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Understanding variations
in hospital length of stay
and cost: Results of a pilot
project

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**UNDERSTANDING VARIATIONS IN HOSPITAL LENGTH OF STAY AND COST: RESULTS OF A
PILOT PROJECT**

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ABSTRACT

Hospitals are the most expensive component of OECD health care systems, accounting for around one third of total health care expenditure. Given growing pressures on government budgets, this is an area of expenditure that has already been, and will continue to be, thoroughly scrutinised for potential increases in efficiency. One way to assess hospital efficiency is to measure the amount of resources each hospital uses to treat specific conditions. A care delivery process may be seen as more efficient – after accounting for broader health system and market factors that may constrain the hospital from operating at an efficient level – if it consumes fewer resources while delivering adequate care for the same condition, the dimension of efficiency under review here. In this light, measuring hospital length of stay and costs for a given condition helps the understanding of how efficient (better performing) hospitals are relative to each other. Through international comparative work, this paper helps policy makers understand the scope and nature of length of stay/costs variation across hospitals in OECD countries. It also explores whether characteristic of hospitals or of countries' regulatory and operating environments can explain differences in efficiency. Data on length of stay and costs to treat patients admitted to hospitals for nine tracing conditions/treatments were collected and analysed for Canada (Alberta province), France, Ireland and Israel for 2012-2014. Our analysis shows that hospitals with a number of beds ranging between 200 and 600, and not-for-profit hospitals report shorter length of stay and lower costs for several conditions/treatments. It also shows that variations in efficiency are more likely to exist at the hospital level for cardiac surgery (acute myocardial infarction with percutaneous transluminal coronary angioplasty and coronary artery bypass graft), and at country level for hysterectomy, caesarean section and normal delivery. These results shed some light on the importance of hospital payment system in fostering efficiency in care delivery for standard/high volume treatments such as normal delivery, whereas hospital management and organisation seem to drive efficiency for more complex/technology driven treatments such as bypass surgery.

RÉSUMÉ

Les hôpitaux se révèlent être le secteur le plus coûteux des systèmes de soins de santé de l'OCDE, représentant environ le tiers des dépenses totales en soins de santé. Compte tenu des pressions croissantes sur les budgets gouvernementaux, il s'agit d'un domaine de dépenses qui a déjà été, et continuera d'être, minutieusement examiné afin d'obtenir toujours plus d'efficacité. Une façon d'évaluer l'efficacité de l'hôpital est de mesurer la quantité de ressources utilisées par chaque hôpital pour soigner des affections spécifiques. Un hôpital peut être considéré comme plus efficace - après avoir pris en compte les facteurs plus larges du système de santé et du marché qui pourraient limiter le fonctionnement de l'hôpital à un certain niveau d'efficacité - s'il consomme moins de ressources tout en offrant des soins adéquats pour les mêmes affections, ceci définissant ici la performance. Dans cette optique, mesurer la durée de séjour en hôpital et les coûts pour une affection donnée permet de comprendre à quel point les hôpitaux peuvent être plus efficaces (plus performants) les uns par rapport aux autres. Grâce à un travail comparatif international, ce rapport cherche à explorer des pistes pour fournir aux décideurs une compréhension accrue de la portée et de la nature des variations du rapport durée de séjour/coût dans les hôpitaux des pays de l'OCDE, et pour mieux comprendre l'impact relatif des différents niveaux hiérarchiques - pays et hôpital - sur les variations de performance. Les données sur les durées de séjour et les coûts pour traiter les patients admis en hôpital pour neuf affections/traitements ont été recueillies et analysées pour le Canada (province d'Alberta), la France, l'Irlande et Israël pour 2012-2014. Notre analyse montre que les hôpitaux ayant un nombre de lits compris entre 200 et 600 et les hôpitaux à but non-lucratif rapportent une durée de séjour plus courte et des coûts inférieurs pour plusieurs affections. Elle montre également que les variations de performance sont plus susceptibles d'exister au niveau de l'hôpital pour la chirurgie cardiaque (infarctus aigu du myocarde avec angioplastie coronarienne transluminale percutanée et pontage coronarien), et au niveau du pays pour l'hystérectomie, la césarienne et l'accouchement normal. Ces résultats mettent en lumière l'importance du système de paiement des hôpitaux pour favoriser l'efficacité de la prestation des soins pour les traitements standards/à haut volume tels que l'accouchement normal, alors que la gestion et l'organisation des hôpitaux semblent générer de l'efficacité pour des traitements plus complexes ou axés sur la technologie, comme la chirurgie de pontage.

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1. INTRODUCTION

1. Through international comparative work, this paper seeks to provide policy makers with additional ability to understand the scope and nature of length of stay and costs variation across hospitals in a selected number of OECD countries. To do so, the OECD analyses data on how length of stay and costs for nine tracing conditions/treatments vary across individual hospitals across four countries.

2. Hospitals are organisational units which can be the subject of resource consumption analyses as they capture the entire production process, are decision-making units and seek to produce the same set of outputs. Furthermore, hospitals are the most expensive component of OECD health care systems, accounting for around one third of total health care expenditure (OECD, 2015). Given the growing pressure on government budgets, this is an area of expenditure that is scrutinised for potential increases in efficiency.

3. This paper identifies broader health system and market factors, and hospital characteristics that could explain length of stay and cost variations across hospitals. After adjusting for those factors and characteristics, a hospital may be considered as more efficient if it consumes fewer resources while delivering care of the same quality for the same condition/treatment. In this light, measuring hospital length of stay and cost for a given condition or treatment helps the understanding of how efficient hospitals are relative to each other, under the assumption that severity of cases and quality of care are comparable across hospitals.

4. Analysis of variation in length of stay and costs across hospitals has been well documented in the literature (BlueCross BlueShield Association 2015; Duckett and Breadon, 2014; Laudicella *et al* 2013; Busse 2012; Gaughan *et al.* 2012; Bellanger and Or, 2008). A recent report, which examines the costs for 16 conditions and procedures in Australian hospitals, found that the average cost for a hip replacement ranges from \$ 12 500 to \$ 25 600 in major metropolitan public hospitals (National Health Performance Authority 2015). A widespread variation in public hospitals length of stay that indicates inefficiency was reported also for the state of Victoria in Australia (Victorian Auditor General 2016).

5. Variation in hospital length of stay and costs is caused by a variety of factors. The more important determinants include product mix (i.e. case-mix and teaching activities), quantity of output (i.e. economies of scale and scope), degree of competition, payment policy and ownership status (Rosko 1996).

6. This paper also uses a multilevel (or hierarchical) model to shed some light on hospital performance. A simple two-level model yields estimates of the "country effect" and of the "hospital effect" on length of stay and cost by condition/treatment in this study. The insight of this analysis is that the hospital effect may be used as the basis of an organisational performance indicator (Jacobs *et al* 2006).

7. This paper is structured as follows. First, a conceptual framework to assess hospital performance is described. Then, methods used to carry out this analysis are reported. Preliminary results by condition/treatment are provided in section 4. Two final sections discuss the results and conclude.

2. HOSPITAL PERFORMANCE: THE CONCEPTUAL FRAMEWORK

8. The OECD has undertaken a broad programme of work on hospital-level performance to better understand the variation in costs, quality and access to hospital services both within and across countries.

9. The conceptual framework guiding this work (Figure 1) explores various dimension of performance including effectiveness (appropriateness and timeliness), safety, efficiency and equity.

Figure 1 OECD Health System Performance Assessment Framework

Source: Carinci *et al.* (2015).

10. A key dimension of hospital performance is the technical efficiency in providing hospital care within a cost-effectiveness framework for analysis (Figure 2).

Figure 2 Conceptualisation of technical efficiency and cost-effectiveness

Source: Australian Steering Committee for the Review of Government Service Provision, 2015.

11. This paper presents the results of a pilot data collection in a selected number of OECD countries carried out to test methodological approaches and identify robust model for analysis of hospital length of stay and cost. Linking length of stay, costs and quality measures to each condition/treatment at organisational level will then pave the way for a cost-effectiveness type of analysis.

3. HOSPITAL LENGTH OF STAY AND COSTS MEASUREMENT: METHODS

3.1 Indicators

12. This paper focuses on two indicators - average length of stay and average costs – and on four groups of tracing hospital conditions/treatments which are likely to be similarly defined across countries:

- Inpatient:
 - *Treatment of acute myocardial infarction*: Acute myocardial infarction with Percutaneous transluminal coronary angioplasty (AMI with PTCA); Coronary artery bypass graft
 - *Little discretion in use*: Hip replacement: total and partial - unilateral; bilateral; hysterectomy with diagnosis of cancer
 - *High-volume*: Caesarean section; Normal delivery
- Day surgery:
 - Lens and cataract procedures; Arthroscopic excision of meniscus of knee

13. Data were also collected for "Acute stroke" cases to assess how differences in reporting and coding practices among countries influence results.

3.2 Unit of measurement

14. The units of measurement used in this data collection are hospital and hospital admission. It is recognised that countries have adopted various terms to describe and codify these units in their own data systems. For the purpose of the pilot data collection used in this paper, the following definitions are employed:

- *Hospital* is defined as a single separate organisational entity that provides admitted patient care. Some hospitals will have more than one campus, while some hospital campuses will have more than one hospital. The organisation of care in some countries results in the aggregation of single hospital entities into trusts, groups, chains, or networks. For the purposes of this data collection, the unit of measurement is the single hospital entity.
- *Hospital admission* is defined as the period of hospital care from the date of formal admission to a hospital to the date of formal discharge from the same hospital.

15. For inpatient cases, the admission refers to the entire profile of care followed for the treatment of the acute episode. Rehabilitative or long-term care spells and their related days of care and costs if provided during the same admission by the same hospital after stabilisation of the patient are excluded. Moreover, medical consultations that precede or follow a hospital stay and their related costs are excluded. Finally, external transfers and in-hospital deaths are excluded from the population in study as a standard profile of care to treat those cases is not followed.

16. For each condition/treatment, a descriptive definition is given first. Then ICD codes for diagnoses and – when appropriate - for procedures that identify the surgical treatment are provided. Finally, rules and criteria for inclusion/exclusion of hospitalisation cases are reported. Annex 1 shows ICD-10 codes for diagnoses and ICD-9-CM codes for procedures¹. Those descriptions draw heavily on the Eurostat-OECD work on hospitals Purchasing Power Parities (Koechlin *et al.* 2014).

17. To increase resource use homogeneity within conditions/treatments, subsets of cases are identified and compared on the basis of age (< 45 years; 45-64 years; ≥ 65 years) for AMI with PTCA, and on the basis of type of admission (emergency vs planned) and type of procedure (unilateral vs bilateral) for hip replacement.

3.3 Cost finding methods

18. To ensure comparability across countries, the average cost by condition/treatment should:

- Cover the same types of costs across all participating countries reflecting the direct costs as well as overhead costs relating to the production of health services; and
- Include costs that are similarly accounted for across hospitals and countries. (Geue *et al.* 2012; Tan *et al.* 2014).

19. Ideally, patient level costing (PLC) data should give the most accurate reflection of the cost of care provision for each type of care in a hospital. However, it should be recognised that the quality of PLC data in any hospital is driven by the number and quality of feeder information systems which are available in that hospital. In cases where certain information is not available, some cost modelling is usually carried out to fill the gap. The extent of cost modelling in included hospitals could affect the ability to identify and quantify the factors which drive cost variation. It is acknowledged that it is difficult to quantify the level of cost modelling carried out beyond doing a census of available information systems.

20. The table shown in Annex 2 reports the cost items that are included in the cost estimates for the project discussed in this paper (medical infrastructure; non-medical infrastructure; direct cost centres: compensation of employees and goods and services)². Pilot country experts verified that those items are included in the costs reported, and indicated which drivers/parameters³ are used to apportion overhead costs and allocate indirect costs to conditions/treatments or to direct cost centres (e.g. specialties, medical services, operating theatres).

3.4 Country and hospital characteristics

21. This paper explores the extent to which length of stay and cost variations can be explained by factors beyond hospitals' control that constrain the hospital from operating at a technical efficient level (Mason *et al.* 2008; Street *et al.* 2010; Street *et al.* 2012). It is important to adjust for these endogenous variations before comparisons can be considered as meaningful⁴. Two sets of variables are used to measure

¹ Condition/treatment specifications based on ICD-9-CM codes for diagnoses and ICD-9-CM codes for procedures are also available at OECD.

² This paper focuses on current expenditure so as to avoid accounting for differences across countries in the treatment of capital costs

³ Examples of apportionment/allocation statistics used by pilot countries include bed days, number of admissions, floor area/building volumes.

⁴ Notably, variables may be “beyond hospital control” and not beyond the influence of policy makers.

and explain variations in average hospital length of stay and cost by product: health system level; hospital (organisational) level.

22. Following findings from the literature (Cavalieri *et al* 2016; Street *et al* 2011; Ellis and McGuire 1986), two country features are identified and measured for this pilot work as follows:

- Hospital payment system: DRG; global budget; fee-for-service
- Level of negotiation of hospital prices/budget: central level; local/subnational level

23. Previous research has also indicated that hospital level features, such as teaching status, ownership, number of beds, specialisation and availability of technology may all have important explanatory power in the assessment of hospital length of stay and cost variations:

- *Teaching status*: teaching hospitals may systematically attract more severe cases while providing tertiary care services. Moreover, the provision of teaching may require additional time spent on the part of physicians in treating/reviewing each patient so that medical students can learn “hands-on”.
- *Ownership*: the hospital status may impose different incentives on staff. Moreover, hospitals may be subject to different regulatory constraints. There is some empirical evidence of the existence of differences in costs of public and private hospitals but it is not unambiguous (de Lagasnerie *et al.* 2015).). Carey (2000) and Sloan (2000) conclude that there is no clear empirical evidence for a difference between ownership types, whereas private for-profit hospitals have lower costs than not-for-profit hospitals, with a difference of around 15% according to Cowing and Holtmann (1983) and around 5% according to Vita (1990). Valdmanis *et al.* (2008) showed that public hospitals were more inefficient, while for-profit hospitals performed best, on average. Carey *et al.* (2008) indicated that non-profit hospitals were more costly than for-profit hospitals (reference class), and that public hospitals were the most costly.
- *Number of beds*: research mainly in the United States and the United Kingdom indicates that inefficiency/diseconomies of scale starts below about 200 beds and above 600 (Posnett 2002).
- *Specialisation*: Hospitals that specialise may have lower costs than general hospitals. On the contrary, if there are economies of scope⁵, increasing the range of activity may lead to lower costs. There is mixed – and sometimes opposite - evidence on the relationship between specialization and efficiency. Of note that this relationship may also depend on the way specialization is measured (Lindlbauer and Schreyogg, 2014). The number of specialties offered in a hospital can be used as a proxy. When using the number of specialties per hospital as a proxy, we need to be aware that the granularity of specialty may differ between countries so this variable could be picking up differences between the reporting of specialty rather than any real difference between hospitals (measurement/reporting bias). As an alternative, a specialisation index measuring how the proportion of cases in each diagnosis category in a given hospital deviated from a uniform distribution (Daidone and D’Amico 2009) may be used.

⁵ Economies of scope refer to a situation in which the joint production of two or more products can be achieved at lower costs than the combined cost of producing each product individually.

- *High-technology services*: The relationship between hospital costs and technological equipment has been on the research agenda for quite a long time. Technology investments may encompass product, process and organisation that could be assumed to influence hospital costs in different ways (Zweifel and Breyer 1997). However, it is hard to specify a relation between technology, on the one hand, and hospital costs on the other.

24. The EuroDRG project has shown that hospital-level indicators are, to a considerable extent, internationally comparable (Hollingsworth 2008; Street *et al.*, 2010; Street *et al.*, 2012). International projects such as European Collaboration in Healthcare Optimisation (ECHO) (Bernal-Delgado *et al.* 2015) and EuroHOPE (Hakkinen *et al.* 2013) also employ such variables as the number of beds, caseloads and headcounts of employees, physicians and nurses as inputs in their analyses of hospital efficiency (Mateus *et al.* 2015).

25. For the purpose of the pilot data collection and analysis in this paper, the following hospital characteristics are employed:

- Teaching status (dummy): based on the designation of hospitals as academic medical centre/tertiary referral centre;
- Ownership: publicly-owned; private for-profit; private not-for-profit;
- Number of beds, that is the average daily number of inpatient open and available beds: small (< 200); medium (> 200 and <600); large (>600) hospitals;
- Bed occupancy rate: <70%; 70%-90%; >90%;
- Specialisations⁶ (dummies): Orthopaedic hospitals; Maternity hospitals; Oncology hospital;
- High technology services (dummies): catheter laboratory; coronary care unit; neonatal intensive care unit; intensive care unit.

3.5 Data collection

26. To promote consistent calculation of indicators across countries, the data collection process was underpinned by careful and detailed specification of the indicators, key data elements and variables, and the way in which the source data was to be queried by data custodians.

27. Specification of the required key variables was agreed on with data custodians along with the data output tables with anonymised aggregate data that are transferred to the OECD⁷. It is considered that this approach would enable countries to have greater ownership over data and the generation of the resulting variables and/or indicators, and require only the key output data to be transferred to the OECD. The creation of a central database that stores only aggregated results at the hospital level would enable a range of different analyses to be undertaken by the OECD.

⁶ Those three dummies – one for each specialisation type – were identified on the basis of the conditions/treatments in this study.

⁷ A data collection tool has been prepared and made available to countries to facilitate transmission of data to the OECD.

28. Hospital level data from Canada (Alberta province), France, Ireland and Israel for 2012, 2013 and 2014 (except for Ireland) were collected and used for analysis. Tables were filled in for each hospital and each year in this study. Data collection for three consecutive years – 2012, 2013 and 2014 – allowed for pooling of observations over time. Although pooling of the data is not optimal for this kind of analysis, the number of observations of the study at the present stage did not allow for an unbiased panel analysis or the observation of time trends. The observation of time trends with a discontinuity design could allow, in future instances of the model and the data collection, looking at institutional characteristics and policies implemented at the national level at a specific point in time. This design would allow a better understanding of whether and how policies affect efficiency and hospital performance at the country level of analysis.

29. Hospital level data provided to the OECD include, in addition to hospital characteristics:

- number of cases by condition/treatment by hospital
- average length of stay and its coefficient of variation by condition/treatment by hospital
- average cost and its coefficient of variation by condition/treatment by hospital

30. Average costs provided by countries in local currencies were converted in Euro using an average exchange rate for 2012-2014, and in PPPs adjusted currencies using 2014 hospital Purchasing Power Parities statistics^{8 9}. Both measures were then converted in their natural logarithms as is common practice for cost variables to normalise data and to minimise the impact of outliers. Average length of stay data provided by countries were also converted in their natural logarithms for analysis.

3.6 Statistical analyses

31. Preliminary t-test and ordinary least squares (OLS) regressions were performed to test hypotheses regarding differences in costs among condition subgroups, and the restricted set of covariates to be used in the further regressions (multilevel modelling, ML).

32. All the regressions in this pilot study take the log-linear form, for which the interpretation of the estimated coefficient β is that one-unit increase in $X(\beta)$ will produce an expected increase in $\log(Y)$ of β units. Therefore, the expected percentage change of Y is $(e^\beta - 1) * 100$.¹⁰

⁸ Exchange rates are from OECD.stat database. The Hospital Purchasing Power Parities index is from the Eurostat/OECD work on hospitals PPPs (Koechlin *et al.* 2014).

⁹ The use of Purchasing Power Parities allows also taking into account in the analysis country-specific economic and market context.

¹⁰ This is the formal application of the (first level) Taylor expansion, which is far more accurate than the commonly (mis)used Taylor approximation, defined as $\beta * 100$. For example, the ML cost regression for AMI with PTCA shows a coefficient β of -0.1303031 for for-profit hospitals. Following from the Taylor expansion, $(e^{-0.1303031} - 1) * 100 = (-0.122 - 1) * 100 \cong -12.21$. Therefore, a unit change in X corresponds to an expected decrease in Y of 12.2 %.

33. Multilevel regression modelling was used to enable the analysis of the hierarchical data (Gaughan *et al.* 2012; Schreyogg *et al.* 2011; Or *et al.* 2005), whereas regressors are split within a **fixed effects** component and a **random effects** one, with a two-level nesting for hospitals (lower) within countries (upper) for the random part of the model. The specification for the model can be expressed as:

$$Y_{ijk} = \beta_0 x_0 + \beta x_{ijk} + u_i + u_{ij} + e_{ijk}$$

Where a set of fixed variables x_{ijk} (plus intercept) are regressed against Y_{ijk} for i (country nest), j (hospital nest) and k (individual observations). The error is split in random components u_i (country residual), u_{ij} (hospital residual) and e_{ijk} (remaining residual). These errors correspond to the average deviation from the grand mean of the sample at different hierarchy levels.

34. Therefore, when fitting the data in a multilevel model, we specify a mixed regression, with a fixed component holding our hospital-level covariates and a random component estimating the random effect at the country and hospital level, together with the residual e_{ijk} of the regression. The country effect on the random component also includes a random dummy covariate on country payment system. The random-effects analysis is based on the variance of the estimates, to allow for the calculation of intra-class coefficients.

35. It is important to note that the multi-level specification for fixed effects works, on strictly statistical sense, in the same way of a standalone fixed effects analysis. The only difference lies in how the country dummies (which would be used in a normal fixed effects analysis) are interpreted. In a ML model, they are separately analysed as a random effects model that brings the variable at a higher hierarchical level together with the fixed effects component that belong to its level of analysis (such as the payment system or the country level of negotiation between providers). The LR test provided at the bottom of the random effects analyses determines the appropriateness of the model against the use of a fixed effects analysis ($p < 0.05$ means that RE is more appropriate than OLS/FE).

36. The intra-class correlation coefficient was used to estimate the part of variation in performance that is attributable to the different hierarchical levels (Jacobs *et al.* 2006). As an example, the coefficient for the country level of the hierarchy is defined as follows:

$$\rho_v = \frac{\sigma_i^2}{(\sigma_i^2 + \sigma_k^2 + \sigma_j^2)}$$

where σ_i^2 , σ_k^2 and σ_j^2 represent the variance at the different level of the hierarchy (i.e. country, hospital and condition/treatment). The closer ρ_v lies to 1 the larger the extent to which the variance in the performance measure is attributable to the country level.

37. The multilevel model cannot clarify why the proportions of variation attributed to the different levels of the hierarchy differ. Thus further work should explore features that explain variations in performance.

4. RESULTS

4.1 Descriptive statistics

38. Table 1 reports the number of observations, average costs, exchange rate adjusted costs, PPP-adjusted costs and average length of stay by country and by condition. Standard deviations are reported in brackets. Averages represent simple averages over the hospitals reporting, without adjustment for size – therefore, they do not represent the average length of stay and cost (within the hospitals reporting) of providing care in different countries. Hospitals reporting less than 10 cases by condition/treatment by year were excluded from analyses. Panel A shows inpatient conditions/treatments, while Panel B reports day surgery treatments. Descriptive statistics by condition/treatment are presented in Annex 3 (distribution of length of stay and cost by condition/treatment) and Annex 4 (average length of stay and cost by condition/treatment by covariate used in the fixed effects model).

Table 1 Summary statistics by condition/treatment in study

Panel A. Inpatient

<i>Condition - Inpatient</i>	<i>Country</i>	<i># of hospitals (pooled)</i>	<i># of total cases (pooled)</i>	<i>Exchange rate adjusted costs in €</i>	<i>PPP-adjusted costs in €</i>	<i>Average length of stay in days</i>
AMI with PTCA (IN01)	<i>CAN</i>	20	1798	11550 (2638)	7927 (1811)	4.7 (0.9)
	<i>FRA</i>	68	972	7188 (1867)	6977 (1812)	7.1 (2.4)
	<i>IRL</i>	45	1557	9324 (2568)	6911 (1904)	5.6 (2.1)
	<i>ISR</i>	163	18060	9548 (459)	8645 (416)	4.9 (1.3)
	Total	296	22387	9107 (1925)	7949 (1497)	5.5 (1.9)
CABG (IN02)	<i>CAN</i>	2	885	36862 (6336)	25298 (4348)	13.4 (1.1)
	<i>FRA</i>	47	9366	17631 (2155)	17114 (2091)	14.5 (1.7)
	<i>IRL</i>	8	844	22303 (3462)	16530 (2566)	14.3 (1.6)
	<i>ISR</i>	32	7043	17035 (3776)	15423 (3418)	13.8 (3.9)
	Total	89	18138	18269 (4355)	16637 (3083)	14.2 (2.7)
Acute stroke (IN03)	<i>CAN</i>	16	1630	14228 (4582)	9764 (3144)	17.1 (7.4)
	<i>FRA</i>	139	69389	6656 (3670)	6461 (3562)	11.2 (2.8)
	<i>IRL</i>	21	3480	10340 (2444)	7664 (1811)	18.8 (4.4)
	<i>ISR</i>	76	24440	4181 (1452)	3785 (1314)	8.2 (2.8)
	Total	252	98939	6697 (4050)	5964 (3329)	11.3 (4.6)
Hip replacement (IN04)	<i>CAN</i>	22	3589	16243 (7527)	11147 (5166)	11.7 (11.8)
	<i>FRA</i>	334	53169	7947 (2128)	7714 (2066)	10.6 (2.9)
	<i>IRL</i>	32	3707	13953 (4495)	10342 (3331)	16.9 (9.6)
	<i>ISR</i>	—	—	—	—	—
	Total	388	60465	8913 (3814)	8125 (2661)	11.2 (5.0)

Hysterectomy with diagnosis of cancer (IN05)	<i>CAN</i>	21	4716	6426 (1055)	4410 (724)	2.4 (0.8)
	<i>FRA</i>	112	3798	6732 (2490)	6534 (2417)	7.2 (1.9)
	<i>IRL</i>	13	654	10832 (2512)	8029 (1862)	7.2 (1.7)
	<i>ISR</i>	54	2326	4026 (656)	3645 (594)	7.0 (1.8)
	Total	200	11494	6236 (2629)	5628 (2382)	6.6 (2.3)
Caesarean section (IN06)	<i>CAN</i>	42	13511	5336 (816)	3662 (560)	2.8 (0.4)
	<i>FRA</i>	150	72199	4283 (744)	4157 (722)	6.8 (1.0)
	<i>IRL</i>	10	13223	4284 (548)	3175 (406)	5.2 (0.5)
	<i>ISR</i>	72	81358	2819 (560)	2552 (507)	5.5 (1.0)
	Total	274	180291	4060 (1086)	3624 (933)	5.8 (1.6)
Normal delivery (IN07)	<i>CAN</i>	34	1792	2595 (437)	1780 (300)	1.3 (0.2)
	<i>FRA</i>	150	215562	2319 (311)	2251 (302)	4.2 (0.3)
	<i>IRL</i>	10	5394	1922 (288)	1424 (213)	1.8 (0.2)
	<i>ISR</i>	63	176709	2457 (107)	2225 (97)	2.7 (0.3)
	Total	257	399457	2374 (323)	2150 (338)	3.4 (1.1)

Panel B. Day Surgery

<i>Condition – Day surgery</i>	<i>Country</i>	<i># of hospitals (pooled)</i>	<i># of total cases (pooled)</i>	<i>Exchange rate adjusted costs in €</i>	<i>PPP-adjusted costs in €</i>
Lens and cataract procedures (DS01)	<i>FRA</i>	154	179308	1398 (362)	1357 (351)
	<i>IRL</i>	11	8397	1887 (686)	1398 (508)
	<i>ISR</i>	60	55917	1131 (74)	1024 (67)
	Total	225	243623	1351 (375)	1270 (345)
Arthroscopic excision of meniscus of knee (DS02)	<i>CAN</i>	—	—	—	—
	<i>FRA</i>	172	24709	1244 (362)	1208 (351)
	<i>IRL</i>	14	443	1751 (575)	1298 (426)
	<i>ISR</i>	46	4932	1473 (58)	1333 (53)
	Total	232	30084	1320 (369)	1238 (324)

39. Care should be taken in interpreting results for “acute stroke”, as we observed differences in reporting and coding practices across countries that may question the validity of the cross-country analysis. Thus even if we report descriptive results for “Acute stroke”, these results will be excluded from the interpretation.

40. Covariates included in all sets of regressions are:

- Teaching — dummy for whether the hospital is a teaching hospital;
- Beds — dummy (three levels) for the number of beds in a hospital (the baseline is less than 200 beds);
- Occupancy — dummy (three levels) for the occupancy rate of a hospital (the baseline is less than 70%);
- Ownership — dummy (three levels) for the ownership of the hospital (the baseline is public);
- Condition — dummy for particular subdivisions in a condition:
 - AMI — age dummy (0 = less than 45, 1 = 45 to 64, 2 = 65+);
 - Hip replacement — unilateral or bilateral treatment (0 = unilateral, 1 = bilateral);
- Capacity use — interaction dummy between the number of beds and the occupancy rate, to partially capture hospital economies of scale. The interaction produces 9 dummies, but for the scope of this analysis, coefficients are not reported due low number of observations, and therefore capacity use is only used as a control. Whenever capacity use is missing from results, the number of observations was too low for the simulation to run. This is the case for all length of stay analyses.

4.2 Multilevel regression results: length of stay

41. Table 2 reports the multilevel regressions results on the log-transformed length of stay for all conditions k ($n=1880$) for hospital j ($n=360$) in country i ($n=4$)¹¹. All regressions were performed on a three year (2012-2014) pooled sample, excluding hospitals with less than 10 cases per year. Panel A shows fixed component estimates, while Panel B report random components ones.

42. At the fixed component level, we observe highly significant coefficients for teaching status for caesarean sections; and similarly high significance for number of beds for hysterectomy (higher costs for both small and large amounts of bed compared to a medium amount). It has to be noted that the high coefficients on AMI with PTCA are not significant because of their very high standard error. Occupancy rates (under-occupied and over-occupied alike) are highly significant for AMI with PTCA, hip replacement and normal delivery. Ownership status is also significant across conditions, with the exception of normal and caesarean sections.

¹¹ Note that a few observations were dropped in the regression analysis due to similar multicollinearity issues when simulating the multilevel concavity function.

Table 2 Multilevel regressions on length of stay by inpatient conditions

Panel A. Fixed component estimates

Length of stay	IN01 AMI w PTCA	IN02 CABG	IN03 Acute stroke	IN04 Hip replacemen t	IN05 Hysterectom y w dx of cancer	IN06 Caesarian section	IN07 Normal delivery
Constant	1.33*** (.21)	2.37*** (.14)	2.51*** (.17)	2.55*** (.13)	1.58*** (.23)	1.48*** (.14)	.83*** (.22)
Teaching	.01 (.06)	-.23* (.13)	-.26*** (.05)	.00 (.05)	.00 (.05)	.16*** (.02)	-.01 (.02)
Beds							
200 to 600	.18 (.21)	—	.09 (.05)	.03 (.03)	.16*** (.05)	.00 (.02)	.00 (.01)
600+	.23 (.21)	—	.35*** (.06)	.06 (.05)	.12* (.07)	.05* (.02)	.01 (.02)
Ownership							
For-profit	-.24*** (.05)	.18** (.09)	-.01 (.04)	.01 (.04)	-.09* (.05)	.03 (.02)	-.03* (.01)
Not-for-profit	-.03 (.24)	.12 (.16)	-.13* (.07)	-.07* (.04)	-.15** (.06)	.00 (.02)	-.00 (.02)
Condition	2 = 65+ I =						
	Bilateral						
1	.08*** (.02)	—	—	-.44*** (.02)	—	—	—
2	.36*** (.02)	—	—	-.39** (.16)	—	—	—
Capacity use	No	No	No	No	No	No	No

Panel B. Random component estimates

	IN01 AMI w PTCA	IN02 CABG	IN03 Acute stroke	IN04 Hip replacement	IN05 Hysterectomy w dx of cancer	IN06 Caesarian section	IN07 Normal delivery
Country effect	.022 (.017)	.003 (.056)	.11 (.080)	.045 (.039)	.215 (.155)	.085 (.060)	.198 (.140)
Hospital effect	.026 (.005)	.056 (5.367)	.063 (2.007)	.0001 (.000)	.045 (.946)	.011 (.568)	.006 (.504)
Residual	.03 (.003)	.007 (5.367)	.011 (2.007)	.075 (.005)	.009 (.946)	.002 (.568)	.002 (.504)
LR test χ^2	101.20 (.000)	1.78 (0.409)	118.16 (.000)	27.34 (.000)	148.39 (.000)	409.88 (.000)	666.82 (.000)
N of Countries	4	4	4	3	4	4	4
N of Hospitals	120	89	248	213	199	274	257
N	296	89	248	388	199	274	257

* indicates significance at the 10% level, ** at the 5% level, *** at the 1% level. Standard errors are reported in brackets. In some instances, standard error estimation failed during the ML simulation.

43. Notably, when regressing occupancy rates on length of stay in a multilevel model without additional controlling factors, we might be introducing an unknown amount of bias because of the possible simultaneity or reverse causality of the variable. This is an endogeneity problem inherent to the variable, since the calculation of occupancy rates includes length of stay in its equation. For example, some patients in some conditions will have a specific, obligatory amount of days in terms of length of stay, which will in turn affect the occupancy rates of the hospitals. Some other patients, however, will have their suggested, but not required, stay shortened because of occupancy rates problems (therefore the hospital will discharge patients faster to make more room). Therefore, occupancy rates are excluded from the length of stay analysis because of endogeneity issues.

4.3 Multilevel regression results: costs

44. Table 3 reports the multilevel regression results on the log-transformed by condition for hospital j ($n=360$) in country i ($n=4$). All regressions were performed on a three year (2012-2014) pooled sample, excluding hospitals with less than 10 cases per year. Panel A shows the fixed component results for inpatient conditions holding hospital-level covariates fixed, whereas Panel B reports the results of estimating the random effect at the country and hospital level, together with the residual e_{ijk} of the regression. Panel C shows results of the ML and OLS regressions for day surgery conditions.

Table 3 Multilevel regression on costs by condition

Panel A. Fixed component estimates

PPP log costs	IN01 AMI w PTCA	IN02 CABG	IN03 Acute stroke	IN04 Hip replacement	IN05 Hysterectomy w dx of cancer	IN06 Caesarian section	IN07 Normal delivery
Constant	8.77*** (.15)	9.74*** (.18)	8.33*** (.23)	9.14*** (.05)	8.58*** (.19)	8.14*** (.10)	7.68*** (.11)
Teaching	.07* (.04)	-.11 (.15)	.02 (.07)	.02 (.03)	.14*** (.05)	-.00 (.03)	-.06*** (.02)
Beds							
200 to 600	.11 (.15)	-.38** (.18)	-.50** (.26)	-.04* (.02)	.00 (.10)	-.21*** (.05)	-.00 (.04)
600+	.08 (.15)	-.04 (.17)	.36*** (.12)	-.03 (.04)	-.05 (.11)	.03 (.05)	-.02 (.04)
Occupancy							
70% to 90%	—	—	.10 (.12)	—	.10 (.07)	-.15*** (.03)	-.11*** (.02)
90%+	.03 (.04)	.29*** (.08)	.19 (.15)	—	-.01 (.11)	-.06 (.05)	-.07* (.04)
Ownership							
For-profit	-.13*** (.04)	-.00 (.08)	.18*** (.05)	-.01 (.03)	-.02 (.04)	.02 (.02)	-.03 (.02)
Not-for-profit	-.13 (.17)	.13 (.17)	.20** (.09)	-.23*** (.02)	-.67*** (.07)	-.09** (.04)	-.16*** (.03)
Condition							
2 = 65+				1 = Bilateral			
1	.00 (.01)	—	—	.49*** (.11)	—	—	—
2	.05*** (.01)	—	—	—	—	—	—
Capacity use	Yes	No	Yes	Yes	Yes	Yes	Yes

Panel B. Random component estimates

	IN01 AMI w PTCA	IN02 CABG	IN03 Acute stroke	IN04 Hip replacement	IN05 Hysterectomy w dx of cancer	IN06 Caesarian section	IN07 Normal delivery
Country effect	.07 (.03)	.018 (.018)	.40 (.14)	.08 (.03)	.34 (.12)	.20 (.07)	.04 (.03)
Hospital effect	.12 (.01)	.046 (1.8)	.30 (–)	.04 (.02)	.18 (–)	.13 (–)	.01 (.47)
Residual	.12 (.00)	.007 (1.8)	.12 (–)	.17 (.00)	.08 (–)	.05 (–)	.001 (.47)
LR test χ^2	71.75 (.000)	5.81 (0.054)	110.29 (.000)	19.58 (.000)	166.65 (.000)	165.82 (.000)	169.13 (.000)
N of Countries	4	4	4	3	4	4	4
N of Hospitals	120	89	248	213	199	272	255
N	294	89	248	388	199	272	255

Panel C. Multilevel and OLS regression on costs by day surgery condition (fixed and random)

Fixed	DS01 (ML) Lens/cataract procedures	DS02 (OLS) Excision of meniscus	Random	DS01 (ML) Lens/cataract procedures	DS02 (OLS) Excision of meniscus
Constant	7.09*** (.10)	7.25*** (.06)	Country effect	.02 (.02)	<i>Not significant</i>
Teaching	.06** (.03)	-.06** (.03)	Hospital effect	.02 (1.4)	–
Ownership			Residual	.00 (1.4)	–
For-profit	-.03 (.03)	-.07** (.03)	LR test χ^2	88.59 (.000)	–
Not-for-profit	-.23*** (.03)	-.53*** (.02)	N of Countries	3	3
Capacity use	No	No	N of Hospitals	225	232
Orthopaedic	–	.03 (.06)	N	225	232

* indicates significance at the 10% level, ** at the 5% level, *** at the 1% level. Standard errors are reported in brackets. In some instances, standard error estimation failed during the ML simulation.

45. We observe significant variations across the estimated coefficients, underlining the importance of analysing hospital efficiency at condition/treatment level. Hospitals with a number of beds ranging between 200-600 and a not-for-profit status show lower costs for several conditions. Sub-condition coefficients such as age class for AMI are also highly significant; with the sub-condition parameter for hip replacement (bilateral) showing, as expected, doubled costs. Capacity use, defined as the interaction between beds and occupancy rates, was included as a control variable in all regressions except for CABG, where it was excluded because of multicollinearity. Its coefficients are not reported, although jointly significant in most regressions, indicating that excluding the interacted variable might lead to endogeneity issues between beds and occupancy in regressions.

46. With the exception of abnormal coefficients for AMI with PTCA - a very large, unexplained residual component which hints at the fact that there might be important omitted variable bias for this particular sub-condition -, the random component estimates mirror almost exactly those for the length of stay analysis, making the results more robust.

4.4 Intra-class correlation

47. Table 4 shows the intra-class coefficients for country level, hospital level and general residual by condition for costs (Panel A) and length of stay (Panel B). The condition DS02 is excluded from the multilevel regression because of estimation issues (only estimated through OLS).

Table 4 Intra-class coefficients by condition

Panel A. Cost

<i>Intra-class coefficient (%)</i>	IN01 AMI w PTCA	IN02 CABG	IN03 Acute stroke	IN04 Hip replacement	IN05 Hysterectomy w dx of cancer	IN06 Caesarian section	IN07 Normal delivery	DS01 Lens/ cataract procedures
Country	14	13	60	17	74	67	94	48
Hospital	42	85	34	4	20	28	5	44
Residual	42	1	5	78	4	4	1	8

Panel B. Length of stay

<i>Intra-class coefficient (%)</i>	IN01 AMI w PTCA	IN02 CABG	IN03 Acute stroke	IN04 Hip replacement	IN05 Hysterectomy w dx of cancer	IN06 Caesarian section	IN07 Normal delivery	DS01 Lens/ cataract procedures
Country	28	6	60	37	80	85	96	—
Hospital	33	83	34	1	17	12	3	—
Residual	39	11	6	62	3	3	1	—

48. The intra-class correlation coefficients indicate that a large part of the variation in performance as measured by cost (Panel A) is attributable to hospitals for AMI with PTCA (IN01) and CABG (IN02), and to country for hysterectomy (IN05), caesarean section (IN06) and normal delivery (IN07). The high share of the residual variation for hip replacement (IN04) is accounted for by the very little variation of costs at hospital level and large variation of costs at country level. Results are consistent if length of stay is used as a measure of performance, except for AMI with PTCA where additional covariates not comprised in this study may help explaining variation in length of stay at country and hospital level.

5. DISCUSSION

49. Results from the fixed component regressions on cost and LOS show highly significant coefficients across hospital characteristics, with signs and sizes broadly consistent with literature and intuition. Under the assumption that severity of cases and quality of care are comparable across hospitals for the conditions/treatments in study, we find that public hospitals are generally more costly at providing care than for-profit ones for all conditions/treatments in study, and significantly more costly than not-for-profit ones for all conditions/treatment in study except CABG. More work is nevertheless needed to understand how much of this variation is explained by differences in case complexity and quality, as opposed to technical efficiency in delivering care.

50. Results also show significant coefficients for costs for teaching hospitals, although with contrasting signs depending on the specific condition. Similar differences appear in length of stay analysis, with significantly shorter stays for CABG, but longer stays for caesarean sections. These results point to the need to explore further the way countries identify a hospital as a teaching facility.

51. A medium number of beds (between 200 and 600) is consistently associated with lower cost per case, except for PTCA. Results concerning length of stay show consistently higher coefficients for a number of beds higher than 200 for all conditions/treatments in study.

52. A bed occupancy rate of 70% or more is associated with lower costs for all conditions except hysterectomy, and with lower length of stay.

53. The intra-class correlation coefficients calculated from the random effects variances shows that for AMI with PTCA and hip replacement, most of the variation in costs and length of stay is unaccounted for by either country or hospital level. This suggests that there might be a high degree of endogeneity within the regression, because of functional form misspecification or, more likely, because of omitted variable biases. For CABG, the largest hospital level intra-class coefficient for costs and length of stay is reported, meaning that most of the variation is picked up by the fixed effect component of the model. For the remaining conditions, large country level coefficients are observed. This is likely due to the low number of countries in the regression, which prevented the introduction of country level variables such as the level of negotiation for providers, therefore large cost differences are unaccounted for in the fixed component of the model (since they are just broadly excluded by the random effects country level).

54. Notwithstanding hospitals being the data collection unit for this pilot analysis, we are effectively looking at the technical efficiency of provision (and performance) of particular types of hospital services (conditions or treatments). Future work will need to look more specifically at hospitals in the broader context of health care systems. While we use of the payment system as a country-level covariate in our regressions, there is space for additional variables that take into account other factors, such as the organisation of primary care or the broader market structure related to the health system, which are not measured in our study. The use of hospital Purchasing Power Parities as a conversion factor for costs allows us to take partly into account the market context, in terms of labour and material cost differences across countries (market baskets). However, a better measure in the form of a control variable could be explored.

55. An important limitation of the analysis is that it does not consider differences in outcomes - that is, it assumes that the conditions being compared across countries result in the same health outcomes in terms of quality. Future methodological work will explore how to link resource-based indicators to quality indicators at hospital level.

56. Another limitation of this analysis is that it assumes consistency in the way cost by condition/treatment is estimated across countries, but countries do differ in this regard. Empirically, however, there is some evidence that different accounting approaches do lead to similar results, especially at higher levels of aggregation (Chapko *et al.*, 2009; Tan *et al.*, 2009).

6. CONCLUSIONS

57. The results of this pilot data collection confirm the feasibility of collecting length of stay and cost data by condition/treatment at hospital level. Preliminary findings also confirm the importance of measuring and understanding variations in hospital length of stay and cost in the context of international comparative work assessing the technical efficiency of hospitals in providing specific types of care.

58. Results from this pilot work shed some light on the importance of hospital payment systems for fostering efficiency in care delivery for standard/high volume treatments such as normal delivery, whereas hospital management and organisation seem to have an effect on efficiency for more complex/technology driven treatments such as bypass surgery.

59. Care needs to be taken in the interpretation of our findings, as the results presented here are preliminary and based on a relatively small sample. The extension of this type of analysis to other countries will allow drawing more robust inferences on country and hospital characteristics that could explain variations in length of stay and costs observed across hospitals for selected conditions/treatments, and getting more robust estimates of the change in hospital length of stay and cost associated with these factors. Further robustness checks will be conducted to provide greater confidence in the initial results reported in this paper.

60. Linking length of stay, costs and quality measures to each condition/treatment at organisational level will then pave the way for analysis of cost-effectiveness of hospitals activity.

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ANNEX 1

Treatment/Condition Definitions: Diagnoses, Icd-10; Procedures: Icd-9-Cm*IN.01: Acute Myocardial Infarction with Percutaneous transluminal coronary angioplasty*

<i>Case type description</i>	This case type relates to a percutaneous transluminal coronary angioplasty (PTCA) following an acute myocardial infarction. PTCA is a procedure in which a small balloon at the tip of the catheter is inserted near the blocked or narrowed area of the coronary artery. When the balloon is inflated, the plaque or blockage is compressed against the artery walls and the diameter of the blood vessel is widened (dilated) to increase blood flow to the heart.
<i>ICD-9-CM codes (Procedure)</i>	00.66, Percutaneous transluminal coronary angioplasty [PTCA]
<i>Rules</i>	<u>Principal diagnosis</u> of Acute Myocardial Infarction: I21.0, Acute transmural myocardial infarction of anterior wall I21.1, Acute transmural myocardial infarction of inferior wall I21.2, Acute transmural myocardial infarction of other sites I21.3, Acute transmural myocardial infarction of unspecified site I21.4, Acute subendocardial myocardial infarction I21.9, Acute myocardial infarction, unspecified I22.0, Subsequent myocardial infarction of anterior wall I22.1, Subsequent myocardial infarction of inferior wall I22.8, Subsequent myocardial infarction of other sites I22.9, Subsequent myocardial infarction of unspecified site
<i>Inclusion (the reporting of these codes is allowed)</i>	Invasive treatments: 36.04, Intracoronary artery thrombolytic infusion 36.06, Insertion of drug-eluting coronary artery stents 36.07, Insertion of non-drug-eluting coronary artery stents 37.21, Right heart catheterization 37.22, Left heart catheterization 37.23, Combined heart catheterization 37.26, Catheter based invasive electrophysiologic testing 37.61, Implant of pulsation balloon 88.52, Angiocardiology of right heart structures 88.53, Angiocardiology of left heart structures 88.54, Combined right and left heart angiocardiology 88.55, Coronary arteriography using a single catheter 88.56, Coronary arteriography using two catheters 88.57, Other and unspecified coronary arteriography 88.58, Negative-contrast cardiac roentgenography
<i>Exclusion</i>	36.1_, Bypass anastomosis for heart revascularization

IN.02: Coronary artery bypass graft

<i>Case type description</i>	A surgical procedure used to divert blood around narrow or clogged arteries (blood vessels). This improves blood flow and oxygen supply to the heart. CABG involves taking a blood vessel from another part of the body, usually the chest or leg, to use as a graft. The grafts replace any hardened or narrowed arteries in the heart.
<i>ICD-9-CM (Procedure) codes</i>	36.10, Aortocoronary bypass for heart revascularization, not otherwise specified 36.11, (Aorto)coronary bypass of one coronary artery 36.12, (Aorto)coronary bypass of two coronary arteries 36.13, (Aorto)coronary bypass of three coronary arteries 36.14, (Aorto)coronary bypass of four or more coronary arteries 36.15, Single internal mammary-coronary artery bypass 36.16, Double internal mammary-coronary artery bypass 36.17, Abdominal - coronary artery bypass 36.19, Other bypass anastomosis for heart revascularization
<i>Rules</i>	Any principal diagnosis code
<i>Inclusion</i>	
<i>Exclusion</i>	

IN.03: Acute stroke

<i>Case type description</i>	This case type includes intracerebral hemorrhage, subarachnoid hemorrhage and acute ischemic stroke cases. It excludes transient cerebral ischemia cases and acute but ill-defined cerebrovascular diseases
<i>Principal diagnosis: ICD-10 codes</i>	I60._, Nontraumatic subarachnoid hemorrhage I61._, Nontraumatic intracerebral hemorrhage I62._, Nontraumatic subdural hemorrhage I63._, Cerebral infarction I64._, Acute stroke, not specified
<i>Rules</i>	No operating room procedure is performed ¹²
<i>Inclusion (the reporting of these codes is allowed)</i>	Invasive treatment: 00.63, Percutaneous insertion of carotid artery stent(s)
<i>Exclusion</i>	G45._, transient cerebral ischemic attacks and related syndromes

¹² As a proxy, cases which fall into a DRG which is unusual for the case type being considered should be excluded as this would indicate the presence of a significant unrelated procedure having taken place.

IN.04: Hip replacement: total and partial

<i>Case type description</i>	Hip replacement surgery provides a long term solution for worn or damaged hip joints which can cause severe pain and loss of mobility. The operation replaces both the natural socket (the acetabulum) and the rounded natural ball at the head of the thigh-bone (femur) with artificial parts (prosthetics). This item includes revision and partial replacement.
<i>ICD-9-CM (Procedure) codes</i>	00.70, Revision of hip replacement, both acetabular and femoral components 00.71, Revision of hip replacement, acetabular component 00.72, Revision of hip replacement, femoral component 00.73, Revision of hip replacement, acetabular liner and/or femoral head only 81.51, Total hip replacement 81.52, Partial hip replacement 81.53, Revision of hip replacement, not otherwise specified
<i>Rules</i>	Any principal diagnosis code
<i>Inclusion</i>	Revision of hip replacement
<i>Exclusion</i>	Bilateral hip replacement

IN.05: Hysterectomy: abdominal and vaginal with diagnosis of female genital cancer

<i>Case type description</i>	A procedure where the womb (uterus) or a part of the womb is surgically removed. Hysterectomies are performed to treat conditions that affect the female reproductive system, such as a malignant neoplasm of vagina
<i>ICD-9-CM codes (Procedure)</i>	68.31, Laparoscopic supracervical hysterectomy [LSH] 68.39, Other and unspecified subtotal abdominal hysterectomy 68.41, Laparoscopic total abdominal hysterectomy 68.49, Other and unspecified total abdominal hysterectomy 68.51, Laparoscopically assisted vaginal hysterectomy (LAVH) 68.59, Other and unspecified vaginal hysterectomy 68.61, Laparoscopic radical abdominal hysterectomy 68.69, Other and unspecified radical abdominal hysterectomy 68.71, Laparoscopic radical vaginal hysterectomy [LRVH] 68.79, Other and unspecified radical vaginal hysterectomy 68.9, Other and unspecified hysterectomy
<i>Rules</i>	<u>Principal diagnosis of cancer:</u> C53.0, Malignant neoplasm of endocervix C53.1, Malignant neoplasm of exocervix C53.8, Malignant neoplasm of overlapping sites of cervix uteri C53.9, Malignant neoplasm of cervix uteri, unspecified C54.0, Malignant neoplasm of isthmus uteri C54.1, Malignant neoplasm of endometrium C54.2, Malignant neoplasm of myometrium C54.3, Malignant neoplasm of fundus uteri C54.8, Malignant neoplasm of overlapping sites of corpus uteri C54.9, Malignant neoplasm of corpus uteri, unspecified C55., Malignant neoplasm of uterus, part unspecified C56, Malignant neoplasm of ovary C57.0, Malignant neoplasm of fallopian tube C57.1, Malignant neoplasm of broad ligament C57.2, Malignant neoplasm of round ligament C57.3, Malignant neoplasm of parametrium C57.4, Malignant neoplasm of uterine adnexa, unspecified C57.7, Malignant neoplasm of other specified female genital organs C57.8, Malignant neoplasm of overlapping sites of female genital organs C57.9, Malignant neoplasm of female genital organ, unspecified D39.0, Neoplasm of uncertain behavior of uterus D39.1, Neoplasm of uncertain behavior of ovary D39.9, Neoplasm of uncertain behavior of female genital organ, unspecified
<i>Inclusion</i>	
<i>Exclusion</i>	

IN.06: Caesarean section

<i>Case type description</i>	Procedure where a baby is delivered by cutting through the front wall of the abdomen to open the womb. It can be performed as a planned procedure, where the medical need for the operation becomes apparent during pregnancy; an emergency procedure, where a situation arises during labour that calls for urgent delivery of the baby; or an elective procedure, on the basis of personal choice rather than as a result of medical risk
<i>ICD-9-CM codes (Procedure)</i>	74.0, Classical cesarean section 74.1, Low cervical cesarean section 74.2, Extraperitoneal cesarean section 74.4, Cesarean section of other specified type 74.99, Other cesarean section of unspecified type
<i>Rules</i>	Any principal diagnosis code
<i>Inclusion</i>	
<i>Exclusion</i>	

IN.07: Normal delivery

<i>Case type description</i>	Delivery requiring minimal or no assistance, with or without episiotomy, without fetal manipulation [e.g., rotation version] or instrumentation [forceps] of a spontaneous, cephalic, vaginal, full-term, single, live-born infant
<i>Principal diagnosis : ICD-10 codes</i>	O80.0, Spontaneous vertex delivery O80.1, Spontaneous breech delivery O80.8, Other single spontaneous delivery O80.9, Single spontaneous delivery, unspecified
<i>Rules</i>	No operating room procedure is performed ¹³
<i>Inclusion</i>	
<i>Exclusion</i>	

¹³ As a proxy, cases which fall into a DRG which is unusual for the case type being considered should be excluded as this would indicate the presence of a significant unrelated procedure having taken place.

DS.01: Lens and cataract procedures

<i>Case type description</i>	Extracapsular cataract extraction is a category of eye surgery in which the lens of the eye is removed while the elastic capsule that covers the lens is left partially intact to allow implantation of an intraocular lens. This approach is contrasted with intracapsular cataract extraction, an older procedure in which the surgeon removed the complete lens within its capsule and left the eye aphakic (without a lens)
<i>ICD-9-CM codes</i>	13.11, Intracapsular extraction of lens by temporal inferior route 13.19, Other intracapsular extraction of lens 13.2, Extracapsular extraction of lens by linear extraction technique 13.3, Extracapsular extraction of lens by simple aspiration (and irrigation) technique 13.41, Phacoemulsification and aspiration of cataract 13.42, Mechanical phacofragmentation and aspiration of cataract by posterior route 13.43, Mechanical phacofragmentation and other aspiration of cataract 13.51, Extracapsular extraction of lens by temporal inferior route 13.59, Other extracapsular extraction of lens 13.64, Discission of secondary membrane [after cataract] 13.65, Excision of secondary membrane [after cataract] Capsulectomy 13.66, Mechanical fragmentation of secondary membrane [after cataract] 13.69, Other cataract extraction 13.70, Insertion of pseudophakos, not otherwise specified 13.71, Insertion of intraocular lens prosthesis at time of cataract extraction, one-stage 13.72, Secondary insertion of intraocular lens prosthesis 13.8, Removal of implanted lens 13.90, Operation on lens, not elsewhere classified 13.91, Implantation of intraocular telescope prosthesis
<i>Rules</i>	Any principal diagnosis code
<i>Inclusion</i>	
<i>Exclusion</i>	

DS.02: Arthroscopic excision of meniscus of knee

<i>Case type description</i>	Knee arthroscopic surgery is a procedure performed through small incisions in the skin to repair injuries to tissues such as ligaments, cartilage, or bone within the knee joint area. The surgery is conducted with the aid of an arthroscope, a very small instrument guided by a lighted scope attached to a television monitor. Arthroscopic surgeries range from minor procedures such as flushing or smoothing out bone surfaces or tissue fragments (lavage and debridement) associated with osteoarthritis, to the realignment of a dislocated knee and ligament grafting surgeries
<i>ICD-9-CM codes</i>	80.26, Arthroscopy, knee + 80.6, Excision of semilunar cartilage of knee
<i>Rules</i>	Any principal diagnosis code. The two codes should be reported at the same time for the same case
<i>Inclusion</i>	
<i>Exclusion</i>	

ANNEX 2

Cost Items Included in the Hospital Costs

<i>Resource Macro Category</i>	<i>Resource Micro Category</i>		<i>Cost classification: Direct, Indirect, Overhead</i>	<i>Allocation/ apportionment statistic to direct cost centres/ cases</i>
Medical infrastructure	Laundry	Pay ¹		
		Non-pay		
	Sterilization	Pay		
		Non-pay		
	Patient Transports (within the hospital)	Pay		
		Non-pay		
	Food Service (to patients)	Pay		
		Non-pay		
	Other (includes patient transports outside the hospital, staff transports, and transportation of samples/blood)	Pay		
		Non-pay		
Non-medical infrastructure	Cleaning	Pay		
		Non-pay		
	Security	Pay		
		Non-pay		
	Gardening	Pay		
		Non-pay		
	Desk officers	Pay		
		Non-pay		
	Printing and stationery	Pay		
		Non-pay		
	Legal office	Pay		
		Non-pay		
	Professional services	Pay		
		Non-pay		
	IT/IS services	Pay		
		Non-pay		

	Building maintenance	Pay		
		Non-pay		
	Pieces of equipment maintenance	Pay		
		Non-pay		
	Telephone			
	Rent			
	Taxes			
	Energy			
	Water			
	Waste disposal			
Direct cost – compensation of employees	Administrative staff			
	Paramedical staff			
	Nursing staff			
	Medical staff			
Direct cost – goods and services	Medical and surgical pieces of equipment ² and supplies			
	Laboratory pieces of equipment and supplies			
	X-ray pieces of equipment and supplies			
	Drugs			
	Medical gases			
	Blood products			
	Dressings			
	Prosthesis			

¹ staff salaries

² include small tools, that is goods that may be used repeatedly, or continuously, in production over many years but may nevertheless be small, inexpensive and used to perform relatively simple operations.

ANNEX 3

Log-Adjusted Average Length of Stay Distribution by Condition/Treatment

Log-PPP adjusted average costs by condition/treatment

ANNEX 4

Distribution of Length of Stay and Cost by Condition/Treatment by Covariate

The table below shows the cost and length of stay distributions across all inpatient conditions/treatments for the covariates used in the fixed effects analysis. Cost is the main number reported in the cells, with LOS reported in brackets. The data is not reported according to a country subdivision because of the low number of observations. Costs are reported in their PPP-converted values, LOS is reported as average length of stay in number of days.

<i>Condition - Inpatient</i>	<i>Dummy category</i>	<i>Teaching status*</i>	<i>Number of beds</i>	<i>Occupancy rates</i>	<i>Ownership*</i>	<i>Sub-condition**</i>
AMI with PTCA (IN01)	Low (0)	6566 (6.2)	6902 (3.8)	—	8201 (5.6)	7940 (4.4)
	Mid (1)	8129 (5.4)	7748 (5.1)	7890 (6.2)	6887 (4.9)	7818 (5.0)
	High (2)	—	8121 (5.8)	8010 (5.0)	6096 (7.6)	8077 (6.8)
CABG (IN02)	Low (0)	16647 (13.3)	19336 (13.5)	—	16666 (14.1)	—
	Mid (1)	16636 (14.4)	14209 (12.0)	16573 (14.3)	17104 (15.0)	—
	High (2)	—	17161 (14.8)	16716 (14.2)	15234 (13.0)	—
Acute stroke (IN03)	Low (0)	6492 (12.3)	6534 (12.2)	4528 (9.0)	5713 (11.2)	—
	Mid (1)	5559 (10.3)	5529 (10.6)	6137 (10.8)	6883 (12.0)	—
	High (2)	—	6291 (11.6)	5893 (12.3)	6365 (9.8)	—
Hip replacement (IN04)	Low (0)	7707 (10.6)	7494 (9.9)	6972 (9.8)	8753 (11.5)	8048 (11.2)
	Mid (1)	9238 (12.7)	8162 (11.8)	7945 (10.7)	8824 (13.3)	18064 (11.2)
	High (2)	--	8839 (12.0)	4248 (10.3)	6584 (9.6)	—
Hysterectomy (IN05)	Low (0)	5610 (6.2)	4692 (4.9)	4256 (6.1)	5829 (6.7)	—
	Mid (1)	5644 (7.0)	5592 (7.1)	6253 (7.0)	6401 (6.6)	—
	High (2)	—	6157 (7.2)	4925 (6.2)	3639 (6.1)	—

Caesarean section (IN06)	Low (0)	3918 (5.5)	3602 (4.9)	3813 (5.5)	3669 (5.7)	—
	Mid (1)	3263 (6.2)	3588 (5.9)	3851 (6.2)	3396 (6.0)	—
	High (2)	—	3686 (6.7)	3042 (5.2)	3599 (6.3)	—
Normal delivery (IN07)	Low (0)	2151 (3.5)	2107 (3.0)	2268 (3.8)	2134 (3.2)	—
	Mid (1)	2148 (3.2)	2182 (3.5)	2154 (3.7)	2206 (3.4)	—
	High (2)	—	2156 (3.5)	2085 (2.5)	2190 (4.2)	—

*Teaching status uses Dummy category Mid for teaching hospitals, Low otherwise.

**Sub-condition reports age groups (Dummy category High for 65 and older) for IN01 and unilateral or bilateral surgery for IN04 (Dummy category Mid for bilateral).

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