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CRITICAL CARE AIR SUPPORT TEAMS AND DEPLOYED INTENSIVE CARE

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Abstract

The evacuation of injured patients by air has been going on in one form or another for nearly 100 years. This paper presents some of the history behind Aeromedical Evacuation (AE), the current situation and looks to the future of this vital component in the chain of care from point of wounding to rehabilitation.

History

The first reliably documented evacuation occurred in 1915 when an unmodified French plane moved Balkan patients. The first recorded British aeromed flight occurred in 1917. This move reduced the patient transfer time from three days to 45 minutes when a Camel Corps soldier with an ankle injury was flown in a De Havilland (DH) 4 biplane to hospital in Turkey.

The first time the Royal Air Force (RAF) undertook a significant aeromedical evacuation (AE) was in Somaliland in 1919. The air ambulance was a DH9 modified to carry a stretcher and attendant, and though an experiment, quickly proved its worth. The red cross was draped over the stretcher-bearing section of the aircraft when a patient was being transferred. The fuselage opened coffin-style to allow the patient complete coverage with the attendant standing fore of the patient with his back to the pilot (Figure 1).

Figure 1. Modified DH9.

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The German Luftwaffe were the first to undertake AE missions which more resemble those of today. From 1936-41 the Luftwaffe flew missions of up to ten hours duration at heights of 18,000 feet in Junkers (JU) 52 aircraft during the Spanish Civil War.

The United States Military formed the first dedicated AE unit, the 38th Medical Air Ambulance Squadron in 1942. Using spacious transport aircraft (Douglas Skytrain and Skycraft) more than a million patients were returned to the US towards the end of WWII.

As technology improved driven by wartime necessity rotary assets became available. The first recorded AE mission using a rotary wing aircraft occurred in Burma in April 1944 using an R-4B Sikorsky helicopter. While slower than fixed wing aircraft, helicopters were irreplaceable during conflicts in jungles. The war in Korea saw the first major uses of helicopters for AE and the Vietnam war saw its development with the addition of continuing care to wounded during rotary wing flight.

Modern Critical Care Air Support Teams

The Medical Emergency Response Team (MERT) evacuates patients from the point of wounding to the Role 2 or 3 facilities in theatre. Once advanced resuscitation and/or damage control surgery have been undertaken within this setting, critically ill patients are returned to the UK using the Critical Care Air Support Teams (CCASTs).

At any time two CCASTs are immediately available for tasking. The in-theatre (tactical) team is used to move patients around theatre and the strategic team (based at RAF Lyneham, Wiltshire, UK) is tasked to return patients to the UK or other host nations. A third team is available at 6 hours notice to move (NTM) should another mission be raised while the strategic team is tasked.

Team Composition

The RAF provides the CCAST, which comprises of the following specialist personnel:

1. Two Flight nurses trained in intensive care, one of which is the Team Leader.
2. A medical devices technician to maintain the equipment.

3. A Consultant Anaesthetist (and usually a trainee anaesthetist)
4. A Flight Nursing Assistant (FNA) who assists with patient interventions, patient transfer and logistics.

Whilst each individual member has a specific role, the strength of the team lies in the flexibility with which the critically care trained team members cross-cover each other. This is particularly important in reducing the fatigue associated with long transfers. Box 1 outlines the timeline of a typical CCAST mission and the potential for fatigue on such missions is obvious.

Pre-activation - Normal daily activities

Zero hours - Activation of team

03 hours - Arrival at departure airport
05 hours - Take-off
13 hours - Arrival at refuel point
14 hours 20 mins - Take off
16 hours 45 mins - Arrival at destinationand emplaning of patient
18 hours 15 mins - Take off
27 hours 15 mins - Arrival at UK airport. Load to road ambulance
27 hours 50 mins - Arrival at Role 4 hospital
28 hours 50 mins - Patient care handed to receiving doctor
29 hours 30 mins - Return to unit by road
31 hours 30 mins - Arrive at unit
33 hours - Stand down from task

Box 1. The timeline of a typical CCAST mission.

Additional members from each trade may compliment and 'up-rate' the team in order to provide practical training and support. In this way the above team may collect additional patients upon arrival into theatre, as shown in Figure 2, which may have been generated while the team was already in transit.

Figure 2. Modern CCAST multi-patient lift onboard a C-17 Globemaster.

Training

Each member of the team undergoes specific training according to his or her trade. For the Medical Staff this involves Aviation medicine and for all staff there is an intensive, 2 week training course on the equipment used in-flight (CCAST(E)). All trades undergo a course in aeromedical evacuation whereupon each trade learns the duties of the others. This covers the administrative and safety aspects of missions including aircraft familiarisation and emergency drills. This is particularly important in team building.

The medical and nursing staff split their time between periods of CCAST duty and their normal place of work. The core team spends a month on call at RAF Lyneham at a time whereas the anaesthetic trainee is on call from their base hospital on 6 hours' NTM. In this way clinical skills are maintained at a level where the CCAST can deliver critical care, during a transfer, at a level expected in the NHS. This is particularly important for the medical staff as they are also tasked with other anaesthetic/critical care duties when deployed.

Equipment

Suitable equipment is central to the operating capability of CCAST. For the RAF, this equipment needs to be portable and independent of aircraft power and oxygen supplies. This maintains the maximum flexibility that allows a high level of patient care to continue in the face of unexpected changes in route and aircraft serviceability issues. A rolling system is used whereby equipment is stored in modular form to allow a second strategic team to operate independently of the first team. A typical set of kit for a single patient transfer weighs in excess of 500kg. 48 Ah batteries are used to allow the ventilator, volumetric pump and monitor to work independently of the aircraft power system for up to 12 hours and at least two batteries are carried per patient. All equipment has to pass stringent air-worthiness checks. These assess the equipment for its potential to interfere both physically (eg chemicals) and electronically (eg radio waves) with the aircraft. While this is clearly important it can have the effect of delaying the introduction of newer pieces of kit. The additional stresses of flight and field conditions place extra demands upon the kit, dust and extremes of temperature being particularly damaging.

Ventilator

Currently CCAST uses the Pulmonetics LTV-1000 ventilator (Figure 3a). It is an electrically powered, turbine driven transport ventilator capable of providing most modern modes of ventilation. Both pressure and volume control options are available with both mandatory and supported spontaneous ventilatory modes available. Oxygen can be taken from both low and high pressure sources. It has an internal battery providing emergency back-up for up to 60 minutes of ventilation.

Monitor

Both routine and CCAST aeromedical teams use the MRL-PIC device (Figure 3b) which is a combined monitor, defibrillator (Biphasic) and external pacemaker. Two invasive pressures can be monitored at any one time in addition to non-invasive blood pressure, oxygen saturation, ECG, temperature and end-tidal CO_2.

Syringe Driver

CCAST use the Braun Perfusor Compact syringe driver, a robust device which will run for up to 80 hours from one set of batteries (Figure 3c).

Volumetric Pump

The Alaris Medsystem III pump (Figure 3d) is currently in use on CCAST missions. It is a 3-channel device allowing multiple infusions to be administered from one module. Primary and secondary flows are supported, providing maximum flexibility.

Civilian standards for patient transfers are aimed for in many respects but certain environmental differences ensure that enhanced vigilance is important at all times. For example in the noisy environment of an aircraft the clinician cannot rely upon audible alarms. Visual signs may be difficult to elicit in a poorly lit cabin or particularly in tactical darkness. Vibration and the electromagnetic fields of aircraft equipment may cause monitoring artefacts.

iStat Blood Analyser

This versatile piece of equipment is a hand-held device which (depending on which cartridge is used) can perform standard Blood Gas analyses, routine biochemical tests and much more. It is also used on the Intensive Care unit in the deployed environment and is used in the Pathology lab while deployed as well. Results are obtained in about five minutes and provide an essential part of the monitoring armamentarium for CCAST.

Figure 3a. LTV 1000 ventilator.

Figure 3b. MRL-PIC monitor.

Figure 3c. Braun Perfusor Compact syringe driver.

Figure 3d. Alaris Medsystem III volumetric pump.

Airframes

Assets available to the RAF at present are as follows:

Boeing C-17 'Globemaster'

This is the latest addition to the RAF's Air Transport (AT) fleet and was designed with the aeromedical role in mind. This platform was initially leased from the United States Air Force (USAF) but the RAF has now owns all the C17s it uses. This aircraft's huge load capacity allows us to carry CCAST and AE patients alongside cargo and passengers. Where other passengers are carried, privacy is maintained with a curtain fit. While the C-17 is equipped with power outlets and liquid oxygen (LOX) these are not utilised by the CCAST in order to maintain independence from external sources. Non-CCAST AE does use this oxygen for their transfers of less critically injured patients.

Lockheed C130 J/K 'Hercules'

The Hercules in its many variants has been a major workhorse of the RAF AT fleet and whilst still heavily tasked is also used for tactical patient moves by the CCAST. The noise levels pose additional problems especially for team communication.

VC-10

The VC-10 is now the fastest passenger aircraft in-flight today following the removal of Concorde from service. The narrow width of the aircraft can make emplaning patients difficult but all-round access can be achieved with a centre fit and removal of the surrounding seats.

Tristar

The three different variants of Tristar (C1, C2 and KC1) are currently used by CCAST, principally this involves using aircraft already tasked in the trooping role and adding an aeromedical 'fit'. The stretcher fit allows excellent all round patient access and a privacy fit allows patient care to be undertaken with passengers on board.

Civilian platforms

When necessary, the RAF can use civilian air ambulances/private jets/commercial flights to meet its strategic requirements.

Rotary Assets

This review deals principally with strategic and tactical CCAST, however MERT in Afghanistan use the Chinook, while the Incident Response Team (IRT) in Iraq use the Merlin and Puma platforms.

The Future

Given the high tempo of operations, the support of exercises around the globe and the continued commitment to the repatriation of sick or injured entitled civilians (eg government employees stationed overseas) the requirement for a CCAST capability will not cease.

CCAST needs to be responsive to the changes in battlefield injuries and at all times remain flexible in its approach. Factors such as Clinical Governance continue to drive forward excellence in the care it provides. Improvements to equipment and training are under constant review but in the immediate future, research is ongoing in order to provide an evidence base to further improve care and delivery of it.

Research

There are currently two main areas of research interest: fatigue and feeding.

Fatigue

Crew Resource Management (CRM) is an essential component of aircrew training and within it lies the recognition of the effects of fatigue on performance impairment. While there are strict regulations covering the number of hours aircrew can work, this has not yet transferred to the CCAST. Indeed frequently CCAST missions are extended due to the requirement to change aircrew. This is being addressed in two main ways. Firstly since the first Gulf War in 1991 there has been a progressive expansion in staffing levels, particularly of medical staff. This has allowed the frequency of duties to be reduced. Trainee medical staff are now a routine part of the team as are two members of nursing staff. Secondly there is a research study in progress specifically looking at the impact of fatigue on clinical judgement and capacity. This is being driven by Clinical Governance and undertaken through the Centre for Aviation Medicine in order that we may see if there is evidence of a decrease in performance, specifically, of medical staff working with critical care patients in the rear compartment of an aircraft.

Feeding

There is an ever-increasing recognition of the importance of early enteral nutrition and its potential to improve patient outcome following major trauma and burns. At the present time we are not feeding CCAST patients in-flight. The intention is to start enteral feeding (via the naso-gastric route) at the Role2/3 setting in theatre and continue this throughout AE back to the Role 4 in the UK. There is however the concern that CCAST patients may be at an increased risk of micro-aspiration and hence the development of nosocomial pneumonia. This increase in risk may arise from the inability to raise the patient's head (due to the stretcher harness and any spinal injury) and due to stresses of flight ("G" forces, coarse and fine vibration and the effects of barometric pressure on air filled spaces – endotracheal cuffs and the gastrointestinal tract.) In order to determine if CCAST patients are at any increased risk of micro-aspiration it is intended to assay tracheal aspirates for pepsin. This will allow samples taken as part of routine clinical care to determine whether patients can safely be fed during transfer. If deemed safe to start feeding, it is intended to repeat the study to determine whether there are any additional risks posed by the feeding itself.

Audit

A redesign of patient observation and note-keeping charts will allow the audit of aspects of CCAST missions not previously available. This can be used, as always, to feedback and further improve patient care.

Equipment and Training

Equipment

New and, usually, better equipment is continuously appearing on the market. Our job is to identify our patients needs and see if any new equipment fulfils these needs but with, for example, improved battery life, a lighter weight, increased robustness or is ease of maintenance. Ideally equipment parity between all 3 sister services, in all specialities should be the aim.

Training

We strive to give the best patient care but now, with yearly appraisal and 5 yearly revalidation having been recently introduced to the UK, we are obliged to provide documentary evidence that we are competent to give that best care. With this in mind, specific training requirements are being introduced for both generalists and specialists. These are simply an amalgamation of those which already exist but are not part of a complete package. As these competencies are achieved they are subject to refresher training. Part of this will involve high fidelity manikin simulators placed in realistic aircraft simulators with scenarios based on previous CCAST critical incidents.

Summary

CCAST is a specialist, highly mobile team which has the capability to provide critical care, to a level expected in the NHS, for multiple patients. At the end of the 'Cold War' it grew from the fundamental change of moving patients, for definitive surgery, away from the area of conflict rather than treating them 'in-theatre'. It continues to adapt to new treatments, procedures and equipment enabling it to transport sick patients even more safely and better transport patients who would previously have died of their wounds. Furthermore, it uses data collected from patients and the 'incident reporting system' to audit the whole process and endeavour to build safety into the system and become the basis of the way we work.

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