3. RTAS AND OTHER SPECIAL SERVICE LIFE RISKS

3.1 Overview

An attempt is made here to address the questions:

- what opportunity is there to save life and reduce the severity of injuries by a swift emergency intervention at, for example, Road Traffic Accidents, and;
- how does the attendance time and mode of intervention of the fire service influence survival rates and the degree of injury.

These questions are important as the response standard guidelines, suggested for the purpose of this study, link the level of emergency cover to the number of lives which can be saved (or serious injuries which can be mitigated). Similar questions were addressed by the aforementioned 1996 NHS Executive review of ambulance response standards. Whilst the latter review focused the response of the ambulance service to cardiac arrest cases, the derived relationship between attendance time and survival rates was generalised to all %mmediately life threateru'ng" conditions. Having plotted a relationship between attendance time and survival rates amongst cardiac arrest casualties, they determined an attendance time which would achieve a significant reduction in mortality rates at a cost (per averted death) which compared favourably with the cost of other life saving medical treatments.

Ideally, a fire service response standard for "life risk special services" would likewise be based on a consideration of empirical research regarding the impact of fire service response on outcome of RTAs and other "entrapment" incidents and the cost of such response. However, a review of current research identified only a few examples of pertinent research. This research indicates that the swift rendering of appropriate medical care combined with appropriate management of casualty extrication and immobilisation does have a significant impact on survival rates and severity of injuries in RTAs. Therefore, it is considered reasonable here, at least for the purpose of this study, to assume the fire service response standard should match the ambulance service standard for immediately life threatening incidents - for those cases where fire service assistance is required to allow life support care to be rendered to a casualty.

In brief, a fire service (extrication) response standard could be based on:

- a 15 minutes interval between occurrence of an incident and initial emereency service attendance - ie allowing 7 minutes for a call to the emergency service and i mi`nutes for emergency service attendance,
- 30 minutes to evaluate, access and extricate casualties,
- 15 minutes for a casualty to be conveyed to hospital and for commencement of hospital treatment.

Where invasive resuscitation is required in situ, previous research has indicated that it should be possible to evaluate and access a casualty within 3 to 5 minutes of arrival, in the case of a road traffic accident.

Analogous standards could be set for other life risk special services, such as extricating or accessing casualties in confined noxious spaces.

Clearly, these standards only apply to imminent life risk special services. Accordingly, a categorisation of special services is proposed, which distinguishes between imminent, serious and other special services, as per Table 2.3. These categories are analogous to those proposed by the NHS Executive for the ambulance service, where they recommend:

- 8 minutes attendance for Category A immediately life threatening conditions,
- 15 minute attendance for Category B serious emergencies,
- No recommended standard for other incidents.

3.2 Review of previous research

The incidence and severity of RTA injuries.

A few studies have estimated the number of serious injuries arising from road traffic accidents and other causes of trauma, and the survival rate. The most relevant study was completed by the Royal London Hospital Helicopter Emergency Medical Service (HEMS), as part of an assessment of the RTAs attended by HEMS (Wilmink, 1996). They compiled statistics regarding road traffic accidents in the UK, including:

- each year 190,000 car users are injured in RTAs in the UK, 2,300 are fatal and 26,000 car users sustain serious injuries.
- the Fire Service is involved in extricating trapped car occupants 7,500 times a year.
- more than half of spinal cord injuries are caused by RTAs, and 40% of spinal fractures have associated neurological damage.
- they also cite American studies which show that if an accident is severe enough to require the vehicle to be towed, one third of the patients will sustain a severe neck injury. This figure is expected to increase if entrapment occurs because of the greater impact and invasion of passenger space.

Another pertinent, ongoing, study is being conducted by a group of UK emergency physicians entitled the UK Major Trauma Outcome Study (MTOS). MTOS was started in 1988 with the aim of collecting and analysing clinical and epidemiological data to provide a statistical base to support clinical audit and the development of trauma services. Whilst the study is designed to support clinical services, some data can be identified for the purpose of reviewing the fire service response to RTAs. A number of reports have been published by NITOS. One study reported on the cause of "blunt injuries". Of 14,051 patients who sustained blunt injuries in a survey of 33 UK hospitals participating in the MTOS at the end of December 1991, it was found that:

- 28.5% of these were from RTAs, i.e. 4005 patients were injured in RTAs.

The significance of RTA related injuries is also reflected in USA data (Adebonojo, 1993), where it has been found that road traffic accidents account for 60% of chest trauma cases. They

also indicate that trauma to the heart and pericardium occurs in about 6% of all cases of serious injuries and over 70% of them are caused by RTAs. Finally, they also found that:

- 10 - 15% of patients die at the scene of the accident and:
- an additional 5% dying within minutes of reaching the hospital.

When considering the fatality rate at RTAs though, it is important to take note of the more recent MTOS findings, as summarised below, which show that improved casualty care has halved fatality rates amongst seriously injured RTA casualties.

Impact of emergency service response on survival rates

Research regarding the impact of emergency service response to trauma cases midicates that the management of casualties is of critical importance as well as the response time. In particular, the HEMS study found that the vast majority of spinal cord injuries attended by HEMS are incomplete, suggesting that significant numbers of neurological injuries seem to occur during extrication or ~port of the patient without adequate immobilisation. Thus, the manner in which the fire service extricates casualties is of great importance, ie a balance must be struck between facilitating swift medical attention and the risk of exacerbating injuries during extrication.

A few studies have been carried out m the UK and the USA regarding the impact of attendance time on survival rates in RTAs. At least two studies have been carried out in the USA. A 1979 study (Brown, 1979) found a positive relationship-,between ambulance delay times and the ratio of fatal to serious injuries, suggesting that RTA victims who had to wait longest for ambulances were the most likely to die. A second and more recent USA study (Brodsky, 1989) examined data from 1982 to 1987 on emergency medical service (EMS) arrival times (i.e. estimated time between the accident and EMS arrival at the scene) on the survival rate in multiple fatality accidents. This work drew on attendance's in both rural and urban areas and thus gave a sample of faster and slower response times, ie 20 minutes in rural areas and 11 minutes in urban areas. It was found, based on data for 1985, 1986 and 1987, that:

- as the arrival time of EMS micreases, the percentage of multiple fatality incidents increases.

These conclusions do not take account of potentially confounding variables in the assessment, such as vehicle speed and occupants' age. The results are shown in Table 3.1 below.

Table 3.1: % of fatal accidents with multiple fatalities in overturning accidents against emergency service attendance time.

		% of fatal accidents with multiple fatalities	
		6-14 minutes attendance	30+ minutes attendance
Number of persons involved in accident	2	7.6	9.0
	3	9.8	16.2
	4	9.4	17.3
	5	15	14.3

Thus, the likelihood of multiple fatalities doubled for accidents involving 4 persons if attended in over 30 minutes instead of within 14 minutes.

Work in England and Wales in the period 1979 and 1983 examined the relationship between proximity to hospital and RTA mortality within 401 local authorities (Bentham, 1986). It indicated that, after adjusting for levels of car ownership and class, local authorities with an Accident and Emergency department within their boundary had a lower RTA fatality level than those without. This suggests that the time taken for casualties to be rendered intensive care impacts survival rates.

The importance of timely rendering of emergency medical care is indicated by a MTOS study (Roberts et al 1996) based on 3,230 cases of blunt trauma patients in the UK, admitted to hospital between 1989 and 1995. The cases involve persons aged up to 24 years old, with an Injury Severity Score of 16 or more (i.e. equivalent to major trauma). 7 1 % of these patients had been involved in RTAs, i.e. 2293 major trauma patients under 24 years old from RTAs. The study indicated a significant reduction in the level of mortality during the seven year period considered. In particular, the fatality rate amongst children with severe injuries has fallen as follows for children and younger adults:

Fatality rate amongst young persons with severe injuries

		1989	**1995**
Age of casualty	0 to 4	50%	8.8%
	5 to 14	29.5%	16.2%
	15 to 24	29.7%	20.4%

The downwards mortality rate was broadly consistent across the period. This improvement was attributed to:

- improved assessment and resuscitation techniques in hospital,
- provision of integrated management from scene of the incident through intensive care and definitive surgery.

ie improved casualty care at the scene of accidents (as well as better hospital care) is considered to have played a part in the halving of RTA fatalities amongst children and younger adults.

Thus, the timely rendering of appropriate medical care combined with appropriate management of casualty extrication and immobilisation would appear to have a significant impact on survival rates and the degree of injury suffered by RTA casualties.

Obviously there are other factors which also influence survival rates, particularly vehicle speed, age of casualties and the pre-existing medical condition of the casualty. Children, elderly, persons with pre-existing medical conditions and higher speed crash victims are all more likely to die than other casualties. For example, based on data from the UK MTOS database for 33 hospitals, 198 major trauma patients, 38.8% of whom had pre-existing medical conditions (PEMC), it was found that: 2.4% of injured patients without PEMC died, while 7.8% of patients with PEMC died. Similarly, in another MTOS study based on data from Hope Hospital for 1,471 major trauma patients, 45. 1 % of whom had PEMC, it was found that:

- 6.2% of patients without PEMC died and;
- 10.7% of patients with PEMC died.

The number of PEMCs also influenced mortality increasing from:

- 6.2% with no PEMC to
- 9.3% for one PEMC and
- 12.2% for two or more PEMC.

An understanding of the impact of these factors is important, as they may mask or appear to over-ride the impact of emergency service attendance time and management techniques. For example, a study completed by the University of East Anglia (Jones and Bentham, 1995) examined the relationship between ambulance attendance times and the outcome of RTAs. They examined data for Norfolk on RTAs between 1987 and 199 1. The EMS arrival times (i.e. travel from the ambulance station to the RTA) were between 2 and 23 minutes (mean of 7 mins), RTA to hospital journey times ranged from 2 to 31 minutes (mean of 13 mins) and maximum total journey times of 52 minutes was estimated.

After controlling for confounding variables, the only variables found to be statistically related to the outcome of the RTA were: age, the speed limit on the accident road, the road user type of the casualty (motor bike, pedal bike or other road user) and the number of casualties involved in the accident. Irrespective of inclusion of roadside deaths in the analysed dataset, ambulance response times were not found to have a significant impact on the outcome of RTAs in Norfolk.

The apparent contradiction between this and previous work in the USA and UK may be attributable to the much longer response times considered in the American studies (where

ambulance arrival times could be in excess of 2 hours). However, whilst it is possible that ambulance arrival times are only significant to RTA outcome for longer journey times, it should also be noted that the remoter areas (as in Norfolk) with longer response times are also served by fast rural roads and that road speed limit has been shown to be significant in RTA outcome. Thus, the influence of EMS arrival time may have been masked by an over-riding influence of higher speeds in rural parts of Norfolk. Also, the Norfolk study was unable to control for the type of treatment afforded to individuals, including that rendered by general practitioners who visit the scene first at some RTAs in remote areas.

Current performance

The review of RTAs attended by the London Helicopter Emergency Services (HEMS) is the only identified study of extrication times in the UK- They report on 737 RTAs attended by HEMS between 1/4/91 and 31/3/93, 12% of which involved entrapment, i.e. an average of 45 incidents per year. They found that:

- the average entrapment time was 44 minutes,
- 49% of extraction's took more than 30 minutes and 20% took over 60 minutes,
- 10 of the 44 patients with extrication times over 30 n-dnutes and 2 of the 18 extrications which took over 60 minutes had severe injuries requiring invasive life support measures.
- multiple patients were trapped in 8 cases, with invasive life support measures required for 2 of these patients.
- comparison of extrication times and injuries diagnosed on scene show that more seriously injured patients were extricated in a shorter time than those with lesser injuries.

Proposed response standard

The HEMS concluded that the following emergency service response (ambulance and fire service combined response) would be reasonable:

- roof removal with scene assessment, risk control and vehicle stabilisation in 3 to 5 minutes,
- primary survey of the casualty, application of a cervical collar, administration of oxygen and intravenous access in 5 minutes,
- fitting an extrication device in under 10 minutes,
- sliding casualty onto spinal board within 10 minutes

Thus, they indicate that:

- If no invasive life-support is required, extrication should take less than 30 minutes,
- If invasive life support is required, extrication should be possible 'm 30 minutes of arrival,

- Injured patients should not be moved until they have been properly assessed unless there is an immediate threat to their life - ie casualty assessment and management techniques must be explicit parts of a emergency service response capability.

The importance of including casualty management in a special service response standard is highlighted by the earlier finding that a significant number of neurological damage cases appear to be related to the manner in which casualties are extricated and immobilised rather than due to severing of spinal cords at the moment of vehicle impact.

3.3 Response capacity

For the purpose of this trial it is assumed that fire brigades should aim to be able to:

1 . in the event of an injured person trapped in a RTA, machinery etc - make the scene safe (from fire and stabilise vehicle), allow medical access to casualties within 5 minutes of attendance for purpose of resuscitation or other invasive in situ life support measures, and be able to extract casualty within 30 minutes of attendance if rapid extrication befits the clinical needs of the casualty. If no invasive life support is required, the casualty should be extracted in under 30 minutes (of attendance). The emergency response needs to be able to make an assessment of the clinical needs of the casualty within a few minutes to allow a decision to be made on whether to rapidly extract the casualty or stabilise the casualty in situ, with the response dictated by the medical needs of the casualty unless there is an immediate threat to life from fire or vehicle instability.

2. in the event of unsafe structures or chemical incidents - make areas safe within 30 minutes- or prevent access to the area within 5 minutes of attendance.

3. in the event of person trapped in a noxious, toxic or oxygen deficient atmosphere provide oxygen supply or move person to "safe" area within 5 to 10 minutes (ie prior to irreversible brain damage due to oxygen starvation) - assuming there is direct access to the casualty through (eg) an open hatch.

A review should be completed of whether it is possible to achieve these goals without incurring a significant risk to the health and safety of personnel using equipment, procedures and skills possessed for the purposes of fire fighting. Where-~'generic" resources do not provide a capacity to achieve these goals, additional resources should be provided against the following uppe expenditure limits:

- £50,000 to £100,000 per category A incident with potential for one to ten casualties requiring fire service assistance,

Thus, a cost of no more than £50,000 to £100,000 can be warranted for special equipment and training to provide appropriate capacity to carry out, for example, a line rescue of a person trapped at height at imniinent risk of injury or death. Costs in the order of a few tens of thousands of pounds per life saved are comparable with those incurred by the ambulance service for averting premature deaths

3.4 Special service life risk assessment

Given that the majority of special service incidents occur at a high frequency it is probable that the frequency and severity of such incidents can be assessed using local fire brigade reports. Thus, the risk assessment completed by fire brigades can be as follows:

1. Identify all potential special service life risks in an area. Review of special services suggests that the following types of Micidents could be classed as of "imminent life risks" for which a rapid response is appropriate:

    - extrication of injured persons trapped in motor vehicles, particularly cars, vans and coaches,
    - extrication of injured persons trapped in/under machinery or equipment at places of work, agricultural premises, etc.,
    - extrication of persons (unconscious or otherwise incapacitated) from toxic, noxious or oxygen deficient confined spaces (e.g. sewers, factories, storage vessels, silos),
    - rescue of persons ftom heights where they are unable to reach a safe place unassisted,
    - rescue of persons or their evacuation from areas experiencing severe flooding,
    - making safe of structure in occupied areas at risk of imminent collapse, such as storm damaged or explosion damaged structures,
    - extrication of persons from collapsed structures including collapsed buildings, tunnels, bridges, etc.,
    - facilitating access to properties occupied by unattended vulnerable persons such as babies (i.e. high life risk lockouts), and lockout of "at risk" persons (e.g. women locked out at night i high crime areas).

2. Estimate the fi-equency ofmsuch incidents in each part of a brigade - using a 3 to 5 year period.

3. Compare the estimated frequency of incidents with the emergency cover guidelines given in Table 2.2 and assign appropriate "special service" risk category.

4. Examine the impact that the location and frequency of these incidents and the respective attendance time standard and response capability has on the positioning of resources, i.e. station location, the level of training and types of equipment needed