Outcome after out-of-hospital cardiac arrest in a physician-staffed emergency medical system according to the Utstein style

Heidi L. Estner, MD,[a] Christian Günzel, MD,[b] Gjin Ndrepepa, MD,[a] Frederic William, MD,[c] Dirk Blaumeiser, MD,[b] Bernd Rupprecht, MD,[c] Gabriele Hessling, MD,[a] Isabel Deisenhofer, MD,[a] Michael A. Weber, MD,[d] Karl Wilhelm, MD,[b] Claus Schmitt, MD,[a] and Albert Schömig, MD[a] ***Munich, Dachau, Pfaffenhofen, Amperkliniken AG, and München Germany***

Background Despite a large amount of data assessing outcomes of out-of-hospital cardiac arrests (OHCAs), little information is available about physician-staffed emergency medical service (EMS) systems. The aim of our study was to investigate the impact of a physician on the outcome of patients after OHCA.

Methods This is a prospective, observational study that included 539 consecutive patients (63.9 ± 19.1 years old; 349 males) with OHCA in the community of Dachau (135,000 inhabitants) in whom resuscitation was attempted between January 2000 and January 2006 according to Utstein style. Patients were followed up to hospital discharge. The primary end point of the study was that the patients was discharged alive from hospital.

Results Of 412 patients with an OHCA, 180 (43.7%) were admitted to hospital, and 47 (11.4%) were discharged alive. Resuscitation was started by a physician in 117 (28.4%) patients, by a layperson in 118 (28.6%), or by an EMS personnel in 177 (43.0%). A total of 18 patients (18.6%) treated by physicians, 13 patients (8.0%) treated by EMS personnel (P = .02 vs treatment by physician), and 16 patients (16.5%) resuscitated by laypersons were discharged from hospital (P = .8 vs treatment by physician). In 105 patients with bystander-witnessed OHCA of cardiac origin with shockable rhythm, the discharge rate was 32.4% (n = 34). Multivariate analysis identified ventricular fibrillation on first electrocardiogram, observed OHCA, short response time intervals but not the unit that performed the first resuscitation attempt as independent predictors of survival.

Conclusions A physician on board of the advanced life support unit was not identified as an independent factor of improved survival. (Am Heart J 2007;153:792-9.)

Patient outcome after out-of-hospital cardiac arrest (OHCA) depends on individual, demographic, sociological, and logistic factors.[1-3] The availability and organization of personnel applying advanced or basic cardiac life support is thought to be a crucial factor for the outcome of out-of-hospital cardiopulmonary resuscitations (CPRs).[4] However, nationwide physician-staffed advanced life support (ALS) services are cost-expensive and therefore are still a matter of debate. Despite a large amount of data focusing on outcome of OHCAs, little information is available about physician-staffed emergency systems. Because the Utstein style is mostly used for reporting out-of-hospital resuscitations, a comparative analysis between different emergency medical service (EMS) systems should be possible.[5]

It is well known that a decreasing time delay between cardiac arrest and initiation of CPR is associated with a more favorable outcome.[6] However, by reviewing studies on 39 EMS programs from 29 different locations published between 1967 and 1988, Eisenberg et al[4] showed that qualification of personnel and configuration of the EMS system are the most important independent factors affecting outcome after OHCA. The highest survival rates could be observed in a 2-tier basic life support and paramedic-staffed ALS systems. Physician-staffed ALS systems were not included in this comparative study because of lack of data. One can speculate that physicians are more experienced in tracheal intubation and immediate venous access than other EMS

From the [a]Deutsches Herzzentrum München and 1. Medizinische Klinik, Klinikum rechts der Isar, Technische Universität München, Munich, Germany, [b]Medizinisches Versorgungszentrum, Dachau, Germany, [c]Ilmtalklinikum, Pfaffenhofen, Germany, [d]Klinikum Dachau, Amperkliniken AG, Germany, and [e]Städtisches Krankenhaus Harlaching, München, Germany.

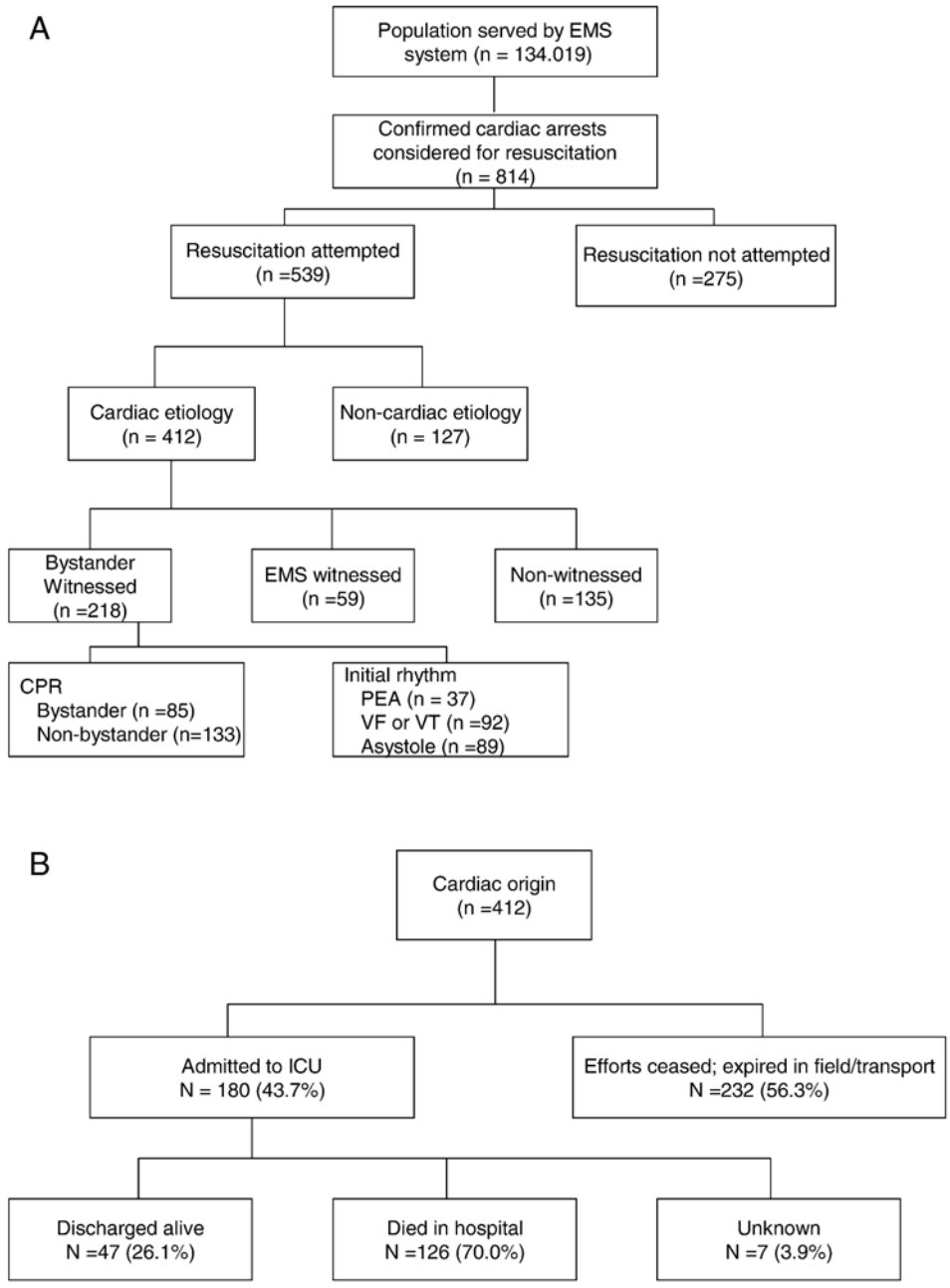
Submitted November 20, 2006; accepted February 22, 2007.

Reprint requests: Heidi L. Estner, MD, Deutsches Herzzentrum München, Lazarettstrasse 36, D - 80636 München, Germany.
E-mail: estner@dhm.mhn.de

0002-8703/$ - see front matter

doi:10.1016/j.ahj.2007.02.032

Figure 1



Flowchart of study participants (**A**) and of patients with an arrest of cardiac origin (**B**). *ICU,* Intensive care unit.

personnel and in reaching a judgment if a resuscitation attempt is futile or not. Thus, a physician-staffed EMS system may be superior to emergency medical systems without physicians with regard to outcome of cardiac arrests. Stiell et al[7] assessed the incremental benefit with respect to survival and morbidity that results from the implementation of full prehospital ALS programs in the context of an existing EMS system of rapid defibrillation. Despite the large sample size, controlled design, and multiple approaches to the analysis, they were not able to identify any evidence of a benefit of ALS for any subgroup of patients. In this context, it remains unclear whether the presence of a physician on board the ALS unit makes a major difference with regard to the

Table I. Location of out-of-hospital in all patients (n = 539)

Location of arrest	No. of patients
Home	380
Public place	119
Industrial workplace	7
Sport	8
Street	55
Public building	7
Long-term facility	41
Educational institutions	1
Other	40

Table II. Etiology of OHCAs

Etiology	No. of patients
Presumed cardiac	412
Trauma	40
Submersion	8
Respiratory	16
Other noncardiac	6
Unknown	57

outcome of patients after a cardiac arrest. The assessment of the impact of the presence of a physician on board the ALS unit on a randomized basis is not feasible due to law restrictions (in Germany). Thus, we investigated the patients' outcome after OHCA in a midsized urban community in a 2-tier emergency EMS consisting of emergency medical technician (EMT) units and a physician-staffed ALS unit. We concentrated on the outcome of patients depending on whether a physician, an EMS personnel or, a layperson started the CPR.

Patients and methods

This study included all patients who had an OHCA in whom resuscitation was attempted by the Dachau ALS services between January 2000 and January 2006. Pediatric patients were included in the study. The Dachau EMS system serves the city of Dachau, a midsized urban community and its suburban environs covering a population of approximately 134,019 residents in a region of 580 km^2. At the time of the study, 48.7% of the residents were male, and 10.6% of residents were ≥70 years of age.

System configuration

During the study period, there were 2 components in the system: the EMT ambulance crews and 2 physician-staffed ALS units. Both components of this 2-tier system were equipped with separate vehicles and met at the scene of the cardiac arrest. The ALS units consisted of 1 EMT and 1 physician, based on the 2 hospitals in the district of Dachau who responded in a nontransport vehicle. All physicians had a minimum of 18 months postgraduate clinical experience and had undergone special ALS training. The EMT ambulances were manned with a minimum of 2 EMT staff. The EMT personnel underwent a minimum of 3 years education in emergency medicine including ALS training with tracheal intubation, medical treatment, and defibrillation. The medical treatment included administration of adrenalin and atropine. All EMT-ALS units were equipped with a semiautomatic defibrillator, and the EMT personnel were allowed to defibrillate if they had diagnosed ventricular fibrillation (VF) or rapid ventricular tachycardias (VT) in a patient presenting with cardiac arrest. During the study, 4 EMT-ALS units were on duty in the daytime, whereas 3 served at night. Diagnosis of cardiac arrest and CPR was performed according to current guidelines and recommendations of the American Heart Association[8] and the European Resuscitation Council.[9]

Dispatching system

All Dachau EMSs are dispatched by one center with a central emergency telephone system, which is also responsible in other 3 administrative districts. The center dispatches about 70,000 medical calls annually. During the study, the operator at the center decided on the basis of formal protocols whether physician-staffed ALS services were required. Indications for dispatching these ALS services were cardiac arrests, severe trauma, traffic accidents, or severe acute diseases. If physician-staffed ALS services were required, the closest available unit and the closest available EMT-ALS unit were both dispatched simultaneously. If the EMT-ALS unit was the first vehicle to arrive on the scene, advanced cardiac life support was provided until the physician-staffed ALS unit arrived.

Data collection

All data were gathered using a detailed protocol for data collection by the EMT and the ALS physician in the prehospital setting and patient hospital records. The documentation system was constant during the registration period, and all data have been prospectively computerized with the exception of survival and data regarding in-hospital stay, which have been evaluated with some time delay. Call-response time intervals—that is, the time intervals between the call and arrival of ALS on the scene—were taken from the computerized dispatch records. All data were double-checked at data entry. The call-response interval is the period form receipt of call by the emergency dispatch center to the moment the emergency vehicle stops moving, including the time required to process the call, dispatch emergency personnel, move personnel from their quarters to the emergency vehicle, and travel to the scene. An arrest was assumed to be of cardiac origin if the traumatic nature of arrest was ruled out. Neurological status of survivors was assessed according to the Cerebral Performance Category (CPC) of the Glasgow Pittsburg outcome category; CPC score 1 indicates good cerebral performance; CPC score 2, moderate cerebral disability; CPC score 3, severe cerebral disability; and CPC score 4, coma or vegetative state.

The primary end point of the study was that the patient was discharged alive from hospital.

Statistical analysis

Data are expressed as mean ± SD, median [25th; 75th percentiles], or number of patients (%). Univariate comparisons between groups were made using χ^2 test or Fisher

Table III. Clinical characteristics of patients

Variable	Hospital discharge (n = 47)	No survival (n = 365)	P
Age (y)	63.2 ± 13.7 [32; 91.4]	68.7 ± 15.7 [0; 94.1]	.003
Female sex	20 (42.6)	117 (32.7)	.18
Response time interval (min)	5.88 ± 2.89	7.98 ± 4.06	<.001
Observed CA	43 (91.5)	228 (63.7)	<.001
Initiation of CPR by physician	18 (38.3)	97 (27.7)	.112
Initiation of CPR by paramedic	13 (27.7)	163 (45.5)	.019
Bystander CPR	16 (34)	97 (27.1)	.32
First monitored ECG			
VF	37 (78.7)	94 (26.3)	<.001
Asystole	5 (10.6)	204 (57)	<.001

Data are median [25th; 75th percentiles], mean ± SD, or number of patients (%).
CA, Cardiac arrest.

Table IV. Neurological status of survivors at the time of hospital discharge

	First resuscitation attempt			
CPC score	Physician	EMS personnel	Bystander	Total
1	17	5	11	33
2	–	8	2	10
3	1	–	–	1
4	–	–	3	3

CPC 1, Good cerebral performance; CPC 2, moderate cerebral performance; CPC 3, severe cerebral diasability; CPC 4, coma or vegetative state.

Table V. Independent predictors of survival at the time of hospital discharge

Variable	Estimate	Adjusted Odds Ratio (95% CI)
Age >70 y	−1.096	0.33 (0.15-0.72)
Female sex	0.96	2.60 (1.21-5.57)
First ECG: VF	1.91	6.77 (1.68-27.29)
First ECG: asystole	−1.09	0.33 (0.12-0.97)
Unobserved	−1.21	0.30 (0.09-0.91)
Response time interval (>8 min)	−1.6	0.19 (0.07-0.56)

CI, Confidence interval.

exact test for categorical variables and 2-tailed unpaired *t* test, Mann-Whitney test, or one-way analysis of variance for continuous variables. Stepwise multiple logistic-regression analysis was performed to control for possible confounding variables regarding the survival at the time of hospital discharge. A P value < .05 was considered to indicate statistical significance.

Results

Within a 6-year period, 814 patients that had cardiac arrest were covered by the Dachau ALS services. In 275 of these patients, CPR was not attempted because death was confirmed by postmortem lividity and rigor mortis or because cardiac arrest had obviously occurred after end-stage malignant or other severe chronic disease (Figure 1, *A*). In 539 patients (349 males, 64.7%; mean age, 63.9 ± 19.1 years; range, 0.1-94.1 years), CPR was initiated. In 149 (27.6%) patients, a defibrillation attempt was carried out. In 13 patients, a shockable rhythm was detected during resuscitation, although the first detected rhythm was not shockable. In 522 patients (96.8%), chest compression and controlled ventilation were started. The remaining 17 patients were found in a shockable rhythm, and the first administered shock achieved stable sinus rhythm and spontaneous breathing. Ten patients were lost to follow-up after admission to hospital. Location of OHCA and etiology are shown in Tables I and II.

Witnessed cardiac arrests and first monitored electrocardiogram

Of 539 patients, 412 (76.4%) had arrests of cardiac origin, and 127 (23.6%) of 539 patients had noncardiac arrests. The mean age of patients with arrest of cardiac origin was 68.1 ± 14.6 years, and 278 (66.5%) of them were men. Of 412 patients with arrests of cardiac origin, 180 (43.7%) were admitted alive to a cardiac intensive care unit. Of these, 47 (26.1%) patients were discharged alive, and 7 patients were lost to follow-up (Figure 1, *B*). Characteristics of survivors and nonsurvivors are shown in Table III. Neurological status of survivors is shown in Table IV.

In 277 of 412 patients with arrests of cardiac origin (67.2%; mean age, 68.1 ± 15.1 years; 184 men), the arrest was witnessed; in the remaining 135 patients (32.8%; mean age, 67.7 ± 16.2 years; 90 men), the arrest was not witnessed. In 218 patients, arrest was witnessed by bystanders, and in 59 cases by EMS personnel. Both groups had higher survival rates (discharge rates 11.0% [24/218] among patients witnessed by bystanders and 32.2% [19/59] among patients witnessed by EMS personnel) compared with survival rates in patients

Table VI. Comparison of different EMS systems with an EMT-ALS and physician-staffed ALS services

Location, Year	Reference	Population served by EMS system	All arrests	Arrests of cardiac origin	Bystander-witnessed arrests in cardiac etiology, n (%)
Dachau, 2006		135,000	539	412	218 (52.9)
Trondheim, 1999	11	154,000	–	442	–
Heidelberg, 1999	12	330,000	512	338	190 (56)
Amsterdam, 1998	16	1,300,000	–	1064	778 (74)
Bonn, 1997	17	240,000	520	464	214 (46)
New York, 1994	18	128,000	481	406	246 (60.6)
Copenhagen, 2000	19	465,000	764	703	464 (66)
Helsinki, 1996	20	516,000	412	255	194 (76)
Ljublijana, 1998	21	397,306	454	337	299 (89)
St. Etienne, 1996	22	571,191	234	113	77 (68)
Scotland, 1993	13	5,102,400			811 (?)
Ontario, 2004	7	2,500,000	–	4247	1737 (40.9)
Gotheburg, 2003	23	431,270	5270	3871	2066 (67)
Ontario, 1999	24	2,700,000	–	1641	6.0

NA, Not available.
*The Utstein gold standard is the number of patients discharged alive divided by the number of persons with witnessed cardiac arrest is ventricular fibrillation of cardiac etiology (Utstein-guidelines recommendation).
†Time interval from the received call to EMS vehicle arriving at the scene.

with nonwitnessed cardiac arrests (discharge rate, 2.9% [4/135]; $P < .01$ for both comparisons). A total of 203 patients were ≤70 years of age, and 34 (16.7%) of them survived compared with 13 survivors (6.2%) in the group with an age >70 years (n = 209; $P = .001$).

Overall, 136 of 412 patients (33.0%; mean age, 66.0 ± 11.7 years; 97 men) were found with VF, 66 patients (16.0%; 73.0 ± 13.5 years, 38 men) were found with pulseless electrical activity (PEA), and 210 patients (51.0%; mean age, 67.7 ± 17.7 years; 138 men) were found with asystole. Hospital discharge rates were 27.2% (n = 37) among patients with initial rhythm VF/VT, 7.7% (n = 5) among patients with PEA, and 2.3% (n = 5) among patients with asystole ($P < .01$ for patients with PEA and asystole vs patients with initial VF/VT).

The arrest occurred at home in 312 patients (75.7%; mean age, 68.1 ± 14.7 years; 212 men), in public places in 57 patients (13.8%; mean age, 65.7 ± 13.2 years; 42 men), and in other locations in 43 patients (10.4%; mean age, 68.4 ± 22.0 years; 18 men) (Table II). Patients who experienced their cardiac arrest in a public place showed a higher survival rate compared with those who experienced cardiac arrests at home (11 vs 31 patients, 19.3% vs 9.9%, respectively; $P = .05$). Cardiac arrests occurring in public places was more often witnessed than arrest occurring at home (45 vs 199 patients, 78.9% vs 63.8%, respectively; $P = .026$). Bystander CPR was initiated more often in public places than at home (25 vs 77 patients, 24.7% vs 43.9%, respectively; $P = .03$).

Response time intervals

The response time interval of the ALS unit was inversely related to long-term outcome. Overall, the mean response time interval for survivors was shorter (5.88 ± 2.89 minutes) than that for nonsurvivors (7.98 ± 4.06 minutes; $P < .001$). An interval of ≤8 minutes was associated with a higher survival rate (40/222 patients, 18.0%) than an interval of >8 minutes (5/116 patients, 4.0%; $P = .01$). There were no significant differences in the response time intervals among patients with the first treatment offered by the physician-staffed EMT unit compared with patients treated by the ALS-EMT unit (7.8 ± 4.6 vs 7.7 ± 3.9 minutes; $P = .96$).

First resuscitation attempt

Of the 412 cardiac arrests, resuscitation attempts were started by a physician in 117 patients (mean age, 66.9 ± 15.5 years old; 79 men), by EMS personnel in 177 patients (mean age, 69.5 ± 16.1 years old; 109 men), and by bystander in 118 patients (mean age, 66.7 ± 14.3 years old; 86 men). The time interval between emergency call and when vehicle stops on scene was 7.4 ± 2.6 minutes (range, 2-16 minutes) in the physician-treated group, 8.0 ± 4.1 minutes (range, 0-29 minutes) in the EMS-treated group, and 8.3 ± 5.0 minutes (range, 0-30 minutes) in the laymen-treated group ($P = .51$). A total of 18 patients (18.6%) in the group treated initially by a physician, 13 patients (8.0%) in the group treated by EMS personnel ($P = .02$ vs survival rate in group treated by a physician), and 16 patients (16.5%) in the group treated by laymen ($P = .80$ vs survival rate in the group treated by a physician) were discharged alive from hospital.

The ALS-EMT arrived at the scene 4.7 ± 4.8 minutes (median, 3 minutes) earlier than the physicians. Upon arrival, they started CPR in 177 of 412 patients with chest compression and controlled ventilation in 163

Bystander CPR in cardiac etiology (%)	EMS system	Discharge rate after cardiac arrest of cardiac etiology (%)	VF survivors of cardiac etiology (%)	The Utstein gold standard*	Time interval†
20.6	Physician-staffed	47/412 (11.4)	37 (27.2)	32.4	7.7
–	ALS-EMS	NA	48 (18.8)	32.4	8.0
–	Physician-staffed	48/338 (14)	36 (34)	37.7	–
55.8	ALS-EMS	218/1064 (20.5)	189 (33.2)	19.0	8.0
29.4	Physician-staffed	74/464 (16)	56 (26.7)	35.0	5.5
19.7	ALS-EMS	7/406 (1.7)	7 (7.3)	6.3	4.5
–	Physician-staffed	82/703 (11.7)	74 (17.9)	–	6.0
22.1	Physician-staffed	44/255 (17)	41 (32.5)	32.5	7.0
20.7	Physician-staffed	19/337 (5.6)	15 (12.5)	13.2	10.0
42.9	Physician-staffed	8/113 (7.1)	8 (17.8)	6.5	13.0
49.0	ALS-EMS	174/1676 (10)	NA	11.0	7.0
14.4	ALS-EMS	217/4247 (5.1)	NA	–	6.3
–	ALS-EMS	340/3871 (8.8)	NA	19.7	5.0
6.1	ALS-EMS	6.2	6.3	6.4	6.5

patients and drug treatment in 36 patients; in 58 patients, the first defibrillation attempt was carried out by EMT personnel without a physician. Bystander started CPR in 118 patients with chest compression and assisted ventilation; in 2 patients, the first shock was delivered by a bystander with an automated external defibrillator. In 13 patients, the first defibrillation attempt was carried out without the presence of a physician or EMT.

In patients whose cardiac arrest was witnessed by a bystander and who were found with VF (n = 105), the discharge rate was 32.4% (34 patients).

Results of multivariate analysis

Multivariate analysis (stepwise multiple logistic regression model) was used to test for various confounding variables regarding the survival at the time of hospital discharge. The following variables were entered into the model: age, sex, witnessed status, bystander CPR, initial rhythm (shockable vs nonshockable rhythm), time interval (from receipt of a call to arrival at the scene), and the unit that performed the first resuscitation attempt (physician-staffed ALS vs EMT-ALS). Although the unit that performed the first resuscitation attempt was not identified as a significant variable in the univariate analysis, the variable was forced in the multivariable model because of it being an aim of the study. The model identified sex and VF in the first electrocardiogram (ECG) as independent predictors associated with a higher survival at the time of hospital discharge. Age >70 years, asystole in the first ECG, unobserved arrest, and response time intervals >8 minutes were independent predictors of poor outcome (lower survival) at the time of hospital discharge (Table V). The unit that performed the first resuscitation attempt did not appear to be an independent predictor of survival at the time of hospital discharge (odds ratio, 0.89; 95% confidence interval, 0.43-1.84 for physician-staffed ALS vs EMT-ALS personnel).

Outcome of the present study was compared with corresponding data from other studies according to the Utstein template (Table VI).

Discussion

In a midsized urban/suburban system with 2-tier ALS services, in which the ALS is provided by physicians, 11.4% of patients resuscitated after a cardiac arrest of cardiac etiology were discharged alive. Most of these patients showed good neurological outcome. Several factors influencing outcome could be identified. Factors such as witnessed cardiac arrest, VF in the first recorded ECG, or shorter response time intervals (<8 minutes) were associated with higher survival rates at the time of hospital discharge. Previous studies have shown that early initiation of CPR is associated with a more favorable outcome.[10,11] The present data are reported according to the recommendations of the Utstein consensus conference to allow comparison of our EMS with others. For this purpose, the Utstein consensus conference recommended the use of outcome data obtained from patients with bystander-witnessed cardiac arrest of cardiac etiology and initial rhythm VF. In the present study, 32% of these patients were discharged alive. Studies were chosen regarding the EMS system, the midsized urban setting, the amount of bystander-witnessed cardiac arrests, the Utstein golden standard, and the time interval between the received emergency call by the dispatch center to the EMS vehicle arriving at the scene, if data were available (Table VI).

By reviewing studies on EMSs from different locations, Eisenberg et al[4] showed that qualification of the personnel and the configuration of the EMS system are the most important independent variables affecting the outcome after OHCA. The highest survival rates could be observed in 2-tier basic life support (BLS) and paramedic-staffed ALS systems. Physician-staffed ALS systems were not included in this comparative analysis due to the lack of the data. Bottiger et al[12] supported the view, that a physician-staffed ALS system is associated with a higher survival rate in patients having OHCA of cardiac etiology. The authors compared their data with data from EMSs without a physician in a variety of regions, mostly at large metropolitan and rural areas. In these regions, call-response time intervals of more than 10 minutes are not unusual. In recently published studies, the EMS systems were optimized to shorten call-response time intervals by training firefighters or policemen in the use of automated external defibrillators, implementation of additional BLS units for rapid defibrillation and CPR,[13] and importantly by the implementation of public access defibrillator programs.

Although the configuration of the EMS system is the most important, independent factor affecting the outcome of cardiac arrest, personnel qualification regarding ALS training and the availability of a defibrillator also play an important role, the presence of a physician on board the ALS was not an independent determinant of improved survival.

The results of the "Ontario Prehospital Advanced Life Support study"[7] did not show any incremental benefit of introducing a full ALS program to an EMS system of optimized rapid defibrillation. The results did confirm the separate value of each of the first 3 links in the American Heart Association's 4-step "chain of survival," which includes early access to emergency medical care, early CPR, early defibrillation, and early "advanced cardiac live support." No evidence of a benefit was identified by the fourth link of the chain of survival, the advanced cardiac life support. In physician-staffed emergency systems, the advanced care is provided by a physician, meaning that he provides advanced airway management (endotracheal intubation) and intravenous drug therapy. Our study supports the hypothesis that the presence of a physician on board the EMS vehicle is not an independent factor for survival rate in OHCA resuscitations. Cardiopulmonary resuscitation first treated by a layperson is associated with an identical rate of survival compared with CPR first performed by a physician.

The findings of the present study should be interpreted with caution because we demonstrated data for the initially started CPR; it should be emphasized that in every case, a physician arrives at the scene and treats the patient after initial treatment by EMS personnel or laymen. A randomized study to assess whether a physician is an independent factor for survival after out-of-hospital resuscitations is not feasible because of law restrictions in Germany. Another note of caution in interpreting the results of the current study relates to the fact that our data are obtained in a midsized urban community extended over a circumvented surface area. Longer response time intervals are usually seen in rural areas or large metropolitan areas.

Comparison of the data of the present study regarding the outcome at time of hospital discharge with those of other EMS systems according to the Utstein recommendations showed that present survival rates are close to those obtained from other 2-tier BLS or physician-staffed ALS services, all located in midsized urban/suburban areas.[12-24] All the data from physician-staffed ALS systems, however, are related to suburban or midsized urban areas, whereas the available data from EMS systems without a physician include a variety of regions, mostly large metropolitan or rural areas. The lowest survival rates could be observed in large metropolitan areas. This is mostly because of the long call-response intervals that often exceed 10 minutes. In midsized urban/suburban areas, BLS or ALS services are usually on the scene within 5 to 10 minutes. The comparative analysis may support the view, that physician-staffed ALS systems are associated with higher survival rates in patients having OHCA of cardiac etiology. Regarding response time intervals, however, physician-staffed emergency systems had very short response intervals.

Multivariate analysis of the study data demonstrated that witnessed arrest and shockable rhythm as a first monitored rhythm were associated with a higher survival rate. Of note, both univariate and multivariate analyses did not identify the unit that initially stated the CPR as an independent predictor of survival. To access more shockable rhythms on scene, a short call-response time interval is crucial. Thus, considering the relationship between the response time interval and the presence of a shockable rhythm at the time of initiation of resuscitation, we believe that the call-response interval has the strongest impact on the survival of an OHCA.

Conclusion

In conclusion, the present data suggest that early initiation of CPR and short response time intervals to increase the proportion of patients with shockable rhythms at the time of initiation of resuscitation improve survival of the patients with OHCAs. A 2-tier physician-staffed ALS system is associated with good survival rates in a midsized urban area. The presence of a physician on board of the ALS unit was not identified as an independent predictor of improved survival at the time of hospital discharge.

We thank all of the paramedics, nurses, and physicians who performed CPR for their contribution to this study. In addition, the following CPR instructors were of exceptional value: Alfred Schmuck, Thomas Vieregg, and Armin Hofberger. We also thank the EMT service of Dachau (BRK) for their help.

References

1. Becker LB, Han BH, Meyer PM, et al. Racial differences in the incidence of cardiac arrest and subsequent survival. The CPR Chicago Project. N Engl J Med 1993;329:600-6.
2. Eisenberg MS, Copass MK, Hallstrom AP, et al. Treatment of out-of-hospital cardiac arrests with rapid defibrillation by emergency medical technicians. N Engl J Med 1980;302:1379-83.
3. Lombardi G, Gallagher J, Gennis P. Outcome of out-of-hospital cardiac arrest in New York City. The Pre-Hospital Arrest Survival Evaluation (PHASE) study. JAMA 1994;271:678-83.
4. Eisenberg MS, Horwood BT, Cummins RO, et al. Cardiac arrest and resuscitation: a tale of 29 cities. Ann Emerg Med 1990;19:179-86.
5. Jacobs I, Nadkarni V, Bahr J, et al. Cardiac arrest and cardiopulmonary resuscitation outcome reports: update and simplification of the Utstein templates for resuscitation registries: a statement for healthcare professionals from a task force of the International Liaison Committee on Resuscitation (American Heart Association, European Resuscitation Council, Australian Resuscitation Council, New Zealand Resuscitation Council, Heart and Stroke Foundation of Canada, InterAmerican Heart Foundation, Resuscitation Councils of Southern Africa). Circulation 2004;110:3385-97.
6. Cummins RO, Eisenberg MS, Hallstrom AP, et al. Survival of out-of-hospital cardiac arrest with early initiation of cardiopulmonary resuscitation. Am J Emerg Med 1985;3:114-9.
7. Stiell IG, Wells GA, Field B, et al. Advanced cardiac life support in out-of-hospital cardiac arrest. N Engl J Med 2004;351:647-56.
8. Guidelines for cardiopulmonary resuscitation and emergency cardiac care. Emergency Cardiac Care Committee and Subcommittees, American Heart Association. JAMA 1992;268:2171-298.
9. International Guidelines 2000 for CPR and ECC. A consensus on science. European Resuscitation Council. Resuscitation 2000; 46:1-447.
10. Cummins RO, Ornato JP, Thies WH, et al. Improving survival from sudden cardiac arrest: the "chain of survival" concept. A statement for health professionals from the Advanced Cardiac Life Support Subcommittee and the Emergency Cardiac Care Committee, American Heart Association. Circulation 1991;83:1832-47.
11. Martens PR, Mullie A, Calle P, et al. Influence on outcome after cardiac arrest of time elapsed between call for help and start of bystander basic CPR. The Belgian Cerebral Resuscitation Study Group. Resuscitation 1993;25:227-34.
12. Bottiger BW, Grabner C, Bauer H, et al. Long term outcome after out-of-hospital cardiac arrest with physician staffed emergency medical services: the Utstein style applied to a midsized urban/suburban area. Heart 1999;82:674-9.
13. Sedgwick ML, Dalziel K, Watson J, et al. Performance of an established system of first responder out-of-hospital defibrillation. The results of the second year of the Heartstart Scotland Project in the 'Utstein Style'. Resuscitation 1993;26:75-88.
14. Gottschalk A, Burmeister M-A, Freitag M, et al. Influence of early defibrillation on the survival rate and quality of life after CPR in prehospital emergency medical service in a German metropolitan area. Resuscitation 2002;53:15-20.
15. Skogvoll E, Sangolt GK, Isern E, et al. Out-of-hospital cardiopulmonary resuscitation: a population-based Norwegian study of incidence and survival. Eur J Emerg Med 1999;6:323-30.
16. Waalewijn RA, de Vos R, Koster RW. Out-of-hospital cardiac arrests in Amsterdam and its surrounding areas: results from the Amsterdam resuscitation study (ARREST) in 'Utstein' style. Resuscitation 1998;38:157-67.
17. Fischer M, Fischer NJ, Schuttler J. One-year survival after out-of-hospital cardiac arrest in Bonn city: outcome report according to the 'Utstein style'. Resuscitation 1997;33:233-43.
18. Westal RE, Reissman S, Doering G. Out-of-hospital cardiac arrests: an 8-year New York City experience. Am J Emerg Med 1996; 14:364-8.
19. Rewers M, Tilgreen RE, Crawford ME, et al. One-year survival after out-of-hospital cardiac arrest in Copenhagen according to the 'Utstein style'. Resuscitation 2000;47:137-46.
20. Kuisma M, Maatta T. Out-of-hospital cardiac arrests in Helsinki: Utstein style reporting. Heart 1996;76:18-23.
21. Tadel S, Horvat M, Noc M. Treatment of out-of-hospital cardiac arrest in Ljubljana: outcome report according to the 'Utstein' style. Resuscitation 1998;38:169-76.
22. Giraud F, Rascle C, Guignand M. Out-of-hospital cardiac arrest. Evaluation of one year of activity in Saint-Etienne's emergency medical system using the Utstein style. Resuscitation 1996;33:19-27.
23. Fredriksson M, Herlitz J, Engdahl J. Nineteen years' experience of out-of hospital cardiac arrest in Gothenburg—reported in Utstein style. Resuscitation 2003;58:37-47.
24. Stiell IG, Wells GA, Field BJ, et al. Improved out-of-hospital cardiac arrest survival through the inexpensive optimization of an existing defibrillation program: OPALS study phase II. Ontario Prehospital Advanced Life Support. JAMA 1999;281: 1175-781.