**Executive Summary:**

Despite the fact that diagnosis-related groups (DRGs) have been adopted in an increasingly large number of countries around the world, knowledge about the effects of DRG systems and DRG-based hospital payment systems, as well as about optimal design features of these systems, remains surprisingly limited. International experiences with DRG systems and DRG-based hospital payment systems can inform countries when developing and optimizing their national systems. In addition, in a context of growing patient mobility facilitated by the European Union (EU) Directive on the Application of Patients Rights in Cross-Border Healthcare, an increasingly important issue relates to whether there is scope for harmonization of DRG systems within Europe.

The EURODRG project aimed to achieve a strategic impact in four dimensions:

(1) advancement of the state of the art,
(2) enhancement of cooperation between researchers in Europe and other geographic regions to promote integration and excellence of European research in the field,
(3) development of the scientific evidence base that supports the Member States to better organize their health systems, and
(4) transfer of research results into practice to empower policy and decision makers to better manage and reform health care systems.

The project was organised in three Phases and has scrutinized both, the design features of DRG systems in Europe as well as the performance of these systems across different countries. In addition, it had a strong focus on ensuring the transfer of knowledge from research into practice by providing recommendations for policy makers within Europe and beyond who are working on improving their national DRG-based hospital payment systems or designing successful policies for the slowly emerging pan-European hospital market.

The project has been extremely successful at achieving its objectives. The project has given rise to an impressive number of presentations and publications. EURODRG consortium members have participated in numerous conferences (ECHE, EHMA, IHEA, PCSI) and policy dialogues (European Health Summit, World Bank, Commonwealth Fund) to discuss the projects findings. In addition, during the project's final conference, a lot of interest was received from countries where DRG systems are currently in the early stages of development, in particular in Bulgaria, China, Russia, Serbia and South Korea (all represented at and involved in the Final Conference). For 2012, a workshop and a thematic session have been selected for the European Conference on Health Economics and the EURODRG project represents one of four themes at the Nordic Case-Mix Conference in June 2012.

The work of the EuroDRG project has resulted in one highly visible book on DRGs in Europe. A number of publications have appeared in a wide array of peer reviewed journals (Value in Health; Health Economics, Policy and Law; Langenbeck's Archives of Surgery). In 2012, amongst others, a special issue in Health Economics containing 11 articles about the results of the quantitative analyses of the EuroDRG project is being published. Nine articles about DRG classifications for selected episodes of care as well as empirical work on the cost-quality relationship have been (or are about to be) submitted to medical journals, and will hopefully appear within 2012. In addition, a commissioned overview is being written for the BMJ and one article highlighting the implications of the project's findings for the United

States is about to be submitted to Health Affairs. Ultimately, the projects' findings contribute to better national DRG systems in Europe and beyond, and they lay the foundations for future coordination and, possibly, harmonization of DRG systems in Europe.

**Project Context and Objectives:**

*The EURODRG project: Context*

Despite the fact that diagnosis-related groups (DRGs) have been adopted in an increasingly large number of countries around the world, knowledge about the effects of DRG systems and DRG-based hospital payment systems, as well as about optimal design features of these systems, remains surprisingly limited. While initially, DRG systems were often introduced for the purpose of measuring hospital activity, they have later become the principal means of hospital payment in most countries. Some countries used DRGs over an extended period of time exclusively just for measuring activity and increasing transparency (for example, up to ten years in England), in order to become acquainted with the DRG grouping logic before they started paying hospitals on the basis of DRGs. Others introduced DRGs after a short period of conversion (for example, in Ireland DRGs were introduced in 1992 and first used for budgetary allocation in 1993).

A DRG-based hospital payment system consists of several essential building blocks and provides a specific set of incentives that is different from other payment mechanisms. Figure 2 illustrates the essential building blocks of DRG-based hospital payment systems:

(1) a patient classification system (PCS) is used to group patients with similar clinical characteristics and relatively homogeneous resource consumption into DRGs;
(2) some kind of hospital cost information is used to determine DRG weight
(3) (3), usually at (about) the average treatment costs of patients falling within a specific DRG;
(4) DRG weights are converted into monetary values and the payment rate may be adjusted for structural (teaching status, region) and further resource-consumption variables (length of stay, utilization of high-cost drugs or services); before
(5) hospitals are paid on the basis of the number and type of DRGs that they produce. The popularity of DRG-based systems is related to the fact that they are thought to have a number of (predominantly desirable) effects on efficiency
(6) and quality
(7) (7), while the effects on technological innovation
(8) (8) are controversial.

International experiences with DRG systems and DRG-based hospital payment systems can inform countries when developing and optimizing their national systems. In addition, in a context of growing patient mobility facilitated by the European Union (EU) Directive on the Application of Patients Rights in Cross-Border Healthcare, an increasingly important issue relates to whether there is scope for harmonization of DRG systems within Europe. This is because if harmonization is not possible, it will remain difficult (or at least in-transparent) to pay hospitals in one EU Member State for care provided to patients from another EU Member State. Furthermore, cross-border comparisons of hospital prices and performance - which are increasingly being conducted in attempts to improve the understanding of differences in terms of efficiency and costs - will continue to be complicated by the lack of a common basis for comparison.

**The EURODRG Project: Objectives**

The EURODRG project aimed to achieve a strategic impact in four dimensions:

(1) Advancement of the state of the art,
(2) Enhancement of cooperation between researchers in Europe and other geographic regions to promote integration and excellence of European research in the field,
(3) Development of the scientific evidence base that supports the Member States to better organize their health systems, and
(4) Transfer of research results into practice to empower policy and decision makers to better manage and reform health care systems.

The project was organised in three Phases and has scrutinized both, the design features of DRG systems in Europe as well as the performance of these systems across different countries. In addition, it had a strong focus on ensuring the transfer of knowledge from research into practice.

Phase I of the project has concentrated on comparative analyses of the essential building blocks of DRG-based hospital payment systems across 12 European countries which are embedded in various types of health systems (Austria, England/ UK, Estonia, Finland, France, Germany, Ireland, the Netherlands, Poland, Portugal, Spain, Sweden). This stream of research aimed at identifying the differences and similarities of their objectives and purposes as well as the country-specific methodologies of patient classification, DRG weight calculation and hospital payment.

Phase II of the project aimed at comparing the performance of DRG systems across European countries. One essential indicator of performance for a DRG system is its ability to define (resource) homogenous groups of patients. Otherwise, reimbursement for a large number of patients is not appropriate: it is either too high or too low; and performance comparisons on the basis of DRGs do not adequately control for differences of patients within groups. Therefore, Phase II of the project aimed at collecting patient level data for 10 episodes of care (EoC) (representing different medical specialties and diagnostic/ therapeutic procedures, with each EoC in the project uniformly defined through diagnosis and/or procedure codes but encompassing varying numbers of DRGs within countries), and it envisaged analyses of (1) the specific classification variables used by different DRG systems and (2) the ability of DRG systems to explain variation in resource consumption. Furthermore, because policy-makers are often concerned about the impact of DRG-based hospital payment systems on quality, the project also had the objective of assessing the relationship between costs and the quality of care.

Phase III of the project has sought to summarize and disseminate the most crucial implications of our findings for policy makers within Europe and beyond. Our results targeted policy makers who are working on both, improving or developing their own national DRG-based hospital payment systems and designing successful policies for the slowly emerging pan-European hospital market. In addition, it was envisaged that hospital benchmarking club would be established in order to identify common issues and systemic factors that will be crucial when designing successful policies for the slowly emerging pan-European hospital market.

**Project Results:**

*Work package 1*

One of the first objectives of the project was to develop a conceptual framework which allowed participants to systematically analyse their DRG-classification. This framework was to take the form of guidelines which were essential in WP 2 to create standardized and systematic DRG-system country reports (D 1.1).

Secondly, existing or ongoing similar work in order to avoid duplication should be identified. Therefore, the conduct of an extensive literature review was another main task at the beginning of this project - specifically to examine the international evidence for existing instruments, systems or concepts for measuring and explaining differences in hospital costs across countries beyond differences in patient case-mix and 'hospital/ medical decision variables' such as staff time or technologies used (e.g. the Market Force Factors and the Medicare Wage Index). Based on the findings of the literature review, recommendations for the projects' further work (eg. variable selection, modelling options) were to be made (D 1.2).

*Guidelines for DRG-system country reports (D 1.1)*

A first draft version of guidelines for the systematic analysis of the classification process of national DRG systems was presented during MC1 on the 5th and 6th of February 2009 in Potsdam by TUB. A revised version, based on the comments of all partners, was developed and distributed by TUB at the end of March 2009. Until WS1 on the 25th and 26th of May 2009 in Berlin, iBMG (the Netherlands), NHF (Poland), and IMAS (Spain) tested the proposed structure of the guidelines by applying it to analyse their DRG systems. The results of these tests were discussed during WS1 in Berlin and the guidelines adapted according to the experience. A final version of the guidelines was presented by TUB on the 19th of June 2009 and distributed subsequently.

During the process, it turned out that the selection of appropriate episodes of care required different skills; this work was therefore split from the work mentioned before. Work started in project month 1 with looking into detail at the 12 potential episodes mentioned in the DoW, based on the criteria also mentioned in the DoW. During MC1, other possible episodes were collected and these were explored as well. Draft papers on (i) defining 17 episodes considered to meet the criteria (it was decided to collect data on more than 10 - 12 episodes in order to have enough ones after knowing which ones have to be dropped due to a lack of comparable definitions and/or data within countries) and (ii) a questionnaire supplementing D 1.1a were discussed at WS1 and afterwards sent around in modified versions. Final versions of these documents were agreed upon in June (D 1.1b - Definition of 'Episodes of Care') and July (D 1.1c - Questionnaire for 'Episodes of Care') respectively.

*Literature review (D 1.2)*

An extensive literature review to examine the international evidence for existing instruments and concepts for measuring and explaining differences in hospital costs across countries was performed. The review considers how patient-level and hospital-level data are related and outlines the main approaches, concepts, and measures for analyzing these data. The second part of the review considers general specification choices as well as methods of efficiency

analysis. Moreover, it specifies a model to be used in the empirical analyses of the EuroDRG project.

Draft versions of the document summarising the main results were presented at MC1 on the 5th and 6th of February 2009 in Potsdam and at WS1 on the 25th and 26th of May 2009 in Berlin by TUB and CHE. It was afterwards finalised for project-internal purposes. The final and copy-edited version of the literature review was published in May 2010 as:

Street A, Scheller-Kreinsen D, Geissler A, Busse R (2010) Determinants of hospital costs and performance variation: Methods, models and variables for the EuroDRG project. Working Papers in Health Policy and Management, Volume 3.

It can be downloaded from: http://opus.kobv.de/tuberlin/volltexte/2010/2661/pdf/10_05_10_WPplaintext_MiG_Band3_mg.pdf.

Moreover, the results of the literature review were summarised in a German-language article:

Scheller-Kreinsen D, Geissler A, Street A, Busse R (2011) Leistungsbewertung von deutschen Krankenhäusern - Stärken, Schwächen und Vergleichbarkeit der bekannten Methoden. Gesundheitsökonomie and Qualitätsmanagement 16(2): 85-95

*Work package 2*

The standardization of the data was of key importance for the further work of the project. Therefore the first main objective for WP 2 was to obtain detailed descriptions of the available data from each participant (D 2.1). On this basis, guidelines for the standardization of the national data sets were to be prepared in WP3.

In order to meet the second main objective for WP2, country reports were to be written about the DRG-based hospital payment systems in all included countries (D2.2), based on the template from WP 1 (D 1.1). These reports should consider questions such as: which variables are included in the DRG-classification process (socio-demographic, diagnoses, procedures/ technologies used, cost data etc.), how is the data collection process organized, how are new emerging innovative health technologies covered by inpatient reimbursement schemes etc.

An additional objective for D2.2 was to describe the DRG classifications in respect to the 10-12 indication groups (now termed 'episodes of care (EoC) ', e.g. number of different DRGs, criteria used to classify patients into the various DRGs, and relative cost weights per DRG).

Given these three distinct objectives, work in WP 2 was organised in three main parts (instead of only two as foreseen in the DoW):

*1. Description of data (D2.1)*

On the basis of a standardized data questionnaire, all participants provided information about the availability of data for empirical analyses (WP 4 and WP 5). A draft summary of the available information was prepared in September 2009 and was discussed in MC 2 (in Nov 2009). For WS 2 (in Jan 2010), this was - based on D 1.1c - supplemented by in-depth information on the data availability and comparability across the 17 episodes of care.

*2. DRG system country reports (D2.2)*

Each participant drafted a country report using the template developed as part of WP 1 (D 1.1a). Country reports were peer reviewed amongst partners, and updated on the basis of received recommendations. At WS 2, the structure of country reports was slightly revised and final versions were prepared by all participants by end of March 2010. Due to the unexpected input of the Advisory Board members from Ireland and Portugal, two additional country reports were produced. Furthermore, cross-country comparisons of specific certain important issues concerning DRG systems were carried out using material from the country reports. Subsequently, country reports underwent extensive editing in order to prepare them for publication as book chapters in a book on DRG systems in Europe. The book, which was published in November 2011, contains 12 country chapters structured according to a common template and cross-country comparisons of specific important issues concerning DRG systems (e.g. cost accounting, innovation, efficiency, and quality). The book is part of the European Observatory on Health Systems and Policies Series with Open University Press, and is widely distributed amongst Observatory partners. In addition, the book will soon become freely downloadable from the website of the European Observatory on Health Systems and Policies.

Busse R, Geissler A, Quentin W, Wiley MM (eds) (2011): Diagnosis Related Groups in Europe: Moving towards transparency, efficiency and quality in hospitals? Buckingham, Philadelphia: Open Univ. Press.

*3. Detailed description of DRG classification for selected indication groups/episodes of care*

A consensus had been reached at WS 1 of how to define 17 episodes of care (EoC) using ICD-10 codes for diagnoses and ICD-9CM codes for procedures (see above; D 1.1b). With the help of a standardized questionnaire (D 1.1c), the frequency of occurrence, treatment patterns, and DRG classification of patients belonging to these episodes of care were analyzed. Each country prepared a report for each EoC including a graph illustrating classification of patients into DRGs. On the basis of these reports, 10 out of the 17 EoCs were selected at WS 2 for further investigations (WP 4 and WP 5). Furthermore (in addition to the deliverables foreseen in the DoW), summary articles comparing patient classification in different countries' DRG systems for each EoC are currently under review at different medical journals or are being finalised for submission. One open-access article has already been published:

Quentin W, Scheller-Kreinsen D, Geissler A, Busse R (2012): Appendectomy and Diagnosis Related Groups (DRGs): Patient Classification and Hospital Reimbursement in 11 European Countries. Langenbeck's Archives of Surgery 397(2): 317-326, http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3261402/pdf/423_2011_Article_877.pdf

Three others are under review:

Quentin W, Rätto H, Peltola M, Busse R, Häkkinen U: Acute Myocardial Infarction and Diagnosis Related Groups (DRGs): Patient Classification and Hospital Reimbursement in 11 European countries. European Heart Journal, in review

Peltola M, Quentin W: Patient Classification and Hospital Reimbursement of Stroke in 11 European Countries. Stroke, in review

Scheller-Kreinsen D, Quentin W, Geissler A, Busse R: How 11 European DRG systems classify and pay for breast cancer surgery patients. Annals of Medicine, in review

*Work package 3*

In order to ensure a common framework for data analyses across countries (considering the analytical choices, variables and model definitions) for the empirical work in WP 4 and 5, guidelines were to be developed (D 3.1). The framework was based on the information from WP 2 about data availability and accessibility in the participating countries.

In addition, this work package aimed to merge information about the patient classification systems (PCS) in the participating countries from the DRG country reports. The aim was to provide a synthesis report considering the differences and similarities of the PCS across Europe (D 3.2). This was intended to lead to a 'mapping' of the various PCS, including criteria for the classification and current grouping algorithms.

*Guidelines for the data analysis in WP 4 and 5 (D 3.1)*

The model for the quantitative analysis of hospital and patient level data was conceptually developed in the framework of the literature review by TUB and CHE (D 1.2). Based on the information from WP 2 about data availability and accessibility in the participating countries, the general methodological choices and, especially, the variables and operationalisations of the model were refined. During WS 2 on the 22nd and 23rd of January 2010, CHE gave a presentation on the remaining methodological choices. The main issues and facts were summarised in a memorandum by CHE that was continuously commented and further developed in the following month. After WS2, THL performed regression analyses based on the preliminary analytical choices and presented first results and experiences during a telephone conference on the 16th of March 2010. The guidelines were adjusted accordingly until a ‘final’ version in mid April 2010.

Subsequently, all partners were asked to generate descriptive statistics for all variables included in the model for MC 3 on the 9th of July 2010 in Helsinki to further refine the model and to increase comparability. Based on that experience (de-facto already part of work packages 4 and 5) and the resulting discussion, a revised version of the guidelines was agreed upon during MC3. These guidelines were then used for performing the regression analysis for a common core model across all Episodes of Care and countries (see WP 4 and 5). All partners generated the results for this core model until WS 3 on the 21st and 22nd of October 2010 in Barcelona.

*Synthesis report DRG-classifications (D 3.2)*

Based on the results of WP 1 and WP 2, first ideas and a preliminary draft of the synthesis report were discussed during WS 2 on the 21st and 22nd of January 2010 in Paris. Building on the former, a draft version of the synthesis report was developed until the 15th of March 2010 and distributed for an extensive review by selected partners. A final draft of the synthesis, which incorporates the comments of the reviewers, was presented by the end of April 2010. It concentrates on the differences and similarities of the PCS across Europe and also allows for a 'mapping' of the various PCS, including the criteria for the classification and current grouping algorithms. The synthesis report has been published as a chapter in the book on DRG systems in Europe.

Kobel C, Thuillez J, Bellanger MM, Aavikso A, Pfeiffer K (2011): Diagnosis Related Group (DRG) systems and similar Patient Classification Systems in Europe. In Busse R, Geissler A, Quentin W, Wiley MM (eds) Diagnosis Related Groups in Europe: Moving towards transparency, efficiency and quality in hospitals? Buckingham, Philadelphia: Open Univ. Press.

*Work package 4 & work package 5*

At this stage of the project all partners were meant to be able to access cost and utilization data from all or at least from a representative sample of health care providers in each country. In order to account for differences in data availability between countries, it was originally intended that we would need to form two groups of partners as we believed that one group of partners would have detailed patient-level data available, while another group of partners would only be able to access hospital-level data. We had planned that the group of partners with patient-level data would be performing data analyses as outlined in WP4 and the second group would perform hospital-level analyses as outlined in WP5.

However, as the data basis in all countries allowed running patient-level analyses, we were able to merge WP4 and WP5. This had the advantage of controlling for diverse dimensions of output and differences in case-mix more adequately. Moreover, statistical analyses using patient-level data require a smaller number of included hospitals compared to approaches using hospital-level data to generate robust results. In addition more sophisticated techniques such as multilevel modelling could be applied.

The work conducted in the newly defined WP4/5 included the following steps. Firstly, the most important diagnoses, demographic variables, co-morbidities as well as treatment variables were discussed and operationalised consistently across countries (and their respective diagnosis and procedure classification system) for each of the ten episodes of care (EoC) selected and defined in WP2. Secondly, the methodology to analyse the national data sets was chosen. Thirdly, the relevant syntax was programmed (consistently) in SAS and STATA for each national data set. Fourthly, models that a) scrutinize costs per case, b) allow to identify the most important cost patient-level determinants, c) explore hospital-level adjustment factors per country, and d) scrutinize how well national DRGs explain EoC specific cost variation were estimated. Cost functions (WP4: patient-level; WP5: hospital-level) were specified as deliverables D4_5.1-D4_5.11.

*Hospital cost functions (D 4 & D 5)*

Adequate models to explore and identify a) costs per case, b) the most important cost patient-level determinants, c) hospital-level adjustment factors per country, and d) the ability of national DRGs to explain EoC specific cost variation were developed. This included a first broad discussion of the adequate methodology and relevant first and second-level variables during MC3 in Brussels on the 09th of July 2010 in Helsinki based on the results of the pilot episode of care 'appendectomy'. By MC4 on the 15th and 16th of March 2011 all models to be run for each episode of care were defined, all syntax in SAS and STATA was programmed, and all final decisions were summarized in a regularly updated memorandum on methodological choices and variables concerning the quantitative analyses of WP4/5.

The consortium agreed to use OLS fixed effects (FESE) framework with the log of cost as the dependent variable in those 6 countries (England, Estonia, Finland, France, Germany and

Sweden) that had patient-level costs available. In the remaining 4 countries (Austria, Ireland, Poland and Spain) we used length of stay (LoS) as the dependent variable and applied negative binominal or poisson models to answer our research questions. We estimated 3 models for each country. First, MD contained only DRG dummy variables in order to analyse of national DRGs to account for patient-level variation in resource consumption.

Second, MP was constructed using a set of patient-level variables other than DRGs in order to identify the most important determinants of hospital resource consumption for treating patients of the respective episode of care. Finally, the model MF includes both sets of variables, i.e. DRGs and the variables considered in MP. This model was used to a) as a benchmark to scrutinize how well national DRGs account for patient-level resource consumption of the respective episode of care and b) to identify possible complementary variables that could help to improve the ability of national DRG systems to explain resource consumption variation.

As all partners were on a good track of delivering highly visible and relevant research results for WP 4/5, it was possible to negotiate with the Editors of the journal 'Health Economics' and its publisher (Wiley) to have a EuroDRG Health Economics special issue (a so-called supplement) to appear in 2012. A 'supplement letter of agreement' was signed by the EURODRG coordinator TUB and Wiley on the 28th of March 2011 that fixed this agreement. All drafts for the HE supplement were circulated, commented, and revised extensively before they were submitted to the electronic data base of Health Economics for peer-review on the 7th of October 2011.

The following ten papers are currently under review for publication in the EuroDRG supplement:

1. How well do DRG systems group breast cancer surgery patients?- Evidence from 10 European countries; Scheller-Kreinsen, David; HEC-11-0358
2. Performance of ten European DRG systems in explaining variation in resource utilisation in inguinal hernia repair, O'Reilly, Jacqueline; Serdén, Lisbeth; Talbäck, Mats; McCarthy, Brian; HEC-11-0347
3. DRGs in Europe: a Cross Country Analysis for Cholecystectomy; Paat-Ahi, Gerli; Maria; Sakowski, Pawel; Saluse, Janek; Aaviksoo, Ain; HEC-11-0368
4. Patient classification and hospital costs of care for acute myocardial infarction in nine European countries; Peltola, Mikko; Häkkinen, Unto; Chiarello, Pietro; Cots, Francesc; Rättö, Hanna; HEC-11-0350
5. Why do patients having coronary artery bypass grafts have different costs or length of stay? An analysis across ten European countries; Gaughan, James; Kobel, Conrad; Linhart, Caroline; Mason, Anne; Street, Andrew; Ward, Padraic; HEC-11-0352
6. Patient classification and hospital costs of care for stroke in ten European countries; Peltola, Mikko; HEC-11-0351
7. Do DRGs appropriately explain variations in costs and length of stay of hip replacement? A comparative assessment of DRG systems across ten European countries; Geissler, Alexander; Scheller-Kreinsen, David; Quentin, Wilm; HEC-11-0359
8. How well do DRGs for appendectomy explain variations in resource use? An analysis of patient level data from 10 European countries; Mason, Anne ; Or, Zeynep; Renaud, Thomas; Street, Andrew; Thuilliez, Josselin; Ward, Padraic; HEC-11-0355

9. Patient classification systems and hospital costs of care for knee replacement in ten European countries; Chiarello, Pietro (contact); Cots, Francesc; Salvador, Xavier; Castells, Xavier; HEC-11-0353
10. How well do DRGs for child delivery explain variations in resource use? An analysis of patient level data from 10 European countries; Renaud, Thomas; Or, Zeynep; Thuilliez, Josselin; Lebreton, Cora; HEC-11-0354

*Work package 6*

Following the national analysis in WP 4 and WP 5, the country-specific data was meant to be standardized e.g. by using crosswalks for different versions of ICD classifications. Subsequently the data on the patients being treated for the 10-12 indication groups was to be merged into a single European project data base.

However, during the explorative stages of the analyses it became clear that due to differences with regard to the depth and quality of coding of procedures, diagnoses, and the cost variables, the statistical noise implied by analyses based on pooled routine data would be beyond acceptable levels. For example, a number of recorded (different) secondary diagnoses differed by factor 5 across countries for some episodes of care (e.g. for hip replacement the mean number of recorded diagnoses ranged from 1.2 per patient in Finland to 6.6 per patient in Germany). Similarly, the number of recorded (different) procedures differed greatly across countries for most episodes of care. Similarly, the first stage of the EuroDRG project established that the cost variables available from routine administrative data were of very different nature (Tan et al. 2011) and could hardly be pooled.

*Trans-national DRG system and hospital efficiency analysis (D 6)*

In order to overcome these problems, we decided to apply an analytical strategy that estimates coefficients and goodness-of-fit measures based on national data, but still facilitates cross-country comparisons. To do so, we made use of hierarchical models recognising that patients (level 1) are clustered in hospitals (level 2). Ideally, we would also directly model that hospitals are clustered in countries (level 3), but, as this was not possible, we approximate the relevance and the characteristics of the third level via (a) graphical visualisation on a common scale and (b) via relative benchmarks within countries that generate standardised performance indicators, which can be compared across countries - independent of the underlying nature of the data basis.

The graphical visualization (a) is based on a comparison and standardised visualisation of the hospital fixed effects derived from the cost and length of stay equations. Standardisation of the graphical representation is achieved by plotting the hospital intercept standardized by the sample average to derive the hospital performance relative to the mean. Consequently, having conditioned on the variables accounted for in the first stage (which was common across countries), each ratio corresponds to the mean cost for the hospital in question relative to the overall mean for all hospitals in the country. We also constructed 95% confidence intervals around each hospital fixed effect. For cross country comparisons the distribution of hospitals was especially interesting as it indicated whether the distribution of efficient and/or inefficient providers is similar or different across European countries. Second stage regression analyses indicated whether hospital characteristics and/or structural variables account for different efficiency levels. Statistical relevance of specific structural variables or hospital

characteristics in the majority of countries would suggest that these should be considered as adjustment factors in order to establish a 'fair playing field'.

The relative benchmarking of countries (b) was then based on a comparison of the explanatory power (adjusted $R^2$ for log costs equations and deviance $R^2$ for length of stay equations) of their DRG system relative to a set of patient characteristics that could be defined consistently across countries. The comparison was operationalised via two indicators that are deducted from the three models outlined above (MD, MP, and MF):

$a = (R^2MF-R^2MD)/R^2MF$ and $b = (R^2MF-R^2MP)/R^2MF$

Using these measures a and b, we categorize countries according to the explanatory power of their DRG system (relative to the common set of patient characteristics). We generally distinguish between three categories:

(1) Both a and b have relatively small values. In this case we would conclude that that DRGs and patient characteristics are equally successful in explaining resource consumption variation and they appear to play a similar function.
(2) Both a and b have relatively large values. Hence DRGs and patient characteristics are only able to capture a small proportion of what the full model (MF) is able to explain. DRGs could be refined.
(3) If a is larger than b, patient characteristics are better than DRGs at explaining variation. This suggests that a countries' DRG system lacks specific criteria which could be used for grouping purposes. The patient characteristics apparently include some of these criteria.

The analytical strategy is described en detail in the manuscript

HEC-11-0356: How well do Diagnosis Related Groups explain variations in costs or length of stay among patients and across hospitals? Methods for analysing routine patient data. Street, Andrew; Kobel, Conrad; Renaud, Thomas; Thuilliez, Josselin which is also currently under review for publication in Health Economics.

The results of this relative benchmarking of DRG systems per episode of care are included in the 10 manuscripts for Health Economics (see above). The results across all episodes of care and all countries are currently summarized in a manuscript that will also be submitted to Health Economics and is meant to be published as a regular article in the journal accompanying the eleven manuscripts meant to be published in the EuroDRG Health Economics supplement.

*Work package 7*

Providing high-quality health care at reasonable cost is a central policy goal in most European countries. In particular, policy-makers are often concerned that efforts to control costs or to enforce competition, e.g. through the introduction of DRG-based hospital payment systems, may lead to lower quality of care.

WP 7 aimed to empirically explore this question of the relationship between the quality of care and costs in hospitals. The objective was to adjust for demographic variables and co-morbidities and to explore the effect of costs on the quality of care using multinomial logit/probit regression and other suitable techniques. Similar to WP6, the aim was to use one

common standardized database created on the basis of merged datasets from individual countries.

*Relationship of quality of care and costs (D 7)*

In order to assess the relationship between quality of care and costs, THL obtained data from five consortium partners (Finland, France, Germany, Spain, and Sweden) that were able to provide cost data for individual patients for the year 2008-2009. Data were merged into one common database containing clinical and cost data of patients with AMI and stroke from a total of about 100 hospitals. The resulting database allowed comparisons to be made of the quality of care for AMI and stroke patients in European hospitals and to relate the quality to the cost of care in hospitals within the five countries.

The methodology for analysing the relationship between costs and quality included (1) comparing the quality of hospital care (measured in terms of in-hospital mortality), (2) examining whether a cost- quality trade-off exists in these countries, and (3) analysing whether there is a correlation between costs and quality in hospitals treating different patient groups. The estimation of hospital effects on quality and costs involved two stage regression techniques. In a first stage, separate models were estimated for risk-adjusted quality of care and country specific costs of service provision. The results of this first stage provided information about the marginal effect of hospital dummy variables on quality and costs. The second stage analysis estimated the effect of certain provider level variables (e.g. teaching status, number of AMI/stroke patients) on quality and costs and identified country-specific differences in the quality of care.

The results show that there are remarkable differences between hospitals and countries in the rates of (crude and adjusted) in-hospital mortality. Swedish hospitals perform better than hospitals in Germany, Finland and Spain in the care of AMI patients. However, after controlling for hospital characteristics, only the difference in mortality between Swedish and German hospitals was statistically significant. Finnish hospitals perform better in the care of stroke patients. There was no correlation both at national as well as at hospital level in quality of treating the two diseases.

There was no clear cost-quality trade off. The only exception is Sweden in the care of AMI patients, where quality of care was highest, when compared with other countries. However, the relationship does not exist for stroke patients in Sweden either. Thus as concluded in other recent studies (Chen et al. 2010, Gutager et all 2011), the relationship between costs and quality is inconsistent and prevails only in some patient group, which indicates potential for improving quality by containing cost or improving quality without increasing costs.

The results of the work performed for the work package have been summarized in a WP7 report 'The quality, cost and their trade-off in treating AMI and Stroke patient in European hospitals' (D. 7). In addition, a condensed version of the result will be submitted to Health Economics, and will hopefully be published within the next months in an accompanying issue of Health Economics around the time, when the special issue with results of work package 4/5 is published.

*Work package 8*

The main objective of WP8 was to create a Hospital Benchmarking Club (HBC) to explore meaningful and feasible ways of implementing a benchmarking system between hospitals on a European level and to identify factors facilitating and impeding transfer of results into hospitals.

On the basis of the work performed for other work packages, hospitals were to be guided in the development of a common benchmarking methodology that would adjust for differences in cost by taking patient variables, technology use and structural variables into account. If successful, the methodology would allow fair efficiency comparisons between hospitals in different European countries. In addition, by establishing close contacts with hospitals (the potential users of results of the EuroDRG project), the HBC was intended to contribute to the dissemination of project results among hospitals.

*Hospital Benchmark Club Report (D 8)*

In 2010, EHMA promoted the hospital benchmarking club through its newsletter and wider networks. This resulted in a list of potentially interested hospitals and funders. The Hospital Benchmarking Club was then launched during the EHMA Annual Conference 2010 (Lahti, Finland). The launch was attended by about 30 participants, of which nearly half expressed interest in participating in the HBC.

Subsequently, EHMA stayed in touch with potential participants who stated to be interested in actively participating in the HBC. A number of organizations expressed interest even though they were not able directly to take part but could see the value in the exercise; this included policy makers and representatives from national health insurance funds who expressed their interest for a wide number of reasons.

A first meeting of the Hospital Benchmarking Club and interested hospitals took place in March 2011. The meeting started with an introduction to the HBC and its aims and promises, followed by an in-depth discussion on what members of the club would like to achieve through the HBC and this meeting in particular. Several technicalities, mostly choices made within the project regarding the selection of groups and definitions, were discussed, and Club members and project partners were able to agree on most of these topics. The most difficult appeared the inclusion of certain cost elements that differ between countries.

Disappointingly, despite efforts to bring hospitals on board (including through EHMA's networks in Spain and through the project partners' networks) all but one withdrew from the club over subsequent months. This meant for the remaining member of the club that there was limited value in their continued membership. While it was disappointing that none of the hospitals that expressed interest wished to participate, it was also interesting and important to understand the nature of the barriers to participation and also to see what changes or incentives might have changed the hospitals decisions.

Between September-October 2011, EHMA interviewed a number of those possible participants representing public hospitals from different countries using a semi-structured interview model to explore (1) the initial motivations for participation; (2) barriers and enablers for participation; and (3) the willingness to invest financial means/staff time in any future exercise.

The results of these interviews together with a literature review about factors influencing the transfer of research into practice are presented in Deliverable 8, the HBC benchmarking club report. Besides providing information about why the HBC failed, the report also presents recommendations about how to improve future attempts at creating a European hospital benchmarking systems.

*Work package 9*

Summarising the work of all other work packages, WP9 was key to achieving the overall aim of the EURODRG project. The work performed for WP9 aimed at exploring and weigh the methodological possibility as well as managerial and political advantages and disadvantages of a uniform European DRG system. Furthermore, because DRG systems are always developed on the basis of data from hospitals, it aimed at summarizing the minimum requirements for measuring and comparing hospitalisation costs across countries. Finally, because quality is increasingly measured in hospitals, the objective was to discuss possible paths from cost-based DRG-systems to quality-based 'pay-for-performance' DRG-systems.

As part of the WP, the organization of a workshop/conference was envisaged to provide an opportunity for presenting and discussing conclusions and recommendations resulting from the project with policy-makers and other researchers. Furthermore, in order to assure wide dissemination of the conclusions and recommendations, a book was to be published in collaboration with the European Observatory on Health Systems and Policies.

*Synthesis of results and recommendations (D 9)*

A synthesis of results from all WPs was presented to policy-makers and researchers at the final conference of the EURODRG project in Berlin in November 2011. Some of the main results are briefly summarized in the following paragraphs.

When looking at the available evidence, it is clear that (1) transparency of hospital services and costs has substantially improved in all countries since the introduction of DRGs in Europe; (2) the evidence on effects of DRG-based hospital payment on hospital efficiency remains somewhat inconclusive although limited evidence indicates efficiency gains in most European countries; and (3) little measurable change in quality as a result of DRGs has been identified in Europe.

Furthermore, the specific design features of DRG systems and DRG-based hospital payment systems as well as the institutional context determine whether countries are able to reap the potential benefits of DRG systems on transparency, efficiency and quality in hospitals.

Currently, six of the twelve countries included in this book develop, update and operate their own national DRG systems. The other six countries use either imported DRG systems from abroad (for example, from Australia and the United States) or a national version of the common Nordic system of patient classification (NordDRGs). For practical reasons, without pan-European cooperation, some (in particular smaller) countries will always need to import certain important elements of their DRG systems and if they have to do so anyway, it is not evident why imported DRG systems from outside Europe - which are used in several

European countries - should be better able to define homogeneous groups of patients in these countries than a common European DRG system.

As part of WP4/5, the EuroDRG project assessed the ability of different DRG systems to define homogeneous groups of patients (in terms of clinical meaningfulness and costs). Because the factors that explain cost differences (in terms of the patient characteristics and diagnoses as well as procedures performed and services provided) are relatively similar across European hospitals, there is a case for cooperation in terms of the development of DRG systems in Europe.

The benefits of greater cooperation would include: (1) avoiding duplication of work, (2) improving knowledge exchange in the refinement of DRG systems, (3) increasing transparency of hospital services across countries, and (4) facilitating cross-border movements of patients and payments. However, similar to the historical emergence of DRG systems as a result of political decisions, a coordination of European DRG systems - and, ultimately, possibly a harmonized DRG system - is likely to emerge only if there is sufficiently strong political will to support the emergence of a common European hospital market, as well as an increasing level of mobility of European patients. While this may be an unrealistic scenario in the short term, the recent Directive on the Application of Patients' Rights in Cross-Border Healthcare demonstrates that now is the time to start such a discussion.

The experience with NordDRGs suggests that a first requirement for a common European DRG system (which could be called the 'EURODRG' system) would be to harmonize the coding of diagnoses and procedures, or - as a second-best option - to develop a mapping system that would allow translation of codes from different coding systems into a common European coding system. The Hospital Data Project as part of the EU's Health Monitoring Programme has suggested a common - albeit for patient classification purposes, too rudimentary -format for hospital activity data, to improve comparability. For the coding of diagnoses, an agreement on a coding system should be relatively unproblematic, since the ICD-10 is already used for cause-of-death statistics in all countries. For procedures, an agreement could be more difficult to reach. This is testified by four decades of work, but the as yet unfinished attempt to develop such an international classification system, initially termed the International Classification of Procedures in Medicine (ICPM), and later the International Classification of Health Interventions (ICHI). European countries may consider not waiting for this development to be finished but to coordinate their efforts based on their own coding and patient classification systems.

A common EuroDRG system could draw on the best features of national DRG systems, such as the most relevant classification variables, concepts for the definition of severity groups (for example, the patient clinical complexity levels (PCCLs), as used in AR-DRGs and G-DRGs) or the definition of short-stay groups, as in NordDRGs. However, detailed cost information collected on the basis of a standardized cost-accounting system from a sufficiently large and representative sample of hospitals from all participating countries would be necessary in order to test the ability of such a EuroDRG system to define homogeneous groups of patients across different countries.

Although quality has been of continuous concern for policy-makers across Europe, it is still relatively rarely explicitly taken into account in existing DRG-based hospital payment

systems. However, it is possible to refine these systems to integrate direct incentives for improving quality. For example, DRG-based payments can be adjusted at the hospital level by increasing payments for all patients treated by one hospital, if one hospital provides above-average quality as measured through hospital-level quality indicators. Similarly, it is possible to increase payments to a hospital for all patients falling into one DRG if the hospital scores above average on DRG-specific quality indicators, or to adjust payments for individual patients if quality can be more robustly monitored at the individual patient level. Yet, an essential prerequisite is that reliable quality indicators are developed and that more robust data about quality of care are collected in hospitals.

A synthesis report of 'recommendations and conclusions' of the EURODRG project was published within the book 'Diagnosis Related Groups in Europe: Moving toward transparency, efficiency and quality in hospitals', which has appeared within the European Observatory on Health Systems and Policies Series with Open University Press in 2011:

Busse R and Quentin W (2011): Moving towards transparency, efficiency and quality in hospitals: Conclusions and recommendations. In: Busse R, Geissler A, Quentin W, Wiley M (eds.) Diagnosis-Related Groups in Europe: Moving towards transparency, efficiency and quality in hospitals. Buckingham: Open University Press, 149-174.

The book was made available for distribution at the Final Project Conference in Berlin in November 2011; and it is being distributed through the normal distribution channels of the European Observatory on Health Systems and Policies. In addition, it will be made open access on the website of the European Observatory in April/May 2012.

**Potential Impact:**

Despite the fact that diagnosis-related groups (DRGs) have been adopted in an increasingly large number of countries around the world, knowledge about the effects of DRG systems and DRG-based hospital payment systems, as well as about optimal design features of these systems, remains surprisingly limited.

Consequently, there is no agreed consensus on how best to design DRG systems and DRG-based hospital payment systems, because the differences between countries' systems remain poorly understood and systematic but detailed comparisons of the main building blocks of DRG systems are rare. Nevertheless, a thorough understanding of international experiences with DRG systems and DRG-based hospital payment systems is necessary to inform countries when developing and revising their national systems. Moreover, as all European health systems increasingly suffer from financial austerity as the debt crisis begins to bite; it is of major importance to evaluate whether the (limited) resources available are devoted to different kinds of patients appropriately.

The EURODRG project was meant to close exactly this research gap. It was organised in three Phases and has scrutinized both, the design features of DRG systems in Europe as well as the performance of these systems across different countries.

Phase I of the project has concentrated on comparative analyses of the essential building blocks of DRG-based hospital payment systems across 12 European countries which are embedded in various types of health systems (Austria, England, Estonia, Finland, France, Germany, Ireland, the Netherlands, Poland, Portugal, Spain, and Sweden). This research has identified the differences and similarities of their objectives and purposes as well as the country-specific methodologies of patient classification, DRG weight calculation and hospital payment.

The results of the first phase of the EuroDRG book were summarized the book 'Diagnosis Related Groups in Europe: Moving towards transparency, efficiency and quality in hospitals'published by the European Observatory on Health Systems and Policies Series together with Open University Press. It is widely distributed amongst Observatory partners (i.e. governments, international organizations, etc.). In addition, the book will soon become freely downloadable from the website of the European Observatory on Health Systems and Policies in order to reach out to the wider public. The book contains 12 country chapters structured according to a common template and cross-country comparisons of specific important issues concerning DRG systems (e.g. cost accounting, innovation, efficiency, and quality).

Overarching findings are that DRG systems were often introduced initially for the purpose of measuring hospital activity, but have later become the principal means of hospital payment in most countries. Some countries used DRGs over an extended period of time exclusively just for measuring activity and increasing transparency (for example, up to ten years in England), in order to become acquainted with the DRG grouping logic before they started paying hospitals on the basis of DRGs. Others introduced DRGs after a short period of conversion (for example, in Ireland DRGs were introduced in 1992 and first used for budgetary allocation in 1993).

Moreover, the book established that DRG-based hospital payment system can be best understood by differentiating several essential building blocks that provide a specific set of incentives, which differ from other payment mechanisms. The findings from Phase One of the EURODRG project presented in the book, can inform countries when developing and optimizing their national systems. In addition, in a context of growing patient mobility facilitated by the European Union (EU) Directive on the Application of Patients' Rights in Cross-Border Healthcare, an increasingly important issue relates to whether there is scope for harmonization of DRG systems within Europe. This is because if harmonization is not possible, it will remain difficult (or at least in-transparent) to pay hospitals in one EU Member State for care provided to patients from another EU Member State. Furthermore, cross-border comparisons of hospital prices and performance - which are increasingly being conducted in attempts to improve the understanding of differences in terms of efficiency and costs - will continue to be complicated by the lack of a common basis for comparison.

Phase II of EURODRG project aimed at comparing the performance of DRG systems across European countries. One essential indicator of performance for a DRG system is its ability to define (resource) homogenous groups of patients. Otherwise, reimbursement for a large number of patients is not appropriate: it is either too high or too low; and performance comparisons on the basis of DRGs do not adequately control for differences of patients within groups. Therefore, Phase II of the project collected patient level data for 10 episodes of care (EoC) (representing different medical specialties and diagnostic/ therapeutic procedures), and conducted analyses of (1) the specific classification variables used by different DRG systems and (2) the ability of DRG systems to explain variation in resource consumption. The analyses were performed for acute myocardial infarction, appendectomy, breast cancer, coronary artery bypass surgery, childbirth, cholecystectomy, hernia repair, hip or knee replacement, and stroke.

The analysis of grouping algorithms, classification variables, DRG weights and quasi prices found that there is a large variation in the classification approach of the episodes of care that were analysed. For most episodes we find that:

1. European DRG systems differentiate their payment for patients to very different degrees; grouping them by very different numbers and types of classification variables (e.g. for breast cancer surgery patients between two and seven) and into different numbers of DRGs (e.g. for breast cancer surgery patients between three and seven).
2. European DRG systems apply fundamentally different approaches to assess complexity which implies that very different types of patients benefit from complexity adjustments and unintended financial incentives for treatment may arise.
3. We find that several European DRG systems do not always allocate higher levels of resources to the more complex cases -rather in a number of DRG systems characterised by less complexity receive higher payments.

These findings are unique as similar studies have never been conducted before. They raise concerns whether all systems rely on the most appropriate classification variables. In several countries, the appropriateness of specific DRG weights and related incentives should be carefully reevaluated as they can incentivize unintended consequences.

In the second part of Phase II, partners conducted regression analyses (with costs or length of stay as the dependent variable) in order to assess the ability of national DRG systems to explain variation in resource consumption. As outlined the results of the quantitative results will be presented in special issue in Health Economics containing 11 articles of the EuroDRG project, which is scheduled for publication in July 2012.

One overarching finding is that in the majority of countries the set of EURODRG patient-level variables, which we were able to define across countries, performs better than the set of national DRGs in accounting for patient-level variation in resource consumption (e.g. hip replacement: seven out of ten countries, breast cancer surgery: six out of ten countries).

Moreover, there appear to be factors that are consistently significant determinants of cost/LoS of hip replacement and breast cancer surgery cases, but are not, or at least only partially, considered in European DRG systems. These findings raise questions about the adequacy of the countries' DRG systems and, especially, the lack of specific criteria which could be used as DRG classification variables, but are currently not used for grouping purposes.

Overall, the results of Phase II of the EuroDRG project will be useful for health policy stake-holders in Europe such as government agency, European institutions and organizations, patient groups, health professionals, payers, and providers aiming to optimize DRG systems. It will contribute to assuring adequate reimbursement for health care delivered to patients, fair performance comparisons on the basis of DRGs, and therefore, ultimately, to better clinical practice in Europe.

The interest from countries where DRG systems are currently in the early stages of DRG development, in particular in China, Russia, South Korea and Bulgaria, indicates that policy-makers in these countries also can draw on the European experience when designing and implementing their DRG systems. The results and activities (see above/below) of the EURODRG project can therefore contribute an important process of policy-learning in the field of health care financing and pay.

Phase III of the EURODRG project related to the communication and dissemination of project results. The EURODRG project here focused on four strategic impact in four dimensions:

(1) Advancement of the state of the art in research,
(2) Enhancement of cooperation between researchers in Europe and other geographic regions to promote integration and excellence of European research in the field,
(3) Development of the scientific evidence base that supports the Member States to better organize their health systems, and
(4) Transfer of research results into practice to empower policy and decision makers to better manage and reform health care systems.

The project partners have made enormous progress in regard to these objectives: The work of the consortium is being recognised in the academic community (as e.g. demonstrated by the selection of a workshop and a thematic session at the European Conference on Health Economics in July 2012) but also in meetings at the academic-policy interface (e.g. at the European Health Summit in January 2012, at the European Health Care Conference in Hamburg in May 2011, at a World Bank Workshop on Hospital financing in Moscow in April

2011, a policy dialogue on hospital payment in Bulgaria in June 2011 - as well as further invitations in the future, e.g. at the Nordic Case-Mix Conference in June 2012).

Besides the highly visible book on Diagnosis Related Groups in Europe that has been published with Open University Press, a number of publications have already appeared in wide array of peer reviewed journals targeting different audiences. For example, one article on DRGs and technological innovation has appeared in Value in Health targeting the HTA community, an article about experiences with DRG-based hospital payment in five countries in Health Economics, Policy and Law was targeted at health policy oriented researchers, and an article about DRGs and Appendectomy that was published in Langenbeck's Archives of Surgery has been targeted at the medical community.

Furthermore, a large number of publications are expected to appear in the year 2012. Amongst other things, there is a special issue in Health Economics containing 11 articles about the results of the quantitative analyses of the EURODRG project, which is scheduled for publication in July 2012. Nine articles about DRG classifications for selected episodes of care have been (or are about to be) submitted to medical journals, and will hopefully appear within 2012. In addition, a commissioned overview is being written for the BMJ and one article highlighting the implications of the project's findings for the United States is about to be submitted to Health Affairs.

The European Observatory has been instrumental for maximizing the project's impact at the policy level by allowing the book on DRG systems in Europe to be published as part of its widely read Open University Press series. In addition, the book serves as a basis for the Observatory's 'policy dialogues' with senior policy makers.

**List of Websites:**

http://www.eurodrg.eu

*Partners*

The EURODRG project consortium is made up of partners from 10 countries (as well as 2 unfunded associated partners which participate in the work) which are listed below. An Advisory Board provides an external review of the quality of the project's processes and deliverables.

-Department für Medizinische Statistik, Informatik und Gesundheitsökonomie, Innsbruck Medical University, Austria

-Centre for Health Economics, University of York England (UK)

-PRAXIS Center for Policy Studies, Estonia

-European Health Management Association, Belgium

-National Institute for Health and Welfare, Finland

-Ecole des Hautes Etudes en Santé Publique, France

-Institut de recherche et documentation en économie de la santé, France

-Technische Universität Berlin, Germany

-National Health Fund, Poland

-Consorcio mar parc de salut de Barcelona, Spain

-National Board of Health and Welfare, Sweden

-Erasmus Universitair Medisch Centrum Rotterdam, The Netherlands

*Associated Partners*

-Economic and Social Research Institute (ESRI), Dublin, Ireland

-Escola Nacional de Saúde Pública, Portugal

*Advisory Board*

-Dr. Josep Figueras, WHO Regional Office for Europe, Brussels, Belgium

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