The HOTTT Drill

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Traumatic arrest & the HOTTT Drill

The HOTTT Drill provides a systematic approach to identifying and treating the most common, correctable causes of arrest in trauma patients. The response model emphasises predetermined roles for the team members and makes the most of the different strengths of physicians and paramedics.

Arrest in trauma does not have a good prognosis but neither is it hopeless. A recent (2013) observational study of 167 traumatic cardiac arrests from Madrid which uses a two physician response model has found an overall rate of complete neurological recovery of 6.6%. Survival by age group was predictably better in children (23.1%) than in the elderly (3.7%). Complete neurological recovery was achieved in 36.4% of VFs, 7% of PEAs, and 2.7% of those in asystole. The study certainly indicates that even asystole is not completely hopeless.

A systematic review of traumatic arrest survival did find significantly higher rates of survival in physician staffed prehospital services (Zwingmann). Optimistic figures are about 50% ROSC and 5% neurologically intact survival.


ORIGINAL ARTICLE

Traumatic cardiac arrest: Should advanced life support be initiated?

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BACKGROUND: Several studies recommend not initiating advanced life support in traumatic cardiac arrest (TCA), mainly owing to the poor prognosis in several series that have been published. This study aimed to analyze the survival of the TCA in our series and to determine which factors are more frequently associated with recovery of spontaneous circulation (ROSC) and complete neurologic recovery (CNR).

METHODS: This is a cohort study (2006–2009) of treatment benefits.

RESULTS: A total of 167 TCAs were analyzed. ROSC was obtained in 49.1%, and 6.6% achieved a CNR. Survival rate by age groups was 23.1% in children, 5.7% in adults, and 3.7% in the elderly ($p < 0.05$). There was no significant difference in ROSC according to which type of ambulance arrived first, but if the advanced ambulance first, 9.41% achieved a CNR, whereas only 3.7% if the basic ambulance first. We found significant differences between the response time and survival with a CNR (response time was 6.9 minutes for those who achieved a CNR and 9.2 minutes for those who died). Of the patients, 67.5% were in asystole, 25.9% in pulseless electrical activity (PEA), and 6.6% in VF. ROSC was achieved in 90.9% of VFs, 60.5% of PEAs, and 40.2% of those in asystole ($p < 0.05$), and CNR was achieved in 36.4% of VFs, 7% of PEAs, and 2.7% of those in asystole ($p < 0.05$). The mean (SD) quantity of fluid replacement was greater in ROSC (1,188.8 [786.7] mL of crystalloids and 487.7 [688.9] mL of colloids) than in those without ROSC (890.4 [622.4] mL of crystalloids and 184.2 [359.3] mL of colloids) ($p < 0.05$).

CONCLUSION: In our series, 6.6% of the patients survived with a CNR. Our data allow us to state beyond any doubt that advanced life support should be initiated in TCA patients regardless of the initial rhythm, especially in children and those with VF or PEA as the initial rhythm and that a rapid response time and aggressive fluid replacement are the keys to the survival of these patients. (*J Trauma Acute Care Surg.* 2013;74: 634–638. Copyright © 2013 by Lippincott Williams & Wilkins)

LEVEL OF EVIDENCE: Therapeutic study, level IV; epidemiologic study, level III.

KEY WORDS: Out-of-hospital cardiac arrest; survival; resuscitation; emergency medical services; SAMUR-Protección Civil.

In a large number of publications, traumatic cardiac arrest (TCA) is associated with a poor prognosis. The most recent studies suggest low survival rates with quite a large variation within the results (0–17%).[1] A French study in 2009 analyzed the survival in 129 patients with TCA who were attended by an emergency medical service (EMS) and found that 24.8% achieved recovery of spontaneous circulation (ROSC), 3.9% were alive after 24 hours, and only one patient survived the first year (survival rate, 0.77%).[2] Neither a chest drain insertion nor a resuscitative thoracotomy was performed on any of these patients, despite the fact that 94.6% of them had experienced gunshot wounds (GSWs) and would therefore possibly have benefited from these techniques. Another study was published in 2006 with patients receiving advanced life support (ALS) after experiencing a TCA caused by penetrating trauma.[3] In this series of 89 patients, only 4 survived to discharge (survival rate, 4.49%). A study with 161 patients published in 2003 tried to find physiologic factors capable of predicting survival to justify continuing ALS in this type of trauma patients. The authors considered that owing to the poor prognosis, administering ALS to all patients experiencing TCA could be considered a poor use of resources. They concluded that sinus rhythm on admission to hospital (defined as the first contact with a doctor) and pupillary reactivity could help to decide whether to continue ALS. None of the VF or asystole patients survived, and the overall survival rate was 9%.[4] In 1983, Shimazu and Shatney[5] published a survival rate with a complete neurologic recovery (CNR) of 1.5% in an extensive series of 267 patients.

The published survival rates of TCA patients have improved during the last 5 years owing to causes as yet undefined, as specified in the European Resuscitation Council 2010 guidelines, and the same guidelines estimate survival rates of 5.6% (range, 0–17%) in TCA patients. Despite the apparent improvement in the survival rates during the last few years, the latest studies published only estimate a mean survival rate with CNR of 1.6% in TCA patients.[1]

The survival of TCA patients poses a challenge for an EMS initiating ALS on-scene, especially with regard to having

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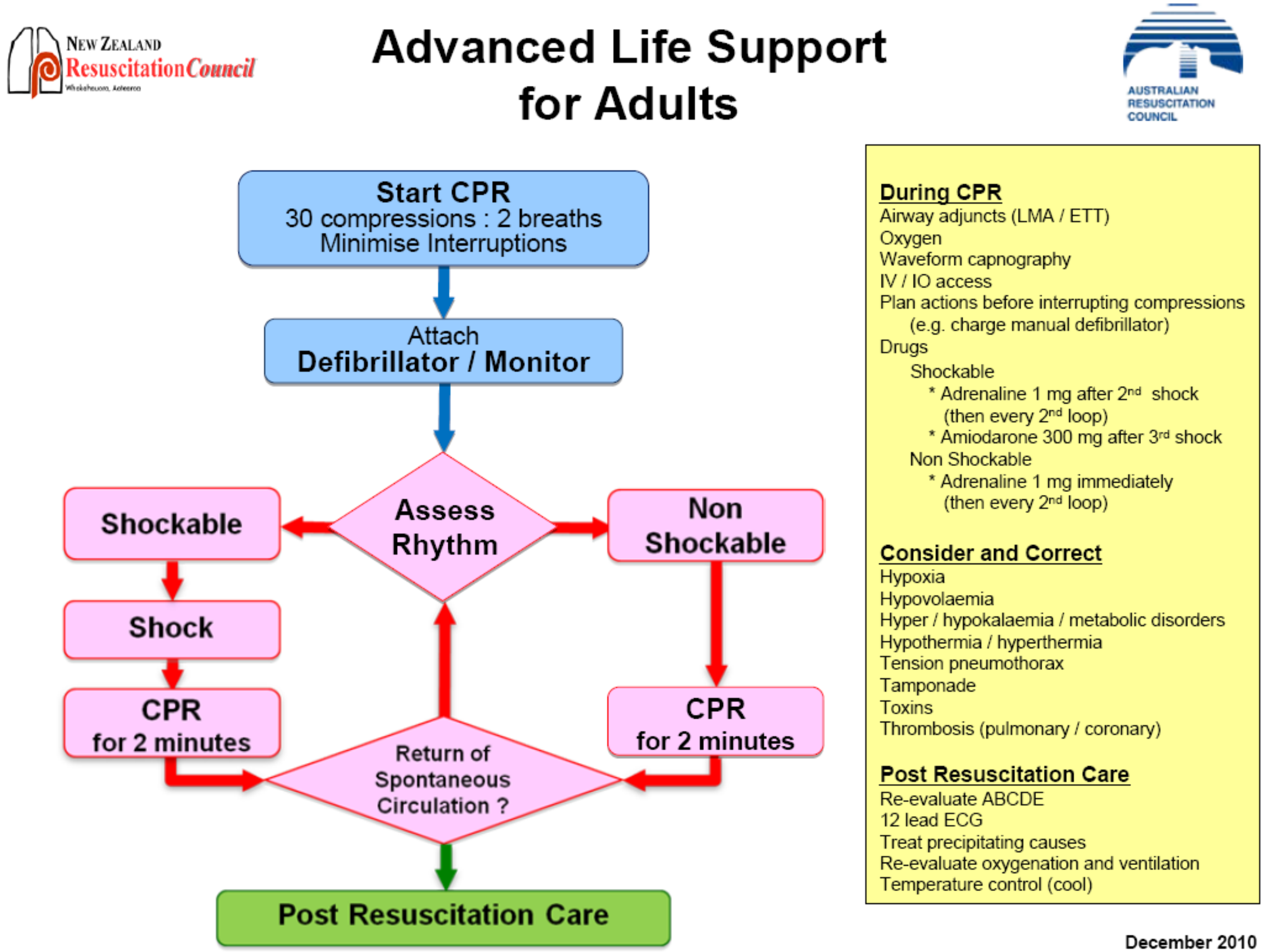
Reversible causes in arrest

To the right is the current ARC standard ALS cardiac arrest guideline. In the "consider and correct" section on potentially reversible causes are the classic 4 Hs and 4 Ts.

The HOTTT Drill focuses on the potentially reversible causes that are most likely in the trauma patient and which are rapidly correctable. These are:

- Hypoxia
- Tension pneumothorax
- (Tamponade in knife wounds to the chest)
- Hypovolaemia

Other causes of arrest are either unlikely in a true trauma patient or are not easily correctable.



So what's HOTTT?

The HOTTT Drill has five basic components then some mechanism specific considerations. The five components are:

Haemorrhage Stop massive external haemorrhage. This has been a major lesson from recent conflicts. Usually this type of bleeding is over by the time EMS arrive as the patient has already exsanguinated. If we however arrive very early then this takes absolute priority. Each ml of the patients own blood is worth 10mls of transfused products. This kind of bleeding is immediately obvious when you approach the patient. Deal with this before you move onto the airway.

Oxygenate This is the paramedics primary responsibility. Intubating the arrested patient without an assistant is in the core skill set of a paramedic and we use it to our advantage here. The patient should then be ventilated on 100% O_2 with no PEEP.

Tension Excluding tension is the doctors primary responsibility. Go straight in with the ultrasound. No definite sliding or B lines means immediate decompression. Use the needle in difficult access situations followed by thoracostomy as soon as feasible. Otherwise go straight in with thoracostomy and insert the drain prior to transport if ROSC is achieved unless the transport time will be very short. If however the lung is clearly up on ultrasound there is no indication for decompression and making a hole can only make a bad situation worse by causing partial collapse and shunting as well as wasting time.

Tourniquet Apply the AAJT unless contraindicated (and if not already done as part of step one). This will cause a dramatic rise in SVR even if the site of haemorrhage is above the tourniquet. This may enable perfusion of heart and brain till surgical control can be achieved.

Transfuse We need to get a lot of volume in very quickly if you are to have any hope of correcting a hypovolaemic arrest. Therefore we recommend a bolus of 7.5% saline (paed 4ml/kg). This approach means you can give the equivalent of 2000mls of crystalloid to an adult in a minute or two. Nothing else gives you this kind of bang for buck in volume expansion. Follow up with packed cells in patients who have either organised electrical rhythm or cardiac motion on echo. Packed cells are a valuable but finite resource. We therefore do not routinely transfuse asystolic patients due to the grim prognosis compared with other rhythms.

Mechanism specific considerations

Depending on the mechanism of injury specific further interventions should be considered:

- Application of a pelvic binder if blunt trauma and AP compression or vertical shear injury is possible
- Crush injury: calcium, bicarbonate, crystalloid (preferably saline) loading, hyperventilation, +/- tourniquets, +/- amputation. See the crush injury chapter in the PHTC course notes for further detail.
- Thoracotomy if:
  - stab wound to anterior chest or epigastrium,
  - arrest < 10 min prior,
  - >5 min transport from a major trauma service
  - *and* doctor is appropriately trained.
- Consider medical cause, particularly where arrest appears inconsistent with injury mechanism.

Thoracotomy notes:

Thoracotomy is not indicated in blunt trauma or gunshot wounds. There are ***no*** reported survivors from prehospital thoracotomy in the world literature for these injury mechanisms. We believe this constitutes reasonable evidence of futility.

Also notable is that all but one survivor of prehospital thoracotomy was tamponading. With the advent of small, reliable prehospital ultrasonography it is possible to rapidly exclude tamponade. Absence of tamponade is also adequate reason to withhold thoracotomy even if the other criteria are met.

Running HOTTT

This is a time critical situation. Like the pit crew, focused parallel processing is required. The team should call a "HOTTT drill" response when they arrive at an arrested trauma patient so that they are both on the same page about who is doing what. While the paramedic and doctor go about their primary responsibilities, ask one of the scene paramedics to get vascular access so that fluids can commence ASAP.

Standard ALS as per ARC guidelines should continue throughout the process – another use for the ground ambulance crews. Although CPR is unlikely to be of benefit in hypovolaemic arrest, you need to be certain that hypovolaemia is the cause before you discontinue it. As part of standard ALS, remember to check the rhythm – some will have a shockable rhythm. Most patients will be asystolic but in the Madrid paper 6.6% of patients were in VF, a treatable rhythm almost certainly helped by CPR. You do not want to discontinue CPR because it is a trauma arrest, only to get the monitor on and find the patient is in VF. And how sure are you that the traumatic incident did not have a medical cause, even in a younger person?

At conclusion of the case, please complete a HOTTT Drill Carebundle form for all arrested trauma patients.

When to cool it

There are a number of factors which have been shown to be associated with a higher chance of survival from traumatic arrest:

- Age is a strong independent predictor of survival: children >> adults > elderly
- One study (Cera) found that almost all survivors had reactive pupils at hospital admission. This might be the most useful single indicator of whether to persist.
- Survival is greater in VF >> PEA > asystole, although the incidence of these rhythms in traumatic arrest is asystole >> PEA > VF.
- A set of guidelines from the American National Association of EMS Physicians and the American College of Surgeons Committee on Trauma suggested cessation of resuscitation at 15mins. Several services have published survivors with resuscitation times that are longer than this however. We suggest 20 minutes in adults and 30 mins in children.

Mechanisms that do better:

- Single stab wounds
- Asphyxia e.g. isolated laryngeal injury, hangings etc
- Obstructive (tension pneumothorax or massive haemothorax due to isolated chest injury)
- Cardiac tamponade (only if thoracotomy performed promptly after arrest)
- Electrocution

Who can be expected to do badly?

Isolated head injuries with cardiac arrest all die. It is a symptom of complete autonomic failure.

Survival from pure hypovolaemic traumatic cardiac arrest is extremely rare.

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