

The Ramstein Airshow Disaster

Squadron Leader T E Martin BSc, MB, BS, DRCOG, RAF

RAF Institute of Aviation Medicine, Farnborough, Hants

SUMMARY: In August 1988 an aircraft of the Italian aerobatic display team fell into the spectator enclosure at the Ramstein Airshow, causing over 500 casualties. The survivors were triaged, treated and evacuated from Ramstein within 96 minutes. The speed and efficiency of this evacuation was a result of prior planning, thorough training, medical reinforcement, co-operation with other agencies and the availability of an abundance of vehicles for both air and road evacuation. Not surprisingly, though, problems did occur, especially with communications, casualty identification and documentation.

Introduction

It has been a year since the airshow disaster at Ramstein, and perhaps now is a time to look back and take stock of the lessons learnt. In August 1988 the author was the British Medical Officer attached to the USAF 316th Air Division Clinic and working for the RAF unit based at Ramstein. Although it houses a NATO headquarters, the majority of serving personnel at Ramstein belong to the US Air Force. Ramstein Air Base is, in fact, the largest USAF facility in Europe. On the 28 August 1988, Ramstein held its annual open day, known as Flugtag ("flight day"). The final act of the airshow was the Italian Air Force national aerobatic display team – the Frecce Tricolori (Tricolour Arrows). The day had been splendid, with excellent weather and stunning flying displays. Unfortunately, only a few minutes after starting their display routine, 3 aircraft of the Frecce Tricolori collided during a cross-over manoeuvre. One fell into the spectator enclosure causing over 500 casualties. The aim of this paper is to describe how the accident happened, to give an account of the subsequent actions of the emergency services, and to discuss the major problems faced by medical personnel in the first hours after the disaster.

Background

Ramstein Air Base lies 15 km to the west of Kaiserslautern in the German State of Rheinland-Pfalz, not far from the French border (Fig 1). Since 1955, the USAF has staged an annual Armed Forces Open House at Ramstein whereupon admission is granted, at no charge, to civilians and military alike. Over the years, Ramstein Flugtag has become known as the biggest and best airshow in continental Europe. Over 300,000 spectators were estimated to have been at the 1988 Flugtag.

The Frecce Tricolori belong to the 313th Gruppo based at Rivolto in northern Italy. They fly Aermacchi MB 339A two seat trainer aircraft (Fig 2). The pilots are volunteers from fighter squadrons who each have more than 1,000 flying hours and are selected for their experience, skill and physical condition. The team had suffered 3 fatal accidents in the previous decade. One occurred at the RAF Mildenhall airshow in 1979 where the pilot managed to guide his aircraft away from the crowd before crashing.



Fig 1. Federal Republic of Germany

The Accident

The Frecce Tricolori had just started their display routine. After a formation flypast over the crowd and return back towards it, the formation climbed and split into 3 groups. A vic ("V" shape) formation of 5 aircraft and a diamond formation of 4 entered loops to fly each half of a heart shape. A solo aircraft flew a loop at right angles, initially away from the 2 formations, but then turning back towards them. At the bottom of the loops the 2 groups of 4 and 5 opposing aircraft flew parallel to, and in front of, the crowd line whilst the solo aircraft flew towards the crowd and attempted to pass above the crossing formations (Fig 3). This is called the "pierced heart manoeuvre".

Medical Preparation

Planning

Based on previous experience, the medical planners expected to see and treat up to 150 emergency patients during Flugtag. In earlier years most of these patients had suffered from heat exhaustion, cuts, sprains and other minor trauma. Nevertheless, plans were made for the possibility of mass casualties and the Base disaster plan had been revised in February 1988 and exercised twice in the 6 months prior to the accident. It was available, in checklist format, to a dedicated disaster response team situated in a mobile command post at the airshow, and to team leaders at each medical location. In addition, full co-operation and support was elicited from both the German Red Cross (DRK) and the nearby Landstuhl Army Regional Medical Center (LARMC). LARMC is a 260 bed US Army medical facility with all the resources of a district general hospital. It lies some 5 km to the south of Ramstein.

Medical resources

In conjunction with the DRK, the concept of operation was to provide forward deployed and dispersible medical support for visitors to the airshow. Four medical aid stations (MAS A,B,C and D) manned by both DRK and USAF personnel were located in the flight line area, but only one (MAS B) was near the crowd line. In addition, USAF medical personnel were prepositioned in the control tower/VIP area and in the Base Clinic. Fig 4 shows the locations of these resources with reference to the crowd line and the site of the accident. MAS A was the main control centre and the only MAS with radio and land-line communications.

There was a total of 15 doctors and 163 paramedical personnel on duty for Flugtag. All the doctors were on the airfield except for 2 who were on duty in the Base Clinic treating routine patients at the time of the accident. The paramedical personnel included dentists, nurses, medical assistants and technicians. A total of 15 ambulances were standing by at the 4 medical aid stations, the VIP enclosure, and at the Base Clinic. USAF medical personnel, 2 ambulances and a dedicated UH 60 Blackhawk casevac helicopter formed a disaster response team (DRT) and were located on the south side of the runway. Unfortunately, it was this UH 60 which was destroyed by falling aircraft debris.

Off-base medical assets

Hospital authorities at LARMC were aware of Flugtag, but no extra staff were on duty at the time of the disaster. Nevertheless, all hospital personnel live on site or within the immediate vicinity and emergency recalls of vital personnel are frequently practised. A second casevac helicopter was on stand-by at the hospital heliport.

There were 28 medical personnel standing-by at the DRK regional headquarters in Landstuhl and in other

nearby towns. A further 91 personnel were on telephone stand-by in their homes in many of the villages that surround Ramstein.

Disaster Response

The crash call was sent at 1546 hrs but, since the accident was clearly visible to all on the airfield, medical forces were organising well before the official call for "all available medical personnel" was received 3 minutes later. Immediately, medical personnel repositioned into 4 triage and treatment areas. Doctors and paramedical staff from MAS A and C moved to the scene of the disaster. Personnel from the VIP area and MAS D set up minimal treatment areas near the tower. The DRT gave medical assistance to the crew of the damaged casevac helicopter and others in the vicinity before moving to MAS B (Fig 4).

Unfortunately, the roads and open areas immediately around the crash site were obstructed by spectators, many of whom were running from the scene, whilst others were running towards it. MAS B was situated adjacent to the disaster site, but a lengthy diversion was used by other emergency vehicles and this meant an inevitable delay of several minutes before some casualties could be reached. During this time, many volunteers came forth from the crowd: they included a further 8 doctors, about 15 nurses and numerous first aiders.

There was an abundance of helicopters at Ramstein. The first was airborne within 3 minutes of the impact and was a UH 1 Huey which had been on stand-by to evacuate VIPs in the event of a terrorist threat. Two other helicopters were airborne in the next 10 minutes. These were soon joined by a UH 60 Black Hawk from LARMC, a Royal Air Force Puma and German civilian emergency helicopters. By the end of the day 18 military and civilian helicopters had evacuated hundreds of casualties, many flying several return flights.

The majority of immediate fatalities was due either to major mutilating trauma caused by the disintegrating aircraft or to extensive third degree burns and inhalation injuries. Hundreds of survivors were burnt, but the flash nature of the fireball meant that, although many suffered extensive burns, they were often limited to second degree.

Many victims stood or walked aimlessly about, apparently feeling no pain, yet able to see their skin and clothes burnt from them. Shock and head injuries were common. Amongst hundreds of casualties, many children were killed and injured, probably because parents had taken them to the front of the crowd to give them a better view of the show.

Although it took 96 minutes to clear all the casualties from Ramstein, the most severely injured were evacuated much sooner and the majority of medical personnel were moved to the emergency room at LARMC to assist with further treatment. The emergency room had been notified of the disaster over

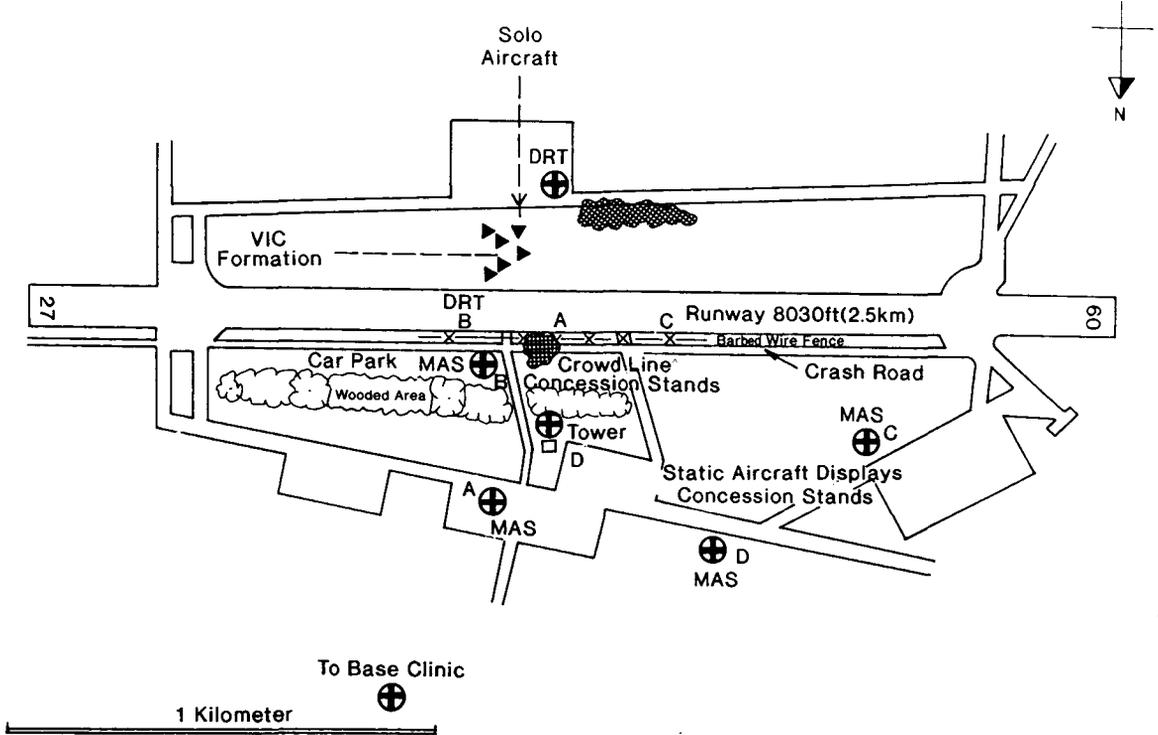


Fig 4. Airfield Map

the VHF link with the first airborne helicopter. A full recall was initiated, and within 15 minutes they became aware of the full extent of the catastrophe. By about 1700 hrs, LARMC had accepted 120 casualties, all others having been evacuated to nearby German hospitals. Their casualty plan was running smoothly and, by the time that Ramstein's medical personnel arrived, the emergency room was bustling, but organised. Patients were being stabilised, many for onward evacuation, whilst others were already in the operating theatres.

In the chaos after the disaster, many family members were separated and casualties were evacuated to any of 21 medical facilities. A cinema was opened as a meeting place for separated persons. Dozens of telephone lines were rapidly installed and computers were brought in to help compile lists of the missing. Within 2 hours a medical control center (MCC) was established in the Base Clinic to cope with the enormous logistical problems of keeping track of all the casualties, and to compare lists of those reported missing with those who were known to have been injured or killed. Chaplains were called in to support the distressed and bereaved. Dozens of distraught and hysterical witnesses had simply "seen too much".

For many, the work continued long after the casualties were cleared from the airfield. These included the explosive ordnance team who were tasked with disarming ejector seats, mortuary volunteers and dental staff tasked with identifying the remains, environmental health personnel who had to account for all potentially infective or soiled medical waste and who were also tasked with collecting soil samples at the sites of fuel and chemical spillage. Also, in those early hours after the disaster, psychiatrists and mental health staff from several US facilities were starting the long task of counselling survivors, relatives and health workers alike. In the following days, open support groups were started on a "walk in" basis. Many patients required more formal treatment and, months later, some are still in therapy.

Casualty Statistics

Within 77 minutes, over 500 surviving casualties were evacuated from the site of the disaster and by 96 minutes they had all been cleared from the airfield. The method used has been described as the "Vietnam" or "scoop and run" concept, whereby patients are moved as soon as possible to the nearest medical resources. This

procedure can be used with advantage when resources are close by and transport is immediately available, though there is still a body of opinion which would prefer to transport medical facilities direct to the patients. Their plan is to stabilise the patients on-site before evacuating them to their final hospital destination, thus avoiding secondary evacuation later.

A year after the disaster there are 73 reported dead, 34 of whom died at the scene of the disaster and were transported to a makeshift mortuary on Ramstein Base. In addition to the 3 Italian pilots, 63 of the dead were German, 4 were American, 1 was French, 1 was Dutch and 1 was British.

Of the 530 patients who were seen and treated, 363 were admitted to 21 medical facilities in the first hours. In the next few days many of these patients were further transported to 46 medical facilities throughout Europe and one in the USA. Three months after the disaster 25 were still in-patients and 3 remained critical. Many more are still undergoing out-patient treatment or require follow up surgery.

The Problems

Were there problems? Did we learn anything? Undeniably, the answer to both is yes but, without doubt, the emergency services performed admirably on the day. Despite the planning, it is folly to imagine that anyone can ever be fully prepared for a disaster of this scale. No amount of training can predict the human responses and emotions that play such a large part in the outcome on the day. The problems encountered by the author may have been localised and not found to be problems in other areas on the airfield. Many of the issues have been described before and since, but perhaps it is now time to address them, and to consider their relevance to disaster planning and training in the UK. The problem areas have been classified into 7 groups:

a. **The Chaos** The accident was sudden and unexpected. There were overwhelming numbers of casualties in widely dispersed groups. The sheer number of spectators and their freedom of access onto roads made transport difficult in the minutes after the crash. Panic was all around and, with a disaster of this scale, one cannot assume that members of the emergency services would be immune to it.

b. **Control and Communication** Communication was almost impossible. As in all disasters, no one appeared to be in overall control during those first vital minutes when decisions needed to be made and conveyed to the growing army of helpers. Radio nets were jammed and became unusable. The PA system was damaged and temporarily out of service. Those on the flight line had no idea if the disaster plan had been implemented, whilst those at LARMC had no idea of the scale of the disaster. With no obvious leader and so many helpers it became important to identify key personnel. Doctors were often indistinguishable from non-trained personnel, as were nurses and others with valuable skills. Instructions were

given to volunteers, but often went unheeded. Many of the helpers (and casualties too) were non-English speaking, and few from the US emergency services could communicate effectively in German or French.

c. **Medical Assets** A dilemma faces the medical planners – where to place the medical assets? It is impossible to predict where an accident might occur and what might be the effect of the crowds on route access. At Ramstein, the majority of the medical equipment and the casualty treatment packs were behind the crowd line and, unfortunately (because of the crowds), in locations that were difficult to travel from. Supplies took up to 15 minutes to reach the disaster site. In addition, the large numbers of casualties meant that there were inadequate numbers of stretchers and blankets, whilst other supplies soon ran out and delays were caused as fresh stocks were located.

d. **Casualty Evacuation** Casualty evacuation was obviously hindered by the unfortunate destruction of the dedicated casevac helicopter. Also, in the early minutes triage failed as volunteers and first-aiders filled incoming ambulances and helicopters indiscriminately. This inevitably led to a number of T4 patients (those not expected to survive) being evacuated despite the efforts of a small number of doctors to rationalise the order of evacuation so that patients with a greater chance of survival could be moved as a priority.

e. **Casualty Identification** There were not enough casualty labels in the ambulances and casualty identification documentation did not occur at the scene of the accident. Volunteers, thinking only of the benefits of rapid evacuation, moved many patients from the scene without clothing or belongings which may have been useful for identification purposes later. Some of the patients lost consciousness, or subsequently died, and proved difficult to identify. This caused great distress to the relatives of the missing and a great deal of confusion amongst the MCC team who were trying to keep track of all the evacuated patients.

f. **Casualty Tracking** Spectators had come from all over Europe and, of course, from many of the nearby US bases. The large numbers of casualties were evacuated to 21 different medical facilities during the first 24 hours. Within a week, those still hospitalised were spread between 47 facilities in Europe and the USA. Many of the more severely injured had still not been identified. It was an immense task to keep track of all the casualties and to correlate lists of missing with lists of those victims who had been positively identified. This was compounded by the fact that, as separated families were reunited, the MCC was often not informed and names needlessly remained on the missing list.

g. **Speed of Evacuation** What was, undeniably, a marvellous effort by all at Ramstein caused problems elsewhere. The incredible speed by which all the casualties were triaged and evacuated simply shifted “our” problem further down the line. Local hospitals became inundated. Our speed caused their receiving

areas to be in pandemonium. Delay in treatment was simply shifted from one location to the next. To make matters worse, many patients initially arrived with no prehospital care, almost all had no clinical documentation, and the staff at the hospitals had little idea of how many more casualties to expect. These same criticisms were voiced after the Boeing 737 disaster at Kegworth¹.

Plans That Went Well

Despite these observations, there is no doubt that the combined US military and German civilian emergency services achieved a rapid evacuation of all surviving casualties. Patient sorting was swift and efficient at the Ramstein Base Clinic and at LARMC. There were adequate numbers of helicopters and an abundance of wheeled vehicles. The evacuation of casualties started within minutes of the accident and continued smoothly well into the evening. Many of the casualties had received vital primary care before their onward journey. The standard of first-aid that was witnessed by the author was exemplary. Fire crews controlled the conflagration remarkably quickly and security forces soon cleared roads for the emergency vehicles.

Discussion

Disasters are always unexpected and are usually unpredictable. Anticipation and specific planning is, therefore, difficult. Nevertheless, a sound working framework is essential, whilst flexibility remains crucial. Ramstein has taught us that medical planners should envisage perhaps as many as 600 casualties, and it has confirmed that disaster exercises need to be practised frequently so that each member of the team knows his or her exact role and location. In the UK there is, at present, no national body which co-ordinates disaster planning and response. Barclay² has recently pointed out that Department of Health policy dictates that contingency planning is a regional responsibility, but a recent news item³ reported that a National Disaster Co-ordinator, responsible for overseeing emergency operations, is to be appointed by the Home Office. Nevertheless, it is essential that planners have a working liaison with the local emergency services and hospital staffs. It is vital to know where mass casualties are to be sent, especially if they are to be transported to burns centres, or to other hospitals distant from the disaster site. Furthermore, if patients are to be dispatched far and wide, a useable system for tracking them is vital. Planners should not forget the voluntary organisations. They should be included in all disaster exercises, since their help will be invaluable on the day.

Ambulance Authorities are usually not slow to develop close ties with military units based within their operational area and mutual assistance can often be obtained, subject to prior Ministry of Defence (MOD) commitments. Aid from the Armed Forces can provide important reserves during a major emergency or when

supporting large public events. Wilby⁴ acknowledges the support that military assets (especially helicopters) can offer, but makes no mention of their inclusion in routine disaster planning, presumably because of the need for the MOD to assess each request on its merits. Roberts⁵, in an effort to clarify how airborne assistance can be coordinated, points out that police authorities may request helicopter or fixed wing aircraft support direct from either of the RAF Rescue Coordination Centres and that, currently, it is MOD policy to waive all charges to individuals for military assistance when life is endangered. He has also drawn attention to RAF Mountain Rescue Teams who are available at one hour readiness and have the training and expertise to deal with aircraft crash rescue.

It is difficult to apply the concept of triage in peacetime and Ramstein showed us that untrained helpers will always try to evacuate those that look worst, often at the expense of more treatable casualties who then suffer the consequences of delayed medical care. A disaster, by definition, exists when the number of casualties exceeds the capability to manage them. Under these circumstances, results depend on the number of survivors and not, unfortunately, on heroic efforts to treat a few individuals. Medical personnel must triage in such a situation. It is always preferable that the most experienced member(s) of the team should take on this responsibility, but Nancekievill⁶ points out that personnel called out to disasters have probably never attended a major accident before and that basic mistakes are still made. It is certainly true that the injuries which occur are often beyond routine experience and decisions made in such chaos and confusion, especially in the face of fear, are not always wise ones. It follows, then, that all medical and paramedical personnel who are likely to respond to a disaster scenario need the relevant depth of training in advanced resuscitation and life support techniques. This might follow the lines of the American Advanced Cardiac and Trauma Life Support courses, or similar courses designed by the Royal College of Surgeons, the Royal Army Medical Corps and the British Association for Immediate Care (BASICS). Doctors must be able to insert intravenous (IV) lines, intubate, insert chest drains and manage cardiac arrest. Paramedical personnel can also be trained to insert IV lines and should be competent in advanced first-aid, including cardio-pulmonary resuscitation and the treatment of shock. The individual's knowledge and proficiency should be tested at every suitable opportunity, but especially during disaster exercises.

Without effective dissemination of information, leadership is difficult, co-ordination is impossible, and valuable time is wasted. Communication is essential. Medical teams need radio telephony equipment with dedicated frequencies available. Other methods of communication may also be necessary, such as tannoy, hand-held loud hailer, telephone land-lines and messenger runners. Furthermore, key personnel must

be easy to identify. Every member of the emergency services should have his own personal item of clothing which annotates the wearer's profession, such as a reflective jacket or protective helmet. If all else fails, a simple pin-on badge, stating the wearer's skills, would help. For military personnel, these items should supplement, not replace, red cross armbands.

Equipment suitable for use in a mass casualty situation should always be readily available and mobile. Time taken to collect and load such equipment is time wasted. A suitable trailer or vehicle can be permanently loaded. Naturally, the equipment must be checked and updated frequently. Ideally, a small number of paramedical personnel should know every detail of the contents so that, during a disaster response, they can be solely responsible for distribution of supplies on site. Reserve stocks must be similarly kept updated and remain easily accessible for rapid augmentation of dwindling supplies.

Ambulances should carry plentiful casualty identification/treatment cards and pencils or chinagraphs. There is, unfortunately, still no nationally agreed triage labelling system, but Robertson⁷, in a review of those labels available at the present time, advocates the Cambridge Casualty Card and other similar labels which are clear, concise, weatherproof and easily allow change of triage category if the patient deteriorates or improves. In view of the current precautions necessary to prevent the dissemination of HIV virus, each ambulance should also carry enough disposable gloves for the entire medical team (extra gloves will be needed for helpers and volunteers). Likewise, care must be taken to ensure the complete and correct disposal of all potentially infective medical waste as soon as possible after casualties have been cleared from the scene.

The timing and method of medical evacuation remain contentious issues and Nicholson⁸ recently examined the advantages of both the "scoop and run" and "on-site stabilisation" concepts. There is no doubt that early medical intervention saves lives. Trunkey⁹ showed that the average time from injury to definitive medical treatment was 12-18 hours in World War I compared with 65-80 minutes in the Vietnam war. The mortality rate of those reaching medical care was 8.5% in the former and only 1.7% in the latter. Obviously, there are many reasons for the decreased mortality rate, but Trunkey suggests that the speed of evacuation is of major importance. Baxt and Moody¹⁰ compared the mortality of 150 helicopter transported patients with 150 patients (matched by age, sex and trauma score) who were transported by road. The airlifted group of patients suffered 52% fewer fatalities. Yet another study (Adams Cowley¹¹) showed that mortality rates varied inversely with the length of time between injury and definitive treatment. That treatment was hospital based, but Nicholson⁸ has pointed out that the helicopter can be used to deploy medical personnel and equipment to

the casualties in a short time and provide for early resuscitative treatment at, or near, the site of injury. Perry¹² has taken this one step further and suggests that medical teams should be flown to the scene where they can stabilise patients who are then fit enough to be evacuated by road. Bock¹³ states that all helicopters and most ambulances in the West German emergency services carry a doctor who works permanently in the field of emergency medicine, anaesthetics or intensive care. Each is highly trained in the extra skills needed by the "roadside physician", but Bock agrees that the first physician at the scene must adopt an organisational role until definitive treatment can be offered to individual patients by medical reinforcements.

There can be no authoritative instruction. The decision to scoop and run or to stabilise on-site must be one taken at the scene of the disaster, by the senior medical co-ordinator, in the light of such variables as the number of casualties, the location and proximity of medical facilities, the availability of helicopters, the accessibility of the disaster site and the quality and quantity of medical assets on site.

At Ramstein, there were enormous numbers of casualties and yet an abundance of both helicopters and ambulances. The nearest accident/emergency unit was only a few minutes away by air, and there were enough medical personnel there to cope with the initial flow of inbound casualties. There is no doubt that some casualties had to be evacuated early, so that the medical personnel at the disaster site could concentrate on the resuscitation of those left behind. The problem appeared to be one of identifying the casualty chain "bottleneck" so that sensible decisions to hold or release casualties can be made. In this way they can be seen and treated either on scene or at a nearby hospital, with minimal waiting time. Inevitably, this means that a sensible mixture of scoop and run evacuation and on-site stabilisation must be applied in each case. The correct balance of both must be reached by the senior medical co-ordinator. He needs to know the status of the casualty situation, not only at the scene of the disaster but also in each of the admitting hospitals.

Planners should also consider that there will be many victims who are not physically injured. Post traumatic stress disorder is now well recognized¹⁴, but experience gained at Ramstein and other recent catastrophes has shown that we should anticipate psychiatric casualties amongst the personnel of the emergency services as well as amongst the survivors. Thus, psychiatric services need to be available in sufficient numbers to deal with the many cases that are bound to occur.

More specifically, in planning for large events where aircraft will fly, medical reinforcement will always be necessary. Perusal of the medical assets available at Ramstein shows numbers of personnel that far exceed those that are normally available at British airfields. Reinforcement might come from nearby military establishments and, if possible, also from volunteer

organisations such as BASICS, the Red Cross and the St John Ambulance Brigade. In addition, careful attention should be paid to the location of medical resources on the airfield. These locations should be in communication with each other and should be clearly marked for ease of access. It goes without saying that each location will require its own transport and mobile supplies.

The role of aeromedical evacuation has already been discussed, but there can be no doubt that the value of helicopter support was, once again, proven at Ramstein. Helicopter units need to be aware of nearby air displays and should perhaps be standing-by at the larger events. Road transport (coaches in preference to trucks) is equally crucial and should be readily identifiable as suitable for re-rolling in stretcher fit, in case of urgent need.

As this conclusion is written, a crash at the Paris Air Show has been reported. Fortuitously, the pilot survived and the aircraft fell short of the crowd line. A catastrophe was averted, but nevertheless the potential existed for another tragic disaster. Ramstein, like all disasters, can teach us. We must learn from the misfortunes of others so as to avoid making the mistakes ourselves. Unlike some European countries^{13,15,16}, British doctors have no formal teaching in disaster medicine and perhaps now is the time to look closely at our planning and to discuss a more formalised system of improving our training. The next disaster, unfortunately, awaits us!

The opinions and interpretations contained herein are those of the author and do not necessarily represent the views, policies or endorsements of the UK Ministry of Defence or any other government agency.

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