

Emergency Medical Care in case of traffic accidents in Bavaria: Actual process analysis in reference to clinical and rescue service structures

C. K. Lackner*, S. Bielmeier**,** and K. Burghofer*

* Institut für Notfallmedizin und Medizinmanagement (INM), Klinikum der Universität München,
Schillerstr. 53, 80336 München, Germany

** Institut für Wirtschaftsgeographie, Universität Regensburg, Universitätsstraße 31, 93053 Regensburg, Germany

Abstract

A change emerges in hospital landscape due to health political measures, which in consequence also influences the pre-clinical medical care of emergencies. The main focus of this study was to gather information about emergency medical care after traffic accidents on the basis of data of Bavarian emergency medical services. In Bavaria, in 2006 it was necessary to call an emergency doctor in the case of 14.261 traffic accidents. Predominantly the patients were provided by land-based life saving appliances, air rescue services were only applied in 19.1 % of the cases. 47.6 % of patients being involved in a traffic accident were transported into a primary health care hospital. A prehospital interval of more than 60 minutes was calculated in 20 % of emergency care. 96.2 % of the patients were transported to hospitals of tertiary or maximum supply by air rescue services. The life saving appliances' readiness for action is however restricted to daylight. A further limitation appeared for routine office hours in hospitals: Only 36.7 % of accidents occurred in this time frame. An increase of hospitalizations in clinics of maximum supply appeared from 2002 until 2006 while simultaneously the prehospital period was extended. To assure a sufficient medical care of seriously injured persons further on, a fulltime and area-wide expostulation of efficient facilities is necessary. For this purpose it is necessary to establish regional trauma networks as well as emergency medical service at night time. Beyond that, a cost efficient compensation of the structural, personnel and logistic expenses has to be assured.

BACKGROUND

In the Federal Republic of Germany 422.337 persons, injured in consequence of a traffic accident, were registered in 2006. In most instances car owners were affected. The survival rate for traffic accidents could be increased as result of medical progress, due to improvements of emergency medical services and also because the active and passive protection systems in cars could be raised continuously. Many patients, who earlier would have died at the place of accident, now reach the clinic as seriously injured persons. It is crucial for the medical treatment result to be successful in taking the patients quickly to an adequately equipped hospital preferably within the first 60 minutes after the accident. In this context the terminus "golden hour disease" is used.

By the introduction of DRG-based payment for hospital services, a process of change in the hospital landscape was initiated. Publications mention the reduction of hospital locations as well as the privatization of hospitals and the tendency to establish centres of excellence as possible consequences. In addition, a specialization in most profitable hospital services as well as a negligence of emergency medical care and a reduction of stand-by duty, bed capacity and length of stay. Furthermore, an insufficient coverage of the treatment expenses caused by severely injured persons, by persons with a long residence time, by emergencies, as well as by relocated patients can be stated.

In regard to the pre-clinical medical care, the following changes can be expected due to close-downs of hospitals and emphases on centres of excellence: a reduction of emergency headquarters, an extension of length of transport, an increased deployment of vehicles and of emergency physicians and their assistants and also an accumulation of the secondary transports. Sufficient medical care of emergencies close to their residence is made difficult because many small-sized hospitals are not able to maintain emergency medical care to the full extent as costs are not covered adequately.

So far there is no analytical study which determines emergency medical care after traffic accidents in reference to clinical and rescue service structures. This study was performed to determine emergency medical care in case of severe traffic accidents in Bavaria.

METHODS

Statistical database of this review were data of all emergency medical care services carried out by all 26 Bavarian rescue coordination centres. The analysis of the actual emergency services after severe traffic accidents resulted from data of 2002 until 2006. For the analysis of process of change data material from

2002 until 2006 was taken as a basis. For the registration of the processing parameters starting from the incoming emergency call until the return of the life saving appliances to their headquarters, Bavarian rescue coordination centres apply disposition programmes like ARLISplus and ELDIS. The Institute for Emergency Medicine and Management in Medicine, INM (attached to the clinical centre of the university of Munich), prepares, analyses and combines the correspondent data with further data (data from the central clearing house for emergency medical services in Bavaria, from private health care providers and from providers for acute transports and air rescue services). The data as a whole allow a complete illustration of the entire emergency medical care events.

All traffic accidents were extracted from the complete data pool. The next step of the present study was a restriction on traffic accidents, which made at least one emergency doctor necessary. In the analysed period (01.01.2002 until 31.12.2006) 77.458 traffic accidents with the need of an emergency doctor and 120.835 traffic accidents without that were documented. The present study classifies the first group as “severe”, the second group as “light” accidents. The analysis of the study is based on the database management system Access TM and on the statistic and analytic software SPSS. The further data preparation was done by the spreadsheet program Excel as well as by the geographical information system ArcGIS, produced by ESRI.

RESULTS

Geographical and temporal spreading of severe traffic accidents in 2006

In 2006, 14.261 severe traffic accidents with the need of emergency care occurred in Bavaria.

Within the 25 cities in Bavaria enjoying county status, 2.834 (19.9 %) accidents were documented, within the 71 administrative districts, 11.427 accidents (80.1 %) were documented. The capital cities Munich (462), Nuremberg (422), Augsburg (283) and Regensburg (226) as well as the administrative districts Passau (340) and Traunstein had a comparatively high accident volume. A relatively small number of severe traffic accidents were documented in the administrative districts Kronach (79) and Lichtenfels (77) as well as in the city Memmingen (36). As expected, the quantity of severe traffic accidents correlated significantly positive with the population figure of the respective regional corporation ($r=0,708$; $p 0,001$).

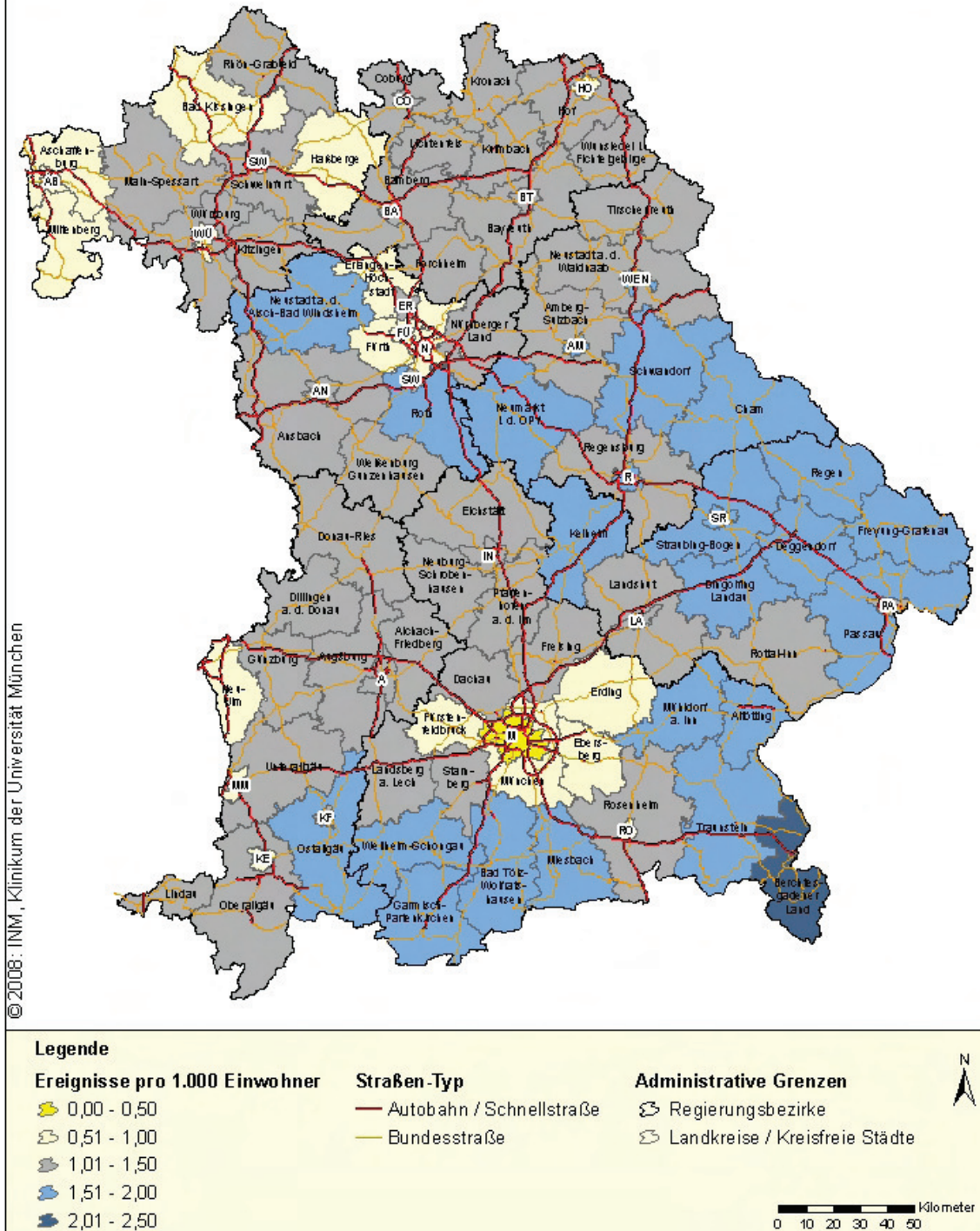
In Weiden, (1.92) and Regensburg (1.75), both cities enjoying county status, as well as in the administrative districts Berchtesgadener Land (2.18), Bad Tölz – Wolfratshausen (1,96) and Traunstein (1,90), the number of severe traffic accidents per 1.000 habitants was comparatively high. Most of the traffic accidents happened indeed in Munich, but related to the population figure, the statistical value of 0.37 pro 1.000 inhabitants had though the lowermost level. Analogically, the administrative district of Munich with a population of 306.182 inhabitants and a number of 171 severe traffic accidents had a relatively low statistical value of 0.56 accidents pro 1.000 inhabitants. The administrative districts Fürstenfeldbruck and Miltenberg also showed a low statistical value of 0.71, respectively 0.73 pro 1.000 inhabitants.

A concentration of the administrative districts and towns of county status, which had high statistical values, predominantly appeared in the more rural regions in the South and East of Bavaria. In densely populated areas like Munich, Nuremberg and Neu-Ulm as well as in such areas in Unterfranken, the number of severe traffic accidents pro 1.000 inhabitants was on a lower level (cp. map 1).

A further step in 2006 was to analyse the severe traffic accidents, documented in the Bavarian rescue coordination centres, in regard to their temporal disposition (illustration 1).

Karte 1: Anzahl der schweren Verkehrsunfälle pro 1.000 Einwohner auf Ebene der bayerischen Landkreise und kreisfreien Städte im Jahr 2006

Zeitraum: 01.01.2006 - 31.12.2006 - Landkreise / Kreisfreie Städte - N = 14.261 (Ereignisse)



Map 1: number of severe traffic accidents pro 1.000 inhabitants based on data of Bavarian administrative districts and independent cities in 2006 (N = 14.261 inhabitants)

A further step in 2006 was to analyse severe traffic accidents, documented in the Bavarian rescue coordination centres, with regard to their temporal disposition (illustration 1).

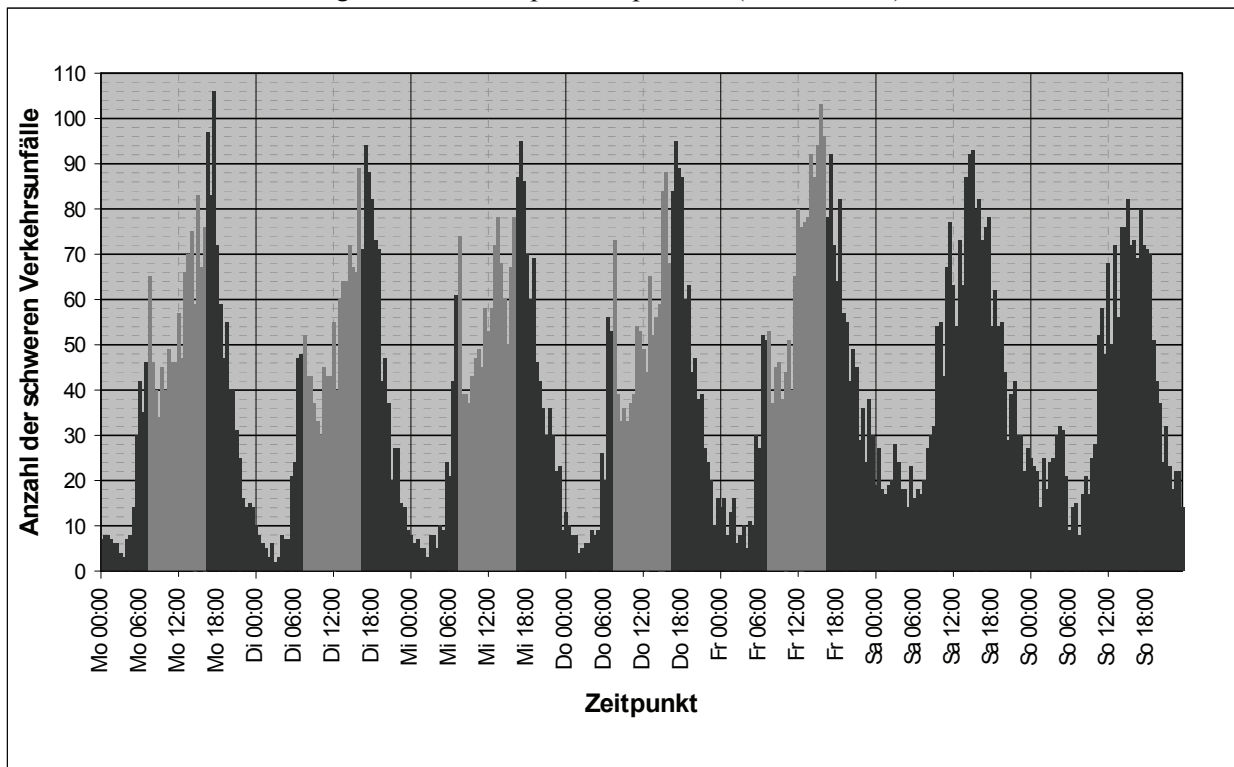


Illustration 1: Temporal disposition of accidents during the course of day and week in Bavaria in 2006 (N=14.003 events; N=258 events without sufficient documentation of time)

Illustration 1 shows a maximum in the course of the day between 05.00 and 06.00 p.m.

All days of the week compared with each other show that most traffic accidents happen on a Friday. Furthermore, an increase of severe traffic accidents during night-time can be proved for the nights from Friday to Saturday and from Saturday to Sunday.

In addition, a categorization was made to the effect whether severe traffic accidents occurred within routine office hours or off-peak. The period between 7.30 a.m. and 5.30 p.m. from Monday until Friday was defined as routine office hours (cp. illustration 2).

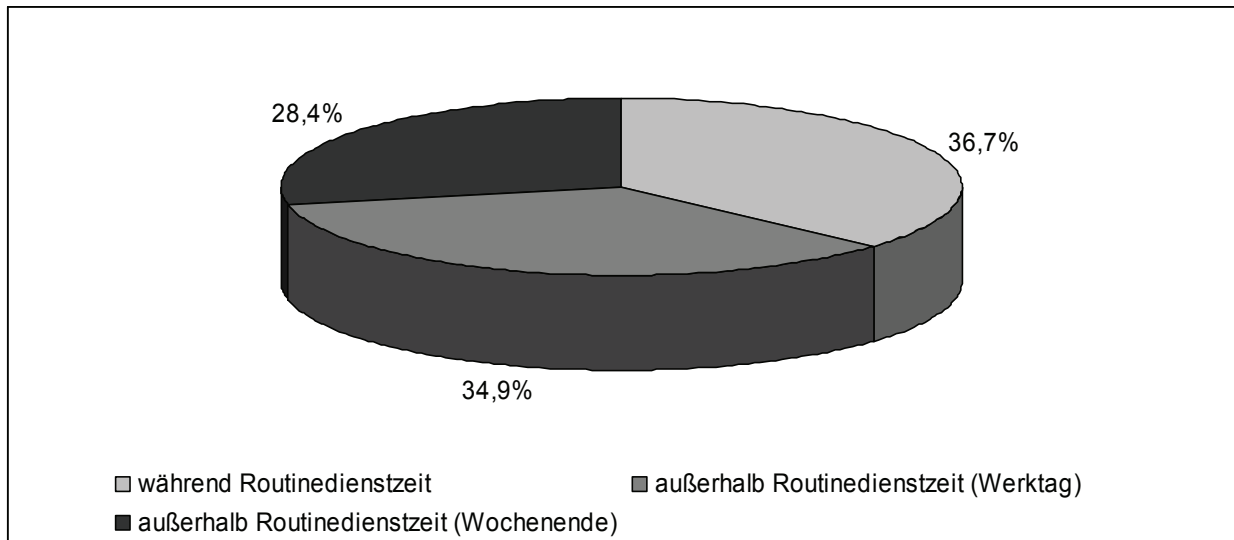


Illustration 2: percentage of events during and beyond routine office hours in hospitals in Bavaria in 2006 (N=14.003 events; N=258 events without any documentation of time)

36.7 % of all severe accidents in Bavaria happened during routine office hours, when all special departments in the clinics were well-staffed. Outside routine office hours, special departments are normally not occupied, which means that the clinic staff, which is on call, has to be ordered to the hospital in case of emergency. On weekdays from Monday until Friday 34.9 % of the accidents occurred during leisure and night time, off routine office hours. Further 28.4 % were registered on the weekends. Altogether 63.3 % of severe traffic accidents occurred during availability time of the clinics.

Target hospitals

The Bavarian rescue service had to hospitalize 17.146 patients being injured in 14.261 traffic accidents documented in 2006. If these patient transports are differentiated with reference to the care level of the targeted hospital, it appears that the majority of the patients (47.6 %) after a severe traffic accident were taken to a hospital of basic medical care. 31.6 % of patients were hospitalized in tertiary care clinics and further 20.4 % were taken to hospitals of maximum care level. The decision to pick a hospital of a higher care level proved to be independent of the time of the accident (p=0,284).

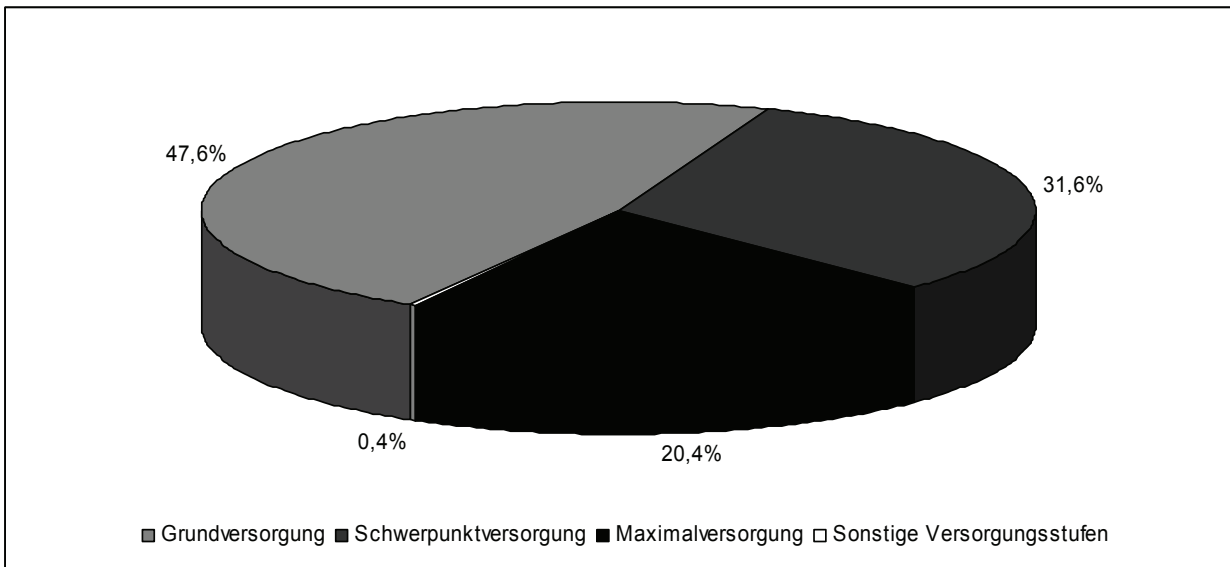


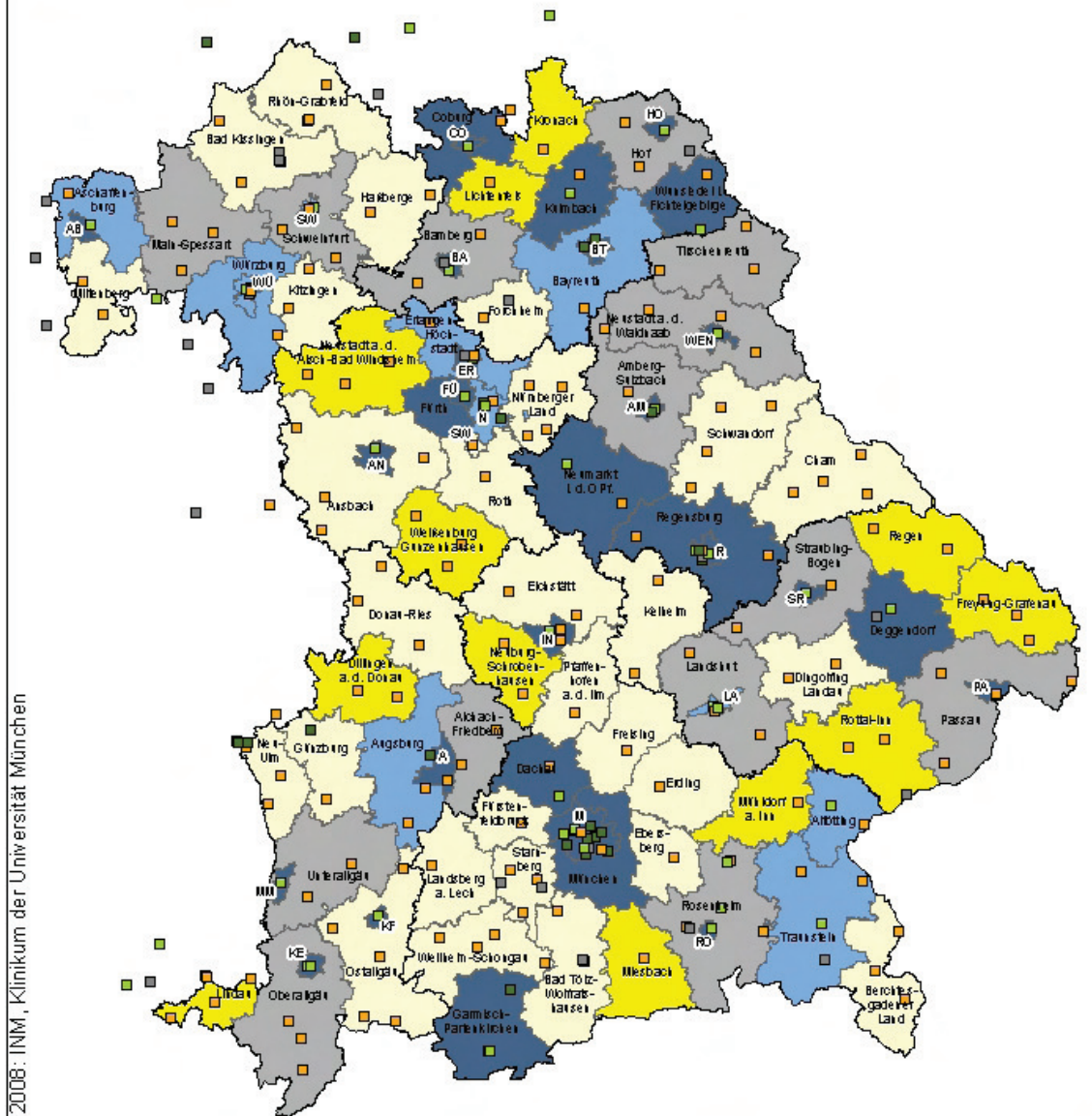
Illustration 3: Medical care levels of selected target hospitals in case of severe traffic accidents in Bavaria in 2006 (N=17.146 transports)

Hospitals with less than 100 hospital admissions were at a rate of 64.3 % facilities of basic medical care. In contrast, clinics with at least 100 hospital admissions after severe traffic accidents were tertiary care clinics or maximum care providers. Hospitals of a superior medical care level normally had a higher quantity of hospital admissions ($p < 0.001$).

Map 2 illustrates the rate of patients per administrative district and per independent city, who were transported in a clinic of tertiary or maximum care. As an average value it could be proved that in independent cities 85.4 % of tertiary or maximum medical care hospitals were chosen, for the administrative districts a value of only 44.7 % arises.

Karte 2: Anteil der in eine Klinik der Schwerpunkt- bzw. Maximalversorgung transportierten Patienten im Jahr 2006

Zeitraum: 01.01.2006 - 31.12.2006 - Landkreise / Kreisfreie Städte - N = 17.146 (Transporte)



© 2008: INM, Klinikum der Universität München

Legende

Anteil der Patienten

- 0 - 20 Prozent
- 21 - 40 Prozent
- 41 - 60 Prozent
- 61 - 80 Prozent
- 81 - 100 Prozent

Klinik, mit Versorgungsstufe

- Grundversorgung
- Schwerpunktversorgung
- Maximalversorgung
- Sonstige Krankenhäuser

Administrative Grenzen

- Regierungsbezirke
- Landkreise / Kreisfreie Städte

Kilometer
0 10 20 30 40 50

Map 2: Number of patients being transported to a hospital of tertiary or maximum care in 2006

Involved life saving appliances

In Bavaria in 2006 averaged 3.1 operating resources and life saving appliances were disposed in case of a severe traffic accident. These were primarily land-based life saving appliances: in 97.6 % of the cases at least one ambulance vehicle (RTW) was involved in emergency care, in 84.2 % a rapid response unit (NEF) was needed. Air rescue services (RTH/ITH), which were applied in 19.1 % of the cases followed by far. The least share of 3.8 % could be determined for the emergency ambulance (NAW). Clear differences appear when air rescue services are compared to land based services concerning their designated hospitals and their medical care level (cp. illustration 4).

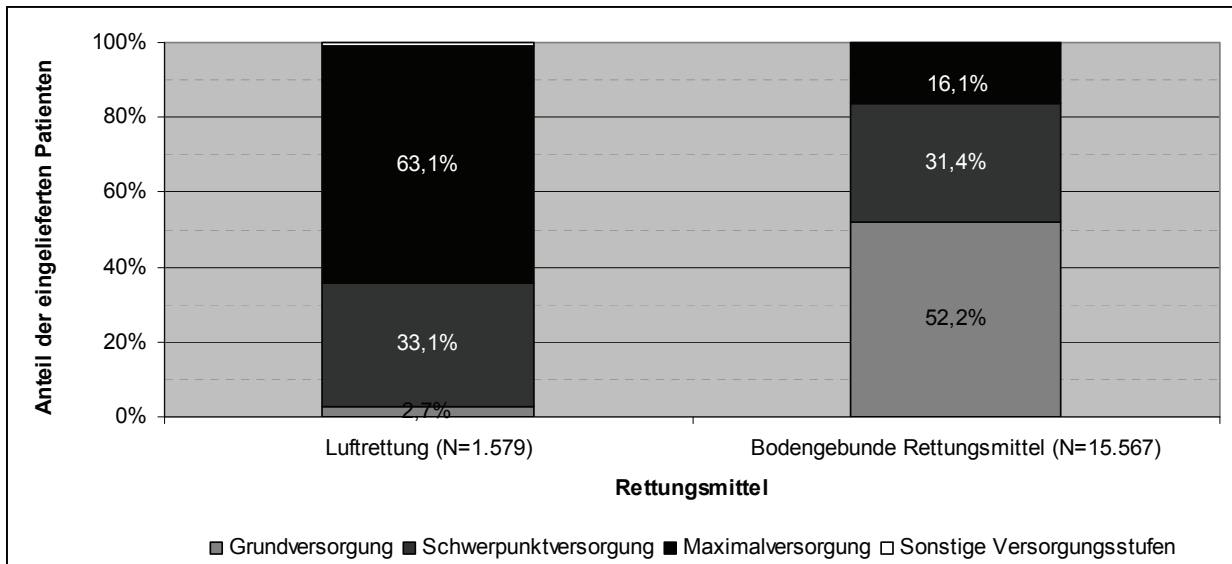


Illustration 4: medical care levels of target hospitals by transports with land based life saving appliances and air rescue services in Bavaria in 2006

96.2 % of patients were transported to hospitals of tertiary or maximum care by air rescue services. Only 2.7 % of the patients were hospitalized in clinics of primary care. 47.5 % of patients were taken to clinics of both superior levels, tertiary and maximum care. By land-based life saving appliances only 47.5 % of patients were taken to hospitals of superior levels, while 52.2 % were hospitalized in primary health care clinics. According to the analysis, air rescue services had a clear preference for hospitals of superior levels ($p < 0,001$).

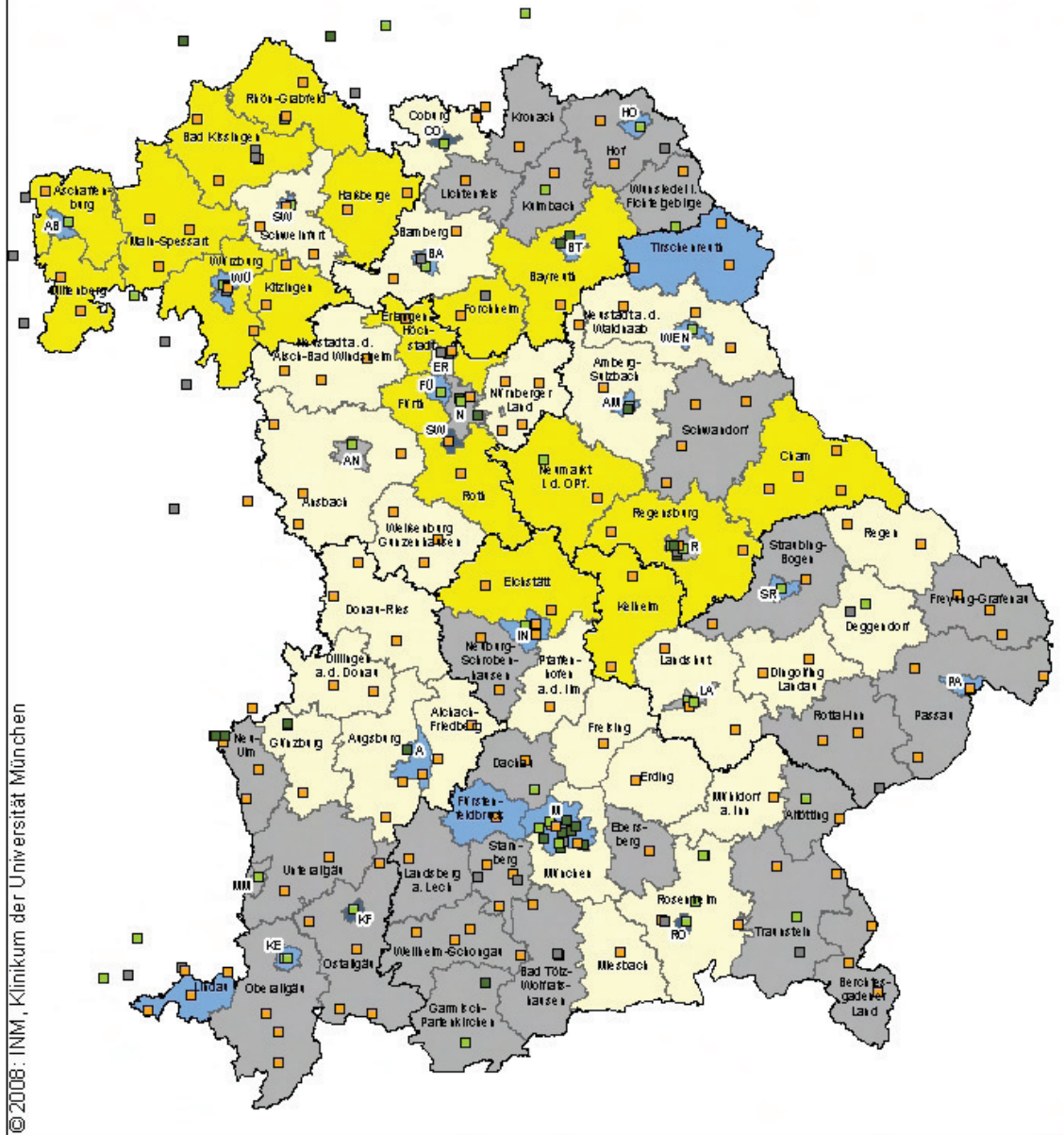
Pre-clinical time – compliance with the golden hour

Averaged pre-clinical time based on Bavarian rescue services data, was in 2006 at an average of 46 minutes and 22 seconds. The result for the independent cities was an average value of 38 minutes and 18 seconds, for the administrative districts a value of 48 minutes and 22 seconds ($p < 0.001$).

The request for compliance with the “golden hour” is only fulfilled in 80.0 % of the cases. In 20 % of the cases, patients were hospitalized more than 60 minutes after emergency call. The independent cities had an average value of 91.7 %, the administrative districts of 77.1 % (map 3).

Karte 3: Anteil der innerhalb von 60 Minuten nach Notrufeingang eingelieferten Patienten im Jahr 2006

Zeitraum: 01.01.2006 - 31.12.2006 - Landkreise / Kreisfreie Städte - N = 14.006 (Transporte)



© 2008: INM, Klinikum der Universität München

Legende

Anteil der Patienten	Klinik, mit Versorgungsstufe	Administrative Grenzen
61 - 70 Prozent	Grundversorgung	Regierungsbezirke
71 - 80 Prozent	Schwerpunktversorgung	Landkreise / Kreisfreie Städte
81 - 90 Prozent	Maximalversorgung	
91 - 99 Prozent	Sonstige Krankenhäuser	
100 Prozent		

N

0 10 20 30 40 50 Kilometer

Map 3: number of patients being hospitalized in 2006 within 60 minutes after emergency call

Development from 2002 until 2006

In the period from 2002 until 2006, the total number of traffic accidents provided by Bavarian rescue services, was reduced from 42.130 events in 2002 to 37.715 events in 2006 (rate of 10.5%). The number of light road traffic accidents decreased in this period about 5.0 %, the number of severe traffic accidents decreased about 18.3 %. Thereby the relation changed for the benefit of easy traffic accidents from 58.6 % in 2002 to 62.2 % in 2006. For the independent cities and the administrative districts a decrease of severe traffic accidents in 90 regional corporations and an increase in 6 regional corporations occurred.

In 2002, altogether 22.607 patients were transported to 299 different hospitals after severe traffic accident. In 2006, 17.146 patient transports after traffic accidents to 278 different hospitals were documented.

The number of patients being transported to hospitals of superior care levels has increased continuously since 2002 (cp. illustration 5). In comparison with 2002, maximum care hospitals have documented an increase of 4.3 %, tertiary care clinics an increase of 1.3 %.

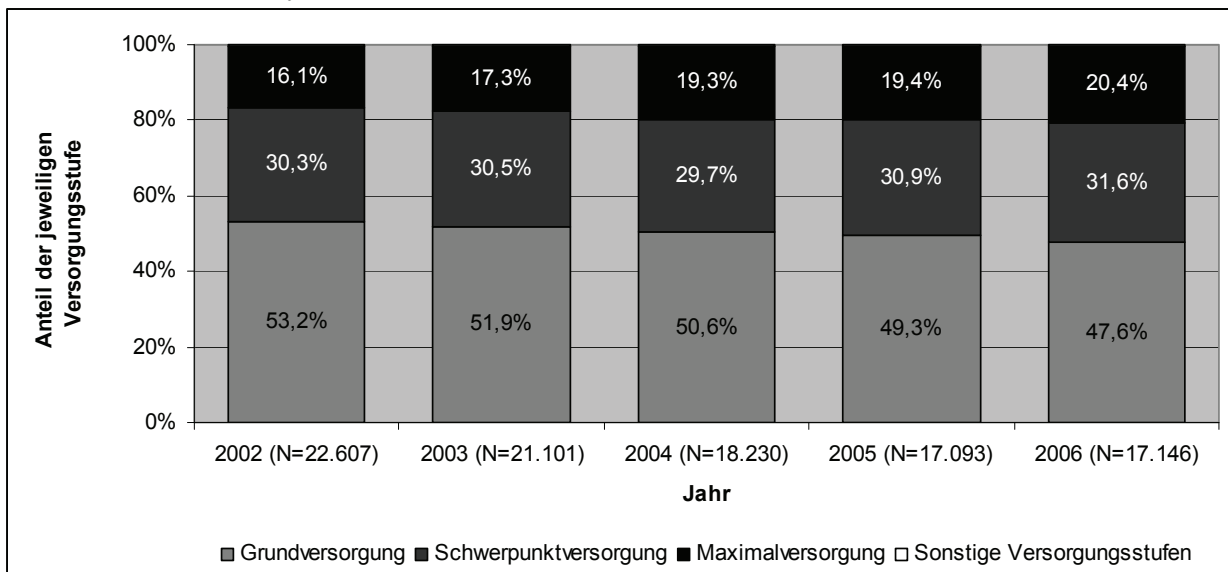


Illustration 5: Change of shares of care levels in target hospitals from 2002 until 2006

In 2006, a transport from place of accident to a target hospital after traffic accident in Bavaria took on average 12 minutes and 36 seconds, which means that this period is 50 seconds longer than in 2002. In the independent cities of Bavaria, duration of transport had an increase of 37 seconds, in the administrative districts an increase of 53 seconds.

In the same period, the prehospital interval starting from the incoming emergency call until the arrival at the target hospital was extended for 2 minutes and 14 seconds in the independent cities, in the administrative districts of Bavaria for averaged 1 minute and 55 seconds.

Discussion

Extensive effects on clinical structures and as a consequence also on the rescue services are induced by the implementation of the health care reform as well as by the gradual initiation of a case-based payment system for hospital services since 2003. The reorganization of the hospital landscape takes also a considerable influence on trauma management system in Germany. Concerning area-wide presence, it can be assumed that regulatory and financial framework induces a reduction of about one third of the facilities being involved in trauma management. These developments mean a special challenge for prehospital care, because –nevertheless- the system has to cope with the postulation for compliance with the “golden hour” rule. The efficiency analysis of the described effects on hospital landscape and pre-clinical care resulted in this study on the basis of data of the Bavarian emergency medical services from 2002 until 2006. The evaluations consider the collective of severe traffic accidents and are not conferrable to other emergency situations.

The available study was focused on traffic accidents with the need of emergency care. One has to bear in mind, however, that emergency doctors sometimes are being called because of an imprecise emergency call, although the patient’s state of health doesn’t require medical care.

These false assignments couldn't be excluded from the analysis. The individual disposition behaviour of the staff of the rescue coordination centre can also be a decisive factor for an emergency doctor's call. Although the Bavarian indication checklist regulates in which cases the rescue service team has to be supported by an emergency physician, this decision is nevertheless determined by experience, medical and tactical considerations and by subjective interpretation of the emergency call.

Geographical and temporal spreading of the road traffic accidents

In 2006, 11.427 severe traffic accidents were registered in the Bavarian administrative counties (population of 9.0 million people). This signifies 1.28 severe traffic accidents pro 1.000 habitants. In the independent cities with a population of 3.5 million habitants and 2.834 severe traffic accidents, we have 0.81 events per 1.000 inhabitants. For this reason 80.1 % of severe traffic accidents occurred in the administrative districts and only 19.9 % occurred in the independent cities of Bavaria. These results are in accordance with data of the Bavarian State Office for statistics and data handling [17], which prove that severe traffic accidents occur frequently on country roads. Reasons for that are a stringent traffic regulation and a slowing down of maximum speed within the cities as well as a disproportionate traffic volume. Furthermore different types of roads as well as touristy influences have to be considered. As expected, the number of severe traffic accidents correlated in the present study positively with the number of inhabitants per Regional Corporation. Here, the independent cities Munich and Nuremberg were an exception, because for these cities a far higher number of severe accidents could have been expected.

The evaluation of the temporal spreading proved that the daily maxima on weekdays from Monday until Thursday came along with usual working time, were thus related to rush-hour traffic. The absolute maximum was registered between 5:00 p.m. and 6:00 p.m. and lies therefore beyond routine office hours of hospitals, which are also called standardized working hours and contain the period from Monday until Friday from 07:30 a.m. until 5:30 p.m.

During that period, only 36.7 % of severe traffic accidents occurred, while 63.3 % occurred beyond these standardized working hours. Furthermore, one has to bear in mind, that approximately one third of all accidents and hospitalizations took place at the weekend which lies to the full extent beyond standardized working hours. It is possible that severely injured patients, who are taken to hospital beyond routine office hours, suffer damages because specialized units are not staffed and further clinical therapy is not possible because the doctors on duty had to be ordered to the hospital at first [18]. An efficient pre-clinical medical care which has to be continued seamlessly in the clinic is essential for the prognosis of the patients. The committal of the patient from emergency physician to the clinic should be flawless and induce a rapid admission diagnose and assignment to the adequate specialized unit [19]. An extension of the standardized working hours would be desirable, but seems to be almost impossible because of economic factors. Therefore the establishment of interdisciplinary full-time emergency units would be a reasonable and adequate alternative. The implementation would cause a permanent organizational performance structure with a permanent staff of doctors, carers and nurses from anaesthetics, surgery and internal medicine as well as from neurology if necessary. To guarantee an area-wide supply all over Bavaria, 300 interdisciplinary emergency units would be necessary. These emergency units should be regarded as independent units within the clinic [19]. By these central hand-over points delays could be avoided and the availability of the resources of the rescue service could be re-established in very short time [20].

Life saving appliances and target hospitals

For the increase of survival chances and a minimization of the effects of the injury, it is ideal if patients are transported into a local clinic of tertiary or maximum care with sufficient capacity for definitive medical treatment [5, 21-24]. Because of the dominating clinic structures this is not always possible. The evaluations proved that 47.6 % of patients in 2006 were transported to a primary health care clinic, 31.6 % to a hospital of tertiary care and 20.4 % to a hospital of maximum care. An adequate medical treatment of most severely injured persons was possibly therefore not given, because nearly half of the patients were not hospitalized in a clinic of the two superior care levels. There were also significant differences between the independent cities and the administrative districts of Bavaria: persons being injured within the district of an independent city were transported to a hospital of tertiary or maximum care in 85.4 % of the cases, within the administrative districts this value is 44.7 %. Furthermore, the analysis demonstrated that in 82.6 % of the cases, clinics with less than 100 hospitalizations in 2006 were clinics of primary health care or of other medical care levels. In contrast, clinics with more than 100 hospitalizations were tertiary or maximum care providers at a rate of 66.7 %. That means that primary health care hospitals frequently had a slightly falling number of injured patients and as an after-effect had less experience and also a shortfall in medical equipment.

In the administrative districts rescue services are more frequently forced to decide between a longer duration of transport to a suitable clinic and a shorter duration of transport to a primary health care hospital. In this context enormous differences could be proved between air rescue services and land-based appliances: In 96.2 % of the cases the injured patients were taken to a tertiary or maximum care hospital by rescue helicopters, while only 47.5 % of the patients being transported by land-based rescue service appliances were taken to those facilities. Therefore, this study could also confirm the clear advantages of air rescue services on the choice of the designated hospital [22, 25]. In this context it has to be considered that regular flight disposition of air rescue services is limited to daylight interval at the moment. Analyses of the nationwide trauma register published by the German College of Trauma Surgery (DGU) proved however that the accident severity does not differ essentially during day- and night time. Even if the commitment of a flying ambulance would be reasonable from the medical point of view, severely injured patients have to be transported by land-based life saving appliances at night because air rescue services were not available. The available collected data showed that for the medical care of the patients primarily land-based life saving appliances had to be chosen. Air rescue service was only ordered in 19.1 % of severe traffic accidents. Besides the use of appropriate life saving appliances, an adequate medical treatment of the patients and the choice of the suitable clinic, the compliance with the "golden hour", is a further essential factor to influence the outcome of severely injured patients [3, 19]. Invasive therapy measures in the first 30 to 60 minutes after the trauma can contribute to an important decrease of the lethality- and morbidity rate, so it should be aspired to hospitalize the patients within one hour after the accident has happened. The longer the pre-clinical interval extends, the more one has to assume a prolongation of the period a patient has to remain in the intensive care unit. Furthermore there is danger of an extended rehabilitation period or of permanent secondary damages.

The analysis of the individual patient transports could prove deficiencies in the medical emergency care with respect to compliance with the "golden hour" norm. 20 % of the transported patients couldn't be taken to hospital within the demanded 60 minutes. These drawbacks could mainly be proved for the regional corporations which border directly to independent cities which in turn have facilities of maximum care. In this context, a possible drawback because of an extended pre-clinical time was subordinated to the advantages of a hospital of superior care level. Altogether, 91.7 % of patients being injured within the district of independent cities were transported to a hospital within a maximum period of 60 minutes; analogous value in Bavarian administrative districts was 77.1 %.

Changes of clinical structures

The German Hospital Federation anticipates nationwide a closure of 330 hospitals (about 15 % of all hospitals) [5]. Besides that, the introduction of the DRG-system induces an increasing specialization of the clinics in preferably profitable areas. Based on the DRG-system, numerous studies show that it can not be worked therapeutically with especially severe injured patients in a cost-covering way [26]. Cost calculations based on G-DRG Version 2005 show a shortfall between 3.500 and 5.000 € per severe injured patient in dependence on the annual rate of treatment per facility [5]. Thereby primarily smaller clinics won't have the possibility in future to maintain the acute medical care to a full extent. Emerging localization and specialization tendencies on centres of excellence will have an impact on local emergency care [8, 11, and 20]. On the other hand, these specializations are also an advantage if increased quality in medical care can be achieved. The establishment of centres of excellence and the localization of complex performances are seen as a target of health policy. The number of smaller and less efficient hospitals shall be dramatically reduced by this [9]. The present analysis proves that first effects can already be pictured empirically. By the analysis of the care levels of all target hospitals between 2002 and 2006 an increase of hospitalizations in clinics of tertiary and maximum care could be proved. It must be considered, however, that in 2006 nearly every second patient was taken to a primary health care hospital after a severe traffic accident. Especially in rural regions which do not own a hospital of maximum care, it has to be decided frequently between the quickest possible transport to a nearby hospital of a lower care level or a longer transport to a hospital of superior care level. This problem is being complicated additionally by changes in the hospital landscape, because the rescue services in the concerned areas are forced to cover longer distances to reach more suitable clinics [20]. Thereby resulting transport times have the effect that patients are exposed to greater dangers and emergency physicians are bounded to rescue missions for a longer period because they normally have to accompany the transport. The search for a suitable transport target is going to be more difficult in future because hospitals near to living areas will cease to exist ([8, 10, and 11]. This study could prove an increase of pre-clinical time of averaged 2 minutes and 15 seconds in the district of independent cities and about 1 minute and 52 seconds in the Bavarian administrative districts. This increase also signifies an extended deployment to rescue mission. 80 % of the injured patients were hospitalized in the designated hospital within one hour after the emergency call was answered in the rescue coordination centre. To avoid life-threatening consequences by the accident, there is only a very limited time slot for seriously injured patients. Therefore, the demand for compliance with the "golden hour" rule is compulsory. To recognize and balance possible structural deficiencies, there is a need of continual scientific evaluation of the present changes.

Conclusion

To guarantee medical care of seriously injured patients at the highest level in future and within the framework of Trauma networks D, a close interaction between facilities of different medical care levels becomes more important [8, 27]. For an efficient coordination and the ideal use of available resources, an intensive cooperation between facilities of primary, tertiary and maximum care becomes much more significant. Furthermore, a cost-suitable compensation of the structural and logistic expenses as well as of personnel costs resulting from treatment of seriously injured persons has to be assured [5]. This implicates also the remuneration of emergency doctors. A further strategic concept concerns the extension of the office hours of air rescue services, which, especially in regions lacking in infrastructure, offer advantages because of higher speed and because they come along with a larger deployable radius. The advantage of air rescue services is the free choice of the target hospital. The transformation process of public health system, initiated in the last years, has a gradual impact on pre-clinical medicine and requires continuous scientific support.

REFERENCES

1. C Lackner, K Burghofer, M Lazarovici, E Stolpe, W Mutschler: Verletzungsmuster verunfallter PKW-Insassen mit Polytrauma. *Notfall und Rettungsmedizin* 2007, 10:23-31.
2. C Peek-Asa, C Zwerling: Role of environmental interventions in injury control and prevention. *Epidemiologic Reviews* 2003, 25:77-89.
3. Deutsche Gesellschaft für Unfallchirurgie: Weißbuch Schwerverletzten-Versorgung: Empfehlungen zur Struktur, Organisation und Ausstattung der Schwerverletzten-Versorgung in der Bundesrepublik Deutschland. <http://www.dgu-online.de/pdf/unfallchirurgie/weissbuch/weissbuch.pdf> (Stand: 20.08.2007).
4. C Kühne, S Ruchholtz, S Sauerland, C Waydhas, D Nast-Kolb: Personelle und strukturelle Voraussetzungen der Schockraumbehandlung Polytraumatisierter. Eine systematische Literaturübersicht. *Der Unfallchirurg* 2004, 107:851-861.
5. Deutsche Gesellschaft für Unfallchirurgie: Flächendeckende Akut-Schwerverletzten-Versorgung in der Bundesrepublik Deutschland unter DRG - Fallpauschalen - Entgelt - Bedingungen. Eine kritische Analyse mit Lösungsvorschlägen. <http://www.dgu-online.de/de/drg/archiv/index.jsp> (Stand: 12.08.2007).
6. T Schlechtriemen, B Dirks, C Lackner, H Moecke, M Ruppert, D Stratmann, K Altemeyer: Defizite in der Notfallversorgung - gute Konzepte schlecht umgesetzt? 9. Leinsweiler Gespräche der agsw e. V. in Zusammenarbeit mit INM, IfN und BAND, 2. - 3. Juli 2004. *Notfall und Rettungsmedizin* 2004, 7:580-588.
7. T Schlechtriemen, C Lackner, H Moecke, D Stratmann, K Altemeyer: Flächendeckende Notfallversorgung - Sicherstellung mit welchen Strukturen? - 8. Leinsweiler Gespräche der agsw e. V. in Zusammenarbeit mit INM, IfN und BAND, 4. - 5. Juli 2003. *Der Notarzt* 2004, 20:20-29.
8. H Siebert, S Ruchholtz: Projekt TraumaNetzwerk D DGU. *Trauma und Berufskrankheit* 2007, 9:265-270.
9. A Billing, M Thalhammer, H Hornung, HJ Eißner, K-W Jauch, G Auburger: DRG und Krankenhäuser der Maximalversorgung: Ausmaß und Ursachen der Unterfinanzierung. <http://www.dgu-online.de/pdf/drg/unterfinanzierung.pdf> (Stand: 10.08.2007).
10. Bundesvereinigung der Arbeitsgemeinschaften der Notärzte Deutschlands (BAND): Stellungnahme der BAND, DIVI und der Ständigen Konferenz für den Rettungsdienst zu Auswirkungen der DRG auf die präklinische Akutversorgung. *Der Notarzt* 2004, 20:89.
11. D Stratmann, P Sefrin, S Wirtz, A Bartsch, T Rosolski: Stellungnahme zu aktuellen Problemen des Notarztdienstes (Ärztmangel, Arbeitszeitgesetz, DRG). *Der Notarzt* 2004, 20:90-93.
12. M Grotz, T Schwermann, R Lefering, S Ruchholtz, J Graf v.d. Schulenburg, C Krettek, H Pape: DRG Entlohnung beim Polytrauma. *Der Unfallchirurg* 2004, 107:68-76.
13. C Kühne, S Ruchholtz, C Buschmann, J Sturm, C Lackner, A Wetzensen, B Bouillon, M Weber: Polytraumaversorgung in Deutschland. Eine Standortbestimmung. *Der Unfallchirurg* 2006, 109:357-366.
14. D Maier, M Bischoff, D Hanser, L Kinzl, E Hartwig: Analyse der Behandlungskosten polytraumatisierter Patienten unter DRG Gesichtspunkten. *Der Unfallchirurg* 2005, 108:432-442.
15. Institut für Notfallmedizin und Medizinmanagement (INM): Trend- und Strukturanalyse des Rettungsdienstes in Bayern. TRUST-Gutachten Abschlussbericht. Band I+II. http://www.inm-online.de/pdf/gutachten/trust_ab_bandII.pdf (Stand: 10.07.2007).
16. C Lackner, K Burghofer, H Moecke: Krankenhausnetzwerke im Terror- und Katastrophenfall. *Notfall und Rettungsmedizin* 2007, 10:547-549.
17. Bayerisches Landesamt für Statistik und Datenverarbeitung: Straßenverkehrsunfälle in Bayern in den Jahren 2005 und 2006. <https://www.statistik.bayern.de/veroeffentlichungen/webshop/download/H1102C%20200600/H1102C%20200600.pdf> (Stand: 07.08.2007).
18. C Bell, D Redelmeier: Mortality among patients admitted to hospitals on weekends compared with weekdays. *New England Journal of Medicine* 2001, 345:663-668.
19. T Schlechtriemen, B Dirks, C Lackner, H Moecke, D Stratmann, K Altemeyer: Die "Interdisziplinäre Notaufnahme" im Zentrum zukünftiger Notfallmedizin. *Notfall und Rettungsmedizin* 2005, 7:502-511.
20. K Burghofer, G Heller, C Lackner: Schnittstelle zwischen Rettungsdienst und Klinik. *Notfallmedizin up2date* 2006, 1:101-113.
21. M Albrech, M Bergé-Hasmann, T Heib, D Prell, D Sinclair, K Altemeyer: Qualitätskontrolle von Rettungshubschraubereinsätzen am Beispiel schwerer Schädelhirntraumen und Polytraumen. Eine retrospektive Qualitätsanalyse der präklinischen Versorgung, des klinischen Verlaufs und des Outcome. *Notfall und Rettungsmedizin* 2001, 4:130-139.
22. A Biewener, U Aschenbrenner, S Sauerland, H Zwipp, S Rammelt, J Sturm, AG Notfallmedizin der DGU: Einfluss von Rettungsmittel und Zielklinik auf die Letalität nach Polytrauma. *Der Unfallchirurg* 2005, 108:370-377.
23. B Celso, J Tepas, B Languard-Orban, E Pracht, L Papa, L Lottenberg, L Flint: A systematic review and meta-analysis comparing outcome of severely injured patients treated in trauma centers following the establishment of trauma systems. *Journal of trauma* 2006, 60:371-378.
24. E MacKenzie, F Rivara, G Jurkovich, A Nathens, K Frey, B Egleston, D Salkever, D Scharfstein: A national evaluation of the effect of trauma-center care on mortality. *New England Journal of Medicine* 2006, 354:366-378.
25. M Frink, C Probst, F Hildebrand, M Richter, C Hausmanninger, B Wiese, C Krettek, H Pape, AG Polytrauma der DGU: Einfluss des Transportmittels auf die Letalität bei polytraumatisierten Patienten. *Der Unfallchirurg* 2007, 110:334-340.
26. H Pape, L Mahlke, O Schäfer, C Krettek: Gedanken zu ökonomischen Aspekten der Behandlung Schwerverletzter unter den Bedingungen der DRG. *Der Unfallchirurg* 2003, 106:869-873.
27. K Wendt: Das Traumanetzwerk der Niederlande. *Der Unfallchirurg* 2008, 4:277-279.