Risk adjustment: beyond patient classification systems

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(Ajuste del riesgo: más allá de los sistemas de clasificación de pacientes)

Abstract

Diagnosis related groups (DRGs) are widely used in several countries. Their various versions aim to value the cost of hospital production. In Europe, the patient classification systems and standard weights used are usually the American originals.

Objectives: The objective of this study was to analyse the extent to which DRGs and DRG-weights explain patient cost variability. Different components of patient cost (severity, comorbidities, complications and socioeconomic status), which are not well explained by DRG and which can be approximated by using administrative data, were also analysed.

Methods: A total of 35,262 discharges from two public hospitals in Barcelona were analysed. The Health Care Financing Administration (HCFA)-DRGs and the All Patient Refined (APR)-DRGs were calculated. Severity was adjusted by Disease Staging, and comorbidities and complications were calculated using Elixhauser and Charlson comorbidities groupings. An ecological socioeconomic status indicator was used. Linear regressions were estimated to explain per-patient cost variability.

Results: We found that Medicare's DRG-weights explained only 19% of cost variability. Cost-based weights explained nearly 40% (38-42%, depending on the DRG classification used). Exclusion of outliers increased explanatory power to R^2 = 47-48%. The remaining adjustment variables increased R^2 to 49-51%.

Discussion: Medicare's DRG-weights are not well-suited to Europe. Cost-based DRG-weights and outlier trimming have significantly greater explanatory power. The remaining clinical and socioeconomic variables have considerably less explanatory power but were statistically significant and behaved as expected. Spanish and other European health authorities should adapt DRG-classification systems to their environments for use in hospital production cost valuation.

Key words: Diagnosis related groups. Hospital cost analysis. DRG-weights. Outliers. Socioeconomic status. Severity. Risk adjustment.

Resumen

Los grupos relacionados con el diagnóstico (GRD) se utilizan ampliamente en diferentes países. Sus diversas versiones tratan de estimar el coste de la producción hospitalaria. En Europa, los sistemas de clasificación de pacientes y los pesos relativos estándares utilizados habitualmente son los originales norteamericanos.

Objetivos: El objetivo del presente estudio fue analizar el grado hasta el cual los GRD y las ponderaciones GRD explican la variabilidad del coste del paciente. También se analizaron los diferentes componentes del coste del paciente (gravedad, comorbilidades, complicaciones y posición socioeconómica) que no se explican adecuadamente mediante los GRD y que pueden abordarse utilizando datos administrativos.

Métodos: Se analizaron un total de 35.262 altas de dos hospitales públicos de Barcelona. Se calcularon los GRD de la Health Care Financing Administration (HCFA) y los GRD refinados de todos los pacientes (APR). La gravedad se ajustó mediante la Disease Staging, y las comorbilidades y complicaciones se calcularon utilizando las agrupaciones de comorbilidades de Elixhauser y Charlson. Se utilizó un indicador ecológico de la posición socioeconómica. Para explicar la variabilidad del coste por paciente se estimaron regresiones lineales.

Resultados: Pusimos de manifiesto que las ponderaciones GRD Medicare sólo explicaron un 19% de la variabilidad del coste. Las ponderaciones basadas en el coste explicaron casi un 40% (38-42%, dependiendo de la clasificación GRD utilizada). La exclusión de los valores extremos aumentó la potencia explicativa hasta un R^2 = 47-48%. Las variables de ajuste restantes aumentaron el R^2 hasta un 49-51%.

Discusión: Las ponderaciones GRD Medicare no son apropiadas para Europa. Las ponderaciones GRD basadas en el coste y la reducción de los valores extremos se caracterizaron por una potencia explicativa significativamente mayor. Para las variables clínicas y socioeconómicas restantes se identificó una potencia explicativa considerablemente menor, fueron estadísticamente significativas y se comportaron como se esperaba. Las autoridades sanitarias españolas y de otros países europeos deben adaptar los sistemas de clasificación GRD a sus ámbitos para utilizarlos en la evaluación del coste de la producción hospitalaria.

Palabras clave: Grupos relacionados con el diagnóstico. Análisis del coste hospitalario. Pesos relativos GRD. Valores extremos. Nivel socioeconómico. Severidad. Ajuste del riesgo.

Introduction

Considerable information on inpatients is available to those working in hospital management. This information enables definition of hospital product and observation of significant attributes that improve the characterisation of patient profile, the health care process and resource use of the hospital where the patient was treated[1,2]. However, analysis of documentation at the individual patient level provides only partial information, often leading to a superficial description of what has occurred in the health care process. Aggregated analysis is usually more complete, since it can establish a resource use profile based on characteristics that define the level of patients' need for care.

Diagnosis-related groups (DRGs) have become the most commonly used tool for the overall analysis of this information, defining products with a similar resource use and clinical coherence[3]. This classification system attempts to establish criteria for patient grouping based on maximising inter-DRG cost variability and minimising intra-DRG variability. In contrast, the number of groups must be limited to make the classification functional for hospital product management[4]. This was accomplished through different DRG versions with the number of groups ranging from 357 to 641. DRGs were introduced in Spain according to the criteria of Medicare, which uses nowadays the Health Care Financing Administration (HCFA) version 16 with 499 groups. Other DRGs versions are also used by different regional administrations.

DRGs are useful in patient classification because they establish an invoicing between the purchaser and different providers, and consequently they can be used in price setting. Their capacity, strengths and weakness have been extensively analysed in the literature[5]. However, little in-depth research on the usefulness of DRGs in hospital cost analysis has been published to date. Studies analysing the isocost capacity per category presupposed by the DRG systems have shown their limited ability to reflect resource use variability[6-9]. The lack of information on real cost per patient has made validation of DRGs as predictors of cost variability difficult.

At the same time, the ability of other characteristics of the health care process to explain cost variability has been evaluated. These characteristics include length of stay[10], aspects related to severity[11,12] comorbidities and complications[13,14], characteristics of provider management (efficiency[15] or specialisation[16]), and the patient's socioeconomic status (SES)[17-19].

The need to understand DRGs as a valuation method of the activity performed and consequently as a payment system has led to the usefulness of using DRGs as the initial point of hospital cost analysis to be overlooked. In Europe, where there is universal public coverage and where hospitals obtain their incomes mainly from the public sector, cost and cost variability should be analysed, rather than market price[20]. In this setting, competition is not in prices, but in the continued functioning of the hospitals, in patient access equity, and in the optimum allocation of final and overall resources[21,22].

Thus, an analysis of health care activity cost and of the causes of its variability in Europe is needed. Determination of the characteristics and causes of this cost would allow improvements to be made to payment systems, which should first reflect cost and then the standardisation of reasonable cost. This in turn would enable the creation of adequate incentives to improve allocation of the available economic resources.

In spite of the considerable information available on hospital processes, cost explanation is usually reduced to length of stay or diagnosis. Authors such as Iezzoni[2], Elixhauser[14] or Peiró[11] have popularised the concept of 'risk adjustment', which refers to variability in the results of the hospital process as a consequence of variability in the hospital process itself and in associated resource use. These authors have advanced the study of the ability of administrative databases to contribute information for use in this adjustment. Information available on the development of hospital activity has enabled patient characterisation based on real resources use.

The aim of this study was to assess the ability of the available hospital administrative dataset to explain hospital discharge cost variability. Specially, to analyse the extent to which cost-based-DRG-weights are able to improve Medicare-DRG-weights, and to analyse the extent to which the various DRG patient classification systems used today are able to explain cost variability.

A cost database containing information on 35,262 discharges from the two public teaching hospitals owned by the Municipal Institute of Health Care (IMAS) in Barcelona enabled evaluation of a range of information from the Minimum Data Set and other registered data available in their information systems.

The research hypotheses were the following: *a)* DRGs provide insufficient information to explain the variability in observed cost, and *b)* use of the information added by the Minimum Data Set substantially improves DRGs' ability to explain cost variability.

Methods

The 35,262 admissions from the IMAS hospitals, admitted and discharged between 1995 and 1996, were retrospectively analysed (table 1).

The relationship between total cost per patient, which is the dependent variable, and the variables and indexes extracted from the available information, which are the independent variables, was analysed. The main in-

Table 1. Description of data base

	H-DRGH[a]	A-DRG[b]	APR-DRG[c]
Number of DRG groups	470	313	319
Discharges per DRG	71	108	106
Number of discharges			
Inliers	33.585	33.718	33.713
Outliers	1.677	1.544	1.549
Total	35.262	35.262	25.262
Outliers			
Percentage of cost	17,9%	17,9%	18,0%
Percentage of hospital day	15,1%	14,9%	15,0%
Percentage of discharge	4,8%	4,4%	4,4%
Average values for inliers			
Average discharge cost	312.687	311.504	311.255
Average LOS	7,89	7,88	7,86

[a]HCFA-DRG. [b]Adjacent-HCFA-DRG. [c]All Patient Refined DRG.

formation sources were the Minimum Data Set, with a maximum of eleven secondary codified diagnoses, and the cost accounting system.

Hospital discharge cost is a monetary reflection of a series of activities and resource uses incurred during the course of the patient's treatment. These activities and resource uses differ according to the product, severity of illness, and the patient's other clinical variables, socioeconomic characteristics, as well as to the management of the health care process.

Variables

A set of variables associated with causes able to explain cost variability was constructed from the information available. These variables were related to product complexity (DRGs and outliers), disease seriousness (severity, complications, comorbidities), patient characteristics (age, gender, SES characteristics), and management of the health care process (readmission, circumstances on admission and discharge, and surgical procedure).

Per-patient cost. The IMAS uses a hospital cost accounting system based on full costing allocation[23.24]. This system ensures that the hospitals' total costs are distributed among the patients. Allocation is based on the direct allocation of the following services to the patient: laboratory, pharmacy, radiology, nuclear medicine, pathologic anatomy, and prosthesis[25]. The computing systems contain exhaustive information on human resources and their activity: storage, admissions planning, outpatient and emergency departments and operating room, diagnoses and complementary tests, and inter-hospital consultations. This information enables the creation and automatic updating of cost drivers based on 'Activity Based Costing' (ABC)[26,27]. Teaching activity is valued according to the agreements between the health institutions and universities. Research activity is valued on the basis of the impact factor of the clinical staff's publications during the period analysed[28].

Consequently, not only is the overall cost per patient known, but also its structure. Thus, costs related to surgical procedures, intensive care unit treatment, pharmacy, radiology, laboratory, prosthesis, and pathologic anatomy can be distinguished from costs related to length of stay.

Medicare's DRG-weights (MW). Patient classification systems were used to define observed hospital product. Relative values were used to value this product definition. Theses relative values are centred in the unity, which is the mean discharge cost, and the different products take values according to this mean. As a first step, Medicare's DRG weights were used. This is the weight system used to value hospital activity in several European hospital payment systems and it is available only for the HCFA's DRGs[3,20,29,30].

Cost-based DRG-weights (CW). As an alternative to using Medicare's DRG-weights, each patient was assigned the CW that represents the average cost of all cases within a DRG with respect to the average total cost of the database analysed[31]. The difference in observed cost-based weights between two discharges belonging to two different DRGs is the closest possible approximation to inter-DRG variability. Any unexplained differences must be due to intra-DRG variability not explained by patient classification system.

Three DRG groupings were used in the analysis: *a)* HCFA version 11 DRG grouping (H-DRG) which incorporates comorbidities, complications and patient age as a splitting variable between product categories; *b)* adjacent-DRG (A-DRG) which are the H-DRG but regrouping categories in which the difference was due to comorbidities, complications, or age, and *c)* All Patients Refined (APR)-DRG grouping (version 15)[32], which leaves each patient's severity of illness to a complementary indicator (severity index).

Outlier cases. Medicare considers that product definition based on DRGs must correct for cases of extreme cost compared with the average of cases belonging to a particular group. These cases, although belonging to a specific DRG, imply a much higher expenditure than the average of the specific DRG to which they belong[7,8,33,34]. The geometric mean plus two standard deviations was used to determine cases of abnormally high cost[35]. This method was applied to each classification system separately, since each DRG category has a different cut-off point.

Severity. The severity of illness associated with each patient was valued using the Disease Staging measurement system[6,9,36,37]. For the APR-DRG classification system, the APR-DRG severity indicator was used.

Comorbidities. Several authors have applied the Charlson[13] Index to reveal comorbidities associated with specific secondary diagnoses and the increased probability of death associated with their presence[16,38-40], after transforming and making it applicable to administrative data. Recently, Elixhauser and colleagues[14] have described a set of 30 groupings of the International Classification of Diseases (ICD-9-MC) diagnoses that imply comorbidity if they occur as secondary diagnoses. However, when the secondary diagnosis giving rise to the comorbidity coincides with a specific DRG they are considered a complication and not a comorbidity. This method is based on administrative data and incorporates individual variability parameters for each comorbidity group with respect to costs. A database with 11 possible codified diagnoses enabled use of the algorithm.

Complications. Complications are processes or events arising from hospitalisation that worsen the patient's condition. Complications may be general (e.g., urinary infection) or related to the complaint treated. Diagnoses considered as a complication by the method of Elixhauser and colleagues are included in this variable. A dummy variable distinguishing cases with complications was used. Both comorbidity and complications indicators were used to complement the information added by the A-DRG.

Readmission. Information, both on the discharges during the last three months of 1995 and on those during the first three months of 1997, was added to the 1995 and 1996 databases. This information was then used to calculate the number of readmissions for each patient. In this analysis, an admission was considered as readmission of a particular patient within 90 days of the previous admission. The accumulated number of admissions for each patient gave the value of each patient's readmission variable. The first admission of a readmission process is called the Index admission.

Hospital. The installed supply and the organisation of each hospital were considered to influence cost variability. A dummy variable was used to control for these differences[41].

Admission type. Emergency admissions may involve more intensive resource use than planned ones. Firstly, emergency admissions are often more complex than planned ones after adjusting for case-mix. Secondly, the cost of the diagnostic tests carried out in emergency admissions belongs to the episode studied, unlike the cost of those carried out before planned admissions.

Exitus. The consequences of a patient dying while hospitalised vary. On the one hand, death may increase cost due to higher treatment intensity, but on the other hand, it may reduce lenght of stay and, consequently, final cost is reduced when the death occurs before the normal length of stay of patients in a specific DRG category.

Age. It is generally believed that hospital resource use tends to be concentrated during the last years of a person's life[42]. Therefore, age positively explains part of cost variability, independently of the clinical characteristics of the disease being treated.

Gender. Gender is a patient-defining variable that may add explanatory power to cost evolution after variables related to the product, complexity, severity, and age have been adjusted.

Socioeconomic status. Several studies have supplied information on the effect of low socioeconomic status on cost[43]. Since of individual patients is not collected in the administrative database, the Household Economic Capacity Index (HECI) was used[44]. This index synthesises differences in economic capacity between small areas in a continuous valuation. Although it is an ecological variable, characteristics of these small areas (census tract) provide information on the socioecenimic status of patients living in the city of Barcelona. Among the 35,262 discharges, 26,676 were living in Barcelona and consequently information on their socioeconomic status was available.

Surgical procedure. A dummy variable based on whether patients underwent surgical procedures or not was determined using DRG type. Although this variable is incorporated in DRG definition, it is expected that there are characteristics related to hospital structure and organisation that may be captured through this circumstance.

Analysis

In the present study, real discharge cost variability based on a set of variables generated by and available in any European hospital is explained. The sign and the explanatory power of each variable related to discharge cost was evaluated.

Three different approaches to the product were used depending on the DRG grouping system. On the one hand, we used the H-DRG, which already incorporates the components of comorbidity and complications. On the other hand, we used the same DRGs, after eliminating differences in comorbidities, complications, and age (A-DRG). In this case, the Elixhauser Index (A-DRGE) and the Charlson Index (A-DRGC) were applied. Finally, we applied the patient classification system based on APR-DRG where severity definition is determined by the APR-DRG's grouper severity indicator.

The relationship between discharge cost and the variables constructed was established with an unadjusted bivariate correlation. The correlation analysis was performed through Pearson's lineal correlation for continuous variables and through Spearman's lineal correlation for dummy variables.

The multivariate analysis was performed through ordinary least squares by relating total discharge cost to explanatory variables. A logarithmic transformation of the variables considered continuous (total cost, socioeconomic status indicator, comorbidity index and average cost weight) was applied to reduce the magnitude effect, thus avoiding the introduction of a fictitious relationship between variables. Similarly, the logarithmic transformation, which approximates the normal distribution expected for these variables, was applied. This guaranteed the absence of bias in the statistics used to validate the estimation[6,45,46].

To obtain more robust cost-based weights, cases belonging to a DRG with less than 37 cases were excluded. A cut-off point was calculated with the aim of including 95% of cases.

To answer the initial hypothesis, the multivariate analysis was performed in various stages:

Equation 1: Analysis of the ability of different DRG patient classification systems using Medicare's weights (MW) and cost-based weights (CW); and Equation 2: The set of variables that provides information to risk adjustment. The variables corresponding to each patient classification system used were introduced. To simplify the analysis, this completed model was applied only to cases not considered to be outliers.

Table 2. Bivariate analysis. Crude correlations between patient cost and independent variables

Variable			
Product			
Medicare's Weights	*continuous*	*0.4762*	*
HCFA-DRG CW[a]	*continuous*	*0.5532*	*
Adjacent HCFA-DRG CW[a]	*continuous*	*0.5299*	*
APR-DRG CW[a]	*continuous*	*0.5288*	*
HCFA-DRG outliers	*dummy*	*0.3091*	*
APR-DRG outliers	*dummy*	*0.3075*	
Adjacent HCFA-DRG outliers	*dummy*	*0.3145*	*
Elixhauser's comorbidities	*continuous*	*0.1564*	*
Elixhauser's complications	*dummy*	*0.1131*	*
Charlson	*continuous*	*0.1483*	*
APR-DRG severity indicator	*categorical*	*0.2211*	*
Disease staging	*categorical*	*0.1551*	*
Socioeconomic status			
Age	*continuous*	*0.1369*	*
Gender	*dummy*	*0.0165*	*
HECI[b]	*continuous*		*NS*
Hospital process			
Readmission index	*dummy*	*0.0346*	*
Readmissions	*continuous*	*–0.0258*	*
Hospital	*dummy*	*0.0545*	*
Emergency admissions	*dummy*	*0.0996*	*
Exitus	*dummy*	*0.1566*	*
Surgical procedure	*dummy*	*0.1521*	*

**significance p < 0.01; NS: no significance. [a]Cost based DRG-weights without outlier cases. [b]Household economic capacity index (HECI). [c]Pearson's lineal correlation for continuous variables and through Spearman's lineal correlation for dummy variables.*

Results

After exclusion of outliers, the 35,262 discharges were grouped into 313 product categories for the A-DRG with an average of 108 cases. The results for APR-DRG were fairly similar: there were 319 DRGs with an average of 106 cases. In contrast, H-DRG had 470 groups with an average of only 71 patients (table 1).

Average discharge cost was 2,180 euros. Average cost, after excluding outliers, oscillated between 1,871 euros for APR-DRG and 1,879 euros for H-DRG. Outlier cases accounted for 4.4% of APR-DRG and 4.8% of H-DRG. However, these cases represented about 15% of stays and 18% of cost, independently of the grouping method.

There was a significant gross lineal correlation in all variables, except for socioeconomic status. The sign was positive in all variables, except for readmissions (table 2).

The ability of MWs to explain cost variability estimated through R^2 was 19.3%. CWs completely representative of the sample studied achieved an explanatory power of between 39% and 42%, depending on the patient classification system used. The HCFA's DRG grouping system had slightly greater explanatory power, even though almost 50% more categories were required to achieve this than with other systems (table 3). When outliers were excluded, the R^2 of the different models increased by 5 points (results not shown).

Equation 2 incorporates the complete risk adjustment model. The overall model explained up to 50% of cost variability with slight differences among the patient classification systems used. All the variables maintained significance except some severity stages evaluated by Disease Staging. All the variables with greater complexity (DRG weight), seriousness (more comorbidities, complications or severity), process complexity (emergency or surgical admission), or unfavourable socioeconomic status (greater age or lower economic capacity) resulted in higher cost. Variables interrupting the hospital process (readmissions and death) resulted in lower cost (table 4).

Discussion

This study shows that the ability of different patient classification systems commonly used in our setting to

Table 3. Valuation of patient classification systems' cost variation explanatory power

Independent variable	*Dependent variable: per-patient cost*							
	MW-HR-DRG		*CW-H-DRG*		*CW-A-DRG*		*CW-APR-DRG*	
	Coefficients	*SD*	*Coefficients*	*SD*	*Coefficients*	*SD*	*Coefficients*	*SD*
Weight[a]	0.7267	0.0091	0.9827	0.0070	0.9907	0.0075	1.0136	0.0079
Constant	9.1651	0.0408	8.0475	0.0315	7.9989	0.0338	7.8947	0.0356
R^2	0.1929		0.4220		0.3924		0.3790	
F	6,374.8		19,476.6		17,231.4		16,280.5	
n[b]	26,670		26,670		26,670		26,670	

[a]*Significance at 99% for all variables.* [b]*Barcelona city residents grouped in significant DRG.*

Table 4. Risk adjustment models based on different patient classification systems and seriousness indicators

	Dependent variable: per-patient cost											
	HCFA-DRG (H-DRG)			*HCFA-adjacement-DRG with Elixhauser index (A-DRGE)*			*HCFA-adjacement-DRG with Charlson index (A-DRGC)*			*All patient refined-DRG (APR-GRD)*		
Explanatory variables	*Coefficients*	*Std error*	*T*	*Coefficients*	*Std error*	*T*	*Coefficients*	*Std error*	*T*	*Coefficients*	*Std error*	*T*
Product												
Cost Weight-APR-DRG	0.9228	0.0072	128.5890*									
Cost Weight-A-DRG				0.8961	0.0075	119.8100*	0.8987	0.0075	120.0790*			
Cost Weight-APR-DRG										0.9259	0.0077	119.513**
Seriousness												
Elixhauser's comorbidities index				0.1418	0.0072	19.6610*						
Elixhauser's complications index				0.1063	0.0117	9.0770*						
Charlson's comorbidities index							0.1916	0.0096	19.9480*			
Severity stage 2	0.0182	0.0097	1.8720***	0.0216	0.0099	2.1860**	0.0219	0.0099	2.2140*			
Severity stage 3	0.0352	0.0115	3.0740**	0.0160	0.0119	1.3440***	0.0231	0.0117	1.9710**			
APR-DRG severity index										0.4222	0.0168	25.151*
Age	0.0158	0.0048	3.2630*	0.0177	0.0050	3.5500*	0.0219	0.0050	4.4090*	0.0139	0.0049	2.8290*
Gender	−0.0205	0.0074	−2.7950*	−0.0380	0.0075	−5.0710*	−0.0396	0.0075	−5.2660*	−0.0357	0.0075	−4.7740*
Socioeconomic status (SES)												
Household economic capacity index (HECI)	−0.0398	0.0131	−3.0430*	−0.0393	0.0133	−2.9680*	−0.0399	0.0133	−3.0090*	−0.0405	0.0133	−3.0490*
Hospital process												
Readmission index	0.1080	0.0244	4.4433*	0.1192	0.0247	4.8200*	0.1186	0.0247	4.7910*	0.2346	0.0247	9.5130*
Number of readmissions	−0.1356	0.0140	−9.7180*	−0.1495	0.0142	−10.5250*	−0.1521	0.0142	−10.6930*	−0.2881	0.0142	−20.3260*
Hospital	−0.1289	0.0107	−12.0890*	−0.1707	0.0111	−15.4120*	−0.1579	0.0110	−14.3560*	−0.1687	0.0109	−15.5170*
Emergency admission	0.2418	0.0086	28.0030*	0.2499	0.0088	28.4910*	0.2570	0.0088	29.3750*	0.2270	0.0088	25.7570*
Exitus	−0.2760	0.0200	−13.7810*	−0.2941	0.0205	−14.3230*	−0.2984	0.0206	−14.4770*	−0.3453	0.0207	−16.6850*
Surgical procedure	0.1846	0.0092	19.9890*	0.2349	0.0094	24.8660*	0.2376	0.0095	25.0100*	0.2358	0.0094	25.0420*
Constant	0.1846	0.0092	19.9890*	8.3495	0.0725	115.1640*	8.3190	0.0725	114.7130*	7.9475	0.0726	109.4270*
R^2	0.5082			0.4893			0.4880			0.4868		
F	2,188.19			1,747.29			1,871.3			2,200.92		
n[a]	25,398			25,516			25,516			25,510		

[a]*Barcelona residents grupped in significative DRG without outliers.* *Significance at 99%. **Significance at 95%. ***Not significant.*

explain hospital cost variability and to determine resource allocation can be evaluated using information from a large number of cases on cost per patient. The first issue to take into consideration is that using patient classification systems with imported standardised weights contributes very little to information on cost variability. Twenty percent of the variability is a low percentage, although it is similar to that obtained in other studies[6,9].

Normally, the poor ability of DRG-weights to explain cost variability has been attributed to the weight systems used[31]. Using the average value after excluding outliers, based on the observed costs of the database analysed, as weight structure, maximises the explanatory power of the classification systems used. Certainly, the doubling of explanatory power after using a completely representative weight structure suggests that the possibility of improving the utilisation of these systems exist. However, 40% is not a high percentage. Furthermore, this percentage is the most satisfactory possible, since it was obtained from two hospitals sharing the same management and thus, it does not show either input price differences or inter-hospital variability.

Another possibility for improvement concerns the effect of outliers in blurring the explanatory power of these grouping systems, which use the group mean to characterise all the cases that they incorporate. Between 4.4 and 4.8% of cases were of extremely high cost. This cost could not be approximated by the mean of the distribution, since it was too far from its distribution core. Their effect in terms of cost was 18%, a figure which led to a displacement of the mean value to higher values, making the mean less representative of all the cases incorporated. Excluding outliers substantially increased the explanatory power of DRGs.

After the increase due to exclusion of outliers was discounted, the set of variables enabling characterisation of patient cost and comparison of resource needs based on different circumstances linked to the patient, process or supply, did not significantly add explanatory power. However, signs and stability of parameters of the different classification systems can add considerable information about the causes of hospital discharge cost variability. More specifically:

– DRG systems with few (313) product categories can achieve a similar explanatory power to those that need 50% more categories, when systems to value the seriousness of the disease treated are used. Also, there are few differences between Elixhauser's and Charlson's comorbidities and complications measures. However, the specificity of the former in distinguishing complications and comorbidities should be positively valued. The APR-DRG system is the logical synthesis of the points 1 and 2 that seeks to minimise the number of products and to maximise information about their seriousness. Differentiating between severity, comorbidities and complications is central to an analysis of the different causes of cost variability. The Adjacent-HCFA-DRGs (A-DRG) could provide qualitatively richer information. Finally, the simplicity of the Charlson and Elixhauser indexes and their immediate applicability is an advantage, since the severity indicator algorithm of the APR-DRG is much more complicated and less intelligible.

In this study, information on the socioeconomic status characteristics of 26,676 patients, which is not normally available, was used to evaluate their effect on cost. There was an inverse relation between socioeconomic status and cost, as in Medicare's payment system, in which serving a population with a lower socioeconomic status than the average is valued as a justifiable extra cost. This relationship was not captured in the bivariate analysis, but is clearly relevant after adjusting for the variables that define product and other circumstances. Because it is very difficult to collect information on the socioeconomic status of individual patients in administrative databases, trust will have to be placed in ecological variables, as is the case with the HECI when analysing the effect of socioeconomic status on hospital resource use.

The remaining adjustment variables behaved in accordance with the initial hypothesis: readmissions resulted in lower average cost per episode while index admissions tended to result in higher costs. Similarly, death reduced the cost of hospital episodes. This was observed only in the multivariate analysis since in the bivariate analysis death was associated with higher cost.

Even though this study presents the limitation of not representing a sufficiently general setting to enable extrapolation of the conclusions to an entire health care system, the results obtained should be valued as highly relevant as they lead to different health policy implications that should not be ignored; that is, the ability of administrative databases to define product and value its cost does not end in DRG grouping. Many aspects could be improved by using information obtained from administrative databases. On the other hand, the relevance of outliers, because of their intense resource use, should be integrated into activity valuation based on DRG. Adjustment of DRG-weights to the environment in which they are to be used is strongly recommended. Moreover, aspects associated with patient characteristics and the hospital process, such as severity, should be valued in order to achieve a good approximation of patient cost. Finally, a clear relationship was seen between resource use and the patient socioeconomic status, which should be integrated into the valuation of cost considered justifiable.

From these five points it can be concluded that a valuation of different hospital activities of a health care system that is based only on DRG-weights can be very inequitable, since these valuation deficiencies may affect some hospitals more deeply than others. Because only two hospitals sharing the same type of management and following the same guidelines were analysed, these five aspects cannot be associated with structural differences, but must be associated with the activity performed. In other words, they must be related to casemix and not to structural differences. According to this reasoning, any payment system based on activity should include these five causes of cost variability in their method of valuing activity. This is not the case in the Catalan or Andalusian payment systems mentioned above. These models consider that beyond Medicare's DRG-weights, and no other reason for variability apart from structural differences between centres exists.

Conclusions

Hospital cost can be reasonably well characterised with the available information. DRGs are not questioned as a tool for hospital activity payment when the purpose is to give a price to the provider-purchaser relationship. Until now, the crossed subsidies among cases in the same DRG and across DRGs have been assumed to provide satisfactory overall application. However, the limitations of DRGs to explain resource use variability in cost analysis are clear. Nowadays, the available information allows for a greater insight into each patient's cost level and thus, resources can be more efficiently allocated.

Explanation of what determines per-patient cost should not be confined to DRGs: all the tools available in hospitals' current information systems should be used in cost and risk adjustment. Measures that complement the information added by DRGs can easily be applied to administrative databases. Only improvement in the weight system, consideration of outliers, and valuation of illness can make the valuation of justifiable cost for different hospitals more objective. Among these variables, those that offer greater potential improvement seem to be those that adjust weights to the context in which they are applied and those that correctly identify outliers. That, qualitative improvement of the information in the Minimum Data Set should be developped and would enable a much more accurate characterisation of hospital product and its cost.

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