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Diagnostic groups of risk in trauma patients as independent groups of atients. Proposition for National Helth Founadtion. Clinical estimation costs of treatment. II. Direct and indirect costs of trauma

Diagnostyczne grupy ryzyka (DGR) w obrażeniach ciała, jako osobne jednorodne grupy pacjentów (jgp). Propozycja do katalogu NFZ. Ocena kliniczna kosztów leczenia: II. Koszty bezpośrednie i pośrednie urazów

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Trauma constitutes one of the greatest plagues of our times, and injuries are responsible for the largest number of years of potential life lost, incapacity to work and impairment. When at the end of 80-ties it turned out, that costs of hospital treatment alone in traumatic patients in the USA reach 11.4 billion dollars annually, this aroused interest and initiated studies lasting over a dozen of years in the USA and Europe. In Poland number of years of potential work lost due to injuries amounts to 300.000 annually, and number of years of potential life lost reaches half of million. Costs of treatment, rehabilitation, compensations and disability pensions were not calculated, because - in contrast to western countries - this problem was not analyzed yet. Retrospective study was performed to assess to what extent particular parameters - localization and extent of injury, age and gender of patients and severity of injury - are related to direct and indirect costs of the treatment, and what are indirect costs in the form of sickness benefits, disability pensions and lost gross national product (PKB) due to short-term and long-term incapacity to work and due to lost years of life by deceased. The other aim was assessment whether those data can be used for construction of new division of the patients - based on ICD-9 and ICD-10 - which would allow National Health Foundation for the more precise calculation of costs of treatment The group of 3614 patients with injuries constituted the study material for statistical analysis. The study group included 3435 patients hospitalized during the "emergency duty days" and 179 trauma victims who died during pre-hospital care. Patients who died in pre-hospital period were not included in the calculation of direct costs of treatment, that covered costs of drugs and other medical expenses (e.g. dressings). Costs of work of medical and auxiliary staff were also excluded. The data were collected on the basis of computer database called "PACJENCI" compiled in our Chair. Statistical analysis included calculation of sums, subtractions, mean values, percentages, standard deviations and other tests - T-Student, Chi² and non-parametric te-

Urazowość jest jedną z największych plag naszych czasów, a urazy są przyczyną największej liczby utraconych lat życia, niezdolności do pracy i niepełnosprawności. Kiedy pod koniec lat 80. okazało się, że same tylko koszty leczenia szpitalnego chorych po urazach w USA wynoszą 11,4 miliardów dolarów rocznie, nastąpił wzrost zainteresowania tym problemem i zapoczątkował kilkunastoletnie badania naukowe, zarówno w USA, jak i w Europie. W Polsce liczba utraconych lat pracy na skutek urazów odniesionych w ciągu jednego roku wynosi około 300 tysięcy, a utraconych lat życia sięga pół miliona, zaś kosztów leczenia, rehabilitacji, odszkodowań i rent inwalidzkich nie policzono, bo w przeciwieństwie do krajów zachodnich, u nas zagadnienia tego praktycznie dotychczas nie analizowano. Badanie retrospektywne przeprowadzono, by sprawdzić, czy i na ile poszczególne parametry - uszkodzona okolica ciała, rozległość obrażeń, wiek i płeć pacjentów oraz ciężkość urazu - wiążą się z kosztami bezpośrednimi i pośrednimi leczenia, a także jak wysokie są koszty pośrednie urazów w postaci zasiłków chorobowych, rent inwalidzkich i utraty produktu krajowego brutto (PKB) na skutek krótko i długookresowej niezdolności do pracy i utraconych lat pracy przez zmarłych i czy mogą one posłużyć do konstrukcji takiego podziału chorych, który, związany z ICD-9 i ICD-10, byłby przydatny dla NFZ dla bardziej precyzyjnego obliczania kosztów leczenia. Dokonano analizy statystycznej danych o 3614 chorych z obrażeniami ciała (3435 hospitalizowanych w trybie nagłym, i 179 zmarłych w okresie przedszpitalnym. Przy obliczaniu kosztów bezpośrednich leczenia, które objęły koszty leków, materiałów medycznych i t. zw. koszty hotelowe, nie uwzględniano ofiar wypadków zmarłych w okresie przedszpitalnym. Nie uwzględniono również kosztów pracy personelu medycznego i pomocniczego. Dane o chorych gromadzono w oparciu o stworzoną dla potrzeb Katedry bazę PACJENCI. W analizie tej obliczano sumy, różnice, średnie, wartości procentowe, odchylenia standardowe, a także szereg testów statystycznych - T-Studenta, chi² oraz szereg testów nieparame-

sts such as Spearman's rank correlation coefficient, Mann-Whitney test, Kruskal-Wallis test and univariate analysis of variance (ANOVA). The highest direct costs were found in the groups of injuries of: lower extremities (11 818 832 PLN), multiple injuries (4 753 080 PLN) and head injuries (4 060 756 PLN). However mean direct costs were the highest in multiple injuries (22 315 PLN) and injuries of lower extremities (9531 PLN). The highest numbers of years of potential life lost were also found in groups of injuries of lower extremities (1748) and multiple injuries (1384). Similarly indirect costs proved to be the highest in the groups of injuries of lower extremities (82 179 256 PLN) and multiple injuries (66 909 600 PLN), but in multiple injuries mean loss reached 269 797 PLN, while in injuries of lower extremities only 122 109 PLN. Except for the abdominal injuries (33.45%) direct costs turned out to constitute only 10% of all costs of treatment of consequences on injuries - that implies necessity of use of the most effective (even if the most expensive ones) therapeutic methods, especially in the injuries of lower extremities. Those results are conditional upon the number of patients in particular groups, which differ from each other in the severity of injuries and in the age of patients. Costs of treatment are directly correlated with localization of injuries, age and gender of patients, severity and extent of injuries. As counted per one patient treatment of multiple injuries and injuries of lower extremities are the most expensive; they also result in the highest indirect costs. Despite the high direct costs of treatment of injuries they constitute only small percentage of all costs of trauma. Probably for the relatively small price better results of treatment could be obtained resulting in marked savings in indirect costs.

trycznych, takich jak współczynnik korelacji rang Spearman'a, test Manna---Whitney'a, test Kruskala-Wallisa i 1-czynnikową analizę wariancji ANOVA. Największe koszty bezpośrednie pociągnęły za sobą obrażenia kończyn dolnych (11 818 832 zł), mnogie obrażenia ciała (4 753 080 zł) i obrażenia głowy (4 060 756 zł), niemniej najdroższe (średnio) było leczenie chorych z MOC (22 315 zł) i z obrażeniami kończyn dolnych (9531 zł). Największą liczbę utraconych lat pracy pociągnęły za sobą również obrażenia kończyn dolnych (1748) i mnogie obrażenia ciała (1384). Podobnie koszty pośrednie najwyższe okazały się w obrażeniach kończyn dolnych (82 179 256 zł) i w mnogich obrażeniach ciała (66 909 600 zł), ale średnio na skutek MOC straty wyniosły aż 269 797 złotych, a w następstwie obrażeń kończyn dolnych tylko 122 109 złotych. Poza obrażeniami brzucha (33,45%), koszty bezpośrednie stanowiły około 10% wszystkich kosztów leczenia następstw urazu, co w istotny sposób narzuca konieczność stosowania najskuteczniejszych (nawet, jeśli droższych) metod leczenia, zwłaszcza w obrażeniach kończyn. Wyniki te w znacznej mierze zależą od liczby leczonych w poszczególnych grupach, które poza tym różnią się tak ciężkością obrażeń jak i wiekiem chorych. Koszty leczenia w prosty sposób skorelowane są z lokalizacją obrażeń ciała, płcią i wiekiem pacjentów, ciężkością i rozległością urazu. W przeliczeniu na jednego

Introduction

Trauma constitutes one of the greatest plagues of our times, and injuries are responsible for the largest number of years of potential life lost, incapacity to work, impairment and stated disability [1-3]. When at the end of 80-ties it turned out, that costs of hospital treatment alone in traumatic patients in the USA reach 11.4 billion dollars annually, this aroused interest and initiated studies lasting over a dozen of years in the USA, Europe and throughout the world [4-8] , . Nowadays it's estimated that those costs in the USA exceed 150 billion dollars annually and in Great Britain reach about 4.5 billion dollars . It's necessary to add to those costs compensations paid, disability pensions and costs of years of potential work lost for professionally active people. In the USA the latter were assessed to reach 4 million years annually, without even attempt to calculate losses suffered by the state due to sickness absence [1,10]. In Poland number of years of potential work lost due to injuries amounts to 300.000 annually [11,12], and number of years of potential life lost reaches half of million. Costs of treatment, rehabilitation, compensations and disability pensions were not calculated, because - in contrast to western countries - this problem was not analyzed yet. Only few authors studied the problem of costs but only direct ones, so regarding only hospital treatment (and only marginally) [13].

It turns out that not direct costs of treatment of injuries but fist of all their consequences constitute a great economical and social problem. Those costs are connected with the sickness absence from work. In the group of all trauma victims 12.8% of patients are incapable to work for 1 month, 22.3% - for 3 months, 17.9% - for 6 months, 31.7% - for 9 months, and as many as 25% retire on a temporary or permanent disability pension, so one fourth of trauma victims become affected by impairment. Therefore together with years of work lost and sickness absence from work completely new and underestimated problem of lost gross national product (PKB) appears12. Moreover to all circumstances of economic and human tragedy (family and personal tragedy) one has to add everyday difficulties of trauma victims with integration with the society, the hardships of daily life of disabled person, or employment problems.

Thus abovementioned data show that economic and social consequences of injuries constitute - in Poland and over the world - a great problem and not only for health care systems but for national budget and whole society as well [14-16].

Epidemiological studies performed allowed for the obtainment of valuable data regarding mechanism, localization and severity of injuries and the extent of posttraumatic impairment. Collected information are used to determine needs of the traumatic health service, optimization of its expenses and for the insurance purposes [17,18]. They are also used in other branches of the science, e.g. by architects, constructors or engineers in the development of new types of machinery, industrial devices or in the construction of roads.

Polish studies - by contrast with Western Europe and the USA - are scant and do not cover whole problem of the consequences of injuries [19]. Analysis of direct and indirect costs in own, large material constitutes the first so full-scale study so far [20].

Aim of the study

Retrospective study was performed to assess to what extent particular parameters - localization and extent of injury, age and gender of patients and severity of injury - are related to direct and indirect costs of the treatment, and what are indirect costs in the form of sickness benefits, disability pensions and lost gross national product (PKB) due to short-term and long-term incapacity to work and due to lost years of life by deceased. The other aim was assessment whether those data can be used for construction of new division of the patients - based on ICD-9 and ICD-10 - which would allow National Health Foundation for the more precise calculation of costs of treatment, and for the estimation of consequences of injuries in Poland, with taking into consideration abovementioned indirect costs.

Table I
Costs of trauma due to isolated injuries of different body regions and due to multiple injuries.

	Patients*	Deaths in pre-hospital period	ICU stay*	Direct costs in general mean*	Direct costs in 2007 in general mean**	Years of work lost (death + sickness absence + disability pension)	Coefficient of years of work lost per 100.000	Pensionable at the productive age	Indirect costs in general mean***	Direct costs in 2007 as a % of all
Head	1095	35	247	994 270 938 ± 1180	4 060 756 3831	988	154.37	840	51 694 412 61 541	7.28%
Chest	163	9	110	261 429 1698 ± 2344	1 191 799 7739	181	28.28	114	9 315 868 81 718	11.34%
Abdomen	58	1	5	96 402 1691 ± 1638	341 537 5992	13	2.03	50	679 480 13 590	33.45%
Pelvis	73	0	7	123 957 1698 ± 1406	440 732 6037	44	6.87	42	2 540 664 60 492	4.65%
Spine	121	4	101	146 590 1253 ± 2021	776 560 6637	142	22.19	70	7 365 836 105 226	9.54%
Upper extremity	523	2	2	792 759 1522 ± 1044	2 700 889 5184	443	69.22	336	25 062 016 74 589	9.73%
Lower extremity	1241	1	72	3 417 807 2756 ± 1587	11 818 832 9531	1748	273.12	673	82 179 256 122 109	12.57%
Multiple injuries	340	127	725	810 715 3806 ± 4550	4 753 081 22 315	1384	217.81	248	66 909 600 269 797	6.63%

*without deaths in pre-hospital period ; ** multiplied by inflation index (1.7), extended with TISS (days in ICU x 27 points x 51 PLN) multiplied by 2 (assuming that costs of work constituted 50% of all); ***for pensionable at the productive age

Material and methods

The group of 3614 patients with injuries constituted the study material for statistical analysis. The study group included 3435 patients hospitalized during the "emergency duty days" in 2nd Chair of Surgery, Jagiellonian University Medical College, Krakow, Poland and 179 trauma victims who died during pre-hospital care during the same days (6 days a month for four years) on the territory inhabited by about 800.000 people over 14 from 1.01.1999 to 31.12.2002. Patients who died in pre-hospital period were not included in the calculation of direct costs of treatment, that covered costs of drugs and other medical expenses (e.g. dressings). Costs of work of medical and auxiliary staff were also excluded. The data were collected on the basis of computer database called "PACJENCI" compiled in our Chair.

Long-term follow-up was performed on the basis of special questionnaire from 2 to 8 after the injury. Whole period of treatment of the patients (duration of temporary work disability, disability and rehabilitation pensions) and number of patients who had to retire from the jobs were calculated. Data were obtained from medical documentation and from medical histories taken from the patients. Social insurance company (ZUS) refused to provide the access to their database on the basis of the Personal Data Protection Act and thus the data were collected for

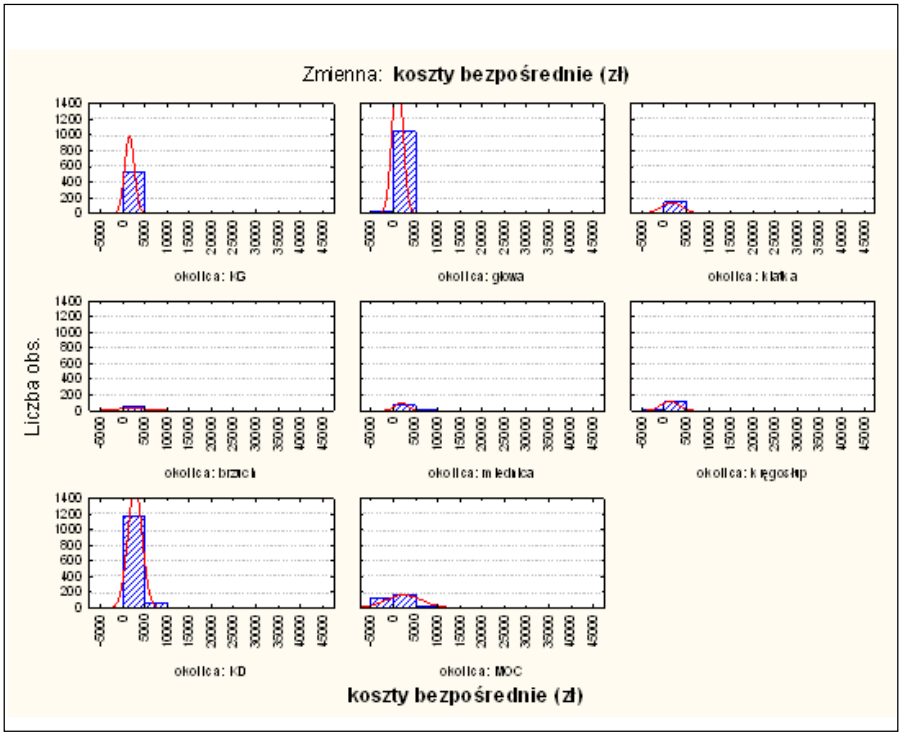


Figure 1
Kruskal-Wallis test. Result: p-value = 0.00.

only (as many as?) 94.63% of the patients that were initially included in the study. Remaining 5.37% (205 patients) were excluded from the study due to lack of the data from ZUS, owing to incomplete data from medical histories or because they did not report to follow-up and did not fulfill the questionnaire.

Statistical analysis included calculation of sums, subtractions, mean values, percentages, standard deviations and other tests - t-Student, Chi^2 and non-parametric tests such as Spearman's rank correlation coefficient, Mann-Whitney test, Kruskal-Wallis test and univariate analysis of variance (ANOVA).

Results

A. Injuries of particular body regions

The highest direct costs were found in the groups of injuries of: lower extremi-

Table II
Correlation between direct costs and localization of injuries.

	KG	głowa	klatka	brzuch	miednica	kręgosłup	KD	MOC
KG								
głowa	0,000000							
klatka	1,000000	0,000000						
brzuch	1,000000	0,000022	1,000000					
miednica	1,000000	0,000000	1,000000	1,000000				
kręgosłup	0,000731	0,146210	0,485378	0,354589	0,105192			
KD	0,000000	0,000000	0,000000	0,000006	0,000001	0,000000		
MOC	0,011569	0,000000	1,000000	1,000000	1,000000	1,000000	0,000000	

Table III
Costs of trauma due to injuries in women and men.

	L.ch.*	Zgony uliczne	Liczba dni na IT*	Koszty bezpośrednie ogółem średnio*	Koszty bezpośrednie 2007 ogółem, średnio**	Utracone lata pracy (zgon + ZLA + renta)	Współczynnik utraconych lat pracy na 100 tys.	Uprawnienia do świadczeń w wieku produkcyjnym	Koszty pośrednie ogółem średnio ***	Koszty bezpośrednie 2007/ całkowitych
Kobiety	1423	41	281	3 077 169 2162 ± 1844	11 236 249 7896	971	284	612	52 389 080 85 603	17,66%
Mężczyźni	2012	138	988	3 566 760 1773 ± 2115	14847936 7380	8624	2892	1761	193 313 052 109 775	7,13%

*without deaths in pre-hospital period; ** multiplied by inflation index (1.7), extended with TISS (days in ICU x 27 points x 51 PLN) multiplied by 2 (assuming that costs of work constituted 50% of all); ***for pensionable at the productive age

Table IV
Costs of trauma due to injuries in particular age groups.

	L.ch.*	Zgony uliczne	Liczba dni na IT*	Koszty bezpośrednie ogółem średnio*	Koszty bezpośrednie 2007 ogółem, średnio**	Utracone lata pracy (zgon + ZLA + renta)	Współczynnik utraconych lat pracy na 100 tys.	Uprawnienia do świadczeń w wieku produkcyjnym	Koszty pośrednie ogółem średnio ***	Koszty bezpośrednie 2007/ całkowitych
14-19 lat	257	9	9	331 519 1290 ± 1266	1 15 1951 4482	247	38,59	196	17 262 620 88 075	6,26%
20-39 lat	1052	67	305	1 547 341 1471 ± 1938	6 100 929 5799	2004	313,12	1099	104 639 340 95 213	5,51%
40-59 lat	928	58	470	1 731 607 1866 ± 2092	7 181 844 7739	2187	341,72	954	115 767 128 121 349	5,84%
60 i więcej lat	1198	45	485	3 033 462 2532 ± 1997	11 649 457 9724	147	22,97	124	8 033 044 64 783	59,19%

*without deaths in pre-hospital period; ** multiplied by inflation index (1.7), extended with TISS (days in ICU x 27 points x 51 PLN) multiplied by 2 (assuming that costs of work constituted 50% of all); ***for pensionable at the productive age

ties (11 818 832 PLN), multiple injuries (4 753 080 PLN) and head injuries (4 060 756 PLN). However mean direct costs were the highest in multiple injuries (22 315 PLN) and injuries of lower extremities (9531 PLN). The highest numbers of years of potential life lost were also found in groups of injuries of lower extremities (1748) and multiple injuries (1384). Similarly indirect costs proved to be the highest in the groups of injuries of lower extremities (82 179 256 PLN) and multiple injuries (66 909 600 PLN), but in multiple injuries mean loss reached 269 797 PLN, while in injuries of lower extremities only 122 109 PLN. Except for the abdominal injuries (33.45%) direct costs turned out to constitute only 10% of all costs of treatment of consequences on injuries - that implies necessity of use of the most effective (even if the most expensive ones) therapeutic methods, especially in the injuries of lower extremities. Those results are conditional upon the number of patients in particular groups, which differ from each other in the severity of injuries and in the age of patients (table I).

For the purpose of this analysis Kruskal-Wallis test was used. It was found that at the significance level of p=0.00 data come from different populations (i.e. groups characterized by different localization of injuries - Fig. 1).

Table II shows pairs of variables responsible for the rejection of the null hypothesis that all studied tests come from the same population marked in red.

B. Gender of patients

Analysis of correlation of amount of direct costs and gender was also performed. It was found out that in men such costs were about 1/5 lower despite the fact that men stayed in ICU three times longer. After correction of this fact differences become largely closer (mean cost of treatment amounted almost 7900 PLN for women and 7400 PLN for men). Indirect costs however are in inverse ratio. They are 4 times higher in cases of injuries of men and in general about 1/6 higher. Men lose 10 times more years of work. Thus ratio of direct to indirect costs is different - direct costs in men constitute only 7.13% of indirect costs, while in women as many as 17.66% (table III).

For this analysis Mann-Whitney test

Table V
Costs of trauma due to multiple injuries.

	L.ch.*	Zgony uliczne	Liczba dni na IT*	Koszty bezpośrednie ogółem średnio*	Koszty bezpośrednie 2007 ogółem, średnio**	Utracone lata pracy (zgon + ZLA + renta)	Współczynnik utraconych lat pracy na 100 tys.	Uprawnienia do świadczeń w wieku produkcyjnym	Koszty pośrednie ogółem średnio ***	Koszty bezpośrednie 2007/ całkowitych
MOC ≤ 8	143	0	103	351 198 2456 ± 2303	1 477 735 10 334	313	48,91	91	15 331 300 168 476	8,79%
MOC 9-15	52	24	387	307485 4046 ± 4963	2 111 247 40 601	412	64,37	62	19 995 840 322 514	9,55%
MOC >14	18	103	235	152032 8446 ± 9345	1164099 64 672	693	108,28	95	31 582 460 332 447	3,55%

*without deaths in pre-hospital period; ** multiplied by inflation index (1.7), extended with TISS (days in ICU x 27 points x 51 PLN) multiplied by 2 (assuming that costs of work constituted 50% of all); ***for pensionable at the productive age

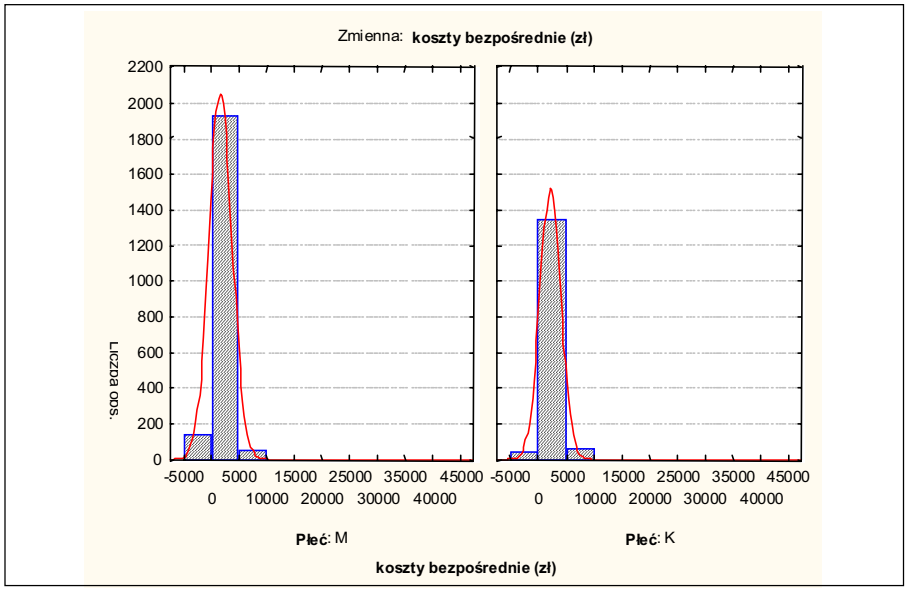
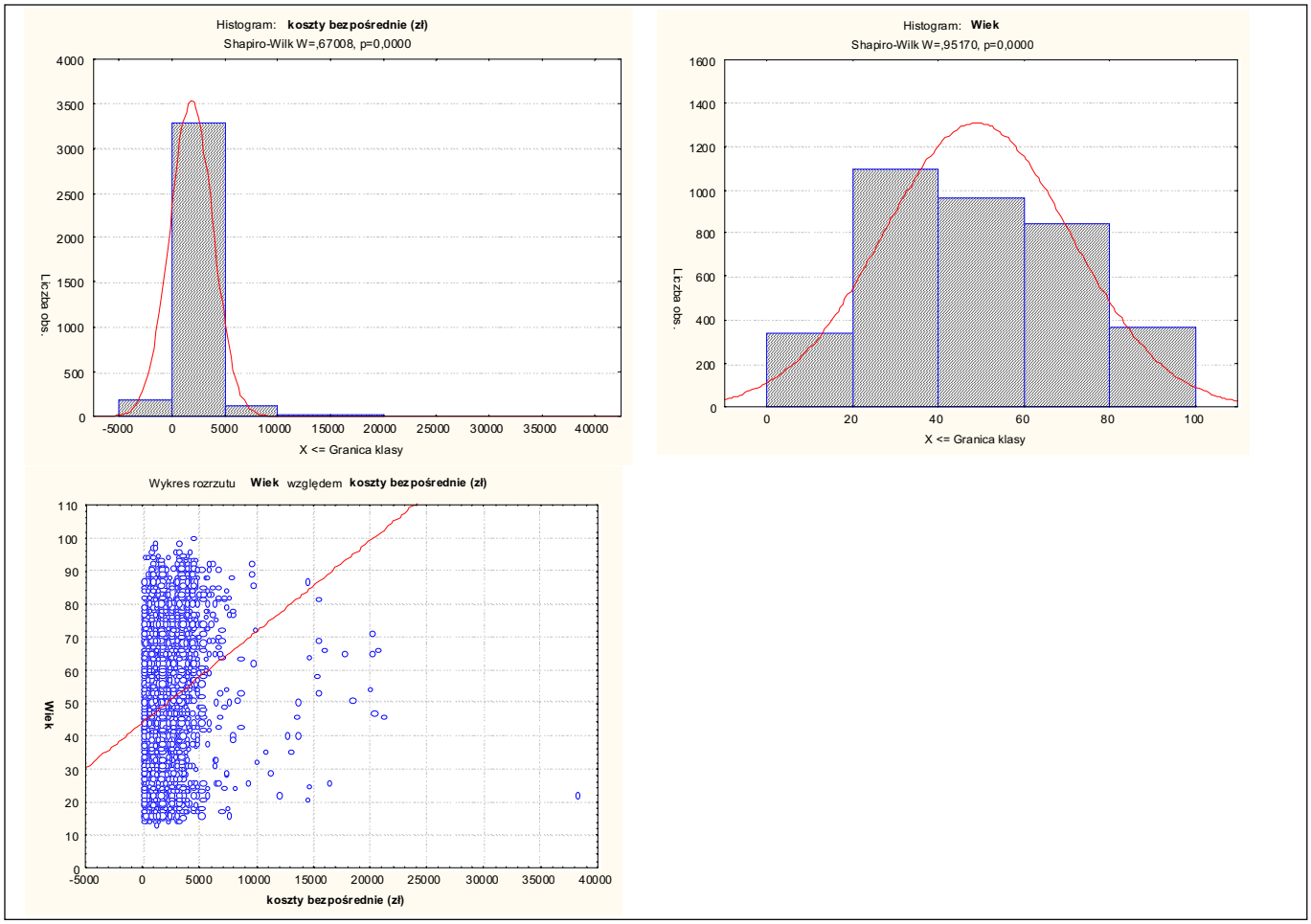


Figure 2
Mann-Whitney test. Result: p-value = 0.00.

Figure 3
Spearman's rank correlation coefficient. Result: R=0.342185, p-value = 0.0.



was used. It was found that at the significance level of p=0.00 data come from different populations.

C. Age of patients

Indirect costs were found to rise with age - in the group of the oldest patients they reached on the average almost 10.000 PLN. The largest number of years of work lost were found in patients aged 40-59, resulting in the highest indirect costs that exceeded on the average 120.000 PLN. The oldest patients (who created the smallest indirect costs because they were at retirement age) stayed in ICU for the longest time which in turn resulted in high direct costs and small ratio of direct to indirect costs (table IV).

To confirm those observations statistical relationships between age and costs were analyzed during epidemiological studies (figure 3).

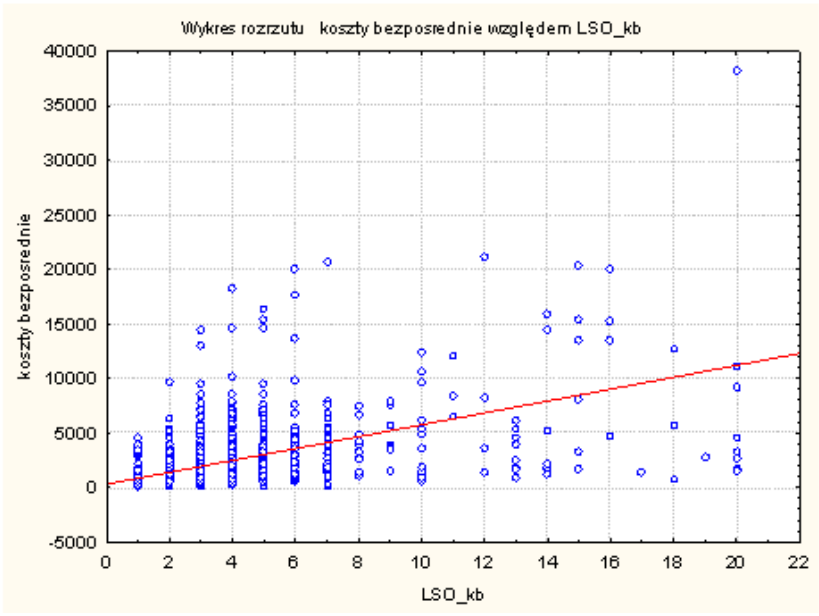
For this analysis Spearman's rank correlation coefficient was used. It was proven that there is a positive, mean correlation between age and amount of direct costs.

D. Severity of injuries

Likewise in cases of isolated injuries direct costs rose together with the severity of multiple injuries exceeding 40.000 PLN already in people with moderate severity and exceeding 65.000 in the group of the most severely injured. Similar observations were made during calculations of indirect costs that markedly exceeded 300.000 PLN in both more severely injured groups. Thus direct costs constituted only few percent of overall costs of treatment of injuries.

To confirm those observations made during epidemiological studies statistical relationships between particular parameters and direct costs were analyzed. Thus correlation between severity of injuries (LSO) and costs were analyzed. Due to lack of normal distribution in study groups Spearman's rank correlation coefficient was used. Zero values of costs were not taken into consideration.

Statistically significant (P=0.0000) correlation between direct costs and number of points according to LSO was found. This correlation is relatively strong (r=0.62) and positive (figure 4).



	N - Ważnych	R - Spearman	t(N-2)	p
LSO_kb & koszty bezposrednie	3435	0,619263	46,21055	0,00

Figure 4
Analysis of direct costs in correlation with LSO.

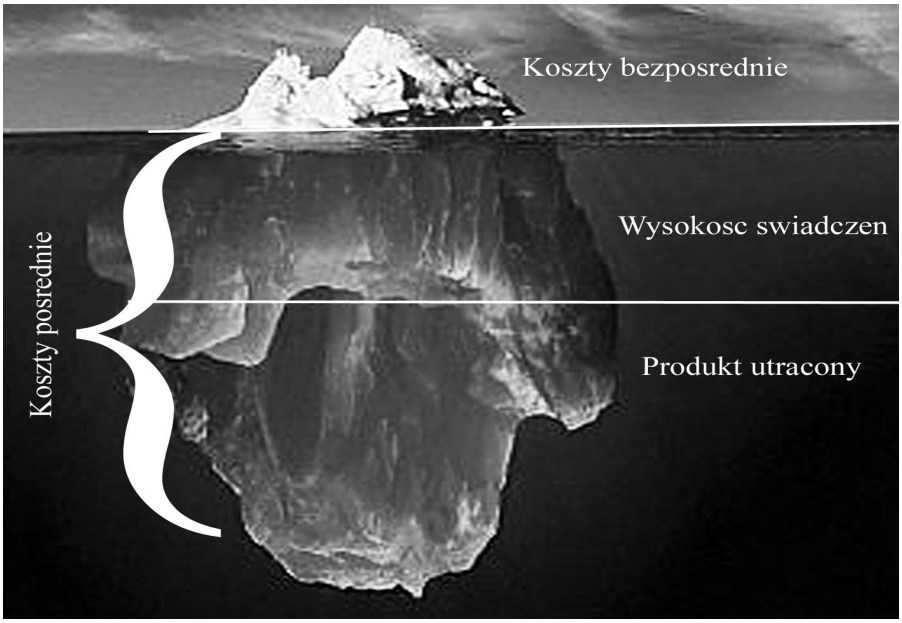


Figure 5
Direct costs of treatment constitute only "the tip of the iceberg" as compared to all costs.

Discussion

Data regarding the incidence of injuries in men and women are similar to the ones found in the literature [21,22], but relationship between gender of patients and costs of treatment proved to be the weakest from the parameters studied. Outcome of patients and costs of treatment were markedly influenced by age of patients - that corresponds with many studies from the literature [23,24], - and severity of injuries [25].

Consequences of injuries are determined by body region that became injured. It turned out that economic consequences of injuries of similar severity and extent or even of different severity are determined by localization of injury. Thus minor and moderate injuries of lower extremities can result in markedly higher economic losses than even more severe injuries of chest or abdomen. This results from the fact, that mortality in even severe injuries of extremities is small, but incapacity to return to former job is usually long-lasting. On the other hand in cases of even severe injuries of internal organs of chest or abdomen - if treatment

is implemented effectively - posttraumatic impairment is slight and allows for early return to former activity.

The highest incidence was noted in cases of lower extremities injuries - more than 193/100.000/year [26,27], - and patients from both age groups sustain such injuries the most commonly. Despite the fact that most of injuries of lower extremities in patients at productive age were minor or moderate, economic consequences of them were substantial - 100% of patients were at least transiently incapable to work; in 79.82% of them period of temporary work disability exceeded 2 months, as many as 34.52% retired on disability pension, of whom 20.48% retired on permanent disability pension. Coefficient of years of potential work lost reached about 1183 years/year.

Huge economic consequences resulted from multiple injuries. They were found in 10% of the patients from the study material, and 73% of them were found in patients at the productive age. 48.33% of survivors at the productive age retired on disability pension with as many as 44.17% of permanent pensions. Number of years of potential life lost reached 5888.8 and years of potential work lost - 1383.2 (both proved to be the highest of all groups).

Once again results obtained in our study are similar to the ones found in the literature, where falls from standing constituted one of the leading mechanisms of injuries, although some authors suggest that road traffic accidents creates the greatest threat in cases of severe and multiple injuries [28-30].

Problem of disability and sickness absence from work is very often mentioned in the literature, although in most of the studies only theoretically. There are just few studies assessing posttraumatic disability and impairment 31-33]. Moreover there are just scant data regarding duration of sickness absence together with the number and duration of disability pensions. J. Lipiński proved that in Poland one out of four injured patients retires on disability pension, but his study covered only selected Polish population. Results obtained however are similar to the ones presented by abovementioned authors.

According to E.J. MacKenzie - pioneer of assessment of economic consequences of injuries - in 1985 2.1 million Americans sustained injuries and costs of their treatment reached 11.4 billion dollars. In turn in 2004 data from 10 trauma centers in Florida were collected [8,9]. Costs of treatment of consequences of injuries amounted to 2.7 million dollars. There were 43 219 patients treated in 12 trauma centers in New York during one year. Level I and II trauma centers spent about 27.5 million dollars more than other hospitals and they treated 2/3 of all injured patients [34].

Studies performed in individual centers, among others in Accident and Emergency Unit (A&E Unit) of University Hospital of the West Indies (UHWI), showed that in 1996 there were 578.000 dollars spent by trauma centers on the treatment of injured patients (costs were calculated for the group of 37% of patients from the group of 22 311 injured patients who were admitted to A&E Unit). Mean cost of treatment of single patient amounted to 70$, but this study included also patients treated in out-patient way, thus costs were markedly underrated [35].

In our study that was performed on much smaller material, direct costs that were born by hospital from 1999 to 2002 amounted to 6 643 929 PLN. Thus annually 8 305 000 PLN is spent for the treatment of injured patients in Krakow region. Comparing our results with abovementioned studies it turned out that costs of treatment in one hospital reached 1 660 982 PLN annually, so using conversion unit about 4 PLN for 1 dollar (value almost constant for the years of the study) costs of treatment in one hospital equaled 415 245$ annually. Thus costs are comparable to the ones calculated in trauma centers in other countries. Of course one has to take into consideration inflation index for 11 years in the USA and fact of inclusion of costs of out-patient way of treatment.

It's worth mentioning that almost all authors engaged in the assessment of direct costs write about markedly higher real costs as compared to the financing of treatment of injuries and about existing budget deficit causing increasing debt of hospitals. Only few authors made attempts to calculate this deficit. Thus e.g. level I trauma center in New Jersey suffered loss reaching 1.86 million dollars (in 1983) [36]. Similarly losses of Bronx Municipal Hospital Center amounted to 5.3 million dollars annually (in 1990) [7].

However assessment of indirect costs of injuries proved to be the most difficult problem. Many authors mentioned this problem, although only few of them made attempts to assess them [4,37]. In our material, indirect costs amounted to 245 294 792 PLN.

Thus it turned out that direct costs constitute only 2.64% of all costs of treatment. Actualization correction performed made only little change. Similar conclusions are presented by authors of those few studies regarding this problem - direct costs constitute only small percentage of all costs of treatment.

Coefficients of years of potential life and work lost were also calculated. Number of years of potential work lost reached in general 6042. In turn number of years of potential life lost reached 8962. After calculations it turned out that coefficient of years of work lost for adult population of Krakow region equaled 944 years/year/100.000 of inhabitants, and coefficient of years of life lost for adult population of Krakow region reached 1400 years/year/100.000 of inhabitants. Comparing these results with the ones presented by J. Lipiński13, who more than 10 years ago had announced that number of years of work and life lost in Poland (about 30 million of adults) reached 300.000 and 500.000 respectively (so 1000 years of work and 1667 years of life per year and per 100.000) it turned out that our coefficients are smaller.

Presented data show how complex is the problem of economic consequences of injuries in Poland. Under-financed hospitals struggling for economic "existence" with difficulty bear costs of treatment of injured patients. On the other hand higher standard of treatment (inextricably connected with higher expenses) could bring further improvement of outcomes, thus reducing dominating indirect costs. Everyone has to agree with Michaels , who stated that no matter how expensive is the treatment of injuries, its costs are still incomparable with inestimable indirect costs held by the society in cases of unnecessary prolonged treatment and incapacity of patients to return to former jobs. One can say that complex specialized treatment performed in the most modern, the best but the most expensive trauma centers (even highly specialized in the treatment of only particular injuries) plus creation of rehabilitation centers will allow for reduction of time of complete treatment and improvement of outcome thus resulting in decrease of both indirect and total costs of treatment.

It's especially important in the treatment of groups of patients that bring the highest financial losses, that is injuries of lower and upper extremities and multiple injuries. Idea of formation of centers specialized in the treatment of hand injuries

has many advocates for years. Unfortunately nowadays there are only some centers in Poland that can take care of such patients, with only very few microsurgical centers. Moreover there is a tendency toward cancelling of formerly prosperous "hand emergency duties" observed. Even the best known Polish centers of hand surgery tend to withdraw from such duties due to inadequate financing of those highly specialized procedures. Similar situation is found in cases of multiple injuries - there are nowadays practically no centers specialized in the treatment of this group of patients. Even treatment of injuries of lower extremities is conducted in orthopedic and even general surgical wards.

It's also worth to mention about dynamically developing technique of modern osteosynthesis in the world that is used only in very few departments in Poland. Too few centers have possibilities to introduce new techniques of stabilizing fractures. Once again such situation results from lack of funds for purchase of medical equipment and too high price of implants as compared to the sums paid by National Health Foundation for the treatment of patients. Examples include LCP (locking compression plate) and DCP (dynamic compression plate) systems and dynamic external fixators (that are the order of the day in the modern world), with price of implants exceeding twice amount of money proposed by National Health Foundation for the whole procedure. Similar situation is found in case of titan implants allowing for early bearing of the operated extremity, thus allowing for early return to job.

Situation of rehabilitation in Poland constitutes another important issue that's worth at least few studies. Closure of hospital rehabilitation workshops and too small limits result in alarmingly long waiting time of patients (not only after injuries) for the place in rehabilitation centers, thus decreasing chances for successful refunded rehabilitation procedures.

Direct costs that can be controlled and assessed constitute only "the tip of the iceberg" in all costs of treatment of injuries (figure 5). Elimination of this "tip" will result in proportional (i.e. many times larger) decrease in the rest of the "iceberg" with real economic consequences. This in turn can result in proper realization of tasks of health care in the form of decreased mortality and increased comfort of life.

Conclusions

1. Costs of treatment are directly correlated with localization of injuries, age and gender of patients, severity and extent of injuries.

2. As counted per one patient treatment of multiple injuries and injuries of lower extremities are the most expensive; they also result in the highest indirect costs.

3. Despite the high direct costs of treatment of injuries they constitute only small percentage of all costs of trauma.

4. Probably for the relatively small price better results of treatment could be obtained resulting in marked savings in indirect costs.

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