

Ambulances and helicopters

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Please note: The studies included in this synopsis were selected from those identified by a systematic literature search of specific databases (see supporting document). The main criterion for inclusion of studies in this synopsis and the DSS was that each study provides a quantitative effect estimate, preferably on the number or severity of crashes or otherwise on road user behaviour that is known to be related to the occurrence or severity of a crash. Therefore, key studies providing qualitative information might not be included in this synopsis.

1 Summary

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1.1 COLOUR CODE: GREEN

Several of the studies reviewed indicate strong benefits of the treatment by helicopter emergency medical services. Mostly though, the topic has been examined in Germany, comparing helicopter emergency medical services to ground emergency medical services. This synopsis can therefore not claim these results apply to all developed countries, as every country has a slightly different system of providing sufficient trauma management on-scene.

1.2 KEYWORDS

HEMS, GEMS, helicopter ambulance, ambulance, response time, time on-scene

1.3 ABSTRACT

This literature review aims at comparing helicopter emergency medical service (HEMS) to ground emergency medical service (GEMS) and providing further information about both.

As helicopters are more expensive to provide and more likely to be out of service because of certain weather conditions or darkness, the question about its advantages for patients should be asked. Several studies were found analysing both transportation systems with different approaches, whereas others only aim at the benefits and disadvantages of helicopters without comparison to ambulances.

Although medical teams from helicopters had to treat more seriously injured patients and their time on-scene was prolonged in comparison to the medical teams from ambulances, studies comparing those two found a significantly reduced mortality risk for helicopter patients. Several causes contribute to this result: HEMS are more experienced in trauma care (especially concerning the severely injured), use more invasive treatment methods on-scene than GEMS and sometimes have access to Level I trauma centres ambulances cannot reach fast enough.

Those studies providing the best data concerning both types of emergency medical services all have been conducted in Germany – therefore it might not be possible to transfer those results to every other developed country using HEMS.

1.4. BACKGROUND

What kinds of trauma patients are transported via HEMS or GEMS?

The reviewed studies show that most of the trauma patients in general are victims of road accidents. The majority are male and under 40 years of age, probably due to factors such as a higher willingness to take risks. In general HEMS treat more severely injured patients than GEMS. To be of relevance for all the studies, only patients with (suspected) severe injuries were included in the analyses.

Where are severely injured patients brought to?

Each country uses different definitions for their levels of trauma centres, e.g. a "Level-I-trauma-centre" being a hospital perfectly equipped for all kinds of trauma patients and the complications

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possible after being severely injured.

Of course having every trauma patient transported to the best equipped hospital is aimed for, but limited capacities or long distances sometimes prevent them from being brought there. In some studies, the authors distinguished between the various levels.

How can the severity of an injury be measured?

The "Injury severity score" ranges from 0 to 75. For defined regions of the body (head and neck, face, spine, thorax, abdomen and extremities) the severity is measured using the AIS scale from 1 to 6 after a defined list of diagnoses and then one squares the three highest numbers and sums them up. (The only exception: should one region of the body be affected by the maximum injury score of 6, the ISS automatically is set to 75.)

Other studies defined their analysis group by the criteria of being treated by a doctor on-scene or of "polytrauma". The term "polytrauma" describes the combination of at least two life-threatening injuries which were received at the same time.

Additionally, important for most of the analyses, is the Glasgow Coma Scale GCS as that scale is also used by the medical teams on-scene, especially after head injury. It describes the patient's level of consciousness from 3 (deeply unconscious) to 15 (normal).

What other factors were reviewed?

Of importance to the authors were factors like the time spent on-scene, response time, how long it took until the hospital was reached, treatment on-scene, expected and actual mortality risk, complications during the stay in the hospital, level of trauma centre and sensitivity/specificity of preclinical diagnoses. Some also calculated the standardized mortality ratio – a ratio between the number of observed deaths and the expected number of deaths in the study population.

1.5 OVERVIEW RESULTS

HEMS directly compared to GEMS in mostly German studies:

- HEMS are highly reliant on pleasant weather and landing conditions and are only flying during daytime
- HEMS-patients are more severely injured and have a higher risk of complications
- HEMS have a prolonged time on-scene and their patients must wait longer for the arrival at a trauma centre
- HEMS practice more extensive prehospital management
- There was no difference found between the accuracy of preclinical diagnosis
- There is a significantly better outcome for patients treated by HEMS, especially for the severely injured. E.g. Schweigkofler et al. (2014) found that in their subgroup of severe trauma to the head, GEMS-patients showed a fatality rate of 41,2%, while helicopter-patients showed 34,6%, even though GEMS-average-ISS was 2 points lower than the average ISS of 33 in helicopter-patients.
- HEMS more often transport patients to level-I-trauma centres - however one subgroup analysis found that in their cases this was not the reason for the better outcome

In addition, some of the studies in different countries made remarks about the assignment of emergency services. They all indicated standardized rules have to be developed to receive definite guidelines for assignment of helicopters.

2 Scientific Overview



This scientific overview on ambulances and helicopters describes knowledge on helicopter emergency medical services and compares them to ground emergency medical services. The section *literature review* describes the studies reviewed on the topic in general, the section *methodology* describes the approach to the task and the section *analysis and results* presents major characteristics and results of the coded studies.

2.1 LITERATURE REVIEW

In the following, major conclusions from studies about HEMS and GEMS are described. Not all of the studies concentrate only on trauma after road accidents, but one can assume the general results are of the same relevance.

Andruszkow et al. (2013) studied the survival benefit of HEMS compared to GEMS in traumatized patients in Germany. They included every trauma patient between 2007 and 2009 with complete data available, who had an ISS ≥ 9 and was treated in a German Level I or II trauma centre. Over 13.000 patients (37,7% were transported via HEMS) were examined and researchers found that HEMS-patients usually were more severely injured than those transported via GEMS because the involvement in high-energy accidents and had a higher risk of multiple organ dysfunction syndrome and sepsis increasing the time spent in hospital and under ICU treatment. Their treatment and time spent on-scene was much more extensive, but nevertheless they demonstrated a survival benefit compared to GEMS. In order to calculate the standardised mortality ratio, they used the Trauma and Injury Severity Score (including prehospital blood pressure, consciousness and respiratory rate). Expected mortality in patients transported by helicopters was 20,4%, actual mortality 13,8%, the standardised mortality ratio being 0,678. GEMS-patients showed an expected mortality of 18,1% vs. an actual mortality rate of 14,7%, the standardised mortality ratio being 0,815 ($p < 0,002$). A subgroup analysis performed on patients transported to Level I centres during daytime furthermore excluded the possibility that the survival benefit resulted from the better access to specialized hospitals HEMS usually enjoy. The analysis included 7.807 patients, about half of them transported via HEMS and the other half via GEMS. Mean ISS in HEMS was 26.0 (1.9 points higher than in GEMS), time on-scene was 39.0 (10.6 minutes more than GEMS), HEMS-treated patients developed multiple organ dysfunction syndrome more often (33.9% vs. 26.4%), the p-value always lesser than 0.001. In GEMS-patients the standardised mortality ratio was 0,815 vs. 0,647 in HEMS, the p-value being $< 0,0011$. A study from Lackner et al. (2010) researched the emergency care for road accidents between 2002 and 2006 in Bavaria, Germany and found that patients transported by HEMS were brought to a Level I or II trauma centre in 96% of cases whereas about half of the patients transported by GEMS were transported to less specialized hospitals.

McQueen et al. (2015) reviewed several studies in developed countries concerning high severity trauma and dedicated dispatch criteria. Concerning HEMS, no dependable conclusions could be drawn as the studies often concentrated on entirely different aspects. The reviewers call for more research concerning the efficiency of systems utilised to dispatch Enhanced Care Teams to optimise the allocation of resources.

McQueen et al. (2015) examined whether helicopters could be the answer to the management of major trauma at night in the West Midlands of England as physician-led Enhanced Care Teams at that time did not utilise helicopters. They used the records of cases submitted by ambulances to

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hospitals in the region during a one-year-period between 2012 and 2013 and cross-referenced them with the dispatch archive. To be included, the ISS had to be greater than 15, the patient had to be admitted to intensive care, had to die within 24 h of admission to the hospital or have an emergency surgery within the first 12 hours after admission. 603 cases of major trauma during night time were identified, 167 were attended by Enhanced Care Teams. Only 6% of those incidents occurred in locations farther away than 45 min by road from the nearest major trauma centre. The study showed that there probably is no need for HEMS at night in that specific region, they call for an expansion of already existing road based resources as they are safer and more cost-effective. It is doubted these results can be transferred to every location.

Melton et al. (2007) analysed the patients brought by helicopters to the Great Western Hospital in the United Kingdom to evaluate whether helicopters are dispatched too often and provide any benefits. During twenty months in 2003 and 2004, 111 trauma patients were flown to the hospital. 45 patients were sent home directly from the emergency department, which led to the authors criticising the dispatch criteria used for helicopters and claiming an over triage by GEMS on-scene resulting in even more extended inappropriate immobilisation of HEMS. Although it was remarked that a certain amount of over triage - 25% - actually is achievable in accordance to studies on that topic. 2 patients died, 24 needed to be operated on, 66 patients did not require follow-up by the Great-Western Hospital (though 8 of them were followed up elsewhere), of those followed up, 37 made a complete recovery. Of all patients the mean ISS only was 12.37. In reference to other studies, the authors also state that there is no evidence of faster total transfer time when the distance from the casualty to the hospital is less than 45 miles (about 72 km). They also refer to the helicopters' lack of flexibility when it comes to hazardous environmental conditions, uncooperative patients, chemical-contaminated patients who could compromise the pilots and the difficulties on board when an airway obstruction occurs, as there is limited space and loud noise making it impossible for the medical team to treat the patient effectively. While the study does not deny the helicopter's clinical value it is strongly advised to remember helicopters do not provide a certain therapy but a different way of transportation, so the resources can be used more cost-effectively in the future.

Schweigkofler et al. (2014) studied almost 40.000 cases of trauma in Germany from 2005 to 2011 with an ISS greater than 8, comparing 26.868 patients treated by a GEMS to the 13.048 patients treated by a HEMS using the database of the German society for casualty surgery. Of all the cases included, 65,6% were brought to the hospitals during daylight, 34,4% were transported during darkness..

A subgroup analysis including the 44 hospitals which had contributed to the database revealed that demographically, no difference could be found between the patients which makes a comparison even more reliable. Helicopters transported their patients to Level I trauma centres in 85% of the cases whereas ambulances showed a rate of 61%. But during night-time, only 15,8 % of the patients were flown. In general, HEMS transported more casualties after road traffic collisions than GEMS and three percent more patients in a state of shock than GEMS.

Medical teams from helicopters treat their more severely injured patients very invasively on-scene - intubation and thoracic drainage are among the options used more often compared to GEMS. That could be one reason why the time needed from the incident to arrival at the hospital for HEMS is prolonged by ten minutes. Although the patients suffered from more severe injuries and expected fatality rates were higher (assumptions based on vital parameters, medication, time spent in ICU and under artificial respiration), HEMS led to a slightly decreased standardised mortality rate (HEMS: 0,793, GEMS: 0,874, with $p < 0,001$).

Another subgroup analysis with patients suffering from severe trauma to the head (GCS < 9, 32,3% of the patients in general) revealed HEMS needed 77 minutes in contrast to GEMS needing only 63 minutes on average. 86% of the patients flown were brought to a Level-I-trauma centre in

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comparison to 72% in the group transported by ambulances. Fatality rates also showed significant differences: GEMS-patients showed 41,2% (42,8% were expected), helicopter-patients showed 34,6% (39,9% were expected), even though GEMS-average-ISS was 2 points lower than the average ISS of 33 in helicopter-patients. In conclusion, the study shows a significantly better outcome especially in the highly severity group of patients when transported by helicopters. The authors point out that a study in American hospitals and Andruszkow et al. (described above) in Germany came to equivalent results. Reasons might be a greater experience with severe trauma and the access to highly specialized centres.

Schweigkofler et al. (2015) analysed the two most extensive databases by emergency helicopter services in Germany, the ADAC and DLR, between 2006 and 2011. 35% of their cases happened due to a traumatic cause. Their aim was to examine the importance of helicopters in prehospital care. In 25% of the assignments, a doctor already had seen the patient before HEMS arrived which lead to 8 minutes less time spent on-scene. Unfortunately, when the helicopter had been assigned later than the GEMS, patients spent 20 more minutes in total on-scene.

86% of those who met the criterion of a polytrauma (10% of trauma patients in general) were transported by the helicopter, mostly with severe injuries to the head and thoracic damage. 72% of that subgroup were intubated, 15% underwent a thoracic drainage. 10% of the polytrauma-patients were transported by an ambulance accompanied by the HEMS-physician.

It took the helicopters 13 minutes on average to fly to their patients, only ten minutes of flying were spent to reach the hospital.

Because of data like the short transfer-time and high intubation rates in cases of polytrauma, the authors think of helicopters as a way to provide efficient trauma care of high quality. In order to provide that help to all severely injured patients, late assignments should be abolished in the future. The authors propose a more efficient system with standardized criteria for the dispatching when it comes to helicopters unlike the momentary situation where every emergency operator relies on his own experience.

Nakstadt et al. (2009) provided a completely different solution for a more cost- and time-effective response to medical emergencies than ambulances or helicopters. They prospectively studied the use of 703 medical emergency motorcycles in an urban Norwegian region. The driving time for these vehicles was significantly shorter than for ambulances (6 minutes 24 seconds vs. 6 minutes 54 seconds). In 121 patients, the MEM-paramedic completed 243 medical interventions before the arrival of other units. Additionally, there was a cost benefit (29€ per hour vs. 75€), though the actual benefit is smaller because of MEM's dependency on weather conditions. Unfortunately, it is not possible to run MEM during Scandinavian winter time. Furthermore, unnecessary car ambulance missions could be reduced as the motorcycles were used to evaluate patients in uncertain state of health.

2.2 METHODOLOGY

A systematic literature study was undertaken to identify scientific studies on the use of helicopters and ambulances in prehospital trauma care. 9 studies were identified, of which 6 were finally coded. Table 2 (Supporting Document) gives an overview of study methodologies.

2.3 ANALYSIS AND RESULTS

General results

The studies reviewed aimed to gather detailed information about assignments and benefits of helicopters, sometimes directly compared to road ambulances. As explained above, the disadvantages of helicopters like higher costs and less flexibility remain, so it is important to find out

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about their actual advantages for patients. One study proposed an entirely different approach to the topic of effective use of resources and introduced the concept of emergency motorcycles which can be very useful in terms of evaluation in uncertain situations, assistance of other paramedics in complicated cases and quick response time.

1. *Severity of injury and complications*

Several studies found out that patients transported by helicopters are more severely injured. Andruszkow et al. mentioned, HEMS-treated patients were more likely to have suffered from high-energy accidents, a subgroup analysis with patients only transported to Level-I-trauma centres revealed a higher ISS in the group of HEMS even though all the patients were thought to need highly specialized hospitals. Another study found three percent more HEMS-patients to be in shock and in several studies pointed out the higher expected mortality rate of patients brought by helicopters. Hemodynamically instable patients are more common in HEMS than stable patients.

In contrast to those results, Melton et al. found that in their study population of 111 patients treated by HEMS, 45 of them were over triaged and the mean ISS was very low.

2. *Transfer time*

Every study showed that although helicopters can travel by much higher speed than ambulances on the ground, the transfer always takes them slightly longer from the alarm up until the arrival at a hospital. This is due to numerous factors such as a longer time spent on-scene and longer distances to travel to further-away hospitals which provide a higher standard of trauma care.

3. *Treatment on-scene*

On-scene, HEMS usually stay longer to perform more invasive treatment methods on their patients. 65.7% of Andruszkows' study population were intubated by HEMS in contrast to 40.6% by GEMS. They too were treated with vasopressors, chest tubes and sedation significantly more often. Other authors also found positive correlations between the more extensive use of methods like intubation or thoracic drainage and HEMS. One reason for these findings could be that HEMS are expensive and therefore only best trained medical staff are on board who are more confident to undertake these more complicated treatments on scene.

4. *Access to highly specialized hospitals*

According to the four studies researching the level of the hospitals, helicopters transport their patients to Level I or II trauma centres very often. Lackner et al. e.g. found that 96% of HEMS-treated patients arrived at Level I or II trauma centres. This is not only influenced by the patient's severity of injury but also by the helicopters' capability to travel long distances in shorter time.

However, Melton et al. criticize the likeliness of over-triage of helicopter-patients and mention further studies stating that transfer time is not decreased should casualty and hospital be less than 45 miles away from each other. But as they only analysed 111 patients treated in the same hospital, the importance of their objections is debatable.

5. *Outcome benefit*

The two biggest studies reviewed on the topic directly comparing HEMS to GEMS both experienced an outcome benefit for helicopter patients, although they were thought to have a higher probability of death. The outcome benefit showed even more in severely injured sub

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groups. In Schweigkofler et al.'s subgroup analysis of severe trauma to the head, 41.2% of GEMS-treated patients died, whereas in HEMS only 34.6% did not survive.

6. Criticism on the allocation of resources

Among the studies reviewed, some criticized the lack of standardised rules for emergency operators (e.g. Westhoff et al., 2008), though the reasons for the remarks were quite contrary. It was claimed that standards should be set to prevent unnecessary assignments of helicopters leading to excessive costs. On the other hand, it was noted that late assignments due to an under triage at first sight can compromise the patient's outcome and increase the time on-scene. When a doctor of GEMS calls for a helicopter, the time on-scene for the patient is increased by twenty minutes according to Schweigkofler et al.

Conclusions

Most of the studies showed clear benefits of helicopters in treatment and outcome despite the fact there is no advantage in transfer time. Nevertheless, further studies are required, as the studies comparing the largest numbers of patients all have been made in Germany and the results might not be transferable to all developed countries. Additionally, it is called for the development of standardized rules when to assign helicopters.

Author, Year, Country	Title	Method	Outcome
Andruszkow, 2013, Germany	Survival benefit of helicopter emergency medical services compared to ground emergency medical services in traumatized patients	13000 trauma patients, 2007-2009, ISS \geq 9, trauma centre level I or II, (37,7% HEMS) Subgroup analysis: patients for trauma centre level I during daytime	Standardised mortality ratio HEMS = 0,678, GEMS = 0,825 (p<0,0011) Subgroup: HEMS =0,647, GEMS = 0,815 (p<0,002)
Lackner, 2010, Germany (Bavaria)	Emergency care for traffic accidents in Bavaria. Current process analysis depending on hospital and emergency service structures	77500 trauma patients treated by a physician on-scene after road accidents	19% transported by helicopters, 96% of those to level I or II trauma centre GEMS: half of the patients to less specialized hospitals
McQueen, 2015, USA, Denmark, Japan, Australia, UK, The Netherlands, Switzerland	Does the use of dedicated dispatch criteria by Emergency Medical Services optimise appropriate allocation of advanced care resources in cases of high severity trauma? A systematic review	Review of several studies concerning high severity trauma and dedicated dispatch criteria	Optimising dispatch criteria for the efficient allocation of resources is called for, otherwise no relevant conclusions. <i>Not coded in the DSS because several studies are reviewed but are not a meta-analysis.</i>
McQueen, 2015, England (West Midlands)	Enhanced care team response to incidents involving major trauma at night: Are helicopters the answer?	603 cases of trauma during night time, 2012-2013, patient-data of hospitals cross-referenced with the dispatch-archive, ISS \geq 15, intensive care unit/dead within 24 h after admission/emergency surgery within 12 h after admission	Only 167 patients attended by Enhanced Care Teams, 6% of those incidents farer away from a major trauma centre than 45 minutes (by road). <i>Not coded in the DSS because the effects of helicopter intervention are not directly studied.</i>

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Author, Year, Country	Title	Method	Outcome
Melton, 2007, UK	Helicopter emergency ambulance transfer service: an analysis of trauma patient case-mix, injury severity and outcome	111 trauma patients, 2003 and 2004, brought to the Great Western Hospital by helicopter	Patients over-triaged, helicopters certainly of clinical value, but should not be used too often (no evidence of faster transfer time, lack of flexibility, high costs)
Schweigkofler, 2014, Germany	Importance of air ambulances for the care of the severely injured	40000 cases of trauma, 2005-2011, ISS \geq 8, (13048 transported via HEMS) Subgroup analysis: severe trauma to the head (GCS \leq 9) = 32,3% of study population	Standardised mortality rate: HEMS = 0,793, GEMS = 0,874 (p>0,001) Subgroup: lethality rate: HEMS = 34,6%, GEMS = 41,2%
Schweigkofler, 2015, Germany	Significance of Helicopter Emergency Medical Care in prehospital trauma care	ADAC and DLR databases, 2006-2011, 115495 trauma patients transported by helicopter	86% of polytrauma-patients transferred via HEMS, high intubation rate (72%) helicopters needed, but too late assignments should be abolished. <i>Not coded in the DSS because the study is mostly descriptive.</i>
Westhoff, 2008, Germany (Hanover)	Entrapped motorists and air rescue services. Analysis of tactical rescue approach, rescue techniques, and emergency medical services illustrated by a helicopter emergency medical service	359 patients, 2000-2004, after extraction from a vehicle, transfer via "Christoph 4" stationed in Hanover	Extracted patients: higher probability of death than others, special care needed Lack of standardized rules for the assignment of helicopters criticized.
Nakstadt, 2009, Norway	Medical emergency motorcycle – is it useful in a Scandinavian Emergency Medical Service?	Prospective study of 703 medical emergency motorcycles, May to September 2007, urban Norwegian region	Advantages: quick response time, cost benefit, flexible assistance of other paramedics possible, abolishment of unnecessary assignment of ambulances Disadvantage: highly dependent on weather conditions

3. Supporting documents



METHODOLOGY

Literature search strategy

For the literature search the database Web of Science was used including articles and reports from various road safety journals and conference proceedings. The search was limited to article titles, abstracts, and keywords fields and filtered in order to acquire only recent articles published after the year 1990. Several combinations of keywords were used for the search. (Table 1).

Table 1: number of hits they generated in Web of science

no.	search terms / logical operators / combined queries	hits
#1	"Rescue unit" OR "Rescue helicopter" OR "SAR helicopter" OR "ambulance" OR "mobile intensive care unit" OR "micu" OR "paramedic" OR "emergency doctor"	15,582
#2	"traffic accident" or "crash"	53,401
#3	DOCTYPE (article OR review) AND PUBYEAR > 2000	
#4	#1 AND #2 AND #3	571

The 571 studies which resulted from the search were further limited to:

- European publications: 350 hits
- Language in English or German: 310 hits
- Source type Journals: 305 hits

The remaining 305 studies were screened by reviewing the titles and abstracts to identify potentially relevant studies which match the topic (Table 2). After screening 13 studies remained which potentially refer to the topic of ambulances and helicopters. Of these 12 studies 10 studies were freely available for inclusion in the synopsis. After reading 9 studies remained as eligible for the synopsis as one study did not deliver any relevant results. Of these 9 studies 6 studies could be coded in the Decision support system.

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Table 2: total number of eligible studies

Total number of studies screened (title and abstract)	305
Potentially relevant studies after screening	12
Freely available studies	10
Eligible papers after reading	9

Eligible Studies from literature search:

Andruszkow, H.a d , Lefering, R.b , Frink, M.c , Mommsen, P.d , Zeckey, C.d , Rahe, K.d , Krettek, C.d , Hildebrand, F.a: "Survival benefit of helicopter emergency medical services compared to ground emergency medical services in traumatized patients". (2013) *Critical Care*, 17 (3), art. no. R124

Lackner, C.K.a , Bielmeier, S.a b , Burghofer, K.a: "Emergency care for traffic accidents in Bavaria: Current process analysis depending on hospital and emergency service structures". (2010) *Unfallchirurg*, 113 (3), pp. 183-194

McQueen, C.a , Smyth, M.a , Fisher, J.b , Perkins, G.a: "Does the use of dedicated dispatch criteria by Emergency Medical Services optimise appropriate allocation of advanced care resources in cases of high severity trauma? A systematic review". (2015) *Injury*, 46 (7), pp. 1197-1206

McQueen, C.a , Nutbeam, T.a , Crombie, N.a , Lecky, F.be , Lawrence, T.b , Hathaway, K.c , Wheaton, S.c: "Enhanced care team response to incidents involving major trauma at night: Are helicopters the answer?" (2015) *Injury*, 46 (7), pp. 1262-1269

Melton, J.T.K.a b , Jain, S.a , Kendrick, B.a , Deo, S.D.a: "Helicopter Emergency Ambulance Service (HEAS) transfer: An analysis of trauma patient case-mix, injury severity and outcome". (2007) *Annals of the Royal College of Surgeons of England*, 89 (5), pp. 513-516

Nakstad, A.R., Bjelland, B., Sandberg, M.: „ Medical emergency motorcycle--is it useful in a Scandinavian Emergency Medical Service?". (2009) *Scandinavian journal of trauma, resuscitation and emergency medicine*, 17, p. 9.

Schweigkofler, U., Reimertz, C., Lefering, R., Hoffmann, R., TraumaRegister DGU®: „ Importance of air ambulances for the care of the severely injured". (2015) *Der Unfallchirurg*, 118 (3), pp. 240-244

Schweigkofler, U.a , Braun, J.b , Schlechtriemen, T.c , Hoffmann, R.a , Lefering, R.d , Reimertz, C.a: "Significance of Helicopter Emergency Medical Service in Prehospital Trauma Care". (2015) *Zeitschrift fur Orthopadie und Unfallchirurgie*, 153 (4), pp. 387-391

Westhoff, J.a b c , Kröner, C.a b , Meller, R.a b , Schreiber, T.a b , Zech, S.a b , Hubrich, V.b , Krettek, C.a b: "Entrapped motorists and air rescue services. Analysis of tactical rescue approach, rescue techniques, and emergency medical services illustrated by a helicopter emergency medical service" (2008) *Unfallchirurg*, 111 (3), pp. 155-161