‘Trauma Resuscitation & Computerized Prompts'

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Trauma Reception & Resuscitation Project

Evidence of error in trauma management

- Research findings have demonstrated that it is difficult to measure the impact of a single intervention in a complex, non-standardized environment with multiple variables.

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Evidence of error in trauma management

- For the seriously injured patient, trauma reception and resuscitation requires a great number of management decisions in a short space of time.
- The Emergency Department/Trauma Centre phase of care is responsible for the greatest number of errors – a mean of 7.52 per patient! Errors also contribute to preventable morbidity - including aspiration pneumonia, sepsis, ARDS - and prolonged ICU and hospital lengths of stay[1].

1 McDermott FT, Cordner SM, Tremayne AB. Evaluation of the medical management and preventability of death in 137 road traffic fatalities in Victoria, Australia: an overview. Consultative Committee on Road Traffic Fatalities in Victoria. *J Trauma*. 1996 Apr; 40(4): 520-33.

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Why?

- The major variable in resuscitation relates to human factors.
- It is time for a new approach - we need to standardize decision making and reduce errors by introducing real-time decision support to minimise human factors.

Clinical algorithms and point of care computer technology

- In an attempt to improve outcomes and establish a standardized environment, algorithmic approaches to trauma resuscitation have been introduced (e.g. EMST/ATLS).
- Although reviews demonstrate improvements, compliance with algorithms is rarely measured in real-time. Recognition of preventable error is often retrospective rather than real-time.

Clinical algorithms and point of care computer technology

Computerized prompts are built into flight-control systems providing immediate feedback and error avoidance

Computer-based decision aids have been shown to improve care and potentially improve outcome

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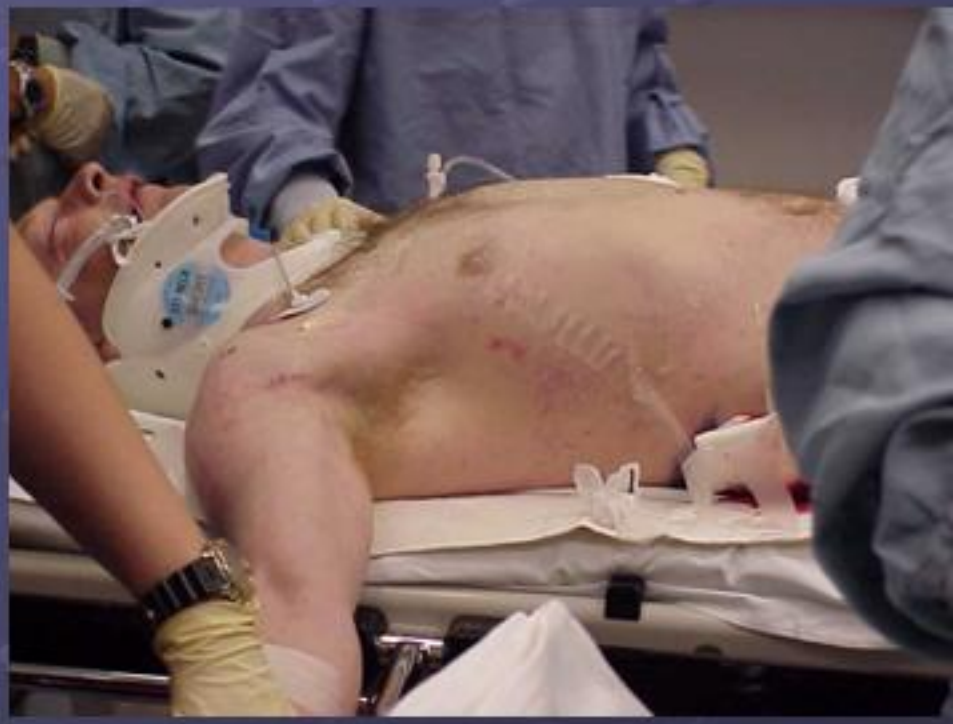
- The most rigorous application of algorithms in clinical decision making involves rule-based computer systems.



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- Clinical algorithms using a branch tree logic approach have been used since the early 1980's to determine fluid resuscitation.
- These algorithms have improved the outcome in hypotensive patients in the Emergency Department, and in patients with blunt and penetrating injuries of the thorax and abdomen.

Shoemaker W. Resuscitation algorithms in acute emergency conditions. Textbook of Critical Care. Edited by Ake Grenvik, Stephen M Ayres, Peter R Holbrook and William C Shoemaker. Fourth Edition WB Saunders Philadelphia 2000 p49-59

Velmahos GC. Demetriades D. Shoemaker WC. Chan LS. Tatevossian R. Wo CC. Vassiliu P. Cornwell EE 3rd. Murray JA. Roth B. Belzberg H. Asensio JA. Berne TV. Endpoints of resuscitation of critically injured patients: normal or supranormal? A prospective randomized trial. Ann Surg. 232(3):409-18, 2000 Sep.

- Bedside (point of care) computerized protocols to standardize clinical decisions for mechanical ventilation of patients with adult respiratory distress syndrome have been in use since 1992.

East TD, Bohm SH, Wallace CJ et al. A successful computerized protocol for clinical management of pressure control inverse ratio ventilation in ARDS patients Chest 1992 101:697-710

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- Bedside computers allow immediate bedside information about clinical algorithms, drug doses, patient alerts, trends in monitoring data, automated physiological event detection and alerting

Bates DW. O'Neil AC. Boyle D. Teich J. Chertow GM. Komaroff AL. Brennan TA. Potential identifiability and preventability of adverse events using information systems. J Am Med Inform Assoc. 1(5):404-11, 1994 Sep-Oct.

Norris PR. Dawant BM. Closing the loop in ICU decision support: physiologic event detection, alerts, and documentation. Proceedings / AMIA ... Annual Symposium. :498-502, 2001.

therefore…

- We need to re-focus on the **first 30 minutes** of trauma reception and resuscitation and establish uniform algorithms with a temporal hierarchy for trauma resuscitation.
- We need to guide compliance with real-time, computer generated prompts linked to real-time data collection. Video audit will verify compliance and error rates.

VTF and Alfred funded Au $1,672,199 ~ US $1,304,315 over 30 months

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Project Goals - Primary

- 1) The development of evidence-based algorithms for trauma resuscitation.
- 2) The development of real-time, computer aided, data collection during trauma resuscitation.
- 3) Testing the hypothesis that the introduction of real-time, computer-prompted algorithms will result in a measurable reduction in management errors associated with reception and resuscitation of major trauma patients.
- 4) Demonstrate that a reduction in management errors translates into a reduction in morbidity and mortality.

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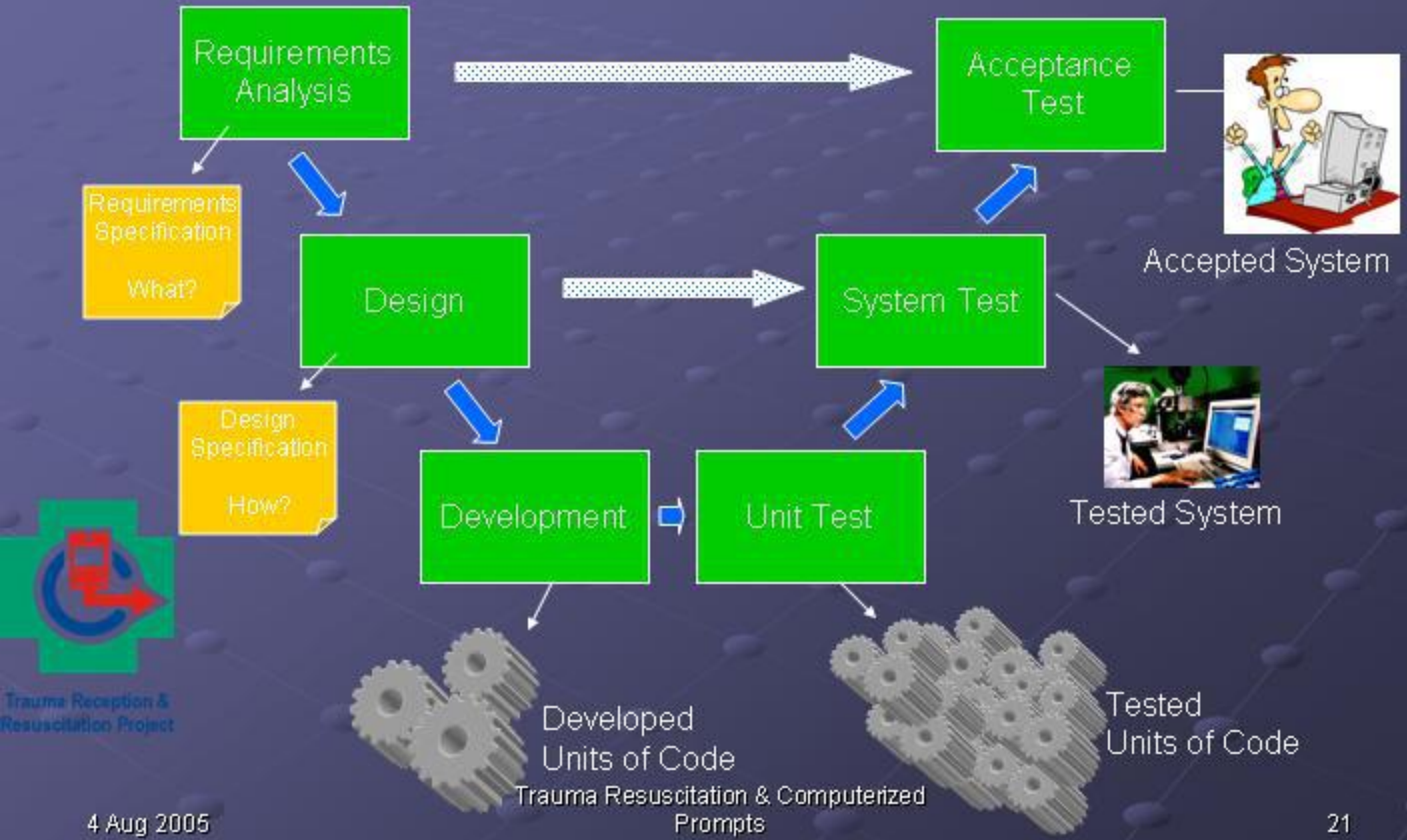
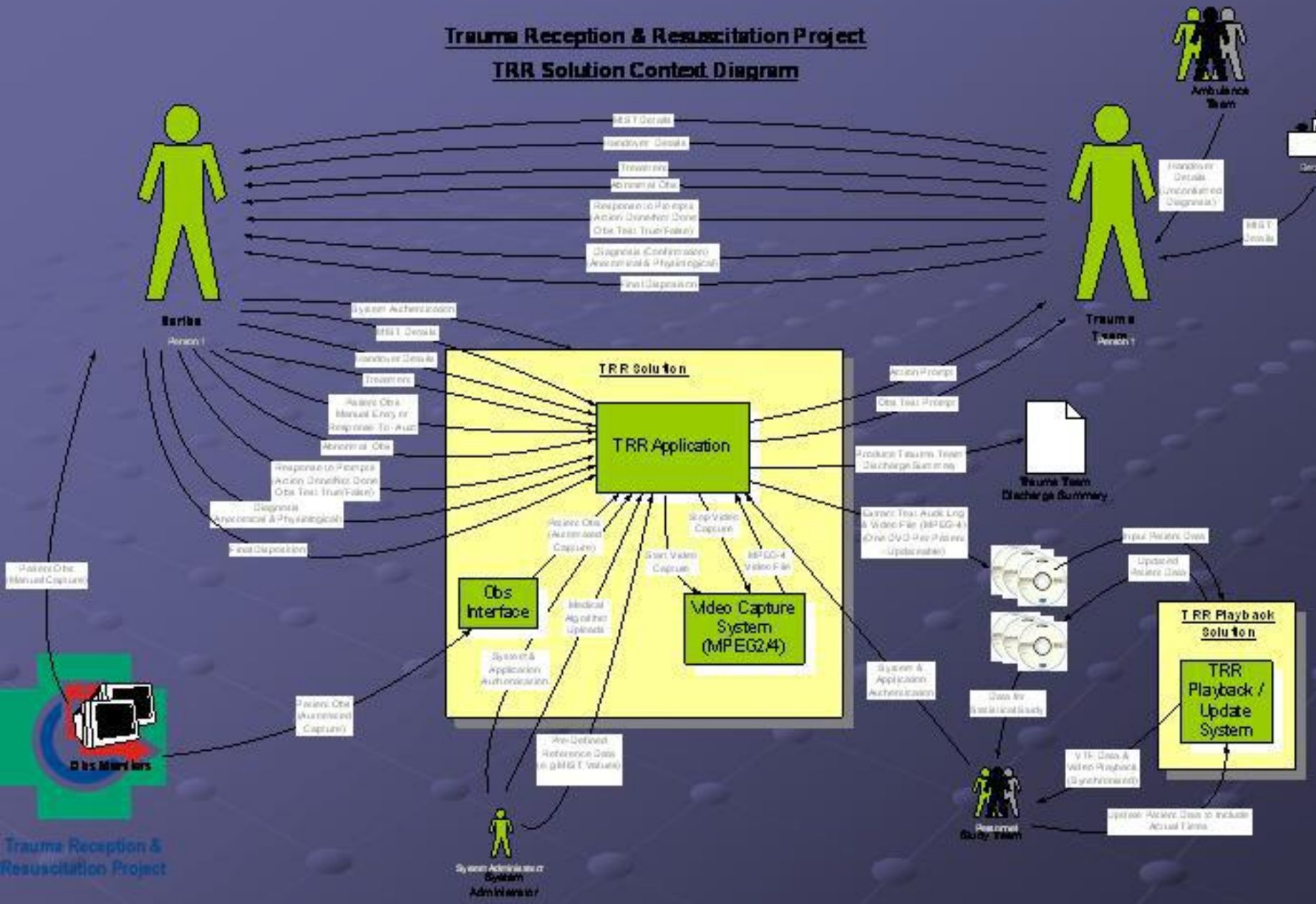
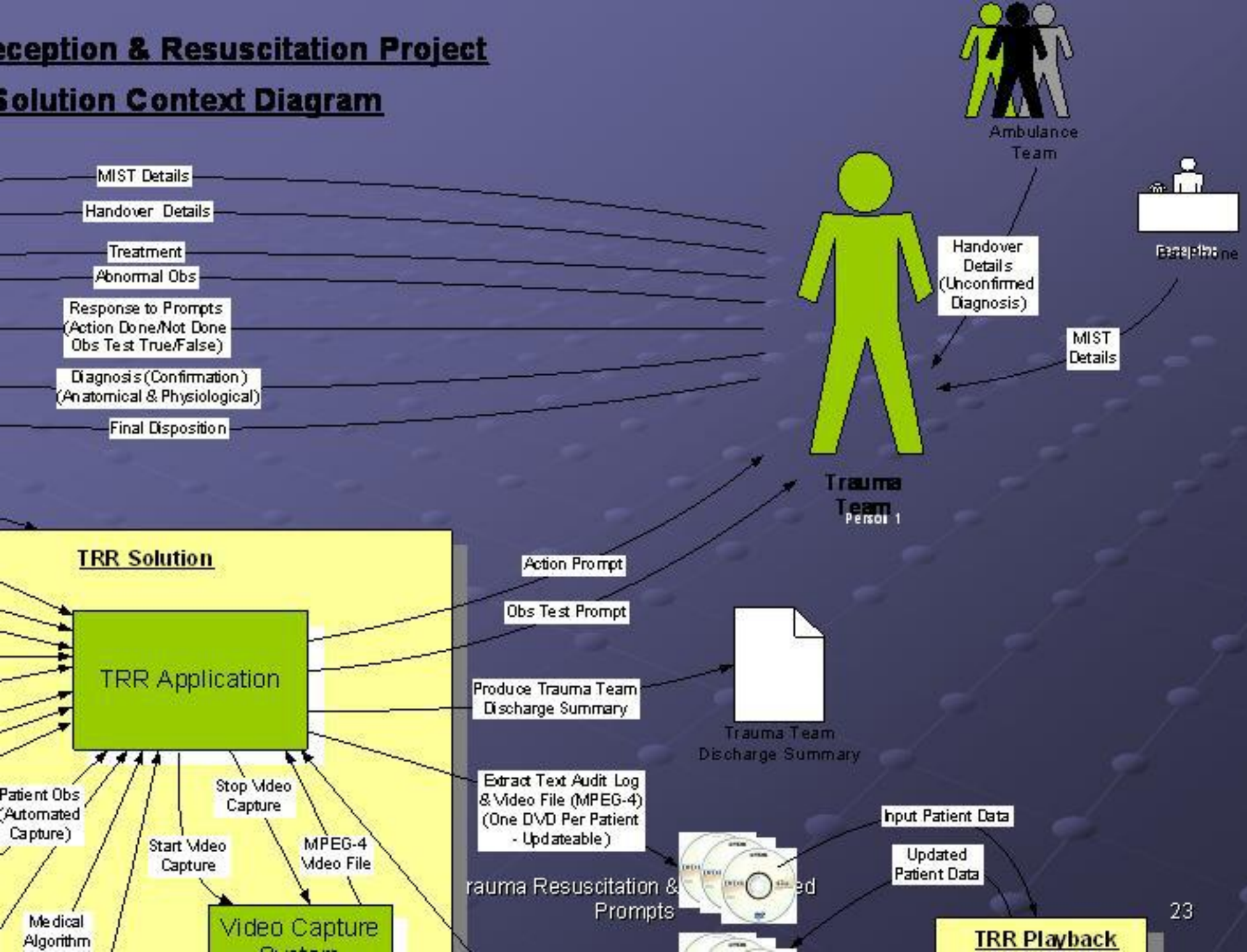
Software Development Lifecycle




Trauma Reception & Resuscitation Project
TRR Solution Context Diagram
Ambulance Team
Reception
Trauma Team
Person 1
TRR Solution
TRR Application
Obs Interface
Video Capture System (MPEG2/4)
Trauma Team Discharge Summary
TRR Playback Solution
TRR Playback / Update System
Obs Monitors
System Administrator
Trauma Reception & Resuscitation Project

ception & Resuscitation Project

olution Context Diagram



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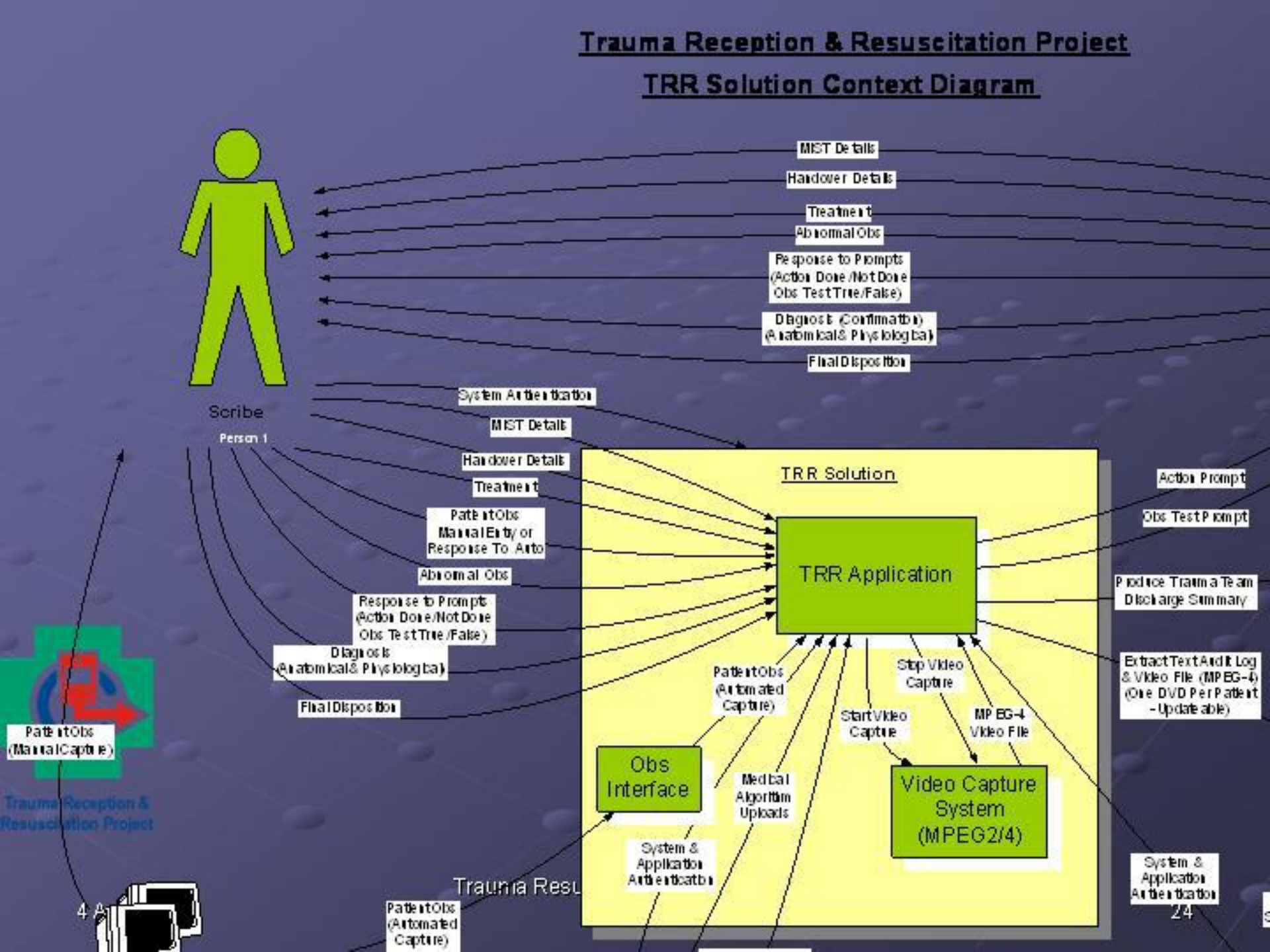
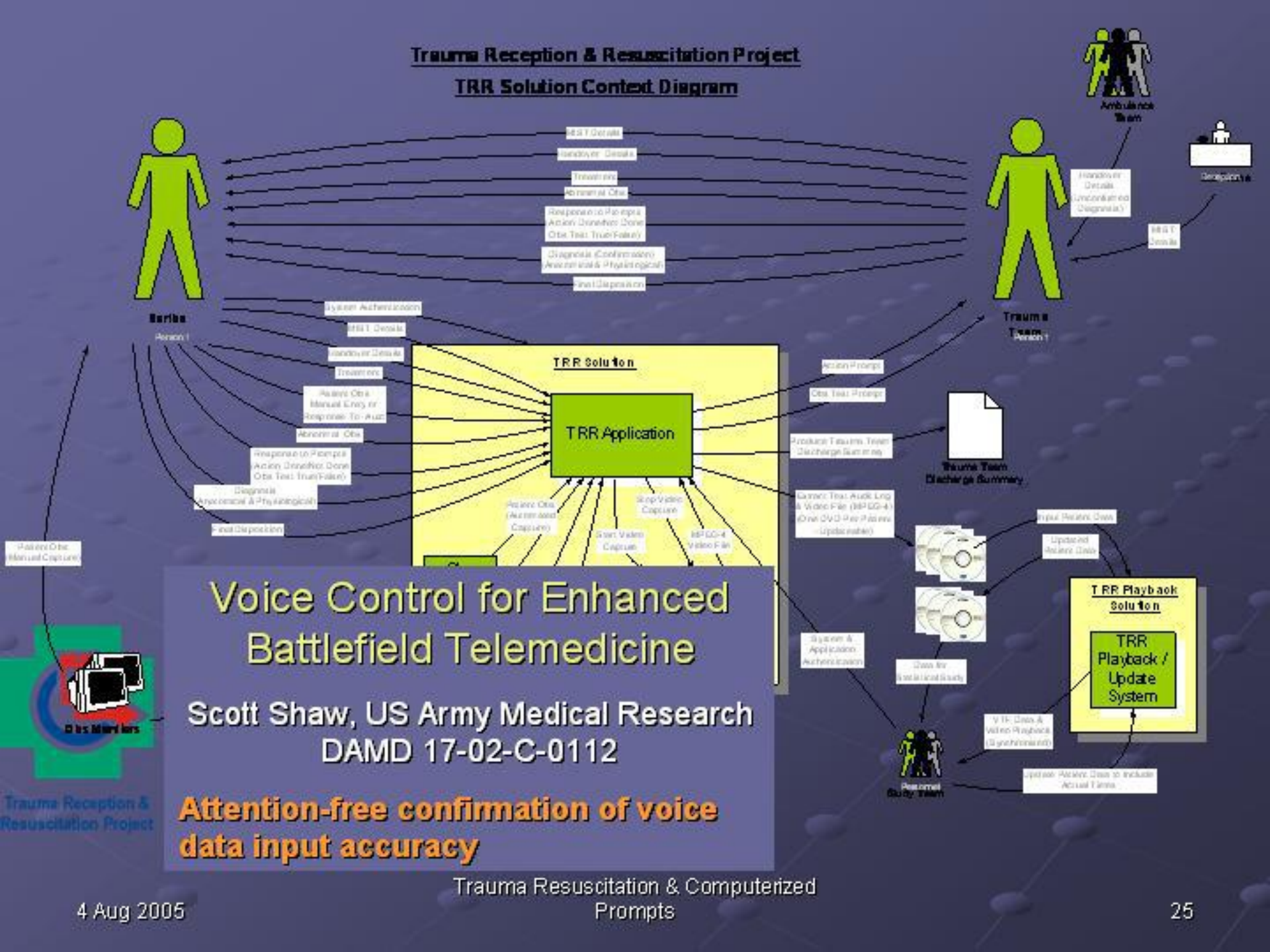
TRR Solution Context Diagram

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TRR Solution Context Diagram
Ambulance Team
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Trauma Team Discharge Summary
TRR Playback Solution
TRR Playback / Update System
Voice Control for Enhanced Battlefield Telemedicine
Scott Shaw, US Army Medical Research
DAMD 17-02-C-0112
Attention-free confirmation of voice data input accuracy
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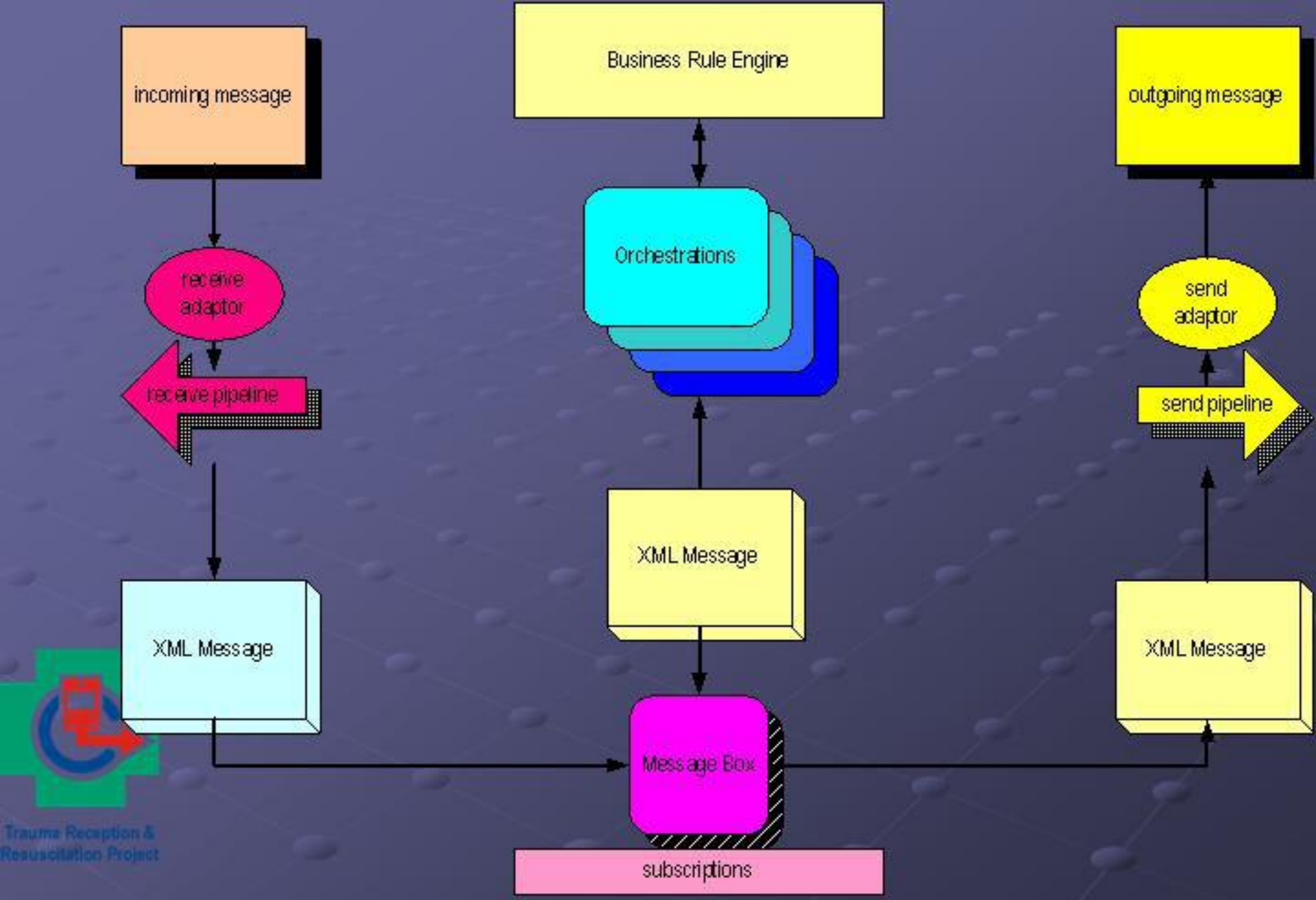
Business Rule Engine
incoming message
outgoing message
Orchestrations
receive adaptor
send adaptor
receive pipeline
send pipeline
XML Message
XML Message
XML Message
Message Box
subscriptions

Business Rule Engine

Business Rule Engine = Decision Support Algorithms

Most of the evidence related to trauma resuscitation outcome is Level IV and at best III-2[1].

1 NHMRC 1999. IV – Evidence obtained from case series
III-2 – Comparative studies with concurrent controls

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- **Signs**
  - are airway reflexes present? is air entry unequal?
- **Diagnoses**
  - pericardial tamponade
- **Physiological parameters**
  - RR>8, SpO2>90, systolic BP>100 & <70
- **Treatments**
  - ICC insertion

'World Report on Road Traffic Injury Prevention',
World Health Organisation / World Bank, 2004.

More than 1.2 million people are killed on the road annually and 20 to 50 million more are injured or disabled

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Algorithm Development

Mark Fitzgerald AD1.1

- yes / positive
- no / negative

'Physiologic measure' that precipitates a 'Treatment'
this is derived from Pulse, BP (systolic), RR, GCS, SpO2 or EtCO2)

'Diagnosis' - unconfirmed

'Diagnosis' - confirmed

'Sign' that precipitates a 'Diagnosis' or 'Treatment'

'Treatment'

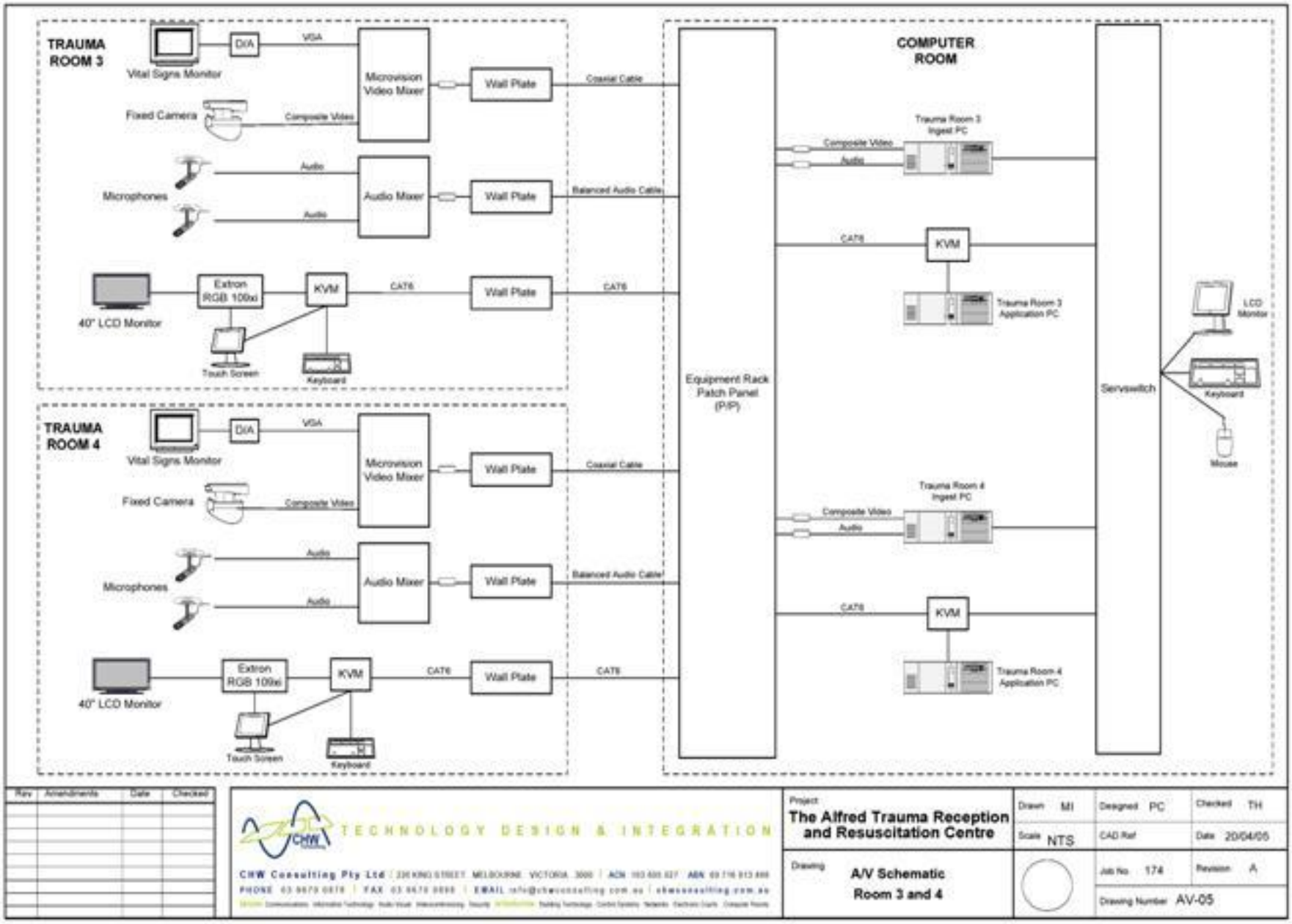
Algorithm development stems from key 'triggers'.

A "Physiologic measure" (e.g.. SpO2 < 90, or BP < 100) at any time during the first 30 minutes of reception and resuscitation may prompt an algorithmic response using a "Sign" (e.g.. is air entry equal?) or other physiologic measures (e.g.. SpO2 < 90 - Is RR < 10?) resulting in a "Diagnosis" and "Treatment".

A "Diagnosis" may prompt an algorithmic response (with or without physiologic measures) resulting in a "Treatment" (Requirements Specification Version 1.0 pp 53-57).

A "Sign" describes a key clinical finding (e.g. are airway reflexes present? Is air entry equal?) which lead to "Diagnosis". or "Treatment" based on associated "Physiologic measure" (Requirements Specification Version 1.0 p 56).

A "Treatment" describes a pre-defined clinical intervention (Requirements Specification Version 1.0 pp 56-58).


TRAUMA ROOM 3
Vital Signs Monitor
DIA
VGA
Microvision Video Mixer
Wall Plate
Coaxial Cable
Fixed Camera
Composite Video
Microphones
Audio
Audio Mixer
Balanced Audio Cable
40" LCD Monitor
Extron RGB 109xi
KVM
CAT6
Touch Screen
Keyboard
TRAUMA ROOM 4
COMPUTER ROOM
Equipment Rack Patch Panel (P/P)
Trauma Room 3 Ingest PC
Trauma Room 3 Application PC
Trauma Room 4 Ingest PC
Trauma Room 4 Application PC
Servswitch
LCD Monitor
Mouse
Rev
Amendments
Date
Checked
TECHNOLOGY DESIGN & INTEGRATION
CHW Consulting Pty Ltd
Project
The Alfred Trauma Reception and Resuscitation Centre
Drawing
A/V Schematic Room 3 and 4
Drawn MI
Designed PC
Checked TH
Scale NTS
CAD Ref
Date 20/04/05
Job No 174
Revision A
Drawing Number AV-05

Audit

Split screen - AV with vital signs monitor overlay and LCD display

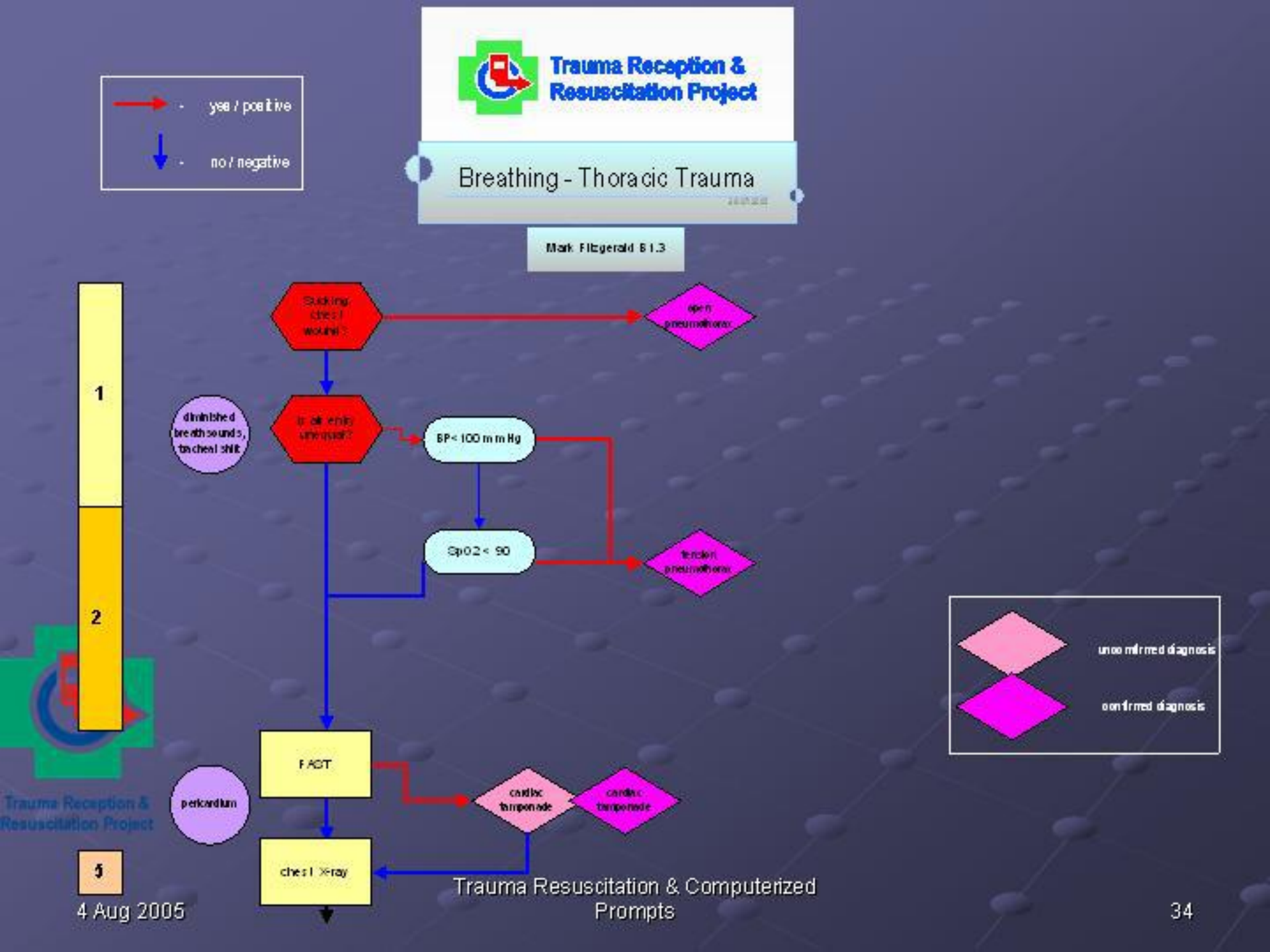
Automated DVD/RW labeler (Rimage 2000i DVD/CD Archiver)

Temporal hierarchy of physiological measures, diagnoses, signs and treatments.

e.g. BP <100, RR>8, SpO2>90, air entry is not unequal

vs

BP >100, RR>8, SpO2>90, air entry is not unequal


yes / positive
no / negative
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Breathing - Thoracic Trauma
Mark Fitzgerald 8.1.3
1
2
diminished breathsounds, tracheal shift
BP< 100 mm Hg
SpO2 < 90
FAST
pericardium
cardiac tamponade
cardiac tamponade
chest X-ray
5
unconfirmed diagnosis
confirmed diagnosis

Start of Stage 3

Validated Algorithms

Accepted System

Implementation of Investigation (Implementation Phase)

Outcomes to be measured

- The Primary outcome variable will be the error rate per patient treated demonstrated by deviation from the algorithms.
- Secondary outcomes measured will be missed injuries and time to decision (time to endotracheal intubation, time to chest decompression, time to first blood product, time to CT scan, and time to theatre).
- This analysis will be performed on the historical control group, the study group and the control group for comparison purposes.
- Patients will be followed for aspiration pneumonia, sepsis, ARDS, FIM score, ICU and hospital length of stay and death. This follow-up will be limited to the admission following their initial trauma presentation. Death will be defined as the coding of patient death on the patient's hospital records. Multi-organ failure will be defined using the criteria of APACHE II.

Will real-time decision support standardize decision making and improve patient outcome by reducing errors due to human factors?

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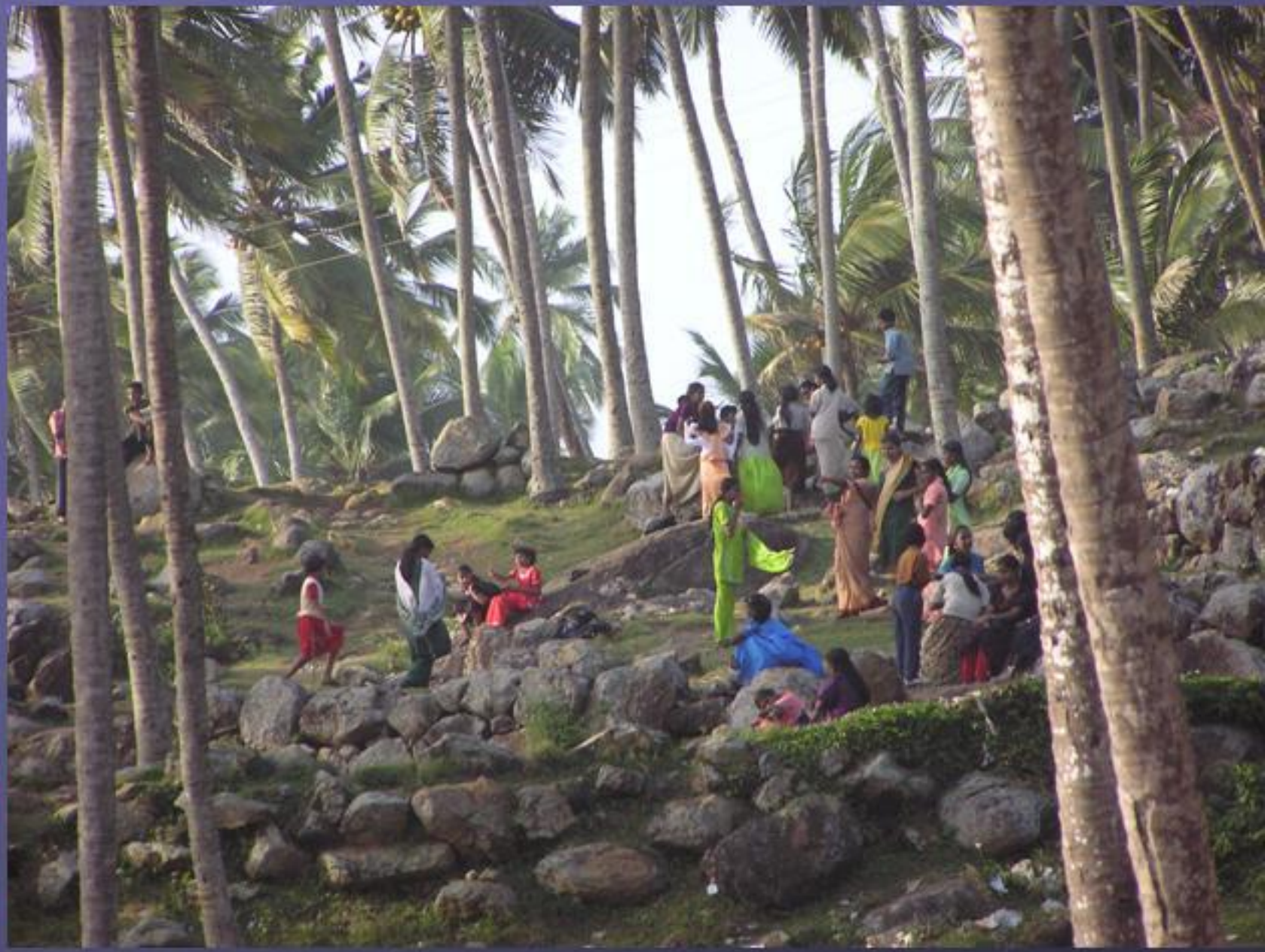

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Fatality Reduction

- Prevention 60%
- Emergency care 20%
- Non-preventable 20%

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When is the major trauma patient most at risk from preventable morbidity/mortality?

- 55% of preventable trauma deaths occur during the Emergency Department/Trauma Centre phase of resuscitation.

Trauma Reception

- The role of the trauma team is to provide organisation out of chaos
- Most of the errors arising during reception relate to resuscitation

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