

Aeromedical evacuation — the first 100 years

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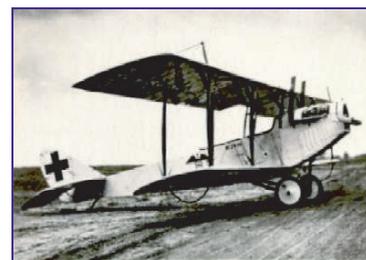
AEROMEDICAL EVACUATION (AME) has made an enormous contribution to improving the well-being of both military and civilian patients who have been injured¹ or who require rapid transfer from one medical facility to another.² Although a relatively new branch of medical practice, AME has undergone an enormous evolution. The care now offered in flight often exceeds that which is available in many land-based treatment facilities. Here I map this evolution and offer some thoughts as to how best the Australian Defence Force can guide Australian military AME into its second century.

The formative years

While many texts of aviation medicine will suggest that AME predates heavier-than-air flight, the rather quaint story of the French using balloons to evacuate patients away from enemy lines during the Franco-Prussian War has only recently been discounted.³ It was not until the Wright brothers completed their history-making flight on the sand dunes of Kitty Hawk that AME really became a possibility. In 1910, only seven years after that first flight, two American Army officers were the first to modify a biplane to carry a litter patient.⁴

World War I

World War I saw an extremely rapid development in the design of aircraft and a broadening of the missions for which they could be effective. In 1915, the French evacuated a wounded soldier from Serbia by aircraft and 1917 saw the arrival of the first aircraft specifically designed for AME use (a French Dorand ARII).⁴ In early 1918 a US Army pilot and Reserve medical officer modified a Curtiss JN-4D “Jenny” to carry a patient on a litter in the rear cockpit area. This aircraft is recognised as the first American air ambulance and was designed as a crash-rescue plane to aid pilots involved in accidents.⁵ By mid-1918 this idea had been further developed and sufficient Curtiss JN-4H aircraft were modified to station one at all flying fields. It should be noted that the main thrust



One of the earliest air ambulances—a Curtiss JN4D “Jenny” modified to carry a patient on a litter by Captain William C Ocker and Major Wilson E Driver, USA, 1918. Top speed: 128km/h.

Synopsis

- ◆ Aeromedical evacuation (AME) began early in the history of aviation, originally as a method of responding to air crashes.
- ◆ In World War II, AME developed into a means of transporting large numbers of patients from field hospitals to definitive treatment centres away from the theatre of war.
- ◆ In the Korean War, the helicopter began to be used for evacuating the wounded directly from the battlefield.
- ◆ AME will soon be able to offer patients a standard of care as good as anything they receive on the ground—provided the training of the AME staff is sufficiently good.
- ◆ In Australia, the highest level of AME skills is found in the civilian sector. The ADF needs to develop a matching level of advanced resuscitation skills for its AME staff.

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of AME during this period was the rescue and treatment of a small number of patients by a physician attendant.

Between the wars

It was the period between the two World Wars that saw the rapid acceptance of the aircraft as a safe and effective means of moving patients over long distances. By late 1919 the US Army had requested that a dedicated air ambulance aircraft be designed. In early 1920 a civilian engineer developed a modification for the De Havilland DH-4A so that it could carry two litter patients and an attendant physician. These aircraft were used extensively throughout the south-western United States but were limited to the crash-rescue role.

In 1920, under the guidance of the Medical Research Laboratory and the School of Flight Surgeons at McCook-Field, Curtiss Eagle aircraft were converted to carry four litter and two seated patients (or six sitting patients) in an enclosed cabin. The flight surgeon sat next to the pilot. This was the first American air ambulance that could operate in an air-route evacuation role rather than crash-rescue. The era of moving

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stable patients by air from one level of treatment to another had begun, although the medical attendant was almost always a doctor or flight surgeon.

In 1922 the French army formed a squadron of six aircraft and evacuated over 2200 wounded soldiers during the Riffian war in Morocco. The French were so widely acknowledged as leaders in the field of AME that in 1925 the Japanese government sent Dr Terasu to study their equipment and techniques. In 1925 the Headquarters of the Imperial Japanese Army ordered Dr Terasu to design a hospital aeroplane. The first aircraft was delivered that year and were introduced into operational service in Manchuria from 1932 to 1934. In all, a total of 33 hospital aircraft were built.⁶ Meanwhile, in 1923, the Royal Air Force (RAF) began routine AME flights from bases in the Middle East. By 1925 the RAF had also acquired two dedicated AME transport aircraft, each capable of carrying 14 litter patients.

While the military was the main force behind the development of AME, between the wars there was an increasing use of aircraft in support of health care delivery in the civilian community. In 1917 a young Australian medical student who had developed an interest in aviation wrote to the then Superintendent of the Australian Inland Mission (AIM), the Reverend John Flynn, suggesting that aircraft could be used to transport a missionary doctor to treat the people of outback Australia. Flynn was taken with the idea, but it was not until 1928 that he was able to raise sufficient funds to establish a flying doctor scheme.² The scheme was an outstanding success and grew rapidly. In 1934 the Presbyterian Church handed the service over to a new organisation, the Australian Aerial Medical Service, which became the nucleus of the now internationally famous Royal Flying Doctor Service (RFDS). The initial aim was to transport medical practitioners into the remote regions of Australia to render higher-level care than could be offered by the bush nursing officers. However, it was not long before the aircraft were also used to transfer patients back to regional centres. This led to the evolution of the Flight Nurse as a multiskilled health care provider, who could conduct clinics in remote regions and escort patients by air.⁷

World War II

Although the Australian Aerial Medical Service had pioneered the use of aircraft in the routine movement of patients, the concept was yet to be embraced by the allied military forces. The Germans had successfully conducted large scale AME using unpressurised Junkers transport aircraft during the Spanish Civil War of 1936–1939 and had further refined their capability in Poland in 1940. In 1940, the US Army authorised the formation of a medical Air Ambulance Squadron using C-47 and C-54 aircraft. In 1942, the new Air Surgeon convinced the higher Army echelons that AME was the best method of patient transport in theatres of war and it was finally agreed that these missions should be staffed with

trained Army nursing officers. The first Flight Nurses graduated in early 1943 and were soon working in New Guinea and the South Pacific.⁸

World War II saw a rapid advance in aircraft performance and this was both a blessing and a curse to the AME teams. While aircraft were larger, faster and more comfortable, they also exposed the patients to the added physiological stressors of vibration, hypoxia and reduced ambient pressure.⁹ New-found knowledge was used to overcome the physiological problems of flight, with various strategies being developed to minimise the potential for harm to patients. These included the use of oxygen delivery systems, blood plasma delivery kits and chemically treated pads to counteract the cold at altitude.¹⁰ The fundamental role of AME during World War II was moving large numbers of stable patients away from the treatment facilities behind the battlefield to higher levels of care or the home country.

The Korean War

While World War II had clearly shown that AME had a role in war, the Korean campaign radically changed the face of AME. By October 1950, Combat Cargo transport aircraft had begun a routine service to return injured and sick personnel to Japan or airfields in South Korea. The US Air Force Military Air Transport System (MATS) then assumed responsibility for airlifting these patients from Japan to the US. These flights were staffed by Air Force flight nurses and medical specialists. By the end of the war Combat Cargo had moved over 310 000 patients within the region and MATS had returned over 43 000 to the US. This system was so successful that it was adopted across the US military and remains essentially unchanged to this day.

Another important step forward was the introduction of the helicopter as a means of rapidly transferring a patient directly from the battlefield to a treatment facility that could offer resuscitative surgery. Although the presence of helicopters had significant positive impact upon soldiers' morale, conditions within the aircraft were primitive. More often than not, no medical attendant was available. If these patients required higher-level care after resuscitation, they were introduced into the fixed-wing AME system.¹¹

The death rate from wounds among UN personnel was about half that recorded for US troops during World War II, and this can be attributed to the wider use of antibiotics, new surgical techniques, the Air Force's AME system and the use of helicopter evacuation.¹²

The Vietnam War

The prolonged conflict in Vietnam saw the further development of the AME doctrine developed in Korea. The helicopter had come of age as a medical rescue platform and the term "dust-off" entered the military lexicon.¹³ So successful was the helicopter retrieval system that most casualties could be

moved from the battlefield to a facility capable of offering definitive surgery within 20 minutes of wounding.¹⁴ In both the US Army and the RAAF, these helicopters were manned by medics with limited resuscitative skills, but travel times were short and in-flight deaths were few.

The RAAF had gained considerable experience in AME during the war in Korea, but it was not until Vietnam that RAAF personnel could claim to be masters of the art. During the early phases of the conflict patients were transported to Australia, often via 4 RAAF Hospital in Butterworth, Malaysia, in C-130A aircraft. These missions were not dedicated to AME and were unpleasant for both patients and staff, as the aircraft were slow, noisy and uncomfortable. These flights also often carried cargo, passengers and even the coffins of dead soldiers. This solution to the AME problem drew strong complaints from the Army and the matter was raised at national level within Parliament. Fortunately, the faster and less noisy C-130E Hercules had just come into service and the RAAF was able to offer a scheduled, dedicated AME service every second week. Fortuitously, the Indonesian government had just reopened its airspace to Australia (closed during the Malaysian Confrontation crisis), thus permitting direct flights from Vietnam to Richmond, NSW.

The Gulf War

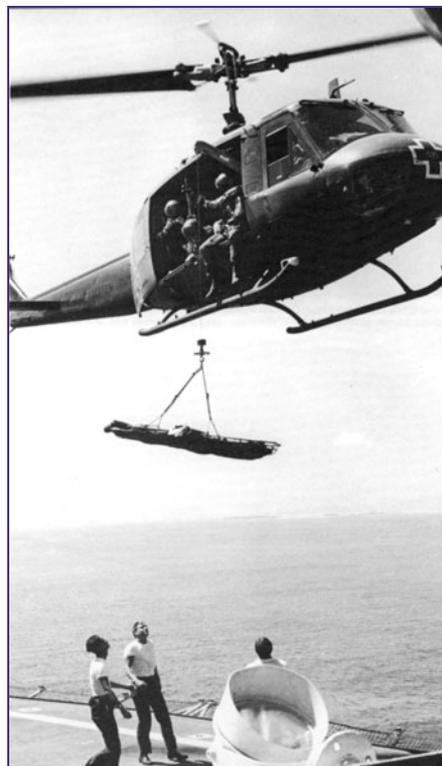
The Gulf War of 1990–1991 saw the largest mobilisation of AME assets since the Vietnam War. In all, 1950 AME personnel were deployed in support of Operations Desert Shield and Desert Storm, giving a capability to move up to 3600 casualties per day intratheatre (to Saudi Arabia and bordering countries) and 2500 intertheatre (from Saudi Arabia to Europe).¹⁵ While this massive system was never called upon to handle large numbers of battle casualties, by the end of the operation over 12 500 patients had been successfully airlifted using converted cargo aircraft.

The USAF AME system continued to follow the paradigm that had evolved during World War II and Vietnam in that AME teams consisted almost exclusively of flight nurses and AME technicians. The presence of large military hospitals within the theatre ensured that all patients underwent extensive investigation, treatment and stabilisation before they entered the AME system. Although provision had been made for allocating dedicated AME aircraft, patient numbers were low enough to be transported on return transport flights after the delivery of personnel and materiel into the theatre.



C-130E aircraft, used by the RAAF for AME from Vietnam to Australia.

This conflict may well mark the end of an era for fixed-wing AME. All of the conventional military conflicts since the Gulf War have tended to rely upon the use of air power to subdue the enemy and thus minimise the casualty rates among friendly forces on the ground. These smaller deployments of land forces will, of necessity, have much more limited intrinsic medical support, requiring AME of less well stabilised patients.



UH-1 ("Huey") helicopter, the mainstay of AME in the Vietnam War.

The present

It has become accepted within the military forces of most Western countries that the preferred method of patient transport is by air.¹⁶ The increasing incidence of small-scale military operations other than war has reduced the size and capability of the health facilities placed forward, and patients are now transported over long distances to receive resuscitative care. Unlike conventional warfare, where casualties are expected and deaths in combat are an accepted cost of achieving the objective, there is a strong political imperative to absolutely minimise casualty rates in military operations short of war. This has become a strong driver, at least within the USA, for the development of a highly skilled, well-equipped AME system that can meet or exceed the standards of care available within the peacetime civilian community. In the case of fixed-wing transport, the US Air Force has recently proposed the formation of specialist Critical Care Air

Transport (CCAT) teams capable of offering high levels of resuscitative support on the ground and in the air.¹⁷

For forward AME, the US military is now using specialist trained medical practitioners working from dedicated AME helicopters. This contrasts with the current Australian Defence Force policy of using medics (in war) or generalist medical officers (in peacetime), in airframes of opportunity, to “swoop and scoop” patients back to a resuscitative facility.

AME within the Australian civilian community is, in general, considerably more sophisticated than within the ADF. Most capital cities now have ready access to helicopter-based emergency retrieval services using dedicated aircraft. The medical staff manning these aircraft are either specialists in emergency medicine, anaesthesia or intensive care (or senior registrars in these fields), supported by qualified paramedics. However, the health care staff receive little formal training in aviation medicine or the theory and practice of AME — the emphasis is upon the requisite clinical skills. This contrasts with the ADF, where the emphasis has been upon health staff being thoroughly indoctrinated in the field of aviation medicine but having no formal requirement for training or current experience in resuscitative medicine. This may reflect the lack of emergency medicine, intensive care or anaesthesia specialists within the active duty force, although there is an increasing emphasis being placed upon these specialities within the Reserve forces.¹⁸

Within the Australian civilian community, the Royal Flying Doctor Service has now become the benchmark for fixed-wing AME. The service operates 40 aircraft, employs 42 doctors, 103 flight nurses and 95 pilots. The daily patient load exceeds 500 and the aircraft fleet covers over 36 000 km.¹⁹ This contrasts with the developments in rotary wing AME, where most organisations are quite small, often with only one or two aircraft. The core business for these operators is the transport of a very sophisticated team to the patient, the stabilisation of the patient at the scene and then transporting the patient back to a major hospital.

The future

The future for both civilian and military AME promises further improvements in quality of care. The range of both fixed and rotary wing aircraft is expanding greatly, with much improved speed, comfort and safety. Of particular interest to the military is the imminent introduction of tiltrotor aircraft that combine the best features of fixed and rotary wing aircraft.²⁰ Rapid improvements in technology have enabled both helicopter and fixed wing AME teams to have access to extremely sophisticated monitoring equipment,²¹ and future telemedicine suites will enable the patient to be monitored, if not treated, by specialists on the ground.²² Soon a patient entering the AME system may be guaranteed a level of care as good as or better than that delivered by the best units on the ground.

However, as the performance (and the cost) of the equipment and aircraft increases, it is imperative that the

training of military AME team members is improved. As it is, the skills of AME personnel in the Australian Defence Force threaten to be the weak link in the chain.

While many of the practical problems associated with AME have been overcome, the problem of conducting aerospace medical evacuation looms larger. As space missions become longer and more demanding, there is an increasing risk that space dwellers will require medical care that exceeds the capability of their habitat. At least two Soviet manned space missions have evacuated members back to earth due to medical problems.²³ However much recent advances in telemetry and pathology testing have improved the scope for remote diagnosis, the pivotal issue is how to treat the patient in space. If successful management protocols cannot be constructed, then the development of a new breed of AME specialists may eventuate, the so-called aerospace medical retrieval team.

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