

Echelons of care and aeromedical evacuation from the Middle East Area of Operations

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THE MIDDLE EAST AREA of Operations (MEAO) has highlighted a new paradigm in the conduct of aeromedical operations. The conflict is being waged in an asymmetric and non-contiguous battle space. Unique aspects of the conflict have brought about a refinement of the multistage aeromedical evacuation system, which is now characterised by five echelons of care and extremely rapid extraction and repatriation of casualties. The current operating concepts draw on the lessons learned from previous conflicts, and also from the civilian trauma system. In addition to the widespread use of damage control surgery, the conflict has seen a new range of battlefield innovations, each credited with decreasing injury and mortality.

Historical beginnings

Civilian and military trauma systems have evolved in partnership over the past 200 years.^{1,2} Air evacuation of casualties began in World War I and developed further in World War II, the Korean War and the Vietnam War. These conflicts were the beginnings of the routine use of aeromedical transportation, and eventually led to the more widespread use of air transportation in the civilian world.² Similarly, advances in battlefield casualty management helped develop civilian casualty management.³ Battalion aid stations and systematic casualty triage were pioneered in World War I. Soon after the end of the conflict, the civilian equivalent of battalion aid stations appeared in the United States, with the advent of accident and emergency receiving rooms.³

The Korean War featured several initiatives in casualty management, including rotary wing aeromedical transfer, rapid advances in radio communications and the placement of Mobile Army Surgical Hospitals near the front line.¹ Advancements in the Vietnam War included the use of organised field medics, who were the precursors of paramedics in the civilian world.⁴ Operation Desert Storm heralded the advent of the forward resuscitative surgical system in the US Marines, and forward surgical teams in the US Army.⁵ In



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Abstract

- ◆ The Middle East Area of Operations (MEAO) has highlighted a new paradigm in the conduct of aeromedical operations.
- ◆ The current medical evacuation system is organised into five echelons of care, beginning with self or “buddy” first aid and the combat medic (Echelon I) and ending with transfer to a US Department of Defense facility on the continental United States or an Australian Government hospital.
- ◆ Casualties in the MEAO are treated almost immediately they become injured, with movement to Echelon II within minutes and onwards to Echelon III (combat support hospitals) within hours. Transfer out of country to an Echelon IV facility may occur within 12 hours and to Echelon V within 2–3 days.
- ◆ Compared with conflicts just over a decade ago, the aeromedical evacuation system and the military trauma system have produced marked improvements in the way we conduct operations, with lower mortality rates.

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addition, the concept of damage control surgery was embraced, and this would occur as soon as the casualty was received.

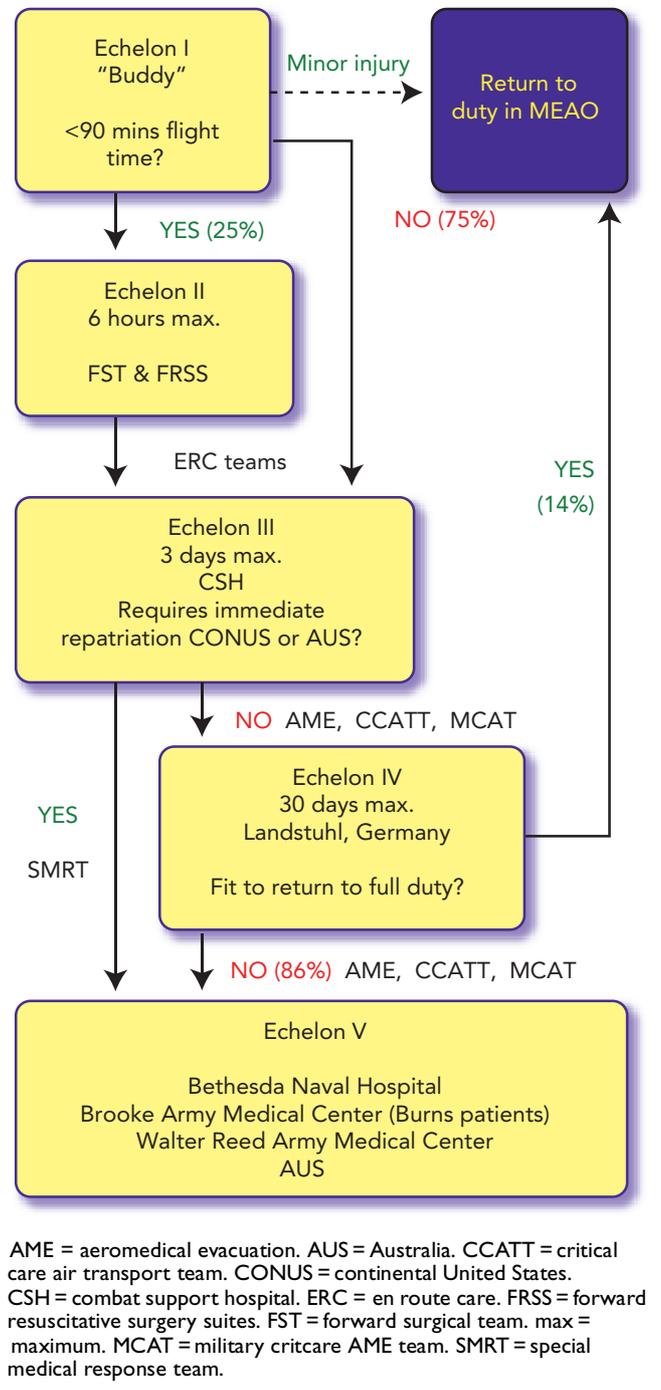
The evolution of a trauma system

A seminal event in the evolution of trauma care in the civilian world was the publication of *Accidental death and disability: the neglected disease of modern society* by the US National Academy of Sciences in 1966.³ As a result of this publication, civilian trauma centres began to grow in number and size over the next few decades. It is widely acknowledged that the mature trauma system has made a dramatic impact on decreasing morbidity and mortality from trauma.⁶⁻¹³

Trauma surgeons returning from the Vietnam War brought with them new concepts encompassing trauma centres, trauma teams and the development of prehospital protocols.¹⁴ The overarching philosophy within the trauma system is that trauma patients should be triaged to the most appropriate trauma facility.¹⁵

The lessons learned from previous military conflicts have brought about key concepts in military trauma care. These include the importance of early intervention,⁵ the validation of the use of forward surgical teams¹⁶ operating near and sometimes within the battle zone, and a hierarchical continuum of care known as echelons of care.² Injured personnel in the

Summary of the echelons of care in the Middle East Area of Operations (MEAO)



battle casualties, and of these about 80% require critical care equipment and transport teams.²¹

Modelled on the civilian trauma system and modified for the reality of combat, the military trauma system has goals of maximising the chance of survival and optimising recovery. To do this, the aim is “to get the right patient to the right place at the right time”.³

Echelons of care

The current medical evacuation system is organised into five echelons of care, with higher capability provided at each echelon.²² The echelon approach in combat begins with self or “buddy” first aid and the combat medic (Echelon I) and ends with transfer to a US Department of Defense facility on the continental US² or an Australian Government hospital (military or civilian) (Box).

In World War I, the average time interval from injury to treatment was 12–18 hours.²³ In World War II, the casualty passed through echelons of care more quickly than in previous conflicts. Resuscitation included blood transfusion and surgical therapy, with the casualty receiving care within 6–9 hours.²³ The Vietnam conflict saw rapid evacuation of casualties, who would arrive at acute care hospitals often with severe injuries.

The conflict in the MEAO sees casualties being treated almost immediately they become injured, with movement to Echelon II within minutes and onwards to Echelon III (combat support hospitals) within hours. Transfer out of country to an Echelon IV facility may occur within 12 hours and to Echelon V within 2–3 days.²¹ US assets in theatre consist of seven forward surgical teams and two forward resuscitative surgery suites providing Echelon II care, and two combat support hospitals strategically divided into four locations to provide Echelon III care.²⁴ Each echelon has a maximum holding interval — up to 6 hours in Echelon II, 3 days in Echelon III, and up to 30 days at an Echelon IV facility, such as Landstuhl Regional Medical Center, Germany.²⁵

Echelon I

The first level of medical care is afforded by self or “buddy” first aid, which may include application of the Combat Application Tourniquet or the HemCon haemostatic bandage.^{26,27} Combat medics use advanced trauma life support skills and protocols to treat their casualties.²⁵ The casualty is transferred immediately to an Echelon II facility for further care, usually by rotary wing transport.⁵

Echelon II

Echelon II is characterised by mobile groups of highly trained medical staff, typified by the forward surgical team and forward resuscitative surgical suite units.

A forward resuscitative surgical suite has a team of eight staff, including two general surgeons, one anaesthesia technician/provider, one critical care nurse, one duty technician, two operating room technicians and one general

MEAO are usually moved rearwards and to increasingly sophisticated levels of care; often undergoing two to three damage control surgical operations while en route.

The emphasis is on rapid evacuation — often permitting repatriation within 36–96 hours.^{17–20} This should be contrasted with evacuation times from the Vietnam War, which were up to 45 days.^{19,20} About 20% of all patients who undergo aeromedical evacuation from the MEAO are



Transfer from Echelon II to Echelon III is usually performed by US Army Blackhawk helicopters and CH46 Chinooks. Photo: G K Bruce, Balad Air Base.



Ground transportation to Echelon II or Echelon III facilities is also provided by "up-armoured" ambulances, where appropriate. Photo: G K Bruce.

duties member.⁵ They operate from a transportable facility which can be moved by a five ton truck or two Humvees with trailers. The facility can provide up to six major operations, including laparotomies, thoracotomies, amputations, craniotomies, surgical airway, external fixateurs and vascular repair.⁵

A forward surgical team operates in a similar manner, with up to three general surgeons and one orthopaedic surgeon, and requires five Humvees to ensure mobility. Surgery is performed using damage control techniques, and the entire facility may exist in one location for less than 12 hours.¹⁶ It is not unusual for an Echelon II facility to come under enemy fire.

Patient transfer is performed as soon as surgery concludes and is usually conducted via rotary wing airframe to a combat support hospital. Echelon II facilities are ideally suited to a rapidly moving ground phase of combat operations, and would usually be dissolved into an Echelon III facility if the situation became static. If flight times to an Echelon III facility are less than 90 minutes, the forward surgical team should be overflowed, as survival is not improved by transiting a patient through a forward surgical team if a combat support hospital can be reached expediently.²⁴ In reality, 75% of casualties appropriately bypass the forward surgical teams

and are taken directly to an Echelon III combat support hospital via rotary wing aeromedical evacuation.²⁴

Echelon III

Aeromedical evacuation teams escort casualties to Echelon III facilities at US Air Force theatre hospitals. If the patient is stable, he or she is immediately on forwarded to more definitive care at Landstuhl Regional Medical Center, Germany.²¹ Stationary Echelon III facilities are provided at combat support hospitals.

The 332nd Expeditionary Medical Group Air Force Theatre Hospital at Balad Air Base, Iraq, is the major evacuation hub for all coalition casualties and non-battlefield disease in the area of operations.²⁸ Australian Defence Force health personnel have been embedded within this facility.²⁵ The facility consists of 25 tents providing 60 ward beds, including 18 intensive care beds and 12 emergency room beds. There are two helical computed tomography scanners and three reinforced operating room structures, each capable of supporting two operations simultaneously.

The unit provides 24-hour coverage and equates to a Level I trauma centre. In keeping with this level of service, the unit participates in process improvement, trauma registry, weekly mortality and morbidity and weekly teleconferences to Iraq, Germany and the US.²⁸

The survival rate for casualties brought to the facility is 96%.²⁸ The patients are handed over to aeromedical evacuation teams and critical care air transport teams for evacuation as soon as practicable.²⁵

Echelon IV

It is a 5-hour flight on a C-17 from Balad to Ramstein Air Base near Landstuhl Regional Medical Center.²⁰ Patients



Aerial view of Balad Air Base, Iraq, showing the 332nd EMDG Air Force Theatre Hospital. Photo: G K Bruce.



The US Air Force maintains a fleet of ambulance buses (AMBUS) at Ramstein, Germany, to receive aeromedical evacuation patients arriving on C-17 aircraft. The interior of the AMBUS is shown at right. Photos: P V McGinty, with permission.



received at these hospitals undergo further medical stabilisation and operative debridement. Patients with less severe injuries or isolated injuries are able to return to the area of operations; this accounts for 14% of battle casualties.¹⁷ However, most patients are transferred to their country of origin within a matter of days.

Echelon V

US casualties are transferred to Echelon V Department of Defense hospitals located at Walter Reed Army Medical Center, Bethesda Naval Hospital in Washington, or the Brooke Army Medical Center in San Antonio.²⁹ Patients are returned to selected hospitals depending on their injuries, or to the hospital nearest their home if there are no special requirements. Burns patients are taken to the Brooke Army Medical Center, and amputees are taken to Walter Reed Army Medical Center.¹⁷

The US Air Force schedules round-trip C-17 missions from the US to Germany. Each mission lasts 5 days and there are 12–18 flights per month.²⁹

Statistics show that follow-up surgery was required on up to 43% of battlefield casualties upon return to the continental US.³⁰

Aeromedical evacuation: airframes, personnel and operating principles

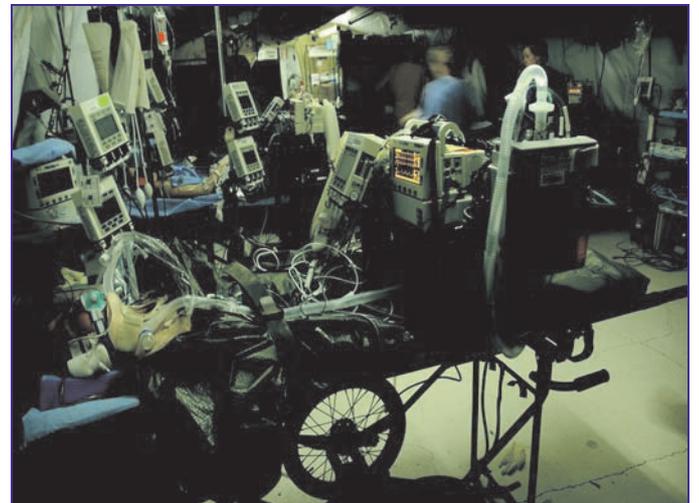
The echelon system only works if a robust system has been put in place. The US Air Force has provided this, as evidenced by the many thousands of casualties that have been evacuated from the MEAO using the echelons of care aeromedical evacuation system.²⁹ As of March 2007, more than 32 000 coalition personnel had been evacuated.

The current operating principle for the allocation of air assets is to use “designated airlift”, as opposed to previous systems where aeromedical evacuation was performed using “dedicated airlift”. It was acknowledged that using dedicated airlift for aeromedical evacuation reduced the operational capability of the mission by segregating the aeromedical evacuation

missions from the rest of the air mobility world. The reality was reduced flight availability for aeromedical evacuation and increased timeframes to perform air evacuation.¹⁸

The quantum shift in approach was the use of more highly trained aeromedical evacuation teams and critical care air transport personnel — allowing air transportation of patients who previously remained in theatre until fully stabilised.¹⁸ Not only did this congest the echelons of care, it meant some patients died waiting. Further to this, the aeromedical evacuation system adopted a more modular approach. The aeromedical evacuation teams and the critical care air transport teams began to use portable patient pallets and equipment that could be supported in a variety of aircraft.¹⁸ It is now unusual to find large numbers of casualties remaining in Iraq or Afghanistan echelon hospitals, because they have already been moved by the aeromedical evacuation system.³¹

Aeromedical evacuation patient priorities for movement are determined by their treating physician. The three categories



A patient on a mobile gurney following damage control surgery. The patient is ready to be loaded onto a waiting C-17 aeromedical evacuation flight for transfer to an Echelon IV facility by a critical care air transport team. Note the intensive care unit stretcher bridge. Photo: G K Bruce.

are routine, priority and urgent.³² An urgent patient requires aeromedical evacuation as soon as possible to save life, sight or limb. A priority patient has needs which allow up to 24 hours, and a routine patient can wait until there is a scheduled flight.³² There are six scheduled flights between Echelon III (Balad) and Echelon IV (Landstuhl) centres each week.¹⁸



Left: aeromedical evacuation stretchers are cleaned down with high pressure hoses. Above: aeromedical evacuation equipment is restocked and stowed in climate controlled facilities. Equipment is tracked using a bar code system. Photos: PV McGinty, with permission.

Airframes

Rotary wing

Transfer between point of wounding to an Echelon II facility is via US Army Blackhawk airframe or CH46 Chinook. The second echelon is bypassed if a combat support hospital (Echelon III) is within 90 minutes' flight time.²⁴

Fixed wing

During the early stages of Operation Iraqi Freedom, the US Air Force moved away from using their traditional aircraft for aeromedical evacuation and began to use whichever aircraft became available. Most commonly this would be the C-17 Globemaster and the C-130 Hercules.²¹ By using modular aeromedical patient equipment, the aeromedical evacuation teams could easily transfer between airframes as they became available. The aeromedical evacuation pallets were adapted for use, and are now compatible for use in the KC-135, C-5, C-17, C-130 and C-141 aircraft.²¹ The C-17 Globemaster can transport up to 70 patients, including nine intensive care patients. The C-17 has many advantages over the C-141 and C-130, being quieter, having less vibration and more capable environmental conditioning systems.²⁰

Personnel

Transfer of critically injured casualties between Echelon II and Echelon III facilities is performed by en route care teams. The patients have already undergone their first damage control surgery and are usually intubated and ventilated.¹⁹ The standard en route care team consists of a critical care trained nurse and a medical technician.¹⁹

The average flight time between the Echelon II and III facilities is 30 minutes, with the round trip taking only 80 minutes.¹⁹

Critical Care Aeromedical Transport Teams and Military Critcare AME Teams

Transfer of critically ill patients between Echelon III and Echelon IV (Landstuhl, Germany) is the responsibility of the US Air Force critical care transport team.^{19,21} The three-person critical care transport team typically consists of a critical care nurse, a respiratory therapist and a critical care

physician. The critical care transport team will also have standard aeromedical evacuation teams on the aircraft.¹⁸ The aeromedical evacuation team is tasked with configuring the aircraft and running the aeromedical evacuation mission. The critical care transport team is tasked specifically with the care of the patient, and is not there to run the aircraft or the aeromedical evacuation mission.¹⁸

The concept of the critical care transport team has been taken up by the Royal Australian Air Force with the formation of an equivalent group called Military Critcare AME Team.³³

Special Medical Response Teams

Brooke Army Medical Center is a specialised burns centre, and provides four-person burns teams to conduct specialised aeromedical evacuation missions. The teams consist of a burns critical care doctor, a critical care nurse, a licensed practical nurse and a medical technician. The team carries specialised burns equipment to assist with the aeromedical evacuation.¹⁹

Conclusion

The aeromedical evacuation system and the current military trauma system synergistically combine to effect the lowest level of battlefield casualty rates ever seen. Advances have included the use of newer aircraft, including the C-17, and dedicated aeromedical evacuation teams with specialist skills. Casualties undergo damage control surgery at the earliest opportunity and are moved rapidly through the echelons even when they are unstable. Compared with conflicts just over a decade ago, the aeromedical evacuation system and the military trauma system have produced marked improvements in the way we conduct operations, with lower mortality rates. It is anticipated that the current echelons of care concept will be standard practice for conflicts in the near to medium future.

Competing interests

None identified. The views, opinions, and/or findings in this report are those of the author and should not be construed as an official policy of the Royal Australian Air Force or the Australian Defence Force.



An aeromedical evacuation pallet in storage — ready for use in a wide variety of aircraft, including the KC-135, C-5, C-17, C-130 and C-141. Photo: PV McGinty, with permission.



An aeromedical evacuation stretcher on the pallet. Note the ease of securing the stretcher. Photo: PV McGinty, with permission.

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