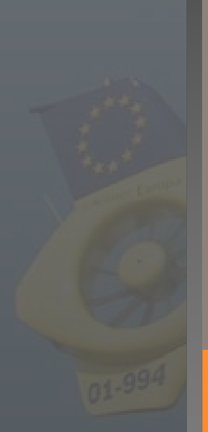
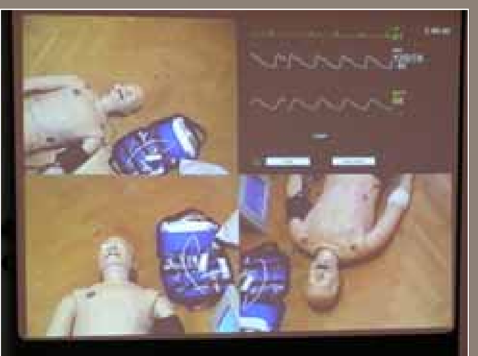
Symposium
‚De luchtvaart brengt ons meer dan het MMT'





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anesthesioloog / MMT arts / aeromedical CRM trainer
UMC Groningen

Lessons to learn from HEMS?

1995

2007

CRM in aviation

- NASA research on airtransport accidents reveals human factors as main cause
- 1978:
  United Airlines crash (DC 8, Portland)
- 1979:
  "resource management on the flightdeck" a workshop sponsored by the NASA introducing
  "cockpit resource management"
- 1981:
  first CRM programme by United Airlines

CRM in aviation

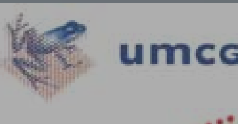
- 1986

  “crew resource management” as second generation of training
- 1993

  evolution of CRM training by Delta Airlines
- Early 1990s

  third generation CRM extending to cockpit-cabin training
- Late 1990s

  fourth generation CRM
- adapting CRM to national cultures of crews



CRM in anaesthesia

Anesthesiology
49:399–406, 1978

Preventable Anesthesia Mishaps:

A Study of Human Factors

Jeffrey B. Cooper, Ph.D., Ronald S. Newbower, Ph.D.,† Charlene D. Long, M.S.,‡ Bucknam McPeek, M.D.†*

A modified critical-incident analysis technique was used in a retrospective examination of the characteristics of human error and equipment failure in anesthetic practice. The objective was to uncover patterns of frequently occurring incidents that are in need of careful prospective investigation. Forty-seven interviews were conducted with staff and resident anesthesiologists at one urban teaching institution, and descriptions of 359 preventable incidents were obtained. Twenty-three categories of details from these descriptions were subjected to computer-aided analysis for trends and patterns. Most of the preventable incidents involved human error (82 per cent), with breathing-circuit disconnections, inadvertent changes in gas flow, and drug-syringe errors being frequent problems. Overt equipment failures constituted only 14 per cent of the total number of preventable incidents, but equipment design was indictable in many categories of human error, as were inadequate experience and insufficient familiarity with equipment or with the specific surgical procedure. Other factors frequently associated with incidents were inadequate communication among personnel, haste or lack of precaution, and distraction. Results from multi-hospital studies based on the methodology developed could be used for more objective determination of priorities and planning of specific investments for decreasing the risk associated with anesthesia. (Key words: Anesthesia: risk; safety. Complications: accidents; death. Equipment: failure.)

PREVENTABLE MISHAPS resulting from human error contribute to anesthetic risk. Yet, the specific etiology of the contribution has received little attention. Even estimates of the magnitude of the contribution of error to anesthetic mortality vary.[1] Human errors were believed to be a factor in 87 per cent of 80 deaths attributable to anesthesia reported by Dripps *et al.*,[2] in 65 per cent of 52 deaths reported by Clifton and Hotten,[3] and in 83 per cent of 589 deaths reported by Edwards *et al.*[4] In the Beecher–Todd study,[5] 7.5 per cent of the deaths reported were attributed to "gross anesthetic mismanagement." These and other risk studies have concentrated primarily on quantitating overall anesthetic risk, using mortality as the one measure of negative outcomes. Attempts to identify risk factors have usually encompassed only those variables directly associated with operative procedures or the patient's disease, age, physical status, etc. Factors associated with anesthetists and/or factors that may have predisposed anesthetists to err have, with a few exceptions,[6–8] not been analyzed. Furthermore, no study has focused on the process of error—its causes, the circumstances that surround it, or its association with specific procedures, devices, etc.—regardless of final outcome.

If the frequency of error is to be decreased, a clearer understanding of that process is needed. The circumstances that encourage error should be identified and the relative frequencies of different classes of errors should be established. While most anesthetists are aware of the potential for certain types of errors, corrective action is difficult to design or implement on the basis of anecdotal information. Established techniques exist for analyzing the etiology of error. However, they have not been previously applied to the practice of anesthesia. We have used a modification of the methodology known as critical-incident analysis to study preventable anesthetic mishaps.[9] Although a somewhat subjective technique, it is a useful tool for transcending individual experience in a controlled manner, and is used often in human-factors research for collecting information about human performance.

Methods

Information about preventable mishaps was collected by interviews with staff and resident anesthesiologists in one large metropolitan teaching hospital. A mishap was labeled a critical incident§ when it was clearly an occurrence that could have led (if not discovered or corrected in time) or did lead to an undesirable outcome, ranging from increased length of hospital stay to death or permanent disability. In order to be included in the study, each incident was also required to have the following characteristics: 1) it involved an error by a member of the anesthesia team or a failure of the anesthetist's equipment to

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Received from the laboratories of the Bioengineering Unit, Department of Anaesthesia, Harvard Medical School at the Massachusetts General Hospital, Boston, Massachusetts 02114. Accepted for publication February 14, 1978. Supported in part by a grant from the National Institute of General Medical Sciences, GM 15904.

Address reprint requests to Dr. Cooper.

§ As intended by Flanagan, the originator of the technique, the term "critical incident" refers to an occurrence that is significant or pivotal, in either a desirable or an undesirable way. For this study, we chose to examine only those incidents that had potentially undesirable consequences.

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Anaesthesiology 1978:

Preventable anaesthesia mishaps

"In this respect it permits the application of human-factors principles to anaesthesia, following the example of successful applications in fields such as aviation."

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CRM in anaesthesia

SPECIAL ARTICLE

Anesthesiology
66:670–676, 1987

Anesthetic Mishaps: Breaking the Chain of Accident Evolution

David M. Gaba, M.D.,* Mary Maxwell, M.D.,† Abe DeAnda, B.S.‡

RISKS OF ANESTHETIC ADMINISTRATION were recognized soon after the advent of surgical anesthesia,[1] and much subsequent attention has focused on the role of anesthesia on surgical mortality.[2] The interpretation of the magnitude and source of anesthetic risks has been controversial. A common view[3,4] is that anesthesia risk should be zero because anesthesia is not itself therapeutic, and "anesthetic agents themselves are not lethal except when they are misused."[4] This view was challenged[5] by Keats on the grounds that anesthetic and adjuvant drugs are potent and have complications both known and idiosyncratic. However, Hamilton[9] responded that management of these drug responses "is the essence of the practice of anesthesia and is an important area in which anesthesia differs from other specialities." Studies[6–10] of anesthetic-related mortality have not conclusively shown the exact contribution of anesthesia to perioperative deaths. No comprehensive prospective study of anesthetic mortality will probably ever be undertaken in the United States, because medical-legal considerations stifle confidential inquiry.[10] More recently, empirical investigations of "near misses"[11–16] have attempted to determine the causes of anesthetic mishaps independent of the occurrence of actual patient injury. These investigations have suggested that many mishaps are due to human error rather than equipment failure, and are therefore "discoverable"[17] and "preventable."[11–13] Extrapolation from these studies suggests that, of the 2,000–10,000 deaths annually attributable to anesthesia in the United States, approximately half are preventable.§

The Normal Accidents Model

WHAT IS PREVENTABLE IN PRINCIPLE IS NOT NECESSARILY PREVENTABLE IN PRACTICE

The accident at Three Mile Island (TMI), and more recently the Challenger explosion, Bhopal disaster, and Chernobyl incident have brought greater public attention to the areas of human factors and accident prevention. A new view of accidents and risks, which grew out of an analysis of the events at TMI, has been introduced by the organizational theorist Charles Perrow.[18] He notes that accidents continue to occur, despite both powerful incentives to prevent them, and the existence of multiple technological and operational fail-safe systems. Perrow terms this phenomenon "normal accidents" or "system accidents," suggesting that "in certain systems multiple and unexpected interactions of failures are inevitable."[18] System accidents are different than simple component failure accidents, in that they involve unanticipated interactions of multiple failures. Thus, a system designed to correct routine single equipment failures or human errors may be incapable of handling more complex mishaps. The analysis which Perrow applies to nuclear power, spaceflight, aviation, chemical manufacturing, and shipping applies equally to anesthesiology.

Characteristics of Systems Predisposing to System Accidents

The two key elements which make a system vulnerable to system accidents are *complexity of interactions* and *tightness of coupling* between components. Systems combining these elements will likely have accidents despite the efforts to avoid them.

COMPLEXITY OF INTERACTIONS

Routine interactions are those which are expected in familiar sequence, and those that are quite visible even if unplanned. "Complex interactions are those of unfamiliar sequences or unplanned and unexpected sequences, and are either not visible or not immediately comprehensible."[18] We extend Perrow's analysis by identifying three types of complexity.

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Received from the Department of Anesthesia, Stanford University School of Medicine, Stanford, California; and the Anesthesia Service, Palo Alto Veterans Administration Medical Center, Palo Alto, California. Accepted for publication January 9, 1987.

Address reprint requests to Dr. Gaba: Anesthesia Service, 112A, Palo Alto VAMC, 3801 Miranda Avenue, Palo Alto, California 94304.

Key words: Complications: accidents. Human factors in anesthesia. Risk management.

§ Deaths during general anesthesia: Technology-related, due to human error, or unavoidable? Technology for Anesthesia 5:1–11, 1985.

- 1987 Gaba et al.
- Many mishaps are due to human error rather than equipment failure
- Extrapolation suggests that, of the 2.000 – 10.000 deaths annually attributable to anaesthesia approximately half are preventable

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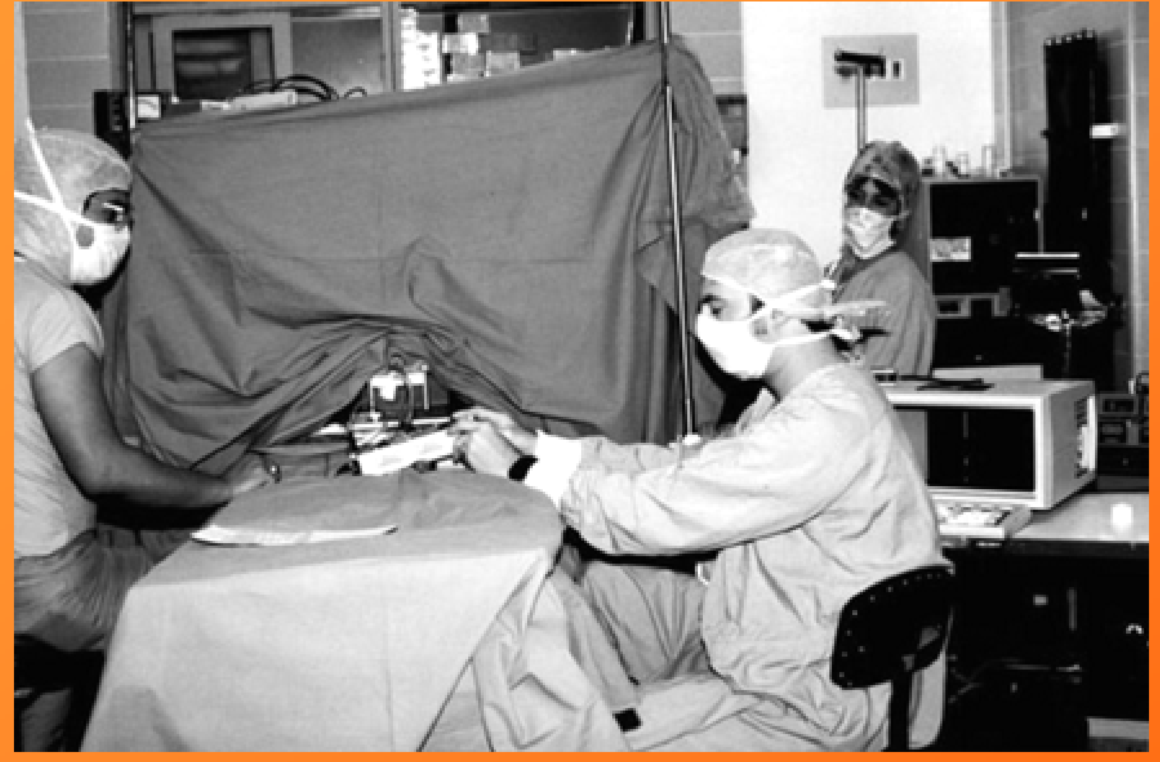
Simulators in anesthesia



David Gaba with CASE (comprehensive anesthesia simulation environment) and Medsim Eagle prototype, 1986

CRM in aviation

Accidents per 100,000 aircraft hours flown

14
12
10
8
6
4
2
0

1975 1980 1985 1990 1995

Year of occurrence

96 1997 1998 1999 2000 2001

Fatal Accidents

Chart 1. Number of accidents (top) and accident rates (bottom), 1975 through 1995. (See Chart 27 in the appendix.)

Errors in healthcare

- „to err is human“ IOM 2000
- “adverse events” bij 3 – 4% van alle stationair opgenomen Patiënten, waarvan in het gevolg 7 – 14% overleden
- De helft ervan wordt geweten aan medische fouten en was dus vermijdbaar
- “Human factors” in 70 – 80% verantwoordelijk voor menselijke fouten
- „onbedoelde schade in ziekenhuizen“ NIVEL 2007
- Het overlijden van 1735 patiënten had waarschijnlijk voorkomen kunnen worden
- 30.000 patiënten lopen schade op tijdens de behandeling, die voorkomen had kunnen worden

What do we want to improve?

- Technical skills
- Non-technical skills
- Procedures
- Workflow
- Resources and material
- Organisation

- Individual skills vs. team skills
- Mono- vs. multidisciplinary
- Low fidelity vs. high fidelity

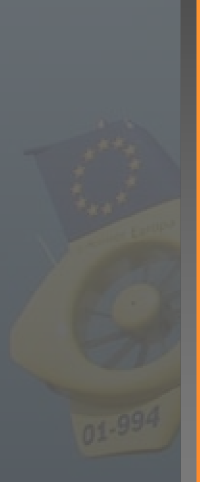
Where are the gaps?

- CIRS (critical incident reporting system)
- PRISMA (prevention and recovery information system for monitoring and analysis)
- RCA (root cause analysis)
- DIMS (decentraal incident melding systeem)
- Trip report
- Simulations
-
-

What offer existing trainingconcepts?

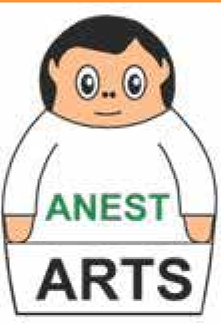
- Technical skill training
- PHTLS
- ETS
- Simulation
- CRM
- Teamtraining / teambuilding
- E-learning
-
-

Technical skill training



PHTLS

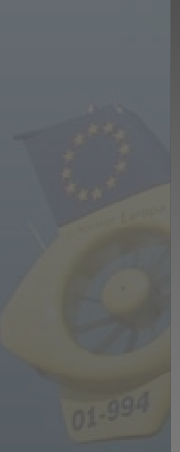
ETS



CRM theory

- CAP 737 Crew Resource Management
  - List of Effective Pages
  - Contents
  - Explanatory Note
  - Foreword
  - Acknowledgements
  - Glossary of Terms
  - Chapter 1 Introduction
  - Chapter 2 CRM History
  - Chapter 3 Requirements
  - Chapter 4 CRM Standards and Traini
  - Chapter 5 CRM Instructors (CRMI)
  - Chapter 6 CRM Instructor- Examiner
  - Chapter 7 Assessment of Flight Crew
  - Chapter 8 Evaluation of the Effectiven
  - Appendix 1 CRM Skills and Example
  - Appendix 2 Human Performance and
  - Appendix 3 Attention, Vigilance, Fati
  - Appendix 4 Information Processing
  - Appendix 5 Human Error, Reliability
  - Appendix 6 Situation Awareness
  - Appendix 7 Communication, Teamwo
  - Appendix 8 Automation
  - Appendix 9 Facilitation Skills
  - Appendix 10 Examination Skills
  - Appendix 11 Assessment of CRM Sk
  - Appendix 12 The "Short Guide"
  - Appendix 13 Miscellaneous CRM To
  - Appendix 14 Sources of Further Infor
  - Appendix 15 Summaries of Key Doc
  - Appendix 16 Standards Document 2

Simulation



Concept of training

Team NTS

Individual NTS

Technical skills

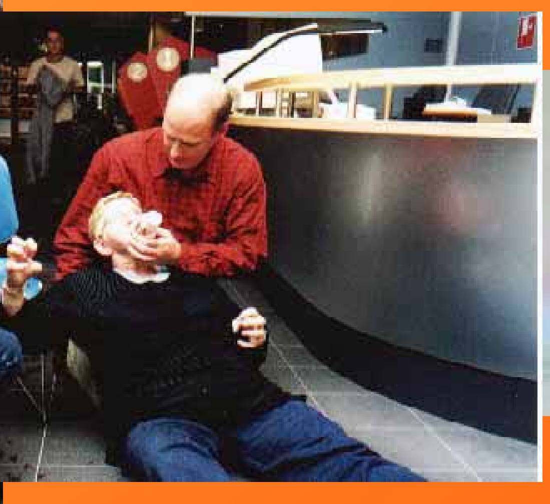
CRM trauma team training

- CRM theorie
  - Communication, stress and workload management, mistakes, leadership, problemsolving, decision making, situational awareness, mental models
- Scenario
  - Highfidelity, full scale, patient simulators, in situ
- Debriefing
  - Video feedback, debriefing, self assessment

Debriefing

- Technical skills
- Non-technical skills
- Self assessment
- Feedback
- Team skills
- Evaluation

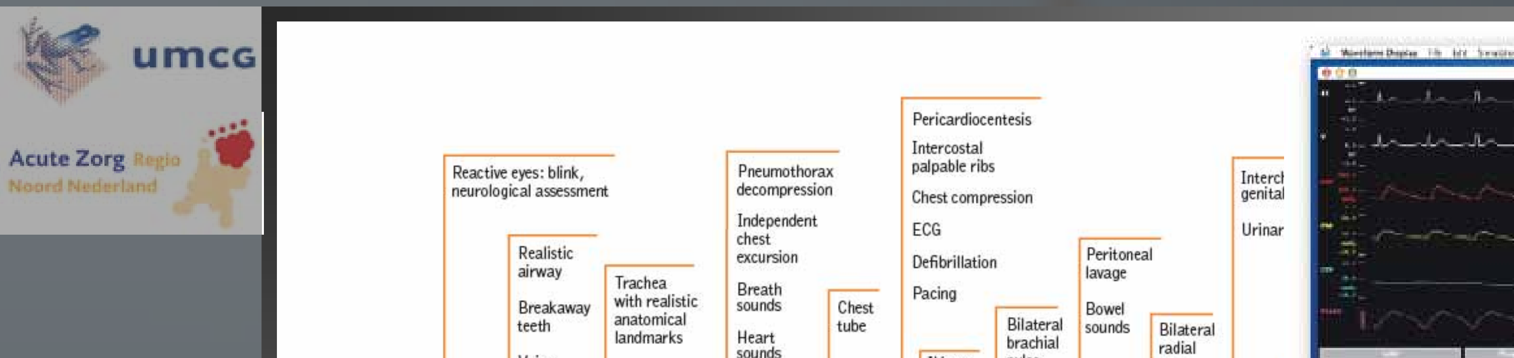
Scenarios



High fidelity

Low fidelity

Simulators



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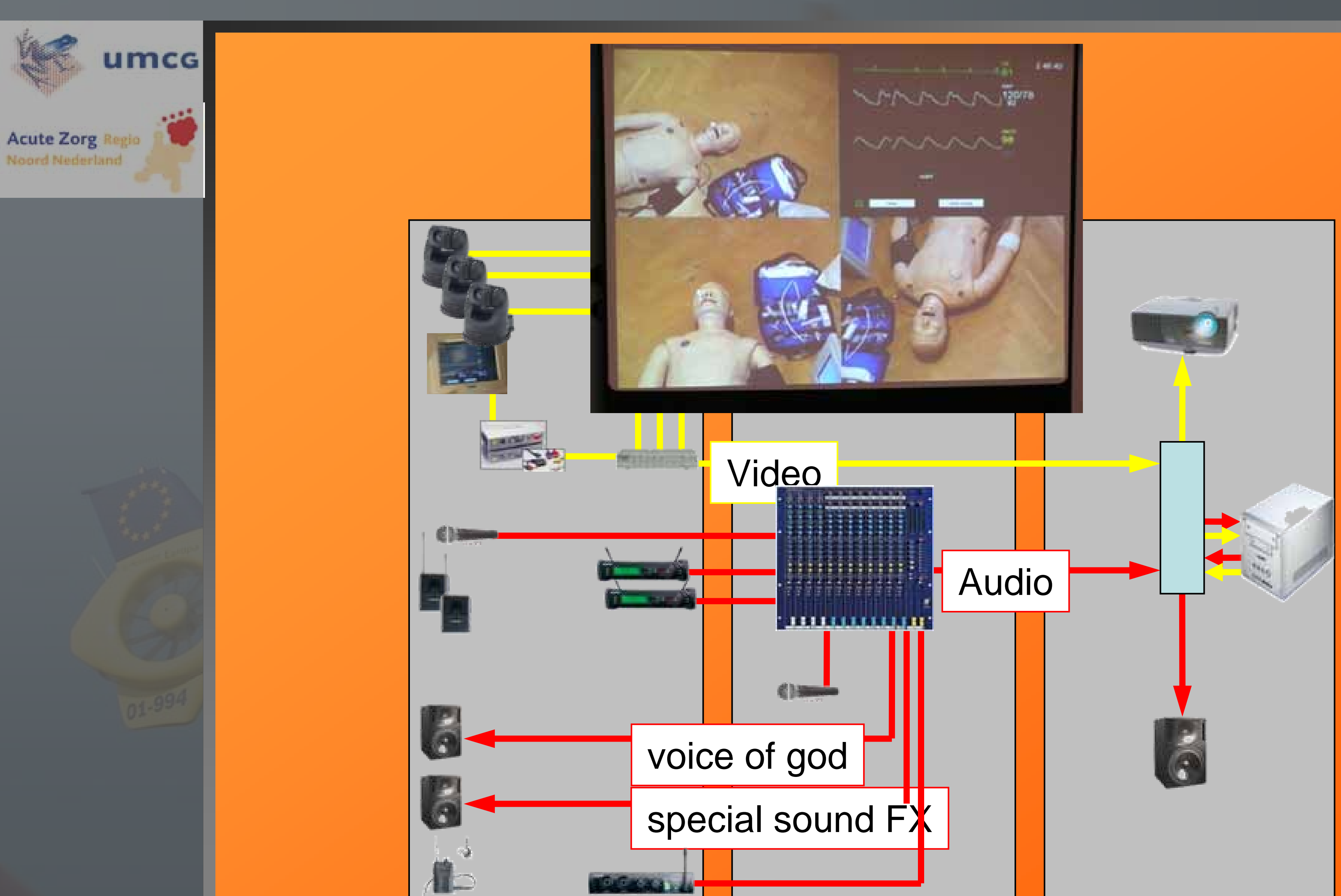
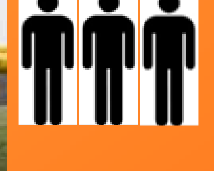
Video feedback

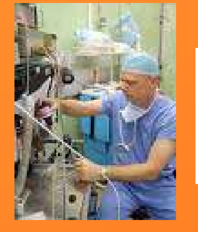


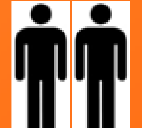
In situ training

Train where you work

(too) many actors







Surgeon Shoots During Operation
Anesthetist Dead ... Patient Faints

Rio de Janeiro...Reuters. A Brazilian surgeon shot a colleague, who was responsible for the anesthesia of the patient, during abdominal surgery. While this was happening on Monday. The patient awoke from anesthesia, and, on seeing the bloodbath, fainted.

The resident who was present attempted to save the life of the anesthetist then ended the abdominal operation. The surgeon was long gone over the mountain.

There was disagreement regarding the surgery between the two doctors, members of a private clinic at Macae, near Rio-de-Janeiro, where the operation took place.

During the dispute, the 60 years old surgeon, Marcelino Pereira da Silva, took out a revolver and put three shots into the head of Elimson Ribeiro Elias, aged 40. Search is on for the surgeon.

Source : Bob Helmreich, Hallifax symposium 2003

CRM in the OR

Development of a rating system for surgeons' non-technical skills

Table 2. NOTSS skills taxonomy v1.1

Category	Element
Situation Awareness	Gathering information Understanding information Projecting and anticipating future state
Decision Making	Considering options Selecting and communicating option Implementing and reviewing decisions
Task Management	Planning and preparation Flexibility/ responding to change
Leadership	Setting and maintaining standards Supporting others Coping with pressure
Communication and Teamwork	Exchanging information Establishing a shared understanding Co-ordinating team

Development of a rating system for surgeons' non-technical skills

S. Yule[1*], R. Flin[1], S. Paterson-Brown[2], N. Maran[3], D. Rowley[4]

Anaesthetists' Non-Technical Skills (ANTS) System Handbook v1.0

ANTS System v1.0: Categories and Elements

Category	Elements
Task Management	• Planning and preparing • Prioritising • Providing and maintaining standards • Identifying and utilising resources
Team Working	• Co-ordinating activities with team members • Exchanging information • Using authority and assertiveness • Assessing capabilities • Supporting others
Situation Awareness	• Gathering information • Recognising and understanding • Anticipating
Decision Making	• Identifying options • Balancing risks and selecting options • Re-evaluating

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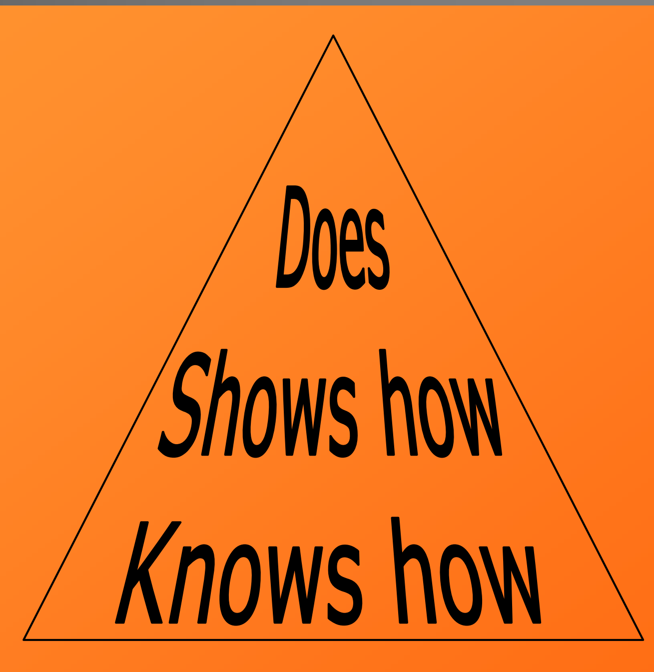
CRM + simulation = happily ever after?

Simulation in EMS

- Train and evaluate skills under realistic circumstances
- Approach to NTS
- Testing new material and procedures
- Addressing operational and patient safety relevant issues



Pitfalls

- Maintenance
- Train the trainer
- Safe learning environment
- Implementation in work practice
- Simulations as examination tool

Where are we going to?

- Targeted training combining TS and NTS using different classes of simulators
- ‘closed loop’ training
- Evaluation of equipment, SOPs, workflow in simulated environment
- Multidisciplinary team training
- In situ training / train as you work
- Genuine healthcare approach towards safety issues
- Simulation network

Thank you very much for your attention