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New standards in prehospital emergency procedures and its impact on treatment results in patients with head injury

A modern system of first-aid service which has been created in Poland since 1999 aims at improving adverse outcome in patients with life or health threat. It also relates to patients with injuries. Implementation of the system involved, among others changes, introducing international prehospital rules, which significantly differed from the rules previously applied at that stage of treatment. Trainings on Advanced Life Support and Advanced Trauma Life Support for ambulance staff and algorithms according to the guidelines of the American College of Surgeons were implemented. In hospitals Emergency Departments came into existence and dispatch centers, which carried alarm notifications and coordinated working of all system units, started to function. The number of ambulances and their disposition was increased in order to maximally shorten the access time to a place of an event. Lublin region was one of the first regions which realized guidelines of a new first-aid system setting up 19 ED, increasing a number of ambulances to 87 and creating 10 Dispatch Centers. Changes introduced in this period concerned only first stages of therapy – prehospital stage and Emergency Department – and there were no significant changes made in the further stages of treatment, no rules of regional trauma system were introduced, no trauma centers were created, no changes in localization and the number of hospitals. Trauma patients, no matter what kind and severity of injuries, are still transported to the nearest hospital and then, after initial stabilization depending on necessity, they may be transported to a specialistic hospital. Injuries of central nervous system, especially those described as severe head injuries (SHI), account for a group of injuries in which organizing and quality of health care in an early period after an injury are crucial for an outcome. The authors of the study took advantage of comparing therapy outcomes of patients with SHI treated before and after the implementation of the new procedure standards in Emergency Medical Services. Advanced Trauma Life Support in out-of-hospital setting was minimal in the period chosen as control group for this study. Current standards of SHI treatment give priority to avoiding secondary brain lesions. Resuscitation, maintenance of air passages patency and oxygen therapy, which affect brain tissue perfusion, are of great importance during prehospital time. Treatment results in patients with SHI depend on many factors which among others are process of care variables connected with Emergency Services organization, such as early prehospital intubation (EPI), early fluid resuscitation (EFR) and prehospital time (PT). Other factors are: severity of head injuries and coexisting injuries, patient's age, coexisting diseases, existence of preadmission hypotension and many others. Therefore, the aim of the study was to determine whether implementation of new national guidelines in Polish Prehospital Emergency Services were associated with lower mortality in patients with SHI treated in Lublin urban area. Conclusions of the research might contribute to choosing new directions in reorganization of health care for victims of injuries in Poland.

MATERIAL AND METHODS

The study was a retrospective observational analysis correlating demographic, clinical and process of care variables with survival of patients with SHI treated in the Department of Trauma Surgery in the University Hospital no 1 in Lublin. Variables are connected with care process, such as early prehospital intubation (EPI), early fluid resuscitation (EFR) and prehospital time (PT). According to a new system model, they should have been modified during the compared periods. Further analyses were conducted using statistical analysis methods to identify risk factors associated with mortality rate in the analyzed group of patients. All patients with injuries who were treated in the Department of Trauma Surgery in Lublin in two 4-year periods: 1995–1998 (n=4115) and 2001–2004 (n=4678) were evaluated. In both groups retrospective analysis of medical documentation was performed and patients with severe head injuries (SHI) were identified. Each case was individually analyzed by the authors, because of the lack of a trauma register functioning on a regional level or even in hospitals. SHI defined as GCS $\leq$8 or Head AIS $\geq$3 or both, admitted to the Department of Trauma or the Intensive Care Unit in University Hospital no 1 in Lublin in the periods from 1st January 1995 to 31st December 1998 (n=117) and from 1st January 2001 to 31st December 2004 (n=132) were included into the study. Neurological state at the admission was assessed according to Glasgow Coma Scale (GCS). To assess severity of body injury Abbreviated Injury Scale AIS 1990 revision was used, and basing on this scale Injury Severity Score (ISS) was calculated. Prehospital time (PT) was defined as time from an injury to hospital admission. Hypotension was diagnosed if systolic blood pressure was $\leq$ 90 mm Hg. Mechanism of injury described as high energy trauma was recognized: a) if a victim was a vulnerable road user (pedestrian, bicycle, bike or motorcycle driver), b) if an injury was caused by a fall from altitude or c) if a victim was a driver or a passenger of a vehicle which at a moment of an accident drove faster than 50 km/h, there were dead casualties inside a vehicle or after-accident deformations of a vehicle indicated huge forces during an accident. The statistical significance of data analysis was based on χ^2 test and was used to assess the significance of association between the mortality and the categorical variables. A p-value of 0.05 was used for obtaining the odds ratio of mortality, adjusting for other significant factors. A 5% conclusion error was assumed.

RESULTS

A total of 8,793 trauma patients treated in the Department of Trauma Surgery in Lublin were included into the retrospective analysis based on medical documentation. Mere mortality increase was stated in the second analyzed period (6.24% vs. 7.31%, respectively) but the difference was not statistically significant. However, in both periods statistically significant differences in mortality of patients with head injuries comparing to those with other injuries were affirmed (12.63 vs. 4.98 and 14.17 vs. 5.97 in the I and II group, respectively)

Table 1. Characteristics of a population of trauma patients hospitalized due to different types of injuries in the years of 1995–1998 (group I) and 2000–2004 (group II)

Groups of patients	Number of patients I / II	Number of deaths I / II	Mortality comparison I / II	Mortality comparison A/B
All trauma patients	4115/4678	257/342	6.24 / 7.31 (χ 2 =3.91 p=0.05)	
A. Patients without head injury	3434/3916	171/234	4.98 / 5.97 (χ 2 =3.48 p=0.06)	χ 2 =119.61 p<0.00001
B. Patients with head injury	681/762	86/108	12.63/ 14.17 (χ 2 =0.74 p=0.39)	

Among all the trauma patients those who fulfilled inclusion criteria (severe head injury) were identified (117 in the 1st period and 132 in the 2nd one).

Table 2. Comparison of a number of patients and mortality rate in both analyzed periods regarding demographic variables

Variable	Group I n. (%)	Group II n. (%)	Statistics I vs. II	Mortality I n. (%)	Mortality II n. (%)	Statistics I vs. II
Male	84 (71.79)	84(63.64)	$\chi 2 = 1.88$ p=0.17	37(44.05)	34 (40.48)	$\chi 2 = 1.1$ p=0.29
Female	33 (28.21)	48(36.36)		14 (42.42)	20 (41.67)	
Mean age (SD)	43.2(19.9)	41.7 (19.7)	Z=0.61 p=0.54	44.31(21.37)	43.04(21.43)	Z=0.28 p=0.78
Median/Range	42/14-92	39/14-92		44/14-92	43.5/14-92	
> 55 year old	33 (28.21)	34 (25.76)	$\chi 2 = 0.19$ p=0.66	18 (54.55)	18 (52.94)	$\chi 2 = 0.04$ p=0.83
≤ 55 year old	84 (71.79)	98 (74.24)		33 (39.29)	36 (36.73)	
High energy trauma	58 (49.57)	68 (51.52)	$\chi 2 = 0.09$ p=0.76	29 (50.0)	33 (48.53)	$\chi 2 = 0.2$ p=0.66
Other mechanism	59 (50.43)	64 (48.48)		22 (37.29)	21 (32.81)	
Total	117 (100)	132 (100)	-	51 (43.59)	54 (40.91)	$\chi 2 = 0.18$ p=0.67

SD – standard deviation

Table 3. Comparison of a number of patients and mortality rate in both analyzed periods regarding clinical variables

Variable	Group I n. (%)	Group II n. (%)	Statistics I vs. II	Mortality I n. (%)	Mortality II n. (%)	Statistics Mort. I vs. II
Isolated injury	53 (45.30)	58 (43.94)	$\chi 2 = 0.05$ p=0,83	19 (35.85)	20(34.48)	$\chi 2 = 0.001$ p=0.98
Multiple injury	64 (54.70)	74 (56.06)		32 (50.00)	34 (45.95)	
GCS 3-5	42 (35.90)	51 (38.63)	$\chi 2 = 0.2$ p=0.66	24 (57.14)	25 (49.02)	$\chi 2 = 0.01$ p=0.94
GCS 6-8	75 (64.10	81 (61.36)		27 (36.00)	29 (35.80)	
Head AIS 3-4	88 (75.21)	99 (75.00)	$\chi 2 = 0.002$ p=0.97	30 (34.09)	31 (31.31)	$\chi 2 = 0.02$ p=0.88
Head AIS 5-6	29 (24.79)	33 (25.00)		21 (72.41)	23 (69.70)	
ISS 9-15	18 (15.38)	17(12.88)	$\chi 2 = 0.61$ p=0.74	3 (16.67)	2 (11.76)	$\chi 2 = 1.45$ p=0.48
ISS 16-24	26 (22.22)	34 (25.76)		4 (15.38)	8 (23.53)	
ISS > = 25	73 (62.39)	81 (61.36)		44 (60.27)	44 (54.32)	
Mean ISS (SD)	30.7(17.64)	31,51(18.34)	Z= -0.32 P=0.75	41.39(19.36)	41.5(20.26)	Z=0.05 p=0.96
Median ISS	25	25		41	41	
Hypotension SBP<= 90	20 (17.09)	22 (16.67)	$\chi 2 = 0.01$ p=0.93	13 (65.00)	13 (59.09)	$\chi 2 = 0.03$ p=0.87
Hypotension SBP> 90	97 (82.91)	110 (83.33)		38 (39.18)	41 (37.27)	
Total	117 (100)	132 (100)	-	51 (43.59)	54 (40.91)	$\chi 2 = 0.18$ p=0.67

GCS - Glasgow Coma Scale, AIS – Abbreviated Injury Scale, ISS – Injury Severity Score, SBP – Systolic Blood Pressure, SD – standard deviation

A comparison of those groups revealed that both groups were homogenous with regard to demographical and clinical parameters. No statistically significant differences in mortality during the analyzed periods were stated (43.59% vs. 40.91%, respectively, $\chi 2=0.18$ p=0.67). Even when adjusting for demographical parameters such as age, gender, mechanism of injury, or selected parameters of clinical state such as: multiple injuries, preadmission GCS score, Head/Neck AIS score, ISS and presence of preadmission hypotension, neither group size nor mortality within particular variables revealed statistically significant differences between both analyzed periods.

Table 4. Comparison of a number of patients and mortality rate in both analyzed periods regarding process of care variables

Variable	Group I n. (%)	Group II n. (%)	Statistics I vs. II	Mortality I n. (%)	Mortality II n. (%)	Statistics I vs. II
EPI						
Yes	14 (11.97)	67 (50.76)	$\chi 2$ =42.52 p<0.001	8 (57.14)	35 (52.24)	$\chi 2$ =26.18 p<0.001
No	103 (88.03)	65 (49.24)		43 (41.75)	19 (29.23)	
EFR						
Yes	24 (20.51)	76 (57.58)	$\chi 2$ =35.45 p<0.001	14(58.33)	34(44.74)	$\chi 2$ =13.33 p=0.0003
No	93 (79.49)	56 (42.42)		37(39.78)	20(39.29)	
PT						
0–30 min n.(%)	25 (21.37)	34 (25.76)	$\chi 2$ =0.73 p=0.69	11 (44.00)	9 (26.47)	$\chi 2$ =0.7 p=0.7
31–60 min n.(%)	81 (69.23)	85 (64.39)		35 (43.21)	41 (48.24)	
> 60 min n.(%)	11 (9.40)	13 (9.84)		5 (45.45)	4 (30.77)	
Mean (SD) in min	48.91 (20.01)	42.75 (17.21)	Z=3.06 p=0.002	49.18 (21.89)	43.96 (15.20)	Z=1.5 p=0.13
Total	117 (100)	132 (100)	-	51 (43.59)	54 (40.91)	$\chi 2$=0.18 p=0.67

EPI - Early Prehospital Intubation, EFR - Early Fluid Resuscitation, PT - Prehospital Time

Significant differences were stated in both groups of patients regarding the process of care variables (EPI, EFR and PT) and were connected with introducing modifications in first-aid system in Lublin region (Tab 4). The percentage of patients who were intubated during prehospital time was almost fivefold higher in group II (11.96 vs. 50.76 %, respectively, p<0.001). Also, the percentage of patients in whom fluid resuscitation was initiated during prehospital time significantly grew in group II (20.51% vs. 57.58%, respectively, p<0.001). It was stated that mean prehospital time was reduced by over 6 minutes from 48.91 min. to 42.75 min. (p=0.002). It should be noticed, also, that in both periods over 90% of victims reached hospital within the time shorter than 60 minutes, which is typical of urbanized areas with a large number of ambulances and a network of hospitals treating trauma patients.

DISCUSSION

Injuries of central nervous system (CNS), as it results from statistical analyses, account for almost 12% of the general number of injuries. In case of multiple injuries the percentage increases up to 60%, and among the deaths because of CNS injuries sustained in car accidents it reaches even 70–80% (6, 10). Genarelli et al., after analyzing a group of over 16 thousands of patients with head injuries treated in several trauma centers in the United States, claimed that average mortality among patients with head injuries (18.2%) was threefold higher than among patients without such diagnosis (6.1%) and deaths of these patients accounted for 67.8% of all deaths caused by injuries. In our research (Tab. 1) in both analyzed periods the percentage of deaths in the group of patients with head injury was almost threefold higher than in the group of patients who sustained other injuries (12.63% vs. 4.98% and 14.17% vs. 5.97%, $p<0.00001$ in the I and II group, respectively). Many factors affect the final outcome in patients after craniocerebral trauma: starting with severity of primary trauma at the moment of an injury, throughout treatment during prehospital time, up to specialistic hospital treatment. In contradiction to primary lesions, secondary lesions occur later, when a patient usually is under medical care, thus they may be prevented or their consequences may be reduced by adequate treatment. Hypoxia and hypercarbia of the brain tissue unquestionably lead to secondary brain lesion and to a worse outcome, which has been proved in many researches [7, 9]. That is why there exists a belief that early intubation, oxygen therapy and fluid resuscitation during transportation to hospital are of such great importance for further prognostication in these patients. Nevertheless, it should be considered that consequences of hypoxia and hypotension depend on their severity and time of their persistence, thus the time passing before an ambulance service arrives to an event scene and transportation time may have a considerable influence on the final outcome. In this study (Tab. 4) it was stated that a majority of patients reached hospital within a „golden hour" from an injury, so cutting down this time by 10 minutes did not significantly affect ($p=0.13$) a decrease of mortality in the analysed group of patients. Our findings were consistent with previous analyses exploring first-aid services activities in urban areas (1). Early intubations and hypotension prevention in patients after SHI belong to a standard of care for this group of patients. In practice it means obtaining access to a patient's vein as early as possible and beginning shock-controlling therapy, as well as conducting oxygen therapy through breathing mask or intubation tube already at the scene of an accident (3, 4). However, it has to be taken into consideration that early intubation does not automatically mean improvement of brain cells' oxygenation. There are some reports over the positive influence of prehospital intubation on a survival rate of patients with TBI. Nevertheless, most of the researchers report on a lack of improvement or an unfavorable influence on an outcome of early prehospital intubations in patients with SHI (5, 11). Similar observations were made on the population of patients analyzed by the authors, where despite a significant increase of prehospital intubation percentage from 11.97% in the group I to 50.76% in the group II, the mortality was similar in both groups (43.59 vs. 40.91% in I and II group, respectively). Moreover, a higher mortality rate was stated in the group of intubated patients in both analyzed periods $p=0.02$. In the analyzed group of patients, despite inclusion criteria similar to other researches, a relatively large percentage of performed intubations can draw the reader's attention (50.76% of patients from the group II were intubated in prehospital conditions). It should be attributed to high professional skills of physicians from ambulance staffs (40% of them are anesthesiologists), who intubate successfully more often than paramedics. Moreover, Polish physicians in ambulances, contrary to many other first-aid systems (8), often apply anesthetic drugs, neuromuscular paralytic agents and sedative agents to facilitate endotracheal intubation (ETI). Bulger et al. confirmed (2) that the availability of paralytic agents

allows expansion of the indications for prehospital airway control. Summing up, it seems that in urban area the creation of a regional trauma system and improvement in hospital care of SHI patients may have a crucial role in the improvement of treatment outcome rather than prehospital activities.

CONCLUSIONS

1. The introduced administrative modifications of first-aid service in Lublin urban area led to prehospital time reduction and increase in percentage of activities for secondary prophylaxis of central nervous system damage; however, they did not influence mortality rate in patients with SHI.

2. Dynamics of changes conditioned by a primary injury is a factor which mainly determines survival rate in patients with SHI in whom prehospital time is shorter then 60 minutes, whereas prehospital time limited by the EMS efficiency and has minor influence on a final treatment outcome.

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SUMMARY

Objectives: To determine whether implementation of new guidelines in Prehospital Emergency Services is associated with lower mortality in patients with severe head injuries (SHI) in an urban population. Methods: Retrospective analysis of patients with (SHI) treated in the Department

of Trauma Surgery in Lublin was performed. Treatment outcomes of patients treated before the development of a new prehospital trauma care model during the years of 1995–1998 were compared to treatment outcomes of patients treated during the years of 2001–2004. Results: Patients in both analyzed periods were homogenous with regard to demographical and clinical parameters. The significant growth of prehospital emergency procedures aimed in CNS protection was observed. Mortality in both analyzed periods did not differ significantly in both analyzed groups. Conclusions: The implemented modifications led to prehospital time reduction and increase of percentage of secondary brain damage prophylaxis activities; however, they did not influenced mortality of patients with SHI in the analyzed urban population.

Nowe standardy w przedszpitalnych procedurach ratunkowych i ich wpływ na wyniki leczenia pacjentów z obrażeniami głowy

Celem pracy jest ocena wpływu wprowadzenia nowych zasad funkcjonowania przedszpitalnych służb ratunkowych na wyniki leczenia pacjentów z ciężkimi obrażeniami głowy. Zastosowano metodę analizy retrospektywnej wyników leczenia pacjentów hospitalizowanych w Klinice Chirurgii Urazowej w Lublinie. Porównano wyniki leczenia chorych hospitalizowanych przed wprowadzeniem zasad nowego modelu ratownictwa przedszpitalnego w latach 1995–1998 z wynikami leczenia pacjentów hospitalizowanych w latach 2001–2004. Populacje chorych w obu analizowanych grupach były jednorodne pod względem parametrów demograficznych i klinicznych. Obserwowano znaczący wzrost liczby procedur ratunkowych w warunkach przedszpitalnych, mających na celu protekcję centralnego układu nerwowego u pacjentów z ciężkimi obrażeniami głowy. Śmiertelność w obu analizowanych grupach chorych nie różniła się w sposób istotny. Wnioskując, zmiany wprowadzone w przedszpitalnych strukturach ratownictwa doprowadziły do skrócenia tzw. okresu przedszpitalnego leczenia oraz wzrostu liczby przedszpitalnych procedur zapobiegających wtórnym uszkodzeniom mózgu, nie wpłynęło to jednak na spadek śmiertelności w analizowanej populacji miejskiej.