Editorials

Helicopters

Helicopters may or may not be essential for civilian casualty evacuation. In general, those involved in the care of the acutely sick and injured either love them or hate them, but whichever your point of view they will not go away and the time has come to think about a critical evaluation of helicopter medical services. The first substantial reports on helicopter air evacuation came from the American forces' experience in Korea[1] and Vietnam[2], where casualty mortality was substantially reduced[3] when compared with earlier conflicts. Civilian use of helicopters lags behind the military for one very good reason; money. Helicopters use a lot of it - for pilots, fuel, maintenance, special landing places, aviation authority certification . . . Nevertheless early efforts were made to use helicopters in an emergency medical service role and some studies were reported from the USA in the early 1960s, using radio station helicopters 'out of hours'[4]. The owners realized this was a heavy, open-ended financial commitment and withdrew.

At about the same time, hard comments were being made about the management of trauma in the USA. Eiseman summarized the thoughts of many American surgeons in the following words: 'Wounded in the remote jungle or rice paddy of Vietnam, an American citizen has a better chance for quick definitive surgical care by board certified specialists than were he hit on a highway near his hometown in the continental United States. Even if he were struck immediately outside the emergency room of most United States hospitals rarely would he be given such prompt, expert operative care as routinely is furnished from the site of combat wounding in Vietnam'[5]. This kind of statement prompted a close examination of trauma services (not just helicopters) which inevitably led to better training of physicians[6] and to the implementation of accredited Level I trauma centres. The first helicopter rescue system was implemented in Denver in 1972[7] and was called the Helicopter Emergency Medical Service (HEMS). In the intervening two decades over 130 medical helicopter services were gradually set up in the US and there are now few major trauma centres without one. The Committee on Trauma of the American College of Surgeons circulates guidelines for standards in air ambulances[8]. Despite all this, only two states in the USA have statewide helicopter services - Maryland and Virginia. The rest have independent services which interact as best they can, sometimes co-operating but often in competition. And hanging over all these systems is the problem of money.

How do you prove that a helicopter actually helps? Does it save lives[9] or is it merely an extravagant misuse of funds[10]? Nobody really knows. Some places in the USA simply could not manage without helicopters, and these include both areas of inaccessible rural population and tightly knit urban sprawls where the traffic is impenetrable. Other centres, notably San Francisco and Dallas, cannot justify the urban use of a helicopter because traffic is lighter and the cities small in area; helicopters only service calls outside city limits. Sadly, there are also centres where helicopters contribute little to the care of the poor, trying only to service insured calls (though this is now illegal) and competing with other hospitals in the same city.

Four papers in the extant literature address the question of the helicopter in a controlled scientific manner, and each of these papers fails in some way or other to come to a firm conclusion. Baxt *et al.*[11] looked at two groups of trauma patients transported either by road or air in the San Diego area and showed a better survival for the helicopter group. Unfortunately the groups are not easy to compare since the helicopter is servicing a largely rural area where distances are great and journey times longer than by land ambulance. Schiller *et al.*[12] looked at patient transport in Phoenix, in a paper which is often quoted as evidence against the use of helicopters for the transport of trauma victims. Unfortunately, the two patient groups are not equivalent; most of the helicopter patients were drawn from a rural area, part of the data has been collected prospectively and part retrospectively and the results combined, and the mission times were estimated in 15% of cases. In the only group where a big statistically significant difference in mortality was demonstrated, helicopter versus ambulance within the city limits, the authors acknowledge that the patients transported by helicopter were more seriously injured than those conveyed by ambulance, particularly in relation to head injury which is the most significant cause of death in trauma and which was statistically more severe in the helicopter group. This skews the data in the overall study, produces a spurious difference between the helicopter and ambulance groups which are unequal in numbers, and invalidates many of the conclusions of the paper. Moylan *et al.*[13] showed that there is no difference in journey time between helicopter and ground ambulance; the better survival in the helicopter group is attributed to a better trained crew. Finally, Schwartz *et al.*[14] suggest that survival in a helicopter-transported group is better than in a ground transport group but again there is a large disparity in the sizes of the compared groups.

The benefit of the presence of a doctor on board a helicopter is clearer. Baxt, for example, in a well-randomized trial[15], showed a 35% improvement in mortality when comparing two large matched groups of injured people, one group transported by helicopter with nurse and paramedic, and the other transported by helicopter with nurse and physician. American systems do not carry doctors because of the revenue and insurance implications, and the presence of anaesthetically trained flight nurses. Such a level of training is not available in the UK.

This brings us to an examination of UK helicopter systems, and the purposes to which they are put.

0141-0768/92/010001-03/$02.00/0

Most other European countries, in particular France and Germany, have well developed systems. Until recently the route to hospital via helicopter in the UK involved the air-sea rescue services of the armed forces. This service has now been supplemented by several different types of civilian helicopter systems which operate under very different constraints, money the most significant.

Cornwall operate an ambulance helicopter service ('First Air'). This uses a small German aircraft (MBB BO105 DBS) which is used largely to augment the existing ground ambulance service in difficult and remote terrain. The Scottish ambulance service have followed Cornwall's example, using the helicopter to cover ground. KentAir provide a similar service although a large percentage of their workload appears to be interhospital transfer (21%). Their primary role (79%) is supplementary to the ground ambulance service which includes a substantial number of trivial complaints[16]. The Northumberland helicopter[17] (the Great North Air Ambulance Service, G-NAAS) has recently ceased operations - no more money - but early data indicated a degree of success in targeting their calls more specifically to seriously sick patients. The Essex ambulance service have flirted with the police helicopter system to the extent of carrying an ambulance paramedic to the accident scene, reducing the 'therapy free interval', but cannot carry patients even when not chasing villains. The Wiltshire police, however, will provide this additional service on the principle that life is more important than interdiction.

There are only two helicopter systems in the UK that carry a doctor, Careflight[18] based at St Bartholomew's Hospital and HEMS[19] at the Royal London Hospital. Careflight provides a transfer system for severely ill patients, usually between intensive care units, and is staffed by an anaesthetist. Their first 50 non-neonatal transfers are described in this journal (p 29). HEMS is a trauma-only service on two-minute callout from the roof of the hospital, staffed by an anaesthetist or a surgeon with a paramedic, which networks 132 hospitals in the South-East but brings a proportion of severely injured patients to the recently established multidisciplinary trauma facility at the Royal London. Both services rely on charitable money - Careflight on several sources, and HEMS on Express Newspapers and the Department of Health. The services are complementary and aim to cover most emergencies requiring helicopter transport, HEMS by extending the arm of the hospital to the roadside and Careflight by linking hands between intensive care units.

The helicopter must be part of a complete care system[20]. Its maximum cost effective range in the USA is about 100 miles[21]; in this country the distance is greater. A transfer system may be better served by fixed wing aircraft over greater distances. An airborne intensive care unit obviously requires complex medical facilities on the ground at both ends to be effective; equally it it pointless to rush the severely injured to hospitals ill-equipped to deal with them. It is logical that a helicopter attending multiple injury patients by the roadside should be able not only to resuscitate the patient expeditiously but return to a hospital which has all the specialties necessary for prompt definitive care. Ambulance helicopters alone fit more or less into a prehospital transport system which is more concerned with logistics, patient mobility and the availability of suitable transport than with the immediate provision of advanced medical care.

The academic stumbling block in assessing all these services is the provision of control groups. HEMS probably saves lives by being speedy on the outbound leg of the service, bringing a doctor quickly to the scene where he can start advanced treatment immediately. This makes a reduced journey time on the return leg less important than with a system which does not carry a doctor. The definition of a comparable control group of land-transported patients thus becomes almost impossible. Careflight has a similar problem with its first 50 patients in that their comparison group is not truly matched and has to rely on historical controls from another paper. There may in fact be no other practical way of doing this.

Although helicopter systems are 'high-profile' in nature, proper audit of their efficacy should be carried out by people with their feet firmly on the ground in order to circumvent the kind of anecdotal approach often used to describe such enterprises[22]. A cavalier approach to helicopter transport leads to vast squandering of precious resources with little to show as a result. Thoughtfully used in an integrated system with properly trained staff, the helicopter can help to reduce mortality and morbidity in both the sick and injured, whilst at the same time reducing the need for costly duplication of ground-based facilities. The onus of proof rests with the operators of such systems.

A Wilson
F Cross
The Royal London Trust
The Royal London Hospital
Whitechapel, London E1 1BB

References

1 Neel SH. Helicopter evaluation in Korea. *USAF Med J* 1955;**6**:691-702
2 Neel SH. Army aeromedical evacuation procedures in Vietnam: implication in rural America. *JAMA* 1968; **204**:309-13
3 Bzik KD, Bellamy RF. A note on combat casualty statistics. *Milit Med* 1984;**149**:229-30
4 Whisenand K, Sparling T. Helicopters for emergencies. *Hosp Progr* 1968;**49**:68-71
5 Eiseman B. Combat casualty management in Vietnam. *J Trauma* 1967;**7**:53-63
6 Collicott PE. Advanced trauma life support course, an improvement in rural trauma care. *Neb Med J* 1979; **64**:279-80
7 Thomas F. The development of the nation's oldest operating civilian hospital-sponsored aeromedical helicopter service. *Aviat Space Environ Med* 1988;**59**:567-70
8 Committee on Trauma. Air ambulance operations. *Bull Am Coll Surg* 1984;**69**(10):33-5
9 In defence of helicopters. *Emerg Med* 1987;**19**:8-11
10 Lee JD. Helicopters not best use of funds. *Am Med News* 1984;October:7
11 Baxt WG, Moody P. The impact of a rotocraft aeromedical emergency care service on trauma mortality. *JAMA* 1983;**249**:3047-51
12 Schiller WR, Knox R, Zinnecker H, *et al.* Effect of helicopter transport of trauma victims on survival in an urban trauma center. *J Trauma* 1988;**28**:1127-34
13 Moylan JA, Fitzpatrick KT, Beyer AJ III, *et al.* Factors improving survival in multisystem trauma patients. *Ann Surg* 1988;**207**:679-85
14 Schwartz RJ, Jacobs LM, Yaezel D. Impact of pre-trauma center care on length of stay and hospital charges. *J Trauma* 1989;**29**:1611-17

15 Baxt WG, Moody P. The impact of a physician as part of the aeromedical prehospital team in patients with blunt trauma. *JAMA* 1987;**257**:3244-50
16 The Kent helicopter ambulance service final report on assessment study. Margaret Heraty, AA Foundation for Road Safety Research, March 1991
17 The Great North Air Ambulance Service. Appeal document. Northumbria Ambulance Service Headquarters, Scotswood Road, Newcastle-upon-Tyne.
18 Ramage C, Kee S, Bristow A. Interhospital transfer of the critically ill patient by helicopter. *Br J Hosp Med* 1990;**43**:147-8
19 Earlam R, Wilson AW. Helicopter emergency medical services - HEMS One. *Ann R Coll Surg Engl* 1989; **71**(suppl):60-4
20 Cleveland HC, Moore EE. Helicopter medical transport: Past, present, and future. *Adv Trauma* 1988; **3**:1-14
21 Champion HR. Helicopters in emergency trauma care, [Editorial]. *JAMA* 1983;**249**:3074-5
22 Cusack SC, Robertson CE. The value of helicopter transportation for trauma patients. *Injury* 1991;**22**: 54-6

Inhalation therapy in asthma

Treatment of respiratory diseases by inhalation is a form of therapy which has been used for many years. This method of administration is used to obtain a more rapid and a more selective effect of the drug in the airways. Successful inhalation therapy is, therefore, a question of depositing an adequate amount of drug in the lungs.

The respiratory tract acts as a very complicated series of filters for inhaled particles. Deposition of therapeutic aerosol takes place by two primary mechanisms, namely inertial impaction (in the oropharynx and at bifurcations between the larger airways) and gravitational sedimentation (in smaller conducting airways and alveoli)[1]. Three factors affect deposition: aerosol particle size, mode of inhalation and degree of airway obstruction. Delivery efficiency to the small conducting airways can be increased by reducing the aerosol particle size. Ideally, particles should be approximately under 5 μm (respirable range) for inhalation into the lungs. Particles greatly exceeding 5 μm diameter are readily deposited in the oropharynx and those particles which reach the lungs are unlikely to penetrate to the periphery. Lung deposition can be also increased by performing inhalation manoeuvres which reduce the probability of aerosol inertial impaction and increase the probability of deposition by gravitational sedimentation in the airways.

Three types of delivery system are used to administer therapeutic aerosols: metered dose inhalers, dry powder devices and nebulizers.

Since their introduction in 1956, metered dose inhalers (MDIs) have become a mainstay of asthma therapy using inhaled bronchodilators, sodium cromoglycate and topical corticosteroids. MDIs are often preferred to other types of inhalation devices, since they are compact, convenient and unobtrusive. The MDI spray consists of the drug contained within large droplets of chlorofluorocarbon propellants. Although the propellant droplets lose velocity on encountering air resistance and droplet shrinkage occurs by evaporation, the initial velocity of the spray is high (>30 m/s) and the initial droplet size is large. This leads to a high probability of inertial compaction in the oropharynx. Even with the best inhalation technique, only 10-15% of the aerosol reaches the lungs[2]. Matters may be made even worse by the patient's failure to use the MDI properly. One of the major difficulties patients have is the so-called 'hand-lung' problem, with inability to coordinate actuation of the aerosol with inhalation. An ideal inhalation technique involves a combination of slow, deep inhalation to reduce inertial impaction losses in the oropharynx, with about 10 seconds of breath holding to allow those particles which enter the lungs to settle out under gravity[3]. Proper instruction by a trained person with a placebo aerosol is essential to teach the correct inhaler technique. This should be followed subsequently by regular checks to locate any faults that may develop.

Aerosol size may be reduced by allowing the large propellant droplets to evaporate before inhalation. This can be achieved with a spacer device or holding chamber between the MDI and the patient's mouth. The aerosol arriving at the mouth will comprise smaller droplets and will be moving more slowly, compared to that from an MDI alone, so that a more easily respirable aerosol is provided, and changes in the aerosol deposition pattern may result. Despite this, no more than 15-25% of the dose reaches the lungs even under the most favourable circumstances. Spacers fulfil a further, most important, role in that synchronization between actuating the aerosol and inhaling is less important than with the MDI alone. The spray can be actuated into the spacer and inhaled subsequently without coordination being necessary. The spacer attachment, therefore, makes the pressurized aerosol rather easier to use, but more cumbersome to carry. In patients with adequate inhalation technique, there is probably no additional benefit to be gained from inhaling bronchodilators via a spacer[4]. For inhaled corticosteroids, however, the improved intrapulmonary delivery from a spacer may achieve the same level of asthma control at a lower and less toxic dose if the drug is delivered by spacer instead of correctly used MDI. A secondary advantage of using spacers with inhaled corticosteroids is that the incidence of local side effects, such as oropharyngeal candidiasis and hoarseness, is reduced[5].

The use of MDIs has recently come to environmental scrutiny in many countries. Chlorofluorocarbon degradation by ultraviolet radiation leads to the build up of chlorine and hence to depletion of stratospheric ozone[6]. Medical aerosol inhalers use only 0.5% of the total chlorofluorocarbon consumption and make an insignificant contribution to the problem. Nevertheless,

0141-0768/92/010003-03/$02.00/0