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TRAFFIC SAFETY EVALUATIONS FOR EMERGENCY VEHICLES

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ABSTRACT

One essential part of a working health system is that people who are seriously injured or sick receive professional assistance as fast as possible. Therefore there is an optimal rescue time for emergency vehicles (in Germany the rescue time is normally around 8 - 15 minutes). To keep this rescue time, emergency vehicles like fire trucks, ambulances and police cars have special rights in case of an emergency situation. These special rights give emergency vehicles priority at intersections and allow them to violate red lights etc. But driving an emergency vehicle is still a dangerous and stressful situation. The probability of having an accident with an emergency vehicle that is driving with siren and flashing blue light is much higher than with a normal car and the probability that someone will be killed in an accident is also 4 times higher.

This paper analyses the reasons for accidents with emergency vehicles and presents a description of the driving behavior for emergency vehicle. Furthermore typical accident situation are determined. The evaluation showed that most accidents happen at controlled and uncontrolled intersections. Mostly, not the traffic behavior of emergency vehicle is the only influence on traffic safety; also other traffic participants play an important role.

INTRODUCTION

In case of an emergency situation help needs to reach the incident location immediately. Driving an emergency vehicle is a stressful situation. The driver is in a conflict situation to reach the emergency location as fast as possible but also to avoid accidents and critical situations (Bockting, 2007). Additionally, the drivers might be thinking about the following operation while they should put their full attention on the traffic. The aim of this and following studies is to improve the operation drives of emergency vehicles considering traffic safety and travel time. To implement traffic solutions for improving emergency vehicles it has to be evaluated the current state of traffic safety for emergency vehicle, first. Afterwards it can be detected which reasons are causing the accident which is done in this study. In a later step solutions for improving traffic safety could be derived from these results and their effectiveness can be investigated in traffic simulations.

Traffic Safety of Emergency vehicles

Statistically, emergency vehicles are more often involved in car accidents than other traffic participants (Hempel, 2007). A traffic safety study of BAST (1995) discovered that the probability of an emergency vehicle is 8 times higher to be involved in an accident than for other vehicles. Furthermore the study calculates that at least one person is killed every 272,000 emergency drive. This is very dramatic, because emergency vehicles should help other people and prevent death and not cause injuries and death.

There are many studies which investigated that the risk for emergency vehicle drivers is higher to be involved in an accident (e.g. BAST 1995, BAST 1994, Hempel 2007, Burke 2001). Burke (2001) evaluated accidents in Florida and concluded that most of the accidents with emergency vehicles happened at intersections which are caused by multiple factors like a reduced visibility of the emergency vehicles or careless pedestrians. But in these studies the reasons for the higher risk of emergency vehicles are not analyzed. The question rises whether emergency vehicles are more involved in accidents because of their special driving behavior and what the main reasons are for the accidents?

Rescue and respond time

In Germany the federal countries determine in which time period emergency vehicles should reach the incident location (Bockting, 2007). This rescue or respond time is usually around 10 to 15 minutes for ambulances. This includes the time from the emergency call until the emergency vehicle reaches the location. Bockting (2007) states that fire brigades in Germany have normally 8 minutes to reach their destination as legal restriction. The study of Schmiedel (2011) evaluated how long the rescue and respond times for emergency vehicles with special rights was in Germany. Accordingly, the rescue time was in average 8.7 minutes and 95% of all incidents were reached in less than 17 minutes. The respond time is different for every federal country and also sometimes for regions. In urban areas the respond time is usually longer because operation units have to drive more kilometers to the incident. These time periods are legal time limits but in any case the rescue teams should be able to help as fast as possible. Therefore, Emergency vehicles are allowed to use special rights in case of an emergency.

Special Rights and driving behavior of Emergency vehicles

This section describes the special rights and driving behavior of emergency vehicles. Emergency vehicles are vehicles which normally respond to an emergency situation. These vehicles can be divided into three subclasses (Becker, 2003):

1. Ambulances and medical vehicle
2. Fire trucks and rescue service
3. Police and security cars

In case of an emergency these vehicles are allowed to break road rules and request special rights e.g. they are allowed to violate red light and drive faster than the speed limit. Emergency vehicles are only allowed to use these special rights if it is necessary to reach the destination as fast as possible to save human lives or prevent serious injuries (Hempel, 2007). When an emergency vehicle wants to use special rights it has to signal this while switching on a blue flashing light and a siren. Other traffic participants are warned by these two signs that an emergency vehicle is approaching and can react accordingly (e.g. give way to the emergency vehicle). Though, vehicle should give an emergency vehicle priority but the driver of an emergency vehicle is not allowed to use the special rights regardless of other traffic participants. Therefore the driver of an emergency vehicle has to stop at a red light first and has to decide whether it is possible to violate the red light without endangering other people. Special rights are used in every second operations (50.5%) on the way to the emergency location (Schmiedel 2011).

The special rights of emergency vehicles are listed as follows. But all these special rights can only be used if other people will not be harmed (Hempel 2007):

- **Speeding:** Emergency vehicles are allowed to drive faster than the speed limit if the current traffic situation allows this.
- **Violate red traffic lights:** When an emergency vehicle approaches a red traffic light it should reduce speed and take care that other vehicles see that an emergency vehicle is approaching.
- **Request priority at intersections:** The traffic behavior of emergency vehicles is similar at controlled and uncontrolled intersections. The emergency vehicle request priority while using blue flashing light and the siren but the driver still has to take care that other traffic participants realize this.

- Use emergency lane: Emergency lane can be used by the emergency vehicle to safely overtake other vehicles.
- Use one way streets in opposing direction: Emergency vehicles can use one way streets in the wrong direction.
- Overtake other vehicles: Emergency vehicles are allowed to overtake even in roads where overtaking is not allowed.
- Use roads which are restricted: Roads which are restricted to use e.g. for Busses, Taxis or residents can be used by emergency vehicles.
- Ignore stopping restrictions and parking prohibition: If necessary to reach the incident location, emergency vehicles are allowed to park even in these restricted areas.

Interaction with other traffic participants

The emergency vehicle is not allowed to use its special rights if it would harm other traffic participant. Therefore, other vehicles, bicycles and pedestrians have to adapt their traffic behavior, too.

- Stop at green: Driver should stop at a traffic light even if it is green to let an emergency vehicle pass.
- Build emergency lane: Driver should build up an emergency lane in case of a traffic jam or when they are waiting in front of a traffic light etc.
- Give way to emergency vehicles: There are different situation where drivers should make way to the emergency vehicle.
 - Intersections: Driver should stop at an intersection even if they have right of way to let emergency vehicle pass.
 - Overtaking: If an emergency vehicle is approaching from behind, driver shall not overtake other traffic participant so that the emergency vehicle is able to overtake itself.
 - Normal streets: Driver should try to give way to emergency vehicles, for e.g. turn into another street to let the emergency vehicle overtake. If there is no way to turn the driver should keep the speed so that the emergency vehicle does not lose speed and overtake as soon as possible.

METHODS

For analyzing the traffic safety of emergency vehicles an internet research of accidents of emergency vehicles with special rights was performed. As sources for this search mainly local newspapers and reports of emergency vehicle drivers were used. As keywords the German words for “emergency vehicle accidents”, “traffic safety for emergency vehicles” or similar words were used. For this study only accidents in Germany were evaluated. For every accident it was collected:

- whether the accident happened while using special rights
- Involved traffic participants
- Reason for the accident
- Date
- Number of insured and killed people
- Time of Day
- Road type
- Reference

The whole section uses data from the references mentioned in the Appendix “References for Accidents with Emergency vehicles”. The information about the traffic accidents were very detailed described in the newspapers. Many of the found newspaper and reports mentioned all of the evaluated data fields other data source presented only aggregated data and could not be included in this study (5 papers). For the evaluation 189 accidents with emergency vehicles in Germany in the years 2009 to 2015 were analyzed. All accidents happened while the vehicle was requesting special rights with blue flashing lights and siren. Emergency vehicles which were driving without special rights have a similar traffic behavior as normal vehicle and therefore are not considered in this study. Consequently, all accidents with emergency vehicles which were not using special rights were excluded from this study (about 20 reports).

RESULTS

Most of the recorded accidents happened at controlled and uncontrolled intersections (51%). For 32% of the reported accidents the reason was that the emergency vehicle has crossed the intersection while the traffic light was red. Also overtaking (12%), abrupt breaking (4%), one way road (0.5%) and stop sign (0.5%) are reasons of the accidents which are related to the special rights of emergency vehicles. Other types of accident situations are not related to the special driving behavior of emergency vehicles for example the influence of alcohol (3%) or icy roads (5%). Furthermore, there is also a group of accident situations where the emergency vehicle caused an accident indirectly. For example a child was scared by the siren and fall down the bike which caused an accident or one driver wanted to give way to an approaching emergency vehicle but the following driver could not react appropriately and bumped into the leading vehicle but these are individual cases. The accident types can be seen in Figure 1.

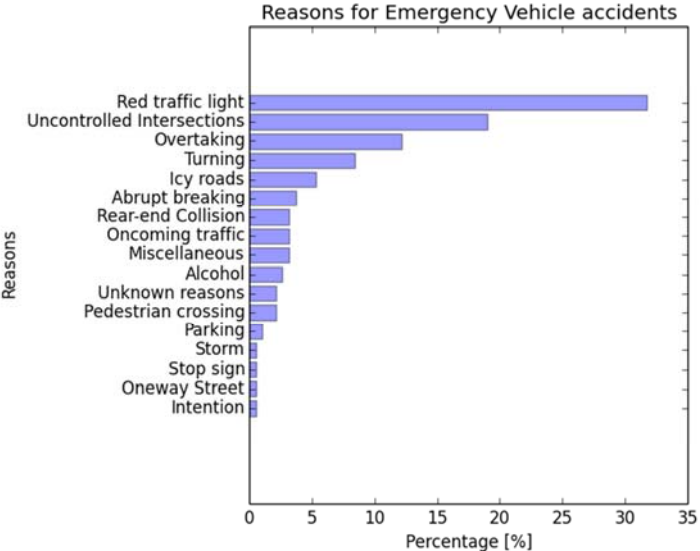


Figure 1 Accident types with emergency vehicles for different reasons

In 118 of the 189 analyzed accidents at least one person was insured. The reasons for the accidents with insured people are similar to the all accidents. Again controlled (37%) and uncontrolled intersection (20%) are the main reason for accidents, see Figure 2.

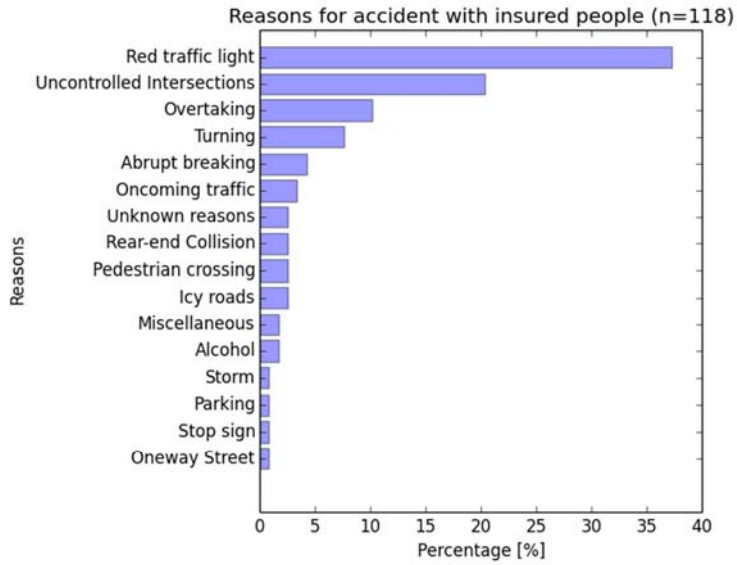


Figure 2 Frequency of insured people in the reported accidents

The results are differently if the reasons for all accidents with killed people are regarded. In this case the main reasons for the accidents are uncontrolled intersections (see Figure 3). But there were only 9 accidents where a person was killed, so the numbers are not very meaningful.

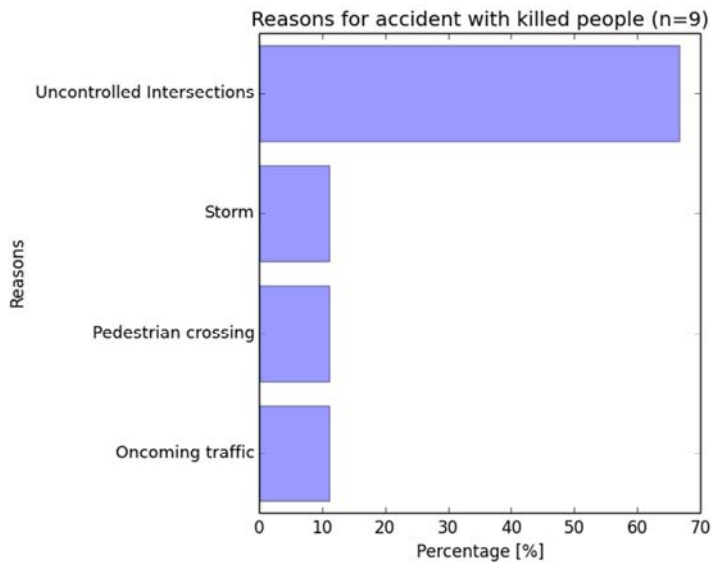


Figure 3: Reasons for the accidents with killed people

Most of the accidents are happening with (emergency) ambulances (38%) followed by police car (28%) and other special services (19%) which includes emergency doctors , courier services or transport of organs (see Figure 4).

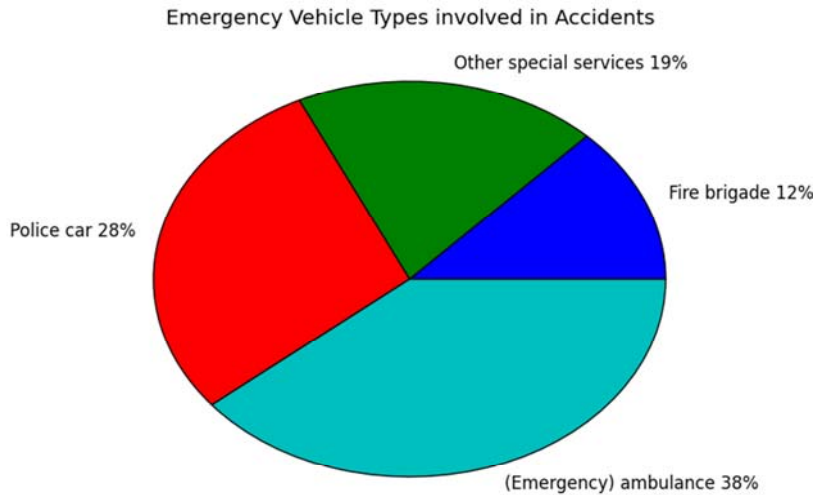


Figure 4: Emergency Vehicle Types involved in Accidents

DISCUSSION

In this study 189 accidents with emergency vehicles which happened during an operation have been evaluated. For the evaluation mainly newspaper articles and reports from emergency vehicle drivers were used. These reports included a very detailed description of the accidents. But it must be bear in mind that accidents reported in newspapers are already filtered. Therefore it is expected that very small accidents are not reported while more heavy accidents will get much more attention. Consequently, the numbers in this study can be used only as indication and not as the absolute real numbers.

The results show that most of the accidents are strongly related to the use of the special rights, so the main reason for accidents are that emergency vehicle requested priority at a controlled or uncontrolled intersection while other traffic participants did not realize that an emergency vehicle is approaching (51%). In the study of Bockting (2007) similar results were found. Bockting asked ambulances, police stations and fire departments about typical accident situations. A big part of the accidents are related to use of special rights (e.g. violate a red traffic light, using a one way street in the wrong direction or request priority at an uncontrolled intersection).

In 62% of all accidents at least one person was insured. This high number could have different causes. One reason might be that emergency vehicles are driving with a higher speed and

therefore an accident will be much worse than with a personal car. Furthermore, during an emergency drive often paramedics are taking care of the patient and therefore they are not wearing a seatbelt. The similar results were found by Becker (2003). But on the other side, it could also be that accidents with insured or killed people get more attention in media.

CONCLUSIONS

The results showed that many accidents are happening at controlled and uncontrolled intersections and are often related to use of the special rights by emergency vehicles (e.g. violate red lights).

The motivation of this work was to find solutions how emergency vehicle can reach their destination as fast as possible but also safe at the same time. This paper is only the first step for this aim; it provides the database which can be used for further research. The result show clearly that the highest risk for an accident is at intersections. In most of the cases the accident could be avoided if the drivers were aware of the approaching emergency vehicle. Therefore solutions from Car2Car Communication Application could be used and should be investigated in further studies. Possible applications could be a warning message which indicates that an emergency vehicle is approaching or to present recommendations to drivers how they should react to the emergency vehicle.

Especially, when an emergency vehicle violates red traffic lights the risk for an accident is very high. Another solution for improving traffic safety would be to set traffic lights according to an approaching emergency vehicle. In this case emergency vehicle drivers do not have to driver over red traffic lights while other traffic participants have red. This approach was already evaluated in a small scale in Bieker (2011).

Another research topic which should be evaluated will be traffic simulation models for emergency vehicles. The impact of traffic applications are often analyzed using traffic simulations, because it is safer and less expensive than analyzing the application in real life or in a test field environment. Afterwards the simulation model can be used for evaluating traffic solutions for emergency vehicles.

ACKNOWLEDGEMENT

This work has been partly funded by the German-Israeli Foundation for scientific Research and Development. The author wishes to acknowledge the Foundation for their support.

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