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Introduction

The Consultative Committee on Road Trauma continue to produce important reports on their work on trauma outcomes. Their current study published in the Journal of Trauma September 1998, has received international interest. It should be one of the hall mark papers in a catalytic process to improve trauma services. A ministerial committee have been established in Victoria to evaluate trauma care. On a Federal level, steps need to be taken to evaluate and improve trauma care. The paper from Victoria raises some key questions, not just about the smaller hospitals but also about the major trauma services and their role or lack of role in obtaining regional improvements in trauma care. It has been suggested that there is a need for legislative change in terms of trauma outcomes, similar to that which occurs in certain states in the US. This has resulted in significant, scientifically documented improvement in care. A good example of this is the disparity of care between the adjoining states of Washington and Oregon with improved care in Washington where trauma care is legislated.

We are pleased to have just released our Three year Regional Trauma Registry Report. This is a 160 page overview of regional care of trauma in South West Sydney. The report is not to be missed!

We would like to wish our readers in Australia, New Zealand, South Africa, Tanzania, UK, Ireland and the US a very Happy Christmas and a peaceful New Year. We currently print 3000 copies per issue so if you would like to receive your free copy let us know.

Michael Sugrue



Hypothermia and severe trauma

Tim Skinner, MB Bch, FRCA

Hypothermia continues to be a problem faced by many severe trauma victims. It is generally accepted to be detrimental to the patient and there are numerous methods of preventing or treating it. And yet many trauma patients are still hypothermic at some stage in their early management. This review takes another look at the evidence on hypothermia: incidence, effects, outcome and treatment.

What is hypothermia?

Most clinicians would agree that a core temperature of 35°C is consistent with mild hypothermia and moderate hypothermia occurs at a core temperature of less than 32°C. Some would argue that this definition should be skewed when considering trauma patients as the outcome is so poor when hypothermia and severe trauma co-exist.

The treatment of severe hypothermia (<28°C) as a result of environmental exposure is covered in other reviews and will not be dealt with here.

What is the incidence of hypothermia in trauma patients?

A study performed locally showed that 17% of patients with an ISS of more than 15 were hypothermic (<35°C) at some stage during their first 24 hours in hospital¹. 3% of patients became hypothermic in the ED or CT room.

The incidence of hypothermia in trauma victims in other countries may be as much as 50%. In some of these studies the greatest temperature losses occurred during the resuscitation period. In another study, 18% of trauma patients became hypothermic in the ED and only 1% of patients became hypothermic in the OR. Nonetheless 47% of patients who had a trauma laparotomy were hypothermic in the OR.

It seems that local practices may influence the timing of hypothermia during the passage of a patient through the trauma system. The evidence is, however, that a substantial number of severe trauma victims become hypothermic and will suffer its consequences.

Detrimental effects of hypothermia (or so what?)

There are a number of reviews that detail the complications of severe hypothermia in the general population. Accidental severe hypothermia (<32°C) affects many organ systems and there is a dose response relationship that ultimately ends in refractory asystole at 20°C. Clinicians are much more frequently faced with the moderately hypothermic (32-35°C) patient who will exhibit a less dramatic, but nonetheless unfavourable side effects profile.

COAGULOPATHY

The direct effects of hypothermia on clotting mechanisms are difficult to measure and are frequently masked by dilutional coagulopathy or DIC in the trauma setting. Hypothermia per se does not result in reduction in clotting factor levels and conventional clotting studies will be near normal. Routine clotting tests are performed on blood that is rewarmed to 37°C.



Hypothermia and severe trauma

Continued...

When these laboratory tests are repeated at hypothermic temperatures the clotting times are prolonged in a dose-related manner. A temperature of 32°C equates to clotting factor activity of 2.5% of normal. It is postulated that the major effect on clotting factors during hypothermia is on the kinetic activity of clotting enzymes. The appropriate treatment for hypothermia-induced coagulopathy is rewarming rather than administration of clotting factors.

Hypothermic coagulopathy is implicated as the cause of significantly increased blood loss and increased mortality following trauma laparotomy. Even when patients were stratified by injury severity (ISS), blood loss was significantly increased by intraoperative hypothermia. Hypothermia in a trauma Patient is a surgeon's nightmare.

MYOCARDIAL ISCHAEMIA

Inadvertent perioperative hypothermia has been shown to be associated with myocardial ischaemia, angina and hypoxia (PaO₂ < 80mmHg). A randomised controlled trial of routine vs. supplemental warming care in patients undergoing abdominal, thoracic or vascular surgical procedures with pre-existing coronary disease. Maintaining normothermia reduced the risk of cardiac events by 55%.

OUTCOME

There are a number of retrospective studies that identify hypothermia as an independent predictor of poor outcome in trauma patients. The landmark study of Jurkovich et al showed that a core temperature of 35 - 32°C was associated with a significant increase in mortality from trauma². Patients with core temperatures less than 32°C were unlikely to survive.

More recently the same workers in Seattle have published a number of papers extolling the virtues of rapid correction of hypothermia. The latest study is a randomised controlled trial of conventional rewarming vs. rapid rewarming of critically ill trauma patients. Rapid rewarming was achieved using a continuous arteriovenous rewarming device (CAVR) similar to an A-V haemofiltration circuit, but with the filter replaced by a heat exchanger.

CAVR patients were rewarmed more quickly and required less fluid during resuscitation (~24L vs. ~33L). Patients who underwent CAVR had significantly less early mortality (although the mortality advantage was non significant at discharge).

The case for rapid restoration of normothermia in the trauma patient is strong but not without dissenters. Those concerned with the treatment of brain injured patients point towards a small number of studies that suggest a beneficial outcome from hypothermia. These studies were in the treatment rather than resuscitative phase of the patients' hospitalisation and were not necessarily on patients with multiple injuries at

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| COMPLICATIONS OF SEVERE HYPOTHERMIA |
| BLEEDING |
| DIC |
| STRESS ULCERS |
| PNEUMONIA |
| OTHER INFECTIONS |
| CARDIAC DYSRHYTHMIA |
| RENAL FAILURE |
| HEPATIC FAILURE |
| PANCREATITIS |
| DIABETES LIKE SYNDROME |
| HYPOGLYCAEMIA |

VV. In patients with isolated serious head injury there may be a role for controlled moderate hypothermia.

Why do trauma patients become hypothermic?

Heat loss occurs when metabolic heat production is less than heat loss to the environment. A trauma patient is not only exposed to an adverse thermal environment but has a much reduced capacity for heat production.

ENVIRONMENTAL EXPOSURE (PRE-HOSPITAL)

Severe trauma will greatly limit the patient's ability to protect himself from the environment. Even with the arrival of help heat loss is sometimes difficult to control and other life-saving activities will take precedence. Paramedics are sensitive to the issue, particularly during prolonged entrapment, but there are few specific things that they can do. The NSW paramedic protocols mention "space blanket if cold" in the hypovolaemia section. There is no protocol for warming of IV fluids, although many will use vehicle or body heat if time allows.

5% of severe trauma victims were hypothermic on arrival in ED in a local study¹. More patients were hypothermic in the winter months, suggesting that Sydney's hot summers protect against hypothermia.

PATHOPHYSIOLOGY OF HEAT PRODUCTION

The influence of environmental exposure is compounded by the reduction in heat production that is a feature of traumatic injury.

Severely injured patients do not increase their metabolic rate to compensate for heat loss in the same way as the uninjured. It is not known exactly why this is. It is suggested by some, with supporting animal evidence, that hypothermia is a protective reflex during shock and that the thermoneutral 'set point' is lowered. Certainly shivering, the body's main method of acutely increasing heat production, is inhibited during hypotension and hypoxia. Other animal research points toward cold fluid resuscitation as the cause of hypothermia.

An increase in metabolic heat production may simply be impossible during traumatic shock as the tissues are no longer adequately supplied with oxygen. Rapid resuscitation following trauma

produces a rise in oxygen consumption above normal, suggesting that the metabolic response is appropriate when the tissues are adequately perfused.

INTRA-HOSPITAL ENVIRONMENT

Particularly during the summer months a trauma patient may be exposed to a worse thermal environment when admitted to hospital. Most areas of the hospital, including the ED, OR and ICU are air conditioned and the temperature and humidity may both be considerably less than outside. A normal human's thermoneutral temperature when naked is 28°C. When exposed to a typical ED environment with dry air at 22°C, radiant and evaporative heat loss will continue unless specific measures are taken to reduce them. Many normothermic trauma victims become hypothermic in the ED.

RESCUCITATION AND INVESTIGATION

Exposure of the patient must, of course, allow a thorough survey of injuries. Exposure is also necessary for many of the routine or diagnostic procedures associated with trauma resuscitation. Bladder catheterisation, peripheral and central intravenous access and peritoneal lavage will all expose a good deal of the patient to further heat loss.

Intravenous fluids are seldom at optimal temperature when infused into the patient, despite efforts to warm them. Even normothermic fluid will simply prevent further heat loss rather than treat hypothermia from other causes. Room temperature crystalloid (the 'hanging bag') and poorly rewarmed blood products will significantly contribute to heat loss.

Initial and definitive radiological investigations require the removal of 'excess' coverings and transfer to the X-ray department may increase environmental exposure, as well as postponing rewarming techniques.

Intubation bypasses the body's normal humidification system. Up to 10% of total heat loss occurs via respiration, principally due the specific latent heat required to vaporise water and humidify the inspired gases. Active warming and humidification of the airway is rarely a feature of ED resuscitation.

ANAESTHESIA AND SURGERY

The patient requiring surgery will be subjected to a whole new range of heat losing opportunities.

The thermal environment may be even worse than the ED as modern theatre suites possess air conditioning systems with high rates of air exchange. Evaporative heat loss is dramatically increased by air flow, particularly over moist body surfaces or cavities. In addition conduction to the operating table becomes a significant factor.

Surgery itself demands not only exposure of relatively large areas of the body surface, but also involves covering significant areas in cold skin

Quality Assessment of the Management of Road Trauma Facilities at a Level 1 Trauma Centre Compared with Other Hospitals in Victoria

Journal of Trauma October 98 Vol. 45 Page 772-779

Aim: The Consultative Committee on Road Trauma Fatalities in Victoria, Australia identified problems that contributed to the death of patients involved in Road Trauma. This current study, one of a few published by the group examines the outcomes at a Level 1 Trauma Centre compared to other hospitals in Victoria.

Methods: Between 1992 and 1997, 257 consecutive eligible fatalities were evaluated. Problems were identified and classified according to the hospital, be it trauma centre, specialist teaching level 2 hospital, metropolitan level 3, large regional level 3 and small regional hospitals.

Findings: Mean problems identified and those contributing to death were less frequent at the trauma centre than other hospitals. Preventable and potentially preventable deaths were also less common at the trauma centre (20%) than at the other hospital groups (specialist teaching 40%, metropolitan 41%, large regional 53%, small region 62%). Management of patients with major trauma at a level 1 trauma centre were associated with fewer problems contributing to death and fewer preventable and potentially preventable deaths than at the different hospital groups. A trauma system in Victoria including bypass of major trauma patients to designated hospitals or 24-hour trauma services is likely to decrease the frequency of problems including preventable death rates.

Comment: This study identifies many challenges which we all face in the care of trauma patients, that of commitment, education and evaluation of outcome. The group are to be commended on trying to improve road trauma care in the state of Victoria. There is obviously a long way to go.

Pre-Hospital Airway Management in the Acutely Injured Patient: The Role of Surgical Cricothyrotomy. Journal of Trauma 1998; Vol 45: Page 312-314

This paper by Thorsten Gerich and colleagues from Hanover Medical School evaluated airway care in the pre-hospital field.

Background: Ensuring an unobstructed airway and adequate oxygenation are first priorities in the resuscitation of the trauma patient. In situations of difficult endotracheal intubation, rapid sequence protocols frequently include the use of paralytic

What's new in Trauma?



agents and cricothyrotomy for airway management. Recent literature findings suggest that the pre-hospital use of cricothyrotomy is too frequent. The purpose of this study was (a) to evaluate the efficacy of a rapid sequence intubation protocol without the use of paralytic agents, and (b) to determine the need for cricothyrotomy by using this protocol in the field.

Methods: We prospectively analysed 383 acutely injured patients who were in need of airway control. Success rates, indications, and complications of endotracheal intubation and cricothyrotomy were analysed.

Results: Successful orotracheal intubation on the scene with the use of this protocol was performed in 373 of 383 patients (97%). Two patients (0.5%) arrived at the trauma center with unrecognised esophageal intubation. Eight patients underwent cricothyrotomy in the field, six without previous attempts at intubation.

Conclusion: Experienced emergency medical services personnel can effectively perform endotracheal intubation with narcotic analgesics without the use of paralytic agents in the field. With proper training for field airway management, cricothyrotomy in the field can be reduced to a few indications with high success rates.

Comment: The success rate of oral intubation on scene in these patients is to be commended. Their indications for pre-hospital intubation were clear with a GCS < 9, respiratory distress, saturation < 90%, haemodynamic instability with multi-system trauma, suspected thoracic trauma and three or more extremity fractures and airway obstruction. This experience contrasts sharply with our experience in South Western Sydney, where a small percentage of our patients meeting these criteria are intubated in the pre-hospital setting. Their incidence of cricothyrotomy was 2.4% with patient

inaccessibility in the airway obstruction as the leading indications for cricothyrotomy. It is pleasing to note that all surgical airways were established properly. The reported frequency of cricothyrotomy in relation to failed intubation in the field ranges from 2.6 to 18.5%. In the Emergency Department, the cricothyrotomy rate is usually reported between 1.5 and 2.5%. Of note in their series, cricothyrotomy was performed in 6 of the 8 cases as the primary mode of intubation, not as a result of failure to intubate. This is an important concept. Cricothyrotomy should always be considered both in the pre-hospital and resuscitation emergency rooms.

Outcome after Haemorrhagic Shock in Trauma Patients. Journal of Trauma 1998; Vol 45: Page 454-459.

This was a retrospective study from Seattle and Chicago looking at outcome from Haemorrhagic Shock by Susan Heckbert and colleagues.

Background: It is essential to identify patients at high risk of death and complications for future studies of interventions to decrease reperfusion injury.

Methods: We conducted an inception cohort study at a Level I trauma center to determine the rates and predictors of death, organ failure, and infection in trauma patients with systolic blood pressure (< 90 mm Hg in the field or in the emergency department).

Results: Among the 208 patients with haemorrhagic shock (blood pressure (< 90 mm Hg), 31% died within 2 hours of emergency department arrival, 12% died between 2 and 24 hours, 11% died after 24 hours, and 46% survived. Among those who survived (< 24 hours, 39% developed infection and 24% developed organ failure. Increasing volume of crystalloid in the first 24 hours was strongly associated with increased mortality ($p = 0.0001$).

Conclusion: Haemorrhage-induced hypotension in trauma patients is predictive of high mortality (54%) and morbidity. The requirement for large volumes of crystalloid was associated with increased mortality.

Comment: It is important that pre-hospital notification occur of patients who are significantly hypotensive. It is also our policy to inform the admitting surgeon of a patient who is hypotensive. This would appear to be justified based upon the significant mortality and morbidity in this group.



LETTER TO THE EDITOR

Circulatory Management of the Seriously Ill or Injured Child

It is well recognised that vascular access can be difficult to achieve at times in young patients. APLS (Advanced Paediatric Life Support) states that: "all seriously injured children require vascular access to be established urgently".

Most Paediatric centres in Australia and indeed worldwide nowadays are training staff (both nursing and medical) according to the standards laid down by APLS which highlights the need for early access by the Intraosseous route if other means are unobtainable.

The John Hopkins Hospital Golden Hour Handbook of Paediatric Advanced Life Support also states that "Vascular access must be obtained immediately when IV access cannot be obtained within 1-2 minutes in children < 5 years of age, use the Intraosseous route".

Indeed the gold standard for urgency of vascular access is well recognised as 60-90 secs. If this cannot be achieved Intraosseous access should be achieved

without further delay in the shocked patient.

APLS, Australia, is a newly formed group committed to improving the early management of acutely ill or injured children. The course has been brought to Australia with the support of the Australian College of Emergency Medicine, College of Paediatrics and College of Rural and Remote Medicine. Courses are conducted throughout Australia on a regular basis.

Material on the course is presented in a didactic fashion and is based on sound clinical and educational principles. Information may be obtained from:

Sandra Willis, Course Co-ordinator, APLS Australia
Email: willis@cryptic.rch.unimelb.edu.au

Editor

It is important for Trauma Teams to be aware of this concept. Pre-arrival notification of a hypotensive paediatric trauma is vital so that the arrival cannulation plan can be discussed and agreed upon. Time should not be wasted on difficult and often fruitless peripheral IV access in shocked babies and children.



TRAUMA TEAM ROLES

Team Leader:

- Co-ordinate the overall resus and stay hands off it at all possible.
- Ensure airway doctor in undertaking A,B,C and Disability assessment.
- In the event the patient requires urgent intubation the Team Leader should complete the primary survey.
- Check the circulation doctor has cannulated and organised bloods, arrested major bleeding, notified his/her surgical colleagues, be it neurosurgery or general surgery. In the event of the surgical registrar being unavailable (in Theatre), the team leader must organise a second surgeon/registrar.
- Encouragement of the scribe nurse to obtain vital signs and documentation.
- Support the radiographer to ensure x-rays are performed expeditiously.
- Ensure appropriate involvement of the orthopaedic registrar.
- Consideration of the family and advise Social Worker.
- Ensure that nursing duties are functioning well.
- Protection of staff with gloving gowning and eye protection.

- Role identification tags must be worn by all staff.

TIP: A team leader cannot lead if taking bloods, filling out forms or on the telephone. The need for delegation is a vital part of the role of the team leader in the Major Trauma Service. Obviously this will not be possible in the rural service.

Airway Doctor:

- Pre-arrival preparation n check intubation equipment
- Lead Gown and ensure that airway nurse has undertaken same
- Have introduced him/herself to the airway nurse and know nurse's name
- Evaluate the oropharynx while maintaining cervical spine immobilisation proceeding to appropriate airway manoeuvres which may include jaw thrust, chin lift, suctioning, Guedal airway, endotracheal intubation, consideration for orogastric or nasogastric tube and reassurance to the patient.

Circulation Doctor:

- Swift assessment of C, insertion of IV access and perform secondary survey.

Airway Nurse:

- Have intubation equipment ready
- Check drugs

Procedure Nurse:

- Have IV fluids ready
- Check catheter/DPL trolley
- Anticipate next move

Scribe Nurse

- Document observation and treatment
- Watch for hypothermia

Orderly:

- Appropriately remove patient's clothes.
- Oxygen cylinders checked, transport modules checked, suction ready
- Access to other departments expedited, lifts organised.

Social Worker:

- Social Worker should be informed of the patient's potential outcome so that family liaison can take place.

Protection of the staff is important

- Gowns, gloves, protective eyewear and masks should be worn to prevent potential contamination as the incidence of Hepatitis C and HIV is significantly over represented in the trauma population.

The rural and urban Trauma Team requires a different make up. The activation criteria can be somewhat similar and a group paging mechanism is obviously of advantage. It is important that prehospital communication begin and alert the impending arrival of a trauma. This is particularly important where less resources are available. Again a Team Leader is required. This may be a C.M.O or a General Practitioner. Usually the Rural Trauma Team has two nursing members. One from the Emergency Department and potentially one from a ward. In addition depending on the size of the hospital there may be surgical back-up or anaesthetic back-up. In general a team of four can function adequately to resuscitate the patient, provide vital airway and breathing and circulatory support. Consideration for transfer is important and activation of a retrieval team is vital.

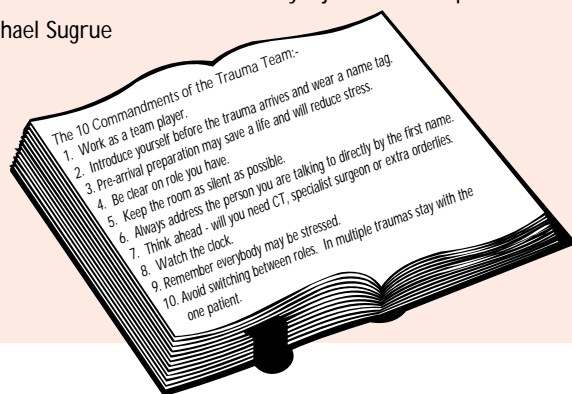
In major hospitals it is possible to regularly run major trauma resuscitations with a small Trauma Team. Dr. Brent Eastman in San Diego runs a team based upon an on call surgeon, respiratory technician and two nurses which deal with all major resuscitations.

Dr Eastman's staff however have little change over and work fairly exclusively in trauma.

The Trauma Team response is a vital and important part of patient resuscitation. Continued education is the only way to ensure smooth running. Positive feedback and video analysis are two very important aspects of improving Trauma Team function.

All hospitals, rural, urban or Major Trauma Services should have a Trauma Team to receive seriously injured trauma patients.

Michael Sugrue



Backchat

Congratulations to Professor Tim Hodgetts, formerly honorary Trauma Fellow at Liverpool who has been appointed to The Chair of Emergency Medicine and Trauma at the University of Surrey. This is a tremendous step forward for Trauma and Emergency care in the UK.



We wish Dr. Augustin Mallaya and staff at the Christian Medical Centre at Kilimanjaro (formerly honorary Trauma Fellow Liverpool Hospital) the very best in his conference on Trauma and Injury, the first to be held in Tanzania.



This month Ian Civil's Auckland unit ran a national trauma training day for registrars in New Zealand with over 50 in attendance - well done.



SWAN 7

SWAN 7 will be held on the 5th & 6th of August, 1999, bringing to you six (6) of the world leaders in Trauma care from overseas.

Dr. Bill Schwab, Philadelphia, USA, Dr. Margaret Knudson, San Francisco, USA, Dr. Ken Boffard, Johannesburg, Sth Africa, Dr. Don Trunkey, Oregon, USA, Jorie Klein, Dallas, USA, Lt. Col. Tim Hodgetts, Aldershot, UK. This Traumaganza is a must for all Swanoholics!

Controversies in Civilian and Military Trauma This promises to be a very exciting meeting on May 15-16th 1999 Brisbane Contact 07 33955743.

Australasian Trauma Society Meeting 20th November 1999 Auckland 64 7 8383123

Trauma Education Evening Thursday 16.30-19.30 January 14th Cheese and Wine sponsored again by our partners in photography Photosphere. (With Photosphere - your problem is their problem).

Definitive Surgical Trauma Care Course (DSTC)

Two 2 day course will be held in late July/August 1999. One in Sydney and the other in Melbourne. This course will focus on the Surgery of Trauma and will be aimed at specialist surgeons and trainees. This is a unique experience to work with icons in Trauma Surgery. Course numbers are limited.

Applications: m.sugrue@unsw.edu.au for Sydney
peter.danne@nwhcn.org.au for Melbourne

Meetings

cleaning solutions, some of which are more volatile than water and will cause significant cooling during vaporisation. During any operation there is the potential for further blood loss, requiring fluid replacement. One or more body cavities may be opened, greatly increasing evaporative heat loss.

Anaesthesia causes the greatest heat loss in the OR despite all these 'surgical' factors. This occurs in four distinct ways.

Firstly, all forms of anaesthetic agent reduce the basal metabolic rate from a normal of 50 to 40 W/m². Secondly, anaesthesia and muscle relaxation abolish shivering thermogenesis, which can increase heat production by up to 5 times normal. Thirdly, all forms of anaesthesia cause peripheral vasodilation, opposing vasoconstrictive heat conservation. This redistributes the body's heat energy to the periphery, where it can be more easily lost to the environment. Finally, volatile and narcotic agents reset the hypothalamic control of temperature to a lower 'normal'.

Additional heat losses will continue if intravenous fluid is inadequately warmed and if inspired gases are allowed to remain dry and cold.

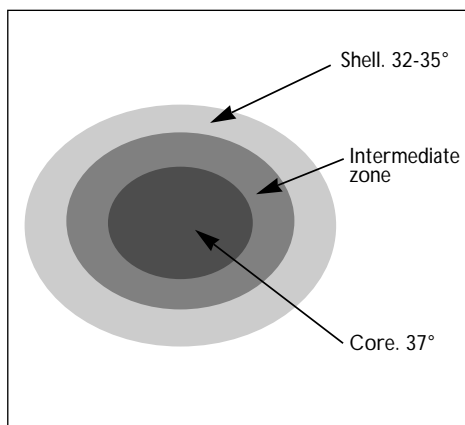
Measuring body temperature - core temperature is misleading

The human body is not a thermally homogeneous mass. The body may be divided into three thermal areas:

Core = brain, thoracic and abdominal organs, deep tissues in limbs

Intermediate zone = can be part of core or can reduce in temperature.

Shell = variable depth, in contact / insulation from external environment.



Temperature regulation and the relative size of these areas is under central control in the pre-optic anterior hypothalamus which responds to both central and peripheral temperature receptors. Vasoconstriction in response to cold will increase the size of the intermediate zone and reduce the temperature of the shell in order to maintain the core temperature. Core temperature is maintained despite a considerable

loss of heat energy, until a critical decrease in body heat content has already occurred.

Measurement of core temperature alone will miss total body heat loss until decompensation. Waiting for core temperature to drop before instituting treatment is analogous to waiting for hypotension before treating blood loss.

Treatment of hypothermia

Fiddling whilst Rome burns

According to the available evidence, we as ED physicians and anaesthetists are simply watching (and maybe documenting) whilst many of our sickest patients are progressively becoming more hypothermic. We are then expecting the surgeons to deal with a haemorrhaging patient whose clotting factor function is next to zero. In one series of trauma victims undergoing laparotomy, 90% of deaths occurred in the coldest patients (<33°C). Nine of these ten patients exsanguinated either in the OR or in the immediate postoperative period.

The ideal scenario would be one of early identification of at-risk trauma patients and timely intervention to prevent the development of hypothermia. Local audit will identify those at risk and their differentiating features, protocols backed by staff education and awareness will provide a framework for intervention. This may not be as exciting as the dramatic intervention of a portable bypass machine but certainly better for patient outcome.

PREVENTION OF FURTHER HEAT LOSS

Drying

The benefit of removing wet clothing and drying the patient as soon as possible cannot be overemphasised. Water is a much better thermal conductor than air and will convey heat away from the body by evaporation and conduction to any objects in contact with the patient.

Environment

Radiation to surrounding objects and the air immediately adjacent to the skin accounts for 40% of heat loss. Convection of the surrounding air and conduction to surfaces in contact with the body (the resus' trolley) account for a further 30% of heat loss. These three forms of heat loss are dependant upon a temperature gradient between the patient and his surroundings. The closer the environmental temperature is to the patient's thermoneutral temperature, the less the heat loss.

Thus the thermal comfort of the staff working in ED, OR and ICU is paid for by the induction of hypothermia in a proportion of their patients. Similarly, evaporative heat loss continues to be a significant factor even when the patient is cold. Up to 20% of total body heat loss may be via evaporation. 100% humidity in the resuscitation areas would, of course, reduce this loss to zero. More realistically, surgeons and anaesthetists who care for paediatric or burns patients are

more acutely aware of the effect of the environment and describe ambient OR temperatures of up to 26°C as "tolerable". In Liverpool hospital this would mean a rise of 4°C in ED and OR temperature. A 4°C difference between the patient's skin and the environment has the same thermal consequences as infusing 4 litres of room temperature fluid per hour.

INSULATION

1. Blankets

- Several layers trap air which acts as effective insulation.
- pre-warming blankets prevent heat loss from the patient performing this task.

2. Space blankets

- better insulation than a standard blanket.
- must be closely applied next to skin to act as radiant barrier - cover with normal blanket(s).

3. Convective air blankets

- when body well covered and blanket 'sealed' by additional coverings around the edges - provides very effective 43°C insulating layer.
- Little active warming as air has minimal heat content.
- patient must be dry to prevent evaporative loss.

PASSIVE REWARMING

If thermal insulation reduces heat loss to less than metabolic heat production, then the patient's temperature will increase. If all heat loss is prevented then basal heat production can be expected to achieve a rewarming rate of 1.2°C per hour. If the effects of hypoxia, trauma or anaesthetic agents do not prevent it, shivering can increase the rewarming rate to 3.6°C per hour. This will be at the expense of a greatly increased metabolic rate and oxygen consumption and may lead to anaerobic metabolism, lactic acidosis and significant cardiopulmonary stress. Passive rewarming should therefore be reserved for patients with moderate hypothermia who still have some physiological reserve to allow an increase in metabolic rate.

It should always be remembered that as much as 50% of radiant heat loss occurs from the head, particularly in those that lack their natural insulation.

Active Rewarming

AFTERDROP

External active rewarming of a hypothermic patient will cause peripheral vasodilation. Increased blood flow through the peripheral tissues is thought to return cold, acidotic blood to the central circulation. Core temperature initially falls 0.5 to 1°C before rising again. In severe hypothermia the acidosis may increase myocardial irritability and acute peripheral vasodilation may cause a relative hypovolaemia and require volume correction.

External rewarming

1. Water-circulating heating blankets

Electrically heated pads

- external active warming to body surface in contact with pad/blanket (20-30% of BSA).
- more effective when placed over patient (decreased radiant heat loss).

Continued next page



Hypothermia and severe trauma

Continued...

• may burn poorly perfused tissues.

2. Radiant heaters

- radiant heat gain requires that the patient is uncovered.
- allow procedures without interrupting rewarming.
- heat attending staff as well as patient.
- may cause thermal injury to underperfused tissues.

3. Airway rewarming

- modest heat transfer.
- 41°C supersaturated air - water condenses releasing latent heat of vaporisation.

CORE REWARMING

Water is a very efficient conductor and therefore donor of heat energy. Heat transfer is simply a function of the temperature change of the water that is being infused or circulated and the volume of the water. Core rewarming avoids the problem of afterdrop.

1. Warmed intravenous fluids

- many IV warming devices are inefficient at resuscitation flow rates.
- the greater the temperature difference between fluid and body, the greater the heat transfer.
- Technique is volume limited.
- hyperthermic fluids would add benefit but <45°C provides only modest heat transfer and 45 - 65°C requires central venous access to avoid tissue damage³.

2. Body cavity lavage

- Stomach via NG tube (risks aspiration), rectum, peritoneal or pleural cavities.
- relies on a large supply of preheated (40°C) sterile balanced salt solution.
- delivers heat energy in proportion to the in-out temperature difference.
- rewarms faster than most other methods (approx. 3°C

per hour)

3. Extracorporeal circulation

- most efficient and rapid methods of rewarming.
- Continuous arteriovenous rewarming (CAVR) or Cardiopulmonary bypass (CPB)
- circumvent limitations imposed by patient's volume requirements.
- require specialist equipment and experience / training in use.
- invasive techniques with associated risks.

Summary

On current evidence hypothermia is a common danger faced by trauma patients and every effort should be made to avoid its development. The majority of severely traumatised patients develop their hypothermia after arrival in the hospital. Techniques to prevent hypothermia are cheap, easy and relatively free of side effects. A fall in core temperature represents thermal decompensation and occurs only after considerable heat energy loss. Effective, rapid treatment of hypothermia requires equipment and expertise but may improve patient outcome.

All personnel should remain alert to the dangers of hypothermia in the trauma victim. Many are distracted during resuscitation by more obvious injuries. Perhaps the solution would be to add a member to the trauma team with a label proclaiming "hypothermia nurse".

Tim Skinner, MB Bch, FRCA

Careflight registrar and Visiting Anaesthetic Fellow.

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3. Gore DC, Beaton J
Infusion of Hot Crystalloid during operative burn wound debridement
The Journal of trauma 1997 42:6:1112-5

Case of the month

A 46 year old rider of a motorbike was involved in a high speed accident.

Pre-Hospital Information

Mechanism (M) Driver of motorbike
Injury (I) Head, Chest, Right arms
Signs (S) BP 90, P120/m, RR 34/min, GCS 12
Treatment (T) Oxygen, C Collar, Haemaccel 750mls, Morphine 5mgs

Pre Hospital Scene Time 15 min
Pre Hospital Transport Time 45 min

Resus Room

Primary Survey and Early Management

On arrival the patient was in obvious distress.

Airway - intact
Breathing - oxygen saturation was poor on 92% RR32/m
Circulation - Pulse 130 per minute
BP 110mmHg
Disability - GCS 13 Parasthesia R arm

The team organised urgent supine chest X-ray, C Spine and Pelvis X-rays. Breath sounds were reduced on the right side. Saturations came up to 96% on oxygen, rebreathing mask.
The blood pressure at this point was 120 systolic.

Secondary Survey

His head showed laceration to the right side of his face measuring 2 cms. His right humerus and right clavicle was clinically fractured. There was marked bruising over the right scapula. His abdomen was soft, but difficult to assess due to the slightly unco-operative nature of the patient and the relative decrease in the level of consciousness. There was significant parasthesia over most of right arm which was difficult to assess.

His circulation had stabilised after 1.5L of Haemaccel and 500mls of Saline.

The patient was in significant pain related to his right shoulder. A chest x-ray revealed a widened mediastinum, a fractured 1st, 2nd and 3rd ribs on the right side, fractured clavicle, fractured humerus and fractured neck of scapula.

Where do you go from here?

What are the most likely diagnoses?

What are your investigations going to focus on?

THE TRAUMA TEAM AND PATIENT CARE



An organised response to trauma care has been shown to work throughout the developed world with improvements in morbidity and mortality. To achieve this organised trauma care regionalisation of trauma systems have occurred and organisation of hospital services have been undertaken. One of the more important aspects of initial trauma care is the trauma team. This team can vary from 2 to 3 members in a rural hospital to 15 members in a Major Trauma Service. The numbers are not the crucial aspect to a trauma team, it is the structure, organisation, team work and communication that will determine the performance of the team and improve patient outcome.

A trauma team requires a trauma team leader working with the members of the team to predetermined roles. Anticipation and preparation for an impending trauma arrival requires good prehospital communication. Ideally the hospital communication system should be based in the receiving resuscitation and have

direct radio communication with the Ambulance Officers.

This review of the trauma team will outline two systems, one for the Rural Urban Services and a system for a Major Trauma Service. In general most Major Trauma Services in Australasia will receive between one and three trauma team activations per day. The criteria for trauma team activation vary from hospital to hospital. There may be a two tiered response or a single response. The aim of the trauma team response is to ensure that seriously injured patients receive maximal and timely care. A recent review of patients by the Trauma System Advisory Committee with ISS (16 presenting to Emergency Departments in Metropolitan Sydney found that 90% were seen by a trauma team. This figure is of concern as outcomes are significantly better when the patient was seen by an organised team. At Liverpool Hospital we use a single trauma team response activated on the base of history, vital signs and injury. The criteria are shown below.

PROTOCOL FOR PAGING THE TRAUMA TEAM

HISTORY

MVA ejected from vehicle.
Pedal cyclist, motorcyclist or pedestrian hit by car or truck.
Fall 5m or greater.
MVA with one or more fatality.
Fall from horse.
Interhospital trauma transfer.

VITAL SIGNS

Airway obstruction.
Shallow or retractive breathing.
Cyanosis.
Skin pallor or slow capillary refill >2 sec.
Systolic blood pressure 90mm/Hg.
Pulse >130 or <50/min.
Depressed level of consciousness or fitting.
Pupil(s) dilated or unreactive.
Trauma score 12 or less.
Deterioration in Emergency.

INJURIES

Injury to two or more body regions
(head/neck/chest/abdomen/pelvis/back/femur).
Fracture to two or more long bones (adjacent radius/ulna or tib/fib do not count as two).
Spinal cord injury.
Crush injury or amputation of a limb.
Penetrating injury to head, neck, chest abdomen, pelvis, groin or back.
Burns to airway or smoke inhalation. Adults >15% surface area, children >10%.
Penetrating injury to head, neck, chest, abdomen, groin or back.

There are some who will argue that a two tier response is beneficial in that it is less costly and more specific for treating patients with greater injury severity. However, the disadvantage is that in an Australian environment the number of trauma team activations is relatively small. This may result in significant under exposure of team members to trauma roles and a dysfunctional trauma team.

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