, using individual crewmembers' first names. This invokes a team mentality, empowering all team members to think as autonomous healthcare practitioners, and encourages others to contribute.

Considering all suggestions and making team decisions, can result in a cultural shift where juniors are comfortable questioning decisions, and seniors are open and willing to modify their behaviour. Where two or more potential team leaders exist, it is vitally important that one is clearly identified as being in control, to avoid **risk shift**, where safety may be compromised due to increased risk taking behaviour seen in groups.

For **communication** to be effective communication must be *addressed* (not 'someone'), *heard* (no unnecessary noise) and *understood* ('repeat back to me'), by team members. Ambiguity leads to confusion and instructions must be clear and concise. Pick your time carefully to pass information and ensure team members are ready to receive your message.¹⁷ Declare any problems or errors early to the rest of the extended team.

Resist assigning blame, and do not insult team members. There are a number of barriers to effective communication in theatre. Surprisingly, just 7% of meaning is in the words that are spoken: try listen to the message behind the words. (Importantly also in the South African context, English is often not all the team members 1st language). 38% of meaning is 'paralinguistic' and expressed in the pitch, volume and intonation of the message.

Even more surprising is the fact that more than half (55%) of the meaning is conveyed by facial expressions, most of which is covered by surgical facemasks, visors and theatre caps. Many errors of commission or omission therefore result from communication failure.

Individuals have a limited capacity to handle and process different pieces of information at any one time; this capacity is referred to **bandwidth**. Bandwidth is narrowed in times of stress: one should recognize this in oneself and others, and not panic. Most people can recall seven (+/- two) pieces of information from memory, but there is a significant decline when attempting more than three tasks.

This is made even worse with stress and fatigue. Narrowed bandwidth during multitasking is referred to as 'overload'. The brain can selectively ignore hearing during task fixation in an overloaded individual.

Similarly, excessive noise or music, reading or more recently electronic device distraction, can negatively affect situational awareness and concentration; all should be kept to a minimum during critical phases of an operation.

Communication failures can result from the inability to pass information to the overloaded individual. Team leaders can get an overloaded individuals' attention by using their first name, making use of the *Cocktail Party Effect*.¹⁸

Importantly, The brain does not stop *listening*, and people are habitually conditioned to respond to their names, which explains the phenomenon of being able to hear when ones name is mentioned, and recall aspects of that conversation, despite being in a crowded noisy room such as a cocktail party.

Using a team members name during the chaos of a resuscitation scenario for example, helps focus their attention on the message being passed, improving communication.

Team leaders must also 'offload' to maintain bandwidth and avoid overload. Situational awareness is vital to provide optimum management in an environment that is in constant flux, and this is a fundamental skill of an anaesthetist.⁶ One technique to enable offloading is to ask the team member to report back once the delegated task has been completed. This enables the leader to focus on the next step rather than worry about what may or may not have already been done.

As previously explained, only a limited amount of new information can be recalled, and therefore it is clear that nametags are essential, especially when working in unfamiliar theatre teams. This results in improved communication and potentially fewer errors, and is the rationale behind having all team members introduce themselves at the start of the WHO Safe Surgery Checklist. Probably the most important part of this booklet therefore is the nametag included below: *please cut this out, write your name on it, and wear it somewhere visible whenever in theatre.*

Nametag cutout: *see last page of the booklet.*



Checklists are vital to improving theatre safety, and help to prevent primarily errors of omission. There has however been reticence to incorporate this change by doctors. (Checklists have however been used by nurses for many years). This has led to the recommendation that there be a named consultant to champion, and audit, the use of the WHO Safe Surgery Checklist at each institution. Checklists should ideally be of the 'Challenge and Response' variety and carried out by 2 individuals.

Checklists should be short, made locally relevant and with the critical items at the start. Before starting any checklist, get everyone's attention and concentrate. Guard against the 'tick and flick phenomenon', and minimise any interruptions. If used correctly, checklists can assist in reducing errors committed by experienced clinicians as a result of slipping from unconscious competence into unconscious incompetence (a theory explained further below).

Properly performed checklists have been shown to reduce inpatient complications from 11 to 7%. The surgical safety checklists effects are sustained, and team culture is strengthened.¹⁹ Checklists can be used to check drugs and equipment; they should be reviewed regularly and should not limit an experienced clinician's ability to exercise critical thinking. Excessive checklists and checking is unnecessary, and badly designed checklists may be counterproductive.

Bias is an important source of error. **Confirmation Bias** or Anchoring, describes the tendency to ignore evidence that does not support one's theory and select only that which does. It commonly occurs in situations where information is limited.

An anaesthetic plan is formulated is often based initially on the expected or perceived problems. Occam's razor states that entities should not be unnecessarily multiplied. Put another way, common things occur commonly, and plans should be kept *simple*. Mencken is quoted as stating however, "For every complex problem, there is an answer that is clear, simple, and wrong."

It goes without saying that one should not remain inflexible in the face of mounting evidence to the contrary. Nothing should be assumed: "the most important assessment is the reassessment" is the mantra of the Advanced Trauma Life Support course.²⁰ If a test result contradicts your theory or diagnosis, it should not be discarded outright as an anomaly, but should make one reconsider the diagnosis. There is a military dictum that states "No plan survives contact intact", and the lead clinician should be able to '*adapt or (the patient may) die*'.

There are many different types of bias that have been described. *Visceral bias* exists when all of an individual's actions or motifs are viewed in a negative light based on a previous bad interaction.

The team leader should be open to the suggestions from all team members irrespective of any unresolved issues between team members or specialities. If interpersonal difficulties do arise, these should be reported to ones supervisor up the chain of command, to avoid unnecessary conflict which compromises patient care.

Human error can when the most critical problem is ignored because attention is inappropriately focused on a less important problem, or incorrect solution. This reduced situational awareness is also called **task fixation**. The team leader should at all times try to remain hands off, and avoid preoccupation.

During anaesthetic training we are constantly reminded that our goal is 'oxygenation not intubation'. Similarly, resuscitation is fundamental, and not necessarily CVP placement. Complicated tasks that require intense concentration such as Trans-Oesophageal Echocardiography (TOE) can therefore detract from overall patient care. It is all too easy to become overly involved in one small aspect of patient care and fail to recognize a fundamental error.

Briefing the team about the plan before starting is important, as is the **debriefing** following a SUI. Know your limits, never rush in blindly, and always make use of personal protective equipment. We learn from role models in medicine, both good and bad. Good leaders encourage team members to ask questions regarding management decisions.

Be the kind of leader people want to follow, and remember that while it's nice to be important, it's more important to be nice. Focus on the behaviors of team members, not outcomes. Gareth Davies, Medical director of London Helicopter Emergency Medical Service (HEMS) said: "The best performing units in the world deliver clinical excellence, not because they provide unique treatments or have access to highly technical equipment but because *they deliver the most basic of care in a quality-assured manner with exquisite attention to detail.*"²¹ Show appreciation for work well done, and give credit where it is due.

CRM and Healthcare:

The healthcare industry has started to embrace the concepts of CRM and checklists, but the uptake has been slow, and is most likely as a result of limited available data.

CRM was initially incorporated into crew training programs for aero medical units such as London HEMS, where doctors and paramedics worked closely alongside aircrew. Anaesthetic *Crisis* Resource Management (ACRM), and Anaesthetic Non-Technical Skills (ANTS) were subsequently developed to improve patient safety in theatre. The principles of these courses mirror those in the aviation industry and are summarized below.

Key ACRM principles

Know your environment	Situational and theatre awareness. Read the notes. Make use of all available information. Avoid Electronic Device Distraction.
Anticipate and plan	Always have a Plan A, B, and C. 'Proper preparation prevents poor performance'.
Take a leadership role	Hands off. Clearly identify the clinical lead to avoid risk shift.
Communicate effectively	Use names. Consider timing when passing information.
Call for help	Call early enough.
Allocate attention wisely	Consider bandwidth and recognize overload.
Distribute the workload	Offload and utilize all available resources appropriately.

ACRM consists of some didactic lectures, group exercises, as well as **simulation** and debriefing, otherwise known as moulage training. Moulage scenarios are high fidelity case simulations, incorporating complex and dynamic decision making, and interaction with multiple personnel, followed by a detailed debriefing.⁶

The mannequin is analogous to a flight simulator, and the military maxim of 'train hard, fight easy' applies: the cases are made highly realistic to limit so called 'moulage artefact'. Errors occur commonly in unfamiliar situations and hostile environments: such as performing anaesthetics outside of theatre, in suboptimal conditions with an ad hoc team.

Moulage scenarios can be constructed to mimic these conditions in order to familiarise crewmembers to these less commonly encountered situations. Gaps exist in emergency medical training: critical emergency scenarios such as the unanticipated difficult airway or malignant hyperthermia may only be rarely encountered in individual practice and specific teaching goals are therefore difficult to achieve without simulation.²²

Theatre staff such as doctors and nurses, or even anaesthetists and surgeons train separately, so it's understandable why medical errors occur as a result of miscommunication during emergencies. It is therefore essential to train as a team, rather than as separate clinical disciplines. While critical events may be rare, they can be rapidly fatal.

Training empowers well-trained teams to react quickly and decisively when faced with a crisis.²³ Regular training also enables trainers to test and refine SOPs. Critics have however questioned the value of such training: while team members who have undergone CRM training subjectively report feeling better equipped to handle emergency scenarios, multiple confounders unfortunately make it difficult to objectively measure improved patient outcomes as a direct result of the training.

High fidelity simulators have a number of other potential benefits and could be used to assess competence, revalidation, and re-training for those returning to work after a period of absence, and are the topic of another presentation by Dr Horsten, Simulation in Anaesthesia²⁴.

GUIDELINES, ALGORITHMS AND SOPS

Unit protocols are developed in an attempt to standardise management of complex scenarios where a high likelihood of error exists. One problem of a protocol driven approach, is that it relies on the team first detecting the problem.

Once a problem has been identified, protocols aim to set a minimum standard of care. Experienced clinicians should not be constrained by the SOP, and should be permitted to provide additional care over and above the SOP, but no one should practice below this level.

'Red Mist' is a concept described in the British Police response driving handbook, Roadcraft²⁵: certain emotive emergency situations, such as accidents involving children, can result in increased risk taking behaviour when responding.

This tendency to deviate from protocols in highly charged scenarios should be avoided as it puts both the responder and victim at increased risk. SOPs should ideally be evidence based, and reviewed regularly and updated when appropriate.

A useful model to consider when discussing the utility of SOPs is that of the so-called 'Competence Quadrants', and can be easily explained using the example of learning to drive a car.²⁶ A young learner driver starts off in the *unconscious incompetence* quadrant, blissfully unaware of the risks involved and how dangerous they are on the roads.

A small dent in an expensive vehicle moves the learner into the next *conscious incompetence* quadrant: the learner is now acutely aware of the complexity of the new skill and their own inexperience. With regular lessons and practice, the driver progresses to *conscious competence*, a safe quadrant to operate within.

Over time driving becomes routine, and many advance into the *unconscious competence* quadrant, or automaticity. I am sure many of those who drove here today cannot recall the specifics of the K53 learner drivers' test²⁷, any more than the finer details of their journey into work this morning.

Driving becomes routine; but the problem with automaticity is that many drivers try to perform additional tasks, such as texting on a cell phone. They are unaware that they are drifting back into unconscious incompetence, with disastrous consequences.

The same analogy can be made using medical students, interns, registrars and consultants, and the price for inattention can be just as lethal. SOPs and checklists are one method of focussing attention and maintaining situational awareness required for competence.

CLINICAL CHECKLISTS

The theatre environment is dynamic: equipment should be standardised and redundancy is crucial for safety. Checklists enhance a team *culture*, by empowering nurses and junior doctors to insist that seniors adhere to approved and safe procedures.

Checklists such as the WHO Safe Surgery Checklist, have been shown to increase efficiency, prevent errors, mitigate harm, and reduce the associated costs. Some critics assign these benefits however to the 'Hawthorne effect', surmising that the improved outcomes are as a result of being watched during checklist implementation, rather than the checklist itself.

Regardless of the mechanism, checklists can translate evidence into clinical practice²⁸, but the uptake has been slow. It is for this reason that the WHO advocates assigning a lead consultant to champion the implementation and use of the Safe Surgery Checklist.

CARE BUNDLES

Care Bundles are bundles of evidence-based interventions, which can be delivered to a selected group of patients, such as patients with Traumatic Brain Injury (TBI).

These groups of interventions are related to a disease process, and act synergistically: therefore 100% compliance is required to maximise the patient benefits.²⁹ Care Bundles ensure uniformity of care and reduce errors of omission. Other examples in ICU include ventilator care, and central line care bundles.

CLINICAL GOVERNANCE

A full in-depth description of the seven pillars of good clinical governance is beyond the scope of this booklet.³⁰ Traditionally medical errors have been associated with secrecy and embarrassment, due to fear of litigation and loss of reputation. John Powell said: "The only real mistake is the one from which we learn nothing."

Regular, *confidential*, Morbidity and Mortality (M+M) meetings should take place and should take the format of impartial case presentations of *de-identified* data and review.

This should be followed by open and honest discussion, and constructive criticism. There should be a 'non-blame' culture, and the meetings should be an opportunity to reflect on personal practice.

Well run M+M meetings can lead to quality improvement through group learning and improved patient-centred care.

The meetings can be a valuable source of information, facilitating education and preventing future errors. This can be done by keeping a record of SUIs and disseminating learning points to all staff members.

Other benefits include improved staff training, organization, workload management, system and protocol design. Through good clinical governance, the department can engender a safety culture, rather than blame culture.

CRM training in Durban:

The simulation centre located in the anaesthetic department at Inkosi Albert Luthuli Central Hospital (IALCH) in Durban has state of the art training facilities. Recently the paediatric anaesthetic department began offering the 'Management of Emergencies in Paediatric Anaesthesia' (MEPA) course to all registrars rotating through the department.

This is an international course that incorporates elements of ACRM. In aviation, pilots must undergo regular CRM training to remain current, and the same is true of ACRM if it is to be effective.

Currently at London HEMS, all the team members on duty on any given day must complete a moulage exercise, after completing all the necessary checks, and before the start of work. Ideally all members of each theatre crew should regularly train with the whole healthcare team in simulated emergency scenarios at the IALCH simulation centre.

Summary of practical points of CRM relating to improved patient safety in theatre:

- Identify a single clinical lead.
- Stand back (Keep the 'bigger picture' and avoid any bias).
- Introduce yourself, use names (to avoid command gradient).
- Involve the whole team, use all available resources.
- Assign roles appropriately, according to skills.
- Verbalise a clear plan/ instructions ('Talk through').
- Narrative feedback: think out-loud.
- Hands off team leader (to maintain bandwidth).
- Debrief/ M+M.

CONCLUSION

Doctors are not infallible, operating theatres are high-risk environments and mistakes are inevitable. With a better understand of human limitations, and utilizing CRM principles, SOPs and checklists, theatre staff can work together as a team to reduce medical errors, limit morbidity and mortality, and improve patient safety.

Recommended Reading:

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Notes:

HELLO
my name is