Trauma Care: A Continuum of Care

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Trauma is like any disease except

Causative agent is Energy

Higher the acute transfer of energy, greater is the damage

Acute rupture of a great vessel  = dramatic death
Rupture of intestines may take 48 hrs. to manifest peritonitis.
Trauma Care:
A Continuum of Care

From the time of impact the injury patient is evolving physiologically and coping mechanisms of the body are responding successfully or unsuccessfully to the situation

Trauma Care:
A Continuum of Care

The outcome varies depending on
Severity of Trauma
Age of the victim,
Co-morbidities,
Time to treatment,
Type and appropriateness of care given,
Level of support given for rehabilitation
Including psychological support, and
Integration back into primary job and back into society
Trauma Care:  
A Continuum of Care

Trauma patient needs a continuum of care

- Recognition
- Transfer to emergency room
- Repeat primary assessment
- Appropriate diagnostics
- Definitive management
- Continuous monitoring for evaluation
- Rehabilitation

Trauma Care:  
A Continuum of Care

Depending on the need, type of technology and skills

- Different specialties evolved over the years
  - Each in its own compartment
A team approach is most important for trauma care
Trauma Care: A Continuum of Care

Prehospital care is care until definitive care

Historically prehospital care evolved in the battlefield
“Flying ambulance” was conceived by
Dominique Jean Larrey, Napolean’s Surgeon, 1792

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Prehospital care continues to evolve in the battlefield. The Tactical Combat Casualty Care (TCCC) a set of best-practice prehospital trauma care guidelines customized for use on the battlefield.


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Currently Prehospital care is pushed for by national and international agencies to provide immediate care for the injured on roads and the civilian battlefield.
A vast amount of technology has evolved around Prehospital care interventions.

What are the evidences in the use of these?

Over the years different protocols have evolved for the care of the injured.
Historically the concepts that form part of modern prehospital care has evolved over a period of 60 – 70 years.
1966
- Use of Normal Saline
- Use of Hypertonic Saline
- Tracheal injury
- Retropitoneal hematoma
- DPL

1976
- ICP monitoring
- ECMO for ARDS
- Splenic scans
- MAST

1991
- "Hypotensive" resuscitation
- APACHE 2 score
Trauma Care: 
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Emergency Care protocols
- Basic Life Support (BLS)
- Advanced Life Support (ALS)
- Advanced Trauma Life Protocols (ATLS)
- Prehospital Trauma Care Protocols(PHTLS)

Each of these with a different level of expertise, skills and technology available

German S3 Guidelines

Treatment of Patients with Severe and Multiple Injuries by lead German Trauma Society in association with 10 other German surgical societies including The Radiology Society of Germany

Recommendations were approved with “strong consensus” (agreement of > 95% of participants)
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The traditional response paradigm of **sequential response** and scene entry by law enforcement, first responders, and emergency medical service (EMS) personnel produced delays in care and suboptimal victim outcomes.


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Access

**Universal access phone number** like 911
Not implemented across countries and even within states
Lack of unified number globally

911, 112, 15, 18, 108.....

Multiple numbers in most LICs
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Triage

Sorting patients for care as per their injury severity

Triaging can be difficult and challenging in Early and the evolving phase of trauma consequence

Three phases of triage

Prehospital triage on information
Triage at scene by the first medical person reaching
Triage on arrival at emergency department or receiving hospital

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CDC Triage Criteria (2009)
Transport to a trauma center if any of the following:
- Glasgow Coma Scale of <14,
- Systolic BP <90,
- Respiratory rate <10 or >29 breaths/Minute

1. All penetrating injuries to head, neck, torso, and extremities prox. to elbow and knee;
2. Flail chest
3. two or more proximal long-bone fractures;
4. crushed, degloved, or angled extremity;
5. amputation proximal to wrist and ankle;
6. pelvic fractures;
7. open or depressed skull fracture; or
8. paralysis

• Triage Based on Mechanism of injury

High-Risk Auto Crash –
- Intrusion of >12 Inches at Occupant Site
- or >18 Inches at Any Site:
- Ejection (Partial or Complete) from Automobile,
- Death in Same Passenger Compartment:
- Auto Versus Pedestrian/Bicycle Thrown, Run Over,
- Significant (>20 mph) Impact:
- Motorcycle Crash >20 mph:
- Elderly and those on anticoagulants/ bleeding disorders

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A story.....
Trauma Care: A Continuum of Care

FAST was done soon after arrival

Focused Abdominal Scan for Trauma
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Key components of the Pre-hospital component focus on:
- ABC of Life Support
- Control of hemorrhage
- Protection of Spine
- Early transportation of the injured to a hospital

CPR Update

CPR guideline is changed from "A-B-C" (Airway, Breathing, Chest compressions) to "C-A-B" (Chest compressions Only)

Airway, Breathing) for adults. Also, "Hands-Only (compression only) CPR" is emphasized for the untrained lay rescuer

The Outcome of outside hospital Cardiac arrest in a traumatic patient is usually poor.

Mechanical CPR Devices

**No evidence** that mechanical CPR devices improve survival

They may worsen neurological outcome


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- Ventilatory strategies to mitigate lung injury can be initiated in the operating room, and
- Resuscitation must be effectively transitioned to the intensive care setting after surgery

*Tobin JM*, *Barras WP*, *Bree S* et al *Anesthesia for Trauma Patients, Mil Med*. 2018 Sep 1;183(suppl_2):32-35.
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A Continuum of Care

Uncontrolled haemorrhage is the leading cause of potentially preventable death.

Control of haemorrhage may represent the next major hurdle in reducing trauma mortality.
Pre-hospital Care

Physiology of Bleeding

• IV fluids
• Bleeding
• B P
• Severe vasoconstriction
• Local blood flow
• Facilities clot formation
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Intravenous Fluids
Used as a volume replacer for lost blood
ATLS(7th Ed) protocol recommended 1 – 2 Litres of Ringer’s in a severely injured patient.

Several reports show the lack of any benefit of intravenous fluids on injured patients


Pre-hospital care:
Evolution, practice, science and evidence

The European Guideline on Management of Major Bleeding and Coagulopathy following Trauma (fourth edition), S3 Guideline on Treatment of Patients with Severe and Multiple Injuries

In severely injured and bleeding trauma patients

Volume replacement level is advocated (permissive hypotension) until the bleeding is controlled.
ATLS principles with Hb, BE, and/or lactate can assess perfusion, estimate/monitor the extent of bleeding/shock, and guide therapy.

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What about drugs for prehospital care?

Most are pain killers

Narcotic death problem in the US
Tranexamic acid, 
Only effective drug to control bleeding.
(CRASH 2 trial)


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Tranexamic Acid
High-level evidence supports its use in trauma and
Offers a survival advantage to many patients,
particularly in Delayed cases


It is also recommended by the ATLS 10th Edition.
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Tranexamic Acid TXA was introduced to all emergency ambulances and emergency departments in the South West, UK, on 1 December 2011


First aid  First interventions done to a victim of trauma to protect his life and limb and to reduce suffering is called first aid.

Lay persons can provide valuable help by
  Calling for help,
  Getting the patient to a safer place and
  Positioning the patient and
  Splinting for Pain relief
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ALS Vs BLS
In a study done in Netherlands on TBI with GCS \( \leq 8 \)
Despite more on-site ALS
There was no reduction in mortality


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ALS Vs BLS
In a recent study
Patients with out-of-hospital cardiac arrest
BLS patients had higher survival at hospital discharge and at 90 days
Compared with those who received ALS

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Spine Clearance
Protocol has been to assume a spinal cord injury in a patient who is unconscious
Protect the spine in a paralysed patient or
Protect the spine in a conscious patient complaining of pain in the back

Cervical collars
Routinely applied in trauma patients with C spine Injury/ suspicion

Associated with:
- Unadjusted increased risk of mortality and
- Increased scene time in another study and
- Worsened neurological outcome

Spinal Cord injury
In neurological deficit patients, better to reach definitive care centres early on
Delay greater than 24h to reach a SCIU were 2.5 times more likely to develop a secondary complication

## Pre-hospital care

### TRANSPORTATION TIMES

<table>
<thead>
<tr>
<th>WAR</th>
<th>TRANSPORTATION TIMES</th>
<th>MORTALITY</th>
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</thead>
<tbody>
<tr>
<td>WW I</td>
<td>12-18 HRS</td>
<td>8.0%</td>
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<tr>
<td>WW II</td>
<td>6-12 HRS</td>
<td>4.5%</td>
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<tr>
<td>KOREAN</td>
<td>2-4 HRS</td>
<td>2.5%</td>
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<tr>
<td>VIETNAM</td>
<td>1.5 - 2 HRS</td>
<td>2.0%</td>
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</table>
## Pre-hospital care

### MEAN PREHOSPITAL TIMES FOUND IN SEVERAL STUDIES

<table>
<thead>
<tr>
<th>SITE</th>
<th>Response</th>
<th>Scene</th>
<th>Transfer</th>
<th>TOTAL</th>
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<td>5.32</td>
<td>15.6</td>
<td>11.7</td>
<td>32.06</td>
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<tr>
<td>WASHINGTON</td>
<td>12.3</td>
<td>24.9</td>
<td>19.4</td>
<td>58.08</td>
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<tr>
<td>ORANGE COUNTY CALIFORNIA</td>
<td></td>
<td>-</td>
<td>8.0</td>
<td>23.0</td>
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<td>DENVER</td>
<td>4.66</td>
<td>9.79</td>
<td>8.04</td>
<td>20.49</td>
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<tr>
<td>OHIO</td>
<td>4.6</td>
<td>-</td>
<td>-</td>
<td>20.00</td>
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<tr>
<td>BELFAST</td>
<td>4.57</td>
<td>4.96</td>
<td>4.83</td>
<td>14.36</td>
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</tbody>
</table>

*VR J. Surg (Feb 1992)*
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A Continuum of Care

In HICs 90% of patients are transported by ambulances. In LICs like India and Africa over 90% patients are transported in taxies, private cars and police vehicles.
Pre-hospital care

TRANSPORTATION

- Personal vehicles
- Taxies
- Police vehicles
- Air ambulances
- Boat ambulances

Delhi study on transportation mode used

<table>
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<tr>
<th>Mode</th>
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<th>2004</th>
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<tr>
<td>Taxi</td>
<td>13</td>
<td>29</td>
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<tr>
<td>Auto</td>
<td>34</td>
<td>42</td>
</tr>
<tr>
<td>Amb</td>
<td>43</td>
<td>19</td>
</tr>
<tr>
<td>PCR</td>
<td>14</td>
<td>33</td>
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<tr>
<td>Others</td>
<td>9</td>
<td></td>
</tr>
</tbody>
</table>
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A Continuum of Care

Speed of Ambulances and Early transportation of the trauma patient within first hour of trauma is highlighted by transportation in the ‘Golden Hour’.
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Speed is emphasised in the response of EMS services

Do we know the right speed?

Response time is taken as an outcome measure of an effective prehospital care.
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Transportation times of Ambulances

- Ambulances
- With sirens and flashing lights
- Mean saving of time
- In 50 trips 43.5 seconds

Richard Hunt, North Carolina

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In a study the mean time saved was 2.9 minutes in urban areas and 8.9 minutes in rural areas

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Ambulance crashes

From May 1, 2007 to April 30, 2009.
466 crashes examined
358 resulted in injuries and
99 persons were killed

Pre-hospital care

Higher incidence of fatal crashes during emergency use of ambulances

Trauma care a Continuum of care

The National transportation safety board (NTSB) ranks Helicopter emergency medical services as one of the most perilous occupations in USA.

1998 – 2012

139 Crashes
120 Killed
146 seriously injured

Habib AF Journal of Trauma, 77(6);989- 993, 2014
Advances in Prehospital care
without improving Hospital care
only shifts death from roadside to bedside

Trauma team concept evolved in the 1990’s
UK Trauma team

- Surgical and Ortho Registrar
- Anaesthetic registrar
- A&E SHO. Surgical HO
- A&E Staff Two Nurses, Porter
- Radiographer
- Operating Department asstt.


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How many low and middle income hospitals have Trauma teams?
Multiple Injury patients and Poly trauma patients need tertiary care

Where are these capacities in Low and Middle income countries?

Missed Injuries

High possibility in trauma
Depends on the time at which patient is seen

Need for repeated evaluations
Primary
Secondary
Tertiary...
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Missed injuries important issue in trauma patients

**Primary** and **Secondary surveys**, recommended by ATLS guidelines

**Tertiary survey** can minimise the number and effect of missed injuries

- The best available evidence demonstrates and favours tertiary survey in management of trauma patients

Hajibandeh, 2015, Meta-analysis of the effect of tertiary survey on missed injury rate in trauma patients, Injury 46 (12), 2474-2482

Trauma Care: A Continuum of Care

Clinical Decision Making

Cognitive
Integration of visual and verbal cues

Combined with complex motor skills
Clinical Decision Making

• Intuitive vs Analytical reasoning

• Actually a cognitive continuum

• Pattern Recognition

Heuristics: Cognitive shortcuts/ Rules of thumb

• Representativeness heuristics: pattern recognition

• Availability Heuristics: recall bias

• Anchoring Heuristics: estimating probability from familiar points

• Simplicity Heuristics: simplest explanation for the patients symptoms or findings (Occam’s Razor)

  Negative findings are often neglected
Trauma care a Continuum of care

Injury Phases

- Acute treatment phase: Emergency Care
- Rehabilitation phase: Gradually improving personal capacity
- Adaptation phase: Adjusting with the environment
- Stable end situation: No further change expected


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- Effective community reintegration is best achieved with a diverse interdisciplinary team.

- Recovery from polytrauma injuries is often a lifelong process, with the goal of maximizing functional independence

Trauma Care: A Continuum of Care

- Acute rehabilitation is particularly important in facilitating recovery, maximizing the effect of emergency and surgical services

- Preventing complications, and ensuring that the optimal functional outcome is achieved


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WHO guideline recognises

- Lack of evidence about benefits of advanced technology

- Lack of a system
Long term studies are essential to understand the long term and social implications of trauma.

This is rarely done as such studies are very expensive and difficult to do.

There is a need to evaluate Evidence Gap Maps (EGMs) in the area of emergency trauma care.
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A Continuum of Care

Policy, ethical and legal barriers to research in

**Article 5 of EU Directive 2001/20/EC** required consent before enrolment in a research study to ensure the autonomy of potentially incapacitated research subjects.


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Research

Many parameters change **minimally during the early stages**, and when they finally become abnormal,

**hypovolemic shock has already occurred.**

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Research

- The **compensatory reserve (CR)** is a parameter that represents a new paradigm for assessing physiologic status.

- It is the sum total of compensatory mechanisms that maintain adequate perfusion to vital organs during hypovolemia.

- When these mechanisms are overwhelmed, hemodynamic instability and circulatory collapse will follow.


---

**Compensatory Reserve Index** decreased by 97% in a linear fashion across progressive blood volume loss,

With no clinically significant alterations in vital signs.

Augmentation of negative intrathoracic pressure (nITP) with an **impedance threshold device** would improve hemodynamics **without** compromising permissive hypotension or causing hemodilution.


We are still struggling with Prehospital care

Evidence is only for early definitive care

Still need evidence for how early and how late

Evidence is only for BLS

Evidence is only for tranexamic acid in early care
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Until we have the evidence

Scoop and run
  with the injured to the nearest hospital
  with a trauma team

Give Tranexamic acid
  at the earliest

Trauma Care: A Continuum of Care

We need to Focus on **hospital care improvement**
  along with or even before prehospital care
Access to Free, publicly provided tertiary care is critical to saving lives

Multispecialty care; not just trauma care

Continuum of care from injury to recovery
Trauma Care:  
A Continuum of Care

Thank You

mathewvarghese.ms@gmail.com

<table>
<thead>
<tr>
<th>Month</th>
<th>No of cases</th>
<th>No admitted</th>
</tr>
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<tbody>
<tr>
<td>January</td>
<td>215</td>
<td>49</td>
</tr>
<tr>
<td>February</td>
<td>242</td>
<td>47</td>
</tr>
<tr>
<td>March</td>
<td>266</td>
<td>66</td>
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<tr>
<td>April</td>
<td>213</td>
<td>54</td>
</tr>
<tr>
<td>May</td>
<td>261</td>
<td>53 (57 with 4 Poisonings)</td>
</tr>
<tr>
<td>June</td>
<td>207</td>
<td>53</td>
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<tr>
<td>Sub Total</td>
<td>1404</td>
<td>326</td>
</tr>
<tr>
<td>Month</td>
<td>No of cases</td>
<td>No admitted</td>
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<tr>
<td>---------</td>
<td>-------------</td>
<td>-------------</td>
</tr>
<tr>
<td>July</td>
<td>211</td>
<td>54</td>
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<tr>
<td>August</td>
<td>193</td>
<td>61</td>
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<tr>
<td>September</td>
<td>30</td>
<td>07</td>
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<tr>
<td>October</td>
<td>134</td>
<td>43</td>
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<td>November</td>
<td>108</td>
<td>30</td>
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<tr>
<td>December</td>
<td>100</td>
<td>30</td>
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<tr>
<td><strong>SubTotal</strong></td>
<td><strong>776</strong></td>
<td><strong>229</strong></td>
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<td><strong>TOTAL</strong></td>
<td><strong>2180</strong></td>
<td><strong>505</strong></td>
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<table>
<thead>
<tr>
<th>Gender</th>
<th>Number of cases admitted</th>
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<tr>
<td>Male</td>
<td>359</td>
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<tr>
<td>Female</td>
<td>128</td>
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Figures till October 2011
<table>
<thead>
<tr>
<th>Type of injury</th>
<th>Number of cases admitted</th>
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<tbody>
<tr>
<td>Blunt</td>
<td>308</td>
</tr>
<tr>
<td>Penetrating</td>
<td>120</td>
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<tr>
<td>Unknown</td>
<td>56</td>
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Figures till October 2011

<table>
<thead>
<tr>
<th>Mechanism of injury</th>
<th>Number of cases</th>
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<tbody>
<tr>
<td>Motor vehicle accidents</td>
<td>39</td>
</tr>
<tr>
<td>Motorcycle accidents</td>
<td>74</td>
</tr>
<tr>
<td>Bicycle accidents</td>
<td>5</td>
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<tr>
<td>Pedestrians</td>
<td>19</td>
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<td>Other Traffic</td>
<td>8</td>
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<td>Firearm injury</td>
<td>1</td>
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<tr>
<td>Stab injury</td>
<td>5</td>
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<tr>
<td>Hit by a blunt Object</td>
<td>11</td>
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<tr>
<td>Low energy fall</td>
<td>40</td>
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<tr>
<td>High energy Fall</td>
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<td>Others</td>
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<td>Unknown</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>236</strong></td>
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<td>Intention of injury</td>
<td>Number of cases</td>
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<td>--------------------</td>
<td>-----------------</td>
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<tr>
<td>Accidental</td>
<td>250</td>
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<tr>
<td>Self inflicted</td>
<td>24</td>
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<tr>
<td>Assault</td>
<td>28</td>
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<tr>
<td>Others</td>
<td>20</td>
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<td><strong>Total</strong></td>
<td><strong>322</strong></td>
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<table>
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<tr>
<th>GCS in ER</th>
<th>Number of cases</th>
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<tr>
<td>1-3</td>
<td>8</td>
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<tr>
<td>4-7</td>
<td>9</td>
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<tr>
<td>8-11</td>
<td>13</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>306</strong></td>
</tr>
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</table>

(excludes 20 cases of poisoning)
<table>
<thead>
<tr>
<th>ISS</th>
<th>No of patients</th>
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<tbody>
<tr>
<td>&lt;15</td>
<td>255</td>
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<tr>
<td>15-25</td>
<td>31</td>
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<tr>
<td>26-35</td>
<td>7</td>
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<tr>
<td>&gt;35</td>
<td>1</td>
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<tr>
<td>Could not be determined (poisoning, NFS injury etc)</td>
<td>32</td>
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<table>
<thead>
<tr>
<th>Duration of Stay in Days</th>
<th>Number of patients</th>
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</thead>
<tbody>
<tr>
<td>1 - 5</td>
<td>173</td>
</tr>
<tr>
<td>6 – 10</td>
<td>76</td>
</tr>
<tr>
<td>11 – 15</td>
<td>31</td>
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<tr>
<td>16 – 20</td>
<td>10</td>
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<td>21 – 25</td>
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<tr>
<td>26 - 30</td>
<td>2</td>
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<tr>
<td>&gt; 30</td>
<td>7</td>
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<tr>
<td>Time from alarm to arrival at ER</td>
<td>Number of patients</td>
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<tr>
<td>---------------------------------</td>
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<tr>
<td>&lt; 30 Minutes</td>
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<tr>
<td>30 Minutes – 1 Hour</td>
<td>47</td>
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<tr>
<td>1 – 2 Hours</td>
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<td>2 – 6 Hours</td>
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<td>&gt; 6 Hours</td>
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<table>
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<th>Type of transportation</th>
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<td>Ambulance</td>
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<tr>
<td>Private/Public vehicle</td>
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<tr>
<td>Walk in</td>
<td>2</td>
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<tr>
<td>Others</td>
<td>7</td>
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</table>
Survival Status | Number of patients
--- | ---
Alive | 294
Not survived | 12

Detailed Evaluation of some of the severely injured

- Selected all the GCS < 10
- Selected all the ISS more than 20
Detailed Evaluation of some of the severely injured

<table>
<thead>
<tr>
<th>Condition</th>
<th>Count</th>
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<tbody>
<tr>
<td>GCS &lt; 10</td>
<td>14</td>
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<tr>
<td>ISS more than 20</td>
<td>18</td>
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<tr>
<td>GCS &lt; 10 and ISS &gt; 20</td>
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