Can the "Golden Hour of Shock" Safely Be Extended in Blunt Polytrauma Patients?

Prospective Cohort Study at a Level I Hospital in Eastern Switzerland

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Abbreviations:
AIS = Abbreviated Injury Score
ASCOT = a severity characterization of trauma
ATLS = Advanced Trauma Life Support
CI = 95% confidence interval
ED = emergency department
EMT = emergency medical technician
ISS = Injury Severity Score
KSSG = Kantonsspital St. Gallen
MTOS = Major Trauma Outcome Study
OR = odds ratio
PM = paramedic
REGA = Swiss Rescue Flight Guard
TRISS = trauma and injury severity score

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Abstract

Background: The objective was to test, in this trauma system, the North American hypothesis that exceeding the 60-minute limit for the entire prehospital time ("golden hour of shock") increases mortality of blunt polytrauma patients.

Methods: In a prospective, observational, cohort study conducted between 1990 and 1996, a severity characterization of trauma (ASCOT) score was used to compare the actual mortality with the predicted mortality in 107 blunt polytrauma patients (Group 1) with prehospital rescue periods ≤60 minutes (time from accident until arrival at the emergency department). The same comparison was performed for 147 blunt polytrauma patients (Group 2) with rescue periods >60 minutes. Inclusion criteria were blunt trauma of at least two body sites, an Injury Severity Score (ISS) of ≥8, and direct admission to the trauma centre. Multivariate regression analysis was performed to test for bias and confounding, and to identify factors that might influence mortality. Odd ratio (OR) and 95% confidence interval (CI) were calculated.

Results: The mortality in Group 1 was 14%, and was not statisticvally significantly higher than the 10.2% observed for Group 2. 4.8 patients, or 47% more than predicted, died in Group 1 (p = 0.057). The corresponding figures in Group 2 were 4.2 patients or 22% fewer than predicted (p = 0.19). Multivariate logistic regression confirmed this trend with a significant mortality odds ratio of 8 (95% CI 1.7 to 38.5) for Group 1 compared to Group 2. Significantly more patients in Group 2 were treated by emergency physicians.

Conclusions: It appears in this trauma system, in which emergency physicians often are deployed, that the 'golden hour of shock' can be extended safely in many blunt polytrauma patients, since this was associated with better survival figures than in those patients for whom the time was <1 hour.

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Introduction

In North America, an important determining factor of an efficient trauma system is considered to be the adherence to minimal rescue periods and direct admission to and treatment in a tertiary trauma centre.[1] Absolute priority is given to transporting moderately and severely injured patients as quickly as possible to the nearest trauma centre. This approach is based on the concept of the "golden hour of shock."[2-4] By instituting aggressive and definitive measures within the first hour after the accident to preserve vital functions, observing the "golden hour of shock" aims to prevent both early and partially late death. Therefore, some North Americans trauma surgeons are of the opinion that field stabilisation contributes to reducing mortality only if it does not prolong the on-scene time or if the patient would die without immediate intervention.

In Europe, however, more importance is attached to field stabilisation with prolongation of the on-scene time regarded as unavoidable. This has become a preferred approach, primarily due to the high number of blunt polytrauma patients with injuries to the central nervous and musculo-skeletal system. Life-threatening haemorrhages of the thorax and abdomen play only a secondary role to these injuries.

However, there are no data that can be used for determing the best rescue periods, i.e., the on-scene time and the entire elapsed time between the accident and arrival at the trauma centre (rescue period), for penetrating and blunt trauma.[5] Many of the papers that have been published often use questionable methods, and comparison is limited by differences between inclusion criteria.[5] For example, some studies have not demonstated a relationship between longer rescue periods and mortality,[6-8] others have shown increased mortality,[9-13] and some even have demonstrated lower mortality in patients with longer rescue times compared to shorter rescue times.[14]

In the light of this unclear situation, the author chose to test, in this trauma system, the North American hypothesis that prehospital rescue times of >60 minutes (the “golden hour of shock”) are associated with increased mortality in blunt polytrauma patients.

Material and Methods

Study Design and Sample Size

This was a prospective, non-experimental, observational cohort study. The actual 30 day mortality for 107 blunt polytrauma patients with rescue periods of ≤60 minutes (i.e., time from accident until arrival at the emergency department) was compared with the predicted mortality, based on a severity characterization of trauma (ASCOT) score.[15] The same comparison was performed for 147 polytrauma patients with rescue periods of >60 minutes.

The sample size calculation was based on a comparison of crude mortality rates. Assuming a mortality rate in the group with rescue periods of ≤60 minutes of 10% compared to an assumed mortality rate of 20% for those with rescue periods >60 minutes, an alpha value of 0.1, and a power of 0.8, a total of 306 patients or 153 per group was required.

Inclusion Criteria and Source of Data

All trauma patients admitted to the shock room of the Central Emergency Department of St. Gallen Cantonal Hospital (Kantonsspital St. Gallen; KSSG) between 15 June 1990 and 15 June 1996 were entered into a trauma registry similar to that maintained by the Centers for Disease Control (CDC), Atlanta, Georgia USA. Criteria for inclusion in this study were blunt trauma, treatment in the shock room, presence of injuries with a minimum abbreviated injury score (AIS) of ≥2 in at least two of six defined body regions (without external system AIS-6), transfer to the intensive care unit, or a stay of at least three days in hospital, or death following admission. Details of the study design have been published elsewhere.[16]

Survival was determined from KSSG or third-party medical records (if the patient was transferred early) and, in some cases, from inquiries made at citizen's registration offices. For the purposes of this study, patients who died within 30 days of sustaining the trauma were classified as deaths.

Trauma System

The KSSG is an acute central hospital (Level I) with about 800 beds (340 surgical beds) and two intensive care units (1 surgical unit with 16 beds) during the study period. As a tertiary care centre, it serves Eastern Switzerland with 10 regional hospitals (Level II), has a catchment area of about 600,000 inhabitants with a radius of 8–70 km. The immediate catchment area comprises about 100,000 people and has a radius of 5–8 km.

Emergency Service

During the study period, this region had no central emergency switchboard and emergency services were coordinated via decentralised services (hospitals, police, and Swiss Rescue Flight Guard [REGA]). If severe injuries were suspected, often the REGA or an ambulance with an onboard physician was dispatched.

The ambulance teams generally consisted of two emergency medical technicians (EMTs), in rare cases with the support of a paramedic (PM). In special cases, for ground rescue, an anaesthetist, or more rarely, an anaesthetic nurse qualified to intubate, was deployed. Emergency helicopter flights always were staffed by one physician, one paramedic, and a pilot.

Different criteria determined whether an injured person from the immediate catchment areas of the regional hospitals (Level II) was transported primarily from the scene of the accident to the KSSG or not. These included the type of notification service (direct via REGA, police, or hospital emergency service), the hospital policy (three of the hospitals usually did not permit direct admissions to the KSSG), or chance.

The ambulance transport times varied between five minutes up to a maximum of one hour and the helicopter flights between 10 and 15 minutes.

Analysis

The Trauma Registry software, version 2 of the CDC, was used to convert ICD-9CM to AIS-85. All results were transferred to a personal computer program and the ASCOT score was calculated using Champion’s formula.[15] Systat for Windows, version 8.03,[17] was used for the statistical analysis. The outcome measures of interest were: actual 30-day mortality rate of patients, the predicted mortality rate based on the ASCOT score, and the resulting excess mortality rate, i.e., actual mortality rate minus predicted mortality rate.

The actual 30-day mortality rate was compared with the predicted figures on the basis of Flora's Z-statistics[18] and the associated 95% confidence intervals (CI). Possible confounding variables and further comparisons were tested using the independent Student's t-test, the Mann-Whitney U-test, the chi-square test, and multivariate

Characteristics	Rescue period ≤60 minutes Group1	Rescue period >60 minutes Group 2	*p*-value	Total
Demographic characteristics				
Number (n)	107	147		254
Men (%)	(66)	(78)	ns	(72)
Women (%)	(34)	(22)		(28)
Age (years)	30	29	ns	30
Scene of accident (%)				
Primary catchment area	(32)	(5)		(17)
Secondary catchment area	(68)	(95)	<0.001	(83)
Injury characteristics				
ISS Median	24	24	ns	24
ISS Mean	24.4	24.8	ns	24.6
ASCOT Median	0.974	0.972	ns	0.974
ASCOT Mean	0.905	0.870	ns	0.885
AIS-Head	2	3	ns	2
AIS-Face	0	0	ns	0
AIS-Chest	3	3	ns	3
AIS-Abdomen	0	0	ns	0
AIS-Extremities	2	2	ns	2
AIS External	0	0	ns	0
Cause of trauma (%)				
Road traffic accident	(77)	(69)	ns	(72)
Work	(11)	(12)	ns	(12)
Sport	(1)	(13)	0.005	(8)
Suicide/Violence	(9)	(1)	0.004	(5)
Others	(2)	(5)	ns	(3)
Prehospital care characteristics				
On-scene emergency physician (%)	(49)	(91)	<0.001	(73)
Intubation				
on scene (%)	(20)	(37)	<0.001	(30)
in ED (%)	(16)	(16)	ns	(16)
On-scene time (min)	17	34		25
n =	99	144	<0.001	243
Transport (%)				
Helicopter	(29)	(79)	<0.0001	(58)
Ambulance	(71)	(21)		(42)
Transport time from scene of accident to ED (min)	10	15	<0.001	14
n =	99	144		243
Time from accident until arrival at ED (min)	50	85	<0.001	70
n =	107	147		254
Prehospital fluid volume administered (ml)	100	500	<0.001	500
Outcome characteristics				
Deaths <30 days (%)	(14)	(10.2)	ns	(12)
Cause of death (%)				
Haemorrhage ± fatty embolism	(53)	(27)	ns	(40)
CCT, PE, organ failure	(47)	(73)		(60)
Time of death (%)				
<1 day	(73)	(40)	ns	(57)
>1 day	(27)	(60)		(43)

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Table 1–Patient characteristics (ns = not significant; ED = Emergency Department; CCT = Craniocerebral trauma; min = minutes; PE = Pulmonary embolism; Median for continuous variables unless otherwise stated)

logistic regression for an adjusted mortality odds ratio (OR), and risk-factor analysis.

Results

Patient Characteristics (Table 1)

Ninety-one percent of the 280 patients had complete data for the comparison of crude mortality rates. The characteristics of the two groups, results of the statistical testing, and totals are summarised in Table 1.

Comparison of Mortality (Table 2)

The 30-day mortality rate in Group 1 was 15/107 (14%), and was higher than the 15/147 (10.2%) observed in Group 2 (not statistically significant).

Based on the ASCOT score and a predicted mortality rate in Group 1 of 10.2, there were 4.8 more deaths (CI-0.162 to 9.79), or 47% more than predicted; this difference fell just below the level of statistical significance at p = 0.057. In Group 2, for which the predicted mortality rate

Deaths	Group 1 ≤60 minutes (n = 107)			Group 2 >60 minutes (n = 147)		
	Number	*p*-value[1]	Mortality (%)	Number	*p*-value[1]	Mortality (%)
Actual	15	0.057	(14) 15/107	15	0.19	(10.2) 15/147
Predicted	10.2		(9.5)	19.2		(13.1)
(95% confidence interval)	(5.2 – 15.2)		15/107	(13 – 25.4)		15/147

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Table 2–Comparison of actual and predicted mortality rates according to time from accident to arrival at emergency department ([1] = 2 tailed)

	With intubation (n = 99, 25 deaths)		Without intubation (n = 228, 26 deaths)	
	Odds ratio	**(95% CI)**	**Odds ratio**	**(95% CI)**
≤60 minutes vs. >60 minutes	8.3	(1.3 – 51.5)	8	(1.7 – 38.5)
and	and		and	
Risk Factor	**Odds ratio**	**(95% CI)**	**Odds ratio**	**(95% CI)**
ASCOT	0.95	(0.092 – 0. 98)	0.93	(0 9 – 0.95)
Causes of trauma				
Road traffic vs. others	2.7	(0.66 – 10.99)	0.41	(0.11 – 1.53)
Primary catchment area vs. secondary catchment area	0.47	(0.04 – 5.98)	0.42	(0.07 – 2.6)
EMT vs. EP	72	(3.4 – 1'542)	56	(2.7 – 1'160)
On-scene time ≤ 20 min vs. >20 min	0.63	(0.13 – 2.97)	0.39	(0.099 – 1.57)
Ambulance vs. helicopter	0.099	(0.007 – 1.39)	0.07	(0.005 – 0.97)
Prehospital intravenous volume infused	1.4	(0.75 – 2.6)	1.65	(0.87 – 3.1)
Transport time from scene of accident to ED	1.004	(0.931 – 1.082)	0.995	(0.92 – 1.08)
On-scene intubation vs. intubation in ED	1.44	(0.18 – 11.6)		
	Mc Fadden's Rho-Squared = 0.396 ($p < 0.001$)		Mc Fadden's Rho-Squared = 0.339 ($p < 0.001$)	

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Table 3–Statistical comparison of actual and predicted mortality rates according to time from accident to arrival at emergency department (ED = Emergency department; EMT = Emergency medical technician; EP = Emergency physician)

was 19.2, there were 4.2 fewer deaths (CI - 10.35 to 2.056), or 22% less than predicted (p = 0.19).

Adjusted Mortality Odds Ratio for Patients and Risk Factor Analysis for Mortality (Table 3)

Group 1 differed significantly from Group 2 with regard to 10 characteristics (Table 1). The adjusted mortality OR of Group 1 compared with Group 2 was 8 (CI = 1.7 to 38.5) and this difference was significant statistically (p = 0.009). The factors of the ASCOT score (p <0.001), care by an emergency physician (p = 0.009) and the means of transport (p = 0.047) also were significantly different.

Discussion

Exceeding the "golden hour of shock" as a time limit for the entire rescue period had no negative effect on the mortality rate of blunt trauma patients. On the contrary, in Group 1 more patients than predicted died (just below the level of significance, p = 0.057) and the relative risk of death was eight times higher than in Group 2. The latter difference was significant statistically.

In view of the large number of papers published about mortality rates in victims of traumatic injuries and great differences in methods used, the scope of this paper is too small to allow a comprehensive review. For this reason, only a few important studies have been chosen to represent the different results and points of view. The findings in the current study contradict those of the collective results of one of the leading research groups in the field of prehospital trauma life support. In several papers of a cohort between 1987 and 1988, based on the same group of patients the researchers reported an increased risk of mortality for rescue periods >60 minutes.[9-11] They also studied a group of 12,208 patients and found a significant reduction in mortality rates between 1992 and 1998.[12] This improvement was seen following the introduction of a new regional trauma system, and the trend of shortening of prehospital times. In arithmetic terms, mortality increased by 5% for each minute the prehospital time was extended up to the institution of definitive treatment measures inhospital. Recently, the same group of authors published a meta-analysis on the outcome of prehospital advanced trauma life support (ATLS) compared to basic trauma life support. The mortality OR of 2.59 (with no mention of statistical significance) for ATLS was attributed to the longer on-scene times.[13]

A series of other publications[6-8,14,19] confirm the results of the current study. Longer prehospital times were associated with a better clinical outcome in two investigations.[14,19] However, these positive results were not discussed. The authors either were unable to explain them or chose not to. Pepe *et al* found that longer rescue periods albeit within the first hour–did not affect the outcome, even in cases of penetrating trauma.[6] Reines *et al*[7] and Cayten *et al*[8] also were unable to establish a relationship between increased mortality rates and longer prehospital periods.

The question is: "What is the explanation for these contradictory results in the literature?" So far, no minimal standards for the scientific investigation of aspects of prehospital trauma care have been available.[20] One result of this is a wide range of study designs with correspondingly different results. For example, studies have included groups with blunt trauma,[19] penetrating trauma,[6] and mixed trauma.[9,10] A wide range of trauma severity scoring systems (TRISS,[7] ISS,[10] Prehospital Index,[11] and ASCOT) and severity scales also have been used. Further confounding factors include different levels of care at the treating hospitals, different demographics, different types of emergency services with paramedics, emergency medical technicians and physicians, and different emergency systems. The following also have an influence: inclusion of a subset or the entire population,[10] prospective[6] or retrospective[19] nature of the study, and whether the study was randomised. Studies very often make no mention of the quality of care, e.g., the success rate of intubation and its complications.

Significantly fewer patients (49%) were treated by an emergency physician in the group with rescue periods ≤60 minutes than in the group with rescue periods >60 minutes (91%). In accordance with other reports,[11,13] the deployment of an emergency physician in this trauma system was associated with longer on-scene times: 34 minutes vs. 17 minutes (p <0.001). However, multivariate logistic regression analysis showed that on-scene times with limits of 20, 25, and 30 minutes were not associated with a significant risk of death in this study. This confirmed the North American experience with the audit filter of >20 minutes on-scene time. The on-scene time filter proved to be useless and inefficient.[21] Therefore, it was excluded from the Guidelines in 1993.[1] Also, all of the other components of the rescue period; the time from the accident to the emergency call, the time from the emergency call, to the arrival of the emergency team at the scene of the accident, and the time from departure to arrival in the emergency department–all significantly higher in the group with rescue periods >60 minutes–had no influence on mortality rates.

Similar to the study reported by Sampalis *et al*,[13] it is easy to imagine that the emergency physician extended the on-scene time by instituting ATLS measures (significantly more intubations and prehospital fluid). These ATLS-measures could have been responsible for the better outcome in the group with rescue periods >60 minutes. Surprisingly, in contrast to the univariate analysis (Table 1), on-scene intubation and the amount of intravenous fluids did not decrease mortality rates in the multivariate analysis. This possibly may be due to a sample size problem (too little power).

It also should be considered that the significance of prehospital ATLS has changed decisively since the introduction of the concept of the "golden hour of shock." Generally, early intubation now is recommended for patients with craniocerebral trauma with a Glasgow Coma Scale Score ≤8.[22] It should be performed by an experienced physician on-scene. The prevention of a single, even if short-term, hypoxic and hypotensive episode has emerged as a significant prognostic factor in patients with craniocerebral trauma.[23] Non-surgical management of blunt trauma to the liver and spleen, regardless of the severity of the injury, seems to become standard practice in haemodynamically stabilised and stable patients.[24] This means that one of the main arguments for the adherence to the principle of the "golden hour of shock" in blunt polytrauma– namely surgical treatment of intraabdominal haemorrhages as soon as possible–no longer carries such weight. Larger centres in the USA perform laparomities in children with traumatic haemorrhage of the spleen and liver only once every four to 17 months.[24] No figures are available for adults.

Furthermore, based on pathophysiological considerations, still it is often claimed that early intravenous analgesic therapy, in addition to subjective relief for the patient, contributes to the prevention of multiple organ dysfunction syndrome, although no specific studies have shown this. If so, it should be possible to prevent deaths with the help of an early and appropriate analgesia.

Finally, the current data and additional arguments from the literature only allow speculation on the extent to which the presence of an emergency physician and/or the ATLS measures discussed explain the better outcome in the group with rescue periods >60 minutes. If they did have a positive effect, this means that the emergency physician gave definitive on-scene treatment for potentially life-threatening conditions, and in doing so, saved the patient's life. The decisive factor would be that for some patients it would not have been possible to defer such measures until arrival at the emergency department. The design of the present study, however, does not permit this conclusion as well. It is not possible to prove that no patient died later because of the time spent for prehospital treatment.

Reliability

The observational cohort study was the most appropriate design to test the hypothesis of the present study. The best approach at present–the prospective, randomised study–is inappropriate for this type of investigation. Furthermore, for reasons of efficiency and methodology, the study population was restricted to blunt polytrauma patients, and did not use the wider inclusion criteria used for Major Trauma Outcome Study (MTOS).[15] It was expected that this patient group would profit most from definitive medical treatment, and therefore, it should be possible to demonstrate relevant differences with small numbers.

The strength of the current study lies in its prospective design, its limitation to blunt polytrauma patients, and the evaluation of a single trauma system with all patients treated at the same Level I hospital.

However, the study does, have some weak points. The small sample size and low power were probably responsible for the fact that the comparison of the actual and predicted number of deaths in the group with rescue periods ≤60 minutes failed to reach statistical significance. However, by using multivariate logistic regression, it was possible to test for any effects due to the low power, and in addition, to a range of different variables on mortality. This analysis showed a significantly higher adjusted risk for death in the group with rescue periods ≤60 minutes as opposed to those where the rescue period was longer.

Excluding patients from the analysis due to missing information also can affect the results. Among the 26 patients with lacking time data, there were two deaths. Even assuming the worst case, namely that only these deaths belong to Group 2, there was no significant difference between actual and predicted mortality rates. The difference, however, would be significant statistically (p <0.05), if the two deaths belonged to Group 1, since in this case, seven patients more than predicted would have died among the patients with rescue periods of ≤60 minutes. Furthermore, it must be borne in mind, that 10% of the data essential to perform regression calculation were missing (Table 3).

Data quality assurance also was not conducted for staffing and logistical reasons, and in particular, it was not possible to verify how precisely the different time periods involved were documented. The information used was provided by the emergency services and dispatchers. They were not informed about the objectives of the study and did not make use of automatic registration of times.

No indications of any major bias or confounding factors were identified that were not controlled for by the multivariate logistic regression analysis.

However, there are some reservations with regard to the conclusions, and in particular, it is not possible to draw firm conclusions on the results with regard to the whole of Switzerland or areas with similar emergency systems. These can only be supplied by further comparative studies.

Conclusions

The small sample size and missing data in 9% of the cases mean that these findings must be interpreted with caution. However, it does appear in this trauma system, where emergency physicians often are deployed, that the “golden hour of shock” can be extended safely in many blunt polytrauma patients, since this was associated with better survival figures than patients for whom it was <one hour.

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