Case Report

Two cases of penetrating left ventricular cardiac trauma: Pre-hospital ultrasound and direct to theatre

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ABSTRACT

Left ventricular (LV) Cardiac penetrating trauma is a rare and grave injury.

In cases of penetrating cardiac trauma, pre-hospital Ultrasound by flight doctors can assist identify specific pathology. This pre-hospital triage has now been linked to a change in both pre-hospital and in-hospital management.

There are minimal cases reported where Pre-Hospital ultrasound provided definitive diagnosis and, while providing Pre-Hospital blood transfusion, informed a direct to theatre approach. In 2017 in New South Wales, Australia, a new protocol “Code Crimson” has been introduced to formalise a system wide process where Pre-Hospital medical teams can expedite a straight to Theatre approach.

Case presentations

Case 1

A 28-year-old otherwise healthy male sustained two stab wounds to the right chest. The Care Flight Rapid Response Helicopter (CRRH) staffed by a retrieval physician and advanced care paramedic was airborne 3 min after notification. The Team was at the patient 21 min later. At initial assessment the patient was pale and diaphoretic. A systolic blood pressure (BP) of 70 mmHg, heart rate (HR) 136, respiratory rate (RR) of 30, SpO2 of 100% on room air and Glasgow coma scale (GCS) of 14.

Intravenous (IV) access obtained. The physician performed an extended focused assessment with sonography for trauma (EFAST). A large pericardial effusion was observed with features of tamponade including right ventricular systolic collapse, right atrial diastolic collapse and a distended inferior vena cava (IVC). A decision was made to transport immediately by air (see also Fig. 1).

The team departed with patient 17 min after arrival. 1 unit of red cell concentrate (RCC) and 500 mL of crystalloid were administered. The receiving Major Trauma Centre was advised of the EFAST findings. The receiving Cardiothoracic Service and Operating Theatre (OT) were prepared for patient arrival. The local Massive Transfusion Protocol (MTP) was activated. During flight a further 120 mL RCC was transfused and the patient received 1 g of IV Tranexamic Acid (TXA).

After a 20 min flight the patient was met on the helipad by the Trauma Team Leader and transported directly to the OT. He

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arrived in theatre 37 min after patient contact with Retrieval team from a distance of 84 km by direct flight. Emergency Sternotomy and mini thora
cotomy revealed a left lower chest wound penetrating the chest wall with entry into the LV myocardium and a five-
millimetre wound lateral and distal to the Left Anterior Descending Coronary Artery with active bleeding. There was also a 500 mL
haemothorax in the left thoracic cavity. These injuries were surgically repaired. The patient was extubated immediately post op-
eratively, discharged from intensive care the following day, and made a full recovery.

Case 2

A 52-year-old otherwise healthy male received two stab wounds to the chest and a laceration to his left wrist. The CRRH was
airborne three minutes after tasking and arrived at the patient 29 min later. A road EMS crew had already obtained IV access,
performed needle decompression of the left hemi thorax and administered oxygen after finding the patient was agitated with SpO2 of
80%. Upon arrival of the CRRH team, the patient had SpO2 of 99% on 15 l via non-rebreather mask, a systolic BP of 82 mmHg, HR of
115, RR of 15, and GCS of 10.

The physician performed an EFAST, identifying a large pericardial effusion with features of tamponade and a large left hae-
mopneumothorax. 1 unit RCC and 500 mL of compound sodium lactate were infused, followed by rapid sequence intubation (RSI),
left thoracostomy and pleural drain insertion.

After 30 min on scene, the retrieval team transferred the patient, administering TXA 1 g in flight, three units of RCC and a further
1000 mL of compound sodium lactate to maintain systolic BP between 70 and 80 mmHg. Flight time was 16 min to travel 75 km. The
hospital was notified of EFAST findings and patient condition during flight and Cardiothoracic Surgery team and the OT were
activated. The retrieval team was met on the helipad by the Trauma Team with a further 2 units RCC. The patient proceeded directly
to the OT and arrived there 66 min following initial patient contact. See Fig. 2.

At left thoracotomy a profusely bleeding left internal mammary artery was revealed. The patient had a laceration to the left lower
lobe of the lung that went through pericardium and penetrated the left ventricle. The patient remained intubated post operatively and
underwent surgery the following day for removal of thoracic packs and definitive closure of his chest. He was extubated 2 days after
injury, discharged from ICU a day later, and made a full recovery. See Table 1.

Discussion

The state of New South Wales (NSW) in Australia has an area of 800,000 km². This is approximately three times larger than the
total United Kingdom and twice as large as Germany. It is often challenging to minimise time to transport trauma patients to
definitive medical interventions. The ability of Pre-Hospital Medical teams to obtain diagnoses, exercise high level clinical decision-
making and notify Hospital services before arrival at Hospital can provide these patients with time critical care (See Fig. 3).
We present two cases with isolated penetrating stab injuries to the chest that penetrated the Left Ventricle. Both injuries occurred remote from the nearest trauma centre and both resulted in cardiac tamponade. Both with prolonged time to definitive care and a poor prognosis [1].

Diagnosis of pathology using pre-hospital ultrasound is now being supported by the literature [2,3]. These patients received an in-flight red cell concentrate transfusion. Early Pre-Hospital blood transfusion is associated with improved survival [4]. There was Pre-Hospital activation of the Hospital massive transfusion protocol and activation of the Cardiothoracic Surgery team and an Operating Theatre. Each patient was then transferred directly from the helipad to the OT.

Previously trauma centers in Australia had different approaches for receiving patients like these.

A recently introduced statewide protocol aims to formalise and expedite the process from retrieval, through the emergency
department to intervention for patients with non-compressible, life-threatening haemorrhage (Fig. 3). Following a Pre-hospital act-
viation, the protocol standardises Emergency room responses (Fig. 4), Facilitating streamlined surgical decision-making at the
receiving hospital.

The importance of time to de
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nitive treatment in trauma patients is documented [5]. This is particularly relevant for hypotensive
patients with non-compressible penetrating thoracic injuries, as longer transport times are associated with higher mortality. Mini-
mizing time from injury to OT is a challenge in Australia, where long transport times are common. Pre-hospital ultrasound, pre-
hospital transfusions, and a rapid transfer to the Trauma Centre are only of bene
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t to the patient if this hard won precious time is
respected and matched by the processes within the receiving Hospital itself.

Both patients survived neurologically intact this often-fatal injury.

List of abbreviations

NSW ITIM NSW Institute of Trauma and Injury Management
LV Left Ventricular
OT Operating Theatre
MTC Major Trauma Centre
MERT Medical Emergency Response Team
BP Blood Pressure
HR Heart Rate
RR Respiratory Rate
GCS Glasgow Coma Scale
EFAST Extended Focused Assessment with Sonography for Trauma
IVC Inferior Vena Cava
CRRH CareFlight Rapid Response Helicopter
MTP Massive Transfusion Protocol
TXA Tranexamic acid
IV Intravenous
RSI Rapid sequence intubation

Author’s contributions

PH and JH collated the patient case information. PH and TJ performed the literature review. PH, TJ and wrote the manuscript and
prepared it for publication. AG and AW revised the manuscript prior to submission. All authors read and approved the final
manuscript.

Ethics approval and consent to participate

Not applicable.

Consent for publication

Written informed consent was obtained from the patients for publication of this case report and accompanying images. A copy of
the written consent is available for review by the Editor-in-Chief of this Journal.

**Availability of data and material**

Data sharing is not applicable to this article as no datasets were generated or analysed during the current study.

**Competing interests**

The authors declare that they have no competing interests.
Trauma ‘Code Crimson’ activated by pre-hospital medical retrieval team

ED to confirm “pre-hospital activation of trauma ‘Code Crimson’ ”

Document pre-hospital notification from retrieval team in IMIST format

Activate trauma team – for example, “Trauma Attend”

Notify Surgical Consultant / Fellow on for Trauma via phone – immediate response required
Notify other relevant subspecialty surgical Consultant / Fellow
Notify Radiographer – to be present in resuscitation room

Confirm Operating Theatre / Interventional Radiology room and staff availability

Mobilise additional theatre / radiology team if necessary

Notify blood bank – activate Massive Transfusion Protocol

2 units uncrossmatched Red Blood Cells to be available immediately in ED and or helipad
Blood Bank to thaw and supply uncrossmatched Fresh Frozen Plasma

ED fluid warmer and or rapid infuser primed with blood

Trauma Team reception of patient in ED

Handover and initial assessment (primary survey)

Rapid decision (<10 minutes) for disposition

Surgical Consultant or Fellow +/- Trauma Consultant to decide:
Operating Theatre / Interventional Radiology / Computer Tomography

Fig. 4. Code crimson actioned by receiving trauma centre.
Flow chart of NSW Government Policy. Courtesy of ITIM – NSW Institute of Trauma and Injury Management.
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