Major Bus Crashes in Sweden 1997–2007

Kamedo Report No.94

THE NATIONAL BOARD OF HEALTH AND WELFARE

Socialstyrelsen

Kamedo (the Swedish Disaster Medicine Study Organisation) has existed since 1964. The committee started its activities under the auspices of the Swedish Research Delegation for Defence Medicine. In 1974 Kamedo was transferred to FOA (the Swedish Defence Research Establishment), now called FOI (the Swedish Defence Research Agency). Kamedo has been affiliated with the National Board of Health and Welfare since 1988.

The main task of Kamedo is to send expert observers to places in the world affected by large-scale accidents or disasters. The observers are sent to disaster areas at short notice and collect relevant information by contacting key individuals, principally on a colleague-to-colleague basis. The information they obtain may only be used for documentation purposes. There are four main areas which are studied first and foremost: the medical, psychological, organisational and social aspects of disasters.

Results from the studies are published in Kamedo reports. Since 1979 (report 34) they have a summary in English, which are presented on the Kamedo website. Several reports have also been translated in full into English. The aspiration is that all reports will be translated into English. (http://www.socialstyrelsen.se/Amnesord/krisberedskap/specnavigation/Sakomraden/KAMEDO/).

The general guidelines for Kamedo activities are set by the National Board of Health and Welfare. To support this work a reference group with representatives from some of the National Board of Health and Welfare centres for research and development within the area of emergency preparedness, the joint authority needs assessment group for international actions, Crisis Management Research and Training (Crismart), the Swedish Civil Contingencies Agency, the Red Cross and experts with previous experience of Kamedo.

ISBN 978-91-86885-68-7
Article No. 2011-11-19

Preface

Major bus crashes cause so many injuries that they are often counted as "major accidents" or "disasters" in Sweden, not least because they have a tendency to occur in sparsely populated areas during winter. Over a ten year period, ten crashes of this kind have occurred in Sweden. Experiences from these crashes show that both the rescue operation and the care of those injured can be considerably improved, which the Swedish Accident Investigation Board (SHK) has also pointed out. In line with SHK's recommendations, an extensive development has been carried out as regards rescue operations in major bus crashes. The National Rescue Services Agency (changed to – The Swedish Civil Contingencies Agency, 2009), the National Road Administration (changed to The Swedish Transport Administration, 2010) and the National Board of Health and Welfare – through the Centre for Research and Development in Disaster Medicine at the Department of Surgery at the University of Umeå – have participated in this work.

This Kamedo report summarizes experiences of different kinds of typical major bus crashes. The data comes from in-depth studies carried out by the National Road Administration and the Swedish Accident Investigation Board as well as from other local reports of these crashes.

The aim of this report is to highlight factors that have proved to be specific to these incidents. The account presupposes that the rescue services have applied standard routines of command, safety, and management of incidents affecting the environment, and so on. These factors are not commented upon in particular, if the experiences from the crashes do not show that the routines have failed. The work of the police has not been studied in detail.

The report was written by Professor *Ulf Björnstig*, at the Centre for Research and Development in Disaster Medicine at Umeå University in Umeå, in collaboration with *Pontus Albertsson* Ph.D., on behalf of the National Rescue Services Agency. The section on the media was written by Associate Professor *Jörgen Lundälv*, the Department of Surgery, Umeå University. The sections on psychosocial consequences and crisis support had been written by postgraduate student *Kerstin Bergh Johannesson* and Professor *Tom Lundin*, both from the National Centre for Disaster Psychiatry (KcKP), Uppsala University, Uppsala. External reviewer was Associate professor *Louis Riddez*.

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Summary

Major bus crashes with a large number of casualties create a challenge for the emergency services. During the period 1997–2007 ten crashes of this kind occurred in Sweden, of which the characteristics of six typical cases are described in detail in this report. In most cases the bus also overturned, which hampered the rescue effort. The aim of the report is to illustrate the problems that may be encountered in the rescue work, and how the casualties can be taken care of in the best possible way.

There are many factors contributing to the crashes, for example the construction of the vehicle, where the wind sensitivity of high-built buses is a factor that has not attracted great attention previously. In some cases, the crashes were caused by the driver not adapting the speed of the vehicle to slippery road conditions. In one case, a front wheel puncture on an approaching timber truck was the direct cause of a head-on collision with a bus with school children. In another case, the driver sustained an attack of sudden unconsciousness. The lack of side and central barriers on the road has in most cases led to more serious consequences than would otherwise have been the case.

The crashes described here occurred during the period between October and April, which means that those injured were exposed to cold and damp conditions which consequently added a hypothermia problem to the incident.

In Sweden, there is a high level of preparedness for traffic incidents. The rescue work in these cases did not suffer from any lack of number of people engaged in the rescue work, because they happened during daytime, when the emergency resources were optimal. The rescue operation, however, took rather a long time which made it easier to build up adequate resources also in rural areas. On the other hand, it was technically difficult to access all of the injured, who in the worst cases were trapped underneath the bus. As regards the buses that overturned, the severe lack of suitable tactics, technology and equipment hampered effective work.

To improve the rescue process the Centre for Research and Development in Disaster Medicine at Umeå University in Umeå has together with the National Rescue Services Agency School at Sandö, developed a training programme for how to run an efficient rescue operation after these types of bus crashes. A training of instructors has been undertaken jointly with support from the National Board of Health and Welfare and the then National Rescue Services Agency since 2007.

Information is today disseminated rapidly through different media channels, which is positive in many respects. Radio, TV, internet and newspapers have also been able to help provide medical services and the public with information about the crashes. On the other hand, this can also lead to

problems, when the media are allowed direct access to the incident site and hospitals, and are able to film and interview the injured passengers and their relatives in a their vulnerable position.

In 1988 a bus carrying Swedish schoolchildren crashed in a tunnel in Måbödalen in Norway. In that incident many children and adults were killed, and the need for psychosocial support was considerable, for both those directly affected and their relatives, but also for, for example, those school friends who were not themselves present at the incident. Lessons learned from this crash form the basis for the crisis support work currently pursued after similar incidents and are described in Appendix 2.

Experiences

The present report shows that many different pre-crash, crash, and post-crash factors influence the occurrence and outcome of a major bus crash. In the post-crash phase it is also important that all emergency services are aware of the special tactics needed to reduce the consequences optimally.

Pre-crash Factors

- High-sided buses. High buses are sensitive to wind, and in strong side winds during wintertime they have been blown off the road especially when the road surface was slippery. This has been confirmed through wind tunnel studies at the Swedish Defence Research Agency/ Swedish Institute for Aeronautic Research, Solna. Tail-heavy double-decker buses with the engine and cargo space at the back are particularly sensitive to wind. The strange fact is that this type of bus was previously substantially subsidised by the National Road Administration because they were regarded to be suitable for people with disabilities. Currently some bus operators have begun to use a system based on the wind-tunnel data, which means that drivers reduce speed to a safe level on the basis of the forecast about wind and road friction. In very windy weather traffic may be cancelled.
- Lack of road barriers. Adequate side and central barriers would have been able to prevent or reduce nearly all of the crashes, and the Swedish Accident Investigation Board has directed severe criticism at the National Road Administration for the lack of these barriers in several crash investigations.
- Inadequate speed limits. The Swedish Accident Investigation Board has also questioned the permitted speed (90 km/hour) on the narrow road outside Uppsala (Rasbovägen), which had no central barrier. According to The Swedish traffic safety strategy - Vision Zero - the maximum speed limit should not have exceeded 70 km/hour.
- Weak bus chassis and roofs. Requirements are insufficient as regards the strength of the roof construction on modern buses with regard to roll over incidents. There are further no requirements in Sweden for buses to have a protection beam (to reduce the risk of penetration) on the left-hand side against oncoming traffic. With a protection beam and

stronger roof design, many injured would have received fewer and less severe injuries, particularly in the Arboga and Uppsala/Rasbo crashes. The Swedish Transport Agency (formerly the National Road Administration) has, with these experiences as a basis, now the opportunity of pursuing these issues at EU level in order to improve safety.

Crash Factors

- ***The use of seatbelts.*** At least half of the passengers would have received less severe injuries if they had used a two-point belt, and the proportion would have been even higher if they had used a three-point belt. Unbelted passengers are also a danger to the others, as they can be thrown into their fellow passengers and in the worst case force them through a window if the bus overturns. The installation of three-point belts on all buses, and making passengers use them, would be a significant measure in the reduction of injuries.
- ***The infrastructure***. If there is no side barrier, then the embankments along the road should be flat and with no objects projecting upwards. In the crash at Ängelsberg, the embankment was, however, very steep, and in the Arboga crash there was a small rock which caused the bus to roll over on the roof. Shortcomings of this kind in the infrastructure have aggravated the consequences of the incidents where the bus left the road.
- ***The final position of the bus***. The bus usually ends up on its right-hand side, with the doors blocked, which impedes the rescue work, especially the evacuation.

Post-crash Factors

After the incident, it is vitally important that there are clear routines for the way in which the alarm and dispatch centre should act. The rescue work must get underway quickly, and the emergency service personnel (ambulance, fire brigade and police personnel) need to be aware of the special circumstances connected to a major bus crash. It has also been shown that it is an advantage to start psychological and social crisis support already at the scene of the incident. Further, different media will quickly be on-site, and the commanding incident officers need, at an early stage, plan and decide how to deal with them.

Alarm and communication

- ***Effective alarm routines***. The alarm and dispatch centre must be given clear directives as to how an alarm should be raised, who should be alerted, what equipment should be requested, and where special equipment needed is to be found.
- ***Good communication between all parties***. It is important to establish and practice the paths of communication in the whole chain between the dispatch centre, the different incident commanding officers and health services.

Rescue work

To improve the rescue work a training programme has been developed focusing on tactics, methods and equipment. A national train-the-trainer program has been given since 2007 and the instructors have given local training courses to more than a thousand ambulance - and rescue service personnel (2010). There are many special medical and rescue factors included in the courses as well as some special issues as:

- ***Heat for casualties***. In a long drawn-out rescue operation the cold and hypothermia can aggravate the condition of those injured. For this reason, it is important at an early stage to arrange warm air to the bus. It is also important to insulate the victims with e.g. blankets to reduce heat loss. Chemical heat pads under the clothes could easily provide heat to trapped victims..
- ***Tactics.*** In a bus crash, rescuers sometimes have to take care of and remove casualties in the order they reach them. For this reason, it is not always possible to evacuate the casualties in a strict order of priority.
- ***Moving in a bus on its side***. For the ambulance personnel which need to move, or walk, on the side windows it may be important to know that intact windows will bear their weight without crashing.
- ***Injured under an overturned bus***. It is important to find all injured under the bus as quickly as possible, because they may be possible to save if the bus is lifted quickly..
- ***Communicate clearly***. For example, a megaphone is a very good aid at busy and noisy incident sites.
- ***Register casualties***. Take care also of uninjured and those with only minor injuries – they may deteriorate. Be also aware that some people may organise their own transport and disappear from the incident site.

Psycho-social crisis support

- ***Crisis support workers at the incident scene***. Already at an early stage, crisis support workers may be needed at the scene of the incident, who, for example can help protect the casualties from the media and curious bystanders, and also accompany them to hospital.
- ***Alternative means of transport***. Uninjured passengers and those with minor injuries who are going to be transported from the scene in another bus may be distressed. Alternative modes of transport might be appreciated by these, or they may need a supporting person to accompany them.
- ***Collaboration between casualty departments and crisis support organisations.*** Support workers can be stationed at casualty departments and provide help there, while injured passengers are waiting to be examined. This will also take some of the pressure off the medical staff.
- ***Collaboration between the crisis support organisations within the county councils and municipalities.*** Operations are more effective if county council crisis support can focus on the injured that have been taken to hospital, whilst the municipal crisis support groups can pro-

vide acute crisis support to uninjured passengers at assembly points and in local follow-up work. With good collaboration, it becomes easier to refer those needing help to the correct individual.

- ***Who needs support?*** Most casualties manage with basic practical and psychosocial crisis support, whilst others may need professional follow-up and a trauma-focused treatment.

The media

- ***Identification of members of the media***. It is advisable that media staff working at the incident site, or in its vicinity, is identified, for example by vests marked with a clear text.
- ***Public relations staff***. It is wise if the incident commanding officers early decide who and how media should be handled.
- ***Good contact with the media.*** TV, radio, internet and newspapers often have the opportunity of acquiring and disseminating information quickly. This could be used for dissemination of information to the public.

Hazards and Vulnerability

In this report some important factors as regards the incidents and injuries have been identified:

- ***Drivers.*** *Some* drivers, all with many years of driving experience, kept speeds that were higher than weather, road conditions and other circumstances really allowed. One driver was affected by sudden illness.
- ***Vehicles***. High-sided buses catch the wind, especially a frontal wind coming in at an angle of 30 degrees results in strong side forces on the bus. In one case, a frontal crash resulted from an approaching articulated timber truck sustaining a front wheel puncture making it difficult to steer.
- ***Safety belts in buses***. Unbelted passengers can both injure themselves and other people. Passengers with a lap belt may also be partly ejected through the window if the bus turns over and they are sitting on the side that tips. Passengers with three-point belts can also slip out of the thorax portion of the belt if this is incorrectly mounted (as it is in some buses) with the upper anchoring point located towards the middle of the bus (in board). A passenger's upper body is much better fixed in a roll over crash if the anchoring point is located on the out board side.
- ***Physical surroundings***. In certain cases barriers at the side of the road and between the carriageways were not present, which has contributed to aggravating the consequences in these incidents. Several of the crashes have occurred on roads that were slippery and not cleared from snow and ice. Cold and wind has made the consequences for those injured worse.
- ***Experience and routines***. In several of the crashes the emergency services staff had little experience, or knowledge, of the suitable tactics and methods as well as they lacked suitable equipment.
- ***Dispatch and communication***. The alarm and dispatch centres did not always have defined all appropriate factors and measures required in a "major traffic accident", for example, who should be alerted, and whether tow trucks and heat tents should be dispatched. This has on occasion delayed the provision of resources of this kind. The dispatch call has also so vaguely formulated the dispatch call that the units called out have not understood its seriousness. In one crash, the routines for contact between the crew of an air ambulance helicopter and the rescue personnel on the ground were not applied causing disturbances.
- ***The media***. Injured passengers and their relatives have been upset by the media activities at incident site, hospital and other sites. In certain cases, the commanding officers have been disturbed. The personnel at the hospital's emergency departments have sometimes experienced

media’s activities as intruding on the victims’ rights to privacy, and also felt that journalists and photographers have hampered their work.

Background

Major Bus Crashes Worldwide

Globally 1.3 million people die every year in road traffic incidents. Disasters involving hundreds or thousands of fatalities are however rare, and usually result from collisions involving vehicles with inflammable or explosive goods. The worst incident so far is the fire in the Salang Tunnel in Afghanistan in 1988, when presumably a tanker and an army ammunition convoy crashed. At least a couple of thousand people were estimated to have died in the terrible tunnel fire that ensued.

Every year approximately 3 to 5 bus crashes occur worldwide with more than 30, and in the worst case up to 120 fatalities. It is relatively rare to find more than 50 fatalities in a bus incident (approximately one every year). These incidents are not unusually caused by buses, sometimes overloaded, falling into a ravine, or watercourse, or catching fire. The following example from 2008 illustrates an incident of this kind:

> *A bus carrying approximately 70 passengers was travelling on a mountain road in Honduras when it left the road. The bus rolled and bounced down a slope of more than half a kilometre. At least 26 people died. However, approximately 45 passengers survived, which is an unusual high number with regard to the circumstances.*

One of the worst bus incidents in Scandinavia occurred in Finland in March 2004 at 01.30 in the morning, when a tourist bus collided with an articulated truck whose trailer had skidded. The heavy load on the trailer, which consisted of 800 kg rolls of paper, slipped from the trailer and into the bus, crushing everything in its path. In total 38 people were involved, of who 23 died.

Collisions between buses and heavy vehicles such as trucks or trains also cause many fatalities, but often not as many as the types of crashes mentioned above. It happens on occasion that school buses are involved in this type of crash, which gives rise to special considerations. Bus fires also have a tendency to result in high numbers of fatalities, as buses easily become engulfed in flames. A total of 53 people died in a bus fire on the motorway near Beaune in France in 1982, after a collision with several other vehicles. The reconstruction showed that the bus was completely filled with black smoke after 90 seconds [1].

Injury statistics from bus crashes in Europe were compiled through the European project ECBOS (Enhanced Coach and Bus Occupant Safety). Bus crashes involving larger buses (so-called M3 buses with room for more than 22 passengers) generally lead to an injury outcome where 40% of passengers receive serious injuries and 10% die [2]. These statistics are based on data from 31 bus crashes involving 1,341 casualties. The ECBOS report also shows that it is unusual for a bus to turn over or roll, and when this happens a larger proportion of passengers receive serious injuries. Head-on collisions are, on the other hand, considerably more common, but they generally produce a less serious injury outcome, as they often occur on low speed stretches of the road. Head-on collisions with trucks, however, result in a large proportion of the passengers dying [2].

Crisis support is an important part of the work after a major incident. The long-term consequences have been studied after the bus crash at Måbödalen in Norway in 1988. The lessons learned from this bus crash have increased awareness of the need for crisis support for both those directly and indirectly involved in connection with serious incidents. This incident is described in greater detail in Appendix 2.

Swedish citizens have also been affected by injuries and deaths in bus crashes abroad, for example in Copenhagen in 2001, Gedser in 2002, the Canary Islands in 2005 and Morocco in 2006. In this last case medical care personnel were sent from Stockholm to the incident site, to support those afflicted.

Major bus crashes in Sweden

The road traffic incident in Sweden causing the greatest number of fatalities in modern times was the bus fire outside Axamo, Jönköping in 1976, when 15 people died. Most died from inhaling toxic smoke as they could not escape from the bus quick enough. [1].

During the period 1997 – 2007 a number of bus crashes have occurred in Sweden with large numbers of injuries. This means that bus incidents are presumably one of the most probable types of “major accident” or “disaster” that the emergency services have to deal with – especially difficult to handle in sparsely populated areas; see Table 1.

Table 1. Major bus crashes in the period 1997–2007

Date	Place	Incident	Injury outcome
1997, February	Knivsta	Head-on collision between two buses	25 casualties, no fatalities
1998, November	Fjärdhundra/Sala	Single crash + fire	50 casualties, no fatalities
2001, September	Indal/Sundsvall	Frontal collision between a school bus and a timber truck	42 casualties of whom 6 died
2001, November	River Granån/ Robertsfors	Single crash	34 casualties, no fatalities
2002, February	Mantorp/Linköping	Single crash	45 casualties of whom 1 died
2002, June	Råneå	Collision between two buses	17 casualties of whom 2 died
2003, January	Ängelsberg/Fagersta	Single crash	49 casualties of whom 6 died
2004, February	Sälen	Single crash "sleeper bus"	20 casualties of whom 4 were seriously injured
2006, January	Arboga	Single crash	51 casualties of whom 9 died
2007, February	Rasbo/Uppsala	Frontal collision between two buses	62 casualties of whom 6 died

Table 1 shows that single crashes were most common (6/10). The bus has for one reason or another left the road and ended up on its right side, after having turned over, or rolled, 90 degrees to the right. In the worst case it ended up upside down. Collisions were less common. They were, on the other hand, more difficult to deal with, as for example the frontal collision outside Sundsvall, when the timber load from the approaching truck filled and penetrated the bus.

Naturally enough, the risk of major bus crashes is greatest during the winter period from October to April, which implies that casualties can suffer from hypothermia caused by low ambient temperature and wind. The risk of hypothermia is aggravated by extended rescue operation.

The Swedish crashes studied in greater detail in this report fulfil the criteria for a "major accident" or "disaster" according to the definition by the National Board of Health and Welfare [3].

Extract from the National Board of Health and Welfare Term bank

Disaster

Serious incident in which available resources are insufficient in relation to the acute need, and the stresses are so great that normal quality requirements, despite adequate measures, can no longer be maintained.

Major accident

Serious incident in which available resources are insufficient in relation to the acute need, but where through a reallocation of resources and changes in technology, it is possible to maintain normal quality requirements.

The crashes presented in Table 2 and in this report exemplify various factors and circumstances typical for these incidents.

Table 2. Types of crashes described in this report

Type of crash	Crash
Single crashes	
▪ Roll 90°	River Granån/Robertsfors
	Ängelsberg/Fagersta
	Mantorp/Linköping
▪ Roll 180º	Arboga
Collisions	
▪ Bus and timber truck	Indal/Sundsvall
▪ Bus and bus	Rasbo/Uppsala

Preparedness

In many of these crashes the emergency personnel have been faced with unexpected situations for which they had not been trained. This may be one reason why the rescue operation has often taken too long time according to the concept of "the Golden Hour" [4]. The Golden Hour is the desirable time within which severe and critically injured should receive appropriate hospital treatment. The Swedish Accident Investigation Board has, in its enquiries after both the Ängelsberg and Arboga crashes, pointed out the lack of preparedness as a major problem [5,6].

Bus crashes in the media

In major crashes and disasters a copious flow of news and information quickly emanates from the mass media (newspapers, radio and TV) who seek to report from the incident site [7]. The pressure from the media also affects the emergency personnel and institutions involved. Problems have been described for Emergency Physicians in conveying correct information about injuries [8]. "Accident journalism" has been studied for a long period in Norway [9-10]. These studies have primarily dealt with information from a "public interest" angle, and in this way the patients' special interests have been largely ignored.

Those journalists reporting and dealing with injury information in the case of major incidents need to be experienced and well-informed about the subject. This was expressed at a joint medical – media seminar in Umeå, at which these questions were discussed [11].

The Sequence of Events in Six Major Crashes

The Bus Crash at River Granån

At the end of November 2001 a single crash occurred that led to one of the most extensive rescue operations in the county of Västerbotten in modern times [12]. The bus left Skellefteå bus station early in the morning to begin its tour to Umeå. Snow was falling, and the temperature was around zero with gusting winds. The bus made a number of stops to pick up passengers on its journey south. When the bus approached the small river Granån, near Robertsfors approximately 67 km north of Umeå, 34 people were on board. During the journey along the main road E4, the driver was able to maintain a good speed as the road surface was wet, had been snow cleared and salted. When the driver turned off the E4 onto a smaller road, the road surface changed from wet asphalt to mostly ice and snow. After approximately 2 km on this road the bus approached an open field and a bridge crossing the small river Granån, a minor watercourse. The bus was hit by a powerful side wind from the left just before the bridge, and the driver lost control of the bus, which slid up on and through the road barrier on the right-hand side. The bus followed the barrier and at the bridge the left front wheel of the bus straddled the higher bridge barrier. At the centre of the bridge the bus rolled 90° to the right and the front of the bus violently fell down and struck the far side of the river bank with considerable force. The bus thus ended up lying on its right-hand side right across the small river Granån, shown in Figure 1.

Figure 1. The bus in its final position beside the bridge and across the small river Granån (notice the narrow roof hatches, which are expected to be emergency exits). The front of the bus is to the right in the picture.

Source: Länsförsäkringar, Västerbotten.

The Bus Crash at Ängelsberg

On January 24, 2003 the train from Ludvika to Västerås was cancelled as a result of a technical fault [5]. Swedish State Railways (SJ), who was operating the line in question, arranged a replacement bus to take the train passengers to Västerås. The bus journey ran in principle parallel to the rail line, so that passengers were able to get on and off at stations along the line. The driver, an experienced driver of heavy vehicles and buses, was completely fit. He had driven the route previously and he did not feel any pressure to keep to a timetable. There were 49 occupants in the bus. The road was covered with ice and snow and was slippery, but the driver nevertheless considered the grip to be acceptable. He carried out a careful braking test to gain some appreciation of the road friction. Just west of Ängelsberg he was driving at approximately 60 km/h when he approached a left-hand bend. He slowed down to 48 km/hour, but in the bend he felt that the front wheels suddenly lost their grip. The bus left the road in the curve, descended a 2-metre deep embankment and rolled 90° to the right and hit the bottom of the embankment violently. Ten passengers were completely or partially thrown out through the broken side windows. The bus then slid a number of metres on its right-hand side until it came to rest against a post of a high-voltage power line and a large rock (Figure 2) [5]. The high-voltage power line fell down close to the windscreen.

Figure 2. The final position of the bus against an electricity power line post and rock. The power line fell down in the area of the frontal windscreen.

Source: Fagerstaposten.

The Bus Crash near Mantorp

On February 22, 2002 a bus with 45 people on board was en route from Stockholm to Jönköping on the highway E4. It was snowing, with strong gusting winds and the road was covered with packed snow and thin ice. Just outside Mantorp the road exits from a forested area and runs over an open field straight ahead to the site of the crash. The driver states that he did not feel any effect on the bus from the strong side wind in the forested area, and he estimated his speed to 80–90 km/hour. When the bus came out in the open field area, the driver felt as if the front of the bus was lifted up, which made it impossible to steer. He could not avoid the following crash and everything took no more than a second or two. According to eyewitnesses the speed of the bus was 90–100 km/hour. The bus drifted out towards the right-hand border of the road, went down into the ditch and tipped over onto its right-hand side. At the scene of the crash there was a road barrier on the right-hand side, but the bus left the road before this barrier started and then continued behind the barrier where it came to rest on its side (Figure 3).

Figure 3.The overturned bus in its final position after having slid on its side for approximately 50 metres.

Source: National Road Administration

The Bus Crash on the E18/E20 near Arboga

On January 27, 2006 a tourist bus with a total of 51 occupants on board was on its way from Skövde to Stockholm on a weekend trip [6]. On the two-lane motorway E18/E20 between Örebro and Arboga the bus left the road and overturned. This was caused by the driver suffering a sudden attack of unconsciousness. The driver was experienced and had no prevous medical condition impairing his ability to be a commercial driver. During this attack the bus drifted first out into the left lane and subsequently drifted back to the right and continued out onto the verge and down a long and steep embankment, where it overturned and finally ended up on its roof; see Figure 4. Tracks in the snow on the embankment showed that the bus had left the road without skidding or braking. On the embankment it did, however, skid slightly when it hit a small rock, whereupon it quickly rolled 180° and landed on its roof. This was compressed when all of the windows crashed simultaneously. Subsequently it glided for a short distance on its crashed roof before stopping against a tree stump at the bottom of the embankment. In the crash the roof was not only compressed, but was also displaced to the side. The crash occurred near the boundary between three different county councils, which had to cooperate in the rescue work.

Figure 4. The crash near Arboga was a technical challenge for the rescuers because the bus had ended up on its roof which had been compressed and jammed a number of passengers.

Several of the passengers were trapped, some between the back of the seat and the roof, which meant that all movements of the chassis during the rescue work were potentially dangerous for these passengers and for the ambulance personnel who needed to enter the bus.
Source: Swedish Accident Investigation Board

The Collision between a Bus and Truck at Indal

A bus carrying 41 occupants, primarily schoolchildren, collided head-on with a articulated timber truck in September 2001 at Indal, 30 km north-west of Sundsvall [13,14]. The left-hand front tyre on the truck suddenly exploded just before meeting the school bus. The truck then crossed over into the bus's lane. The bus driver attempted to avoid a collision by moving to the right-hand side of the road but nevertheless did not succeed in avoiding a collision. The left front side of the truck hit the left front side of the bus. Timber broke free from the truck and continued into the bus. After the collision the bus was lying on its right-hand side in the ditch, whilst the truck continued over onto its right-hand side where it descended into a small ravine and rolled, ending up upside down.

Figure 5. The collision between a school bus and timber truck at Indal.

In the collision, the front left-hand side of the bus was filled with the penetrating logs which caused many of the fatal injuries. This bus also finally ended up with its right-hand side downwards, and the doors blocked.
Source: Sundvalls tidning

The Collision between Two Buses at Rasbo/ Uppsala

Two identical buses collided with each other an early morning in February 2007 on the narrow and busy 7-metre road between Östhammar/Öregrund and Uppsala. A total of 62 occupants were travelling on the buses, of whom many were commuting to their work [15]. There had been a light snowfall during the night and the road conditions were wintry, with slush and patches of ice. The road had been ploughed on one side in the direction Östhammar-Uppsala. The buses came from opposite directions on a long straight stretch with forest on both sides. Just before the collision, one bus passed a large high truck with trailer which was standing close to the road but in a parking space. Witness accounts of the sequence of events vary, and objective details are so few that the Swedish Accident Investigation Board has not succeeded completely in elucidating the final seconds before the crash. The buses crashed with a small overlap of their left-hand sides, which were substantially demolished. The side wall of one bus entered just inside that of the other bus until their front wheels met each other and were turned out 90 degrees. Both buses then passed each other and stopped in the ditch.

Figure 6. Both buses were subject to similar deformation damage after a "small overlap" collision. In this bus five people died.

The 5+1 people who died were all sitting in the area where one bus forced its way into the other and were therefore subject mainly to "penetrating force".
Source: Ulf Björnstig.

Figure 7. The media after the Rasbo crash, with many photographers not wearing professional vests with media markings.

Source: Leif Gustavsson, *Norrtelje Tidning.*

Media presence at the crash at Rasbo

At the scene of the crash at Rasbo there were more journalists and photographers than there were members of the emergency services.

In total, the rescue service (fire brigade) had 26 people on site, compared with 39 photographers (press photographers and TV cameramen) and approximately 10 journalists. Two air ambulance helicopters were used, and the media had the same number helicopters for their reports. A total of 13 media companies covered the incident, with the help of a total of 132 press photographers and journalists [16].

As the incident site was only a dozen miles from the city of Uppsala, the media could reach it relatively quickly. Several members of the media were on site even before the first ground or air ambulance arrived, which shows that media are efficient in rapidly acquiring alarm information and getting to the site.

Damages and Disturbances

The accounts in the previous chapter show that there are several factors contributing to bus crashes. These factors are often structured according to the so-called Haddon Matrix [17]. The Haddon Matrix examines the significance of the factors, (i) human, (ii) vehicle/equipment and (iii) physical/socio-economic environment, in the various phases (a) pre-crash, (b) crash and (c) post-crash. The matrix is used internationally, primarily within the profession dealing with the sequence of road incidents. The structure is related to that in the "Utstein template" which forms a basic structure applicable to disaster medicine contexts, and which is also used in this report [18]. Preventive and injury-reducing measures can be applied to all phases in the chain of events. Here the factors that are relevant in the different phases – pre-crash, crash and post-crash – will be illustrated.

The Haddon Matrix

The matrix provides a structure to those factors operating in the different phases of the crash. Planning of rescue and pre-hospital care (*) are placed in the pre-crash socio-economic cell and the emergency rescue operation itself, that is say when something has happened (**), is placed in the post-crash socio-economic cell [18].

Phases	Factors			
	Human	Vehicle/ Equipment	Physical environment	Socio-economic environment
Pre-crash				*
Crash				
Post-crash				**

The disturbance on the emergency services and the involved medical facilities was mostly limited to the first 24 hours after the crash. This extra burden was often well managed through good planning and training of the staff within these organisations. The extra pressure on the medical care involved mainly emergency, surgical and orthopaedic departments as well as, operating theatres. It was possible to manage a large number of injured well, and the disruption of services to other patient categories was limited to the day of the incident or a few days after. At the Granå crash, the Umeå University Hospital treated about 30 injured occupants without any major problems – half of them had relatively serious injuries. Normally the Emergency Department on average treat 35 injured per day, of which however most involve minor injuries.

The injured could be provided with care of ordinary quality, as the hospitals had the opportunity of reorganise its activities, which was relatively easy as the crashes happened daytime. The fact that major hospitals have resources to handle a large number of injured, at least in daytime, was a satisfactory experience from these crashes

The bus crashes also caused local traffic disturbances as often is the case also in normal major traffic incidents. The crashes occurred, however, at places where disturbances could be dealt with relatively easily by the police, who closed the road around the incident scene and diverted other traffic around the site.

Pre-crash factors

Drivers

In the crashes described above, the drivers were sober, possessed the correct qualifications, and had considerable experience as bus drivers. At the crash near Arboga, the previously completely healthy driver was subject to an unexpected blackout similar to an epileptic seizure, which meant that the bus slowly out of control left the motorway. In some cases, the drivers were driving too fast for the road and weather conditions. Particularly when there was an icy road surface and a keen wind, this proved problematic. A lack of knowledge about the effects of wind on high-sided buses may have contributed.

Vehicles

The bus that crashed across the small river Granån was a relatively high-sided bus buss (3.8 metres) and therefore provided a large surface exposed to the wind. In the prevailing weather conditions, with slush and a relatively strong side wind, the lateral forces were too great, so that the bus was forced off the road "as if by an unseen hand". The Swedish Defence Research Agency (FOI) and the Aeronautical Research Institute have conducted wind tunnel tests with a representative bus model, which strongly indicates that the wind loading initiated the crash. The fact that this is not an isolated occurrence is supported by another study reporting 10 crashes of this kind that have been published by Petzäll et al 2005 [19].

In the collision at Indal, where a bus carrying schoolchildren was hit by a timber truck, the timber truck suffered a front wheel puncture, making it difficult for the driver to keep his vehicle on a steady course. It began to sway and collided with the bus, so bad that the bus compartment was filled with logs. The investigation by the National Road Administration together with the tyre manufacturer has confirmed this sequence of events. Representatives of the haulage industry have also confirmed that vehicles of this kind may be difficult to keep on course when they have suffered a front wheel puncture.

Physical environment

The crashes we have described occurred in winter and sometimes also in connection with strong winds, which meant that cold and hypothermia was a problem present during the rescue phase. The single crash at the small river Granån was caused by the relatively strong side wind at 11–21 m/s (25-47 mph) which caused the bus, with its large side surface area exposed, to deviate to the right and over a side barrier. The roadside barrier located before the bridge was too short and weak and was mown down when the bus drove over it. It was therefore of little use in this case. Similar wind conditions and crash mechanisms existed in the crash at Mantorp.

The road and its surroundings have in several cases contributed to exacerbating the subsequent events. In the single crash at Ängelsberg/Fagersta the road surface was very slippery, and the National Board of Accident Investigation found in its crash investigation that the bus, because of the road conditions, could not have negotiated the bend at a speed greater than 25 km/hour. At the time of the crash the bus was travelling at 48 km/hour. What is more, there was no barrier on the outside of the bend to prevent vehicles from going off and down the steep embankment. The bus therefore travelled out across the embankment, rolled 90° before it rapidly and with great force landed at the bottom of the embankment. At least ten people were then thrown out of the bus and were crushed or trapped beneath it.

As regards the single crash near Arboga, where the driver fell ill, there was no barrier here either, despite the fact that the relatively recently built motorway should have had a side barrier according to the new standard enforced at the time of the crash. The bus therefore travelled down a long embankment where a few decimetres rock caused the bus to overturn and land on its roof. At the bottom there was a tree stump which stopped the bus's forward motion and broke the roof backwards. The roof was thus deformed backwards and to the side, so that those sitting on the right-hand side in the bus were exposed to further impact directly from the ground that they were traversing.

The crashes in Rasbo and Indal were the result of collisions with oncoming vehicles, and in both cases the road was narrow with no central barrier. The speed limit was 90 km/hour in both places, but according to the basic philosophy of the Swedish traffic safety strategy – Vision Zero – this speed is too high for a safe traffic also for private cars if there is oncoming traffic. The basic thesis of Vision Zero states that the force of the crash should be kept below the level which results in fatal, serious or disabling injuries in a head-on collision, which for modern vehicles means a maximum of 70 km/hour. In the crash near Rasbo/Uppsala there was also a thin layer of wet snow on one side of the road and a parked articulated truck in a parking space very close to the road. This latter factor may have contributed to aerodynamic side forces on one of the buses.

Preparedness

It is important for society to create laws and regulations to reduce the risks of these kinds of incidents, for example by speed limits, by design requirements of roads and vehicles and by legislation on the use of seat belts. If a serious crash nevertheless occurs, the alarm and dispatch centre, the ambulance and health services and the rescue service (fire brigade) and police should be well prepared so that rescue operations can be performed in an efficient manner to minimise the injury consequences and save lives. The preparedness has, however, not always been adequate in the incidents reported here. The Swedish Accident Investigation Board has pointed out that both ambulance and rescue service personnel have had little experience and training of handling these situations, and have also had a lack of suitable equipment [5,6].

The alarm and dispatch centre (SOS Alarm) has alarm lists stating procedures for different types of incidents. It has, however, turned out that the lists do not always define measures for a “major traffic accident”, for instance tow trucks and heat tents, resulting in long waiting times. The alarm call has also been formulated in such a vague way that the units dispatched have not understood the seriousness of the incident. At the Arboga crash, the ambulance crew in ambulance number 2 was not aware of the seriousness of the incident before the crew heard on the radio news that a bus had crashed. In the crash at the small river Granån, the police were not dispatched, despite the fact that they were included in the alarm plan. In the Rasbo crash, the air ambulance helicopter was not called out immediately, which it should have been. The dispatch was delayed until after the Medical Incident Officer had asked for this support, and it was not in the air until 37 minutes after the collision. Routines for contacts between the crew of an air ambulance helicopter and rescue service personnel on the ground was prepared, but an analysis of the crash at Rasbo showed that these routines were not applied. Experiences from this crash show that better routines are also required for directing air traffic in the airspace above a crash site. The helicopters landed at the crash scene and according to the rescue service personnel, these landings were dangerous because the helicopters landed in the middle of the scene, blowing parts of the damaged buses around [15].

There are thus indications that routines for directing air traffic (media helicopters and air ambulance helicopters) in the air space above a crash scene need to be developed, to support the pilots and increase safety. In these events all of the helicopters were presumably flying according to present Visual Flight Rules (VFR), which places the entire responsibility on the pilot.

The Crash – Personal Injuries and Kinematics

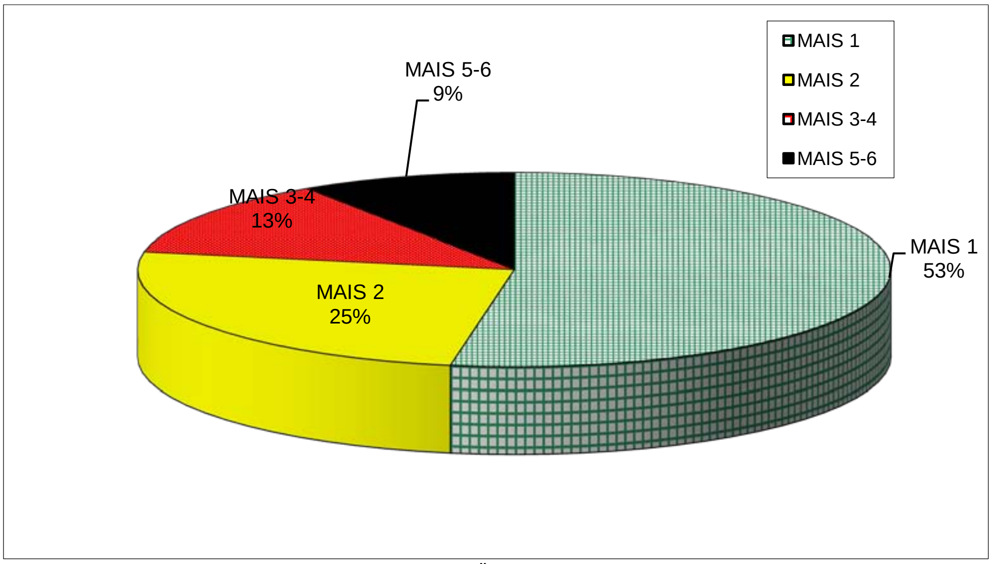
It is important that rescue and healthcare personnel have a rough idea of the seriousness of the injuries they can expect in a major bus crash. Our classification is based on the Abbreviated Injury Scale (AIS), where Maximum AIS (MAIS) is the individual’s most serious injury [20].

Kinematics: Describes the motion of bodies in a crash – in this context closely related to injury mechanism.

Classification of the seriousness of different injuries:
AIS 1: minor injury
AIS 2: moderate injury
AIS 3: serious injury
AIS 4: severe injury
AIS 5: critical injury
AIS 6: maximal injury (currently untreatable)

Below we provide a view of the injuries of the 258 casualties involved in six crashes for which detailed injury information was available: the river Granån, Mantorp, Råneå, Ängelsberg, Arboga and Rasbo crashes (Figure 8). Approximately half of the casualties suffered moderate or more serious injuries (MAIS 2+), that is from moderate injuries (fractures, concussion with loss of consciousness) up to maximal injuries (MAIS 6). More than one in five had injuries classed as MAIS 3+. (MAIS 3 roughly corresponds to injuries requiring intensive care). Almost one in ten had critical or maximal injuries (MAIS 5-6), mostly fatal. A majority died at the scene, but for example at the Arboga crash one hypothermic (32°C) casualty (MAIS 4) died later in hospital. Several of those who died in the Arboga crash suffered no real fatal injuries, but died because of immobilisation of thorax when they were stuck between the crushed roof and the interior of the bus. It has been assessed that at least four of those stuck people lived for a half to one hour after the crash – i.e. they would have been potentially rescuable.

Figure 8. The proportion of injured from the crashes at river Granån, Mantorp, Råneå, Ängelsberg, Arboga and Rasbo distributed according to the degree of severity of their injuries (total of 258 casualties)



Source: Data from the crashes at Granån, Mantorp and Ängelsberg [23]

Single crashes – rollover of 90 degrees

It has been shown that in both single crashes and collisions the bus often ends up at the side of the road with the right hand side downwards, so that the doors are blocked. The single crashes at small river Granån, Mantorp and Ängelsberg, are some examples of this course of events, and all these crashes have similarities in the kinematics (Figure 9).

Figure 9. Examples of the crashes at small river Granån 2001, Mantorp 2002 and Ängelsberg 2003, when the bus in each case rolled 90° to the right

Sources: L-G Halvdansson, National Road Administration and *Fagerstaposten*

This means that the passengers were injured in several different phases of the crash; (i) when the bus rotated to the right and (ii) when the rotation suddenly stops when hitting the ground. Some unbelted passengers were thrown out of the bus, when the side windows were crushed. Other unbelted passengers may have contributed to push passengers out on the “downward side”. In certain cases the bus continued to slide on the ground a number of metres before it stopped, and then the ejected passengers suffered further injuries of course. One example of this is the crash in Ängelsberg, where 10 people, either entirely or partially, ended up beneath the bus, after having been ejected through the crushed side windows [5,21]. Unbelted passengers were also injured when they were thrown against seatbacks, armrests or other passengers. In those cases where the bus rolled 90 °, the unbelted passengers were also found piled up against the lowest side.

Albertsson et al. [22] have carried out in-depth studies of these three typical *single crashes* in which 128 people were injured. The injury severity was distributed in the following way:

- Minor injuries (MAIS = 1) 45%
- Moderate injuries (MAIS = 2) 34%
- Serious–critical injuries (MAIS 3+) 21%

In the data set described, a quarter of the group with serious–critical injuries (MAIS 3+) died. Worst affected were those who had been thrown out (completely or partially) during the crash, and of them more than half died. However, it is important to remember that half of those who were thrown out survived. One in six of those who remained in the bus had serious to critical (MAIS 3+) injuries. These injuries were most common (33%) among those who sat next to the window on the side which landed in the ditch. If the crash also involved a sudden stop in the longitudinal direction, the most serious injuries were to be found at the frontal end of the bus [1].

On average, the casualties had two injuries each. A good third had received cuts from glass. The localisation of the injuries is shown in Figure 10. Head injuries comprised a third of all injuries, and approximately 60% of those people with head injuries had an intracranial injury, often concussion, but more serious inter-cranial bleeding were also observed. Serious skull injuries are often associated with neck injuries, but despite this, moderate or serious (MAIS 2+) neck injuries were rare in this material (fewer than 2% of those injured). Of the injuries to the thorax, half were rib fractures. A few were fractures to one or more vertebrae in the chest or lumbar regions. Extremity injuries were most common in the upper extremities, of which one in four involved a fracture, amputation or crush injury. The fatal injuries affected primarily the thorax and head [22].

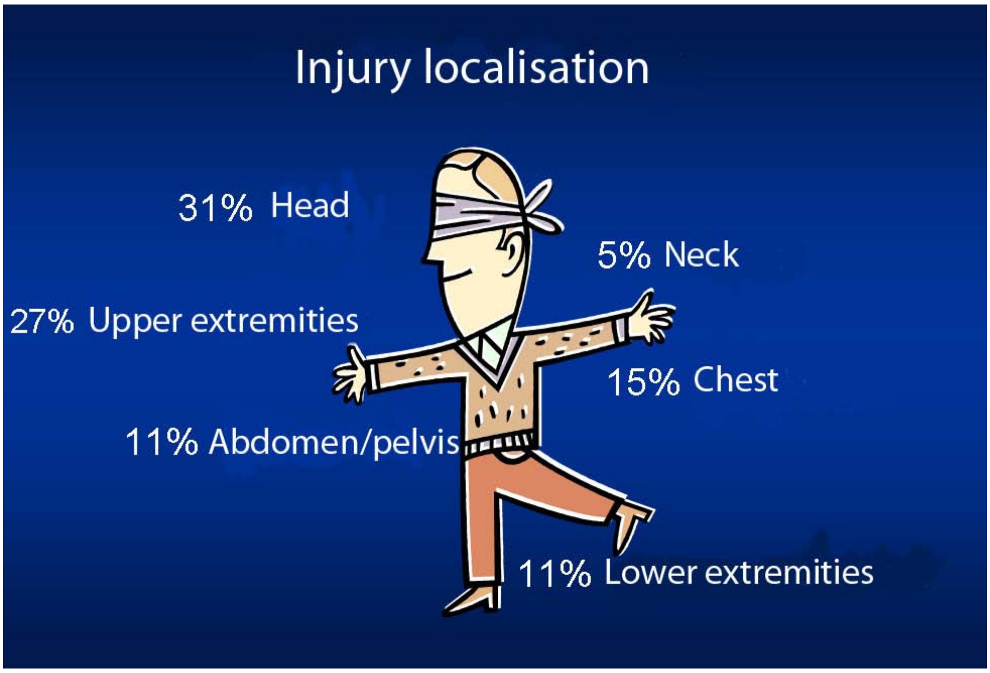


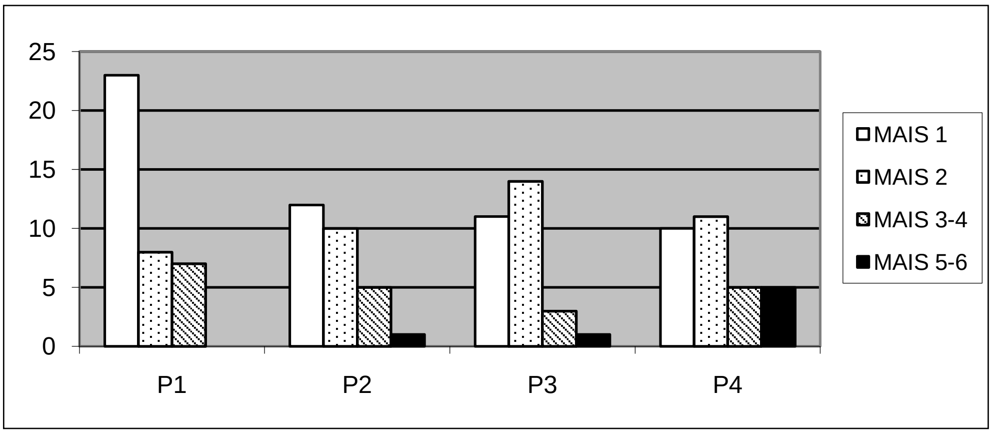
Figure 10. Distribution of 277 injuries among 128 injured persons from the three single crashes described with 90 degree rollover to the right

Source: Data from Albertsson et al. [22]

In the crashes concerned, few of the passengers were wearing seat belts. Those with only a lap belt, who were sitting closest to the tipping side, may also be, at least partially, pushed out through the large windows. This is shown by combining data from the crashes with computer and simulation studies. Passengers with three-point belts can also be pressed out if the belt has the upper anchoring point towards the middle of the bus (inboard side). The upper body is better retained in the bus if the anchor point is on the outboard side [22]. Belted passengers sometimes ended up hanging in the seat belt because they had difficulties to open the lock when it was under tension. In these cases, the fall height may be relatively large, particularly for those people who have been sitting on the left-hand side of the bus. In a few cases this also caused problems for the rescue personnel.

The seats in a bus are usually placed in four longitudinal rows which can be numbered from left to right. P1 is the row furthest to the left in the direction of travel; P2 is the one next to it; P3 is the row on the other side of the aisle and P4 is the row furthest to the right. According to Figure 11 below, it was the passengers in position P4 who primarily suffered serious or more severe (MAIS 3+) injuries, when the bus rolled 90° to the right. These passengers were thus sitting on the side which hit the ground, and were therefore subjected to the highest forces and had also a risk of being ejected and trapped beneath the bus.

Figure 11. Distribution of injured passengers and their injury severity (MAIS) from the crashes at the small river Granån, Mantorp and Ängelsberg by the row position (P) of the passengers.



P1 is the row of seats furthest to the left and P4 the row furthest to the right.
Source: Data from the crashes at small river Granån, Mantorp and Ängelsberg [22]

Single Crashes – Rollover of 180 Degrees or More

In Sweden it is unusual to find bus crashes where the bus rolls 180 degrees or more.

Råneå

In 2002 a school bus in Råneå somersaulted one and a half revolutions after having been hit in the side by another bus. The rear portion of the bus ended up on the bridge rail of a viaduct across the highway E4. Seventeen people were injured in the crash, of which two schoolchildren died when they were ejected from the bus. One of them was crushed beneath the bus whilst the other child was thrown from the bus on the viaduct and fell seven metres down on to the highway E4.

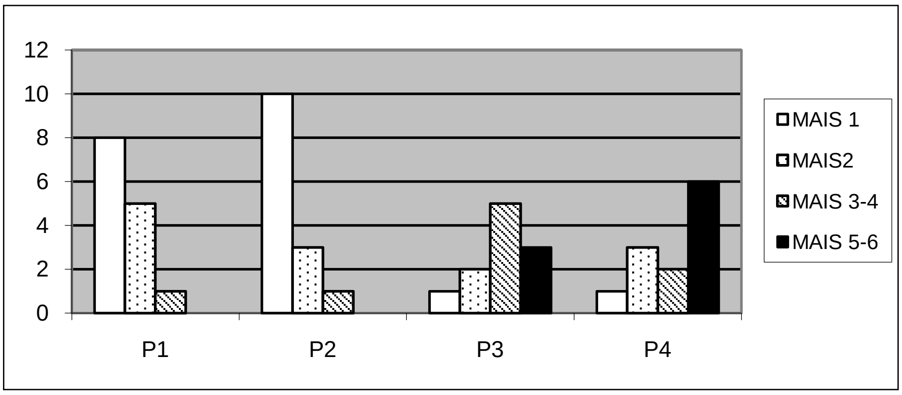
Arboga

The bus crash near Arboga, illustrated in a dramatic way the difficulties encountered in the rescue work when the bus ended up upside down. In the crash all of the windows in the bus shattered at the same time as the window pillars gave way and were broken down. The roof was pressed down and displaced backwards and to the left, so the people in the far right row of seats were subjected to direct force against their heads from the ground. In this case none of the passengers were thrown out, despite the fact that all of the windows were crushed. Possibly the fact that around half of the passengers were using their seat belts contributed to this [6].

This crash illustrates the weakness of the roof structure which seems to be severely under-dimensioned. The current regulation means that a stationary bus on an 80 cm high podium should sustain being rolled off the podium with only limited intrusion of the roof. This requirement is not at all representative for a crash of a bus also moving forward at speed, as in the Arboga crash. With those high forces in a different direction the consequences will of course be disastrous. The fact that strength of the roof pillars was negligible is supported by the investigation carried out by the Technical Research Institute of Sweden (SP). SP stated that the kinetic energy and forces in the Arboga crash was very high in the longitudinally (3 000 kJ) direction, whilst the European testing directive ECE R66 only gives a level of about 100 kJ. This means that the requirements are quite inadequate both as regards the direction and magnitude [15].

When the roof of the bus collapses, the space between the seats and the roof, or hat rack, is substantially reduced. According to the rescuers who worked at the bus crash in Arboga, the headrests were in contact with the roof at the back of the bus, thus providing only a limited survival space. When the roof was pressed down, the window pillars were bent downwards and inwards across the seats. Many of the unbelted passengers were crushed between the seats, the roof and other fittings. [15]. When the roof was then also displaced to the side, exposing the passengers in the right-hand side row for direct contact with the ground, their chances of survival fell dramatically. All of those who died, and most of those with serious or severe injuries (MAIS 3–4), sat in the right-hand rows (seats P3 and P4), where the passengers were most exposed. Of the 51 casualties 34 (67%) received moderate or more serious injuries (MAIS 2+), which makes the Arboga crash to the crash with the highest proportion of non minor injuries.

Figure 12. The number of injured by injury severity (MAIS) and seating position (P) in the Arboga crash in 2006 [6]



Source: Swedish Accident Investigation Board

In this crash also belted passengers ended up hanging upside down, which is a position which worsens the condition of especially people with head and trunk injuries. The position leads to severe physiological changes even among healthy people [23]. The organs of the abdomen push and compress the internal organs of the thorax. At the same time also blood is transferred to the head and thorax from the legs and abdominal organs. This means that heart and lung function is affected, blood pressure increases and the ability to breathe is compromised. Within five minutes the pressure in the brain doubles and stasis papillae are developed in the eyes, which is a sign of increased intra cranial pressure. These factors thus cause a further deterioration in the condition of an injured person hanging upside down, particularly if he or she also has head and/or chest injuries.

Collisions

In collisions the crash sequences is often such that injuries arise in two different ways: (i) through objects entering the bus, or (ii) through deceleration. As a bus is a heavy vehicle with a weight of around 15–25 tonnes, the deceleration are relatively low in collisions with smaller vehicles, but when a bus collides with another heavy vehicle the consequences will be worse.

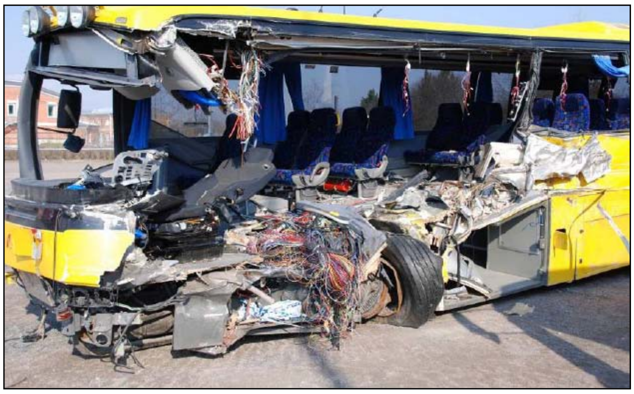
Indal

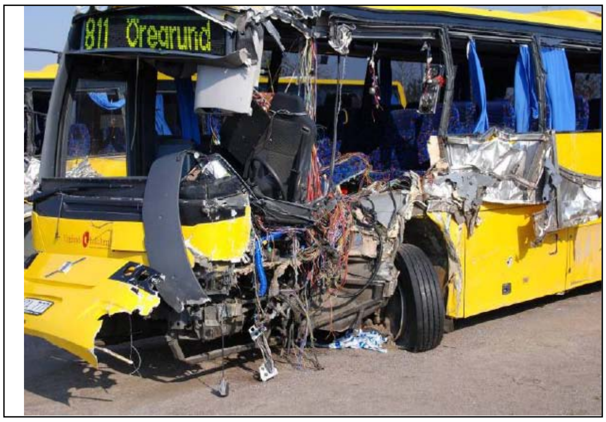
At the collision at Indal 42 people were injured, of whom six died. The most serious injuries were caused by timber which penetrated the bus. The truck driver, who also died, was trapped hanging upside down for a relatively long time. This may have contributed to aggravating the consequences of his injuries.

Figure 13. The crash at Indal in which a timber truck collided head-on with a bus carrying schoolchildren.

Source: Sundsvalls tidning

Figure 14. The two buses that collided at Rasbo/Uppsala were identical



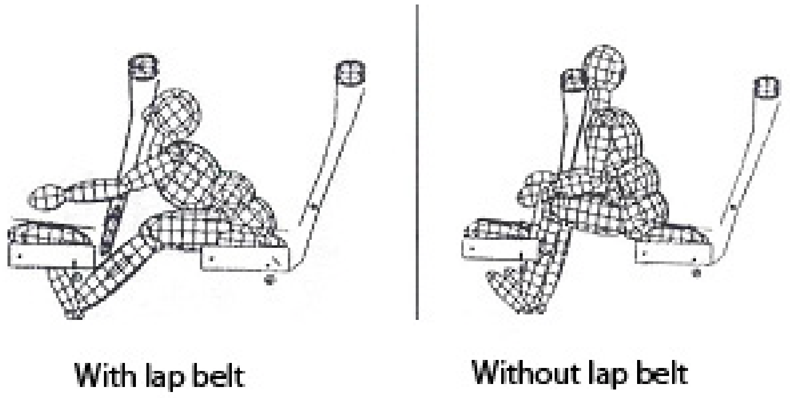


Both buses had very similar deformations. The passengers in the deformation zone suffered very powerful direct penetrating force. In the bus shown in the top picture five people died; in the bus in the lower picture one person died. When the left front wheels met, they were twisted 90 degrees from their mountings.
Source: Swedish Accident Investigation Board

Rasbo

The collision between two identical buses at Rasbo caused massive injuries to the passengers in the areas that were torn apart in the crash. The fatal injuries were primarily to the head and chest. Those who were sitting in the margin and were not directly impacted by the penetrating force received moderate to serious injuries. The rest of the passengers had mostly minor injuries, primarily cuts from the glass in combination with whiplash injuries. The whiplash injuries were caused by their heads hitting the seat in front of them and being bent backwards (see Figure 15). More than half of the survivors had neck injuries (whiplash-like symptoms), but none had a fracture of the cervical spine. The proportion of passengers with whiplash injuries was about the same independent of whether they were wearing a seat belt or not [15]. It is remarkable that some of the involved stated that the belt had not locked and consequently had not restrained them in the crash.

Figure 15. Passengers using a seatbelt can be subjected to a more violent backward flexing of the neck than those without a belt



Source: Kecman et al [24]

In the Rasbo collision 16 out of 62 people (26%) were subjected to moderate or more serious injuries (MAIS 2+). The 56 survivors had a total of 283 different injuries, and the injury severity is presented in Table 3. More than half (32 out of 62) had whiplash injuries and five had concussion. The lower extremities suffered 18% of all injuries and the upper extremities 16%.

Table 3. Distribution of injuries of different severity in women and men – from the collision at Rasbo

Severity	Women	Men	Total
MAIS = 1	17	29	46
MAIS = 2	5	2	7
MAIS = 3	1	2	3
MAIS = 4	-	-	-
MAIS = 5–6	5	1	6
Total	**28**	**34**	**62**

The Media

The behaviour of the media and their presence on the scene has sometimes been regarded as annoying, and at the bus crash in Måbødalen in Norway in 1988 both the commander of rescue operations and the casualties felt the media to be a problem [25]. The media companies used their own helicopter, which flew in the airspace above the crash site and disturbed the rescue work. One TV channel also showed a class photograph of the children with rings around the faces of the children who had died. A study of the experiences of the media by ambulance personnel has been published in Norway.

On March 19, 2004 a major bus crash occurred at Konginkangas near Äänikoski in Finland, in which a total of 23 young people died. There were reports from this crash, too, that the media had behaved in an insensitive manner towards the casualties at the crash site.

Other examples are the bus crashes near Arboga 2006 and at Rasbo/Uppsala 2007 [15] when there was great pressure from the media [26]. The companies used helicopters to show the crash from the air. The journalists approached the emergency departments and also disturbed the work of the crisis teams.

After the Rasbo crash, journalists and photographers from media intruded on the casualties and their relatives for example when leaving the Emergency Department at Uppsala University Hospital, and they also later waited around outside a funeral bureau trying to interview relatives of those who died.

Below are quotations from one of TV4's news broadcasts:

TV journalist from TV4:

"What are you thinking now when looking back?"

Passenger from the bus:

"I don't know ... I'm still quite shaken actually, although it is so many hours ago. I have no hold of the situation ...."

The man continued to speak during the interview:

"It was chaos. It looked terrible. I tried not to look, but next to me there was a woman and somebody else who they took away and … they didn't make it."

Responses

Resources

Depending on the situation, different resources are alerted, and Table 4 summarises the resources involved in the different crashes. These crashes affected between 34 and 62 individuals per crash, and therefore considerable resources were needed. For example, between 10 and 34 ambulances were involved, which in some cases meant that almost all the ambulances in the surrounding area were alerted. In all these cases the resources of the rescue services were also deployed to the maximum. Emergency Departments, operating theatres, and intensive care units came also under heavy pressure. Some medical facilities also sent out mobile medical teams to the site of the crash for administering care to the injured at the scene. Sometimes health authorities from several administrative areas were involved in the same crash. At the crash near Arboga personnel from three different county councils were active, and at the bus crash near Ängelsberg personnel from two county councils worked together. All of the crashes occurred at times when staffing was at its maximum and was simple to reinforce. Some crashes occurred in the morning just around the time of the shift change, making it relatively easy to increase staffing in the ambulance service and free up operating theatre space. To summarise, the number of ambulances and rescue vehicles has been acceptable from a transport point of view, and the health sector has, through redistribution of resources, managed the situation in an acceptable way without compromising the care quality.

Table 4. Number of casualties, hospitalised, and hospitals involved plus rescue resources deployed

	River Granån	**Man-torp**	**Ängelsberg**	**Arboga**	**Indal**	**Rasbo**
Casualties	34	45	49	51	42	62
Number hospitalised	19	17	12	24	*	7
Ambulances	10	15	22	34	15	12
Helicopters	1	-	-	-	4	2
Mobile medical teams	2	2	2	2	4	2
Hospitals	2	2	4	3	2	3
Firefighters	15	15	25	23	31	21
Police officers	6	*	23	*	19	*
Recovery vehicles	2	-	1	3	2	1

*No data

Raising the Alarm and Dispatch

Alarm Call and Communication

Some problems have occurred in the alarm call phase. For example some SOS alarm and dispatch centres have not had any criteria for “major traffic accident”, and in another case the alarm did not reach parties who should have been alerted.

In Västmanland there was newly introduced a computer based system called SWEDE management system, so in the crash at Ängelsberg there was an expectation that this management system would facilitate the work. However, in practice the system was not used.

At the bus crash near Arboga, problems arose with the ordinary radio communication system during the dispatch phase. The first ambulance had to communicate via a mobile phone. The ambulance crew got a brief report indicating that a bus had crashed and was lying on its roof, that they were the first ambulance to the scene and that they were expected to take on the role of Medical Incident Officer. The second ambulance that was dispatched did not, however, understand the seriousness of the initial alarm, as it only stated “traffic accident”. However, when they heard about a bus crash on the news on the radio they understood the seriousness of the incident.

The dispatch call to the air ambulance helicopter in Uppsala was for some reason initially missed in the Rasbo crash. The crash site was located only a few minutes flying time away. The helicopter was called out half an hour after the crash upon request from the Medical Incident Officer.

Figure 16. Overview of the crash site in the Rasbo crash, showing how the helicopters from Uppsala and Stockholm respectively landed

For the Uppsala helicopter, this was its second landing, as it had already made one trip with an injured person. The bus that is not visible is lying to the left of the position where the photographer is standing, and the other can be seen to the left of the helicopter on the road.
Source: Uppsala Fire Service

Dispatch Time

The time from dispatch to the scene of the incident was in most cases 15–20 minutes, sometimes more. In the crash at river Granån, at least ten people were unconscious, but no ambulance arrived until after half an hour. One ambulance in the nearby Robertsfors, was at the time of the crash at their main station in Umeå, 65 kilometres away, for change of crew. An occupational health nurse from Robertsfors, however, witnessed the crash and carried out a remarkable first aid operation before the rescue and ambulance services arrived. The newspaper *Västerbottens-Kuriren* had a local reporter on the spot at river Granån after 15 minutes and, as a result of the reports on the paper's internet edition, the health services got access to prompt and mainly correct information about the incident, directly from the incident scene.

Also in other incidents as, for example at the Arboga and Rasbo crashes, passing doctors and other medical and emergency staff have carried out significant first aid before regular emergency teams arrived. In the collision with a timber truck at Indal, a great deal of spontaneous help was provided by people living near the crash site, before the rescue service and ambulances arrived. These people helped to remove logs and evacuate injured from the bus, and freed the road from logs by using local tractors.

Pre-hospital Medical Care and Rescue Work

Command and control

The pre-hospital staff had the knowledge and training of handling major incidents as stated in the National Board of Health and Welfare's guidelines on pre-hospital medical command and control. In the two most recent incidents the systematic training in command and control of major incidents, as the National Board of Health and Welfare has supported, has probably contributed to the considerable improvement noted regarding communication, as well as command and control. In the Arboga crash, command and control on the whole worked well according to this concept, despite the fact that not all of the county councils personnel had been updated on this command strategy. The command function seems to have worked excellent in the Rasbo collision, in which all medical command personnel was well trained in their different roles.

In these bus crashes it was natural to place the command centre on or near the road so that the commanding officers had a good overview of the incident scene. The commanding officers from the organisations concerned – ambulance, rescue service and police – found it easy to cooperate in this situation, but the work was in some cases disturbed by the media.

In some cases the commanders divided the site or bus into different sectors. In, for example the Arboga crash, the Södermanland ambulance crews were responsible for the front end of the bus, Västmanland for the central section, and Närke for the rear end of the bus. In the tricky Arboga crash communication between the rescue workers and different sectors were problematical, because severe environmental circumstances made it difficult to process a message to all involved when, for instance,a lift of the bus should be done. This would presumably have been much easier if a megaphone had been used.

In the Rasbo crash the two buses ended up a couple of hundred metres apart – in this case it was natural to define each bus as a specific sector.

Access and evacuation

Figure 17. Photograph from an exercise illustrating the environment in a bus lying on its side. Here it is necessary to step on the windows to move around in the bus and to get access to the injured. The injured may be piled up on top of each other because they have not used the seatbelt

Source: Pontus Albertsson

In the cases, where the bus rolled 90°, the ambulance and rescue personnel entered the bus via the front and rear windscreens. In the crash at river Granån, the bus had landed across the small river and the rescuers were uncertain as to whether the side windows of the bus would hold if they walked on them. The windows did, however, bear the weight, and later research has shown that the windows are usually double and relatively strong, as they are load-bearing structures in the construction of the bus. Personnel who have worked in a bus lying on its side have described it as a very unusual situation: no floor to walk on, people lying on top of each other, and so on (Figure 17).

In the bus crashes studied, the ambulance personnel had to work themselves step by step into the bus and during this process remove casualties in the order in which they lay. There was really no organised triage done in any of the cases.

When the bus ended up upside down in the Arboga crash, the situation was difficult because the rescue service had not trained for such an incident, nor did they have access to the necessary equipment. In such a case, the bus ends up in an unstable position with a large part of the weight (engine, drive train etc.) high up making it instable and prone to sway. The roof pillars, which had already become deformed during the rotation in the crash, were in this situation under a load of approximately 15 tonnes. In this case the rescue service had to improvise and try to roll the bus up onto large air bags along one side with the help of wires from heavy tow trucks (Figure 18). This was a risky manoeuvre. The aim of the roll operation was that the bus would open up like a mussel to attain an evacuation route. Therefore, the rescue process took a very long time adding a hypothermia problem to the injured victims' status. The prehospital personnel – ambulance and mobile medical teams – working at the site, had to crawl into the narrow space in the bus compartment to gain access to the injured. They also had to cut loose the casualties with the help of rescue service's cutting equipment. The work of rolling the bus onto the airbags was carried out in many steps, and before each new step all personnel in the bus were forced to crawl out for safety reasons. It took 3.5 hours before the last survivor, who then had a body temperature of 32°, was removed. An ambulance nurse describes how devastating he felt to leave someone behind in the bus during this process, someone who was pleading for help and was dead the next time he entered into the bus compartment.

Figure 18. The photo shows how, at the Arboga crash, ,the rescue service tried to roll the bus up onto large airbags to ease the pressure on trapped passengers squeezed between roof and interior.

Source: Nerike Fire and Rescue Service

Also in the Indal crash it was difficult to evacuate the injured because the bus was full of logs on left side, logs that were pressed into the bus's compartment injuring people and demolishing the interior. Hydraulic tools and stretchers could not be used before the logs were taken out, because of the minimal space. To extract the logs a local tractor was used. The rescuers had to free trapped passengers “by muscle power”, and remove them mostly by clothing lifts since stretchers and similar equipment not could be used [27].

As regards the collision at Rasbo, the left-hand sides of both buses were torn open, and for this reason the rescuers had no problems in getting in and out.

In one of the crashes passengers have been discovered in the bus toilet, which might be a space where rescuers may not search for people.

Individuals Thrown Out Beneath the Bus

In, for example, the Ängelsberg crash, people were thrown out and ended up beneath the bus when it ended up on its right side. Also in this crash the rescue service lacked both training and equipment needed to make a rapid lift. Now the lift was carried out with the aid of small airbags, so-called Vetterbags®, which had a lift height of 10 to 20 cm. Four to six bags were used on the wheel side of the bus which was the side closest to the road. Logs were used to secure the lift successively as the bus was lifted. The rescue incident commander chose this method to get a controlled lift with a minimal risk of unexpected lateral movements, which would have injured the trapped passengers. The lift was co-ordinated by radio between the personnel working inside and outside the bus, and the work was carried out in close collaboration with the ambulance personnel with the aim of not causing further injuries to those trapped under the bus [5]. The lift was carried out on the heavier wheel side, as that side was easier to gain access to. It was also judged as being least harmful for the injured. Naturally the lift would have been on the roof side, but in this case it was difficult to get access to this side initially, because it lay in darkness and was close to the edge of the forest. In order to be able to lift the bus from that side, the rescue service first would have had to fell some trees. The whole rescue procedure was drawn-out in time, and it took two hours and twenty minutes before the bus had been raised sufficiently so those trapped could be freed. Half of them were dead. On the other hand, it is remarkable that a handful passengers survived, in most cases thanks to the uneven ground [21]. It might be worth recording that the aim of rapidly lifting the bus must not be abandoned in the belief that it is hopeless. In its investigation of this crash, the Swedish Accident Investigation Board has directed criticism at the lack of suitable tactics, techniques and equipment for this type of rescue operation on the part of the rescue service [13].

Retaining Heat

Despite the fact that most of the incidents happened in winter with low temperature and snow, none of the buses were heated with the help of the rescue service’s fan heaters. The wind chill effect, where the air temperature and wind speed are assessed together, has been considerable low, in several cases corresponding to -15°. In at least one case there was an attempt to start a heating fan, however, this attempt was unsuccessful. In almost all the incidents casualties suffered from hypothermia, and it would have been a great advantage to be able to rewarm the casualties who were trapped for more than three hours in the worst case. This is a measure sometimes vital to survival.

Triage

The prehospital personnel had generally not done any systematic triage of the injured, because the circumstances made them choose to work themselves into the bus successively, lifting out injured people in the order as they reached them. In most crashes so many ambulances were engaged that it was possible to immediately transport people with moderate or serious injuries to hospital in the order that they were evacuated. There were, however, attempts to identify life-threatening conditions in the bus, and when possible these were given high priority for evacuation. Walking injured could in most cases get themselves out, and were then assessed where they were gathered, often in a commandeered bus. In some cases a casualty clearing station was organised, where the prehospital personnel carried out a more systematic triage of the injuries.

In the river Granå crash it was, however, shown how important it is to have medical supervision of all the injured, including those who initially were assessed as having minor injuries. The passenger who was finally shown to be the most severely injured was first classified as having only superficial and minor head injuries after having struck a clothes hook with the temporal area of the head. Later he began to lose consciousness and he suffered a serious intracranial bleeding.

Casualty Clearing Station

In most cases no casualty clearing station was needed because the extrication and evacuation of the injured took such a long time that those who needed ambulance transport could be taken directly to a waiting ambulance, or helicopter, for transport to hospital. Those with minor injuries were often gathered in a bus where they were protected from the cold weather and where they received first aid and a triage assessment. The disadvantage was that many of them did not appreciate being taken in to another bus immediately after having survived a major bus crash in which they had seen dead and severely injured people.

In the Rasbo collision the buses were “wide open” and easily evacuated, and a casualty clearing station was established for those with moderate and minor injuries in the parish hall in Stavby – a nearby village – to which they were transported by bus. The relatively few seriously injured passengers were transported directly from the site of the collision by ground ambulance or air ambulance helicopter (one was flown to Uppsala University Hospital and one to Stockholm South Central Hospital.).

Cooperation at the Site of the Crash

In the incidents described, cooperation between the pre-hospital medical care personnel, the rescue service and police seems to have worked well. In certain cases large forces were brought together from each organisation, for example at Ängelsberg where the on-scene rescue commander stated that 35 firefighters from three forces were working together with 22 ambulance crews (44 individuals) and 23 police officers. In some situations, heavy tow trucks or crane trucks were needed. In the Arboga crash tow truck personnel, who were monitoring dispatches from the alarm central – SOS Alarm – came on their own initiative early to the scene, which was beneficial. There was also a heavy crane truck passing by on the road, but unfortunately it lacked the counterweights which would have been necessary [6]. Another example is the bus crash at Indal, in which the rescue service personnel from four stations worked together in six units, a total of 31 people. Fifteen ambulance crews (30 people) and four helicopters (however not air ambulance helicopters) were also available, together with four mobile medical teams and 19 police officers [28].

The police have a very efficient system for identifying and registering casualties. This has been reported to work very well at several of the crashes and facilitated the work of keeping track of casualties. It does happen, however, that casualties “take matters into their own hands” such as at the river Granå crash, when the University Hospital in Umeå was waiting for an injured pregnant woman and had organised a full team of gynaecologist and ultrasound equipment. She had, however, on her own initiative hitched a lift with a private motorist to the local health centre.

Safety

One important safety measure at the crash sites was, of course, to stabilise the bus to prevent it from moving during the rescue work. Other risk factors include the risk of fire. For example in the Arboga crash 400 litres of fuel was spilled although fortunately it did not catch fire. In another crash in 1998 with a double-decker bus, a fire did break out when the bus blew off the road and crashed at Fjärdhundra/Sala. The bus had around 60 passengers on board, when it left the road and continued in the ditch until it stopped against a culvert and rolled over. The bus then caught fire and bystanders and people from the bus tried to extinguish the fire with hand-held fire extinguishers, but without success. A person who was partially trapped was at the last moment pulled away from the flames by some fellow passengers. When the rescue service arrived, the bus was burning heavily and it took 10 minutes to put out the fire. One passenger suffered burns whilst a number of other passengers were affected by smoke inhalation injuries from the evacuation and extrication attempt [29].

At the bus crash in Ängelsberg the bus collided with a power line pylon, which meant that a 10 000 volt high tension line was hanging across the front windscreen of the bus. Initially during the rescue work no particular notice was taken of this, as the rescue service incident commander assessed the power line as being dead, as several passengers who spontaneously evacuated the bus had passed the line without any problem [5]. Later it was shown that the line initially was dead, but that staff at the power company was just about to switch on the power again, when the rescue service officer rang to confirm that the power was disconnected. [21].

Traffic at a crash scene can also be a danger to rescuers. In the cases described here, the police have managed cordoning off and diversion these problems thus minimizing risks and disruption.

Air traffic is another potential danger. In certain cases there were several helicopters (both air ambulance and media helicopters) over the crash site at the same time, without any radio contact between them or with the rescue service officers, which might compromise the safety.

Transports and Times

All of these bus crashes occurred in sparsely populated areas, but nevertheless it was possible to successfully assemble a sufficient number of ambulances in almost all cases, since the crashes occurred at favourable times and the rescue work was prolonged. At times there was even access to more resources than were needed, as in the case of the Arboga crash. In most cases those with minor injuries were transported by bus to different hospitals and health care centres. Those with more serious injuries were often difficult to extricate and evacuate, and during the work to do this a sufficient number of ambulances had arrived and the injured were successively taken to most appropriate hospital. In most of these incidents it was the Medical Incident Officer at regional level who decided which medical facility the injured should be transported to.

In all known cases, the time before arrival at hospital exceeded “the Golden Hour”. The Rasbo collision occurred just 20 km from Uppsala University Hospital (UAS) and there were no technical problems in evacuating the injured, but nevertheless, it took 1 hour 13 minutes after the crash before the first casualty arrived by air ambulance. The second injured person was flown to Södersjukhuset (“Stockholm South Central Hospital”), arriving after 2 hours 18 minutes. Those transported by ground ambulance to UAS arrived between 1.5 and 2.5 hours after the crash, and for 12 persons with minor injuries transported to Enköpings sjukhus (60 km), it took up to 4.5 hours before they reached the hospital.

These times are fairly typical for these incidents. The river Granå crash occurred in a sparsely populated area 65 km from the nearest hospital, and it took 1 hour 45 minutes to 2 hours and 30 minutes before the seriously and severely injured (MAIS 3+) arrived, whilst those with minor injuries transported by bus arrived after 3 hours.

Not all bus crashes occur at favourable times however. An example of this is the collision at Konginkangas in Finland where a tourist bus and an articulated lorry collided in the wilderness at 01.30 hours one March night in 2004 (see Figure 19). In the Konginkangas crash, 38 people were injured of whom 23 died.

Figure 19. A nightmare scenario for rescuers in a sparsely populated area – the bus crash at Konginkangas on a winter night in 2004

Source: Äänikoski fire and rescue services

Medical Treatment

In the incidents described, between two and four hospitals were involved in medical treatment, and in almost all cases a university hospital was also engaged (Umeå, Linköping, Örebro and Uppsala). In one case the university hospital only contributed with specialist care, for example neurosurgery. In the incidents there were between 34 and 62 casualties, of whom some died. After each crash up to about twenty people required inpatient care. The distribution of the injured between different hospitals was decided by medical incident officers at regional level or the equivalent, and in certain cases a predetermined distribution key was applied.

The experience from these crashes shows that large hospitals can reorganise and reinforce staff giving them good capacity to receive and treat a large number of casualties, without compromising the quality of care..The planning and training for disaster situations of the medical personnel is probably a key to successful action in real life.

To quote the former head of the Emergency Department at Sundsvall hospital, Dr Leif Israelsson, after the Indal crash: “We have attended the National Board of Health and Welfare courses and we applied every letter we have learned and that is why our work went so well”.

Crisis Support

Psychological and social crisis support is an important part of the care after major injury events and is a natural part of every disaster plan. As regards the crash at Rasbo, the crisis support work began during the rescue work at the incident scene. Those who were on call in the psychosocial alarm group in Uppsala Municipality were alerted, and they in turn contacted the municipality's psychosocial care group (POSOM) in Uppsala. They prepared to open a crisis centre in Uppsala and what is more sent out support staff to the accident scene and to the assembly point established in Stavby Parish Centre. At the same time, a crisis support group was activated in Östhammar Municipality which also sent representatives to the assembly point.

In the parish centre the local group saw that casualties were given something to eat and drink, and they were offered first acute crisis support by members of the POSOM group accompanying them on the bus into the Uppsala University Hospital, whilst others followed in their own car. [30].

Just after the crash, the head of psychological/psychiatric crisis management (PKL) in the hospital was alerted to ensure that the PKL group control room was opened and staffed by two representatives from the PKL group. The head of PKL also contacted the regional disaster management and the hospital's accident and emergency department. The group worked primarily in three locations at the University Hospital, but initially there were also support staff in the Emergency department in the rooms set aside for relatives. The surgical reception was used for the approximately 30 people who had minor injuries and shock, and for this reason a crisis support reception was also set up there. PKL at the University Hospital equally kept in touch with Enköping Hospital, Södersjukhuset and Karolinska Hospital to which casualties were also taken.

A crisis telephone number was activated, and information about it was put on the internet with the help of the hospital IT department. Congregations in the area arranged for support staff to visit the homes of the next of kin of those who had died. Local support centres were established in several locations during the first days, on one hand in parish centres in the town of Uppsala, on the other in parish centres in Alunda, Gimo and Östhammar.

The Media

The bus collision near Rasbo was covered very intensively by the media, and journalists from TV and the press interviewed several casualties in a way which those concerned later reacted to in a very negative way. No bus passengers or other casualties have, however, reported any of the media companies [16], nor has the media coverage of the Rasbo crash been the subject of any internal debate, or report, within the Swedish journalist profession.

The bus crash at river Granå/Robertsfors was initially covered by the local editor of *VästerbottensKuriren* (VK), who was on the scene a quarter of an hour before the first ambulance. His reports on the internet edition of the paper proved in later analysis to have maintained a good standard as regards data about the scope of the incident. Some casualties found it strange that a representative of the media appeared so soon and before the ambulance, and went about taking photographs. This newspaper has, however, a responsible policy as regards not unnecessarily exposing casualties, so no unsuitable photographs were published.

Recovery

It is not known how many of the casualties that suffered permanent physical disabilities, or how long their period of sick leave has been. On the other hand, there has been a certain follow-up of the crashes at river Granån, Rasbo and Indal as regards psychological long-term effects and the crisis support provided.

Crisis Support

After the crashes in Ängelsberg, Arboga and Rasbo, the Swedish Accident Investigation Board (SHK) arranged meetings for all those concerned, in order to show the buses involved, and to go through SHK's information and conclusions from the incidents. At these meetings, there was also an opportunity for discussion and questions. The SHK also had an opportunity of learning further facts directly from attending victims and their relatives. Many of the participants have appreciated these activities very much, including grieving relatives of those who died, who saw this as an important part of their grieving process. However, on the other hand at one occasion there was a desire to find a scapegoat in a rather unpleasant way.

The Crash at River Granån 2001 – Long Term Effects

The long-term psychosocial effects of the river Granån crash have not been studied to any great extent. However two months after the crash the research group at the Centre for Research and Development in Disaster Medicine at the Department of Surgery at Umeå University arranged follow-up meetings in Skellefteå and Umeå with those involved. At these meetings, facts were presented about the incident and the participants had an opportunity of asking questions. Information was also received from those involved making the picture of the incident more complete for the researchers. Nearly a dozen passengers had suffered from concussion and memory loss and were very keen to fill in the gaps in their memory. Some attended both meetings, as they hoped to find out more about what had happened. Some of them were worried that they had hurt someone when they crawled out of the heap of bodies, and so on. All 33 passengers were interviewed about their remaining conditions and other symptoms two months after the incident. These were:

- 97% had some form of physical or psychological problem.
- 85% had pain from their injuries.
- 61% experienced worry and anxiety that they had not had previously.
- 42% had sleep disturbance resulting from the incident.
- 21% had nightmares about the crash.
- 76% were anxious about travelling by bus again (according to some of them because, as a passenger, you cannot influence the journey).

- 27% felt a greater anxiety also about flying (according to some of them because, as a passenger, you cannot influence the journey).
- 48% felt a greater anxiety about travelling by car.
- 25% had been able to talk about the incident with someone from health care (three quarters of these during their time in hospital). Of those who have not talked about the crash with anyone, more than half had wished to have such a conversation.
- 61% considered that it was valuable to meet other people involved in a therapy group.

The Crash at Indal 2001

In the collision at Indal near Sundsvall, six people died and many were injured. Since most of them were children, the schools concerned were involved to a considerable degree and initiated active crisis work in the classes. The social services rapidly opened a crisis centre for casualties, and the rest of the local community. The rescue service, police, ambulance and church personnel were also involved.

Some weeks after the incident the municipal offices of Sundsvall sent out a questionnaire to 15 internal and 12 external actors (within and outside the municipality) in order to evaluate the crisis management of the incident. This evaluation contains no information from those directly affected. The results indicate that the people questioned have a positive image of the crisis support work. The communication and collaboration between the rescue service and the other parties were given high ratings. The National Rescue Services Agency however pointed out that the information to the general public came out too late, and that there should have been public relation staff at the "incident site" to deal with the media. It took time to set up the barriers at the "incident site" with the result that members of the media worked very close to other parties at the crash scene, where several relatives of the injured schoolchildren also were present. Moreover, the presence of the media had a negative influence on the rescue work. [28].

Several actors pointed out that the crisis management had to start at the incident site, as in this case many relatives of the injured from the local community were assembled at this site. In situations when the relatives go directly to the crash site, or when they take part in the rescue work, as was the case in the Indal crash, it is particularly important to be aware of the need for early crisis support at the scene.

The municipality's crisis group also stressed the importance of the allocation of a clear role and responsibility as regards crisis support [28].

The Crash at Rasbo 2007

After the incident at Rasbo, most of the passengers were contacted by phone by support staff from the PKL organisation within a week. Most seemed then to have recovered and stated that they did not need any further contact. Some of them also received help with continued crisis support through their employers. In the aftermath the psychiatric emergency reception received a number of telephone calls about the bus crash, not merely from passengers on the buses but also from passing travellers who had a certain need for crisis support during the initial period. Individuals also started trauma-focused psychotherapy. In Östhammar Municipality the local POSOM organisation in the aftermath organised a number of follow-up meetings for the survivors of the crash.

Of the bus passengers, 71% received acute crisis support, 16% felt no need for crisis support and had declined it, whilst 11% stated that they had not received any support. Of the people questioned, 82% had residual reactions in the form of sleep disturbance and nightmares, flashbacks, panic attacks and stress conditions, greater vigilance and unease when they were out in traffic. Most said that they no longer felt safe to travel by bus, even if almost all of them (93%) nevertheless continued to do so. Furthermore, 80% had received crisis support through their employer and through the local POSOM group. A few individuals had not been offered any support or had declined it.

Development

The National Board of Health and Welfare, the National Rescue Services Agency and the National Road Administration have worked jointly on developing rescue operations in bus crashes. The focus has been primarily on improving the technique, tactics and equipment used in major bus crashes. This work has resulted in a report and a training programme containing a teacher's manual and a programme of pictures that can be used in local training programmes. National courses have been held annually in collaboration between the National Board of Health and Welfare and the Swedish Civil Contingencies Agency, where instructors have been trained. By November 2010 a total of 215 instructors had been trained, geographically widely spread across the country. In the course, close collaboration between the rescue service and pre-hospital personnel has been emphasized, as has the time aspect for the injured. The instructors have been chosen with aim to create local groups of four individuals (two people each from the ambulance service and the rescue service). Below follows a short description of the main points in the report and course.

Securing the Vehicle

Initially the emergency shutdown of the engine has to be carried out on the vehicle to secure against fire. Then the work involves (i) stabilising the chassis of the bus, (ii) securing access into the bus, and (iii) ensuring that the casualties can be evacuated in a safe and rapid manner. As regards stabilising and lifting the bus, there are certain differences between buses with a *steel chassis* and those with an *aluminium chassis or stainless steel chassis*, as their robustness around the roof hatches varies. Tourist buses almost always have a steel chassis, whereas buses operating to a regular timetable are more evenly divided. Most "country buses" are, in other words, constructed with a steel chassis. In 2009 it was reported that buses constructed in stainless steel have come onto the market, which poses new problems as the emergency service tools may have difficulties to cut into them.

Access and Evacuation

It is important to gain access into the bus as quickly as possible and to begin to treat the injured before their condition deteriorates. Inside the bus there should be a safety officer who is responsible for the safety of the personnel and casualties on the bus and who from inside can help when opening up holes in the chassis. The doors and windows of the bus can, of course, be used to gain access. It may, however, be necessary to make new openings or enlarge the existing holes in order to more easily bring in medical equipment and other materiel needed in the work. By enlarging a window space downwards as shown in Figure 20, it becomes easier to gain access to a bus that is standing on its wheels, at the same time reducing the vertical distance to the ground, which also facilitates evacuation.

Figure 20. An opening from a window space downwards makes it easier to gain access to the bus

Source: National Rescue Services Agency

Buses on wheels

When the bus is standing on its wheels, it is convenient to use the doors to gain access. If seats and partitions near the exits can be removed it creates more space, making it much easier to carry casualties out on stretchers (see Figure 21). According to the EU's bus directive 2001/85/EG, a full-sized coach should have at least one exit door and a further five emergency exits evenly spaced, for example, in the form of roof hatches, or windows, marked "Emergency exit".

Figure 21. In order to be able to evacuate casualties from a bus standing on its wheels it may be necessary to cut away seats and partitions by the exits in order to provide more room to manoeuvre a stretcher, as in the right hand picture

Source: National Rescue Services Agency

As the space in which to work is restricted on the bus, it may be a good idea to use a sling (see Figure 22) to pull the passengers from narrow spaces and onto for example a spine board. Sharp edges and glass need to be covered and medical equipment that is easy to manoeuvre should be used.

In crashes like the Rasbo crash, it is important to bear in mind the risk of neck injuries. Clothes lifts and manual stabilisation of the cervical spine are recommended to be able to evacuate quickly. Also consider arranging a smooth flow to minimise the evacuation time.

Figure 22. The picture sequence shows how a twisted sheet can form a sling which may be of great help in evacuating casualties

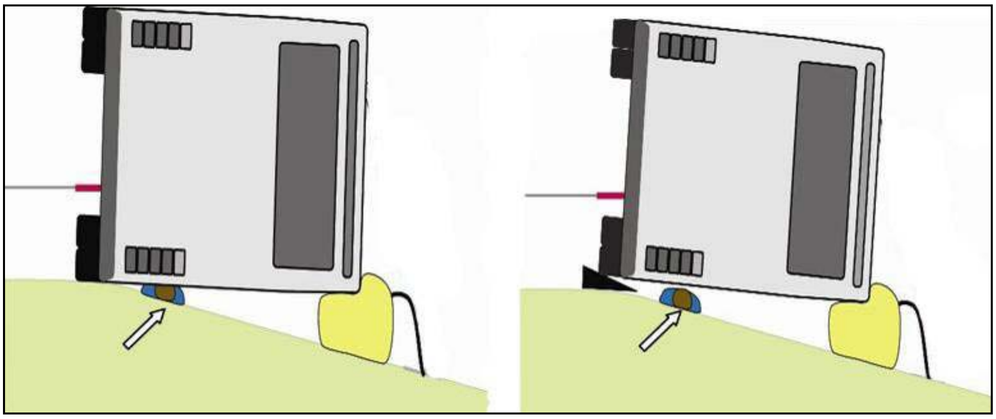
Source: Umeå ambulance service

Buses that have rolled 90 degrees

It is very common for a bus to roll 90° to the right so that the doors are blocked. The position of the bus provides particular conditions as regards gaining access to the bus, stabilising it and evacuating it. Unbelted passengers may be lying on top of each other inside the bus, and they may also have been thrown out through the windows, ending up partly or completely under the bus. If anyone has been thrown out, the bus has to be lifted immediately, as recoverable casualties can be found underneath it. The bus can be lifted using air bags, which work well on both steel and aluminium chassis, or hydraulic cylinders placed at the corners of the roof hatches. This latter method can be used on buses with a steel chassis (75% of all tourist and regular service buses in Sweden) and is three times quicker than the method with airbags. The tactic should be characterised by speed, teamwork and parallel operations.

Trials with a standardised panorama of injuries involving 22 stretcher cases have shown that it is possible to gain time by optimising all phases of the evacuation: the evacuation time was reduced from about 50 minutes in the “ordinary” mode of evacuation work to less than 10 minutes with optimal cooperation. The technique of making a central opening in the roof – which can be done in two minutes – increases the number of evacuation pathways in the middle of the bus and is the key to rapid evacuation.

Figure 23. Schematic depiction of how the bus should be raised on wedges knocked in on the wheel side to not squeeze a victim under the bus.



The wedges are used to reduce the pressure on people who are trapped beneath the bus. The wedges have to be placed correctly around the wheels and knocked in as far as possible in order for the bus to be raised in the right way.
Source: Gunno Ivansson, National Rescue Services Agency

Figure 24. Two hydraulic cylinders, placed at each corner of the roof hatch, provide a rapid and stable lift of a bus with a steel chassis

An effective safety base, in this case of wood parts, is necessary to assure against structural collapse or similar.
Source: National Rescue Services Agency

It is difficult to evacuate casualties from a bus that is lying on its side because it is not possible to use the central aisle to access the bus. It is important to be prepared for the special problems that must be dealt with and to have trained evacuation during these circumstances; otherwise the evacuation takes an unnecessarily long time.

When a bus has rolled over, one can expect unbelted passengers to be lying on top of each other against the lowest side. This causes special demands on tactics and technique for efficient work in the narrow spaces. It is likely to be difficult to gain access, and rescuers may have to walk on glass shards and sometimes have to clear a path through objects that have penetrated the bus, baggage and casualties. The roof hatches intended for emergency evacuation are unfortunately narrow (50 x 80 cm), and it is often difficult to manoeuvre an injured person on a stretcher out through the hatch. In certain cases objects such as logs have penetrated the bus, and then the situation will be even more difficult. The tactics have to be adapted to the situation.

Figure 25. Possible evacuation routes

Evacuation proceeds much more rapidly with an opening hole in the roof, which takes two minutes to cut with a circular saw
Source: Pontus Albertsson and the National Rescue Services Agency

Bus upside down

A bus lying upside down presents an unusual and challenging situation from a rescue point of view: This situation requires particular considerations as regards tactic and technique, especially if the roof has collapsed, as it did in the crash in Arboga in 2006. Then the passengers on the bus may have been subjected to powerful forces resulting in many serious injuries. What is more, there is a risk that casualties without serious injuries are squeezed and may die as a result of compression of the thorax with difficulties in breathing. Belted passengers and others hanging upside down are subjected to serious physiological changes [23], which must be borne in mind when prioritising the different moments in the rescue..

At this stage, it is important to stabilise the bus, which may easily sway because of the high centre of gravity. Hydraulic cylinders or airbags may be used to try to prise the rest of the chassis away from the roof, which presumably will have collapsed. Cutting openings in the side of the bus, as described earlier, will make it easier to get in and out.

In such a crash situation, there is a considerable risk of fuel leakage which can contaminate casualties and the scene, as well as increasing the risk of fire.

Discussion

Major bus crashes are unusual in Sweden, but when they do occur – which often happens in sparsely populated areas – they imply a major strain and challenge for the rescue service and emergency medical service.

Preventive and injury-reducing measures can be applied in all phases of the sequence of events. To quote the Red Cross World Disaster Report from 2003: "Prevention is the most effective way of reducing the consequences of various disasters". If a crash occurs, well developed preparedness and training has the potential to mitigate the injuries

Rescue Work

The crashes described here have mostly occurred in daytime, and during the winter. Cold, and in a few cases darkness, have made the rescue work difficult and have increased the risks both to those who were injured and to the rescuers. Children among the victims impose special considerations in the rescue work.

In several cases parts of the alarm routines failed. It is important that representatives from the health sector and from the rescue service actively are involved in defining the content of alarm and dispatch plans, and make an attempt to clarify obscure points already in the planning phase. Exercises may also help for identifying shortcomings, which can then be addressed before the alarm routines need to be used in a real situation.

The development indicates that the command and control function has improved in the prehospital setting, and that the National Board of Health and Welfare's command and control training program has been successful. Identifying the commanding officers has in a few cases been difficult, for example, when medical incident officers from different organisations and places have been working together. In the Arboga crash, which happened on the boundary between three counties, several individuals were marked as medical incident officers. This had presumably no negative effect on the operation [6]. Media representatives have almost never worn the recommended media vest identifying them.

Other road users had called SOS Alarm and also acted as first responders before the regular rescuers arrive in several cases.

The police has the responsibility to seal off the site and take care of the traffic. It is also important to seal off the scene of the incidents so the rescue work can be carried out efficiently, without disturbance from media and curious people. This is especially important nowadays when it is easy to take photographs or film people who are seriously injured or desperate by a mobile phone. Rewards in the form of money are often promised by the media to those who send in pictures directly from the scene of an incident, which contributes to undesirable exposure of the casualties.

In most of the crashes, only a few passengers had used their seatbelt, but in the Arboga and Rasbo crashes 41% and 66% respectively of the survivors stated that they had been using the seat belt. According to Albertsson et al. [22], a seat belt provides good protection. If the bus rolls 90°, no objects penetrate the bus and no passengers are thrown out, then a two-point belt means that the risk of moderate injuries (MAIS 2) falls by approximately 50%, whilst the risk of serious or severe injuries (MAIS 3–4) falls by 80%. A three-point belt has even better outcomes. A two-point belt should also protect against being thrown out, with the exception of those sitting in the row closest to the tipping side. These facts provide ambulance and rescue personnel with an indication of the injury panorama that could be expected.

Tactics, techniques and equipment have been developed in order to retrieve casualties quickly from buses, and now there is a training programme for this work. The most difficult situation is when the bus ends up on its roof. The tactics in this situation may need to be evaluated and developed further. Medical triage is sometimes difficult to apply systematically – attempts with various methods have not provided a clear-cut result. It may be advisable first to take out the high priority cases, but not to hesitate to remove lower priority cases first if they are in the way. In the crashes described here, the evacuation of those with non-minor injuries has been slow, which has meant that a sufficient number of ambulances and helicopters have had time to arrive and immediately been able to take the more seriously injured directly to hospital. In a more rapid evacuation with lack of transport resources, the importance of a warm casualty clearing station becomes clear.

When there may be casualties jammed under the bus (windows smashed), the bus has to be lifted immediately. The technique, tactics and equipment developed for this purpose make it possible to carry out in minutes with the right training. It is thus important that knowledge of these methods is disseminated and kept up-to-date through local training courses.

Crisis Support

Experiences of psychosocial care after the Måbödal crash formed an important basis for general advice and recommendations about crisis support work. On the basis of these, hospital PKL groups and municipal POSOM groups were subsequently established at the beginning of the 1990s (General advice from the National Board of Health and Welfare 1991:2) [31]. These experiences have also to a great extent influenced the National Board of Health and Welfare's current recommendations "Crisis support in serious incidents" [32]. In the Rasbo collision, for example, support staff from POSOM accompanied casualties into hospital to provide them with continued support, and as the PKL group were also present, initially there was some lack of clarity around the apportionment of responsibility and roles in crisis support.

Crisis support is necessary for the injured and their relatives, but there may be risks involved in too active a "protection" for a long period. Those who are injured must have an opportunity to "move on" and leave the psychologically painful period behind. At the same time it is of course important to carry out follow-ups over time, but such work should be kept at a suitable level. The follow-ups organised locally by municipalities and employers seem to have been much appreciated and can help make it easier for the injured to deal with the incident. People with post-traumatic stress reactions which do not abate should, however, be given access to professional assessment and trauma-focused psychotherapy.

Those individuals who take part in rescue work should of course also have the opportunity of helping to process the impressions and feelings of what they have experienced. This group was previously often forgotten, but in most places the rescue service, police and medical staff have access to crisis support after serious incidents. One aspect worth particular notice is the risk that staff in the rescue service or other staff involved may have children or other relatives on a bus that has crashed in their area.

The Media

When a bus crash occurs, the media can reach the scene very quickly, even more quickly than, for example, the police and rescuers. The media also entice the general public into taking photos at the incident site by offering money for early pictures, before their own team of photographers has reached the scene. Whether any pictures of this kind were published in connection with the bus crashes described here is not known, but the evening press advertised for photos as soon as it was known that a bus crash had occurred.

Helicopters are nothing new in the context, as media companies have for several decades used them to film and photograph various incidents. At several of the bus crashes, however, the crews on site felt that helicopter flights at low height above the crash site disturbed the rescue work. In Norway it is estimated that between five and ten media helicopters are used every time they suffer a major incident or disaster. Experiences from the US show that there are also risks involved in using media helicopters, e.g. in 2007 two helicopters collided and four people died [33]. During the rescue work at the Rasbo crash a total of four helicopters (two air ambulance helicopters and two media helicopters) were in the airspace above the crash site. Bearing in mind the disturbances and the risks, limiting the media's right to use helicopters above an incident scene may be discussed.

The media reporting of the Rasbo crash was very intensive and sometimes also intrusive for the injured. For this reason, it would be wise if those responsible for psychological crisis support could arrange for casualties to be protected from media also when leaving the Emergency Department or a support centre, until they are met by relatives or are put into a taxi.

After the crash at river Granån the local correspondent for the newspaper *Västerbottens-Kuriren* was on scene after 15 minutes and thanks to that reporter's information in the internet edition of the paper, the Emergency Department received good information about the incident. Looking back, it proved that the newspapers' information was just as good, or better, as the medical emergency service's own.

After the bus crash at Konginkangas in Finland, the media were reported to the Council for Mass Media in Finland (ONM) after an injured child was photographed at the scene of the incident. One newspaper was convicted of having published the picture, as they had published a photo of an injured girl who came to symbolise the incident in an unsuitable way. The picture was published despite the parents' pleas not to do so, and the Council censured the media for having caused suffering to both the girl and her parents (ONM 3348/AL/04). Another person reported that a victim could be identified from their photo in a newspaper (ONM 3341/SL/04) and considered that this was offensive to the person involved. The Council however cleared the publication.

In Sweden, anyone experiencing annoyance and insult from a media publication or TV broadcasts can report this to the press ombudsman and the review board for radio and TV. If it is in regard of the TV company TV3, the report must be sent to a British review board called the Office of Communication (Ofcom, http://www.ofcom.org.uk/). Unethical and offensive working methods can also be reported to the professional ethics committee at the Swedish Union of Journalists.

As soon as the emergency medical treatment begins at an incident site health and medical legislation applies, and the injured are considered to be patients, which means that privacy legislation applies to them. Despite this, several newspapers have published detailed descriptions of the conditions of casualties and their suffering. Casualties and their relatives seem to be in need of stronger protection from the mass media than they have today.

Figure 26. Media helicopter above the incident site

Source: Leif Gustavsson, *Norrtelje Tidning.*

The task of the media is to quickly report from the incident site and get the message, preferably with pictures, out to the public. If there was a good collaboration with the health sector, both parties could derive benefit from their reports [34] To train and authorise, journalists, photographers and medical emergency personnel in emergency and disaster medicine, would presumably provide both parties with deeper knowledge of, and respect for, the other party's work. [11].

In recent years the National Board of Health and Welfare has taken part in the work of developing recommendations for safety garments (safety vests) for the photographers and journalists who attend an incident scene. They are recommended to wear a fluorescent orange vests with the text "Photographer" or "Journalist [35]. This is, however, just a recommendation, and it is optional for members of the media to wear it. As a comparison, it is obligatory at many sports events, both major ones like the European football championships, or minor ones such as the Arctic Cat Cup for snowmobiles. Those journalists and photographers who do not wear correct vests are not allowed to enter the arena of the event. (www.arcticcatcup.se).

Figure 27. TV-cameraman wearing a safety vest at a bus crash near Umeå on February 15, 2008

Source: Patrick Trägårdh/Umeåbild.

When the media publish correct and timely information on their internet pages, this can help the general public, the casualties and the emergency personnel, as well as the staff at the receiving hospitals. One example is the bus crash that happened at Inndalen in Verdal in Nord-Trøndelag, Norway, on November 24 2007, when the major newspapers published cross-references in the form of internet links to local newspapers and to the company that owned the bus. One newspaper also published an internet link to a receiving hospital (St. Olav's Hospital in Trondheim) on their press releases. The model of cross-references in media contexts might be applicable and should also be evaluated in Sweden

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Appendix 1

The Rasbo Crash and the Media

The location of the incident site in relation to the metropolitan area meant that the media concentration was particularly high. There were more journalists and photographers at the incident site than personnel from the emergency services. In total, 26 staff from the emergency services was on-site compared with the media, who had 39 photographers (press photographers and TV cameramen) and 10 journalists on site. The media used two helicopters (two), the same number as ambulance helicopters (two). From 13 media companies a total of 132 press photographers and journalists covered the bus crash (Table I).

Table I. Media actors at and outside the incident site

Reporting actors	Number
Journalists	80
Press photographers	28
TV cameramen	11
News directors	13
Total	132

Lundälv [i] has analysed the reporting of the crash by a total of 13 media companies from the genres of press, radio and TV, as well as internet journalism. The study consists of all the material published and broadcasted about the bus crash over the first two days after the incident. The study illustrates the fact that the media operation was from a staffing viewpoint larger than the rescue operation, and in certain respects also more rapid.

[i] Lundälv J. Intensiv medierapportering efter busskraschen vid Rasbo-Uppsala. Läkartidningen 2008; 105:2418-20.

Table II. Type of media production or illustration at and outside the incident site

Type of media production	Incident site	Outside incident site
	Number	**Number**
Newspaper articles	18	13
Internet articles	15	25
Radio item	5	7
TV item	12	2
Total	50	47
Photographers		
Newspaper articles	12	14
Internet articles	2	11
TV item	3	8
Total	17	33

Table III. Interviews/interviewees

Type of media production	Casualties	Spokesperson, operational commander
	Number	**Number**
Newspaper articles	9	18
Internet articles	8	15
Radio item	1	0
TV item	3	1
Total	21	34

Only articles and items that had been *published* or *broadcast* 48 hours after the crash are included in the study. Therefore, there may have been a large number of photographs, TV recordings and radio interviews produced which were not subsequently shown to the public for ethical reasons, which the media themselves had taken cognisance of, after the material was produced. This, of course, means that rescue actors, bus passengers and patients in different situations may have been exposed to more interviews than is apparent from the published material. The stress that arises from this has been described in the literature [i, ii].

[i] Lundälv J. Det talande offret. Journalistik vid olyckor och katastrofer. Gävle: Meyers förlag; 2001.
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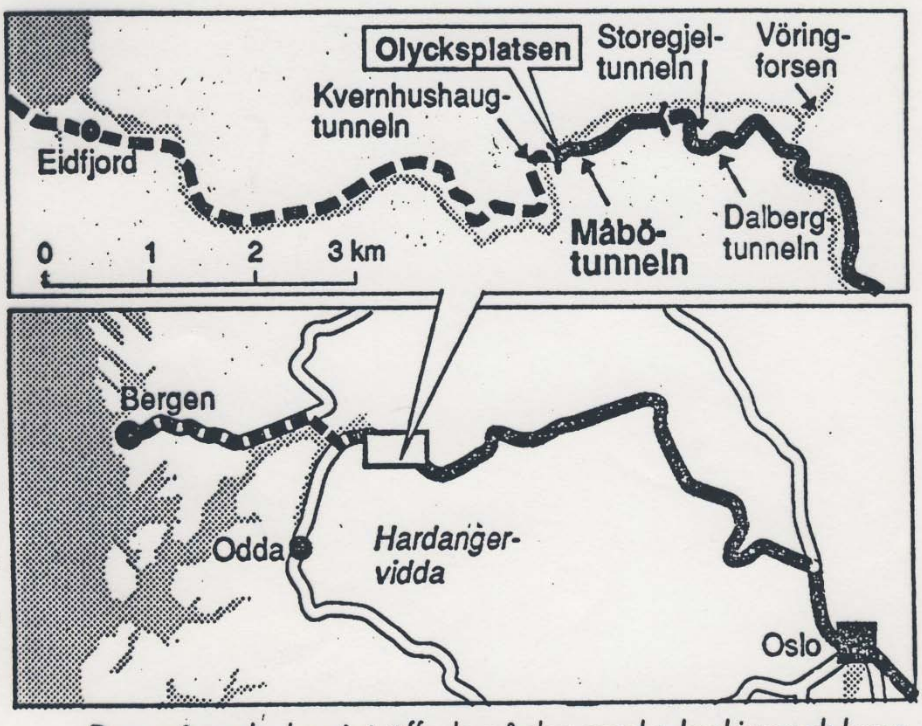
Appendix 2

Psychosocial care after major bus crashes

Måbødalen 1988

On August 15, 1988 a major bus crash occurred in the Måbødal Tunnel, 180 km east of Bergen in western Norway (Figure I). On board the bus were 31 people – school students from class 6B at Kvarnbackaskolan in Kista and some of their parents. They had just set out on a school trip destined for the Shetland Islands. The second day of their journey took them down towards the Norwegian west coast. At the beginning of a long road tunnel through Måbødalen the braking system on the bus ceased to function. In order to avoid the bus going over a precipice after the tunnel, the driver attempted to slow the speed of the bus by steering into the rock wall, resulting in a violent collision against the concrete foundation of the mouth of the tunnel.

Figure I.



Den svåra olyckan inträffade på den smala, krokiga och branta vägen som leder ner från Hardangervidda.

Source: Svenska Dagbladet 1988

Twelve of the children, 12 years old, and four parents, including the bus driver, were killed. The other 11 children and four parents suffered more or less serious physical injuries. Since the site of the crash lay in an, even under Norwegian conditions, inaccessible area, it was more than half an hour before the first rescue crews arrived at the scene. One hour after the alarm was raised the following were available on-site:

- 4 helicopters
- 19 ambulances
- 4 anaesthetists
- 3 surgeons
- 4 nurses

The medical personnel were transported by helicopter to the scene of the accident.

All the emergency medical care as well as psychological and social care work was allocated to the University Hospital in Bergen for the first week after the accident. The Swedish-Norwegian cooperation developed quickly to provide care and crisis support for casualties that was as appropriate as possible, and to learn from the experience. In June 1980 a school class from Leksand had been involved in an accident with a rail bus. The experiences from that accident proved useful in planning the care during the first days in Bergen and under the subsequent period in Kista/Stockholm [i]. At that time, no local or regional plan for psychosocial care had yet been developed.

All of the bereaved families and the relatives of the injured were allocated their own support/contact worker. These were recruited among well-trained and experienced nurses at the University Hospital in Bergen [ii]. The next-of-kin of both the dead passengers and those who were injured on the day after the accident travelled by special charter flight to Bergen. The relatives were divided into three groups:

- next of kin of the dead
- next of kin of the injured
- families who had both lost family members and had injured members

To make these groupings at an early stage was considered to be important, as the psychological problems are completely different for those people who suffer loss compared with those who have an injured family member [iii].

On the fifth after the accident a special memorial service was held for the dead at two of Bergen's churches. The next-of-kin were invited family by family to see and say farewell to the victim, before the collective transport home to Sweden. During these first days a group of people from Kista and

[i] Tågkollisionen i Storsund 1980-06-02. Tågurspårningen i Upplands Väsby 1980-08-24. Katastrofmedicinska studier i samband med två svenska järnvägsolyckor 1980. Försvarets forskningsanstalt

[ii] Berle, J. Ø., Haver, B. & Karterud, S. (1991) Gruppereaksjoner ved katastrofearbeid i sykehus. Nordisk Psykiatrisk Tidskrift, 45: 329-35.

[iii]Winje, D. & Ulvik, A. (1995) Confrontations with reality: Crisis intervention services for traumatized families after a school bus accident in Norway. Journal of Traumatic Stress, 8: 429-44.

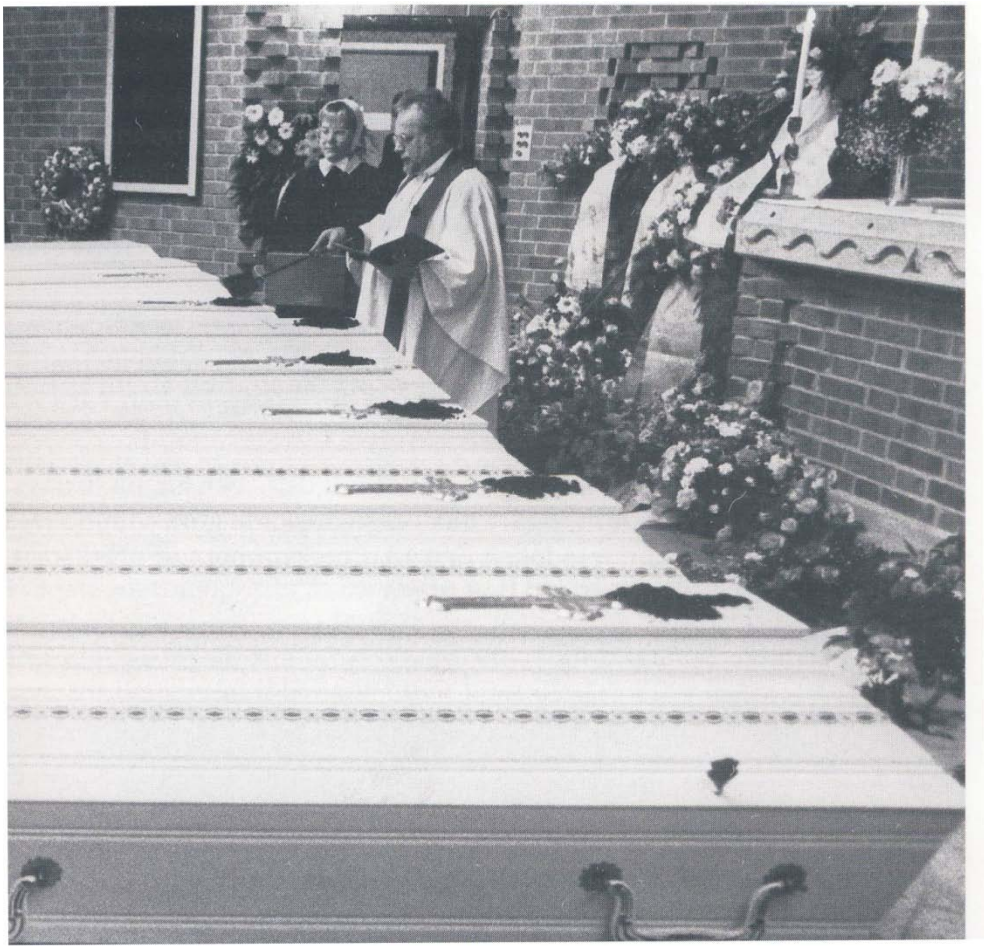
Stockholm (in particular the Saint Göran's Hospital), were organised to take over psychosocial support functions and to be responsible for subsequent medical measures and crisis intervention. In this group there were representatives of the local community (the church, social services, the school and primary health care) as well as medical care, child and adolescent psychiatry as well as general psychiatry.

The management group for continuing care (initially also including somatic care) was organised from the child and adolescent psychiatry clinic at Saint Göran's Hospital. For individual contacts with the families affected, two support or contact staff per family were designated. This group were recruited among the curators, doctors and psychologists in child and adult psychiatry. All of them had basic psychotherapeutic competence, and they were also given guidance in crisis intervention by two doctors trained in adult psychiatry. These individual family support contacts were to continue in some cases for up to a year after the accident [i].

A local crisis centre for collective support measures was instituted at Kista Church on the initiative of the minister, who also came to be personally involved in the situation of all the families concerned. As an example, it should be mentioned that a joint burial ceremony for nine of the dead children was arranged two weeks after the accident (Figure II).

[i] Wode-Helgodt, B. (ad patres), Garberg, A. (ad patres), Vikander, B. & Rydelius, P-A. (1989) Busskatastrofen i Måbødalen. Bättre beredskap efterlyses. Läkartidningen, vol. 86, 46: 3985-86.

Figure II.



Source: TT BILD. Photo: Leif Blom

Nine of the fifteen bereaved families were in this way drawn closely together. On church premises there was a daily open house for many months. Members of the other six bereaved families, several of whom belonged to other religious communities (Catholic, Greek Orthodox, Muslim and Jewish), often attended this open support group activity. A personal and committed description of the care provided in the first week has been given by the minister at Kista [i].

In an accident of this kind, many people will be affected, particularly in the local community. Those mainly affected are, course, primarily the survivors and the families of the dead and injured (Table I). The immediate social neighbourhood is also affected, such as schoolchildren of the same age, the social networks of the siblings of children who were casualties as well as teachers and other school staff (Table II).

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[i] Jonsson, S. (1990). En bro över mörka vatten. Om människorna bakom rubrikerna. Cordia, Stockholm. sid. 15-30.

Table I The class affected, class 6B, Kvarnbackaskolan.

		Relatives
Dead	12 schoolchildren	23 parents 20 siblings
	4 adults	4 spouses 8 siblings
Injured	11 schoolchildren 4 adults	16 adults 16 siblings
Not on trip	2 schoolchildren	
TOTAL	**N=104**	

Table II Those affected in the immediate locality

6 after-school recreation centres
14 day nurseries / part-time preschools
5 intermediate level classes (10 to 13 years)
4 senior level classes (13 to 16 years)
Teachers
school nurses

Nine months after the accident a questionnaire containing 44 questions was handed out to all the students (N=107) in the school in Kista of the same age as the class affected, The questionnaire is based on the method that had been used in Israel in the long-term follow up of all children in year group 7 after a bus accident at Petach Tikva [i].

The Swedish questionnaire was answered by 102 students (95.3%); 55 boys and 47 girls. Half of the group (N=51), 27 boys and 24 girls responded to the follow-up questionnaire.

The children first and foremost reported depression, avoidance, insistent memories and feelings of guilt. There were clear differences evident between boys and girls both as regards symptoms and reactions, and as the use of or need for acute crisis support during the sub-acute phase (after nine months) (Tables III and IV). The girls consistently reported a higher occurrence of these symptoms. Among the girls, the acute crisis support was made use of to a significantly higher degree than among the boys. Ten of the children in the class affected (class 6B) took part in the first survey. Most post-traumatic symptoms were very common both among these children and among the children in a parallel (class 6C), (Table III). There were, however, significant differences as regards nightmares and feelings of guilt.

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[i] Milgram, N. A., Toubiana, Y. H., Klingman, A., Raviv, A. & Goldstein, I. (1988) Situational exposure and personal loss in children's acute and chronic stress reactions to a school bus disaster. Journal of Traumatic Stress, 1(3): 339-52.

Table III Symptoms and reactions, nine months after the accident. Results in %

Question	Girls	Boys	Sign.	6B (N=10)	6C (N=20)	Sign.
Depression	80.4	58.5	p<0.05	90.0	68.4	NS
Anxiety	2.1	3.6	NS	0	0	
Fear	21.7	23.5	NS	22.2	26.3	NS
Avoidance	51.1	65.4	p<0.1	75.0	70.0	NS
Sleep disturbances	13.0	5.6	NS	12.5	0	
Nightmares	19.6	7.5	NS	50.0	5.0	P<0.05
Lack of concentration	4.3	7.3	P<0.06	0	0	
Intrusive memories	27.3	7.7	P<0.05	14.3	0	
Loss of interest	2.2	3.6	NS	11.1	0	
Feelings of guilt	23.8	13.0	NS	62.5	5.0	P<0.01

Table IV Need for acute crisis support, nine months after the accident. Results in %

Question	Girls	Boys	Sign.
Support from family, friends and school staff	76.6	56.4	(p<0.06)
Support from school friends	55.3	29.1	p<0.05
Need for support groups, with curator or psychologist	14.9	1.8	P<0.05
Experience of incomplete crisis treatment	34.0	23.6	NS

In a factor analysis of the responses from the nine months questionnaire (Table V), differences emerged regarding four factors: shock, fear, help-seeking and avoidance. This relates to the needs of boys and girls for psychological help/support and as regards "shock" and "help-seeking" for all pupils in the affected class compared with pupils in parallel classes.

Table V Factor analysis. Differences, nine months after the accident, between boys and girls between the affected school class (6B) and a control group (class 6C)

Factor	Girls	Boys	Sign.	6B	6C	Sign.
F1 "shock" N=17	1.07	1.04	NS	2.38	0.94	p<0.01
F2 "fear" N=17	0.56	0.65	NS	0.62	0.68	NS
F3 "help-seeking" N=35	1.50	1.05	p<0.01	1.62	0.89	p<0.05
F4 "avoidance" N=6	1.12	1.12	NS	1.57	1.05	NS

Thirty-six adults and twenty-eight children (between 9 and 19 years of age) in the families affected have been followed up one, three and five years after the accident.[i]. The bus accident has had a profound effect on the functioning of adults and children irrespective of age, type of trauma or gender. Five years after the incident most of the adults were still distressed, whilst the children's symptoms had abated already three years after the trauma.

Lessons Learned

The lessons learned from the psychosocial care after this accident were to comprise an important basis for the advice and recommendations which, from the beginning of the 1990s, led to the establishment of hospital PKL groups and the primary municipal POSOM (The National Board of Health and Welfare General advice, 1991:2). This so-called “Kista model” [ii] came to form something of a prototype in establishing collaboration between actors belonging to different organisations, for example municipalities, county councils and churches. This is reflected not least in the previously mentioned General Advice (1991:2), and also to a great extent influenced the National Board of Health and Welfare’s current recommendations, “Crisis support in serious incidents”[iii].

There may, however, also be risks involved in too active a “protection”, with special activities organised by the health care for particularly hard-hit groups, for example, survivors and next-of-kin. This may contribute to those affected not being able in a natural way to “move on” and leave a psychologically painful period behind them. Most individuals have a natural ability to psychologically process mental traumas, and very few have need of professional help over a long period.

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[i] Winje, D. (1997) Psychological adjustment after severe trauma. A longitudinal study of adults’ and children’s posttraumatic reactions and coping after the bus accident in Måbødalen, Norway 1988. (thesis) Dept. Clin. Psychol. University of Bergen.
[ii] Johansson, Nobert & Wohlin (red.) (1998) När det ofattbara händer… Bussolyckan i Måbödalen, Norge 1988. Rapport – omsorgsarbetet i Kista. Elanders, Gotab.
[iii] Krisstöd vid allvarlig händelse. Socialstyrelsen; 2008.