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Trauma Care: A Continuum of Care

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Abstract

Trauma care has been compartmentalized into First aid, Bystander care, Pre hospital care, Emergency care, Definitive levels of care and rehabilitation. However, from the time of the impact at the injury site the patient is evolving physiologically and coping mechanisms of the body are responding successfully or unsuccessfully to the situation. Effective trauma care needs a *continuum* of care until the patient is back to his preinjury status. This paper discusses the need to evolve such a process and reviews recent advances in our understanding of the care process and how we need to improve it and how there is a pressing need to generate valid evidence on what we do in emergency care.

Keywords: Trauma Care, Emergency care, ATLS, Prehospital care, trauma system

1. INTRODUCTION

To begin, the story of a real patient: A young 14 year girl jumped off the 5th floor of the backside of a hospital building. Fortunately, a security guard saw her fall down. She came hurtling down and landed on her buttocks. As the alarmed security ran to her side, she kept crying and sitting as she had fallen. The security guard asked her name, she replied, fully conscious and continued to answer questions. In less than 10 minutes a trolley had come to carry her to the Emergency room in 10 minutes, where she continued to talk, had a Pulse rate of 110 per minute, BP of 100 mm. she had no external bleeding but a boggy swelling was already visible on both sides of her hips. Another 10 minutes her pulse was not palpable and BP was not recordable. In five more minutes she was gasping. Soon she had to be intubated and needed Ambu® Bag ventilation. An intravenous line was placed, one in the upper limb and one in the lower limb. In less than forty minutes of being discovered conscious and talking at the fall site she had arrested, and despite repeated CPR and Defibrillation she was declared dead.

Her post mortem radiographs revealed a shattered Pelvis, broken sacrum, and a broken hip on one side. She died of uncontrolled massive bleeding into her pelvis. The fall from 4th floor was a significant fall, very little chance that she could have survived that fall. She took only 40 minutes to manifest the consequences of her serious injury. The security guard was appalled that we could not save a patient found talking and fully conscious. Seriousness of the fall was estimated in this case not on how she was found but by the fact that she fell from the 5th floor, there is no way that such a fall could be survived by anyone as the energy transfer of a fall from that height would be beyond survival (unless someone had put a protective net to cushion her fall).

Trauma is like any disease except that instead of a bacteria or a virus the causative agent is energy. Higher the acute transfer of energy greater is the damage. Depending on which organ system is injured the manifestation may vary and the time taken also varies. Traumatic Brain Injury leads to loss of consciousness immediately from direct concussion, while a delayed loss of consciousness can happen from intracranial extradural or subdural collection of blood. Both TBI and Spinal cord injury can lead to long term consequences from paralysis and many such patients in low income countries die from chronic renal disease caused by an incontinent bladder and inappropriate bladder management.

Acute rupture of a great vessel may have dramatic death while rupture of intestines may take more than 48 hours to manifest with infection in the abdominal cavity (peritonitis). The initial anatomic damage from acute energy transfer leads to acute haemorrhage. This leads to systemic physiological compensations. Sometimes the physiological changes cannot cope, and then pathological changes take over. These changes are brought in through several mediators and many of these serve as markers for irreversible damage.

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So, as explained, the consequences of trauma, like any other disease, take time to evolve. Most physicians and surgeons often do not recognise this aspect of trauma. If the patient lands in a definitive care facility before the full impact of trauma has manifested there is a possibility that some of the clinical or diagnostic features may go unrecognized. Therefore, it is useful to know the nature of trauma, and how the injury happened in a trauma case to understand the severity of injury and understand the outcome of trauma. The outcome may vary depending on many factors including the age of the victim, co-morbidities, time to treatment, type and appropriateness of care given, level of support given for rehabilitation back to normal including psychological support, and finally his integration back into his primary job and back into society. Many trauma patients are not fit to join their primary jobs, even many months and years after their injury and therefore, there is a need to build in vocational and social integration before we can say the consequence of trauma is mitigated.

Outcome measures often deal with time to care or time to definitive surgery or time out from ICU or mortality statistics. While these are indirect measures, however, true outcome of trauma depends on long term function of the victim back in the community. There are very few long-term studies that deal with outcome of trauma. This true not only in low- or middle-income countries but also in high income countries. Despite the presence of seemingly sufficient resources and the evidence-based benefits of trauma systems, a 2017 review of trauma systems globally found only nine of the 23 high income countries had a well-defined and documented national trauma system (1). Although there is a lack of definitive evidence to support many of the current recommendations for the acute care of trauma patients, the historical development of trauma systems, their long experience and even the existing controversies, can help to establish other critical pathways and can guide performance evaluations so necessary to improve outcomes (2).

2. METHOD

This paper is based on author's experience of dealing with multiply injured patients over the last 30 years and a survey of literature available from PubMed and other sources that looks at different aspects of emergency care of trauma victims. This document is not a systematic review of literature.

3. TRAUMA CARE 'BOXED IN PACKAGES'

Historically care of the injured evolved in the battlefield and the idea of a 'flying ambulance' – a horse driven carriage to carry the injured to the non- combat area for care was conceived by Dominique Jean Larrey, a surgeon to the Imperial guard of Napoleon in 1792. The invention of motor car led to motorized vehicles instead of horse carriages to carry patients from the roadside to the hospitals. Evolution of modern medicine as we see it today happened only in the last 60 -70 years. The Ambulance which in the 50's provided little more than first aid now carries a vast number of technologies and equipment for interventions. Prehospital EMS encompasses a range of related activities, including dispatch, response to the scene by the ambulance, treatment and triage by EMS personnel and transport to a care facility via ground and/or air ambulance (3).

With the evolution of Cardio Pulmonary Resuscitation (CPR as it is commonly known) in the early 60's, EMS services rapidly evolved across US to become widespread in the 70's and further evolved with the introduction of ATLS or Advanced Trauma Life Support Programme. Started by James K Styner in 1978 in Auburn, Nebraska the first prototype Advanced trauma Life Support Course was held. [2]

Each of the decades thereafter saw advances in technology to be used on site, within the Ambulance, at the Emergency Room, in the diagnostic laboratories, Imaging Modalities (CT, USG, MRI), in the intensive care facilities, in the operating room, in rehabilitation. While evolution has helped our understanding, in many centres each area operates in silos without interacting with each other. We now see 'boxed in' specialties that deal with areas 1. Bystander Care 2. EMS ambulance Service (Run by different agencies), 3. Emergency Room/ Casualty Services, 4. Intensive care Services, 5. In-hospital Trauma team services to provide in-hospital care 6. Rehabilitation services, 7. Community and social services for long term disability rehabilitation. Lack of a unified accountability disperses responsibility for system failures and perpetuates divisions between public safety and medical-based emergency and trauma care professionals (3).

Current understanding indicates that care of the critically injured begins well before the patient arrives at a large academic trauma centre. It is important to understand the ***continuum*** of care from the point of injury in the prehospital environment, through the local hospital and retrieval, until arrival at a trauma center capable of definitive care (4). Trauma care does not end there. Similar recommendations were made almost three decades back by McMurtry (5) and his colleagues who said 'Trauma care is governed by two underlying principles:

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[2] https://en.wikipedia.org/wiki/James_K._Styner

early definitive management and a continuum of treatment from the time of injury to the return to the activities of daily life.' Most important, a team approach is necessary in the treatment of the trauma patient. Medical care has become complex with need for specialised teams to care for the severely injured.

For a number of such critical care conditions, optimal management not only relies heavily on the talents of highly coordinated, multidisciplinary teams, but it also may require shared responsibilities across a continuum of longitudinal care involving numerous specialties and departments. This continuum usually needs to begin in the prehospital and ED settings with management extending through specialized in-hospital diagnostic and interventional suites to traditional ICU and rehabilitation programs (6). The authors Ghosh and his colleagues discuss the basis and rationale for the 'critical care cascade' concept, which contends that the optimal management of critically ill patients should be a *continuum of care through the healthcare system*.

4. PREHOSPITAL AND TRAUMA CARE GUIDELINES

Several types of guidelines have evolved over time. They have been classified as Basic level and Advanced level based on the level of intervention at the field level that each system is capable of. Ambulances have been categorised as Basic Life Support (BLS) and Advanced Life Support (ALS) ambulances based on the equipment and skills of the Emergenccy Medical Technician available on board. In high income countries Advanced Trauma Life Support (ATLS) programme has gained popularity and most surgeons go through an ATLS training programme. While many in Europe undergo the ATLS training, German trauma societies have got together and evolved their own guidelines for management of serious and multiply inured patients.

4.1. ATLS

As emergency care evolved most of what was done was added empirically based on what was felt to be useful. It was neither based on hard evidence nor was it based on any consensus. One of the earliest consensus based guideline was ATLS guideline. This has gone through several iterations of development and the American college of Surgeons committee on trauma that approves this has released the revised 10th edition of ATLS in June 2018.[3]

While the earlier versions were predominantly consensus based the newer versions have been incorporating evidence based practices. ATLS also has a Prehospital version called the PHTLS and a version for Nurses. The ATLS program provides participants with a safe, reliable method for immediate management of the injured patient and the basic knowledge necessary to:

1.Assess the patient's condition rapidly and accurately
2.Resuscitate and stabilize the patient according to priority
3.Determine if the patient's needs exceed a facility's capacity
4.Arrange appropriately for the patient's inter-hospital transfer (who, what, when, and how)
5.Assure that optimum care is provided and that the level of care does not deteriorate at any point during the evaluation, resuscitation, or transfer process.[4]

4.2. S3 Guidelines

S3 – Guidelines are guidelines on Treatment of Patients with Severe and Multiple Injuries issued by lead German Trauma Society in association with 10 other German surgical societies including the Radiology Society. Most of the recommendations were approved with "strong consensus" (agreement of > 95% of participants). The guidelines also evaluate quality outcomes and have listed the criteria for these in the prehospital, Emergency Room and overall in the hospital.

<u>Process quality for evaluation in the prehospital phase</u>
Duration of prehospital time between accident and hospital admission for severely injured patients with ISS ≥ 16 Intubation rate in patients with severe chest injury (AIS 4-5) by the emergency physician
Intubation rate in patients with suspected traumatic brain injury (unconscious, Glasgow Coma Scale [GCS]

<u>Process quality for evaluation of emergency room management</u>
Time between hospital admission and performance of a chest X-ray in severely injured patients (ISS ≥ 16)
Time between hospital admission and performance of an ultrasound scan of the abdomen/chest in cases of severe trauma (ISS ≥ 16)

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3 http://bulletin.facs.org/2018/06/atls-10th-edition-offers-new-insights-into-managing-trauma-patients/.
4 https://www.facs.org/quality-programs/trauma/atls/about.

Time until performance of a computed tomography (CT) scan of the cranium (CCT) in prehospital unconscious patients (GCS ≤ 8)
Time until performance of a full-body CT scan on all patients, if carried out
Time from emergency admission arrival to completion of diagnostic study in severely injured persons if this has been completed normally (ISS ≥ 16)
Time from emergency admission arrival to completion of diagnostic study in severely injured persons if this has been interrupted due to emergency (ISS ≥ 16)

Outcome quality for overall evaluation
Standardized mortality rate: observed mortality divided by the expected prognosis based on RISC (Revised Injury Severity Classification) in severely injured persons (ISS ≥ 16)
Standardized mortality rate: observed mortality divided by the expected prognosis based on TRISS (Trauma Injury Severity Score Method) in severely injured persons (ISS ≥ 16)[5]

5. INTERVENTIONS IN CARE OF THE INJURED

In the 60 years or so of the EMS a lot of technology has evolved around the care of the injured. How has it influenced the outcome? Here in lies the main challenge. How do we objectivise the outcome and what parameters do we select? How long do we wait before we know the end point of outcome evaluation? While many of these are serious research issues, this section looks at some of the current literature on interventions in care of the injured.

5.1. Access to injured

In many low income countries, the police come into the scene first only then are the other providers of care called in. 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 (7). Universal access phone number like 911 known in case of emergency is simple with all modern telephone systems; however, this is not implemented across countries and even within states multiple numbers have to be accessed for emergency access.

5.2. Triage

Many injured patients are taken to hospitals that neither have the capacity, equipment or expertise to do complete management of their injuries. This leads to unnecessary delay in definitive treatment of the patient. Triage is a French word that means sorting. Triage is used to sort patients according to the severity of their injuries and risk to their life and match them to the care urgency and facility to which they are dispatched. Triaging can be difficult and recognizing the evolving nature of the consequence of injury, a given patients triage category may change rapidly if the full picture is not understood.
Three phases of triage have emerged in modern healthcare systems. First, prehospital triage in order to dispatch ambulance and prehospital care resources. Second, triage at scene by the first clinician attending the patient. Third, triage on arrival at emergency department or receiving hospital (8). To reduce the errors in Triaging different services use different protocols. Kane's "revised" checklist provided the largest improvement in odds against needing a trauma center when the triage instrument is negative. Of the triage instruments with a sensitivity greater than 70%, the respiratory/systolic pressure/Glasgow Coma Scale (RSG) score provided the largest improvement in odds for needing a trauma center when the triage instrument is positive (9). A CDC panel in 2009 also recommended transport to a trauma center if any of the following are identified: Glasgow Coma Scale of <14,Systolic BP <90, Respiratory rate <10 or >29 breaths per minute(Children,20 in infants <1 year). The panel also recommends transport to a trauma center if the following were seen: 1. all penetrating injuries to head, neck, torso, and extremities proximal to elbow and knee; 2. flail chest; 3. two or more proximal long-bone fractures; 4. crushed, degloved, or mangled extremity; 5. amputation proximal to wrist and ankle; 6. pelvic fractures; 7. open or depressed skull fracture; or 8. paralysis.

In addition, the committee also recommended the mechanism of injury criteria: falls from height greater than 20 feet(6.1 Metres)> 10 feet for children, High-Risk Auto Crash --- Intrusion of >12 Inches at Occupant Site or >18 Inches at Any Site: High-Risk Auto Crash; Ejection (Partial or Complete) from Automobile, Death in Same Passenger Compartment: Auto Versus Pedestrian/Bicycle Thrown, Run Over, or with Significant (>20 mph) Impact: Motorcycle Crash >20 mph: and elderly and those on anticoagulants/ bleeding disorders(10). Some of

[5] http://www.dgu- online.de/fileadmin/published_content/5.Qualitaet_und_Sicherheit/PDF/20110720_S3_LL_Polytrauma_DGU_eng_f.pdf

these have been further modified in the 2012 revision of this (11), for example GCS<14 is now changed to GCS<13.
These are technical criteria which cannot be expected to be known by lay persons, therefore, these are possible only in a mature trauma system with a mature EMS system in place. Until then this capacity will have to rest with the trauma teams operating from within hospitals.

5.3. Airway

Maintaining a clear airway is an essential part of basic life support. Can be problematic in patients with Traumatic Brain Injury(TBI), patients with facio-maxillary injury and those with cervical spine injury.

Breathing: assessment of voluntary breathing is important to assess the functioning respiratory centre and need for ventilator support. Airway related complications were defined as hypoxemia, unrecognized esophageal intubation, regurgitation, cardiac arrest, ETI failure rescued by emergency surgical airway, dental trauma, cuff leak, and main stem bronchus intubation. Of the patients included, 23.5% experienced at least one complication (12). Patients with severe TBI who needed to be intubated reportedly had poorer outcomes (13).

5.4. Out of hospital Cardiac Arrest

A trauma patient is usually younger and a majority have good Myocardium with good Myocardial function quite unlike a patient with MI or Angina. So, a cardiac arrest in such a patient is the result of continued hypoxia, severe exsanguination or severe Neuronal damage from Traumatic Brain Injury or Spinal cord injury. The Outcome of outside hospital Cardiac arrest in a traumatic patient is usually poor (14-16). Cardiopulmonary resuscitation itself is a psychomotor skill that needs to be learnt, practiced regularly and periodically retrained to keep the skills correct.

CPR technique itself has changed from the original description pf Mouth to mouth breathing followed by compression, research has shown that the chest compression and spontaneous expansion is sufficient to provide the required oxygenation for the longs. The newest development in the CPR guideline is a change in the basic life support sequence of steps from "A-B-C" (Airway, Breathing, Chest compressions) to "C-A-B" (Chest compressions, Airway, Breathing) for adults. Also, "Hands-Only (compression only) CPR" is emphasized for the untrained lay rescuer (17, 18). Mechanical devices have been invented to provide for mechanical compression of chest CPR using machines but there are no advantages over manual compression (19).

5.5. Bleeding control

Uncontrolled haemorrhage is the leading cause of potentially preventable death. Improving our ability to control haemorrhage may represent the next major hurdle in reducing trauma mortality. New techniques, devices, and drugs for haemorrhage control are being developed and applied across the continuum of trauma care: prehospital, emergency room, and operative and postoperative critical care (20).
Haemostatic agents are currently used in the form of special granules or soaked gauze. Their use is particularly advantageous in difficult body location (e.g. on neck, armpit or groin), where other methods of bleeding control are impossible to use or fail (21).

Tranexamic acid, a very old drug recently has found use as an effective drug to control bleeding. This was started after a major multicentric trial (CRASH 2 trial) of the drug (22, 23). It is increasingly being used in ambulances around the world (24). It is given as a 1gm bolus dose. The authors recommend considering a 1 g TXA bolus en route to definitive care in high-risk patients and withholding subsequent doses until hyperfibrinolysis is confirmed by thromboelastography (25). Available data support the efficacy and the safety of TXA. High-level evidence supports its use in trauma and strongly suggests that its implementation in the prehospital setting offers a survival advantage to many patients, particularly when evacuation to surgical care may be delayed (26). It is also recommended by the ATLS 10th Edition.

5.6. Intravenous Fluids

The concept of replacing loss of blood in trauma with Saline or Ringers started sometime in the 60's. Used as a volume replacer for lost blood the ATLS protocol recommended 1 – 2 Litres of Ringer's in a severely injured patient. Randomised trials started showing no benefit in the use of Prehospital Intravenous fluids(27). Several reports show the lack of any benefit of intravenous fluids on injured patients (28-30). The latest ATLS Protocol mentions 'The initial resuscitation with crystalloid fluid still begins with a 1 liter bolus of warmed isotonic fluid. Large volume fluid resuscitation is not a substitute for prompt control of hemorrhage. Infusion of more than 1.5 litres of crystalloid fluid has been associated with increased mortality'(31).

5.7. First aid

All that is done as first intervention done to a victim of trauma to protect his life and limb and to reduce suffering is called first aid. Often the person most likely to be around at the time of a road crash is likely to be a lay person. However, even lay persons can provide valuable help by calling for expert help, getting the patient to a safer place and positioning the patient and splinting him for reducing pain. They can also help reduce bleeding by simple elevation or compression bandage of the wound. They could trained and there are several programmes that help train lay people in providing bystander care. Lay first-responders effectively retained knowledge on prehospital trauma care and confidently used their first-aid skills and supplies for at least six months. participants had used at least one skill from the course: most commonly haemorrhage control, recovery position and lifting/moving and 96% had used at least one first-aid item (32). Training drivers First aid - a group of people most likely to be on the road to help in the time of a road crash has been used by many (33), (34), (35).

5.8. ALS vs BLS

As EMS evolved more and more interventions started to get done by the Emergency Medical Technicians. A lot of what was done was empirical and not based on hard evidence. Recent evaluations of these interventions have not shown any benefit. In fact there are some reports of causing harm in some patients. The American system of care in accordance with the advanced trauma life support (ATLS) standard of the American College of Surgeons (ACS) and by means of prehospital and advanced trauma life support (PHTLS) given according to the standards of the National Association of Emergency Medical Technicians (NAEMS) was considered to be the 'golden standard' (36). Advanced life support levels of care of patients with an Altered Level of Consciousness (ALOC) does not significantly change outcome compared with those receiving BLS care with the exception of shorter emergency department treatment times for hypoglycemic patients (37),(38). Some studies found harmful effects of ALS in severe trauma. The OPALS (the Ontario Prehospital Advanced Life Support) study found 'that during the advanced life-support phase, mortality was greater among patients with Glasgow Coma Scale scores less than 9' (39). In a study done in Netherlands on TBI witth GCS </= 8 showed despite more on-site ALS in severely head injured patients nowadays compared to the historic cohort, there was no reduction in mortality (40). In a recent study Sanghavi P et al found Patients with out-of-hospital cardiac arrest who received BLS had higher survival at hospital discharge and at 90 days compared with those who received ALS and were less likely to experience poor neurological functioning (41).

5.9. Spine Clearance

The biggest worry for an EMS team is how to prevent a secondary spinal cord damage in a traumatic spine injury or in an unconscious patient. There is always the worry about clinical clearance the protocol has been to assume a spinal cord injury in a patient who is unconscious and to protect the spine in a paralysed patient or to protect the spine in a conscious patient complaining of pain in the back. In a prospective study on GCS 14 and > cases were evaluated clinically by EMTs for C – Spine injury.34% c-spines were clinically cleared by EMS. There were no known missed injuries in this patient group. 6% patients who were not clinically cleared by EMS were diagnosed with c-spine injury. EMS personnel in the prehospital setting may reliably and effectively perform clinical clearance of the c-spine. Further prospective study for prehospital c-spine clinical clearance is warranted (42).

Traumatic spinal cord injury (SCI) often occurs in patients with concurrent traumatic injuries in other body systems. These patients with polytrauma pose unique challenges to clinicians. Bowel and bladder disorders are common following SCI, significantly reduce quality of life, and constitute a focus of targeted therapies. Systematic management approaches to minimize sources of secondary injury are discussed, and areas requiring further research, implementation, and validation are identified (43).

Cervical collars are routinely applied in trauma patients with suspected cervical spine injury. However, cervical collar application was reported in penetrating trauma to be associated with unadjusted increased risk of mortality in two concealment of neck injuries in one study and increased scene time in another study. While, in blunt trauma, one study indicated that immobilisation might be associated with worsened neurological outcome (44).

One paper has criticised everything that is done in spinal injuries –"The emergency care of patients who may have spinal injuries has become highly ritualised. There is little scientific support for many of the recommended interventions and there is evidence that at least some methods now used in the field and emergency department are harmful. Specific treatments that are irrational and which can be safely discarded include the use of backboards for transportation, cervical collar use except in specific injury types, immobilisation of ambulatory patients on backboards, prolonged attempts to stabilise the spine during extrication, mechanical immobilisation of uncooperative or seizing patients and forceful in line stabilisation during airway management (45)."

In Patients with neurological deficit it is far better that they reach definitive care centres early on. Patients who took greater than 24h to reach a SCIU were 2.5 times more likely to develop a secondary complication.(46)

5.10. Ambulances - Transportation of the injured patient

Ambulances have become synonymous with patient transport vehicles. They are designated as per their usage and the technology available within like ALS ambulances, BLS ambulances. In high income countries over 90% of patients are transported by ambulances. Where as in low-income countries like; India and Africa over 90% patients are transported taxies, private cars and police vehicles.

Interestingly patients with severe trauma transported by private vehicles were found to have better survival than those transported via EMS system. Persons without access to telephone also often use private transport to transfer trauma patients to a trauma centre. Of the 4 per cent patients transported in private vehicles 50 per cent did not have access to telephone. Among the others, fears of delay and under estimation of the severity of trauma were the other causes (47). In Philadelphia 61 per cent of Police Chiefs indicated that police officers would occasionally 'scoop and run' with a critically ill child rather than wait for the emergency medical services to arrive(48). In a study done in Delhi it was found that ambulances transported only 4 per cent of patients. Of the injured 51 per cent were transported to the hospital by taxies. This is comparable with urban ambulance transfer times in high income countries(49). In a meta analysis of ambulance transportation times from US it was found that the average duration in minutes for urban, suburban, and rural ground ambulances for the total prehospital interval were 30.96, 30.97, and 43.17 minutes (50).

5.10.1. Equipment in an Ambulance

The ambulance vehicle may be any simple vehicle with a stretcher or it could be custom built and fitted with sophisticated equipment for monitoring and providing advanced cardiac life support. Other equipment like suction machines and immobilization devices for limb or spinal immobilization boards, cervical immobilization collars, IV cannulas, Oxygen cylinders, Bag valve ventilators also form part of ambulance equipment. With improvements in technology defibrillators, mechanical ventilators, and Mechanical CPR machines are also available on some ambulances. However, there is no data to suggest that use of equipment alter the outcome of trauma.

All ambulances must also have patient extrication tools to extricate patients trapped in crashed vehicles especially those involved in high energy crashes.

5.10.2. Speed of Ambulances

Early transportation of the trauma patient within first hour of trauma is highlighted to emphasis the need for early definitive care and the term widely used is transportation in the 'Golden Hour'. However, reported that the Golden Hour concept was not based on data or evidence. Dr Cowley used the term as part of a presidential address rhetoric to the American College of Surgeons (51). The platinum half hour concept is an extrapolation of this to further highlight the importance of reducing time to definitive treatment. But how far can we stretch the 'Golden hour' concept. In a study on TBI it was found that a survival benefit exists in patients arriving earlier to hospital after severe head injury but the benefit may extend beyond the golden hour. There was evidence of improved functional outcomes in patients arriving within 60 min of injury time (52).

Transportation time for the injured during world war was estimated to be 12 – 18 hours while mortality was estimated to be 8%, during world war II it was 6 – 12 hours and the estimated mortality was 4.5%, during Korean war it was 2-4 hours and 2.5% and during Vietnam war it was one and a half hours and mortality was estimated to be 2%. However, during this period not just travel times but the entire medical system changed from asepsis, antibiotics, and anesthesia overall surgery became much safer.

Though it is important for the injured patient to reach a definitive care facility at the earliest in urban situations with short transportation times excessive speeding cannot improve transportation times. This speeding may in fact contribute to risk of injury to patients, other motorists and pedestrian on the road. Ambulance crashes for the time period of May 1, 2007 to April 30, 2009. Of the 466 crashes examined, 358 resulted in injuries and 99 persons were killed (53). The incidence of fatal ambulance crashes during emergency use is reportedly higher than during non-emergency use. These are particularly higher for lights and siren travel (54). Kahn and colleagues found that most crashes occurred at intersections and rear compartment occupants were more likely to be injured than those in the front (55). Hunt and colleagues have shown that ambulances with flashing lights and sirens do not significantly reduce patient transportation time. The study used ambulances with lights and sirens and a control ambulance without any of this, it revealed the mean time saved to be 43.5 seconds in 50 trips (56) In another study the mean time saved was 2.9 min in urban areas and 8.9 min in rural areas (57). Use of sirens also significantly disturbs the patients being carried in it. The noise of sirens and traffic also disturb recording of blood pressures of patients in moving ambulances (58).

Ambulance transport is associated with predictable and likely preventable occupant hazards. Intersection crashes have high injury and fatality risk. Crash testing demonstrates that the ambulance transport environment includes predictable and preventable occupant risks. Failure to use current methods of occupant protection for each occupant or to secure equipment effectively can result in catastrophic outcomes to all occupants (59). In another study the mean time saved was 2.9 min in urban areas and 8.9 min in rural areas (60).

Research needs to be conducted on the type of patients that need to be rapidly transported. While some reports recommend neurotrauma and penetrating injuries this area need further evaluation.

5.10.3. Air Ambulances

Air ambulances have been promoted with a view to reduce transportation times and hence reduce mortality. Air ambulances are costly, and their health benefits are small (61)The study found that there was no improvement in response times and the time on scene was longer for helicopter-attended patients. Logistic regression analysis in helicopter transported trauma patients have shown that transportation by helicopter does not affect the estimated odds of survival (62).

Another study showed that a large majority of trauma patients transported by both helicopter and ground ambulance has low injury severity measures. Outcomes were not uniformly better among patients transported by helicopter. Increased mortality, 18 per cent compared to 13 per cent for ground transported patients for helicopter transportation of victims in urban area (63).

Air transport is also fraught with risks of crashes and fatalities. Helicopters Survival to hospital discharge was 3.5% (severely disabled) in the HEMS group and 0% in the ground-BLS . No significant benefit on long-term outcome was found, but more cases might be needed in future studies because of the inevitably low number of survivors (64).

Fatalities after helicopter EMS crashes are associated especially with post crash fire (65). Some counties have seen a 'distressing number of air ambulance crashes'(66) Helicopter services may have a role in remote inaccessible areas in the sea, desert or mountains. However, routine use of air ambulances in the urban setting is not cost effective.

5.10.4. Ambulance Personnel

The number and training of ambulance personnel varies from place to place. Some have only drivers trained in emergency care while others have emergency care paramedics. In some parts of the world there are physician-manned ambulances. Trained medics and paramedics are posted in the emergency medical service ambulance to ensure that the trauma patients receive optimal care from the site of injury. Physician-manned on scene care was found to cause a significant increase in scene time and total pre-hospital time. These delays are associated with an increase in the risk for death in patients with severe injuries(61). Physicians on the scene tend to try to provide more care in the field than well trained paramedics, therefore, the time to definitive care of the haemorrhage may be delayed (67).

Instead of paramedics physicians also have been recommended to improve outcome but except in special situations this is not feasible logistically or practically on a wider scale. Some papers claim benefit with certain caveats. There appears to be an association between prehospital management by doctors and improved survival in major trauma. Further high-quality evidence is needed to confirm these findings. Level of evidence: Systematic review, level III (68).

With the information available it seems that in an urban setting all that is required is a comfortable vehicle with sufficient space to carry the injured safely to a hospital. Role of medication Analgesics for trauma patients and cardiac drugs for non-trauma patients are the most commonly used medications (69). Drugs were administered in 8.5 per cent of urban emergency patients and 7 per cent of rural emergency patients either at site or during transportation (70). So far, there is no reported evidence that pre-hospital medications are either beneficial or cannot be delayed until the arrival at the emergency room.

The dilemma in the field situation is whether to 'scoop and run' or to Stay and play'. Looking at the literature that is available and in an urban situation where travel times are expected to be within the 'Golden Hour" a ‘scoop and run’ policy seems reliable. However in a rural situation and where delays to definitive care are expected then a balance between "scoop and run" and "stay and play" is probably the best approach for trauma patients. The chosen approach should be made according to the mechanism of injury (blunt versus penetrating trauma), distance to the trauma centre (urban versus rural) and the available resources (71).

5.11. Emergency room care

Once the patient arrives in the Casualty the transition has to be smooth. Full system evaluation is mandatory to ensure that there are no missed injuries. Primary survey has to be a head to toe complete survey. This is also part of the ATLS protocol. Primary care procedures are instituted immediately and following stabilization of the patient a secondary survey is then executed. This is a detailed evaluation which is often supplemented with the investigation reports that are available and a more definitive treatment plan is made for the patient. At this point a decision is made to transfer the patient to the Intensive care or to the operating room or if he can be sent the wards or sent home after preliminary management. This Triaging also needs experience and expertise. More so in a multiply injured patient or a polytraumatised patient. In a multiply injured patient multiple parts of the same system is affected whereas in a polytrauma patient more than one system is affected. For example, a head injury with fractures of both femurs, or a patient with ruptured liver and spinal cord injury and head injury. In multiply injured patients there is a possibility of the dominant system injury may mask some of the other system injuries and there is a higher possibility of missed injuries. To avoid these protocols have been evolved. To ensure that patient’s evaluation is complete checklists have been instituted by WHO. The Trauma Care Check list formed by WHO is recommended to reduce missed injuries and ensure quality of care.[6] This is a 15 point check list implemented after the primary survey and secondary survey has been done and before the patient leaves the casualty.

5.12. Missed Injuries

Missed injuries occurring at any time during the care process can contribute to poorer mortality and morbidity. In on prospective study researchers found an incidence of 25.5% missed injuries (72). Various reasons can be attributed to this Among them the hemodynamic instability (Systolic blood pressure less than 90 mmHg), the tachycardia and the low Revised Trauma Score, Altered level of consciousness (GCS of twelve or lower)all supposedly contributed(72). These are common in trauma patients One study showed higher rates of severe missed injuries mainly in abdomen and pelvis. Circulatory instability and low RTS were assigned as significant factors predicting of this obviousness. Various solutions are proposed to prevent missed during the first assessment in prehospital care (72).

The WHO introduced the Trauma care Checklist after trials in 11 centres around the world with a view to improve quality of care for the emergency trauma patient. Implementation of the WHO Trauma Care Checklist was associated with substantial improvements in patient care process measures among a cohort of patients in diverse settings (73).

5.13. Trauma Systems vs Trauma centres

In the seventies when EMS was still evolving trauma surgeons soon realized the importance of having multispecialty hospitals where all problems of the patient can be dealt with under one roof. So trauma centres became popular. However soon it was realized that trauma patients may have other medical problems and co morbidities and there may be the need for a cardiologist or an endocrinologist or perhaps even an obstetrician for associated problems relating to those. Many a trauma centres had to close down in the 80s and 90s because of this. What was then realized was the need for a trauma team within a multi-specialty hospital. This ensured complete care of the patient and also injury care. In high income countries networks of hospitals that are designated to receive severely injured patients have been created. These systems can be either exclusive, in which all patients are referred only to a small number of specifically designated centres that meet strict criteria, or inclusive, in which patients may be referred to any hospital of a particular area according to capacity, which is observed in France (74).

Despite the presence of seemingly sufficient resources and the evidence-based benefits of trauma systems, only nine of the 23 high income countries in a review have a well-defined and documented national trauma system. Although 90% of all lethal traumatic injuries occur in middle and Low Income countries, according to literature which the study is limited to, only few of these countries a hold formal trauma system or trauma registry (1). To date, studies assessing trauma system efficacy rely on hospital deaths as the primary indicator of effectiveness. Future research should use more sophisticated study designs (Class II) and expand available outcome measures

[6] https://www.who.int/emergencycare/publications/trauma-care-checklist.pdf?ua=1

to assess the entire continuum of care, including prehospital, rehabilitation outcomes, and long-term quality of life (75).

Even in high income countries much is needed in quality improvement as is evident from this review in Netherlands "However serious concerns remain: shortage of intensive care beds, the impossibility to use the helicopter service at night, the shortage in the number of mobile medical teams at night and the slowness in executions of agreements between contracting parties. Many of the remaining problems are a matter of money" (76).

The Prehospital phase should be a part of the hospital based emergency care system. Unless this is so, ownership and seamless transfers of patients will not happen. In China "The prehospital emergency service is an integral and important part of the Emergency Medical Service System. In China, emergency service centres (stations) have been set up at the levels of province, prefecture and county (77).

By developing multidisciplinary plans of care that focus on patient and family outcomes and not arbitrary points in time, hospitals can provide quality care to trauma patients that is both appropriate and cost effective. In fact, this type of plan for SCIs can be expanded on and used across the health care continuum from prehospital to community reintegration (78). Quality of care of the surgical patient is key to reduce complications. The WHO introduced the safe surgical checklist to reduce complications among surgical patients. Researchers found rate of death was 1.5% before the checklist was introduced and declined to 0.8% afterward (P=0.003). Inpatient complications occurred in 11.0% of patients at baseline and in 7.0% after introduction of the checklist (P<0.001) (79). In addition, these, basic science research can help us recognise early signs of deterioration, Multi-organ failure, development of irreversible shock and several other parameters. These fall into a distinct area of research beyond what has been discussed here.

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. In a 5-year follow-up study of a group of 461 consecutive trauma patients treated in an Intensive Care Unit from 1980 to 1983, the entry criteria (initial survival and severe injury: ISS greater than or equal to 18) were fulfilled by 233 patients with a mean ISS of 29.3 and mean age of 35.6 years (80). Full details of medical sequelae, aftercare, missed injuries, occupation, insurance, social integration, economics, legal aspects, and traffic involvement were covered. Final was gathered from 95.6% of the 233 cases. Eighteen percent of the patients died in the hospital, 5.6% died later, and 76.5% were eventually seen. Only 4.4% were lost to follow-up. Outcome was judged using the Glasgow Outcome Scale (GOS), which was compared with a GOS value given prospectively at the time of hospital discharge. Eighty-nine percent of the survivors were healthy or slightly disabled (GOS 5 and 4), 9% were severely disabled, and only 2% were in a persistent vegetative state. Outcome after 5 years was better than tentatively proposed at the time of hospital discharge. Ninety-one patients with severe head injuries (AIS 4-5) were additionally tested using the Mini Mental State Instrument. This test revealed normal mental functions in 77% and dementia, mostly of a minor degree, in 23% of the head-injured patients. Almost all the early deaths and two thirds of the late deaths were related to severe head injury. Seventy-nine percent of the survivors were working after 5 years. During the post-trauma period, patients experienced reduced social well-being and also changed professional and recreational activities. There appears to be extensive room for improvement in the post-hospital recovery phase (80).

Such long-term studies are unusual but only these are able to capture the full impact of a continuum of care including the importance of rehabilitation services and community programmes for the care of the injured.

6. RESEARCH

While today's emergency and trauma care system offers significantly more medical capability than was available in years past, it continues to suffer from severe fragmentation, an absence of coordination, and lack of accountability (81). We are in a situation where something as basic as starting of an intravenous fluid in a traumatized patient is labelled as controversial. Despite evidence from multiple researchers it has taken 20 years for this to translate to protocols. While this may be a good safety mechanism to prevent protocols to be driven 'shooting from the hip' approaches it could also delay implementation of genuine interventions or removal of harmful interventions.

There is a need to evaluate Evidence Gap Maps (EGMs) in the area of emergency trauma care and then factual meta-analysis needs to be done to separate what really works from what is perhaps useful. The future may find that even some of our very basic parameters of measurement of end points of resuscitation may have changed completely. A recent report found a substantial number of Systematic Reviews in acute management of moderate to severe TBI lack currency, completeness and quality. They have identified both potential evidence gaps and also substantial research waste (82). One of the dilemmas of pre-hospital care has been 'are we doing too little for a damage which seems too much?' Our emotional response seems correctly to be to do whatever possible to save as many lives as possible. There is a need, however, to avoid deification of technology and to homogenize responses in a problem which is essentially heterogeneous. To make scientific conclusions we must have well-controlled prospective randomized studies.

There exists a strong general feeling that randomizing pre hospital care is unethical (83). Since component-based research doesn't fit well into the uncontrolled, multi-tasking environment of EMS, we need to begin to develop models specifically for systems research (84). However, there are natural control populations in place in the world where a total contrast of no pre-hospital care exists along with places where high-tech pre-hospital care is practiced. Advantage could be taken of such situations, normalize them for different injuries to have a controlled study. One such study, done in Canada, where researchers compared two cities with two different types of EMS systems. "Two distinct Emergency Medical Services (EMS) systems exist in Atlantic Canada. Nova Scotia operates an Advanced Emergency Medical System (AEMS) and New Brunswick operates a Basic Emergency Medical System (BEMS). Overall survival to hospital was the same between advanced and basic Canadian EMS systems (85)." Until more such carefully designed studies are carried out we will continue to grope for answers and components of pre-hospital care will remains controversial.

Policy, ethical and legal barriers to research in this field also needs to be overcome. 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. However, obtaining such consent is often impossible in emergency situations. Several EU Member States addressed this problem by permitting deferred consent. International ethical guidelines supporting deferred consent were also cited by Good Clinical Practice Directive 2005/28/EC(86).

In summary, a review of literature and the physiological processes involved suggests that in urban areas with transportation times of less than one hour and no delay in extrication scoop-and run seems to be the best policy. But this alone will not improve the survival status of the injured, this need to be alongside major improvements with trauma teams in place with excellent intensive care and operative facilities with a backup of rehabilitation services to get the patient back as a productive member of the community. However, serious research is required is required in this field which has largely been driven by emotions and empiricisms rather than hard evidence.

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