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ANALYSIS OF TOTAL, DIRECT AND INDIRECT COST OUTLIERS IN A POLISH SPECIALIST HOSPITAL

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A b s t r a c t

The purpose of this study is to analyze the factors facilitating the identification of the three categories of cost outliers. They are known as total cost outliers (TCO), direct cost outliers (DCO), and indirect cost outliers (ICO). 4,570 patients have been analyzed. To evaluate the factors that influence the patient being a cost outlier in a hospital; age, length of stay, gender, type of admission, reason for discharge, and type of department were considered. Multivariable logistic regression was used in the study. In our research TCO comprised 9% of the study sample. The percentage of DCO was slightly higher (10%) and ICO was slightly lower (8%). Total cost outliers accounted for almost 37% of total hospital costs, 40% of direct costs, and 34% of indirect costs. The direct cost outliers accounted for 44.39% of direct costs, and indirect cost outliers accounted for 34.91% of indirect costs. It was discovered that, in terms of gender, men are positively correlated with higher cost utilization. The risk of being a cost outlier increases risk in terms of death and referral for further treatment. The type of admission factor can only be a predictor of being an ICO. The risk of a patient being a length of stay outlier increases far more for the ICO (more than 580 times) than in the case of a DCO (3.81 times) or a TCO (13.79 times). The analysis suggests that not only TCO, but also DCO and ICO, should have high priority for hospital managers concerned with variations in the costs of care.

ANALIZA BEZPOŚREDNICH, POŚREDNICH I CAŁKOWITYCH KOSZTÓW LECZENIA PACJENTÓW SZCZEGÓLNIE DROGICH W SZPITALU SPECJALISTYCZNYM W POLSCE

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S ł o w a k l u c z o w e: koszty bezpośrednie, koszty pośrednie, pacjenci o szczególnie wysokich kosztach leczenia, zarządzanie szpitalem, czas hospitalizacji.

A b s t r a k t

Celem badań była identyfikacja czynników powodujących, że koszty bezpośrednie, pośrednie i całkowite leczenia pacjentów są szczególnie wysokie. W toku badań zidentyfikowano pacjentów o skrajnie wysokich kosztach leczenia (TCO), pacjentów o skrajnie wysokich kosztach bezpośrednich leczenia (DCO) oraz pacjentów o skrajnie wysokich kosztach pośrednich leczenia (ICO). Przeanalizowano koszty leczenia 4570 pacjentów. Czynniki kosztotwórcze leczenia wyodrębnionych grup pacjentów zidentyfikowano spośród następujących zmiennych: wiek, czas hospitalizacji, płeć, tryb przyjęcia do szpitala, tryb wypisu ze szpitala, rodzaj oddziału. W badaniu posłużono się wieloczynnikową analizą regresji logistycznej. Pacjenci o szczególnie wysokich całkowitych kosztach leczenia stanowili 9% badanej populacji. Odsetek pacjentów o szczególnie wysokich bezpośrednich kosztach leczenia był nieznacznie wyższy (10%), a pacjentów o szczególnie wysokich pośrednich kosztach leczenia był nieznacznie niższy (8%). TCO odpowiadali za niemal 37% kosztów całkowitych, 40% kosztów bezpośrednich, i 34% kosztów pośrednich. DCO odpowiadali za niemal 45% kosztów bezpośrednich, natomiast ICO za 35% kosztów pośrednich. Badania wykazały, że koszty hospitalizacji mężczyzn są istotnie statystycznie wyższe. Ryzyko, że koszty leczenia pacjentów będą szczególnie wysokie, rośnie w przypadku pacjentów skierowanych do dalszego leczenia i tych, w przypadku których odnotowano zgon w toku leczenia. Tryb przyjęcia istotnie statystycznie jest związany z ICO. Ryzyko, że czas pobytu pacjenta będzie szczególnie długi, znacząco rośnie w przypadku ICO (ponad 580 razy), natomiast w znacznie mniejszym stopniu w przypadku DCO (3.81 razy) oraz TCO (13.79 razy). Przeprowadzone badania wskazują, że w kontekście ponoszonych kosztów w szpitalu na uwagę menedżerów zasługują nie tylko pacjenci o skrajnie wysokich całkowitych kosztach leczenia, lecz także pacjenci o skrajnie wysokich bezpośrednich kosztach leczenia oraz pacjenci o skrajnie wysokich pośrednich kosztach leczenia.

Introduction

In recent years, there has been an increasing focus by administrators, payers and health service researchers on hospital costs as an important indicator of the efficiency of inpatient hospitalization. The year after year growth of financial problems in health care sector entities contributed to the

intensive search for the causes of (and solutions to) growing resource utilization (SZETELA et al. 2011, MĄCZYŃSKI 2011, *Zadłużenie samodzielnych publicznych zakładów*... 2004). One of the ways to do this is to improve the system of managing costs in the hospitals. To achieve this, hospitals attempt to develop a systematic approach for identifying the patients who are driving higher costs in their organizations. Then, they manage these outliers to reduce the cost of care. Outlier detection is concerned with discovering exceptional behaviors of certain patients. Revealing these behaviors is important, since it signifies that something out of the ordinary has happened and should deserve the attention of managers and doctors. Most of the previous studies have analyzed the factors that help to predict the future costs that are connected with the different causes of hospitalization. For example MAPELA et al. (2005) analyzed the methods of predicting the costs of managing patients with chronic obstructive pulmonary disease. HUANG et al. (2013) and UEMATSU et al. (2015) concentrated on evaluating the impact factors concerning the length of stay of the patients. Some of the researchers concentrated their studies on outliers as a group of patients worth special attention (SACKMAN, CITRIN 2014). FREITAS et al. (2012) and RUSSEL-WEISZ, HINDLE (2000) concentrated on the factors influencing high length of stay hospital outliers. Not many studies concentrated on the cost outliers. The probability of being a hospital cost outlier was analyzed in a different context: LOS, acuity of illness, risk of mortality, social status, age, gender, type of admission, destination after discharge, and Intensive Care Union (ICU) stay (DAHL et al. 2012, PIRSON et al. 2006a). However, many of the studies have concentrated on the total hospital costs, while only a few of them have focused on direct costs (SZNAJDER et al. 1998, SAHOTA et al. 2012, ALZAHRANI 2013). No studies to date have explained cost categories determining the patient as being a cost outlier. The purpose of this study, therefore, is to analyze the factors facilitating the identification of the three categories of cost outliers: total, direct, and indirect cost outliers using available administrative data.

Materials and Methods

The main source of data for this analysis was the administrative databases of the voivodeship hospital in Olsztyn. The voivodeship hospital in Olsztyn deals with diagnostics, therapy, care, specialist advice, education, prevention, and health promotion. Between January and June 2013, there were 5,367 patients admitted to the Departments of Cardiology, Laryngology, Ophtalmology, Nephrology, ICU, Gastroenterology, Orthopedics, Surgery, Neurosurgery, Gynecology, Endocrinology, Diabetology and Hematology.

All of the patients that were admitted to the hospital departments between January and June 2013 were reviewed, except newborns ($N=462$). Some of the patients were excluded from the analysis due to missing data ($n=335$). Therefore, the final sample population used in this study was 4,570 patients analyzed. Cost analysis was done retrospectively using the accountancy and statistical data from the hospital, as reported to the National Health Fund. The linkage between the two databases was carried out using Microsoft Access. Patient costs were tracked in three categories: direct costs (DC), such as drugs, medical procedures, and diagnostic tests. These were costs that were identified directly with the care of individual patients. Indirect costs (IC) were administration costs and costs assigned to the specific hospital department, but not associated with a particular patient. Examples of indirect costs include equipment, laundry, medical devices, and medical salaries. The indirect costs were aggregated and assigned to individual patients on an LOS basis. The sum of DC and IC was referred to as total costs (TC). The three categories of outliers were analyzed: direct costs outliers (DCO), indirect costs outliers (ICO), and total costs outliers (TCO).

To select the outliers, the interquartile method using the median and the interquartile distance was used. To select high outliers, the 75^{th} percentile +1.5* interquartile range was used. To identify the low outliers, the 25^{th} percentile –1.5* interquartile range was used. Because in all three cases the 25^{th} percentile rule –1.5* interquartile range detected a negative trim-point in further analysis, only high cost outliers were considered.

To evaluate the factors that influence the patient being a cost outlier; age, LOS, gender, type of admission, reason for discharge, and type of department were considered. Statistical analyses were carried out using StatSoft, Inc. (2011) STATISTICA, version 10. The analysis of contingency tables was executed with the Pearson's χ^2-test and the Mann-Whitney test on continuous variables (LOS, age). Univariate analysis and multivariable logistic regression were used in the study.

Results

Within the studied population, the mean patient age was 56.54 years; and men comprised 43% of the study sample. The mean and standard deviation of LOS were 5.39 days and 6.65 days, respectively. Most of the patients were admitted to the hospital with a planned admission (52,12%) and were discharged from the hospital within 4 days (58.99%). The main reason for the patients' discharge was completing the therapeutic process (66.11%). Most of the patients had been cured in the surgical departments (75.38%). The median

and standard deviation of the total cost of hospitalization, direct costs, and indirect costs were (€) 895.20 (458.91–1633.75); (€) 344.02 (130.30–883.20); (€) 380.44 (193.40–774.30), respectively (Tab. 1).

Table 1

Characteristics of hospitalized patients between January and June 2013 (n=4,570)

Variables	Mean	s.d.
Age	56.54	18.21
LOS	5.39	6.65
Age group in years	*n*	%
18–30	470	10.28
31–50	1,011	22.12
51–70	1,775	38.84
71>	1,077	23.56
Gender	*n*	%
Female	2,591	56.69
Male	1,979	43.30
LOS group in days	*n*	%
1–2	1,663	36.39
3–4	1,033	22.60
5–7	916	20.04
8–10	462	10.11
11>	496	10.85
Admission	*n*	%
Planned	2,382	52.12
Unplanned	2,188	47.88
Reason for discharge	*n*	%
Completed therapeutic process	3,021	66.11
Directed to further treatment	1,443	31.58
Death	106	2.32
Department	*n*	%
Surgical	3,445	75.38
Nonsurgical	1,125	24.62
Costs (€)	median	ranges
Total Costs	895.20	458.91–1633.75
Direct Costs	344.02	130.30–883.20
Indirect Costs	380.44	193.40–774.30

Source: own work.

Within the studied population, 433 patients were identified as TCO, 346 patients as indirect outliers ICO, and 448 patients as DCO (Tab. 2).

The TCO comprised 9.47% of the study sample. The ICO and DCO comprised 7.57% and 9.80%, respectively. Some of the patients were associated with more than one group of outliers. One hundred and twenty seven patients were associated with TCO, ICO, and DCO, 106 patients were associated with TCO and DCO, and 199 with TCO and ICO. One hundred and twenty two

Table 2
Predictive factors for total cost outliers (TCO) and inliers (TCI), indirect cost outliers (ICO) and inliers (ICI) and direct cost outliers (DCO) and inliers (DCI) by univariate analysis

Predictive factors	TCO N=433	TCI N=4,137	ICO N=346	ICI N=4,224	DCO N=448	DCI N=4,122
Age (years) mean (s.d.)	59.47 (14.67)	56.23 (18.51)	58.33 (17.31)	56.39 (18.27)	60.04 (13.82)	56.16 (18.58)
Age n (%)						
<56	158 (36)	1,873 (45)	136 (39)	1,895 (45)	159 (35)	1,872 (45)
>56	275 (64)	2,264 (55)	210 (61)	2,329 (55)	289 (65)	2,250 (55)
p	<0.001		=0,045		<0.001	
Gender n (%)						
Female	175 (40)	2,416 (58)	157 (45)	2,434 (58)	254 (37)	2,424 (59)
Male	258 (60)	1,721 (42)	189 (55)	1,790 (42)	181 (63)	1,698 (41)
p	<0.001		<0.001		<0.001	
LOS (years) mean (s.d.)	12.8 (14.5)	4.6 (4.5)	18.3 (15.6)	4.3 (3.6)	7.8 (7.6)	5.1 (6.5)
LOS n (%)						
<Mean	63 (15)	2,633 (64)	1 (0)	2,695 (63)	152 (34)	2,544 (62)
>Mean	370 (85)	1,504 (36)	345 (100)	1,529 (36)	296 (66)	1,578 (38)
p	<0.001		<0.001		<0.001	
Type of admission n (%)						
Planned	178 (41)	2,204 (53)	87 (25)	2,259 (54)	210 (47)	2,172 (53)
Unplanned	255 (59)	1,933 (47)	259 (75)	1,929 (46)	238 (53)	1,950 (47)
p	<0.001		<0.001		=0,0192	
Reason for discharge n (%)						
Completed therapeutic process	158 (36)	2,863 (69)	164 (47)	2,857 (68)	201 (46)	2,817 (68)
Directed to further treatment	254 (59)	1,189 (29)	167 (48)	1,276 (30)	222 (50)	1,221 (30)
Death	21 (5)	85 (2)	15 (4)	91 (2)	22 (5)	84 (2)
p	<0.001		<0.001		<0.001	
Department n (%)						
Surgical	402 (93)	3,043 (74)	277 (80)	3,168 (75)	433 (97)	3,012 (73)
Nonsurgical	31 (7)	1,094 (26)	69 (20)	1,056 (25)	15 (3)	1,110 (27)
p	<0.001		=0.003		<0.001	

Source: own work.

patients were assigned only to ICO and 113 patients only to DCO. Eight hundred forty eight patients (22% of the study sample) were associated with at least one of the outlier groups. TCO comprised almost 71% of all patients identified as outliers in all categories.

The profiles of TCO, DCO, and ICO seem to be similar. The average age of TCO was 59.47 (14.67), ICO was 58.33 (17.31), and DCO was 60.04 (13.82). The length of stay of TCO, ICO, and DCO was 12.8 (14.5), 18.3 (15.6), and 7.8 (7.6), respectively. The majority of all types of outliers were men. The length of stay of all of the ICO was higher than the mean for all of the analyzed patients. Seventy five percent of the ICO were admitted to the hospital as an unplanned

patient. In the case of the TCO and DCO, the percentage was 59% and 53%, respectively. Most of the TCO were directed to further treatment (59%). The percentage of the ICO and DCO that had finished the healing process or had been directed to further treatment was similar. The majority of all types of outliers were surgical patients.

The profile of TCO, DCO, and ICO differed from that of the respective inlier patients in a statistically significant manner (Tab. 2). The status of the cost outlier in contrast to inliers in all categories was associated with older age, unplanned admission, being directed to further treatment after discharge from hospital, and being a surgical patient.

The median total cost, direct costs, and indirect costs for TCO were (€) 4,779.08, (€) 2,758.49 and (€) 1,755.28, respectively. The median indirect costs for ICO was (€) 2,468,50 and was higher than the median overhead costs for TCO and DCO with (€) 713.22 and (€) 1,398.77, respectively (Tab. 3).

Table 3
Median and range of total hospital costs, direct costs and indirect costs for total cost outliers (TCO) and inliers (TCI), overhead cost outliers (ICO) and inliers (ICI) and direct cost outliers (DCO) and inliers (DCI)

Costs (€) median [range]	TCO	TCI	ICO	ICI	DCO	DCI
Total costs	4,779.08 [3,944.89–6,040.47]	809.90 [423.36–1,346.16]	4,391.28 [2,918.86–5,934.81]	828.75 [432.65–1,394.00]	4,203.37 [3,305.93–5,652.34]	805.74 [421.95–1,335.20]
Direct costs	2,758.49 [2,046.40–3,753.44]	290.02 [115.70–687.84]	1,540.72 [607.65–2,469.44]	308.50 [118.86–772.45]	2,838.09 [2,346.26–3,666.98]	287.20 [1,15.31–671.51]
Indirect costs	1,755.28 [1,115.68–3,075.25]	345.21 [180.47–640.63]	2,468.50 [1,905.03–3,429.3]	350.25 [181.36–643.21]	1,069.73 [415.68–1,755.28]	354.63 [181.36–685.78]

Source: own work.

TCO accounted for almost 37% of total hospital costs, 40% of direct costs, and 34% of indirect costs. The DCO accounted for 44.39% of direct costs, while ICO accounted for 34.91% of indirect costs.

In multivariate analysis, we analyzed the impact of age, gender, LOS, type of admission, reason for discharging the patient, and type of department on being the TCO (Tab. 4), DCO (Tab. 5) and ICO (Tab. 6).

A significant influence of age, gender, LOS, reason for discharge, and type of department on being the cost outlier was discovered. The strength of the predictors varied in the different types of cost outliers. The gender, LOS, reason for discharge, and type of department were associated with TCO.

Table 4
Logistic regression model: estimated probability of a patient being a total cost outliers (TCO)

Variables	Adjusted OR	(IC*95%)	*p*-Value
Gender	Female	1	
Male	1.90	(1.51-2.40)	<0.001
LOS			
<Mean	1		
>Mean	13.79	(10.35-18.37)	<0.001
Reason for discharge (%)			
Completed therapeutic process	1		
Directed to further treatment	4.15	(3.27-5.27)	<0.001
Death	5.79	(3.21-10.45)	<0.001
Department			
Nonsurgical	1		
Surgical	6.51	(4.4-9.62)	<0.001

Source: own work.

Table 5
Logistic regression model: estimated probability of a patient being a direct cost outliers (DCO)

Variables	Adjusted OR	(IC*95%)	*p*-Value
Age			
<56	1		
>56	1.34	(1.07–1.67)	=0.002
Gender			
Female	1		
Male	2.29	(1.84–2.85)	<0.001
LOS			
<Mean	1		
>Mean	3.81	(3.07–4.72)	<0.001
Reason for discharge (%)			
Completed therapeutic process	1		
Directed to further treatment	2.06	(1.66–2.56)	<0.001
Death	4.07	(2.32–7.15)	<0.001
Department			
Nonsurgical	1		
Surgical	13.55	(7.99–22.98)	<0.001

Source: own work.

The probability of being a TCO increased more than 13 times for patients that stayed in the hospital longer than 5 days (mean of all the patients). Age was additionally associated with being a DCO, and the type of admission was associated with being an ICO. The probability of becoming a TCO and a DCO in surgical patients increased 6 and 13 times, respectively. LOS longer than 5 days increased the probability of becoming an ICO more than 580 times.

Table 6
Logistic regression model: estimated probability of a patient being an indirect cost outliers (ICO)

Variables	Adjusted OR	(IC*95%)	*p*-Value
Gender			
Female	1		
Male	1.58	(1.24–2.03)	<0.001
LOS			
<Mean	1		
>Mean	582.71	(81.59–4161.70)	<0.001
Type of admission			
Planned	1		
Unplanned	1.69	(2.28–2.23)	<0.001
Reason for discharge (%)			
Completed therapeutic process	1		
Directed to further treatment	2.64	(2.03–3.40)	<0.001
Death	2.48	(1.32–4.65)	<0.001
Department			
Nonsurgical	1		
Surgical	1.74	(1.30–2.34)	<0.001

Source: own work.

The predictive ability of three regression models was determined. Figures 1-3 show ROC curves for them. The area under the curve was used to represent the accuracy of the predictions. The best AUC estimation was achieved for ICO equitation (AUC = 0,878). The AUC for TCO and DCO was 0.857 and 0.784, respectively.

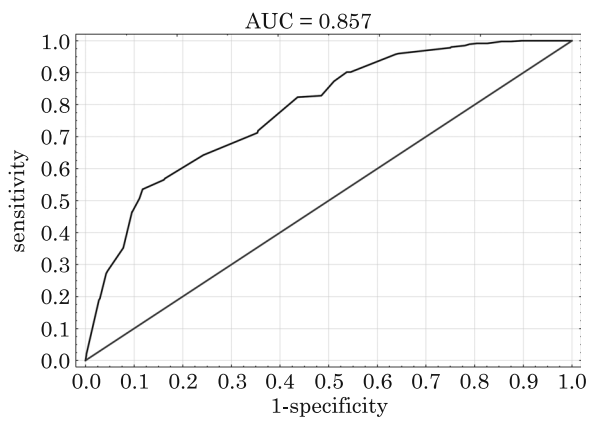

Fig. 1. ROC Curve for TCO

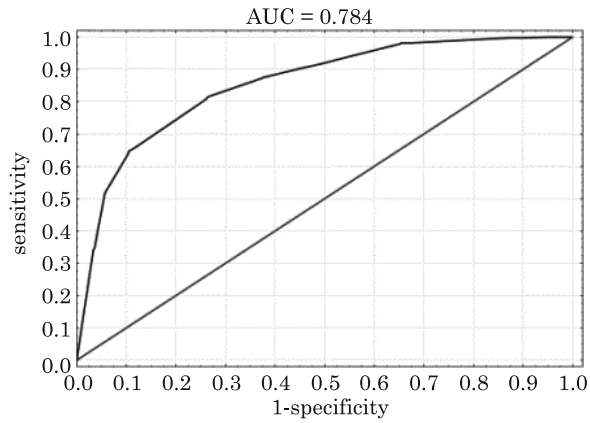

Fig. 2. ROC Curve for DCO

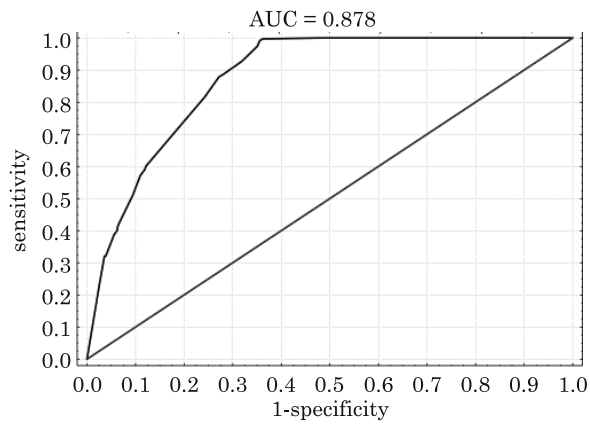

Fig. 3. ROC Curve for ICO

Discussion

In our study, the cost outliers varied between 8%–10% of the study sample. In previous research, the frequency of cost outliers varied between 1.6% and 16% (PIRSON et. al. 2006a, PIRSON et al. 2006b, COONEY et al. 2002, PRADOS et al. 2008). The differences in percentage of cost outliers can be associated with different statistical methods of selecting cost outliers (WEICHLE et al. 2013, YU-WEN et al. 2013), but also with the different definition of cost outliers. For example, PIRSON et al. (2006a) selected cost outliers by the 75th percentile ±1.5*interquartile range, COONEY et al. (2003) defined cost outliers as patients

with hospital costs >1 standard deviation above the mean and CALVER et al. (2006) chose the top 5% of patients ranked from the highest to the lowest total inpatient costs.

Apart from differences in alternative approaches to assess outlying patients, there were also different approaches to measuring the patient costs identified. For example, PRADOS et al. (2008) analyzed only pharmacy costs and found that outlier patients represented only 1.6% of the studied population. On the other hand, COONEY et al. (2002) concentrated on gastric Bypass Surgery patients and reported a 16% incidence of cost outliers. In our study, we have separately analyzed the total, direct and indirect cost outliers and attempted to find the differences in factors facilitating the patients being cost outliers. In our research, TCO comprised 9% of the study sample. The percentage of DCO was slightly higher (10%) and ICO was slightly lower (8%). The TCO accounted for 33% of total hospital costs, which is consistent with the PIRSON et al. (2006b) study, reporting that cost outliers accounted for 22–30% of costs in three public general hospitals. The higher percentage of costs assigned to TCO in our study can be related to the different types of hospitals. We analyzed a public specialist hospital, which admits the most severe patients from the region.

The profile of TCO, DCO and ICO is similar in terms of gender, LOS, reason for discharge and type of the department. In accordance with the OMACHONU et al. (2004) study, we discovered that, in terms of gender, men are positively correlated with higher cost utilization. It could be related to the fact that women are more aware of health matters than men and take better care of themselves (DEAN 1989). In addition they visit physicians more often than men, resulting in earlier detection of health problems (COCKERHAM 1998).

We found that the LOS is an important measure of resource utilization, which is consistent with the HUANG et al. (2013) study. However, the risk of being a cost outlier increases far more for the ICO (more than 580 times) than in the case of the DCO (3.81 times) or the TCO (13.79 times). This is due to the widespread use of allocating indirect department costs to the patients on an LOS basis (RAULINAJTYS-GRZYBEK 2014).

We report an increase in the risk of being a cost outlier in terms of death or referring for further treatment. We presume that it is related to the severity of illness, complications and co-morbidities. The higher resource utilizations associated with death, severe medial co-morbidities and complications was also reported by COONEY et al. (2002), SESHMANI et al. (2004), and WU et al. (2012).

Our research revealed that the patients classified as TCO, DCO and ICO accounted for 41% of total costs. We found that the DCO (10% of the studied population) accounted for almost 45% of direct costs. Our finding that a small

percentage of patients accounted for a significant percentage of the costs is consistent with the PRADOS et al. (2009) findings, where one out of ten patients classified as an outlier was responsible for 60% of the total pharmacy expenditure recognized as direct costs. We presume that the risk of being a DCO can be associated with the higher age of the average DCO. This is consistent with our finding that age is not associated with being a TCO, but increases the risk of being a DCO (1.34 times). This is confirmed by the UEMASTSU et al. (2015) research, which claims that higher hospital costs for older people can be mostly explained by differences in patient comorbidities and complications.

Some of the studies highlighted that the type of admission has an influence on patient costs, but some of the studies didn't reveal it (BRIMHALL et al. 2003, MUNOZ et al. 1989). In our study, the type of admission can be a predictor of being an ICO. This is consistent with the FREITAS et al. (2012) research, which confirmed that emergency surgical admissions have significantly more length of stay outliers than planned surgical admissions.

Conclusion

The study of cost outliers is important since it increases our understanding of hospital costs. In fact, a small percentage of cases represent an important proportion of total hospital costs. This study can contribute to the knowledge of managers about the nature of cost outliers and identify ways to prevent future instances. The approach described in this paper can be applied to improve the accuracy of identifying cost outliers. Outliers have an influence upon hospital costs and, therefore, are considered in some of the healthcare financing systems. To the best knowledge of the authors, the previous studies on hospital cost outliers concentrated only on TCO. However, the information about TCO doesn't give the full scenario concerning cost categories that contribute to being a cost outlier. Moreover, there can be patients with extraordinary costs in some categories that are not reported as TCO. Therefore, we identified two additional types of cost outliers: DCO and ICO. We chose to focus separately on DCO since direct costs reflect the true costs of care and are potentially amenable to future cost savings. Thus, detecting DCO can be especially valuable in the financing systems where high cost outliers that are not associated with LOS are separately paid or in systems where hospitals can incur financial penalties for cost outliers. That is why our analysis suggests that not only TCO, but also DCO and ICO, should have high priority for hospital managers concerned with variations in the cost of care.

The main limitation of this study is the small number of analyzed factors leading to a patient being a CO. We could not analyze medical factors such as

complications, due to the limitation of Polish hospital databases. However, similar analyses with additional explanatory factors derived from accessible hospital databases chosen by clinicians and managers working together could be used for CO identification. The study was carried out in only one hospital located in northeast Poland. To the best of our knowledge, this is the first study in the field within Poland. Thus, we chose to primarily analyze the patient characteristics before concentrating on the diagnoses related groups (DRG).

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