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Original Article

Cholecystectomy and Diagnosis-Related Groups (DRGs): patient classification and hospital reimbursement in 11 European countries

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Abstract

Background: As part of the EuroDRG project, researchers from eleven countries (i.e. Austria, England, Estonia, Finland, France, Germany, Ireland, Netherlands, Poland, Sweden, and Spain) compared how their Diagnosis-Related Groups (DRG) systems deal with cholecystectomy patients. The study aims to assist surgeons and national authorities to optimize their DRG systems.

Methods: National or regional databases were used to identify hospital cases with a procedure of cholecystectomy. DRG classification algorithms and indicators of resource consumption were compared for those DRGs that individually contained at least 1% of cases. Six standardised case vignettes were defined, and quasi prices according to national DRG-based hospital payment systems were ascertained and compared to an index case.

Results: European DRG systems vary widely: they classify cholecystectomy patients according to different sets of variables into diverging numbers of DRGs (between two DRGs in Austria and Poland to nine DRGs in England). The most complex DRG is valued at four times more resource intensive than the index case in Ireland but only 1.3 times more resource intensive than the index case in Austria.

Conclusion: Large variations in the classification of cholecystectomy patients raise concerns whether all systems rely on the most appropriate classification variables. Surgeons, hospital managers and national DRG authorities should consider how other countries' DRG systems classify cholecystectomy patients in order to optimize their DRG systems and to ensure fair and appropriate reimbursement.

Keywords: Cholecystectomy, Diagnosis-Related Groups (DRGs), Europe, Economics, Hospital

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Key Messages

Implications for policy makers

- The result of this study can help policy-makers to consider alternative and possibly better ways to classify their patients into Diagnosis-Related Groups (DRG).
- DRG systems are meant to provide precise measures of the kind of services hospitals deliver.
- The international comparisons can provide a very useful new perspective especially when governments, Ministries of Health or payers are thinking about how to improve an existing DRG system.
- These researches can also allow countries, which are introducing DRG system, to avoid making gross errors or mistakes in composing their own DRG system.

Implications for public

Surgeons and national Diagnosis-Related Group (DRG) authorities should consider how other countries' DRG systems classify cholecystectomy patients in order to optimize their DRG systems and to ensure fair and appropriate reimbursement.

Introduction

Gallbladder surgery is one of the most frequent major surgeries in general surgery departments (1) and a cholecystectomy procedure is considered a benchmark procedure for a surgeon and surgical department (due to high prevalence, relevant impact on the population's health, high clinical variability, and substantial use of resources) (2,3). Diagnosis-Related Groups (DRGs) are Patient Classification Systems (PCSs), which are commonly used to classify, benchmark and ultimately pay for hospital treatment (4). In current DRG-type hospital payment systems, DRGs define the payment categories, i.e. hospital products (4). As such, they are designed to increase the transparency about the services and provide incentives for the efficient use of resources within hospitals (4). Another type of standardized agreement in healthcare are clinical guidelines, which

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are also used for guiding decisions and criteria regarding diagnosis, management and treatment, and are increasingly used as benchmarks for high quality care. It is important that management tools, which provide administrative incentives for clinical decision-making, are coherent. All the above also applies to Episodes of Care (EoC)[1], such as cholecystectomy. Classifications in healthcare are needed to transform information about human health and medical interventions to facilitate aggregation, analysis, decision-making and learning among people, and increasingly between software agents (5).

A well-designed classification system that is serving as the basis for a fair hospital payment or as the basis of performance comparisons should assure homogenous groups of patients based on most important determinants of resource consumption as classification variables and do so in a systematic manner (6). Otherwise, DRGs do not adequately control for differences of patients within different groups and reimbursement or benchmarking for some patient groups will not be adequate (4). It is also possible that if the PCS that is used for payment and benchmarking purposes is performing inadequately, it creates a potential conflict of incentives for clinical professionals and managers (7,8).

DRG systems usually group treatment cases on the basis of classification variables such as diagnoses, procedures and demographic characteristics. However, DRG systems in different countries and sometimes even within countries vary a lot, and they are in a constant state of evolving (4).

Very often professional specialist experts or consultants formally participate in the process of selection, definition, and update of classification criteria for respective DRGs (9). Thus, it is of utmost importance both for specialist groups such as surgeons as well as hospital managers to be aware of how their respective patients are classified by their DRG system in order to assess whether the classification variables adequately reflect differences in the complexity of treating different groups of patients using different techniques.

Comparison of different countries' DRG systems classification principles can help surgeons to identify potential scope for improvement of their system or find cross-country agreement in classification principles in the same manner and direction as clinical guidelines. Also, analysing the different approaches to assigning a value and reimbursement tag for similar patients in other DRG systems may inform and support discussions about the adequacy of the existing practice. To the best of our knowledge, detailed comparative analyses of classification algorithms for cholecystectomy are very scarce, suffer from a very limited scope, and have not assessed the classification of patients using routine inpatient data (10).

Overall, studies across Europe suggest DRG-based payment systems have been associated with reduction in unit costs but also with an increase in total cost, due in part, to increased activity (4). Whether this has improved system efficiency depends on a number of factors, including: the impact on quality; the 'value' of the additional activity in terms of health gain; and whether there was cost-shifting (for example, with greater costs being borne in community and primary care from earlier discharge for patients) and gaming of the system (through up-coding and patient selection). Very few studies have examined the impact of payments based on DRGs on system-wide efficiency (11).

For hospital care, case-mix adjusted bundled payments are well established across Europe and are being expanded to cover more types of inpatient care. While having had an impact in Europe, with respect to increasing activity and reducing Length of Stay (LOS), DRG-type payments may not alone help to improve the quality of care (particularly the coordination of care for patients beyond hospital settings), or control overall costs of hospital care (11).

This study therefore performs a comprehensive assessment of DRG systems across eleven European countries and has three main objectives: 1) to assess classification variables and algorithms used to group patients with cholecystectomy into DRGs; 2) to compare the composition of these DRGs and variations in relative resource intensity; and 3) to determine DRGs and hospital price levels for six case vignettes of cholecystectomy patients with different combinations of demographic, diagnostic and treatment variables.

The results were generated in the framework of the EuroDRG project (4), which selected ten episodes of care to assess European DRG systems and their ability to define homogenous groups of patients. In this article, we focus on cholecystectomy as it is one of the most common emergency surgical procedures in high-income countries (12–14).

Methods

Definition of episode of care and cholecystectomy index case

A common definition for a cholecystectomy EoC was agreed as part of the EuroDRG project by researchers from eleven European countries (i.e. Austria, England, Estonia, Finland, France, Germany, Ireland, the Netherlands, Poland, Spain, and Sweden). The definition was based on the International Classification of Diseases 10th edition (ICD-10) for diagnoses and ICD-9 Clinical Modification (ICD-9CM) for procedures and is presented in Box 1. Researchers from each country translated the definition into national codes for diagnoses and procedures considering available mappings from the Hospital Data Project if applicable (15). Similar methods have been reported for another episode of care (16–21).

A cholecystectomy index case was defined (i.e. adult age, uncomplicated calculus of gallbladder with cholecystitis, laparoscopic cholecystectomy, treated as inpatient) to facilitate comparisons of relative resource intensity of respective DRGs within countries (see Box 1).

Box 1. Definition of EoC and reference case

Definition

Name	→	Cholecystectomy
Defined by	→	Primary procedures AND diagnosis
Primary diagnosis (ICD-10)	→	K80.1 (Calculus of gallbladder with other cholecystitis)
Procedure (ICD-9CM)	→	51.2 (Cholecystectomy)

Index case

Adult age (<36), without complications, non-specific cholecystitis, laparoscopic cholecystectomy, treated as inpatient, LOS 4 days

1. The EoCs are uniformly defined across countries through diagnosis and/or procedure codes and can be understood as 'meta-DRGs' which encompass varying numbers of actual DRGs within countries.

Data sources

In each country, researchers identified national or regional databases of hospital care and obtained access to all information necessary for the purposes of this study. The number of cholecystectomy cases conforming to our definition and the corresponding DRGs were extracted from the databases. An overview of the databases and time interval (years) of data used for the study in each country are presented in Table 1. Databases were required to contain information about diagnoses, procedures, and DRGs of individual patients in order to make possible identification of cholecystectomy patients conform to the agreed definition. The number of identified cholecystectomy cases ranged from 1,845 cases in Finland to 73,545 cases in Poland (22).

Analysis of Patient Classification Systems (PCSs)

For each country the number of cholecystectomy EoC cases and the corresponding DRGs were extracted from the databases. Detailed comparative analyses of classification variables and of grouping algorithms of national DRG systems (16,23) were performed for the most frequent DRGs, i.e. those DRGs that individually contained at least 1% of all cholecystectomy patients in the relevant database.

Grouping algorithms were mapped graphically to facilitate easy comparison of differences and similarities between systems (see below). In addition, the percentage of all cholecystectomy EoC cases grouped into the DRG and the percentage of all cases within each DRG conforming to the definition of cholecystectomy was calculated.

Diagnosis-Related Groups (DRGs) and hospital quasi prices

In addition to the index case (see above), six standardised case vignettes of patients with different combinations of primary and secondary diagnoses, procedures, age and length of stay were defined (Table 2). This selection is meant to describe the grouping logic of different DRG systems in different countries' systems. Case vignettes one, two and three represent more complicated cases of cholelithiasis, while the remaining ones are combinations of mixed gravity of primary and secondary diagnosis and patient characteristics.

DRG-type hospital payments systems differ between and often even within countries, thus, complicating comparisons across

Table 1. Data years and databases by country

Country	Data year	Source of data	Diagnoses coding	Procedure coding
Austria	2008	Procedure-oriented Hospital Financing (LKF) Federal Ministry of Health (BMG)	ICD-10-BMSG-2001	Leistungskatalog
England	2007–8	Hospital Episode Statistic (HES)	ICD-10	Office of Population Censuses and Surveys (OPCS)
Estonia	2008	Estonian Health Insurance Fund (EHIF) database	ICD-10	NOMESCO Classification of Surgical Procedures (NCSP)
Finland	2008	Hospital Benchmarking Database	ICD-10-FI	NCSP-FI
France	2008	Programme of Medicalization of Information Systems: medicine, surgery and obstetrics (PMSI MCO)	CIM-10	Classification Commune des Actes Médicaux (CCAM)
Germany	2008	Diagnosis Related Groups (DRG-statistik) of the Federal Statistical Office (Destatis)	ICD-10-GM	OPS Operationen- und Prozedurenschlüssel
Ireland	2008	Hospital Inpatient Enquiry (HIPE) database of the Health Services Executive (HSE)	ICD-10-AM	Australian Classification of Health Interventions (ACHI)
Netherlands	2008	Diagnose Behandeling Combinaties (DBC) Onderhoud database	ICD-10	Elektronische DBC Typeringslijst
Poland	2009	Register of episodes of care and reimbursements of the National Health Fund (NHF)	ICD-10	ICD-9-CM
Sweden	2008	The National Patient Register (NPR) of The Board of Health and Welfare	ICD-10-SE	KVÅ Klassifikation av vårdåtgärder (Swedish adaption of NCSP)
Spain (Catalonia)	2008	Hospital Minimum Basic Data Set (CMBD) database of the Public Hospital Network of Catalonia (XHUP)	ICD-9-CM	ICD-9-CM

Table 2. Case vignettes: Patient classification variables

	Primary diagnosis	Secondary diagnoses	Cholecystectomy procedure	Age	Setting	Death during admission	LOS (days)
Index case	K80.1	No	Laparoscopic	<36	Inpatient	No	4
Patient 1 Open with CC	K80.0	E11.8, I50.1, I69.3	Open	85	Inpatient	Yes	9
Patient 2 Lap with CC	K80.1	T81.4	Laparoscopic	49	Inpatient	No	16
Patient 3 Lap without CC	K80.4	No	Laparoscopic	55	Inpatient	No	4
Patient 4 Day lap with CC	K80.2	E11.9, I11.9	Laparoscopic	69	Day case	No	1
Patient 5 Day lap without CC	K80.2	No	Laparoscopic	25	Day case	No	0
Patient 6 Open without CC	K80.0	No	Open	42	Inpatient	No	6

LOS= Length of Stay; CC= Comorbidities or Complications

A list of relevant ICD-10 codes is provided as online material (http://apps.who.int/classifications/icd10/browse/2015/en)

countries. In order to compare relative resource intensity for cholecystectomy as expressed by DRGs in each country, an approach similar to that of Koechlin *et al*. was used (10).

Quasi prices were calculated by converting national DRG weights into monetary values using average national conversion rates. If necessary, prices were deflated to 2008 prices using national GDP deflators (24) and converted to Euros using average currency exchange rates for the year 2008 (25). In addition, a quasi-price index was calculated with the index case assuming a value of one. The index score of all other case vignettes was calculated by dividing the monetary value of the quasi price (10) of each case vignette by that of the index case.

Results

Figure 1 shows the grouping algorithms and classification variables of PCS in the eleven European countries. The figure includes classification variables of those DRGs that individually represent at least 1% of cholecystectomy cases in each country. DRGs containing less than 1% of cases in the national database but which are essential for understanding the grouping logic are shaded in light grey and are not considered in the following analysis. The index DRGs are highlighted in dark grey. On the left hand side, the figure specifies for each country the version of the DRG system and the percentage of all identified cholecystectomy cases that are shown in the graph. The last two columns on the right show the percentage of cholecystectomy cases covered by each DRG and the DRG weight index.

On the left hand side, the figure specifies for each country the version of the PCS and the percentage of all cholecystectomy cases shown in the graph. The arrows indicate the sequence in which different types of classification variables are considered in the grouping algorithm. In addition, indicators to assess the composition of DRGs and the relative resource intensity of cases within each DRG are shown. The Finnish and the Swedish algorithms are combined as both use versions of the NordDRG system which is very similar for cholecystectomy.

Grouping algorithms classify cholecystectomy cases on the basis of different classification variables: 1) type of diagnosis, 2) type of procedure, 3) type of admission, 4) the level of Comorbidities or Complications (CC), 5) age, and 6) length of stay.

Patient classification of cholecystectomy cases in Europe

The figure shows large differences in the DRG systems for the 11 European countries. For example, in Austria and Poland there are two DRGs for a cholecystectomy episode, but in England there are nine DRGs. The DRG systems in England, France and Estonia use the highest number of variables, including a variety of medical conditions and procedures. The latter is not directly included in the Frenched system, but there is a distinction between patients with acute and non-acute conditions.

The type and combination of classification variables also vary significantly across countries. The main diagnosis is used as a classification variable only in Finland, Sweden, the Netherlands and Poland. The Austrian, German and Dutch DRG systems do not differentiate patients with CC, while all other countries consider CCs in their classification system. Yet, most countries only make a distinction between patients with and without CCs, while the French GHM (homogeneous patient groups) system (26) differentiates between four levels of CCs and the German Diagnosis-Related Groups (G-DRG system) calculates cumulative Patient Clinical Complexity Levels (PCCLs) (27,28).

In all countries, the DRGs are based on cholecystectomy procedures (including both open and laparoscopic procedures). Open and laparoscopic cholecystectomy procedures are included in DRG systems in Estonia, Finland, Germany, Ireland, the Netherlands and Sweden.

Admission is accounted for in Finland, Sweden and in the Netherlands. Age serves as a classification variable only in France. Length of stay is relevant for grouping cases into DRGs only in France, although it is considered either for outlier deductions or for additional payments in a number of other countries, such as in Austria, England, Germany and France (4).

Distribution of cholecystectomy cases and variation in relative resource intensity

In most countries, the vast majority of cholecystectomy EoC cases are grouped into the shadowed DRG (in Figure 1) containing the index case (see Box 1), i.e. between 55% in Finland and 92% in Austria. Within these index DRGs, almost all patients conform to our EoC definition (i.e. around 90% or above).

The cost index shows that the index DRG is the lowest valued DRG only in Poland, England, Estonia and Spain (see Figure 2). Generally, in DRG systems with only three or four DRGs for cholecystectomy patients, even the highest valued DRG has the cost the index below two. The low variation cost index values compared to index case could be an indication of differences in coding practices across countries or poor quality data.

The lowest variation in DRG weight index scores exists in Austria, Germany, Poland and Netherlands with a range of about one. In these countries, but also in England, Finland, Sweden and France, indicating that the systems do not systematically account for cases that are more than twice as resource intensive as the index case. In contrast, the range of DRG weight index scores is considerably higher in Ireland (0.4-4.0) (see Figure 2).

Diagnosis-Related Groups (DRGs) and hospital quasi prices for case vignettes

Table 3 shows a comparison of DRGs and hospital quasi prices, reflecting national average hospital payments for each case vignette under the assumption that hospital payment would be exclusively based on DRGs. For each case vignette, the first column specifies the DRG into which a patient would be classified and whether he or she would be considered an inlier or an outlier, i.e. whether the predefined length of stay is above or below the DRG system specific upper or lower length of stay threshold. The second column specifies the corresponding quasi price for each patient. In the last column of the table, the index DRGs (see Figure 1) and corresponding quasi prices are presented.

Apparently, large variation in hospital payments exists across countries. Index case forms the majority of total cases. Index

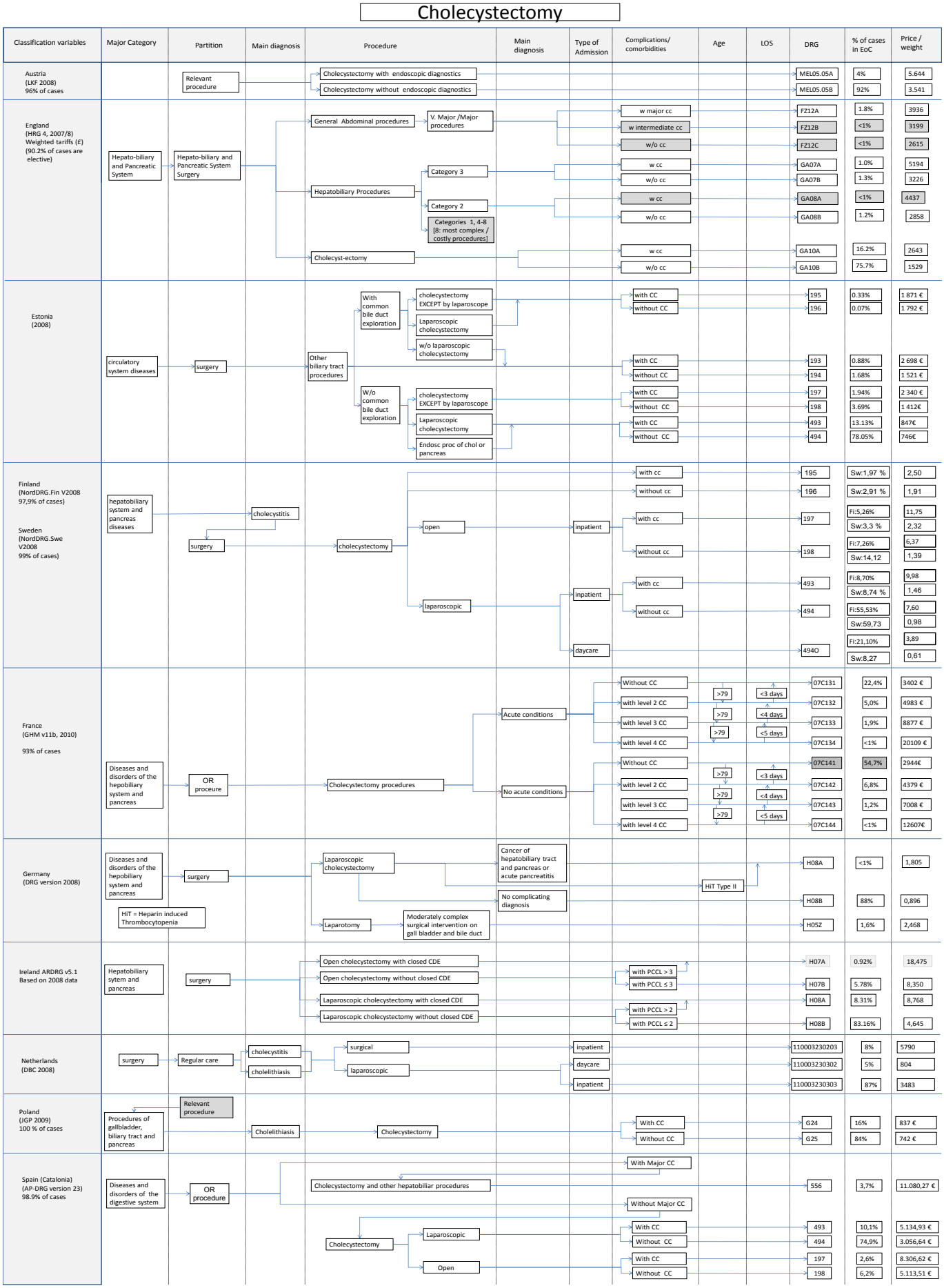

Figure 1. Graphic illustration of grouping algorithms and classification of PCS in 11 European countries

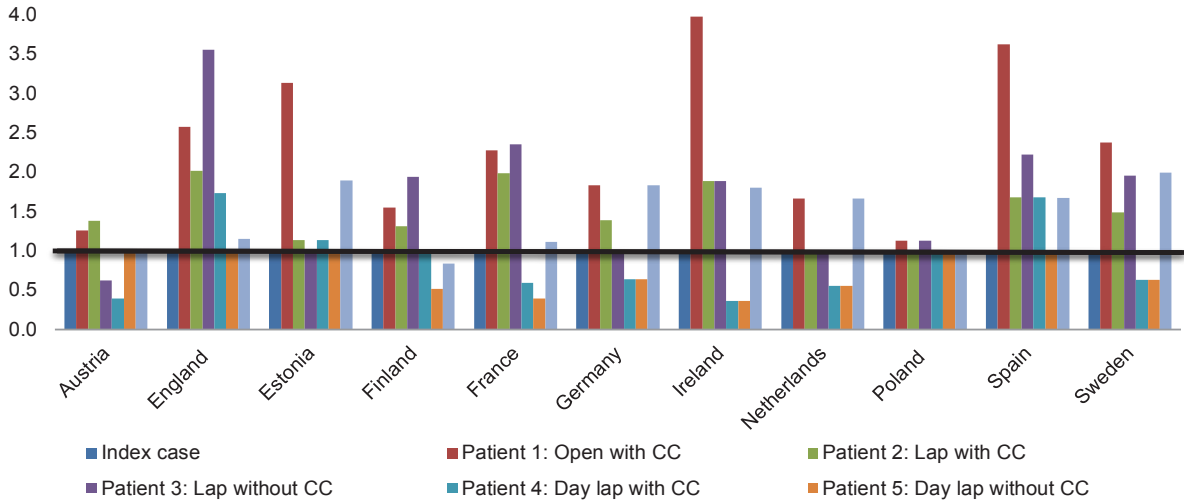

Figure 2. Comparison of price indices for the cholecystectomy case vignettes in eleven European countries (the price index of the index case equals 1.0 in each country)

case is generally a patient with milder condition, without comorbidities. However it is observed that only for Estonia, England, Poland and Spain the payment for index case is lower than for other patient groups. Cases with lower payments are mostly found in patient group 5 (day-care laparoscopic without CC). Cases in patient group 5 are considerably cheaper compared to the index case in Finland, France, Germany, Ireland, the Netherlands and Sweden. Similar payment compared to the index case is found in Austria, England, Estonia, Poland and Spain but this is due to the fact that patient group 5 includes the same DRGs as in the index case.

DRG price is lower compared to the index case in patient group 4 (day-care laparoscopic with CC). The DRG cost of this group is lower in almost every country except for England, Estonia and Spain. In Finland the DRG price is comparable with index case.

The most pricey DRG is in patient group 1 (open with CC), which is to be expected because patients in this group have undergone open cholecystectomy, with CC and a long LOS. Expensive DRGs are also found in patient groups 2 (laparoscopic with CC) and 3 (laparoscopic without CC), although in patient group 3 the DRG cost is similar to the index case in Germany and the Netherlands.

The lowest DRG payment level is in Poland but the most expensive in Ireland. For example, the cost of the index case is 742 euros in Poland, compared to Ireland where it is 4,645 euros. Moreover, in patient group 1 this difference is considerably higher (837 euros versus 18,475 euros).

Figure 2 shows the ratio of the quasi price of each DRG compared to a cholecystectomy without complications (index case) per country. The largest variations are found in England, Ireland, Spain and Estonia, where patients with open cholecystectomy (vignette 1) have a quasi price that is more than twice as high as that of the index case. In contrast, only slight variations exist in Austria, Poland and the Netherlands. In half of the countries, payment for a day case without complications (vignette 4 and 5) is below that of the index case. Other countries do not have specific DRGs for day cases but apply a LOS-based payment reduction for cases staying shorter than a lower LOS threshold, and this also applies for day cases.

Discussion

This is the most comprehensive available comparative analysis of grouping algorithms, classification variables, and prices for cholecystectomy patients in different DRG-based hospital payment systems in Europe. It shows great variation across countries: 1) in the number of DRGs; 2) in the characteristics of classification variables; 3) in the degree of differentiation between complex and less complex cases; and 4) in the quasi prices for different types of patients (case vignettes).

If DRG systems do not adequately account for differences among patients, hospitals and surgeons that treat a greater share of more complex cases are not adequately compensated for their greater efforts. Possibly, in countries with only a few DRGs in order to account for differences in complexity, some of the variations in patient populations among hospitals are accounted for through adjustments (e.g. for teaching status or type of hospital) outside of the DRG systems (9). However, ideally, differences in patient characteristics would be accounted for in the PCS and not in the payment system. The implementation of DRGs also raises several other issues. In particular, the same clinical situation should be approached in an uniform way, but different systems of incentive-based funding may induce a potential conflict of interest for a doctor. In the worst case, the financial incentives could lead to treatments that are clinically inappropriate and to differences in DRG coding motivated by those incentives (29).

Moreover, it does not come out from the study what are the reasons behind the fact that the same clinical situations are priced differently in comparison to the index case. Also, the question arises as to what extent the other factors are reflected in the DRG cost. In most countries the co-morbidities and complications are taken into account in DRGs but their influence on DRG cost is most probably not uniform. Thus, the question arises as to how much the co-morbidities affect the actual prices.

The DRG system may be observed in several aspects. First, their logic is not always the same, even though there is consensus about treatment. Technically, DRGs need to be based on both economically and clinically meaningful groups. That requires careful decisions on the design of the DRG system, such as the hierarchy and algorithms used to classify patients into a limited number of groups. Economically, patients within one group

Table 3. Comparison of hospital quasi prices for cholecystectomy patients in Europe (in 2008 prices)

	Index case		Patient 1		Patient 2		Patient 3		Patient 4		Patient 5		Patient 6	
	DRG (In-/outlier)	Quasi price (Euros)	DRG (In-/outlier)	Quasi price (Euros)	DRG (In-/outlier)	Quasi price (Euros)	DRG (In-/outlier)	Quasi price (Euros)	DRG (In-/outlier)	Quasi price (Euros)	DRG (In-/outlier)	Quasi price (Euros)	DRG (In-/outlier)	Quasi price (Euros)
Austria[1]	Mel05.05B (Inlier)	3,541	Mel05.05B (Outlier)	4,443	Mel05.06D (Inlier)	4,896	Mel05.05B (Outlier)	2,191	Mel05.05B (Outlier)	1,382	Mel05.05B (Inlier)	3,541	Mel05.05B (Inlier)	3,541
England [2]	GA10B (Inlier)	1,785	FZ12A (Inlier)	4,594	GA10A (Outlier)	3,601	GA05B (Inlier)	6,344	GA10A (Inlier)	3,085	GA10B (Inlier)	1,785	GA10B (Outlier)	2,054
Estonia[3]	494 (Inlier)	746	197 (Inlier)	2,34	493 (Inlier)	847	196	1,792	493 (Inlier)	847	494	746	198 (Inlier)	1,412
Finland[4]	494	3,739	197	5,781	493 (Outlier)	4,91	194	7,242	494	3,739	494O	1,914	198	3,134
France[5]	07C141 (Inlier)	3,13	07C133 (Inlier)	7,116	07C143 (Inlier)	6,222	07C101 (Inlier)	7,352	07C141 (Outlier)	1,851	07C141 (Outlier)	1,225	07C131 (Inlier)	3,470
Germany[6]	H08B	2,512	H07B	4,603	H08B (Outlier)	3,487	H08B	2,512	H08B (Outlier)	1,609	H08B (Outlier)	1,609	H07B	4,603
Ireland	H08B (Inlier)	4,645	H07A (Inlier)	18,475	H08A (Inlier)	8,768	H08A (Inlier)	8,768	H08 (Day care)	1,689	H08 (Day care)	1,689	H07B (Inlier)	8,350
Netherlands	110003230303	3,483	110003230203	5,790	110003230303	3,483	110003230303	3,483	110003230302	1,934	110003230302	1,934	110003230203	5,790
Poland[7]	G25 (Inlier)	742	G24 (Inlier)	837	G25 (Inlier)	742	G24 (Inlier)	837	G25 (Inlier)	742	G25 (Inlier)	742	G25 (Inlier)	742
Spain	494	3,057	556	11,08	493	5,135	787	6,784	493	5,135	494	3,057	198	5,114
Sweden	494 (Inlier)	3,876	197 (Inlier)	9,192	493 (Inlier)	5,772	196 (Inlier)	7,566	494O (Inlier)	2,431	494O (Inlier)	2,431	198 (Inlier)	7,723

DRG= Diagnosis-Related Group

[1]Reported values are based on theoretically calculated scores. Actual hospital reimbursement depends on decisions of states, which make use of nationwide DRG scores in different ways. Patient 5 has a length of stay of 0 days but would NOT be considered an outpatient.

[2]Based on 2008–9 tariff prices and HRG version 3.5. All relevant groups are included in the shown tariff. HRG 4 reimbursements could not be determined. Reported figures are reimbursements for emergency admissions. Elective admissions receive a different tariff. Patient 5 has a length of stay of 0 days, but would NOT be classified as an outpatient.

[3]Shadow prices were calculated by multiplying cost weights with the national base rates. In actual reimbursement, hospitals are paid through a mix of DRG based reimbursement and fee-for-service. The actual DRG based reimbursement is only 70% of the reported shadow price with the remaining 30% being related to fee-for-service payments.

[4]Actual reimbursement varies by type of hospital (i.e. university, central, local hospitals) and hospital district. Provided figures are volume weighted averages across all hospitals. Outlier limits differ between hospital districts. In some hospital districts, patient 3 might be considered an outlier. In this case certain surcharges based on per diems might be applied.

[5]Reported prices are for public sector hospitals since private hospital prices do not reflect full costs.

[6]Calculated using national DRG cost weights and the average of state-wide base rates.

[7]Based on 2008–9 tariff prices. Reported figures are reimbursements for emergency admissions. Elective admissions receive a different tariff. Patient 6 has a length of stay=0, but would NOT be classified as an outpatient

should have homogeneous costs. Clinically, cases allocated to one group should form a distinguishable entity based on main diagnosis, severity, co-morbidity and/or treatment performed. But what exactly is homogeneous? When are costs and/or clinical diagnosis so different that a group should be split? (30). Second, DRGs are put together electronically on the basis of input data. Since an electronic format is used, there is a risk that a lack of data may cause conflicts (administrative side, money, information, treatment algorithms, etc.). Thus, the question arises whether the DRG system still takes into account all the needs. Administrators of a DRG system adjust rules for split, fusion or other changes in DRGs. DRGs should be put together according to common guidelines, to ensure its safety, transparency and, immunity against manipulations.

In drawing meaningful conclusions from this study, it is important to be cognisant of its limitations, especially in relation to the ability to undertake direct cross-country comparisons. First, although there was an agreed definition for cholecystectomy, relevant cases in each country were identified using a different procedure and (to a lesser extent) diagnosis coding schemes. In the absence of a common procedure classification system [such as the World Health Organization (WHO) has developed for diagnoses], there is a considerable cross-country divergence in the schemes implemented. Second, coding practice differs across countries. There is variation in coding depth: the maximum number of diagnoses used in DRG assignment is ten in Finland, but 120 in Germany. Furthermore, the propensity to record diagnoses and procedures may be related to whether the DRG system is used in hospital reimbursement.

Limitations

Our study has several limitations. Firstly, the data used to identify patients and to assess the relative importance of different DRGs in different countries, originated from routine inpatient databases in eleven countries (see Table 1). Although the data can be compared, it must be taken into account the fact that countries have different coding practices and the quality may not be entirely comparable.

Secondly, countries have different payment systems for hospitals, and consequently make the payment levels difficult to compare (see Table 3). On the one hand, countries set DRG-based payment rates at varying levels as they include different cost categories. For example, in Germany, fixed capital costs are not included in DRG-based payment, whereas in most other countries, DRG-based payments are supposed to cover capital costs (10). Different systems of additional payments exist, e.g. England assigns additional Health Resource Groups (HRGs) for certain diagnostic evaluations, such as CT scans; Poland and Austria have additional per-diem based payments for stays in intensive care units (23). Furthermore, in the Dutch and the Finnish DRG systems several DRGs per hospital stay can be assigned, each leading to additional DRG-based payments (4). DRG-based payments are adjusted in several countries to account for differences among hospitals or regions. Therefore, the absolute price levels should not be directly interpreted as reflecting more expensive care in one country compared to another. However, relative price levels within countries that were used for comparisons in Figure 2 should be less affected by differences in payment systems as they were always compared to the in-country DRG index case. Thirdly, as we limit part of our comparative analysis to DRGs that account for at least 1% of cases (Figure 1), we partially neglect how different systems deal with rare outliers, which may, however, be particularly relevant for reimbursement (31). In addition, there is one more limitation in this study; it is possible that some patients were inappropriately coded in order to maximize revenues ("up-coding").

Despite these limitations, our study has major implications for surgeons, hospital managers and national authorities involved in the redesigning of national DRG systems. First, awareness about classification algorithms and variables in other countries should encourage surgeons to think about alternative and possibly better ways to classify their patients into DRGs. For example, three countries (Austria, the Netherlands and Germany) do not distinguish between cholecystectomy cases with complications. The average length of stay is taken into account only in the French DRG system, although it greatly affects the price of a cholecystectomy episode. The price index of patient groups 4 (day-care laparoscopic with CC) and 5 (day-care laparoscopic without CC) is lower (<1) for patients in France, Germany, Ireland, Netherlands and Sweden (see Figure 2). Seven countries (except Austria, England, Poland and France) differentiate between open and laparoscopic cholecystectomy, which is a very important measure for differentiating patients with an episode of cholecystectomy. Second, DRG systems are meant to provide precise measures of the kind of services hospitals deliver. This measure is useful only if DRGs describe a sufficiently homogenous group of patients (30). Therefore, quantitative research is needed to verify whether the most important determinants of cost are considered in different PCSs, and whether differences among systems reflect country specific differences in treatment patterns. However, it is also important for clinicians to be aware of the significance of adequately designed DRG systems and to engage in optimizing these systems. Information presented in this article about how DRG systems classify cholecystectomy patients can help surgeons engage with national DRG authorities. In the light of increasing pressure for cost containment, it is very important that DRG systems consider the most important classification variables in order to ensure that limited resources are appropriately allocated for patients undergoing cholecystectomy.

Conclusion

The present survey shows that the DRG systems can be compared, even though there are many limiting factors, arising from the particular national characteristics. These international comparisons can provide a very useful new perspective especially when governments, Ministries of Health or payers are investigating how to improve an existing DRG system. These researches can also allow countries, which are introducing DRG system, to avoid making gross errors or mistakes in composing their DRG system.

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Ethical issues

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Competing interests

The authors declare that they have no competing interests.

Authors' contributions

EuroDRG group provided the general framework for research design; GPA, AA and MS contributed to literature searches, analysis of the results and their interpretation; GPA drafted the initial manuscript. GPA was the main contributor; other co-authors contributed to specific minor parts and by responding to reviewers' remarks and recommendations. All authors read and approved the final manuscript.

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