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

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Declaration

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Pre hospital care: evolution, practice, science and evidence

Mathew Varghese

1 INTRODUCTION

The science of modern medicine and surgery is relatively recent and most interventions that seem so ubiquitous now are only 60 to 70 years old. Emergency care of the injured has evolved alongside in the last fifty or sixty years. Evolution of many of these medical and surgical interventions has changed the outcome of trauma. Prehospital care specifically includes all that we do for the injured from the time when the injury occurred at the site until the patient reaches a definitive care facility in a hospital. Emergency care of the injured, however, is not divided into discrete compartments but it is a continuum of care from injury to rehabilitation and recovery.

The processes and the science of emergency care of the injured are still evolving. Recent wars in the Middle East and other conflict areas have brought us a new set of understanding of the injured patient. This chapter is a review of the evolution of some of these established systems of care, their current practices and understanding, and the controversies thereof.

1.1 History and evolution of emergency care of the injured

Historically emergency care of the injured evolved as part of care of the injured in the battlefield. The idea of a “flying ambulance” was conceived by surgeon to the Imperial Guard of Napoleon, Dominique Jean Larrey in the autumn of 1792, during the Battle of the Rhine. He was required to deal with huge numbers of casualties, many of whom he treated with amputations. Probably saving more lives of the victims of serious limb trauma than any other operation that could then be offered (Welling, Burris, & Rich, 2010).

In 1872 the order of St. John contributed to the establishing Britain’s first transport service and by 1875 had its own first transport litter called the St John’s Ambulance. The discipline of first aid originated in 1878 from a pioneering and revolutionary experiment to teach members of the general public skills that had been developed for military stretcher bearers in the previous decade (Pearn, 1994). The two world wars saw several developments in the care of the injured. World war II also saw the use of antibiotics for the first time. The resuscitator, named “Ambu” (Artificial Manual Breathing Unit), was manufactured and marketed in 1956.

The ground-breaking discoveries of the 20th century finally led to the scientific framework of cardiopulmonary resuscitation (CPR). In 1960, mouth-to-mouth resuscitation was eventually combined with chest compression and defibrillation to become CPR as we now know it (Ekmektzoglou et al., 2012).

Beginning in the late 1960s and accelerating thereafter, emergency care swiftly evolved into its current form. Today, modern emergency departments not only are capable of providing around-the-clock lifesaving care in individual emergencies and disasters (Kellermann, Hsia, Yeh, & Morganti, 2013).

The science of modern medicine and surgery is relatively recent and most interventions that seem so ubiquitous now are only 60 to 70 years old. The processes and the science of emergency care of the injured are still evolving.

An aviation accident in rural Nebraska on February 17, 1976, was responsible for the development of a concept of trauma management that was promulgated as Advanced Trauma Life Support (ATLS). It has achieved global support and is considered by many to be the acme in trauma management (Bridgewater, 2016).

The 1980s saw development of medical interventions that were done at the site of injury and in the ambulance on way to the hospital, such as tracheal intubation and the use of intravenous fluids, cervical immobilisation and other devices. These were followed by techniques and technologies of monitoring and delivering fluids. The 90's saw the evolution of trauma Systems that could activate a trauma team and could comprehensively manage the victims of trauma (Cooper & Laskowski-Jones, 2006). The new millennium saw the evolution of concepts of Balanced resuscitation (Kortbeek et al., 2008) and Damage Control Orthopaedics.

The lack of empirical data on the benefit of many pre-hospital care interventions is a serious problem.

1.2 Injury Severity

The outcome of injury depends on the extent of the injury. The extent of injury is dependent on the amount of energy transferred to the tissues. More acute the transfer of injury, more severe the injury and poorer the outcome. While there are ways of assessing the energy transferred to the patient by investigating the place where the injury took place and the mechanism of injury, (which is a separate science by itself) these are beyond the domains of this article. Neither the health care worker nor the emergency care provider in the pre-hospital or hospital setting is competent to do this. However, it is important to know this to prognosticate the outcome of injury. Abbreviated Injury Scoring (AIS) was one of the earliest scoring systems that attempted an anatomical scoring of injuries to different anatomical parts of the body. The AIS© is an anatomically based, consensus derived, global severity scoring system that classifies an individual injury by body region according to its relative severity on a 5 point scale. The current version is AIS© 2015 and its content was derived from expert consensus and analysis of trauma data including injury diagnostics, classifications and feedback from field use of AIS 2005 / 2008 Update (Gennarelli & Wodzin, 2008). Injury Severity Scoring (ISS) and the New Injury Severity Score (NISS) attempted to look at the impact of injury to multiple regions of the body on the outcome (S. P. Baker & O'Neill, 1976; Osler , Baker,

Trunkey described the classic trimodal pattern of death from trauma where 50% of the deaths occur within the first hour, 30% of the deaths occur early 1 hour to 1 week while 20% of deaths occur late. Recent studies on this trimodal pattern from mature trauma systems seem to challenge this pattern.

& Long, 1997). Both these are important to compare outcomes of injuries in different communities and regions. But data collection and record keeping has been an issue in many settings around the world. This is often because there is a multiplicity of agencies involved (fire, police, heath care technicians, paramedics and, also many times, bystanders), the multiplicity of tasks involved and emergent nature of all that is done.

The lack of empirical data on the benefit of many pre-hospital care interventions is a serious problem (Sasser, 2006). The World Health Organisation in Geneva proposed a collaboration to identify core strategies, equipment, supply, and organizational structure needed to create effective and adaptable pre-hospital care system for injured person world-wide (Mock, Kobusingye, Joshipura, Nguyen, & Arreola-Risa, 2005). To improve the predictability of outcomes after injury several physiological parameters have been included like the pulse, blood pressure, respiratory rate and others. However, these are time dependent variables and are difficult to gather in the field setting. Trauma and Injury Severity Score (TRISS) uses a weighted combination of patient age, ISS, and Revised Trauma Score (RTS) where RTS is calculated from the Systolic Blood Pressure (SBP), Respiratory Rate (RR) and Glasgow Coma Scale (Schluter, 2010). Similarly, other scales have tried to include co-morbidities that may influence outcome s in Acute Physiology and Chronic Health Evaluation (APACHE II).

1.3 Injury outcome

Trauma patients suffer tissue damage from acute exposure to energy. The outcome depends on the severity and the part of the body that is injured. Over 50% of deaths in the early period results from traumatic brain injury. The next most common cause of death is bleeding. Trunkey described the classic trimodal pattern of death from trauma where 50% of the deaths occur within the first hour, 30% of the deaths occur early 1 hour to 1 week while 20% of deaths occur late (Donald D. Trunkey, 1983). Recent studies on this trimodal pattern from mature trauma systems seem to challenge this pattern. A study from New Zealand Pang, Civil, Ng, Adams, and Koelmeyer (2008) found there was a skew towards early deaths. The trimodal distribution of trauma deaths was not demonstrated in this group of patients. Other workers also found the absence of typical trimodal pattern (de Knegt, Meylaerts, & Leenen, 2008; Demetriades et al., 2005). But for the sake of convenience most trauma systems follow this in planning.

2 PRACTICE OF PREHOSPITAL CARE INTERVENTIONS

Prehospital care has over the years evolved into a distinct specialty with guidelines on different aspects of care being given differently. Some of the commonly used guidelines include the Prehospital Trauma Life Support System (PHTLS) and components of Advanced Trauma Life Support Systems (ATLS) both developed by the American College of Surgeons.

ATLS current edition recommends that during the prehospital phase, emphasis should be placed on airway maintenance, control of external bleeding and shock, immobilization of the patient, and immediate transport to the closest appropriate facility, preferably a verified trauma centre. Every effort should be made to minimize scene time, a concept that is supported by the Field Triage Decision Scheme (Subcommittee, Tchorz, & International, 2013)

2.1 Science and evidence of interventions

2.1.1 ABC of Resuscitation

2.1.1.1 Airway

Endotracheal tube insertion is a technically demanding psychomotor skill that needs training, regular practice and in many centres around the world the procedure cannot be done without licensing.

A clear airway is essential for breathing, clearing of air ways is done 'by sweeping' fingers across the mouth to remove foreign bodies. This standard basic life support protocol manoeuvre is practiced by emergency medical technicians. In unconscious patients lifting of chin pulls the tongue away from blocking the air passage. According to the ATLS protocol, if the patient is not breathing after clearing of airway then insertion of an endotracheal tube may be required. However, endotracheal tube insertion is a technically demanding psychomotor skill that needs training, regular practice and in many centres around the world the procedure cannot be done without licensing. This is because the intubation may result in the tube being placed in the food pipe rather than the wind pipe (Bridgewater, 2016; Gerich, Schmidt, Hubrich, Lobenhoffer, & Tscherne, 1998; Pointer, 1988). The survival was found to be low even in those patients that had correct placement of tubes.

There are reports that, compared with direct laryngoscopy, video laryngoscopy does not improve intubation outcomes in emergency and critical patients.

The development of the laryngeal mask airway in 1981 was an important first step toward widespread use and acceptance of the extraglottic airway (EGA) (E. T. Dickinson, Cohen, & Mechem, 1999). Newer designs of tubes do not need to be inserted in the trachea. These newer tubes can be placed in the pharynx to have a tight fit around the laryngopharynx. Combitube[R] is a special design of tube that can supposedly be inserted more safely. Patients with Out of Hospital Cardiac Arrest who receive Endo Tracheal Intubation (ETI) by EMS are more likely survive to hospital admission, and survive neurologically intact when compared to Supra Glottic Airway (SGA) (Hernandez, Klock Jr, & Ovassapian, 2012). Video endoscopic designs for 'safer' intubation has been recommended. However, there are reports that, compared with direct laryngoscopy, video laryngoscopy does not improve intubation outcomes in emergency and critical patients. Prehospital intubation is even worsened by use of video laryngoscopy when performed by experienced operators (Benoit, Gerecht, Steuerwald, & McMullan, 2015).

Recent evidence shows that the compression of the chest done for cardiac resuscitation produces sufficient negative pressure to allow respiration provided a clear air way is maintained.

The ATLS protocol of endotracheal intubation for better outcome needs further validation.

2.1.1.2 Breathing

CPR is a skill that needs an intensive training and re-training.

If after clearing of airway the patient does not breathe, then he will need external support for breathing. In the hospital setting this is done with the help of ventilator, while in the field setting, until recently the recommendation was to do mouth-to-mouth expired air ventilation. In view of the need to do close lip approximation with the patients' mouth there were a lot of inhibitions in this at the field level. This is further compounded by fear of risk of infections. Bag valve ventilation is a good alternative however; this also needs that the technology must reach the patient in a short span of time. Recent evidence shows that the compression of the chest done for cardiac resuscitation produces sufficient negative pressure to allow respiration provided a clear air way is maintained. This understanding has come only recently (Jiang, Ma, Li, Yue, & Xue, 2017).

2.1.1.3 Circulation

If the patient has no pulse and no heart beat then cardio-pulmonary resuscitation (CPR) needs to be initiated. Successful resuscitation following cardiac arrest requires an integrated set of coordinated actions. This includes:

- Immediate recognition of cardiac arrest and call for help which includes the activation of the emergency response system of the area.
- Early CPR with an emphasis on chest compressions
- Rapid defibrillation
- Effective advanced life support
- Integrated post–cardiac arrest care (Travers et al., 2010).

While these are recommendations of the American Heart Association, all this is possible only if a trained person with required equipment reaches the patient. In the short time between a critical injury and cardiac arrest this may be virtually impossible. While this may be possible in a situation of an angina or an MI patient (Myocardial Infarction), but in a trauma patient who is exsanguinated with a cardiac arrest the probability of survival is low. In trauma patients, the probability of revival after pre-hospital cardiac arrest is practically nil, unlike in cardiac disease patients. Usually the injury has caused so much of haemorrhage that the oxygen carrying capacity of blood would be significantly deranged and the myocardium is unlikely to respond to defibrillation and in one series, the overall mortality was reported to be 95% (Travers et al., 2010). In a series of 130 cases of trauma patients who needed CPR there were no survivors (Willis, Cameron, Bernard, & Fitzgerald, 2006). CPR is also a skill that needs an intensive training and re-training. Canadian national survival rates for out-of-hospital cardiac arrests have been reported to be less than 5% (Ala'a, Smith, Jennings, & Stoelwinder, 2014). Conflicting evidence remains regarding the benefit of CPR before defibrillation. The establishment of a consistent timeframe of chest compressions before defibrillation in the out-of-hospital setting will provide uniformity in standards in clinical practice and education and training (Cheung, Morrison, & Verbeek, 2001).

Hypothemia has been recommended by some to improve outcomes after cardiac arrest. However, in a review and meta-analysis regarding the survival to hospital discharge, favourable neurological outcome at hospital discharge, and rearrest found non-significant results. Using the Grading of Recommendations, Assessment, Development and Evaluation methodology, the quality of evidence was found to be very low (Doyle & Taillac, 2008). Current evidence to support prehospital critical care for out of hospital cardiac arrest (OHCA) is limited by the logistic difficulties of undertaking high quality research in this area. Further research needs an appropriate sample size with adjustments for confounding factors in observational research design (Winship, Williams, & Boyle, 2011)

2.1.2 Control of bleeding

By infusing intravenous fluids in the pre-hospital setting without control of bleeding the normal physiological compensatory mechanisms may be delayed. This may lead to increasing haemorrhage and complications.

The overall evidence on the use of intravenous fluids seem to suggest that these may not be useful in the pre-hospital setting where transportation times are less than an hour.

Internal bleeding is difficult to assess and in a patient with suspected internal bleeding the goal should be to reach the patient as early as possible to a definitive care facility for definitive treatment.

All trauma patients bleed. Some externally with the bright red blood causing an alarm reaction in the people around and panic in the patient. Bleeding may also be internal with truncal (abdomen and chest) and pelvic injury patients loosing huge volumes of blood internally without the patient showing any external blood. In such a situation patient assessment may be difficult unless the nature of the crash causing the injury is assessed. In high-energy trauma one can anticipate such bleeding and monitor the patient accordingly. At initial monitoring patient's blood pressure and pulse may show mild increase only while he may go in to shock with no recordable pulse in a short span of time. It is important to keep track of physiological parameters before shifting the patient / transferring the patient.

Traditional understanding of the physiology of bleeding was based on animal experiments where loss of increasing volume of blood led to increasing probability of complications like renal shutdown or shock and cardiac arrest. Replacement of blood volume to these animals led to improvement in survival and reduced complications. This was the basis of IV line placement and IV fluid infusion to patients of trauma. The ATLS 1998 manual recommended the placement of two large bore intravenous lines (IV) and crystalloid solutions may be given. In retrospect, the animal experiment models that were used to arrive at this IV fluid intervention recommendation were flawed models. This was because the experiments did not truly mimic a trauma situation where the closed loop of blood circulation gets converted to open loop and the patient continues to lose blood even when he is being transfused IV fluids. This could cause masking of true physiology and/or cause increased loss of blood from artificial maintenance of blood pressure. An alternative model where bleeding was allowed to continue even as the IV fluid was being infused clearly showed higher morbidity and mortality (Kowalenko, Stern, Dronen, & Wang, 1992; Owens, Watson, Prough, Uchida, & Kramer, 1995; Rosemurgy, Norris, Olson, Hurst, & Albrink, 1993).

In normal human physiology, whenever the closed loop circulatory system becomes an open loop for injury patient compensatory mechanisms get initiated depending on the volume of blood that was lost. Small volume loss causes only slight increase in heart rate, but as the volume of blood loss increases, heart rate increases, blood pressure stops dropping until a point is reached when blood pressure becomes un-recordable. Sensors in the blood circulatory system and the brain convey this message to initiate compensatory mechanisms like re-distribution of fluids from outside the circulatory system which initiate restoration of blood volume, and the clotting mechanism is initiated and completed to seal the leaks in blood vessels. The lowered blood pressure ensures that clots that are formed are not washed away by high pressure head of blood flow. By infusing intravenous fluids in the pre-hospital setting without control of bleeding the normal physiological compensatory mechanisms may be delayed. This may lead to increasing haemorrhage and complications.

Clinical studies by Okumura, Marques, Nunes, Chiosini, and Iriya (1995) and Krausz, Bar-Ziv, Rabinovici, and Gross (1992) showed better results with delayed resuscitation. Bickell et al. (1994) also reported no significance difference in resuscitating shock patients with injury severity scores over 25. Kaweski, Sise, and Virgilio (1990) found that intravenous access placement failed in 27% of cases and an average of 10-12 minutes were lost in placement of intravenous cannula. Placement of an intravenous cannula is particularly difficult in a shocked patient as all the veins collapse in shock. In children, this is difficult even when they are not in shock as the normal calibre of their veins is small. (Krausz et al., 1992) in a review found no level 1 evidence for volume of fluid to be infused in a trauma patient. There was only level II evidence for keeping the vein open and with a recommendation that rapid infusion system should not be used. In a review of the 8th edition of the ATLS protocol found in haemorrhagic shock management that there is no role of hypertonic saline and persistent infusion of large volumes of fluids in an attempt to achieve a normal BP is not a substitute for control of bleeding (Cotton et al., 2009). Balancing the goal of normal organ perfusion with the risk of re-bleeding by accepting by accepting a lower than normal B has been called “Controlled resuscitation” or “Balanced Resuscitation”. The 9th edition of ATLS protocol emphasizes balanced fluid resuscitation instead of aggressive resuscitation (Kortbeek et al., 2008).

The ideal time to initiate re-resuscitation, the ideal rate for a given patient, the ideal volume for a given injury are all grey areas where no clear understanding is available. The recommendations that exist are more in the form of consensus statements as in the ATLS document. In urban settings where pre-hospital times are less than 30-40 minutes, mortality following trauma is not influenced by the pre-hospital administration of intra-venous fluid but it is related to the severity of underlying injuries. In summary, the overall evidence on the use of intravenous fluids seem to suggest that these may not be useful in the pre-hospital setting where transportation times are less than an hour.

Control of bleeding and prevention of haemorrhagic shock is one of the key goals in a bleeding trauma patient. For a patient who is bleeding externally, direct pressure with a gauze or elevation of the limb are very simple measures that can be taught and practiced by any bystander. Tourniquets which were once popular became unpopular because of gangrene and ischemic loss of limb due to improper use of tourniquet. The pendulum is again swinging in favour of tourniquets because of experience from conflict areas in Iraq and Afghanistan where bleeding from blast injuries to the limb could be reduced by “supervised” use of surgical tourniquets (Subcommittee et al., 2013). Another study reports the use of arterial tourniquets in prehospital emergency care has been fraught with controversy and superstition for many years despite the potential utility of these tools. However, after the military experience on the supervised use of tourniquets its use is increasing. Safe prehospital tourniquet use is widespread in the military and is based on sound physiologic data and clinical experience from the surgical use of tourniquets (Shackelford et al., 2017). Internal bleeding is difficult to assess and in a patient with suspected internal bleeding the goal should be to reach the patient as early as possible to a definitive care facility for definitive treatment.

2.1.3 Blood transfusion

Replacing blood for blood may be considered ideal, however, it is not usually possible in the field setting.

Replacing blood for blood may be considered ideal, however, it is not usually possible in the field setting. The risks of blood transfusion have also helped formulate better guidelines for blood transfusion and it is neither desirable nor necessary to provide for blood in ambulances. O negative blood has been made available in some special situations in VIP ambulances but this is not recommended on a routine basis.

Making blood available at the periphery to the trauma victim is again gaining proponents because of the experience gained in recent combat situations. Among medically evacuated US military combat causalities in Afghanistan, blood product transfusion prehospital or within minutes of injury was associated with greater 24-hour and 30-day survival than delayed transfusion or no transfusion. The findings support prehospital transfusion in this setting (Wilson & Gangathimmaiah, 2017). However, replacement without control of bleeding is fraught with risks of further complicating a complex situation.

Many countries have protocols on documenting blood groups of drivers on driving licenses and in ID cards while knowledge of your blood group is useful as a potential donor, it provides you no advantage as a victim of trauma.

Many countries have protocols on documenting blood groups of drivers on driving licenses and in ID cards while knowledge of your blood group is useful as a potential donor, it provides you no advantage as a victim of trauma.

2.1.4 Pneumatic Anti-Shock Garments (PASG)

Pneumatic Anti-Shock Garments (PASG) are therefore not recommended and should not be used.

PASGs were a were developed as a military invention in the 70s. They were like pneumatic trousers that exsanguinated limb blood to re-circulate them to the heart and lung. However, the pneumatic inflation and pressure especially on injured limbs caused several complications. PASGs work like tourniquets and they cannot be used for long periods. They could also increase blood loss especially in uncontrolled truncal bleeds. These are therefore not recommended and should not be used but they are still being sold for use in ambulances of low-income countries (Beekley, Starnes, & Sebesta, 2007).

2.1.5 Triage

The ambulance itself may be a simple vehicle with a stretcher or it could be fitted with the most sophisticated equipment for monitoring and providing advanced cardiac life support.

The classification of patients according to medical needs and matching of these patients to available care resources is called triage. The purpose of triage is to ensure that a given patient gets transported to a definitive care facility where skills and technology for managing his injury are available. This avoids unnecessary delay in treatment and proper utilization of facilities. In trauma situations where one or two patients are involved, this may not seem so critical. This becomes very important in disaster situations where facilities in hospitals of different levels may be overwhelmed by patients

Treatment is rendered based on the ABC priorities (airway with cervical spine protection, Breathing, and Circulation with hemorrhage control). Other factors that may affect triage and treatment priority include injury severity, salvageability, and available resources. Triage also includes the sorting of patients in the field so that a decision can be made regarding the appropriate receiving medical facility. It is the responsibility of prehospital personnel and their medical directors to ensure that appropriate patients arrive at appropriate hospitals (Subcommittee et al., 2013). The ideal triage criteria in any given situation are difficult. In urban situations where ambulances are not available an informal kind of intuitive triage occurs when a crowd of bystanders decide where to take the patient.

2.2 Transportation of the injured patient

Different kinds of ambulances have been designed for transporting patients. Some even have subspecialty designations like Neonatal transport ambulances, ALS ambulances, BLS ambulances. In high income countries over 90% of patients are transported by ambulances, whereas in low-income countries like India and Africa most patients are transported in taxies, private cars and police vehicles.

Even in high income countries some of the patients are transported by non-EMS vehicles (K. Dickinson & Roberts, 1999). Interestingly patients with severe trauma transported by private means in this setting 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% patients transported in private vehicles 50% did not have access to telephone. Among the others, fear of delay and under estimation of the severity of trauma were the other causes (Demetriades et al., 1996). In Philadelphia 61% 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 (Hammond, Gomez, Fine, Eckes, & Castro, 1993). In a study done in Delhi it was found that ambulances transported only 4% of patients (Maheshwari & Mohan, 1989). Of the injured 51 per cent were transported to the hospital by taxies. Despite the absence of an ambulance about 53 per cent of these patients were transported within 30 minutes of the injury. This is comparable with urban ambulance transfer times in high income countries. In a comparative study of trauma mortality patterns, reported no patients were transported in ambulances to a teaching hospital in Ghana while over 90 per cent were transported by ambulances in Mexico and Seattle (Solagberu et al., 2009).

2.2.1 Equipment in an ambulance

The ambulance itself may be a simple vehicle with a stretcher or it could be fitted with the most 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 cannullas, oxygen cylinders, bag valve ventilators also form part of ambulance equipment. With improvements in technology defibrillators, mechanical ventilators, Mechanical CPR machines are all getting added on. However, there are no data to suggest that use of these equipment alter the outcome of trauma. One set of equipment which is essential and often found missing in ambulances are patient extrication tools to extricate patients trapped in crashed vehicles.

2.2.2 Speed of ambulances

Early transportation of the trauma patient within this first hour of high mortality was highlighted by the widely used term ‘Golden Hour’. However, Lerner and Moscati (2001) 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. The platinum half hour concept is an extrapolation of this to further highlight the importance of reducing time to definitive treatment.

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 pedestrians on the road. 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 (Berger, 2010; Saunders & Heye, 1994). 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 (Kahn, Pirrallo, & Kuhn, 2001). A study has shown that ambulances with flashing lights and sirens do not significantly reduce patient transportation time, the mean time saved was 2.9 min in urban areas and 8.9 min in rural areas (Petzäll, Petzäll, Jansson, & Nordström, 2011). Another study used ambulances with lights and sirens and a control ambulance without any of this, and found that the mean time saved to be 43.5 seconds in 50 trips. 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 (Petzall et al. 2011). A study found though the rate of ambulance injuries was greater in the urban environment, the severity of the injuries was worse in the rural environments where crashes occurred at higher posted speeds. In the rural setting non restrained passengers were more likely to be injured (Prasad et al., 1994).

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 are need further

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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.

evaluation. In a systematic review swift transport is reportedly beneficial for patients suffering neurotrauma and the haemodynamically unstable penetratingly injured patient. For haemodynamically stable undifferentiated trauma patients, increased on-scene-time and total prehospital time does not increase odds of mortality (Ho & Lindquist, 2001).

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 (Weiss, Ellis, Ernst, Land, & Garza, 2001). 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 (Snooks, Nicholl, Brazier, & Lees-Mlanga, 1996). Another study showed that a large majority of trauma patients transported by both helicopter and ground ambulance have 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 areas (Brathwaite et al., 1998).

Air transport is also fraught with risks of crashes and fatalities. Fatalities after helicopter EMS crashes are associated especially with post-crash fire (Schiller et al., 1988). Some counties have seen a 'distressing number of air ambulance crashes' (Susan P. Baker et al., 2006). 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.

2.2.3 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 (J. S. Sampalis, Lavoie, Salas, Nikolis, & Williams, 1994; J. S. Sampalis et al., 1997). 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.

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 (von Vopelius-Feldt, 2017).

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. Fentanyl was used in 75% of patients with fractures during transportation to the hospital (McSwain, 1995). Drugs were administered in 8.5% of urban emergency patients and 7% of rural emergency patients either at site or during transportation (DeVellis, Thomas, Wedel, Stein, & Vinci, 1998). So far, there is no reported evidence that prehospital medications are either beneficial or cannot be delayed until the arrival at the emergency room.

Many local haemostatic drugs are being tried to reduce bleeding from injured patients. But the value of Tranexamic acid (TXA) is recognised widely now. 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.

2.3 Drugs to control bleeding

Many local haemostatic drugs are being tried to reduce bleeding from injured patients. But the value of Tranexamic acid (TXA) is recognised widely now (CRASH-2 collaborators, 2011; CRASH-2 trial collaborators, 2010; Guerriero, Cairns, Perel, Shakur, & Roberts, 2011). Tranexamic acid was found to be useful to reduce the amount of blood loss in patients of trauma (Moss, Kolaric, & Watts, 1993). TXA was introduced to all emergency ambulances and emergency departments in the South West, UK, on 1 December 2011 (Paudyal et al., 2017). 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 (Ausset et al., 2015). Prehospital TXA protocol based on the CRASH-2 trial is safe and feasible (Vu et al., 2013). The first dose of TXA administered under this protocol marks the first ground EMS administration in the USA (Strosberg, Nguyen, Mostafavifar, Mell, & Evans, 2016).

There is little evidence regarding the relationship between prehospital spinal immobilization and patient neurological outcomes.

2.4 Care of wounds

Antiseptics and antibiotics are not necessary for care of wounds. All that is required is to keep the wound clean. Healing is a natural process, which cannot be hastened by any medicine and ointments can only delay healing. In case of small wounds if the wound is dirty then the best treatment is to wash the wound with clean water. This is the only first aid that may be required for small wounds and abrasions. Splints for the injured fractured/dislocated limbs can be splinted to help reduce pain and prevent further injury to the patient. This is an important first aid measure and must be attempted on scene to make the patient more comfortable. All kinds of materials can be improvised to work as splints and if nothing is available the opposite uninjured limb of the patient can function as an effective splint. Air splints are available which encircle the limbs and compress tissues. These can cause serious damage if applied too tight. Softer easily available materials like cushions, pillows or even rolled up magazines and newspaper may be equally effective without causing further damage.

In a major study on ALS vs BLS in the field setting did not seem to change outcome. Regardless, these interventions did not appear to benefit our rapidly transported, urban penetrating trauma patients

2.5 Care of the spine

Recognizing a spinal injury is not easy even for trained medical personnel. However, a high index of suspicion can prevent paralysis and further damage in a spinal cord injured patient.

Spinal cord injury must be suspected if the patient has a head injury, is unconscious or has altered sensorium, has paralysis of the limbs or is complaining of pain in the neck or back. There is, however, significant variation in clinically clearing cervical spine practice among emergency duty physicians. If spinal cord injury is suspected then the best first aid is to treat the patient as a 'log of wood'. All movements of bending, extending or rotation is to be avoided. Four or five persons can together transfer a patient as a 'log of wood'. There are no published high-level studies that assess the efficacy of spinal immobilisation in pre-hospital and emergency care settings. Almost all of the current evidence is related to spinal immobilisation is extrapolated data, mostly from healthy volunteers. There is a lack of high-level evidence on the effect of prehospital cervical spine immobilisation on patient outcomes. There is a clear need for large prospective studies to determine the clinical benefit of prehospital spinal immobilisation as well as to identify the subgroup of patients most likely to benefit (Hood & Considine, 2015).

In a Cochrane style systematic review and meta-analysis, and applied GRADE methodology to construct recommendations and to evaluate the literature on the critical outcomes of mortality, neurologic deficit, and potentially reversible neurologic deficit in spinal immobilisation it was found spine immobilization in penetrating trauma is associated with increased mortality and has not been shown to have a beneficial effect on mitigating neurologic deficits, even potentially reversible neurologic deficits. We recommend that spine immobilization not be used routinely for adult patients with penetrating trauma (Cone, Wydro, & Mininger, 1999).

A semi-rigid collar for the neck or even a simple rigid board can be used for shifting the patient. Repeated transfer of the patient is to be avoided in all patients suspected to have spinal cord injury. In a systematic review of literature to look at cervical spine immobilization it was found there is a lack of high-level evidence on the effect of pre-hospital cervical spine immobilization on patient outcomes (Velopulos et al., 2017).

In conclusion, there is little evidence regarding the relationship between prehospital spinal immobilization and patient neurological outcomes (Ala'a et al., 2014; Ala'a, Smith, Stoelwinder, Middleton, & Jennings, 2015).

2.5.1 ATLS vs BLS

In the mid-seventies, cardiac patients were found to do much better with the availability of ALS care. It was assumed, therefore, that all patients would do better with more being accomplished on the field. This assumption neglected a basic premise of patient care: the most important factor in patient survival is the time from the onset of the emergency to the provision of definitive care. There has been a lot of controversy about the value of ATLS for injured patients (McSwain, 1995). ATLS involves a greater use of technology, psychomotor skills and medication for pre-hospital care. BLS on the other hand focuses on basic airway support, control of bleeding, immobilization of spine and provision of supplemental oxygen when required. In a sample of 360 severely injured patients found that the outcome of trauma is not affected by ATLS on the scene (D. D. Trunkey, 1984). John S. Sampalis, Lavoie, Williams, Mulder, and Kalina (1993) also found no benefit from the use of ATLS for trauma patients with pre-hospital times less than 35 minutes. This was also reported by Cayten, Murphy, and Stahl (1993) and Adams, Aldag, and Wolford (1996). Jurisdictions throughout the US and some other parts of the world have invested substantial time and resources into creating and sustaining a pre-hospital advanced life support (ALS) system without knowing whether the efficacy of ALS-level care had been validated scientifically. The strongest support for ALS level care was in the area of responses to victims of cardiac arrest. Provision of ALS on scene was associated with a higher incidence of mortality whereas definitive care in level 1 or 2 compatible hospital was associated with a lower mortality

(J. S. Sampalis et al., 1994). In a major study on ALS vs BLS in the field setting did not seem to change outcome. Regardless, these interventions did not appear to benefit our rapidly transported, urban penetrating trauma patients (Bissell, Eslinger, & Zimmerman, 1998). Two recent studies found patients with out-of-hospital cardiac arrest and out-of-hospital medical emergencies who received BLS had higher survival at hospital discharge at 90 days compared with those who received ALS and were less likely to experience poor neurological functioning (Sanghavi, Jena, Newhouse, & Zaslavsky, 2015a, 2015b).

Two recent studies found patients with out-of-hospital cardiac arrest and out-of-hospital medical emergencies who received BLS had higher survival at hospital discharge at 90 days compared with those who received ALS and were less likely to experience poor neurological functioning.

2.5.2 'Scoop-and-Run' versus 'Stay-and-Stabilize'.

There are proponents for and against each of these approaches. 'scoop-and-run' involves extrication of the patient, maintenance of a clear airway, protection of spine and control of haemorrhage whenever possible. 'Stay-and-stabilize' on the other hand involves placement of intravenous lines, infusion of intravenous fluids, application of immobilizers and endotracheal intubation whenever required. There are many controversies related to the trauma patient care during the pre-hospital period nowadays. 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 (Beuran et al., 2012).

There are many controversies related to the trauma patient care during the pre-hospital period nowadays. A balance between "scoop and run" and "stay and play" is probably the best approach for trauma patients.

3 TRAUMA CARE IN THE HOSPITAL

All hospitals do not have the same level of expertise for managing trauma patients. Unnecessary shifting from one hospital to another hospital can be avoided if proper triaging is done in the beginning. The quality of a trauma system can be assessed by the rate of preventable deaths. If the patient had immediate access to emergency trauma care could we have saved a victim? The main failures in a review of trauma deaths were found to be errors and delays during the first phase of in-hospital assessment and care. An improvement in pre-hospital care will be almost useless if the quality of definitive in-hospital management is not addressed (Stochetti, 1994). It is important to have trauma teams and trauma systems in hospitals to improve the outcome of trauma. These have to be inclusive systems built into general or multispecialty hospitals. Standalone trauma centres are not recommended. This is because a given patient may have multisystem involvement in addition to co-morbidities that affect the outcome. So, it is better to have care where comprehensive care for all the problems of the patient can be given.

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.

Serious research is required is required in this field which has largely been driven by emotions and empiricisms rather than hard evidence.

4 RESEARCH IN PRE-HOSPITAL CARE AND FUTURE OF EMERGENCY MEDICINE

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 (Committee on the future of Emergency care in the U. S. health system, 2007). We are in a situation where something as basic as starting of an intravenous fluid in a traumatized patient is being labelled as controversial. 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.

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 correctly seems 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 (Gold, 1987). 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 (Spaite, Criss, Valenzuela, & Guisto, 1995). 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. Until 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 (Hagiwara, Henricson, Jonsson, & Suserud, 2011).

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. 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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