'Trauma Resuscitation & Computerized Prompts'

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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.
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\(^1\).

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


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.

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


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.

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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.
Software Development Lifecycle

1. Requirements Analysis
2. Design
3. Development
4. Unit Test
5. System Test
6. Acceptance Test

- Requirements Specification: What?
- Design Specification: How?

- Developed Units of Code
- Tested Units of Code

- Accepted System
- Tested System

4 Aug 2005
Trauma Reception & Resuscitation Project
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
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.
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

More than 1.2 million people are killed on the road annually and 20 to 50 million more are injured or disabled.
'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).
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
Breathing - Thoracic Trauma

1. Diminished breath sounds, tachypnea
   - yes / positive
   - no / negative

2. In all cases univocal?
   - yes / negative
   - no / positive

3. BP < 100 mmHg
   - yes / positive
   - no / negative

4. SpO2 < 90
   - yes / positive
   - no / negative

5. FACT
   - yes / positive
   - no / negative

6. Cardiac tamponade
   - yes / positive
   - no / negative

7. Cardiac tamponade
   - yes / positive
   - no / negative

8. Chest X-ray
   - yes / positive
   - no / negative

9. Trauma Resuscitation & Computerized Prompts

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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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Fatality Reduction

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

We've given how much fluid?