DIAGNOSIS-RELATED GROUP PROSPECTIVE PAYMENT SYSTEM IN POLAND – COSTS VERSUS TARIFFS: THE CASE OF INGUINAL HERNIA

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Abstract: In the last 20 years many OECD countries have adopted some form of diagnosis-related group (DRG) prospective payment system to reimburse hospitals. In Poland, hospitals are also paid fixed prices, imposed by Narodowy Fundusz Zdrowia (NFZ) according to DRG, for patients treated. The aim of this paper is to calculate, analyze and compare the costs of patient conditions within the same DRG (F72 – inguinal hernia), collate these costs and the reimbursement from NFZ with the purpose of determining the net profit and then check if it matches bigger research samples. In order to realize the aim of the paper, a comparative and a content analysis of medicals documents and financial data were adopted, and Student's t-test was performed. The Shapiro-Wilk test was applied to confirm the correctness of the research sample. The results revealed that the reimbursement for costs related to inguinal hernia treatment covers the costs of 90% of patient conditions from the research sample.

Keywords: DRG, diagnosis-related groups, prospective payment system, hospitals, costs.

1. Introduction

The inefficiency of the delivery system in medical services has been a recurrent theme in criticism directed towards hospitals for a long time. Therefore in the last 20 years, many OECD countries have adopted some form of diagnosis-related group (DRG) prospective payment system to reimburse hospitals, which caused the question of the efficient use of resources to arise and cost-reducing behavior to emerge. The DRG-based payment system was first introduced in 1983 by the US Medicare Programme to remunerate hospitals for treating the elderly. The most important overall objective of the new Medicare prospective payment system was to stem the growth in hospital costs while continuing to ensure the access of beneficiaries to quality health care [Guterman, Dobson 1986, p. 97]. The DRGs are treated as a powerful tool to

induce providers of health services to reduce costs, and under certain conditions to encourage increases in activity and quality [Hafsteinsdottir, Siciliani 2010, p. 1226]. The advantages of the DRG-based payment system are reflected in increased efficiency and transparency, as well as in the reduced average length of stay; while the disadvantage of DRG is creating financial incentives toward earlier hospital discharges, and occasionally, such polices are not in full accordance with the clinical benefit priorities [Mihailovic 2016, p. 6]. Hospitals are paid a fixed price for each patient treated. A key part of prospective payment system (PPS) is the categorization of patient conditions into DRGs.

The concept of diagnosis-related groups appeared in the late 1970s (designed and developed by Robert Fetter, John Thompson, Ronald Miller, Richard Averill and Jean Freedman – scientists at Yale University in the United States). The first version of DRG-based payment system (applied in 1983 in New Jersey), called the Health Care Financing Administration – Diagnosis-Related Groups (HCFA–DRG), contained 493 groups. DRGs are categories of patient conditions reflecting similar levels of hospital resources required to treat these conditions. The main variables used to assign the patients to particular diagnosis-related groups are: primary diagnosis, secondary diagnosis, intervention and procedures, age and gender – all routinely available from hospital medical information. At admission, every patient is therefore assigned to one of the DRGs taking into account medical diagnosis, and thus, the method of treatment (applied medical procedures, prescribed drugs, etc.), as well as hospitalization costs (resources demands and associated costs incurred by a hospital) [Macuda 2015, p. 331]. Each DRG bears a weight, reflecting the average cost of patients in the given DRG relative to that of the average patient reimbursed by the system. The price for each patient treated is obtained by multiplying the relevant DRG weight by a fixed monetary value.

In Poland, Narodowy Fundusz Zdrowia – NFZ (National Health Fund) introduced a DRG-based payment system – a new form of contracting and financing of the medical services – on 1 July 2008 [Zarządzenie Prezesa NFZ z 11 czerwca 2008; Komunikat Prezesa NFZ z 23 lipca 2008]. The NFZ performed the valuation of DRGs (point system – each group was assigned a number of points, the value of one point amounts to 52 PLN). The DRG tariffs (prices) are equal for all types of providers, regardless of the region where they operate, and are supposed to cover all, or at least the majority of hospital costs, including overheads and administrative expenses.

There is no doubt that the pricing of medical services applying DRGs is transparent, hence the value of received net income from the sale of medical services is well known to hospitals. While contracting medical services with NFZ, hospitals identify the types of medical services to be provided and the population to be served. These contracts constitute a starting point to planning, budgeting and controlling a hospital activity – three phases of the management control system. The third phase represents a feedback mechanism in which plans (in the case of costs related to

health services, their maximum level is set up in advance by NFZ as DRG tariffs) are compared to their realization (in relation to real costs incurred in the process of providing medical services). The importance of measuring the profitability (which ultimately contributes to overall hospital profitability), cost and revenue sources of individual patient condition is highlighted in papers related to the costs of medical services [Popesko et al. 2015, p. 50]. For hospitals to survive they must generate fair profits, therefore finding outliers may facilitate increased profitability [Okada et al. 2014, p. e211].

   The aim of this paper is to calculate, analyze and compare the costs of patient conditions within the same diagnosis-related group, collate these costs and the reimbursement from NFZ with the purpose of determining the net profit on the example of a particular DRG – F72 (inguinal hernia) and then check if it matches bigger research samples. In order to realize the aim of the paper, a comparative analysis and a content analysis of medical documents and financial data were adopted, and Student's t-test was performed. The research sample is composed of 22 patient conditions assigned to F72, according to DRG classification. This sample represents one full month of data from 2017 collected by hand from a particular hospital. The Shapiro-Wilk test was applied to confirm the correctness of the research sample. Inductive reasoning was adopted to develop conclusions. The calculations related to the tests and outliers were done using RStudio Software.

2. DRG prices and costs comparison using the example of inguinal hernia

An inguinal hernia occurs when tissue, such as part of the intestine, protrudes through a weak spot in the abdominal muscles. An inguinal hernia is not necessarily dangerous. However, it does not cure on its own and can lead to life-threatening complications if it is not treated. An inguinal hernia repair is a common surgical procedure.

   High quality data related to the cost of a patient condition facilitate effective decision-making by hospital management [Popesko et al. 2015, p. 50]. The structure of costs related to the treatment of 22 patients assigned to DRG F72 is presented in Table 1.

   The NFZ established the valuation of DRG F72 as follows: the number of points assigned to inguinal hernia is 51 and the value of one point amounts to 52 PLN, thus the reimbursement is equal to 2652 PLN. In Table 2 costs and prices are compared, and the net profit is calculated for each patient condition.

   Figure 1 presents a histogram of costs for 22 patient conditions. The frequency (the number of patient conditions) is as follows: 6 in the range of 0–2000 PLN, 10 in the range of 2000–2500 PLN, 3 in the range of 2500–3000 PLN, 2 in the range of 3000–5500 PLN and 1 in the range higher than 5500 PLN.

Table 1. Structure of costs related to DRG F72 – inguinal hernia (PLN)

Patient	Medicines	Laboratory tests	Diagnostics tests	Materials	Cost of hospitalisation	Other costs	Total costs
1	43.82	21.76	0.00	50.64	1 077.69	1 351.15	2 545.06
2	63.74	46.56	173.32	72.68	1 436.92	1 417.61	3 210.83
3	38.22	37.42	75.00	54.51	1 077.69	1 394.38	2 677.22
4	40.02	21.76	0.00	54.51	1 077.69	1 426.03	2 620.01
5	32.29	34.82	18.75	36.34	718.46	1 209.80	2 050.46
6	30.78	39.16	0.00	36.34	718.46	1 050.75	1 875.49
7	31.72	21.76	0.00	36.34	718.46	1 279.00	2 087.28
8	41.95	28.72	0.00	54.51	1 077.69	975.65	2 178.52
9	35.29	34.82	0.00	36.34	718.46	1 504.08	2 328.99
10	40.22	21.76	0.00	54.51	1 077.69	1 195.05	2 389.23
11	40.22	37.42	0.00	54.51	1 077.69	1 085.35	2 295.19
12	109.58	27.86	0.00	218.04	4 310.76	1 157.50	5 823.74
13	30.70	21.76	0.00	36.34	718.46	1 377.11	2 184.37
14	65.15	21.76	0.00	36.34	718.46	906.45	1 748.16
15	42.51	27.86	120.00	90.85	1 796.15	1 241.45	3 318.82
16	24.85	21.76	0.00	36.34	718.46	1 134.70	1 936.11
17	25.82	21.76	0.00	36.34	718.46	1 281.95	2 084.33
18	37.09	21.76	0.00	54.51	1 077.69	1 125.85	2 316.90
19	26.42	21.76	45.00	36.34	718.46	981.55	1 829.53
20	34.86	21.76	75.00	36.34	718.46	869.12	1 755.54
21	25.37	21.76	0.00	36.34	718.46	1 356.83	2 158.76
22	25.82	21.76	0.00	36.34	718.46	944.00	1 746.38

Source: own elaboration.

Table 2. DRG F72 – inguinal hernia: net profit

Patient	Patient days	DRG	Number of points	Value of one point (PLN)	Price imposed by NFZ (PLN)	Costs of patient treatment (PLN)	Net profit (PLN)
1	2	3	4	5	6	7	8
1	3	F 72	51	52.00	2 652.00	2 545.06	106.94
2	4	F 72	51	52.00	2 652.00	3 210.83	−558.83
3	3	F 72	51	52.00	2 652.00	2 677.22	−25.22
4	3	F 72	51	52.00	2 652.00	2 620.01	31.99
5	2	F 72	51	52.00	2 652.00	2 050.46	601.54
6	2	F 72	51	52.00	2 652.00	1 875.49	776.51

Table 2, cont.

| 1	2	3	4	5	6	7	8
7	4	F 72	51	52.00	2 652.00	3 228.12	−576.12
8	3	F 72	51	52.00	2 652.00	2 178.52	473.48
9	2	F 72	51	52.00	2 652.00	2 328.99	323.01
10	3	F 72	51	52.00	2 652.00	2 389.23	262.77
11	3	F 72	51	52.00	2 652.00	2 295.19	356.81
12	12	F 72	51	52.00	2 652.00	5 823.74	− 3 171.74
13	2	F 72	51	52.00	2 652.00	2 184.37	467.63
14	2	F 72	51	52.00	2 652.00	1 748.16	903.84
15	5	F 72	51	52.00	2 652.00	3 794.41	− 1 142.41
16	2	F 72	51	52.00	2 652.00	1 936.11	715.89
17	2	F 72	51	52.00	2 652.00	2 084.33	567.67
18	3	F 72	51	52.00	2 652.00	2 316.90	335.10
19	2	F 72	51	52.00	2 652.00	1 829.53	822.47
20	2	F 72	51	52.00	2 652.00	1 755.54	896.46
21	2	F 72	51	52.00	2 652.00	2 158.76	493.24
22	2	F 72	51	52.00	2 652.00	1 746.38	905.62
					58 344.00	54 777.35	3 566.65

Source: [Macuda 2018, p. 122].
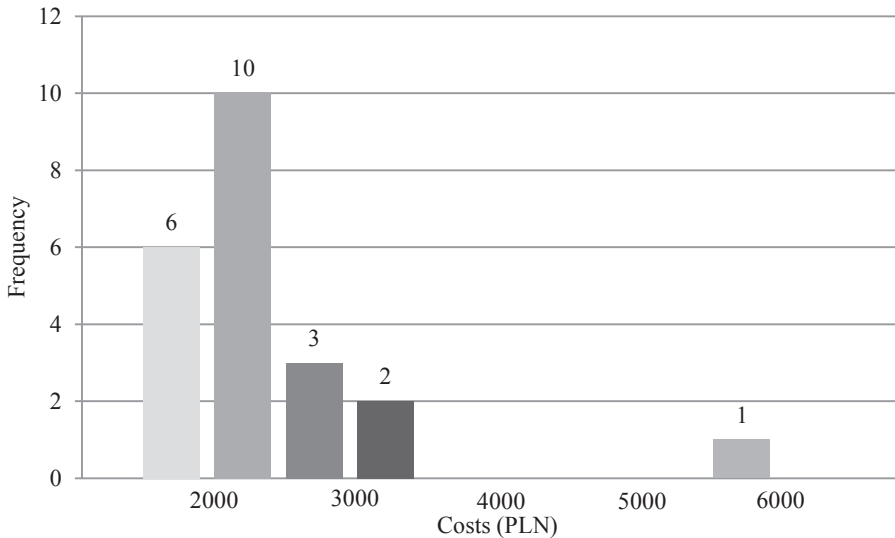
Fig. 1. Histogram of costs for 22 patient conditions (with outliners)

Source: own elaboration.

Clinical outliers can be defined as a case that is highly deviant compared with other cases in the same disease category, while financial outliers can be regarded as cases for which the index value differs greatly from that of other cases in the same disease category [Okada et al. 2014, pp. e210-e211]. The meticulous analysis of cost outliers allows to identify clinical factors which influence the increase of costs incurred in the process of providing particular medical services [Conney et al. 2003, p. 30]. In order to reject from the research sample patient conditions with extreme cost values which can distort the average, lower outliners and upper outliners are calculated as follows:

$$\text{lower outliers} = q1 - 1.5*(q3 - q1),$$
$$\text{upper outliers} = q3 + 1.5*(q3 - q1),$$

where: $q1$ – the value of the 1st quartile, $q3$ – the value of the 3rd quartile.

Calculations for inguinal hernia data (F72) show that $q1$ equals 1964.70 PLN and $q3$ equals 2776.80 PLN, thus lower outliers equal 1152.59 PLN and upper outliers equal 3318.21 PLN. All the costs values that are not in the range (between 1152.59 PLN and 3318.21 PLN) should be rejected. The research sample includes two patient conditions with costs higher than 3318.21 PLN: patient condition P12 – 5823.74 PLN and patient condition P15 – 3318.82 PLN. These two items must be rejected from the sample. The remaining 20 patient conditions are considered the normal cost group. Figure 2 presents a histogram of costs for patient conditions without outliers.
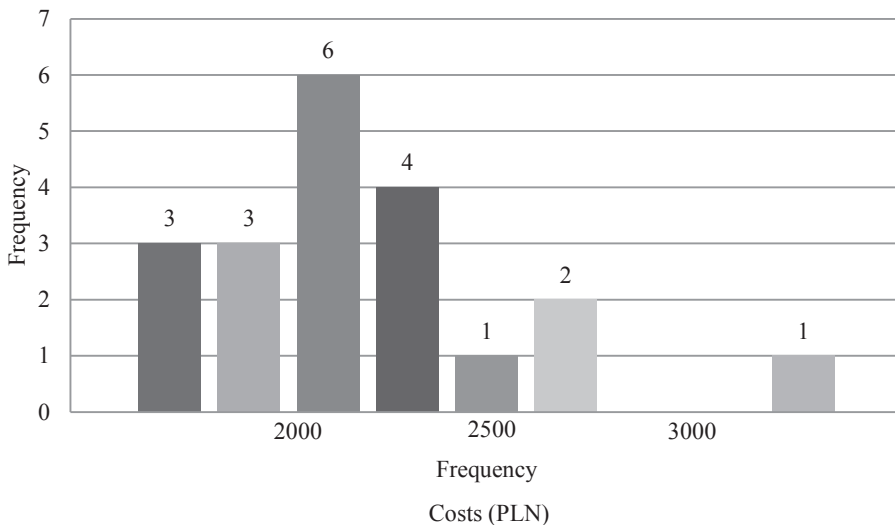

Fig. 2. Histogram of costs for 20 patient conditions (without outliners)

Source: own elaboration.

In order to estimate mean values for the research sample related to DRG F72, to compare them with NFZ tariffs (calculated as an average value, equal for all hospitals) and check if it matches bigger samples (populations), the Student's *t*-test is performed. The principal assumption of the Student's *t*-test says that sample (1) has to include more than 50 items or (2) has to be a sample from normal distribution population. Taking into account that the research sample comprises 22 items, it is necessary to verify if the research sample is from normal distribution. In order to accomplish this, the Shapiro-Wilk *W*-test (the best test for normality statistic) is used. Its application is limited for sample size up to $n = 50$.

The variance test for normality (*W*-test) of Shapiro and Wilk is a statistical procedure for testing a complete sample for normality. The test statistic is obtained by dividing the square of an appropriate linear combination of the sample order statistics by the usual symmetric estimate of variance. This ratio is both scale and origin invariant and hence the statistics is appropriate for a test of the composite hypothesis of normality [Shapiro and Wilk, 1965, p. 591]. The null hypothesis (H0) is that the data is normally distributed. If the *p*-value is greater than the significance level of 0.05 (it is acceptable to have a 5% probability of incorrectly rejecting the null hypothesis), then the null hypothesis cannot be rejected, which is the case of the research sample where W equals to 0.92471 and *p*-value equals to 0.1221.

Therefore, the Student's *t*-test can be applied for the research sample. Confidence levels in this test are expressed as a percentage. A confidence interval (CI) is a type of interval estimate (of a population parameter) that is computed from the observed data. The confidence level is the frequency (i.e. the proportion) of possible confidence intervals that contain the true value of their corresponding parameter [Neyman 1937, pp. 333-380]. If confidence intervals are constructed using a given confidence level in an infinite number of independent experiments, the proportion of those intervals that contain the true value of the parameter will match the confidence level. This means that even if the research is repeated over and over again, for a particular percentage of the time the results will match the results obtained from the population.

Taking into account the data from the research sample, the true mean is equal to 2200.92, *p*-value equals to 1, and the confident interval is within the range of 2058.15 PLN and infinity. Hence, NFZ tariff which amounts to 2652 PLN falls in this range. The results reveal a 95% confidence level, which means that if the research concerning inguinal hernia is repeated, 95% of the time the results will be the same – NFZ reimbursement covers all costs related to the treatment of patients from DRG F72.

3. Conclusion

The specific nature of the hospital is reflected in the fact that its primary purpose is not to generate profit, as it is in the case of the most economic entities, but the realization of a social mission, which is to provide high quality health services. Nevertheless, it

is important for hospitals to cover all costs related to their activity. NFZ tariffs should even enable health services providers to generate a surplus in order to facilitate their development and invest in medical equipment and new technologies.

Due to the fact that NFZ performed the valuation 10 years ago, there is a need to evaluate if the imposed tariffs still cover the costs incurred by the hospitals within particular diagnosis-related groups. Additionally the conditions in which the hospitals operate are constantly changing (population aging, purchase of new equipment, increase of prices of medicines, medical materials and salaries, implementation of new technologies, etc.). This comparison of costs and NFZ reimbursement should be performed periodically in every hospital. This would bring great value if the results obtained are compared amongst different types of medical services providers as well as hospitals operating in various geographical regions. Underestimation of specific DRGs observed in several hospitals would serve as a base to renegotiate higher tariffs with Narodowy Fundusz Zdrowia.

The example of DRG F72 shows that the price for inguinal hernia is calculated by Narodowy Fundusz Zdrowia in a way that a surplus (net profit) is generated. Taking into consideration the existence of outliers, this surplus can cover the loss on particular patient conditions with extreme costs' values, such as P12 and P15 in the research sample.

Hospitals should plan and then control the costs related to their activity and reduce the waste in the use of resources, particularly due to many factors which have an unfavorable influence on costs and are beyond the control of hospitals, such as the increases in the demand for medical services, the impact of new technologies, and the institutionalized nature of health insurance. Therefore, the managers should benefit from the managerial tools needed for proper control in order to rationalize the costs of health services. A management control system is useful in modifying some of the inefficiencies that exist within the health care system.

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PROSPEKTYWNY SYSTEM FINANSOWANIA W POLSCE OPARTY NA JEDNORODNYCH GRUPACH PACJENTÓW – KOSZTY VERSUS PRZYCHODY: PRZYKŁAD PRZEPUKLINY PACHWINOWEJ

Streszczenie: W ciągu ostatnich 20 lat wiele państw OECD przyjęło prospektywny system finansowania szpitali oparty na Jednorodnych Grupach Pacjentów (JGP). W Polsce również szpitale otrzymują stałe stawki za leczonych pacjentów, ustalone przez Narodowy Fundusz Zdrowia (NFZ) zgodnie z klasyfikacją JGP. Celem artykułu jest obliczenie, analiza i porównanie kosztów przypadków chorobowych w ramach tej samej JGP (F72 – przepuklina pachwinowa) oraz zestawienie tych kosztów i uzyskanych od NFZ przychodów w celu określenia zysku netto, a następnie sprawdzenie, czy wyniki te pasują do większych prób badawczych. Aby zrealizować cel, wykorzystano analizę porównawczą i analizę treści dokumentów medycznych i danych finansowych oraz przeprowadzono test *t*-Studenta. Aby potwierdzić poprawność próby badawczej, zastosowano test Shapiro-Wilka. Wyniki wykazały, że refundacja pokrywa koszty związane z leczeniem przepukliny pachwinowej 90% pacjentów z analizowanej próby badawczej.

Słowa kluczowe: JGP, jednorodne grupy pacjentów, prospektywny system finansowania, szpitale, koszty.