ECHO

EUROPEAN COLLABORATION FOR HEALTHCARE OPTIMIZATION

ECHO INFORMATION SYSTEM

Quality Report

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on behalf of the ECHO consortium

Handbook on methodology: ECHO information system quality report
EUROPEAN COLLABORATION FOR HEALTHCARE OPTIMIZATION (ECHO)

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I. ECHO

The European Collaboration for Health Optimization (ECHO) is an international effort to gather healthcare information from several European countries within a single data warehouse (DWH), specifically patient-level data from hospital admissions, demographic and socio-economic information at the geographic level, and supply information at both hospital and geographic levels. The countries participating in the project are Austria[1], Denmark, England, Portugal, Slovenia and Spain.

The goal of ECHO is to describe and analyse healthcare performance in terms of the utilization of effective (or lower-value) procedures, equity of access to effective care, and quality and efficiency (as determined by opportunity costs and technical efficiency). Unlike traditional international healthcare performance assessment, ECHO identifies unwarranted differences in performance within and across countries at different levels of analysis; hospital, healthcare area and region.

II. WHY THIS REPORT?

ECHO, like its scientific predecessors the Dartmouth Atlas of Healthcare (www.dartmouthatlas.org) and the Atlas of Variations in Medical Practice of the Spanish National Health Service (www.atlasvpm.org), is built using routinely collected clinical and administrative data, but in this case using information derived from six different countries.

As a consequence, ECHO has devoted specific efforts to building a single homogeneous and sound information system, assuring the robustness of the raw data used to generate the ECHO performance indicators, and reducing the risks of systematic information biases.

In achieving this goal, ECHO has faced several critical challenges, such as developing a logic model of data that allows the production of comparable

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[1] At the time this report was written, Austrian data were being updated. A new version of this report will contain the quality analysis for those data.

performance indicators from raw information; transforming reliable raw data formats and categories into a common standard; allocating admissions to geographic units and hospital-providers; identifying hospitals' merging processes; linking the different files the comprise the DWH; building crosswalks across different classification systems; and linking this information with hospital discharges.

III. WHAT IS THIS REPORT ABOUT?

Whether ECHO´s findings on healthcare performance can impact decision making will depend on its ability to rule out data issues as alternative explanations for the reported differences in performance.

This report thus provides a systematic and detailed description of all the steps involved in the construction of the DWH, as well as issues that could potentially jeopardize the reliability of the ECHO outputs.

The report also compiles a list of recommendations for optimal use of the information stored in the DWH, highlighting specific issues that should be taken into account to ensure proper interpretation of ECHO performance indicators.

The scope of this report is limited to the assessment of the data structure and the outputs generated by the data. Original datasets, as released by health or data authorities, are not discussed.

IV. QUALITY DIMENSIONS

Although many frameworks have been proposed to achieve the aforementioned objectives, the ECHO quality assessment report has been inspired by some of the dimensions of the Quality Assessment Framework (QAF) proposed in the *Handbook on Data Quality Assessment Methods and Tools*[2]*;* in particular, the verification of original sources of information through data profiling; the identification of critical product characteristics through user requirements; the description of the DWH design, the validation rules and their implementation; the

[2] *Bergdahl M., Ehling M., Elvers E., Földesi E., Körner T., Kron A., et al. (2007). Handbook on Data Quality Assessment Methods and Tools. Wiesbaden: European Comission.*

classification of internal files in terms of their impact; and the definition of a set of quality indicators. The quality dimensions analysed in this report are described in Table 1.

Table 1. Quality assessment components in this report

Quality component	Definition	Indicators
Coherence	Are data reliably linked across the elements in the DWH, regardless of their use?	• Validation rules to be fulfilled: ○ Identity rules ○ Referential integrity of ECHO-DWH ○ Cardinality of ECHO-DWH ○ Preservation of the inheritance rules
Coverage	Measures the extent to which the sample stored in the DWH describes actual performance. Also represents a measure of the potential relevance of the data stored.	• Number of individual episodes registered • Hospital stay (days) covered by ECHO-DWH • Percentage of total episodes by country • Percentage of total hospital stays by country
Relevance	In terms of the number of performance dimensions and indicators covered by ECHO	• Utilization • Equity • Quality & Safety • Efficiency
Internal reliability	A measure of whether the information stored in the DWH is consistent over the years within each country. Forms the basis of accurate estimates.	• Population by country and year • Male percentage of population by age group, country and year • Female percentage of population by age group, country and year • Population assisted (episodes) by age group, day-case surgery, country and year • Male population assisted (episodes) by age group, day-case surgery, country and year • Female population assisted (episodes) by age group, day-case surgery, country and year • Episode rate per day-case surgery by country and year / 10000 inhabitants • Episode rate per type of admission by day-case surgery, country and year / 10000 inhabitants • Episode rate per type of discharge by day-case surgery, country and year / 10000 inhabitants

Accuracy	Denotes how close to facts estimations are expected to be. Allows estimation of potential classification biases.	• Percentage of missing values (null) in main ECHO_CORE variables (5) by country and year • Percentage of episodes without any diagnoses or procedures by country and year • Episodes not allocated to MARE or Hospital • Consistency of risk adjusters over time • Indicators of in-country stability over time (**ANNEX E)**

V. ORIGINAL INFORMATION SOURCES

ECHO is built upon routinely collected administrative data on hospital admissions, demographic and socioeconomic characteristics of the population, hospital supply and geographic information.

Before any original dataset was released, the ECHO team designed an information structure containing the basic data from each hospital episode required to generate the ECHO performance indicators.[3] Table 2 shows the *minimum information requirements,* a set of variables that comprised the ECHO _Core Table and was used to integrate the original hospital administrative datasets into a single coherent relational database.

Some of these variables are patient attributes (*e.g.,* age, sex, diagnoses and procedures), others are episode attributes (*e.g.,* type of discharge or hospital of treatment), and others permit patient geo-allocation (mare_id). A KEY variable (ECHO_key) is also created automatically; this is a univocal numeric variable for each episode that allows coherent episode traceability and linkage across the different datasets and catalogues that comprise the ECHO-DWH. Finally, two other variables, mare_id and hospital_hist_id, allow linkage with additional datasets containing demographic, socioeconomic and supply information (Table 3), thus allowing the allocation of this information at different geographic levels (Figure 1).

Tables 4a-e enumerate and describe the original sources from which the ECHO team extracted raw data, which was transformed and eventually uploaded to the ECHO data infrastructure (ECHO-DWH). Each source is described in terms of

[3] ECHO performance indicators were based upon ARQH quality indicators (*http://*www.**qualityindicators.ahrq**.gov), the Health care quality indicators project by the OECD (http://www.oecd.org/els/health-systems/healthcarequalityindicators.htm), and the indicators of the Atlas VPM project (www.atlasvpm.org).

information type, source, collection methodology, date and periodicity, coverage, compatibility with ECHO-DWH, and the need for sampling or estimation.

Table 2. Variables listed in the 'ECHO_CORE' table.

ECHO Name	Description	Definition	Values
echo_key	ECHO key	Primary key for 'ECHO_CORE'; 'ECHO_DIAGNOSIS'; 'ECHO_PROCEDURES'; 'ECHO_INDICATOR_POPULATION'; 'ECHO_INDICATOR_HOSPITALS'; 'ECHO_INDICATOR_CABG_ELIX' and 'ECHO_DRG'	CYYEEEEEEEE sequential non-recurring number automatically created by each episode (transversal to all ECHO-DWH) Discharges Key (consisting of Country, Year and a sequential ECHO identifier)
country_code	Country identification	foreign key for 'CATALOG_COUNTRY'	1, …,6
year	Year identification	foreign key for 'CATALOG_YEAR'	2, …,9
mare_id	Meaningful area level (mare) identification	foreign key for 'ECHO_MARE'; 'ECHO_MARE_POPULATION'; 'ECHO_MARE_SOCIOECONOMIC' and 'ECHO_MARE_EESRI'	CYYMMM sequential non-recurring number created by mare Patient geographic location Key (consisting of Country, Year and a sequential Mare identifier)
hosp_hist_id	Historic hospital identification	foreign key for 'ECHO_HOSP_HIST' and 'ECHO_HOSP_HIST_EESRI'	CYYHHH sequential non-recurring number created by historic hospital Historical hospital Key (consisting of Country, Year and a sequential Hospital identifier)
sex	Sex	patient's gender; foreign key for 'CATALOG_SEX'	1, …,3; 9; null
age	Age	patient's age	numeric values
gqe	Age group	foreign key for 'CATALOG_GQE'	1, …,18; null
adate	Admission date	patient's admission date	date YYYY-MM-DD
intdate	Intervention date	patient's main intervention date	date YYYY-MM-DD
disdate	Discharge date	patient's discharge date	date YYYY-MM-DD
mfund	Modality of funding	whether the stay/procedure was publicly or privately funded (regardless of the hospital´s status) foreign key for 'CATALOG_MFUND'	1, …,5; 9; null
zip	Postal code	Original postal code (ZIP) declared by each country	string value
dcc	Day-case care	day-case surgery foreign key for 'CATALOG_DCC'	0, …,3; null
tadm	Type of admission	foreign key for 'CATALOG_TADM'	1, …,5; 9; null
los	Length of stay	hospitalization stay (days)	0, …,999; null
readm	Readmission	readmission (only declared by 2 countries)	string value
tdis	Type of discharge	foreign key for 'CATALOG_TDIS'	1, …,16, null
rec	Original admission identifier	Original admission identifier declared by each country	string value
diag1	Principal diagnosis	foreign key for 'CATALOG_DIAG'	sequential non-recurring number created by specific diagnosis code over the 2 diagnosis classification systems
diag2 to 54	Secondary diagnosis	foreign key for 'CATALOG_DIAG'	sequential non-recurring number created by specific diagnosis code over the 2 diagnosis classification systems
proc1	Primary procedure	foreign key for 'CATALOG_PROC'	sequential non-recurring number created by

			specific procedure code over the 5 procedure classification systems
proc2 to 54	Secondary procedures	foreign key for 'CATALOG_PROC'	sequential non-recurring number created by specific procedure code over the 5 procedure classification systems

Table 3a – Demographic-socioeconomic information

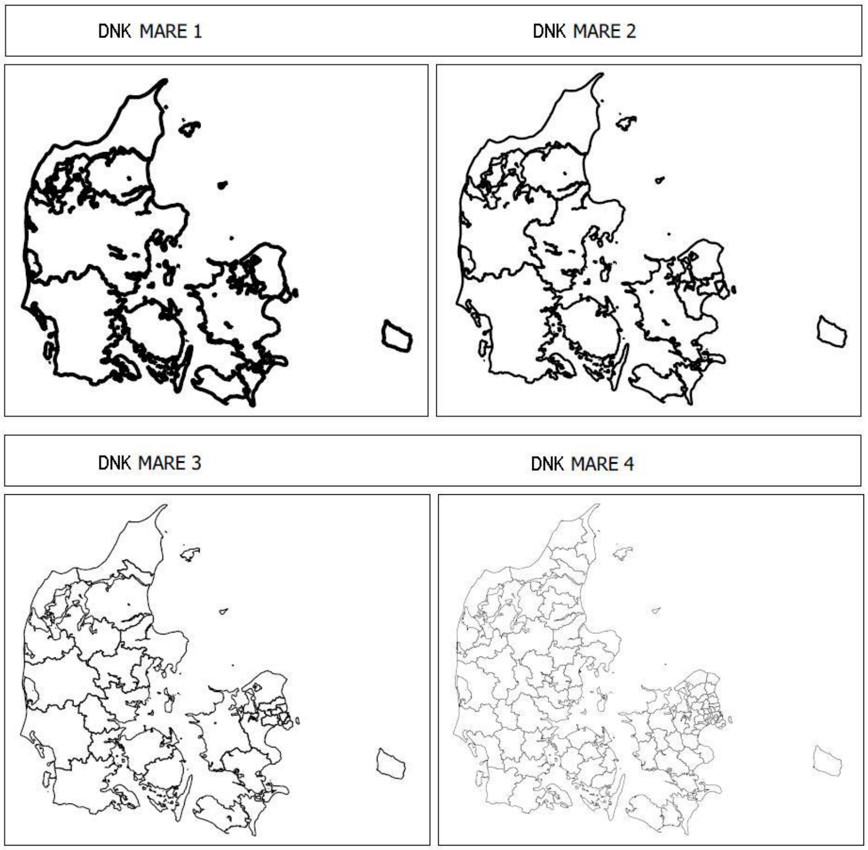
ECHO Name	Definition
mare4	Municipality code, or maximum level of territorial detail (political map)
year	Year
population	Population total in mare4 - year
avinc	Annual per capita income
edu_pri	Percentage of the population with primary education or lower
edu_sec	Percentage of the population with secondary education or vocational training (not college)
edu_uni	Percentage of population with university education or higher, degrees, doctorates *etc*.
un	Percentage of the population unemployed
un_m	Percentage of the population unemployed, men
un_w	Percentage of the population unemployed, women
un_0005	Percentage of the population unemployed, under 30
un_0610	Percentage of the population unemployed, aged 30 to 54 inclusive

Table 3b – Supply information

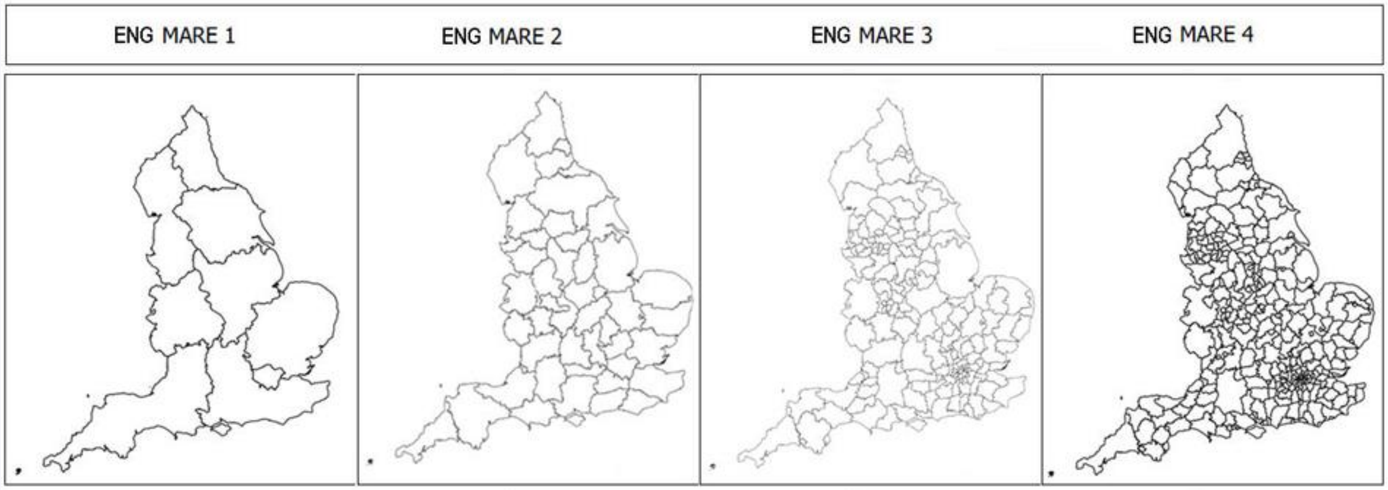
ECHO Name	Definition
hosp_hist	Historical hospital
year	Year of discharge
hosp_terciarity	Tertiary hospital indicator
hosp_univ	University hospital indicator
hosp_priv	Private hospital indicator
hosp_longstaypsy	Longstay or psychiatric hospital indicator
hosp_terminal	Terminal hospital indicator
unit_carthosur	Cardiothoracic surgery unit
unit_hemo	Hemodynamic unit
unit_linac	Linear accelerator unit
unit_mir	MIR, medical residents unit
unit_transplant	Transplant unit

unit_transplant	Transplant unit
bed_go	Total number of gynaecology-obstetrics beds
bed_icu	Total number of ICU beds excluding neonatal ICU beds
bed_nicu	Total number of neonatal ICU beds
bed_ort	Total number of orthopaedic beds
bed_psy	Total number of psychiatric beds
bed_sur	Total number of surgical beds
bed_tot	Total number of beds in the hospitals
discharge_go	Total number of gynaecology-obstetrics discharges
discharge_hemo	Total number of HEMO discharges
discharge_icu	Total number of ICU discharges
discharge_mid	Total number of MID discharges
discharge_ort	Total number of orthopaedics discharges
discharge_sur	Total number of surgical discharges
discharge_tot	Total number of discharges
staff_doc	Number of medical and surgical doctors (irrespective of whether they are employees/independent and the number of hours worked per week)
staff_doc36t	Number of doctors (medical and surgical) working full time in a hospital.
staff_docs	Number of doctors in medical specialities (irrespective of whether they are employees/independent and the number of hours worked per week)
staff_docs36t	Number of doctors in medical specialities working full time in a hospital.
staff_go	Number of gynaecology-obstetrics doctors (irrespective of whether they are employees/independent and the number of hours worked per week)
staff_go36t	Number of gynaecology-obstetrics doctors working full time
staff_mid	Number of MID doctors (irrespective of whether they are employees/independent and the number of hours worked per week)
staff_mid36t	Number of MID doctors working full time
staff_nur	Number of nurses (irrespective of whether they are employees/independent and the number of hours worked per week)
staff_nur36t	Number of nurses working full time
staff_ort	Number of orthopaedic doctors (irrespective of whether they are employees/independent and the number of hours worked per week)
staff_ort36t	Number of orthopaedic doctors working full time
staff_sur	Number of surgeons doctors (irrespective of whether they are employees/independent and the number of hours worked per week)
staff_sur36t	Number of surgeons working full time
staff_tot	Sum of health care professionals (irrespective of whether they work full- or part-time)

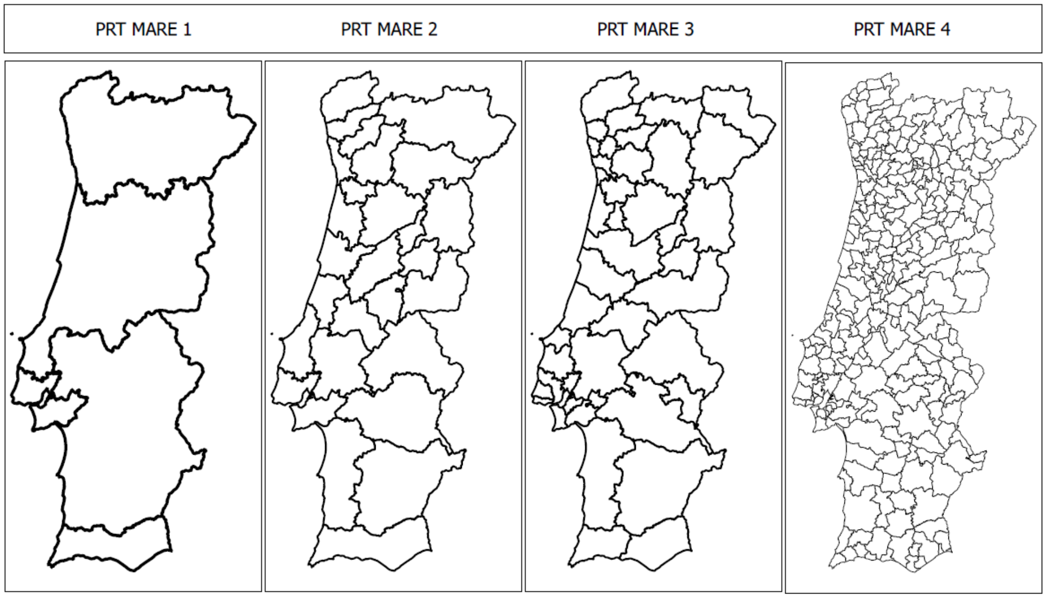
Figure 1. Meaningful areas for healthcare decision-making



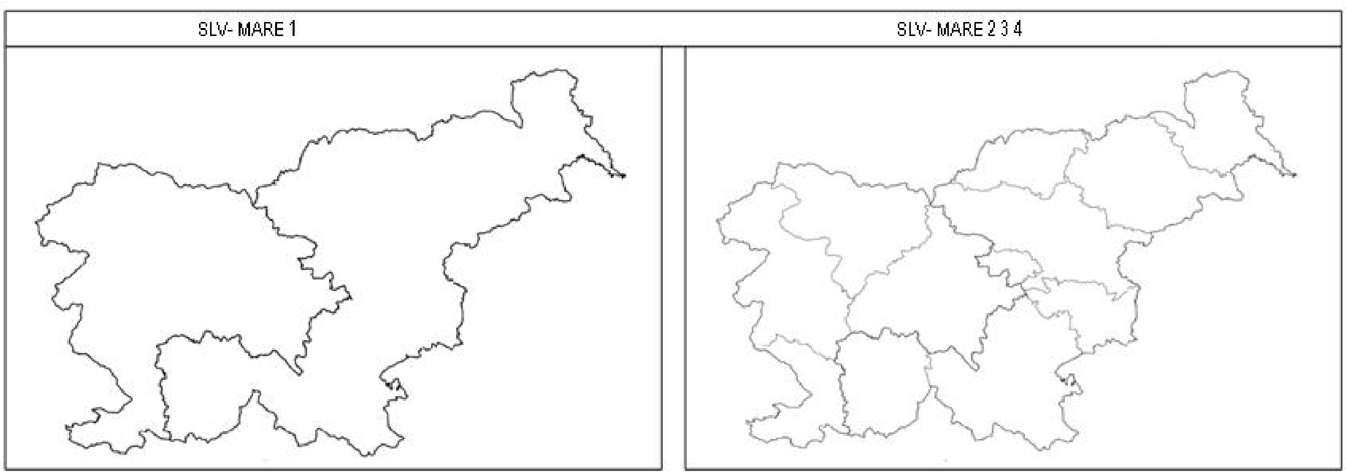
Meaningful area levels (MARE1 to 4) in Denmark.



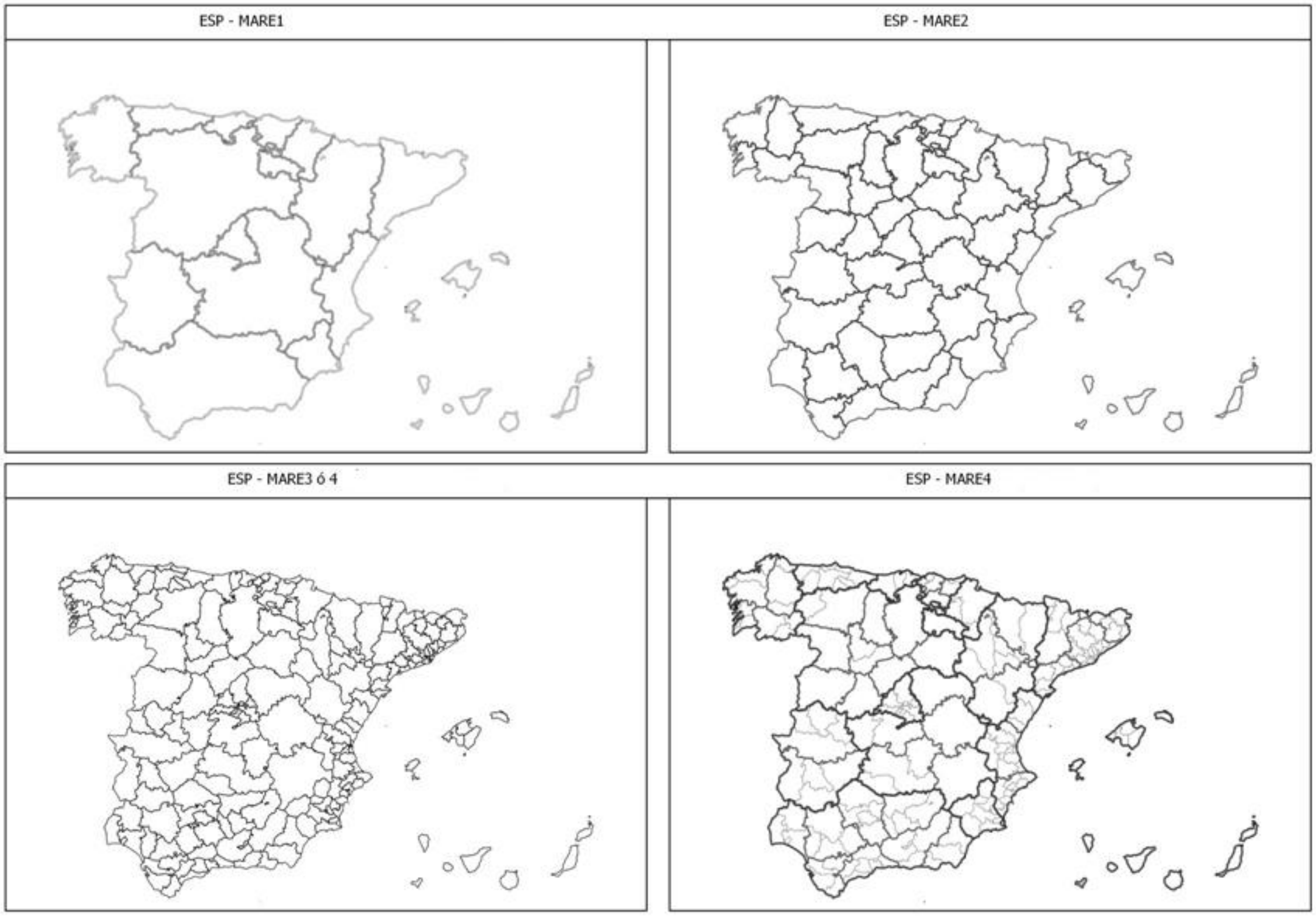
Meaningful area levels (MARE1 to 4) in England.



Meaningful area levels (MARE1 to 4) in Portugal.



Meaningful area levels (MARE1 to 4) in Slovenia.



Meaningful area levels (MARE1 to 4) in Spain.

Table 4a – Original Danish Information Sources

Type of document	Source	Availability	Collection methodology	Date/ Periodicity	Coverage	Compatibility with ECHO	Sampling/ Transformation	Definition/Description
Hospital discharge data	Ministeriet Sunhed Forebyggelse	Restricted access	Declaration of contacts with Health Services registered in a computerized database (all levels of assistance)	2011/ annual since 2002	Full	NO	NO/ contacts must be transformed into episodes without losing any information	Hospital discharge data by year and hospital
Population	Danmarks Statistik	Open access	National census	2011/ annual since 2002	Full	YES	NO/NO	Country population by year, sex and age group
Hospital supply data	Ministeriet Sunhed Forebyggelse	Open access	Hospital declaration through computerized database	2011/2009 referenced	Full	YES	NO/ Hospitals must be traced backwards to note fusions and splits in health assistance organizations	Supply information from hospitals and regions such as tertiary hospital indicator, number of advanced care units, and number and characteristics of staff and healthcare professionals
Socio-economic data	Danmarks Statistik	Open access	Official statistics	2011/ 2009 referenced	Full	YES	NO/NO	Socioeconomic data including annual family income, inequality in locality, local population, educational level, unemployment and registration levels of this information
Diagnoses and procedures classifications	Nordic Medico-Statistical Committee (NOMESCO)	Open access	NO	2011/2010 referenced	Full	Diagnoses: ICD-10 Procedures: NOMESCO	NO/NO	Diagnoses and procedures classification used to code episodes at discharge

Table 4b - Original English Information Sources

Type of document	Source	Availability	Collection methodology	Date/ Periodicity	Coverage	Compatibility with ECHO	Sampling/ Transformation	Definition/Description
Hospital discharge data	National Health Service (NHS) England	Restricted access	Hospital Episode Statistics (HES), centralized declaration through computerized database	2011/ annual since 2002	Full	YES	NO/NO	Hospital discharge data by year and hospital
Population	UK National Statistics	Open access	National Census of England	2011/ annual since 2002	England only (rest of UK excluded)	YES	English population only/NO	Country population by year, sex and age group
Hospital supply data	Department of Health	Restricted access	Hospital declaration through computerized database	2011/ 2009 referenced	Full	YES	NO/ Hospitals must be traced backwards to note fusions and splits in health assistance organizations	Supply information from hospitals and regions such as tertiary hospital indicator, number of advanced care units, and number and characteristics of staff and healthcare professionals
Socio-economic data	UK National Statistics	Open access	Official statistics	2011/2009 referenced	Full	YES	NO/NO	Socioeconomic data including annual family income, inequality in locality, locality population, educational level, unemployment and registration levels of this information
Diagnoses and procedures classification	NHS England	Open access	NO	2011/2010 referenced	Full	Diagnoses: ICD-10 Procedures: OPCS4	NO/NO	Diagnoses and procedures classifications used to code episodes at discharge

Table 4c - Original Portuguese Information Sources

Type of document	Source	Availability	Collection methodology	Date/ Periodicity	Coverage	Compatibility with ECHO	Sampling/ Transformation	Definition/Description
Hospital discharge data	Ministério da Saúde	Restricted access	Centralized hospital declaration through computerized database	2011/ annual since 2002	Full	YES	NO/NO	Hospital discharge data by year and hospital
Population	Instituto Nacional de Estatística (INE)	Open access	National census	2011/ annual since 2002	Full	YES	NO/NO	Country population by year, sex and age group
Hospital supply data	Ministério da Saúde (Serviço Nacional da Saúde)	Restricted access	Hospital declaration through computerized database	2011/ 2009 referenced	Full	YES	NO/Hospitals must be traced backwards to note fusions and splits in health assistance organizations	Supply information from hospitals and regions such as tertiary hospital indicator, number of advanced care units, and number and characteristics of staff and healthcare professionals
Socio-economic data	INE Portugal	Open access	Official statistics	2011/ 2009 referenced	Full	YES	NO/NO	Socioeconomic data including annual family income, inequality in locality, locality population, educational level, unemployment and registration levels of this information
Diagnoses and procedures classifications	Ministério da Saúde (same ICD-9-CM as Spain)	Open access	NO	2011/2010 referenced	2011 reference	Diagnoses: ICD-9-CM Procedures: ICD-9-CM	NO/NO	Diagnoses and procedures classifications used to code episodes at discharge

Table 4d - Original Slovene Information Sources

Type of document	Source	Availability	Collection methodology	Date/ Periodicity	Coverage	Compatibility with ECHO	Sampling/ Transformation	Definition/ Description
Hospital discharge data	Ministrstavo za Zdravje	Restricted access	Centralized hospital declaration through computerized database	2011/ annual since 2002	Full	YES	NO/NO	Hospital discharge data by year and hospital
Population	Statistični Urad Republike Slovenije	Open access	National census	2011/ annual since 2002	Full	YES	NO/NO	Country population by year, sex and age group
Hospital supply data	Ministrstavo za Zdravje	Restricted access	Hospital declaration through computerized database	2011/ 2009 referenced	Full	YES	NO/NO	Supply information from hospitals and regions such as tertiary hospital indicator, number of advanced care units, and number and characteristics of staff and healthcare professionals
Socio-economic data	Statistični Urad Republike Slovenije	Open access	Official statistics	2011/ 2009 referenced	Information limited to MARE1 and MARE2.	YES	NO/NO	Socioeconomic data including annual family income, inequality in locality, locality population, educational level, unemployment and registration levels of this information
Diagnoses and procedures classifications	Ministrstavo za Zdravje / Australian Consortium for Classification Development	Open access	NO	2011/2010 referenced	2010 reference	Diagnoses: ICD-10 Procedures: Australian Classification of Health Interventions (ACHI)	NO/NO	Diagnoses and procedures classifications used to code episodes at discharge

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Table 4e- Original Spanish Information Sources

Type of document	Source	Availability	Collection methodology	Date/ Periodicity	Coverage	Compatibility with ECHO	Sampling/ Transformation	Definition/Description
Hospital discharge data	ATLAS-VPM	Restricted access	Hospital declaration through computerized database, collected by regional health administration of the different Autonomous Communities	2011/ annual since 2002	Full	YES	NO/NO	Hospital discharge data by year and hospital
Population	Instituto Nacional de Estadística (INE)	Open access	National census	2011/ annual since 2002	Full	YES	NO/NO	Country population by year, sex and age group
Hospital supply data	Ministerio de Sanidad, Servicios Sociales e Igualdad	Open access	Hospital declaration through computerized database	2011/ 2009 referenced	Full	YES	NO/Hospitals must be traced backwards	Supply information from hospitals and regions such as tertiary hospital indicator, number of advanced care units, and number and characteristics of staff and healthcare professionals
Socio-economic data	INE Spain	Open access	Official statistics	2011/ 2009 referenced	Informatio n limited to MARE3	YES	NO/NO	Socioeconomic data including annual family income, inequality in locality, locality population, educational level, unemployment and registration levels of this information
Diagnoses and procedures classification s	Ministerio de Sanidad, Servicios Sociales e Igualdad	Open access	NO	2012	2011 reference	Diagnoses: ICD-9-CM Procedures: ICD-9-CM	NO/NO	Diagnoses and procedures classifications used to code episodes at discharge

VI. BUILDING A SINGLE AND RELIABLE RELATIONAL DATASET

a. The ECHO-data warehouse

The ECHO-DWH has been designed as a relational database in which information from hospitalization episodes is linked to contextual information (namely, demographic statistic, socioeconomic data and information on supply) to produce intermediate and final outputs.

The data model is built upon three entities (episodes, hospitals and geographic areas) and their respective attributes. The critical attributes are described along various catalogues – dictionaries containing codes for diagnoses and procedures, hospital names and situations, name of each area in all geographic levels and population living in them. Annex D includes a description of the files containing information for each of the three entities, as well as their attributes. Note that attributes in bold letters represent the maximum level of disaggregation at which the attribute is found in the ECHO-DWH.

Figure 2 shows the relational model developed in the DWH. White boxes represent the underlying catalogues, pale-grey boxes represent the contextual entities (hospital and area attributes), dark-grey represents the files comprising episodes entity, and pale-blue boxes represent the actual outputs of the DWH (see Annex D for full explanation of the attributes stored in each box).

Critical elements in the relational model

The first critical element is that episodes (dark-grey boxes) store individual patient-level information that is actually embedded into both a hospital and a geographic area. Consequently, linkage across files follows either a 1-to-1 scheme (when linkage is limited to episode-based attributes; dark to dark-grey arrows) or a 1-to-N scheme (when episodes are linked to a hospital or an area; dark to pale-grey arrows). To enable this linkage scheme, three key internal univocal key variables were constructed: *echo_key* (episode), *hosp_hist_id* (hospital) and *mare_id* (geographic area).

The second critical element is the need to build a more efficient model*, i.e.,* by reducing computation times while facilitating the implementation of different interfaces for exploitation.

For this reason, episodes (dark-grey) were split in three different files: the Core file containing the basic attributes for each episode (ECHO_CORE), the Diagnoses file containing information on the diagnoses in each episode (ECHO_DIAGNOSES), and the Procedures file, containing information on procedures (ECHO_PROCEDURES).

Instead of producing a single output, four separate output files were created containing the performance indicators and ad-hoc variables for adjustment: an output file relating to geographic analysis (ECHO_INDICATOR_POPULATION); another to hospital analyses (ECHO_INDICATOR_HOSPITALS); a third containing comorbidity and severity variables (ECHO_INDICATOR_CABG_ELIX) designed to allow risk adjustment modelling; and a fourth file including a severity adjustment using AP-DRG and APR-DRG, designed to allow risk adjustment modelling and analyses of technical efficiency (note that this file only contains information for countries using ICD9-CM classification (ECHO-DRG)). Further details on all these attributes can be found in Annex D.

The aforementioned four files are the result of a computation process conducted using the ECHO_CORE, ECHO_DIAGNOSES AND ECHO_PROCEDURES files, using an intermediate output, the crosswalks table. This crosswalks table contains the codes used in the definition of each ECHO performance indicator and the risk-adjustment variables. The catalogue maps out each of these codes across Classification Systems (ICD-9, ICD-10, NOMESCO, OPCS, and ACHI). For more detailed information on the crosswalks table, see http://www.echo-health.eu/

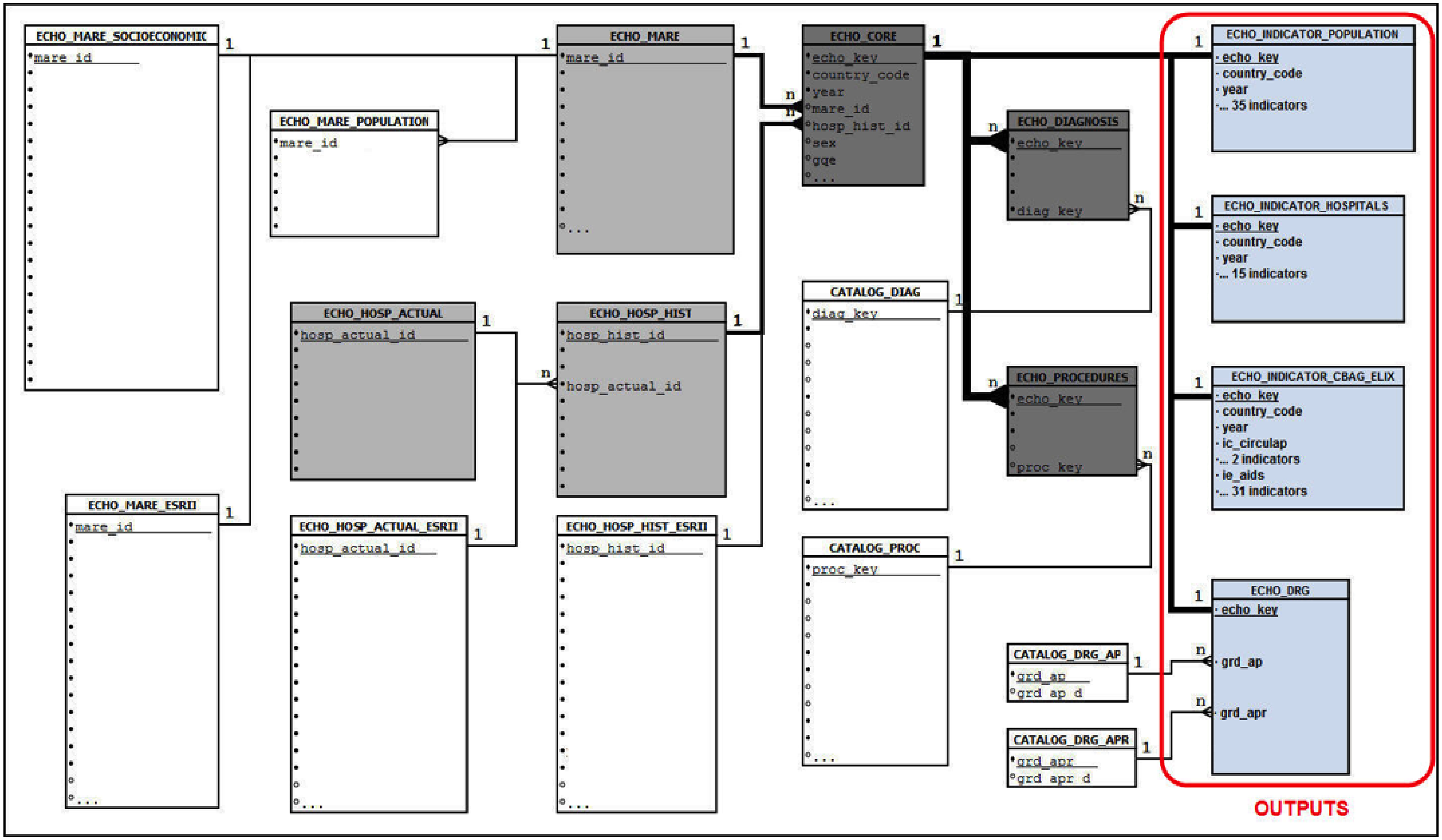


Figure 2. ECHO-DWH relational model scheme.

b. Obtaining a comparable dataset

As observed in Table 4, the information gathered by ECHO was provided by national statistical and information bodies. All datasets provided meaningful information and satisfied the information requirements of ECHO. However, not all the datasets could provide full coverage for each of the variables, and the majority of the original datasets required transformation to ensure comparability.

The following are the main issues that arose in the process of creating comparable datasets from the original datasets: 1) original variables had to be transformed into the ECHO format; 2) Denmark provided contacts instead of episodes; 3) many Portuguese hospitals had merged since 2006; 4) geographic units of analysis were frequently uneven; and, 5) diagnoses and procedures were coded in 6 different languages.

1) Transformation of original variables into the ECHO format

Variables from the original datasets were provided in original formats, which necessitated transformation of the original variable formats and values into common outputs. Transformation was straightforward for some variables (*e.g.,* transforming orginal sex values into ECHO values) while others had so many different categories that they first had to be simplified to basic categories and then local expertise was required to sensibly re-categorize the original categories (*e.g.,* type of discharge). Other country-specific variables (*e.g.,* patient ID, zip-code or hospital codes) did not require transformation, but merely the creation of an internal univocal key variable (aforementioned).

Annex A details the transformation rules for each original source. The first column of the table describes the formats and values for the ECHO-CORE attributes that were eventually stored in the ECHO-DWH.

2) Denmark provided contacts instead of episodes

England and Denmark have the most detailed patient-level data, allowing the study of contacts within an episode. However, ECHO focuses on the study of episodes and both countries were thus asked to provide a solution. While England actually provides episodes (spelled as originally named), Denmark was only able to provide contacts along with a key alphanumeric identifier (forlob) allowing the reconstruction of episodes. However, the aggregation of contacts into episodes was not a straightforward task.

The difficulty arose due to the fact that aggregating various contacts (stored as rows) in a single episode (a single row) requires a decision meant to preserve the information coming from the different contacts (rows). Those decisions did not affect recurrent information across contacts (*e.g.,* age, sex) but did affect contact-specific information (diagnoses, procedures and dates).

Decision process

After removing contacts that were not relevant to ECHO from the original sources (*i.e.,* patients treated in emergency wards and outpatient contacts without at least a procedure record), variables that could be affected by forlob aggregation were identified. This process was applied separately to inpatient and outpatient contacts, and affected 99.9% of the cases (only 0.1% had not been assigned a forlob).

Specific decisions were made on the following issues: 1) how to assign the hospital of treatment (important to properly attribute hospital outcomes); 2) how to decide on admission, discharge and intervention dates (important for accurate estimation of the length of stay); 3) how to assign the type of admission and first diagnoses (critical, since a number of indicators are defined based on the first diagnoses of an admission, and whether the admission was elective or not); and, 4) how to assign the type of discharge (critical, as some indicators are defined or modified using this variable).

<u>Hospital of treatment</u> was assigned based on the first intervention date. This entailed sorting contacts by 'forlob', intervention date, admission date (in ascending order) and discharge date (in descending order).

<u>Dates</u> (for admission, intervention and discharge) were assigned by taking the minimum admission date, the maximum discharge date and the minimum intervention date of each ‘forlob' code. Thus, the duration of the episode was calculated as the difference between the earliest admission date and the most recent discharge date.

<u>Type of admission and main diagnosis</u> were assigned once the first contact was flagged. To identify this first contact, all contacts were sorted by 'forlob' with date of

admission (in ascending order), date of discharge and date of intervention (in descending order) Once type of admission and the principal diagnosis were recovered, the remaining diagnoses and procedures were collected in a table and stored using their codes and relative position in the set of overlapping contacts. This table was then used to complete the episode row after the main diagnosis.

<u>Type of discharge</u> was retrieved from the last contact date within a 'forlob' key, unless there was a type of discharge declared as "death", which took precedence.

The <u>recurrent variables</u> (age, sex, *etc.*) and the country-specific variables were taken from the contact with the most recent date.

3) Merging and splitting of hospitals over the years

ECHO studies hospital behaviour over time; for example, the evolution of mortality rates after coronary by-pass. However, hospitals merge or split over the years, changing supply features in a particular area (number of doctors or beds) and affecting the concentration of services, and ultimately, outcomes. ECHO seeks to report hospital outcomes in an informative way, thus ensuring proper attribution of the results.

To deal with merging and splitting processes, the ECHO data-warehouse has been created to allow annual-basis analyses (*i.e.,* of existing hospitals in a given year) and longitudinal analyses (*i.e.,* taking existing hospitals in the last available year (2009) as a reference). In the latter case, the challenge is to track back each hospital and reproduce the phenomena that have occurred over the years. Figure 3 represents the evolution of doctor supply in two hospital providers (green and yellow). The line representing the number of doctors in the yellow hospital disappears (left), and this number is added to that of the green hospital, resulting in the formation of a new hospital (black). Longitudinal studies in ECHO are based on the type of graph shown on the right.

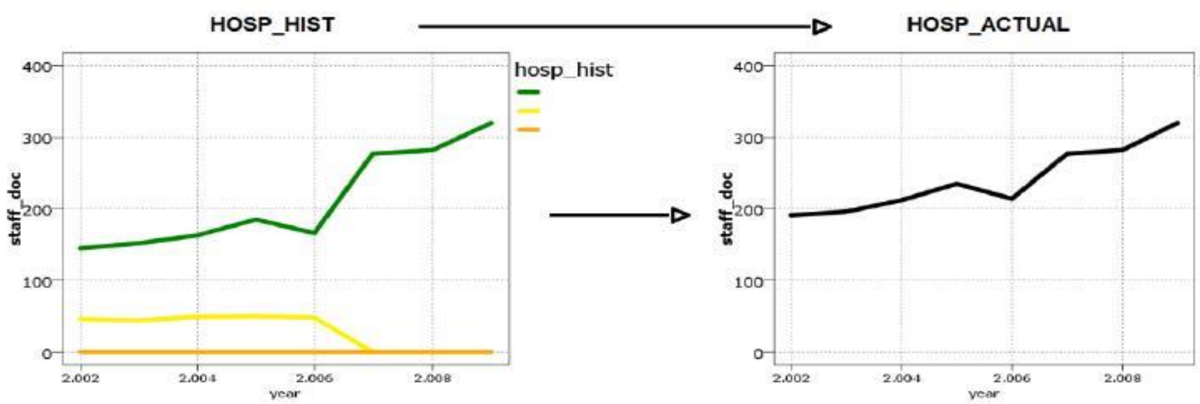


Figure 3. Evolution of staff numbers at three Portuguese hospitals that merged to form one facility during the study period.

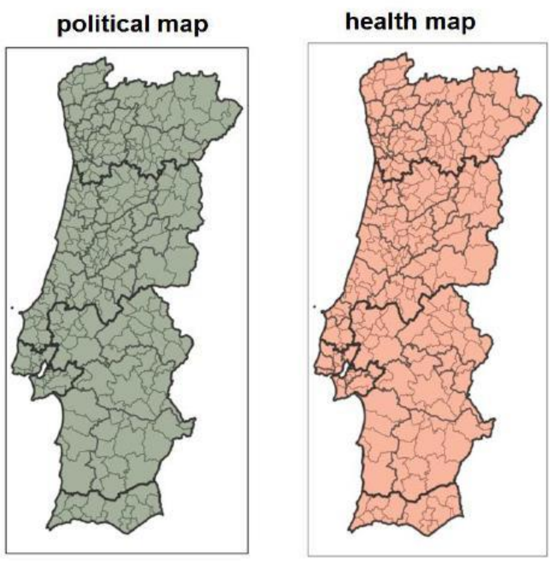
Technically ECHO-DWH contains two different tables with information on hospital supply; one including each hospital (and their attributes) year-by-year (hosp_hist); and another collecting supply information over time (hosp_actual).

4) Uneven geographic units of analysis

In geographic analyses ECHO allocates patients to geographic areas; municipalities, healthcare areas, provinces or regions.

Beyond any consideration on how meaningful the different areas are in terms of health services performance, the different countries involved have quite heterogeneous areas in terms of population size. This may give rise to a problem in the estimation of variation when areas are very small, making it difficult to determine whether the observed variation is true or is a reflection of the uneven population size.

To reduce the risk, particularly in the case of Denmark and Portugal, which have the smallest possible meaningful areas (Kommuners and Concelhos, respectively), ECHO created an intermediate layer in both countries. Figure 4 shows the Portuguese example.



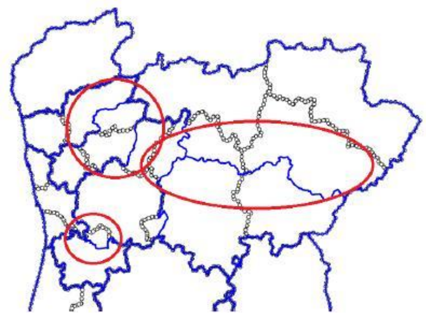


Figure 4. Differences between the original and the intermediate layer in Portugal.

In terms of the DWH logic model in Figure 1, all links "to" and "from" the ECHO_MARE table should consider the different levels of disaggregation, including this *ad hoc* intermediate layer

5) Diagnoses and procedures were coded in different languages

ECHO aimed to assess differences in healthcare performance using several performance indicators created using information recorded within each episode. As shown in Table 5, the different countries in ECHO use different coding languages when recording diagnoses and procedures. ECHO has developed crosswalks to allow the comparison of indicators across countries. The Handbook on Methods has a specific chapter in which this process is explained. Annex B compiles all the indicators stored in the DWH.

Table 5 Codification of diagnoses and procedures by country.

Country	Diagnoses	Procedures
Portugal (PRT)	ICD-9-CM	ICD-9-CM
Spain (ESP)		
Denmark (DNK)	ICD-10	NOMESCO
England (ENG)		OPCS4
Slovenia (SLV)		ACHI

As mentioned above, ECHO indicators are stored as final outputs in the DWH (pale-blue in Figure 2). To create these final files, a script in the crosswalks program was run on the ECHO_CORE, ECHO_DIAGNOSES and ECHO_PROCEDURES files. This script is designed to retrieve at-risk cases (denominator of the indicators) and cases involving the event of interest (numerator of the indicators).

6) Additional minor issues

The following are some minor issues that could potentially jeopardize the comparability of the data.

1) English data follow fiscal rather than calendar years, and thus cover the period from May 2002 to May 2010. Discharges in the first fiscal year were recorded as 2002 discharges, and discharges in the last fiscal year were recorded as 2009 discharges.

2) Portugal does not register discharge type, which limits the characterization of some indicators in which the exclusion of *transfers out* to another hospital provides a complementary perspective on the attribution of hospital outcomes (*e.g.,* case-fatalities after CABG).

3) Denmark changed the type of discharge coding in 2006 and progressively adopted a new coding system. As in the case of Portugal, this issue affects indicators for which *transfers out* matter, as well as longitudinal analyses of these indicators.

4) Slovenia was unable to provide some information from before 2005, specifically diagnoses in 2002 and procedures between 2002 and 2004. Accordingly, Slovene analyses must be limited to post-2005 data.

c. Obtaining a reliable dataset: the coherence principle

The coherence principle is the underlying principle that must be adhered to in order to obtain a reliable relational database. This principle basically refers to the quality of linkage across all the elements in the DWH, regardless of their use. There are several validation rules associated with this principle: identity, referential integrity, cardinality and preservation of the inheritance tools.

In the ECHO-DWH identity has been preserved by establishing a univocal primary key (echo_key) for each episode, consecutive to all countries and all years. Identity was enhanced during the normalization process, since “hospital_hist_id” and “mare_id”, foreign keys for the entities hospital and MARE respectively, were built upon the maximum level of disaggregation (*i.e.,* hospital and the smallest MARE level) allowing linkage across the upper levels of each data domain.

Referential integrity requires that primary keys in each table have a corresponding value (foreign key) in the reference (parent) table – ECHO_CORE. The ECHO-DWH was normalized allowing all the tables to be linked by their specific keys. Those links have been validated for the extraction of information related to concrete episodes for analysis, allowing each episode attribute to be identified and tracked down throughout the entire database. Figure 2 shows the linkage flows across tables.

Lastly, in our data model referential integrity may be jeopardized when an episode lacks information on zip code (used to assign a patient to a geographic location, or MARE) or hospital id (used to assign a patient to the hospital of treatment). To preserve referential integrity two fictitious categories were created containing episodes for which values relating to those two attributes were missing.

The cardinality rule refers to the scheme by which different tables link to one other in a relational model. ECHO-DWH was designed based on the main entity (episode) and two secondary entities (hospital and MARE). In order to preserve cardinality, those secondary entities were conceived as attributes, with an N-to-1 relation with the episode.

To improve the efficiency of data management, the main entity was split into five tables containing the outputs of the DWH exploitation. Those tables follow a 1-to-1 relational scheme with the parent table (see pale-blue tables in Figure 2).

Finally, inheritance describes a set of rules that must be fulfilled by the common attributes of an entity. Inheritance problems arise when certain sub-specific types of attributes within an entity question these rules. In our model data, the only risk of inheritance issues relates to hospital supply information. As mentioned above, hospitals merge and split over time, and ECHO maintains a record of these processes (Figure 3). To avoid any problems of inheritance, ECHO has built two different hospital sub-entities, 'ECHO_HOSP_HIST' and 'ECHO_HOSP_ACTUAL', with a matrix relation over space and time.

VII. QUALITY OF THE RESULTING ECHO DATABASE

Relevance

ECHO analyses the exposure to health services of (averages of the period) 5.4 million people in Denmark, 50.6 million in England, 10.1 million in Portugal, 2 million in Slovenia and 44.2 million in Spain

Since ECHO is based on the use of hospital administrative data the number of performance dimensions and indicators that can be studied is limited to those that can be built using this kind of data.

ECHO has adapted and validated up to 50 indicators in the areas of cardiovascular care, orthopedic care, potentially avoidable hospitalizations in chronic conditions, safety events and low-value surgical procedures, covering the following performance dimensions: utilization, equity of access, quality and safety, and efficiency. A description of the ECHO indicators can be found in Annex B, and further information on the definitions and codes used at http://www.echo-health.eu/

As a limitation, ECHO has not addressed a few of the dimensions of usual performance assessment frameworks such as appropriateness, system responsiveness, timeliness, or patients' satisfaction.

Coverage

ECHO-DWH contains records of all hospitalizations provided by the ECHO countries. With the exception of Slovenia, which provided information pertaining to 2003 and later, the remaining countries supplied episodes recorded between 2002 and 2009. For all ECHO countries, ECHO-DWH contains a record of virtually all the hospitalizations recorded in ECHO countries for the reported years.

The ECHO-DWH contains more than 191.1 million hospitalization episodes, corresponding to 841.6 million days of stay. As observed in Tables 5a and 5b, the number of episodes increased throughout the period of study in all countries, ranging from an 11% increase in Slovenia to a 48% increase in Portugal, while stays decreased (ranging from a 2% decrease in Portugal to a 19% decrease in Slovenia), except in the case of Spain, in which a 6% increase in stays was observed. Figures 5 and 6 show that, except in the case of England where a steady progression was observed (with a clear decrease in stays between 2006 and 2007), little change was observed in any of the countries of interest. The relative contribution of each country in terms of episodes and stays is shown in Figures 7 and 8.

Table 5a Number of episodes in ECHO-DWH

Country	2002	2009	Total Episodes	% Inc.
Denmark	1,365,331	1,683,728	12,021,440	19%
England	11,955,733	15,843,561	110,466,253	25%
Portugal	1,011,715	1,932,293	10,804,099	48%
Slovenia*	321,250	361,657	2,350,428	11%
Spain	3,888,434	4,841,824	35,511,652	20%
			191,136,051	

*Slovenian records begin in 2003

Table 5b Number of stays in ECHO-DWH

Country	2002	2009	Total stays	% Inc.
Denmark	5,961,671	5,055,883	44,016,425	-18%
England	51,877,605	46,324,601	390,519,096	-12%
Portugal	6,806,185	6,690,108	53,835,220	-2%
Slovenia	2,559,098	2,144,600	15,069,089	-19%
Spain	26,679,296	28,441,406	219,889,944	6%
			840,694,633	

* Slovenian records begin in 2004

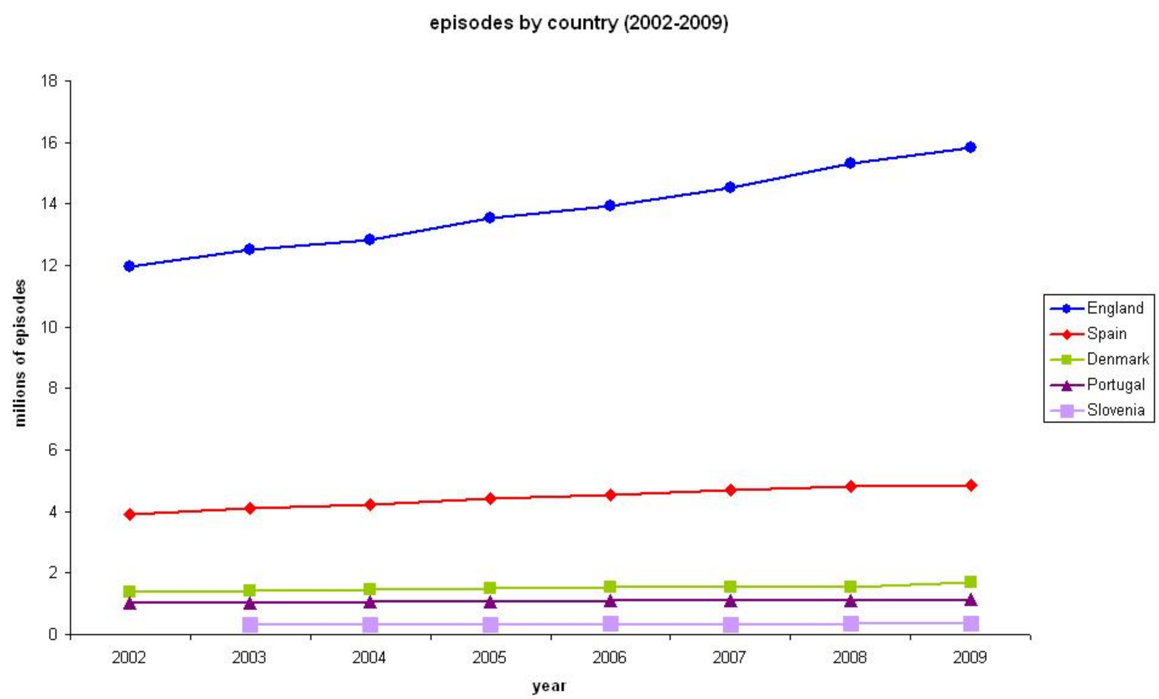


Figure 5. Episode distribution (millions) by country and year.

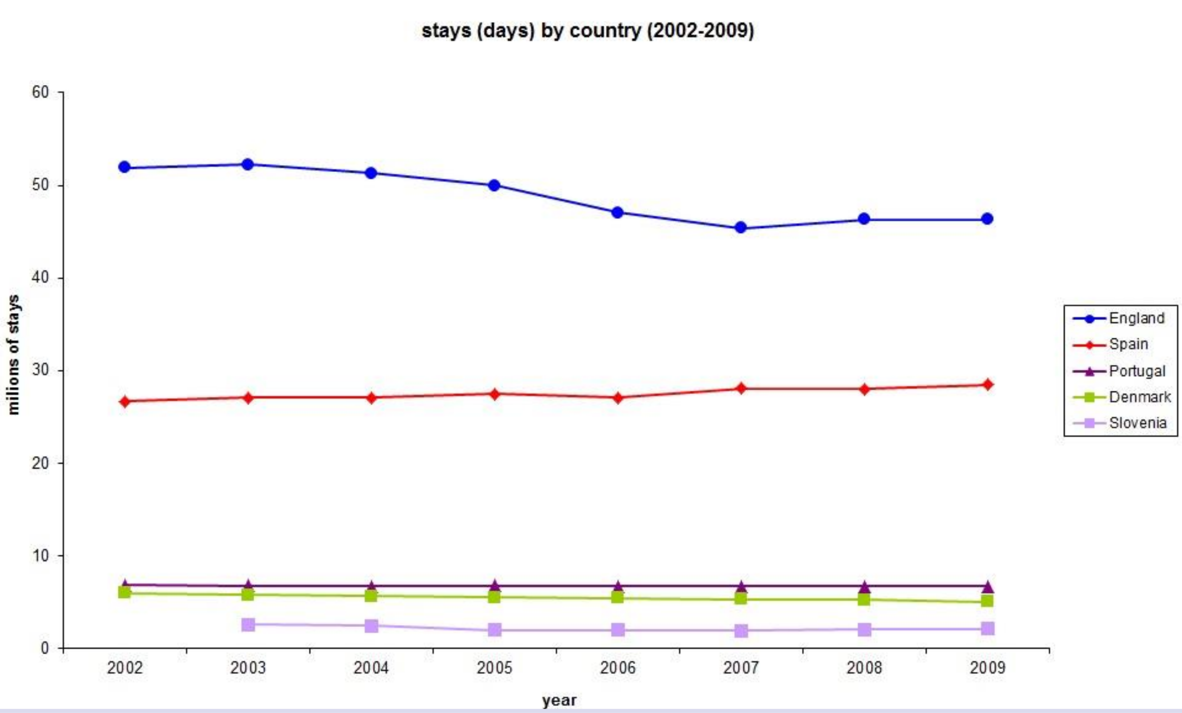


Figure 6. Stays distribution (millions of days) by country and year.

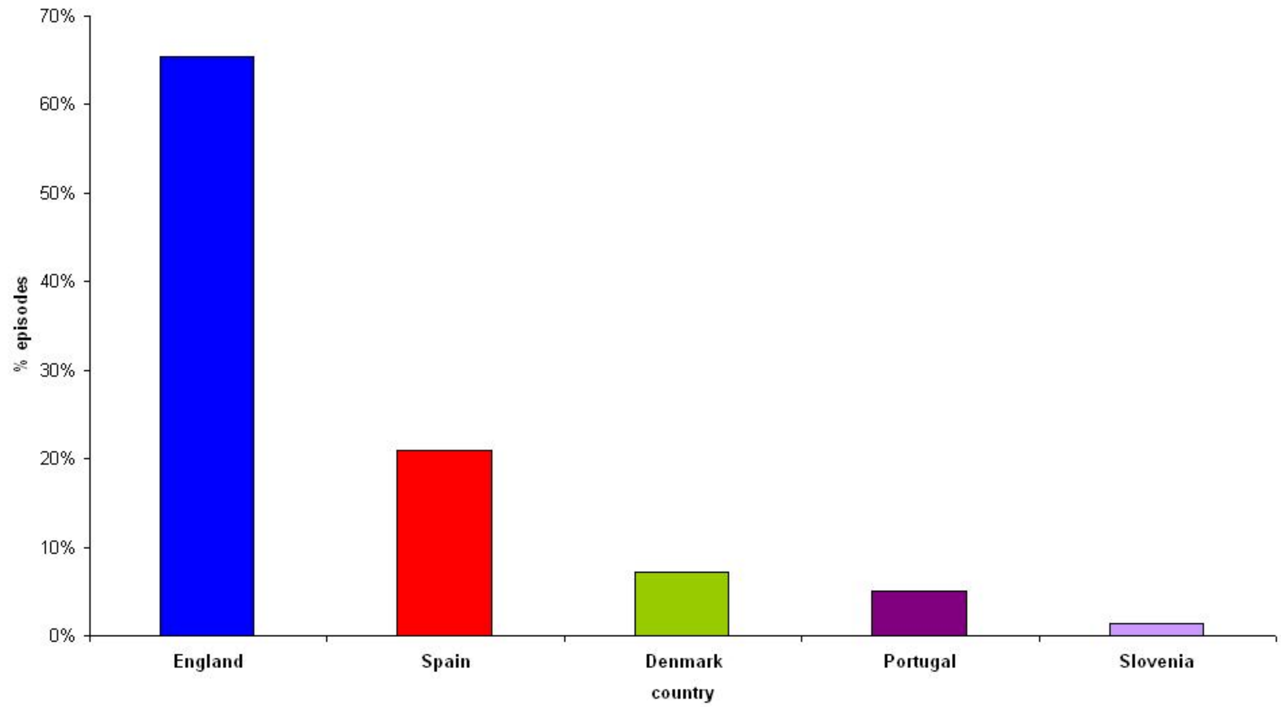


Figure 7. Percentage of episodes contributed by each country to the ECHO-DWH.

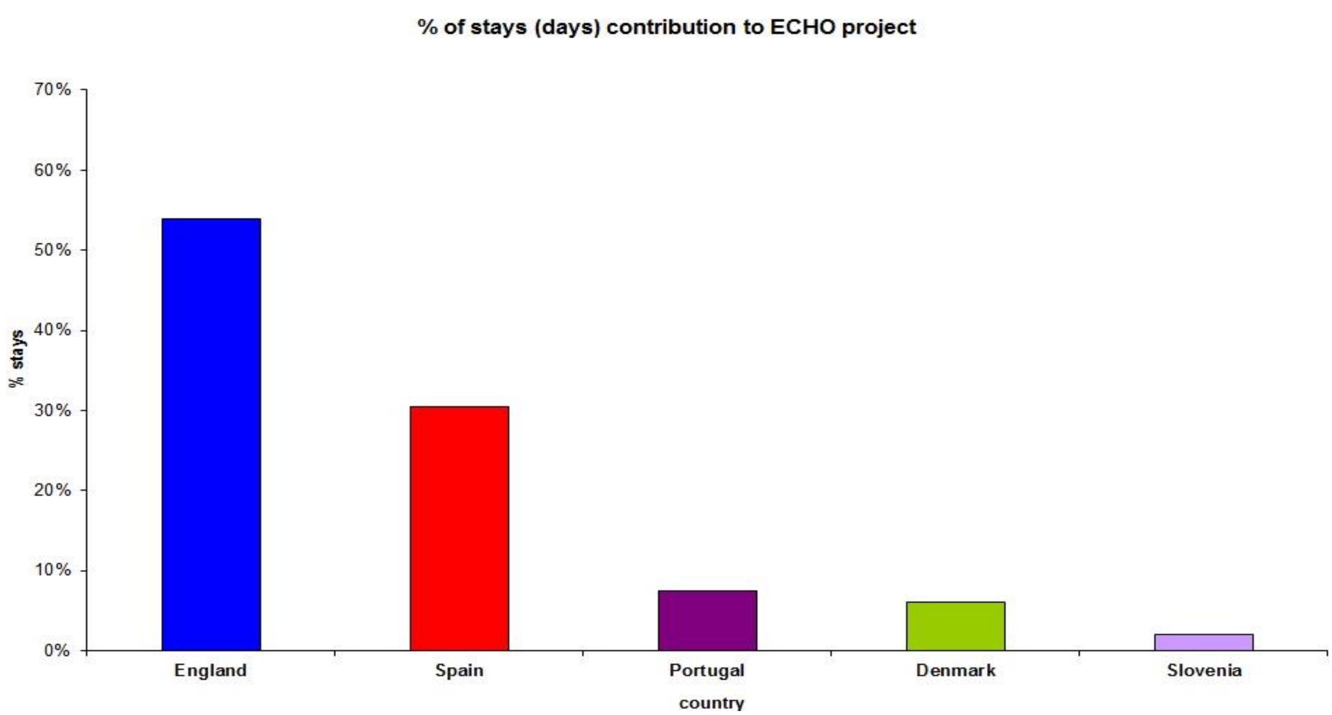


Figure 8. Percentage of stays contributed by each country to the ECHO-DWH.

Socioeconomic data is used to study factors that contribute to unwarranted variation in performance. The ECHO countries were able to provide most of the relevant information, although analyses are limited by some gaps in the data. Tables 6a and 6b describe the main variables stored in the ECHO-DWH. Variables that can be studied across all the countries are shown in red.

Internal Reliability

Internal reliability determines whether the information stored in the DWH is consistent over the years, within each country. It is a necessary condition for accurate estimations.

Hereinafter, the behaviour of the core attributes that define an episode (age, sex, day-case surgery, type of admission, type of discharge, diagnoses and procedures) and are used in the elaboration of the ECHO indicators are analysed graphically. Consistency over the period of study and similar behaviour across countries is interpreted as a sign of data reliability.

Information gaps in critical variables

Figure 9 shows the percentage of episodes lacking any of the aforementioned critical attributes used in the generation of the ECHO indicators. Information gaps in the period of study should be considered negligible with a mean of just 0.4% of episodes lacking information on any of these attributes. The greatest gaps were observed in Danish data for 2002 and 2003, although data on type of discharge was absent in only 1.27% of episodes.

In terms of reliability, information gaps should be considered as negligible since the percentage of missing information is very low and likely randomly distributed. Consequently, this should not affect the construction of the ECHO indicators, nor comparisons across countries.

Figure 10 shows the percentage of episodes lacking data on diagnosis or procedure throughout the study period. No information gaps were observed for England, Portugal or Slovenia. Although, Denmark (with a consistent 0.1%) and Spain (0.7%, albeit confined to the 2004-2006 period) lacked some information, these absences are near negligible.

In terms of reliability, the minimal information gaps observed for Denmark and Spain are not expected to affect either the construction of indicators or comparability.

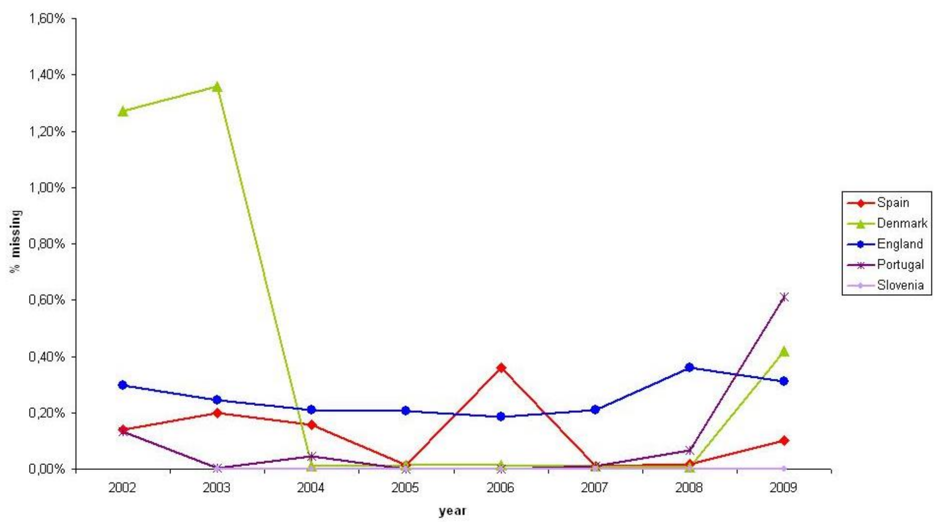


Figure 9. Percentage of episodes with at least one core variable missing.

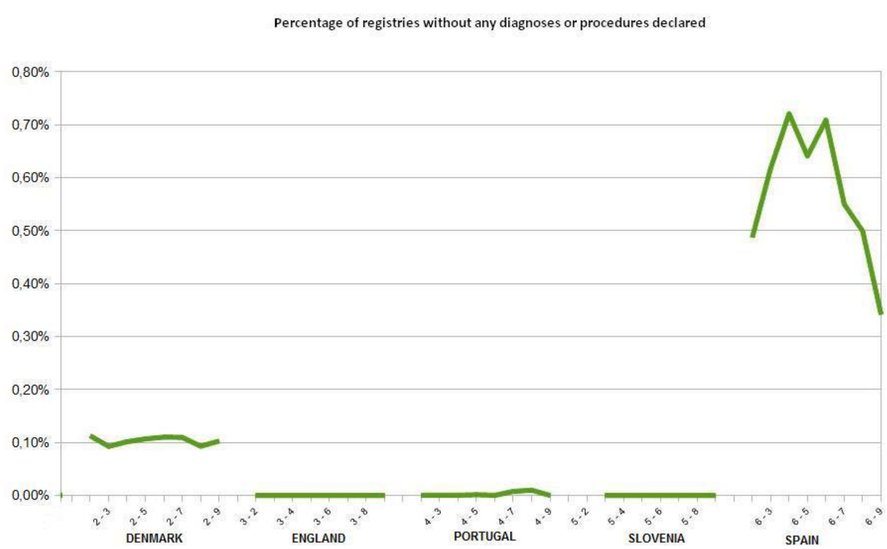


Figure 10. Percentage of episodes (registries) for which no diagnosis or procedure is declared.

Coding precision across countries

Although information gaps can be considered negligible, when it comes to diagnoses, further analyses are required to determine reliability. Code precision (the number of digits used to define a specific diagnosis) could represent a major issue if significant differences are observed across countries that share the same International Classification of Diseases.

The following ECHO indicators could potentially be affected by differences in coding precision: Potentially Avoidable Hospitalizations, C-section (includes low-risk conditions), Patient Safety & Quality Indicators (conditions excluded from the pool of at-risk patients), Comorbidities Used in Risk Adjustment, and Calibrators (myocardial infarction, mastectomy in breast cancer, *etc.*).

The different codes used to define these conditions are required to have at least 4 digits according to both ICD-10 (Denmark, England and Slovenia) and ICD-9 (Portugal and Spain).

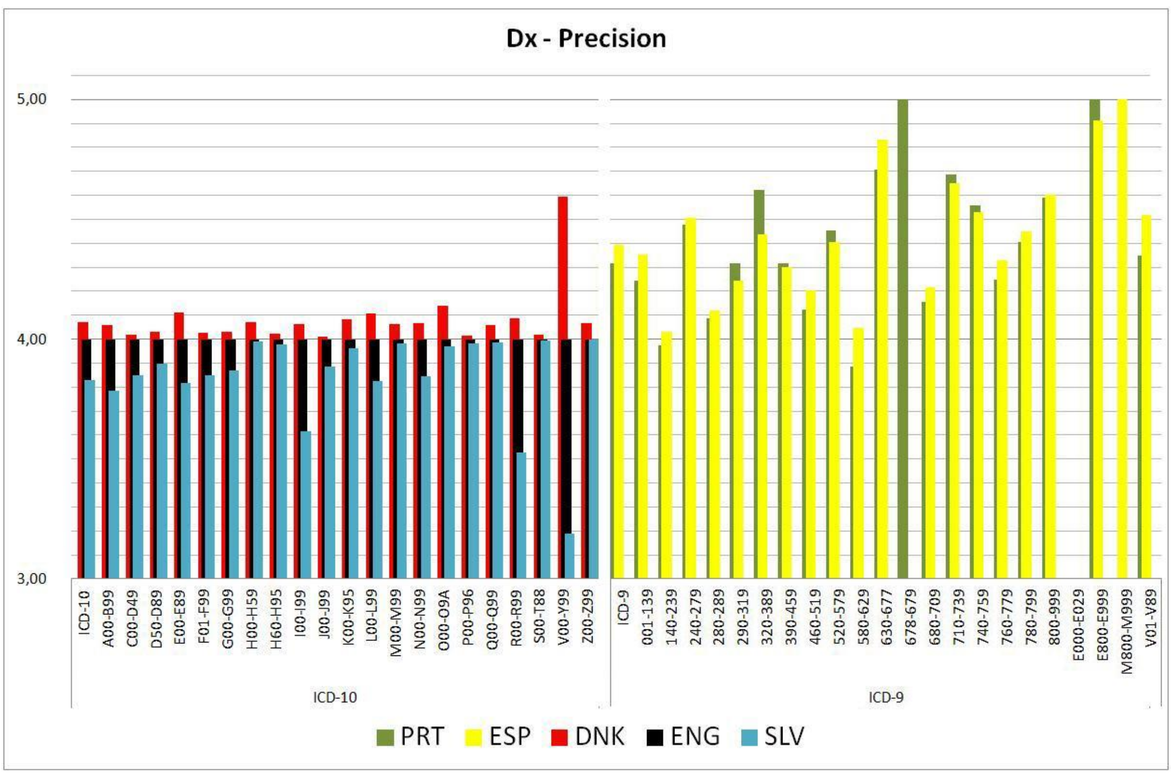


Figure 11. Precision (mean number of digits) for diagnostic codes displayed by chapter and coded by ICD-9-CM and ICD-10.

As shown on the left in Figure 11, the only country that failed to provide 4 digits for most of the major diagnostic categories (MDC) was Slovenia. All remaining countries provided at least 4 digits for all MDCs, except for Portugal in the case of genitourinary diseases.

Whether the lack of precision in the Slovenian data could influence international comparisons is uncertain. The average coding precision for the vast majority of MDCs is greater than 3.8 digits. Among MDCs with a lower coding precision, the only one potentially affected is circulatory disease (I00 to J99), specifically I240, I248 and I251, which denote specific conditions within Coronary Ischaemic Disease (CID). The effect is likely small since the vast majority of CID is coded using I20, I21 and I22.

In terms of reliability, coding precision is sufficient to allow international comparison.

Hospital activity by age group, sex, year, and country

Hospital activity in ECHO is divided into inpatient and outpatient care. In general terms an increase in inpatient and outpatient activity, despite a certain substitution effect, should be expected over time.

As observed in Figure 12, these hypotheses are confirmed, although the increase in slope differs among countries. A closer outlook sheds more light on the differences between inpatient and outpatient cases.

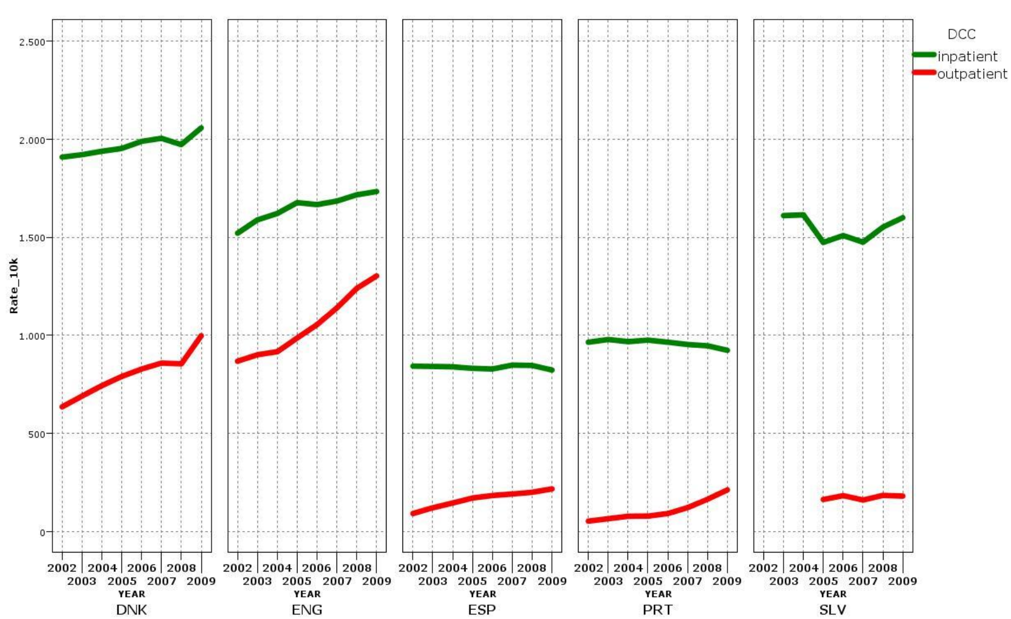


Figure 12. Rate of episodes by day-case surgery (DCC), country and year.

In terms of reliability, these differences between inpatient and outpatient care are unlikely to affect comparisons, since ECHO indicators based on surgical procedures consider both inpatient and outpatient care in the calculation process.

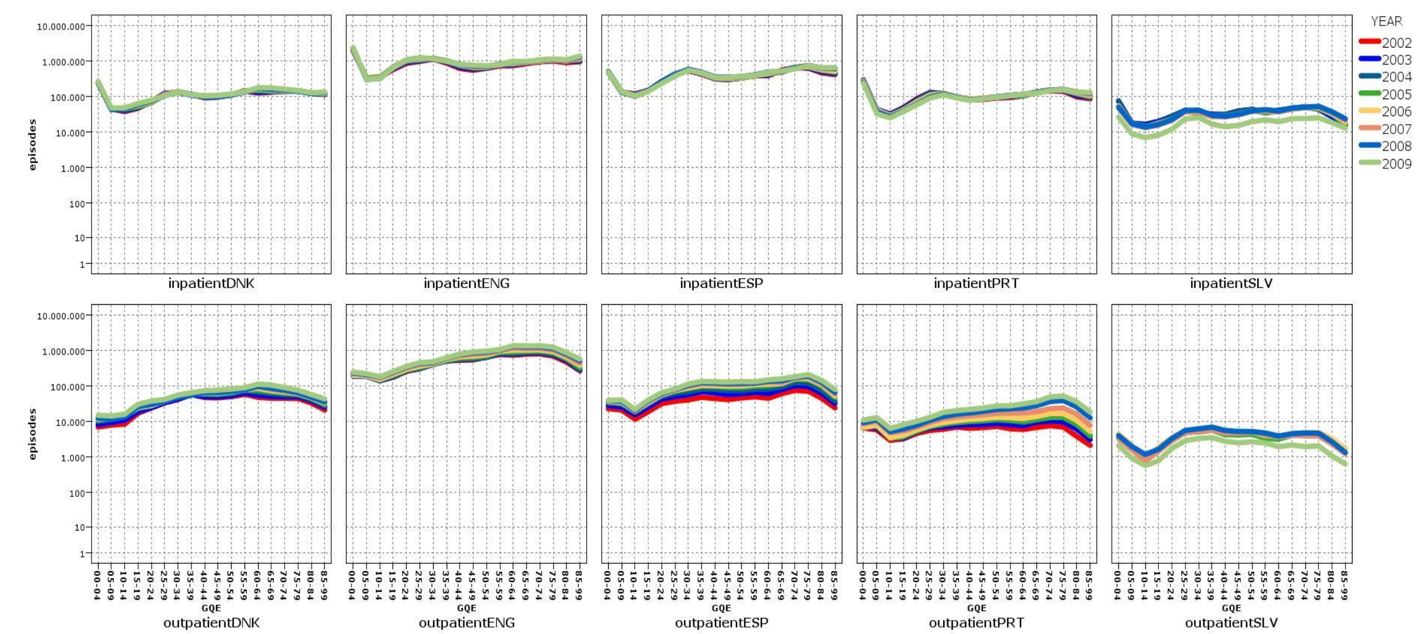


Figure 13. Distribution of episodes in ECHO-DWH by day-case surgery (inpatient/outpatient) and age group.

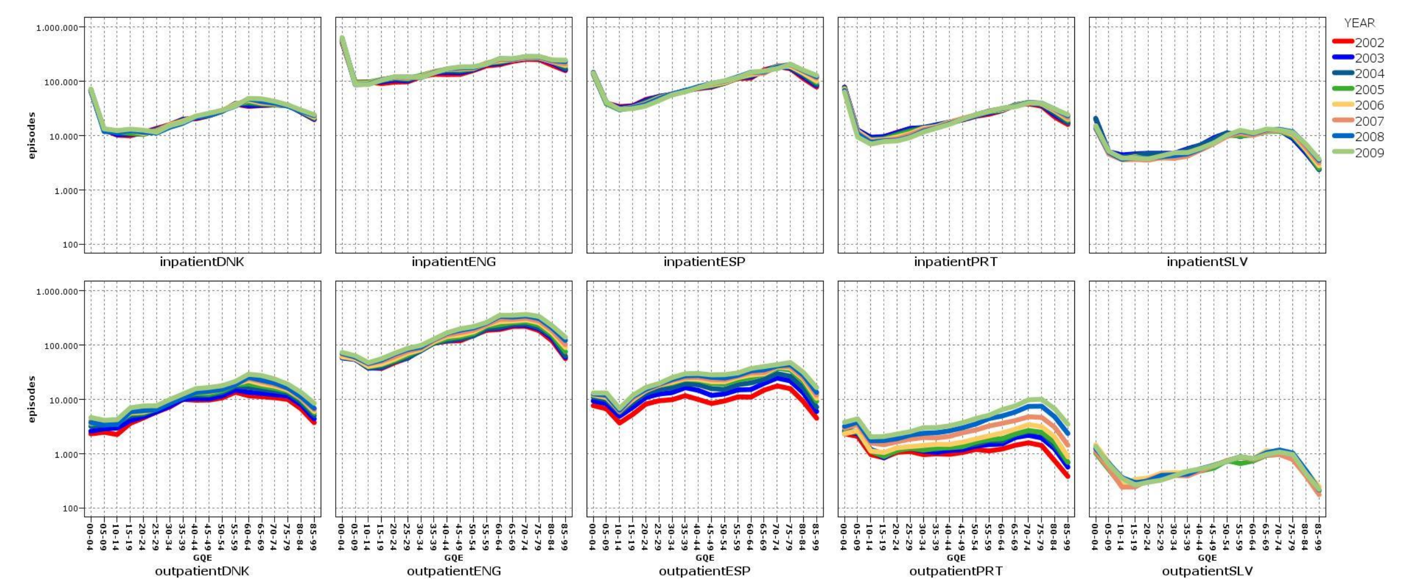


Figure 14. Distribution of episodes for males in ECHO-DWH by day-case surgery (inpatient/outpatient) and age group.

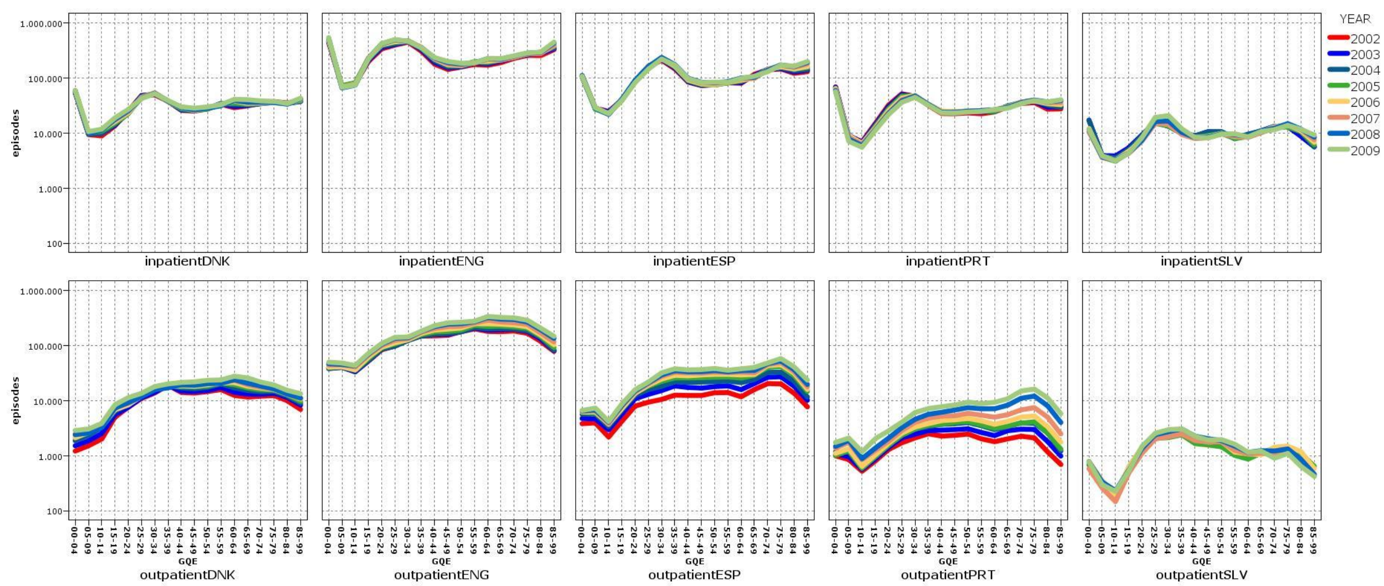


Figure 15. Distribution of episodes for females on ECHO-DWH by day-case surgery (inpatient/outpatient) and age group.

Type of admission: planned or unplanned

Some ECHO indicators gain validity when the analysis is restricted to unplanned admissions. For example, admission for angina is considered a potentially avoidable hospitalization. However, angina admission could be also related to the prescription of a diagnostic procedure, which is usually registered as a planned admission. Restricting analyses to unplanned admissions would avoid misclassifying those cases as potentially avoidable. Indicators that include this condition in their definition are detailed in http://www.echo-health.eu/

As observed in Figure 16, the number of planned (green line) and unplanned admissions (red line) is highly stable over time in all countries except Slovenia, where stability is reached in 2007.

In terms of reliability, international comparisons using Slovenian data from pre-2007 could be jeopardized when the indicators use type of discharge as a modifier. In those instances, it is recommended to use all cases, even though validity will be slightly reduced. For all remaining countries, both in-country and cross-country comparisons are reliable when using type of discharge as a modifier.

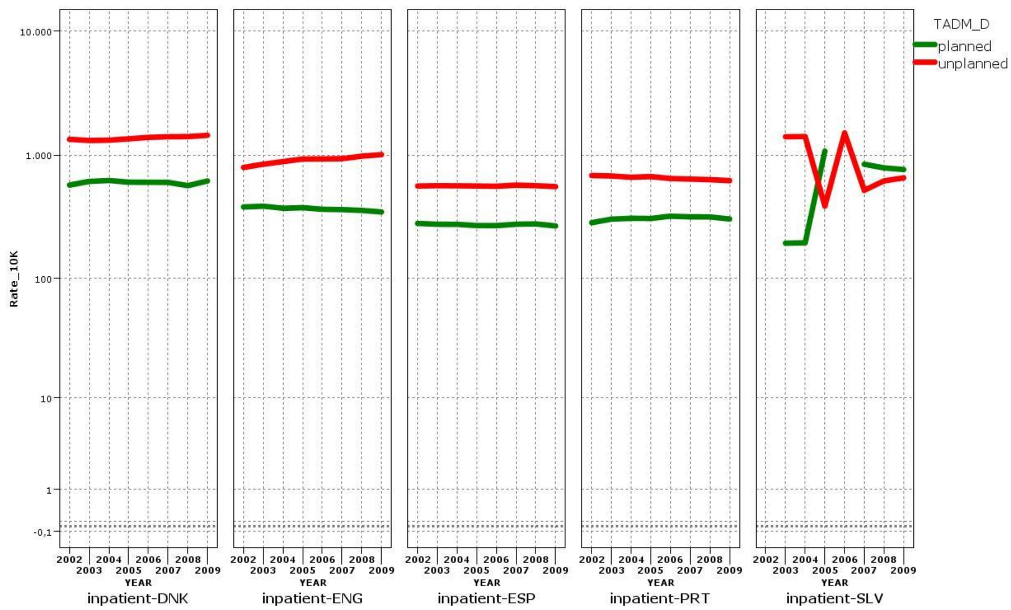


Figure 16. Rate of episodes by type of admission (TADM), day-case surgery, country and year.

Type of discharge

ECHO classifies type of discharge into five categories; *discharge to home, transfer out to another hospital, death, patient choice,* and *other*. The most important in terms for building the ECHO indicators are *transfer out to another hospital* and *death*. In the first case, the exclusion of transfers out might reduce the risk of duplications in the geographic analysis or inadequate attribution of cases in hospital analyses. In the latter, mortality is the event of interest in the majority of hospital quality indicators, composing the numerator of the rates. Therefore the consistency of these categories over time and across countries is critical for indicators using type of discharge in their definition.

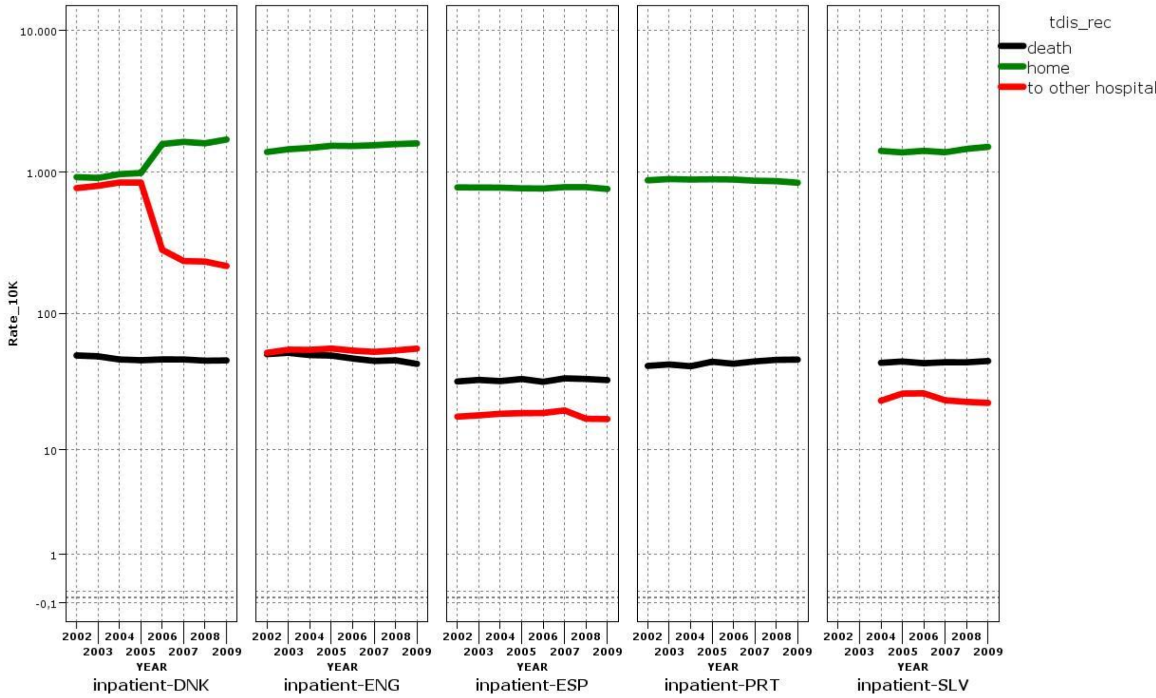


Figure 17. Rate of episodes by type of discharge (TDIS), country and year.

As observed in Figure 17, both *discharges to home* and *deaths* are extremely stable over time and show comparable rates across countries. A similar pattern is observed for *transfers out* to another hospital, except in the case of Denmark where in 2006 a new classification for type of discharge, which particularly affected *transfers out*, was implemented.

In terms of reliability, indicators based on mortality are sound, and indicators using *transfers out* to test duplication or attribution are safe in all countries, including Denmark since 2007.

Accuracy

Accuracy denotes how close ECHO estimations are to the actual facts. An inaccurate estimation signals misclassification biases and indicates that data issues could be an alternative explanation for observed variations in performance.

The accuracy of ECHO performance indicators is tested in a graphical way. Interpretations are made based on the consistency of the rates (for geographic indicators) or risks (for hospital indicators) over the years (and countries) and the absence of irregular patterns or odd trends.

Figures 16 to 34 show the behaviour of the following ECHO performance indicators; potentially avoidable hospitalizations, low-value care procedures, cardiovascular care, orthopaedic care, patient safety indicators, and risk adjusters.

Potentially avoidable hospitalizations

Figure 16 shows the population rates of potentially avoidable hospitalizations per country and year. Patterns in Denmark, England, Portugal and Spain are steady and fairly comparable across countries. However, in the case of Slovenia regular patterns begin in 2005, except for angina, which shows a uneven pattern up to 2007 (likely related with the aforementioned coding issue).

Recommendation: Any international comparison including Slovenia should take into account the lack of stability before 2005 (2007 in the case of angina). The accuracy of comparisons of diabetes and dehydration is unlikely to be jeopardized.

Low-value care procedures

Figure 17 shows population rates of low-value non-sex-specific procedures. Unusual patterns are observed for tonsillectomy in Denmark, Portugal and Slovenia, and proctologic surgery in Slovenia. For the four male-specific procedures in Figure 18 consistent patterns are observed in England, Portugal and Spain (note the overlap of the curves generated for the indicators with and without *transfers out*). In the case of Slovenia a steady pattern is observed for each of the four indicators that requires further follow up. Except for prostatectomy in prostate cancer, all Danish indicators show markedly irregular behaviour, particularly those in which *transfers out* are excluded (as in Denmark changed the method for recording discharges in 2006). Finally, fairly regular patterns are observed for all female-specific procedures (Figure 19) except for births with complications and non-conservative breast cancer and uterine cancer interventions when *transfers out* are excluded. In Slovenia, a marked increase is observed for births with complications during the period of study compatible with an increase in the recording of this condition; a near overlap is observed between curves generated with and without *transfers out*, respectively.

Recommendation: Transfers out should not be excluded when performing comparisons that include Denmark. International comparisons of tonsillectomy, proctologic surgery and indicators using births with complications that include Slovenia will be more accurate if limited to post-2008 data. Accordingly, comparisons of tonsillectomy involving Denmark, Portugal and Slovenia require further analysis.

Cardiovascular care

Figures 20 and 21 represent cardiovascular conditions (myocardial infarction, and ischemic coronary disease), all of which show show regular patterns in all countries except Slovenia, for which only unplanned admissions are considered. Figure 21 examines whether the exclusion of *transfers out* from both total and unplanned admissions affects the indicators. As expected, irregular patterns are observed for Denmark from 2005 onwards (due to the aforementioned effect of registering *transfers out*). Slovenia shows a similar irregular pattern for unplanned admissions.

Figure 22 shows rates of cardiovascular procedures (PCI, CABG and endarterectomy) and conditions (ischaemic stroke). Patterns are fairly comparable across countries although some oddities are observed for Denmark in 2007, Portugal in 2004, and reverse trends in ischaemic stroke and PCI with stent are observed for Slovenia. While in the first two cases the numbers are similar to the information retrieved from other local sources, the reverse trend in stenting observed for Slovenia is compatible with a codification issue. Further analysis of the reverse trend for ischaemic stroke is required, although an underlying information bias can be ruled out. Finally, Figure 23, which examines the effect of excluding *transfers out*, shows essentially the same pattern, with the expected exception of Denmark.

Recommendation: *Transfers out* should not be excluded in international comparisons that include Denmark. International comparisons of PCI that include Slovenia should consider all PCIs, not just those with stenting.

Patterns in case-fatality rates after a cardiovascular procedure (CABG, PCI and elective repair of aortic abdominal aneurysm) and after a clinical condition (myocardial infarction and ischaemic stroke) are shown in Figure 24. Regular patterns are observed for Denmark, England, Spain and Portugal, except in the case of aneurysm repair, where some oddities are found over the years. For Slovenia a steady pattern is observed after 2005 for all indicators except aneurysm repair. The exclusion of *transfers out* (Figure 25) results in a similar pattern for all countries except Denmark, where the expected erratic pattern is observed up until 2007.

Recommendation: *Transfers out* should not be excluded in international comparisons that include Denmark. Comparisons involving Slovenia will be more accurate if only post-2005 data is included. Given the oddities observed for aneurysm repair in Portugal and Slovenia, these conditions should be excluded from international comparisons.

Orthopaedic care

Figure 26 depicts patterns of hip fracture admission and hip, knee and shoulder replacements. In general terms, regular, steady patterns are observed across countries, although some oddities observed for Denmark in 2008 require further observation. The only irregularity observed relates to unplanned hip fracture, and is similar to that seen for cardiovascular conditions.

Recommendation: International comparisons of hip fracture admissions that include Slovenia should include all types of admissions.

Patient safety indicators

Figure 27 shows patterns of pulmonary thromboembolism and deep venous thrombosis (PTE-DVT) and post-operative sepsis in all procedures and in elective procedures only. PTE-DVT shows a steady pattern in all countries (increases and decreases are minimal). The steeper slope seen for England requires further observation, although given the steadiness of the curve information biases seem unlikely. Postoperative sepsis in Denmark, England, and Slovenia show very stable patterns, with an overlap observed between the curve for all procedures and that for elective surgery only. Interestingly, although both display similarly steady curves, a gap between the two indicators is observed for Spain and Portugal, suggesting differential specificity of the indicators.

Recommendation: Unplanned interventions in Spain and Portugal should be excluded in international comparisons of postoperative sepsis.

Risk adjusters

Two types of risk adjusters are used in ECHO. The first group (in Figure 28) are used to capture differences in severity in patients undergoing CABG, while the second group (in Figures 29 to 34) are comorbidities that have been proven to influence patient outcomes (Elixhauser comorbidities)

For CABG risk adjusters, concomitant valve surgery is the most accurate risk adjuster, with similar trends and homogeneous patterns observed across countries. However, interventions that required a heart and circulatory assist system in England and Slovenia show unexpectedly higher rates as compared with major cardiac surgery. In the case of England an inverted J-shape is observed for major surgery beginning in 2005 and a steeper increase is observed in cardiac assisted interventions; a coding substitution or an increase in the number of cardiac assisted interventions are both plausible explanations for this observation. There is no obvious explanation for the pattern observed for Slovenia, although it could be argued that hospitals practicing major cardiac surgery use more cardiac assist devices. On the other hand, Portugal shows a steep increase in the number of major cardiac surgeries compatible with an increase in this activity.

Since the risk of death is greater for assisted versus non-assisted cardiac surgery (the risk is doubled according to our data), regardless of the reason behind the change in trend in England in 2005, CABG adjustment could be affected. If this change is attributed to a coding phenomenon, CABG case-fatality rates in hospitals with more cardiac assist devices would underestimate the actual case-fatality rate.

Recommendation: International comparisons of adjusted case CABG fatality rates should take into account that English and Slovene hospitals could be affected by a change in the number of interventions recorded as using a cardiac assist device since 2005 and 2006, respectively.

Elixhauser comorbidities

Figures 29 to 34 assess the regularity of patterns in Elixhauser comorbidities. Two main findings should be highlighted: the differences in the growth toll across countries and the irregular behaviour of some indicators in some countries. An unexpectedly steep increase is observed in several comorbidities in England (arrhythmia, COPD, diabetes, renal failure, solid tumours, obesity, valvular disease, parathyroidism and hypertension, with or without complications) that is unlikely to be compatible with an actual increase in the corresponding diseases, and probably reflects changes in coding practices. Similarly, marked increase in obesity is observed in Denmark and Portugal.

While the number of cases increased progressively in the aforementioned examples, alterations in solid tumours, metastasis, lymphatic disease and renal failure in Portugal in 2007 appear to be due to a sudden change in coding practices. Finally, a general improvement in the codification of comorbidities is seen in Slovenia, with stable and regular patterns as of 2005.

Since Elixhauser comorbidities are used for risk adjustment purposes, fatality rates, particularly in the latter years, will likely be overadjusted when using comorbidities affected by a disproportionate increase. The two most affected countries are England (with 10 out of 30 comorbidities) and Portugal (with 4 out of 30 comorbidities). In any case, empirical observation of the ECHO data reveals that Elixhauser comorbidities usually explain less than 10% of the variation in case-fatality rates, and barely affect the relative position of a hospital with regard to the benchmark.

Recommendation: International comparisons of adjusted fatality rates should take into account that English and Portuguese hospitals may be affected by differential coding practices. Comparisons that include Slovenia should only use post-2005 data. However, estimates are expected to remain similar (Elixhauser comorbidities will usually explain less than a 10% of the variation).

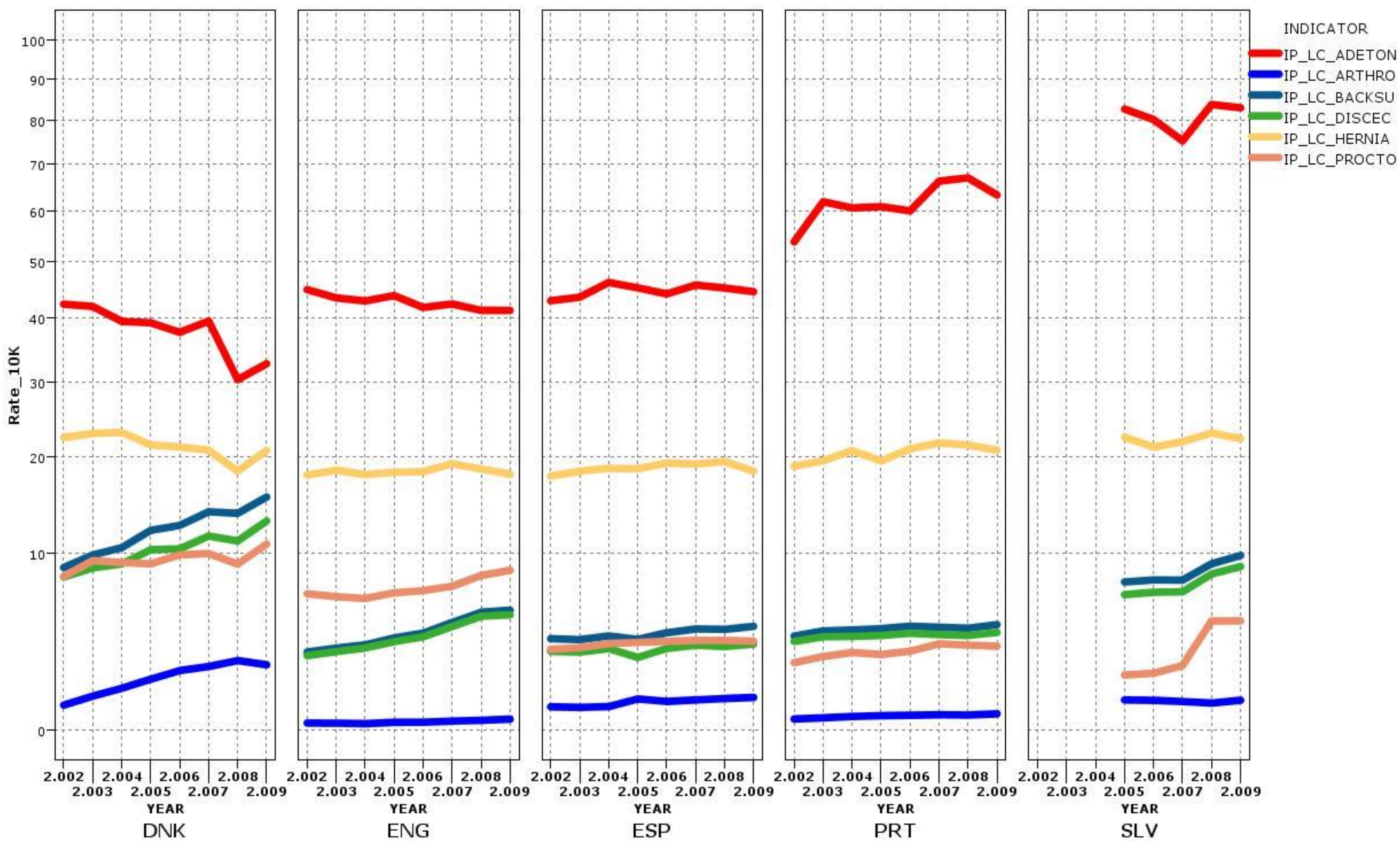


Figure 17. Rate of low-value care (LC) indicators per 10000 inhabitants by country and year.

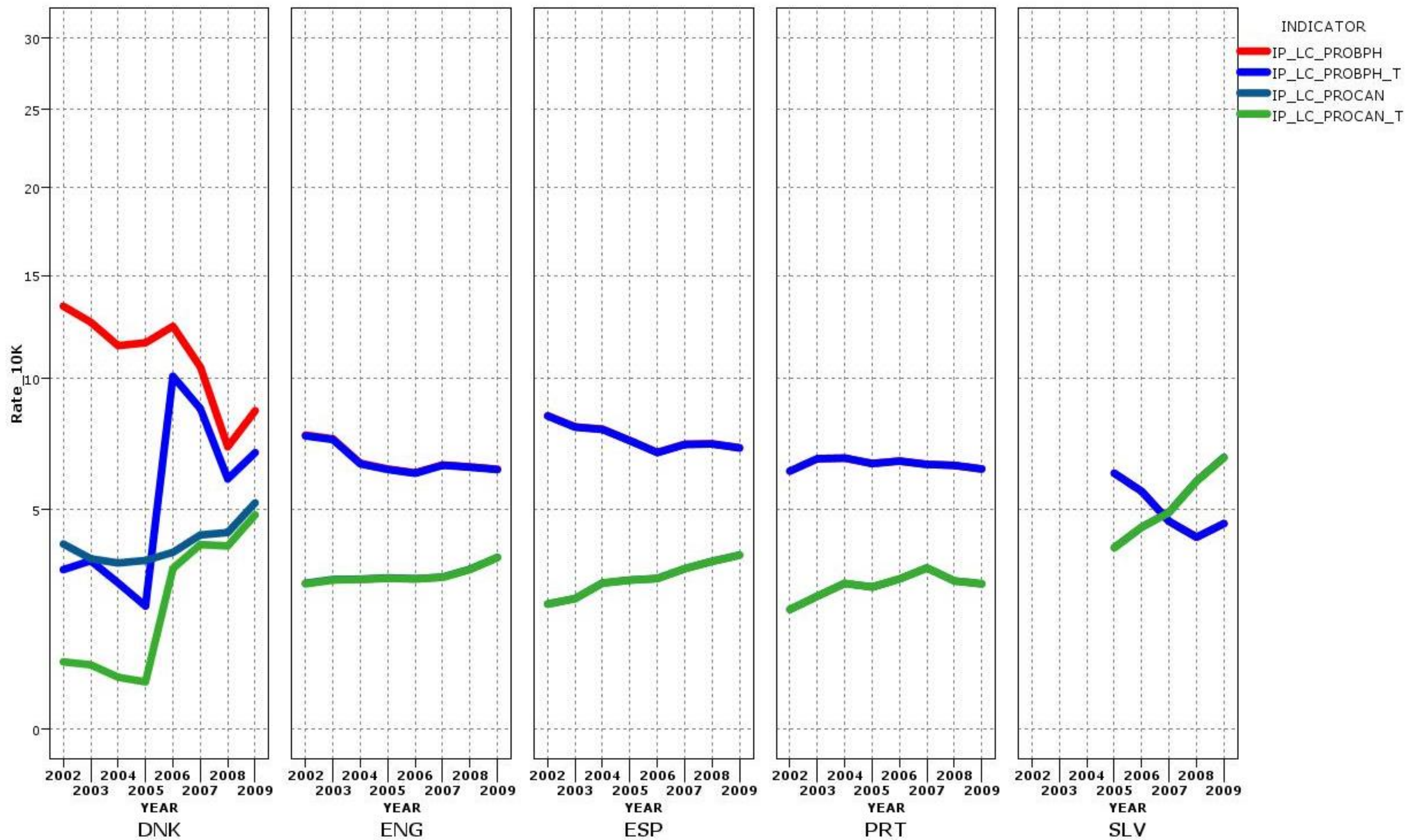


Figure 18. Rate of low value care (LC) indicators per 10000 male inhabitants by country and year.

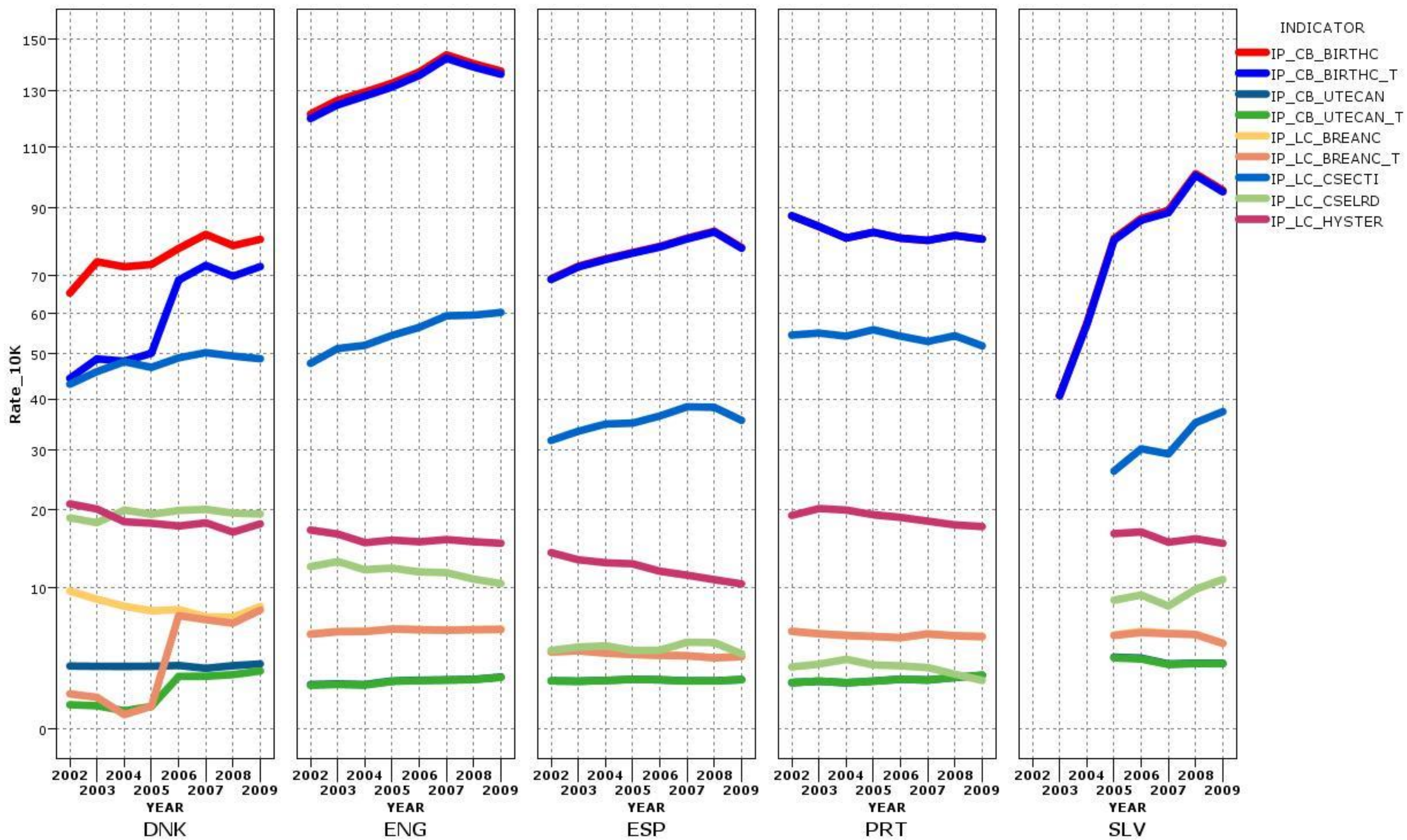


Figure 19. Rate of low value care (LC) indicators per 10000 female inhabitants by country and year.

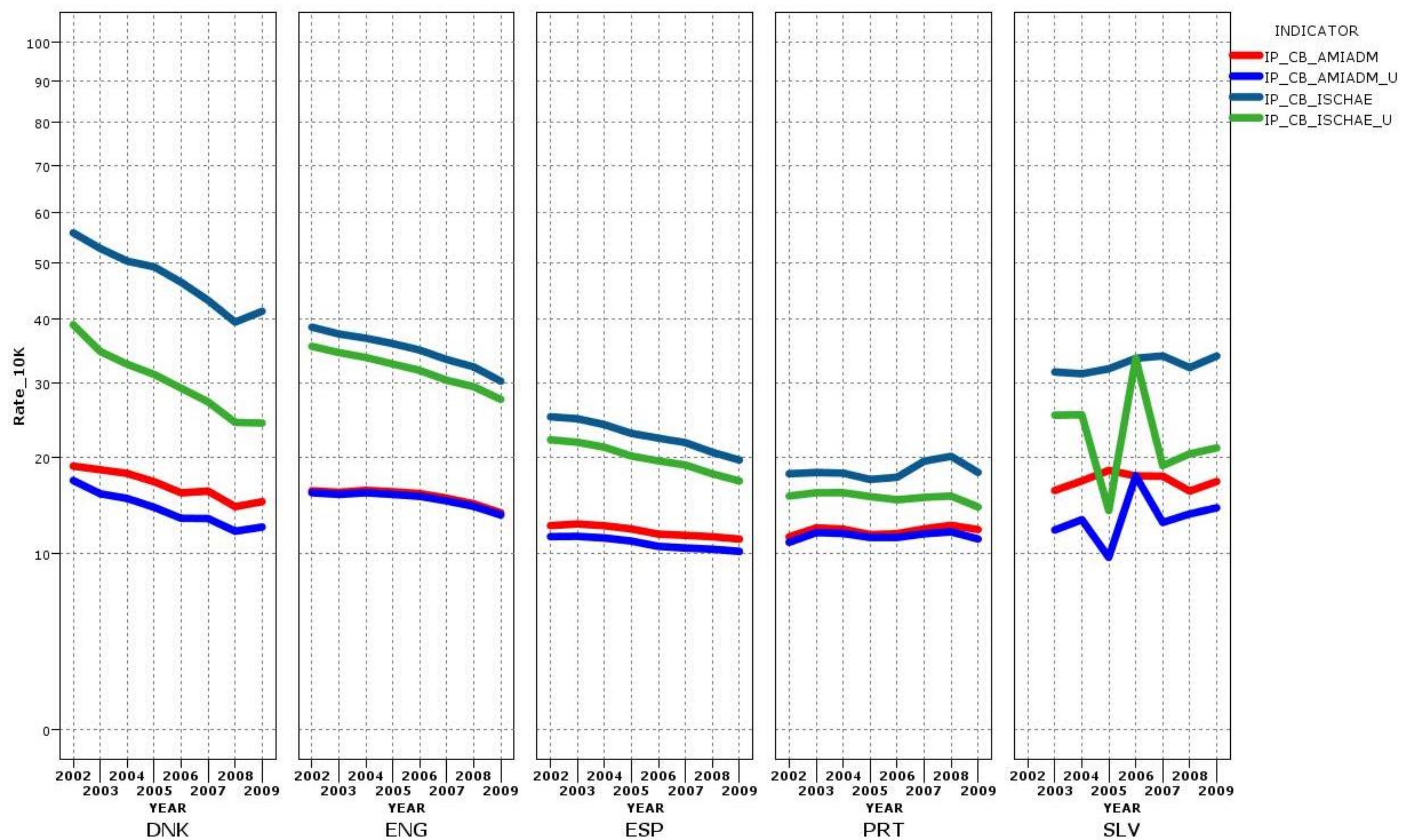


Figure 20. Rate of calibrator (CB) indicators per 10000 inhabitants by country and year.

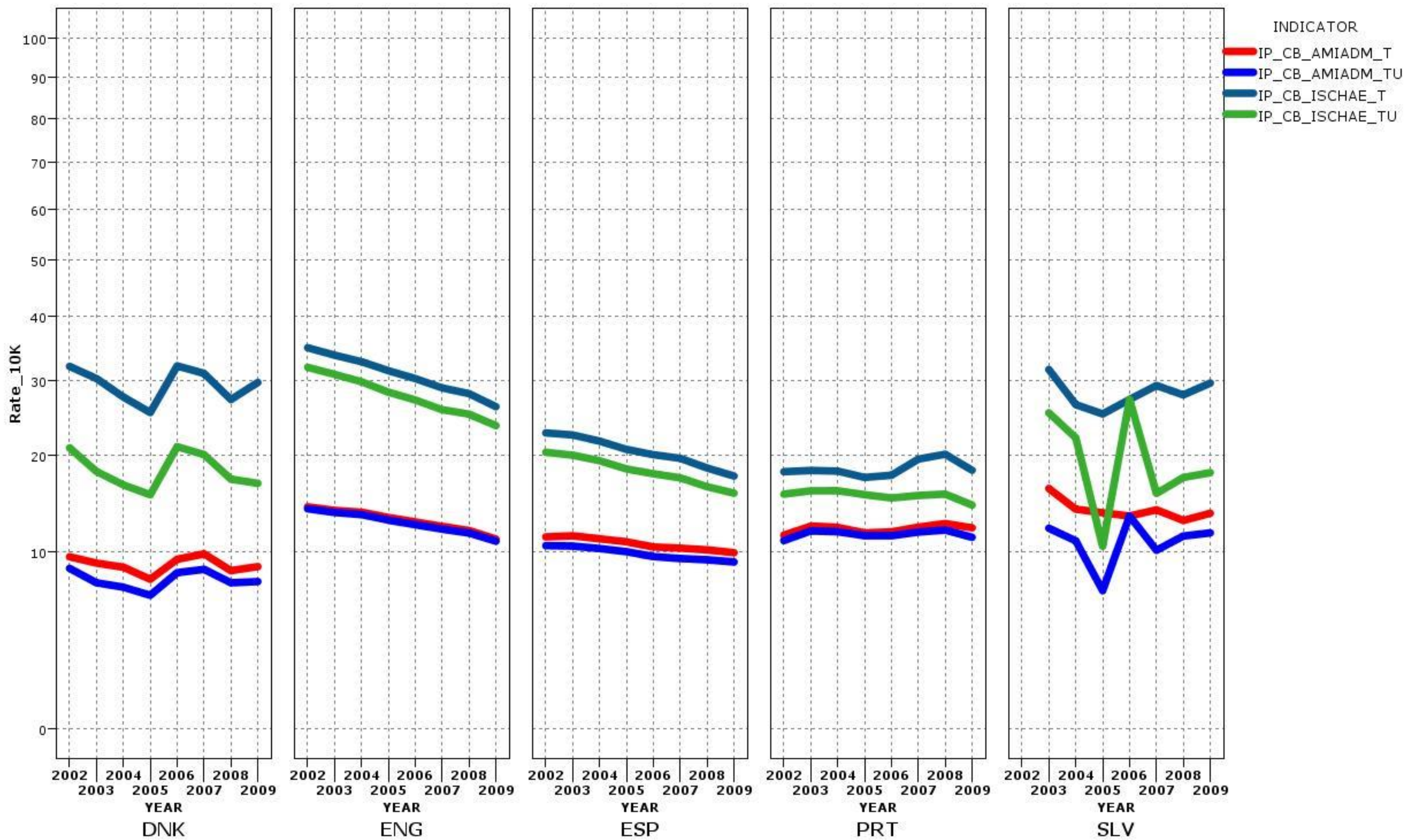


Figure 21. Rate of calibrator (CB) indicators without transfers per 10000 inhabitants by country and year.

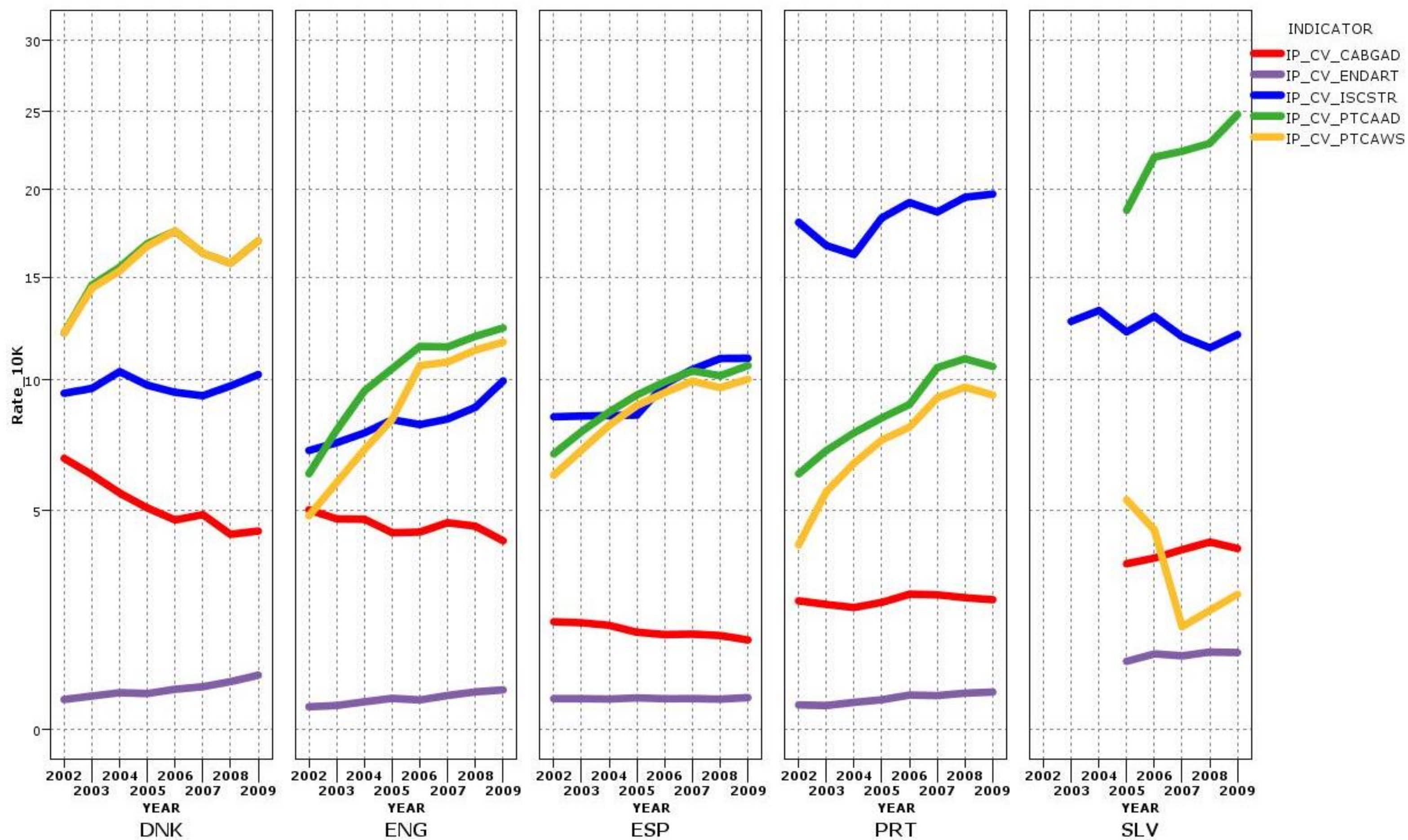


Figure 22. Rate of cardiovascular (CV) indicators per 10000 inhabitants by country and year.

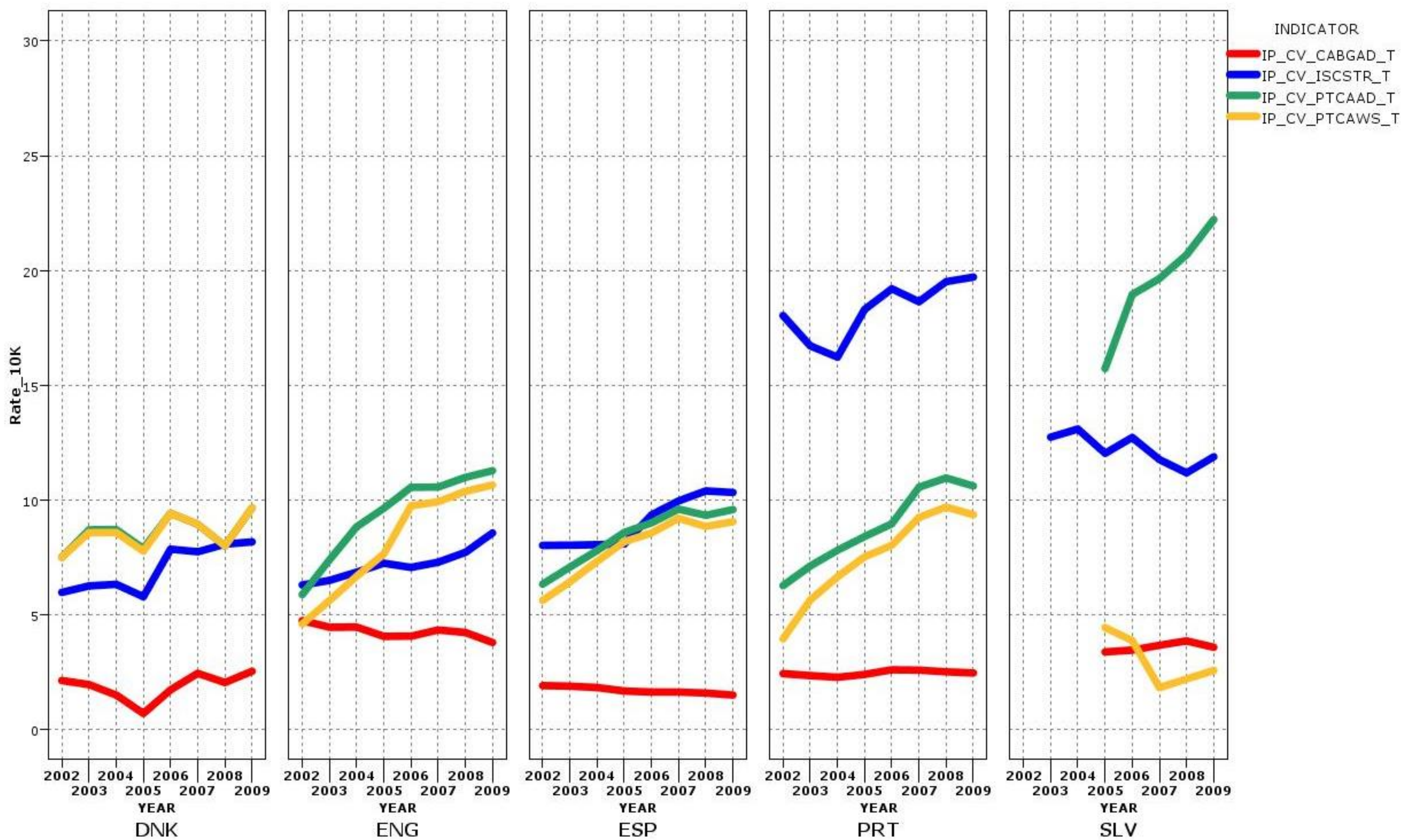


Figure 23. Rate of cardiovascular (CV) indicators without transfers per 10000 inhabitants by country and year.

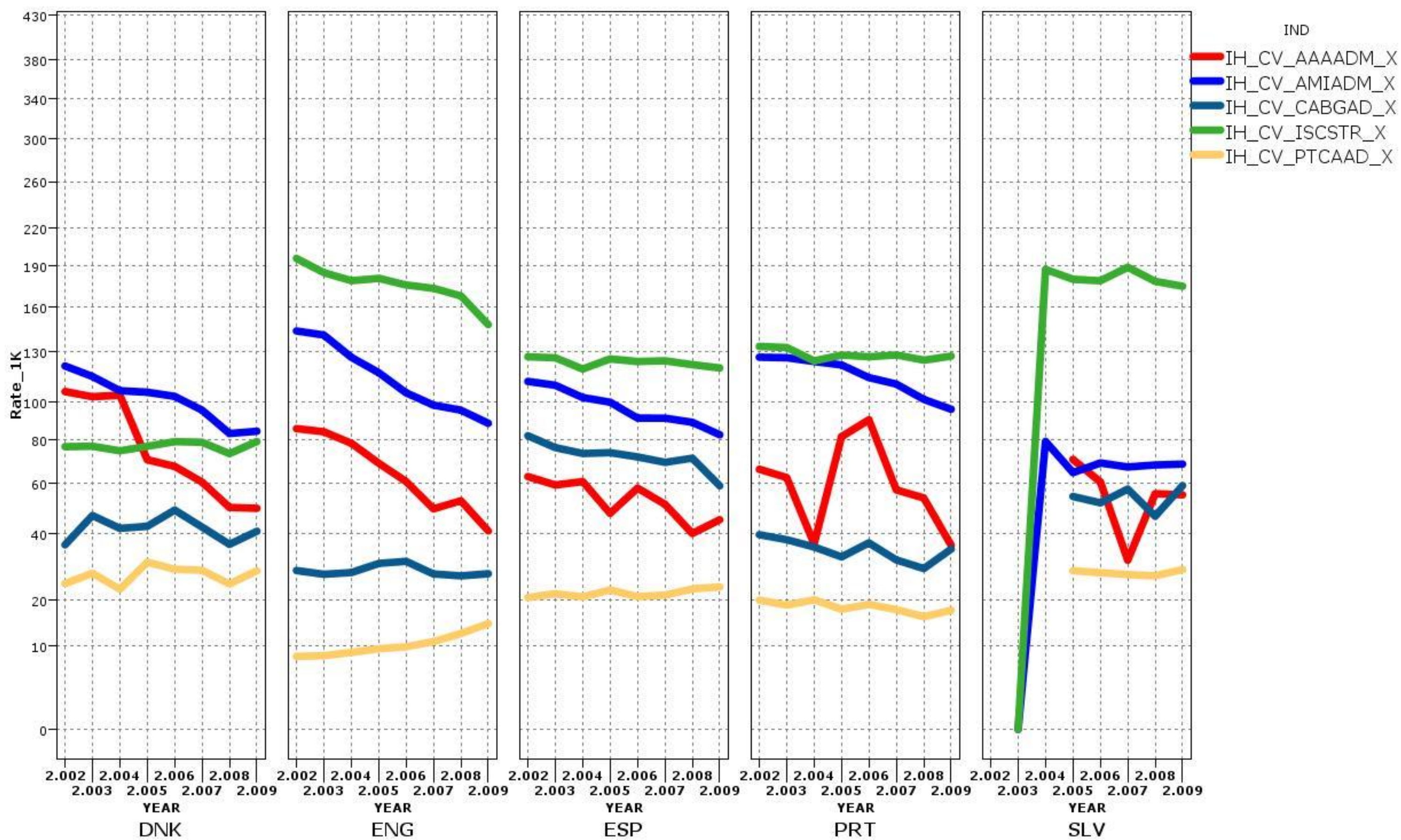


Figure 24. Mortality rate (X) indicators per 1000 hospitalization episodes by country and year.

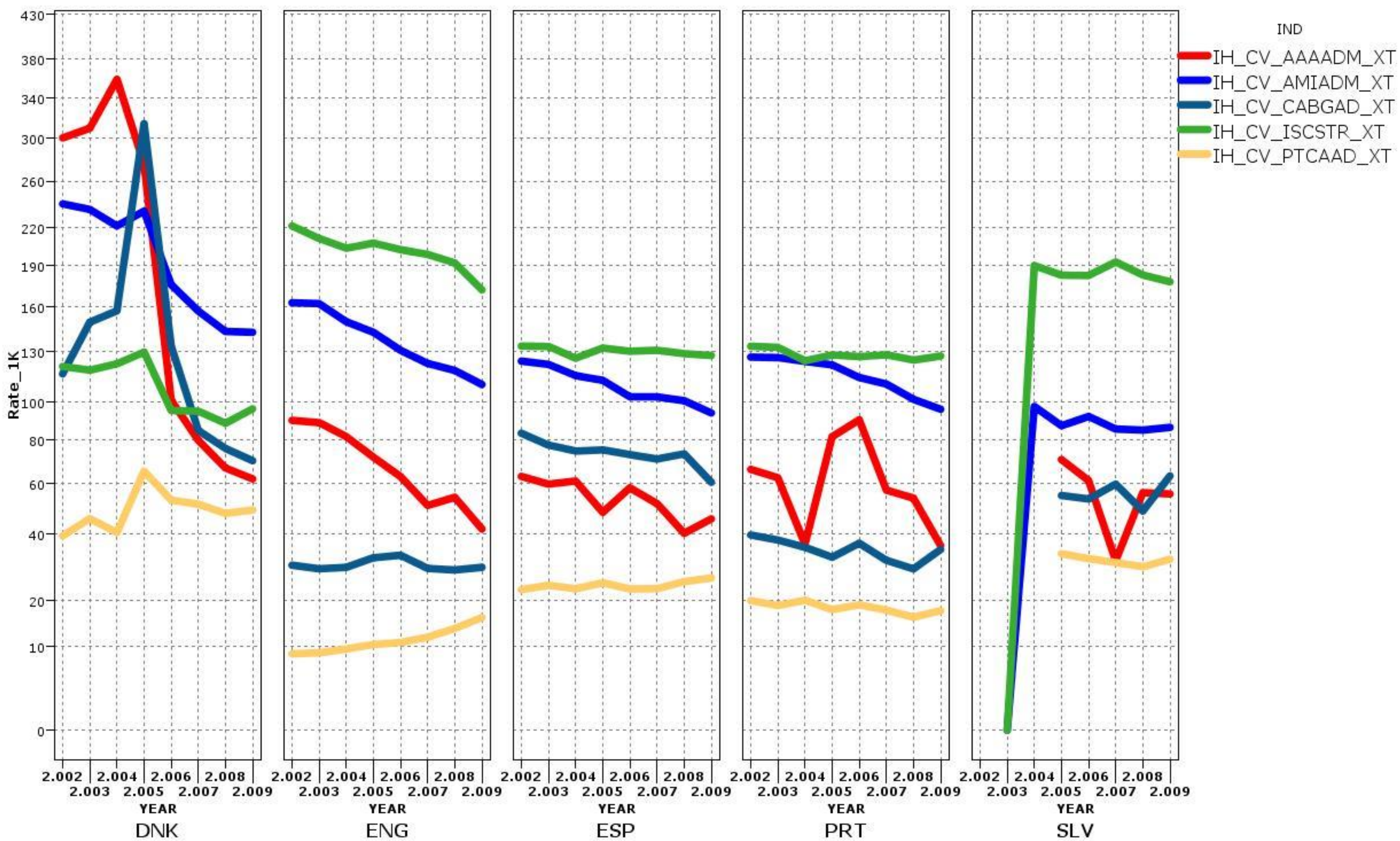


Figure 25. Mortality rate (X_T) indicators without transfers per 1000 hospitalization episodes by country and year.

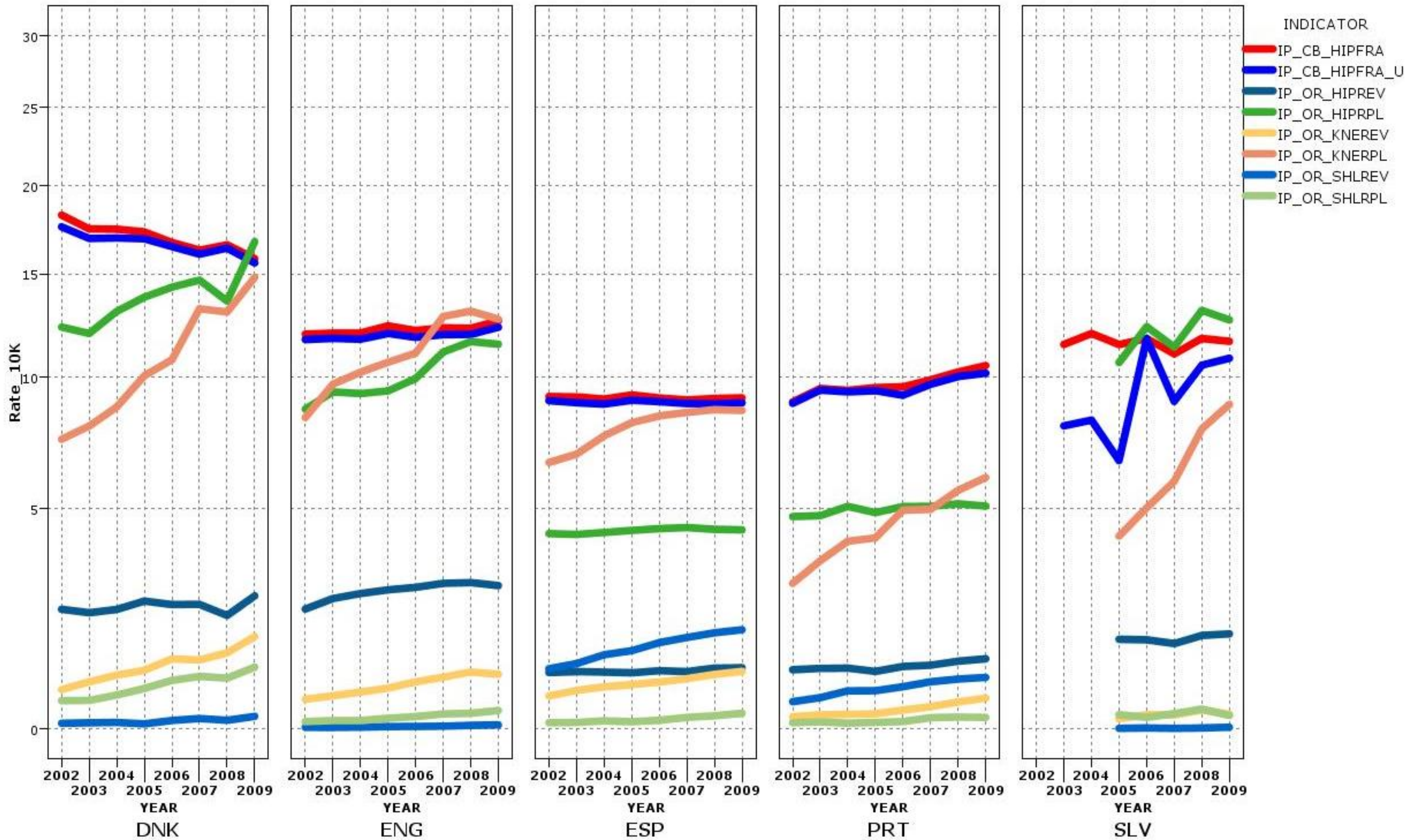


Figure 26. Rate of orthopaedic (OR) indicators per 10000 inhabitants by country and year.

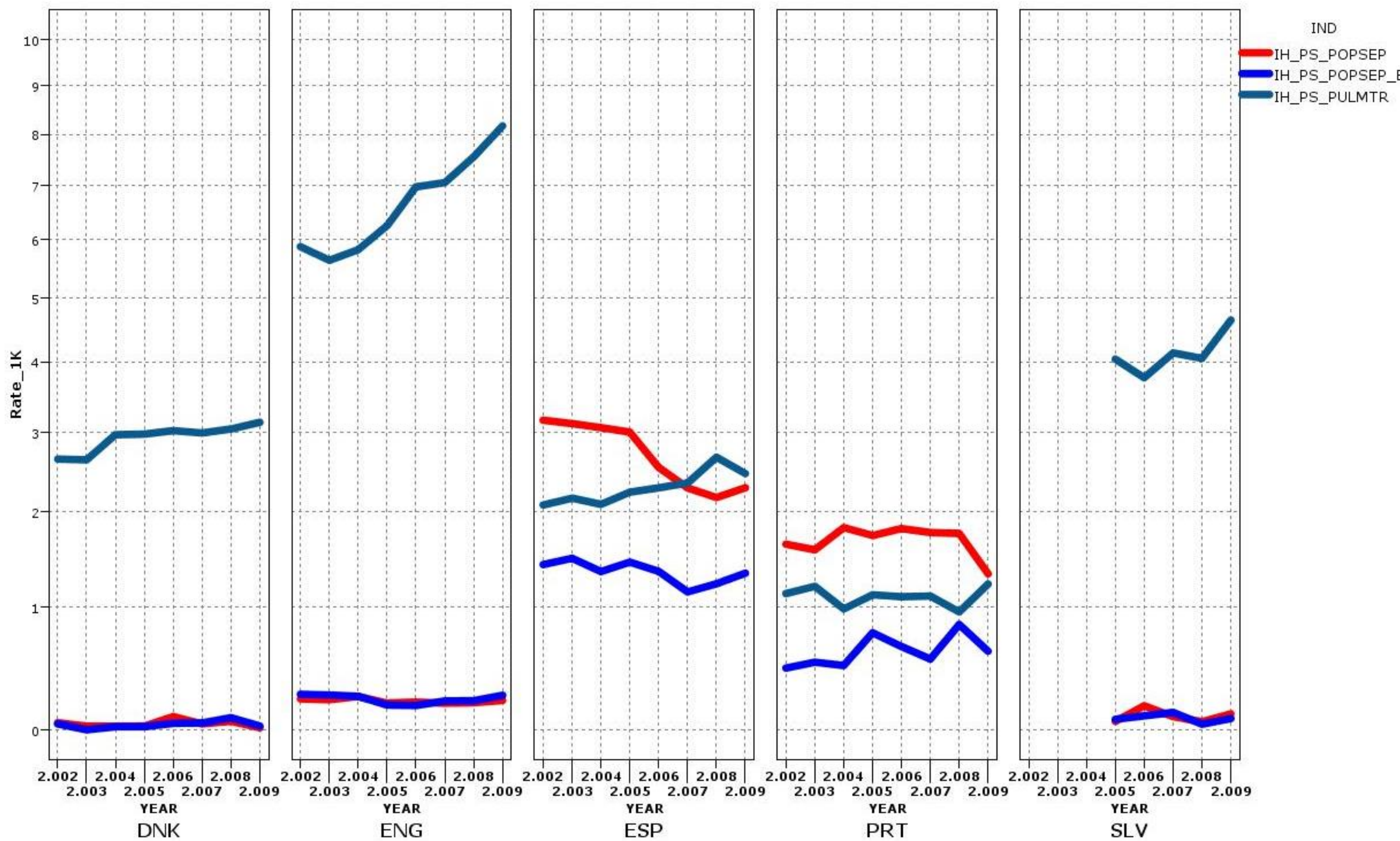


Figure 27. Rate of patient safety (PS) per 1000 hospitalization episodes by country and year.

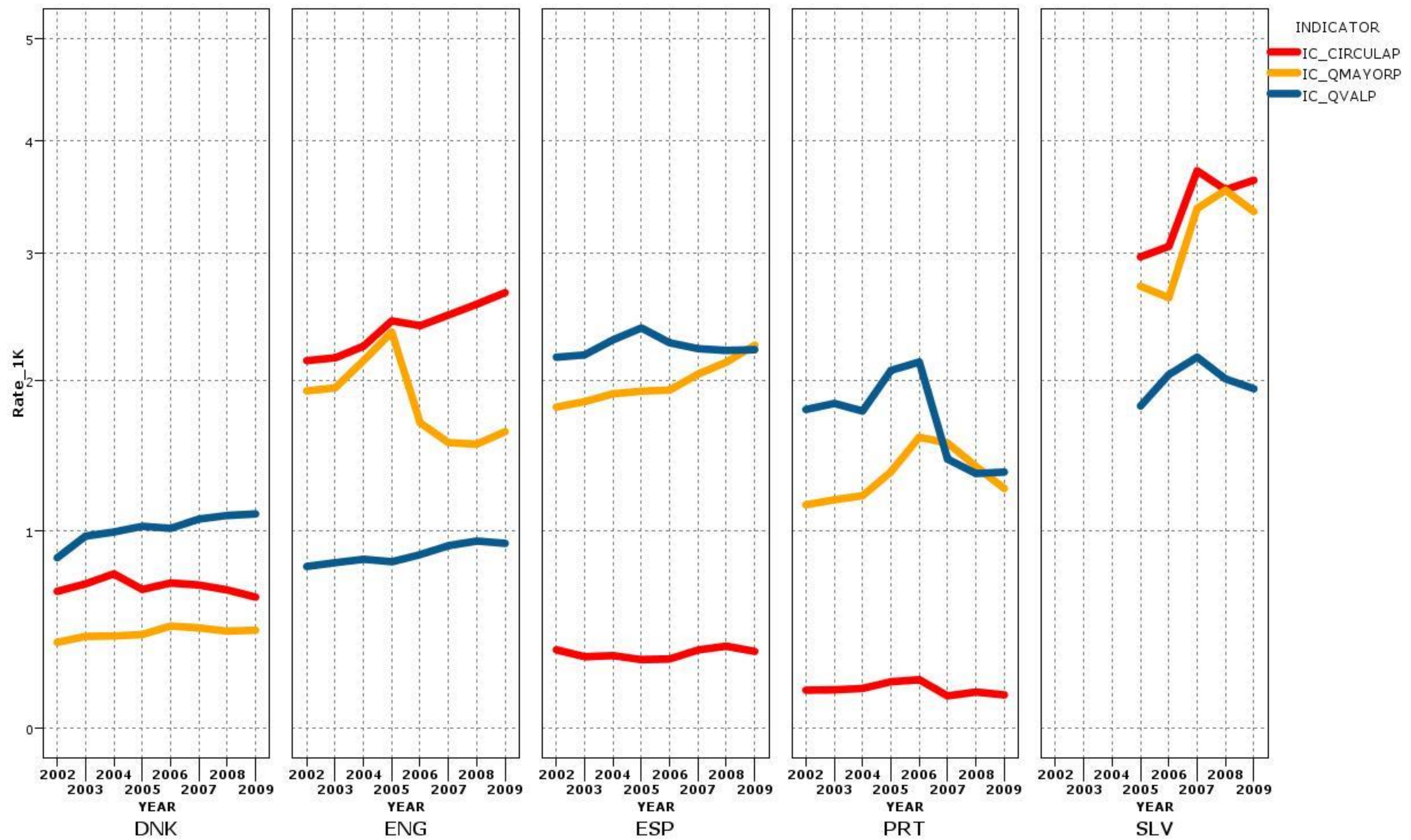


Figure 28. Rate of CABG adjustment (IC) indicators per 10000 episodes by country and year.

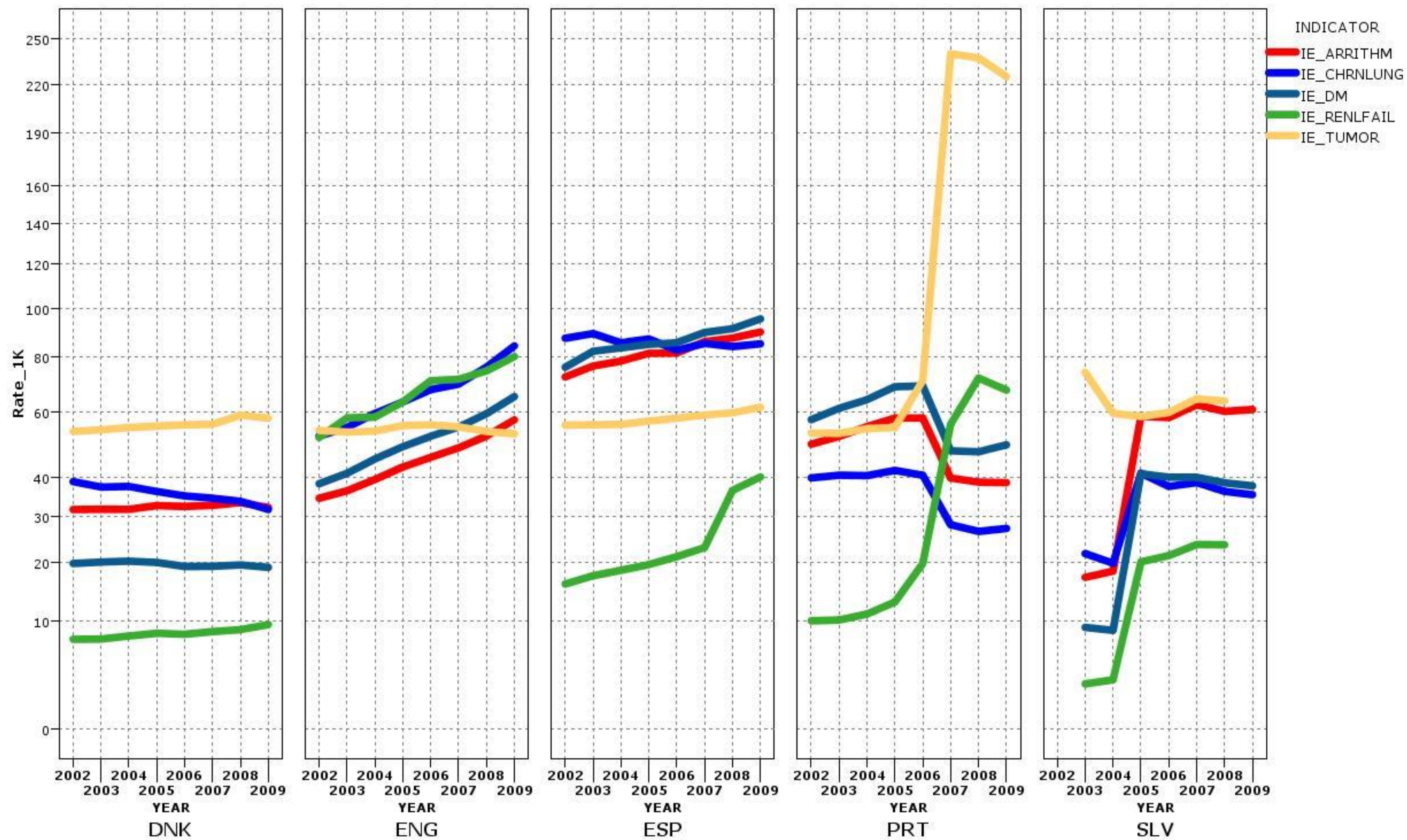


Figure 29. Rate of Elixhauser adjustment (IC) indicators per 1000 episodes by country and year.

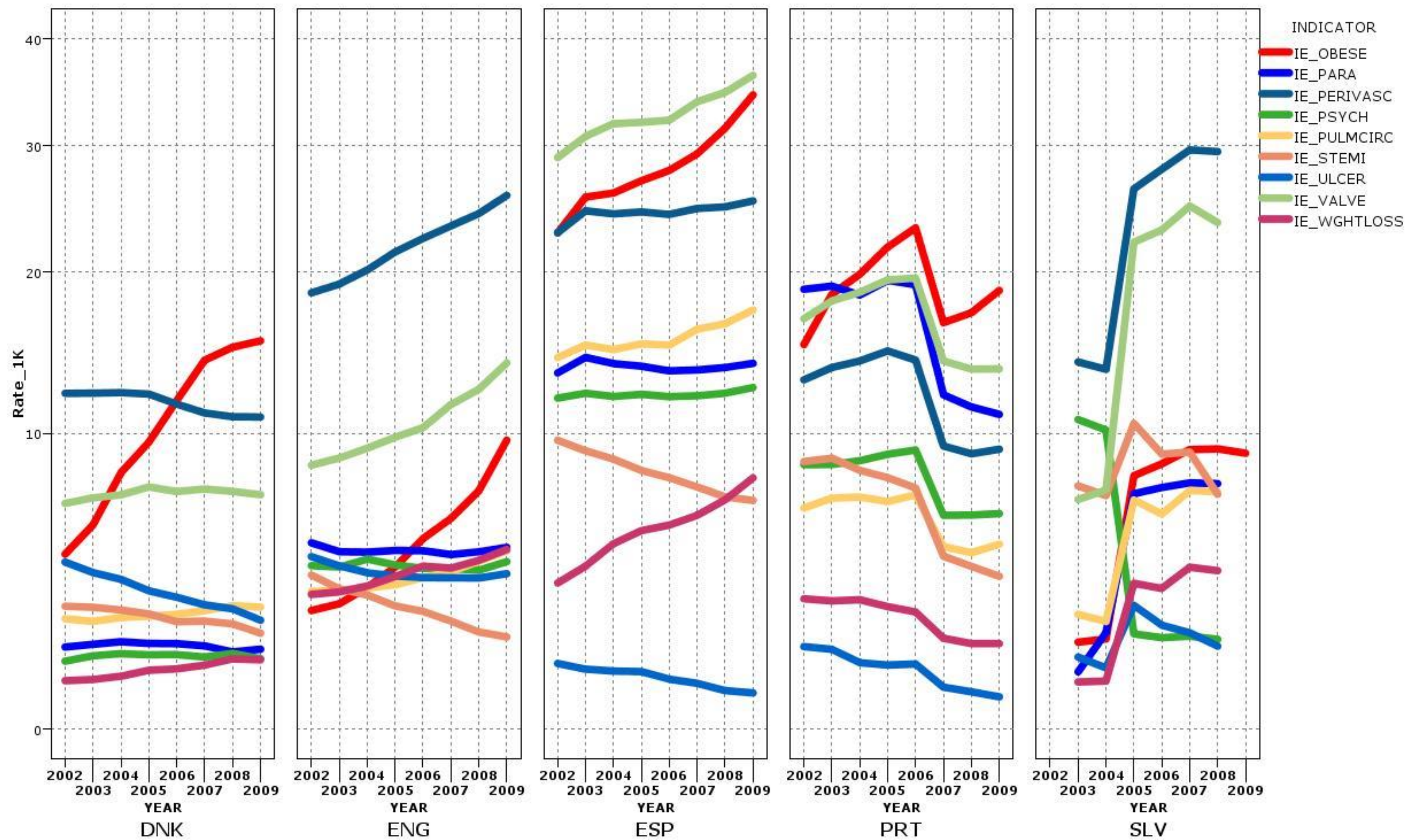


Figure 30. Rate of Elixhauser adjustment (IC) indicators per 1000 episodes by country and year.

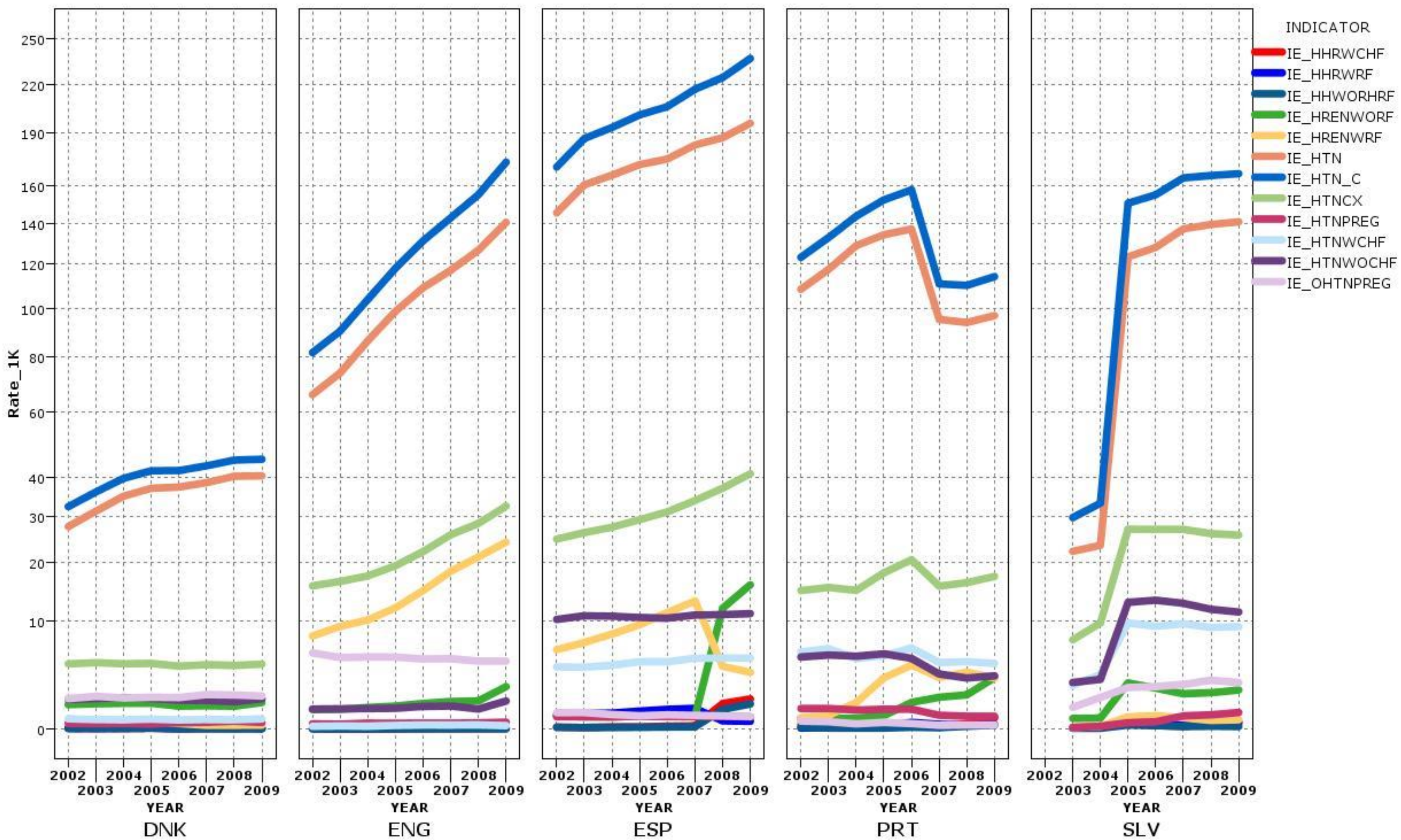


Figure 31. Rate of Elixhauser adjustment (IC) indicators per 1000 episodes by country and year.

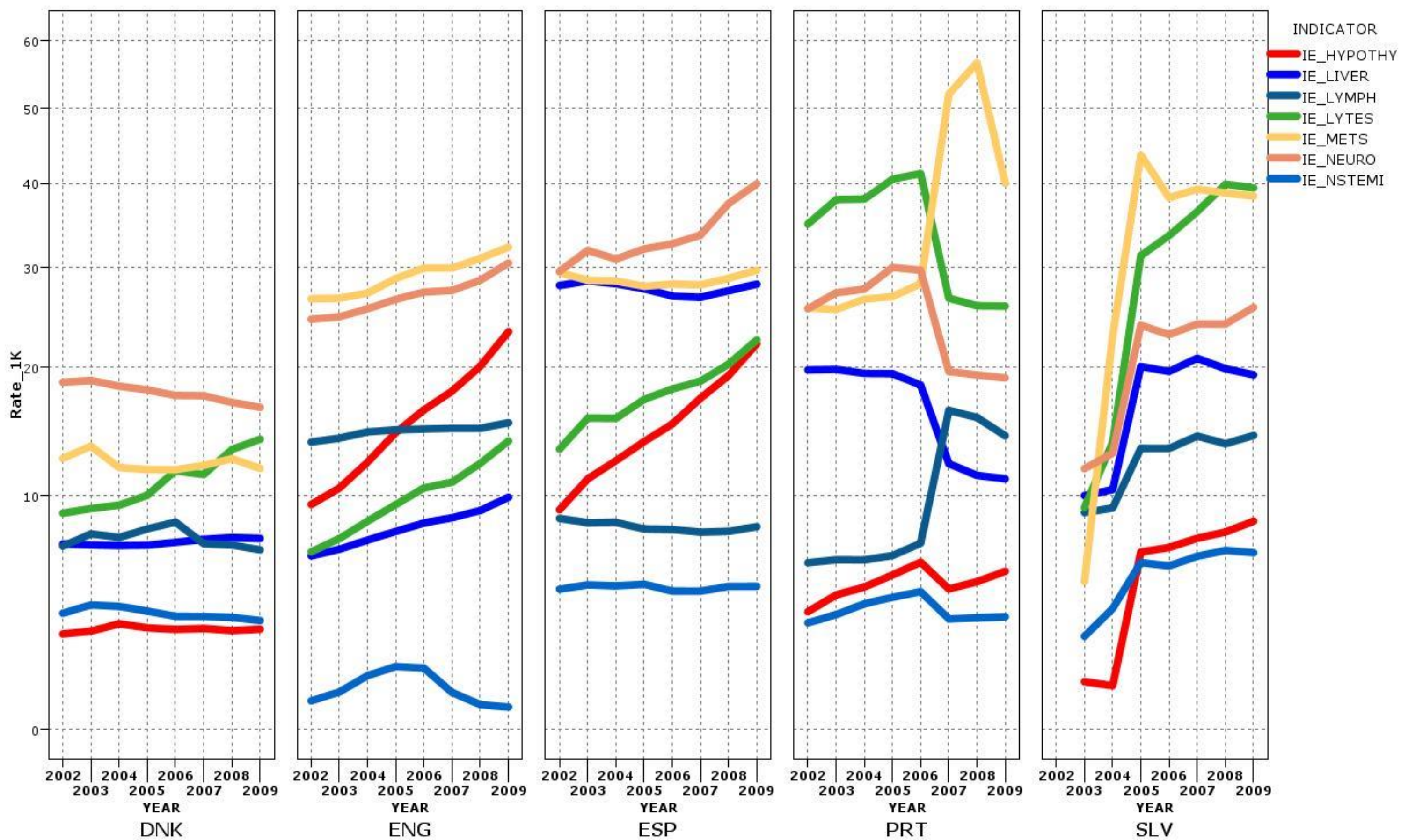


Figure 32. Rate of Elixhauser adjustment (IC) indicators per 1000 episodes by country and year.

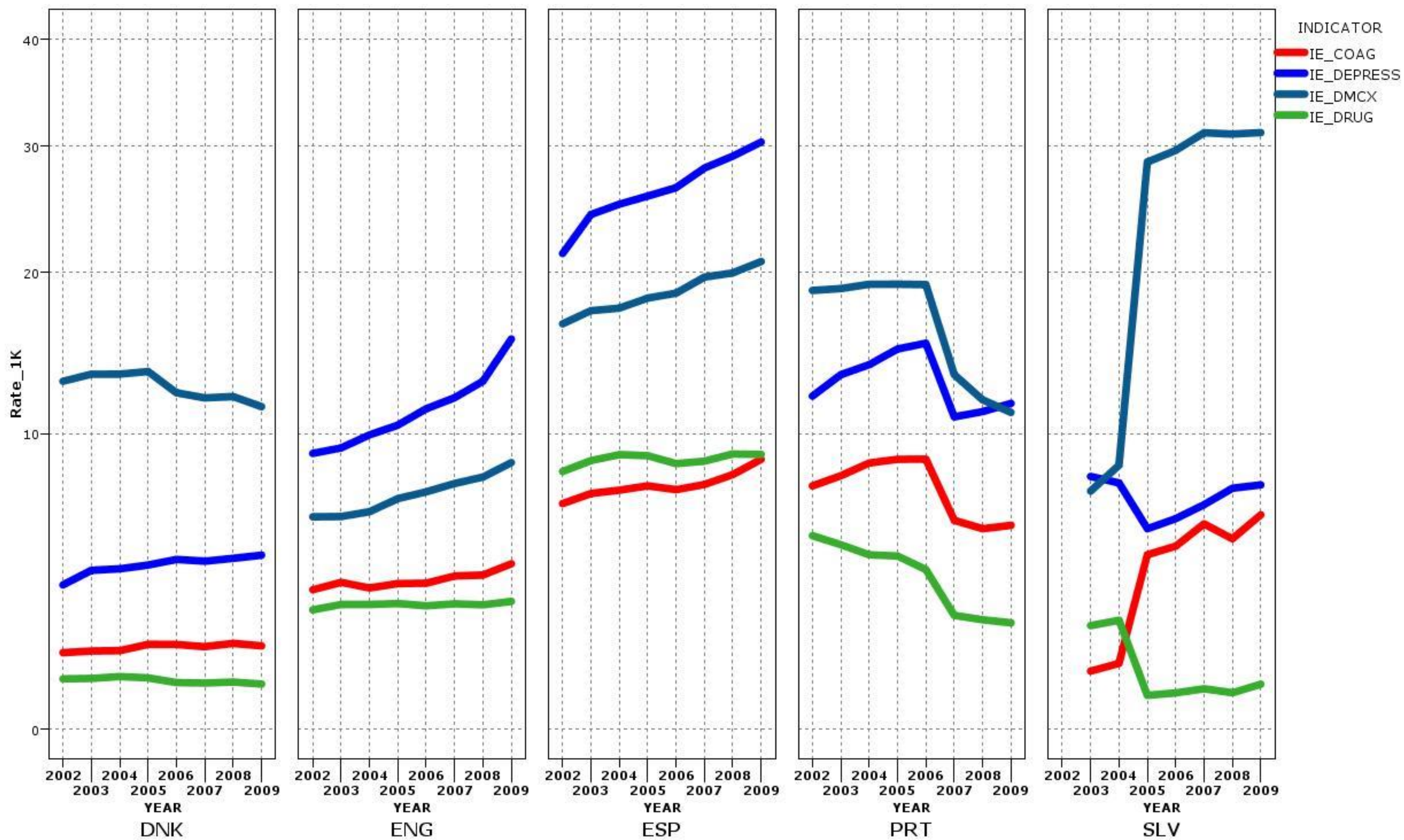


Figure 33. Rate of Elixhauser adjustment (IC) indicators per 1000 episodes by country and year.

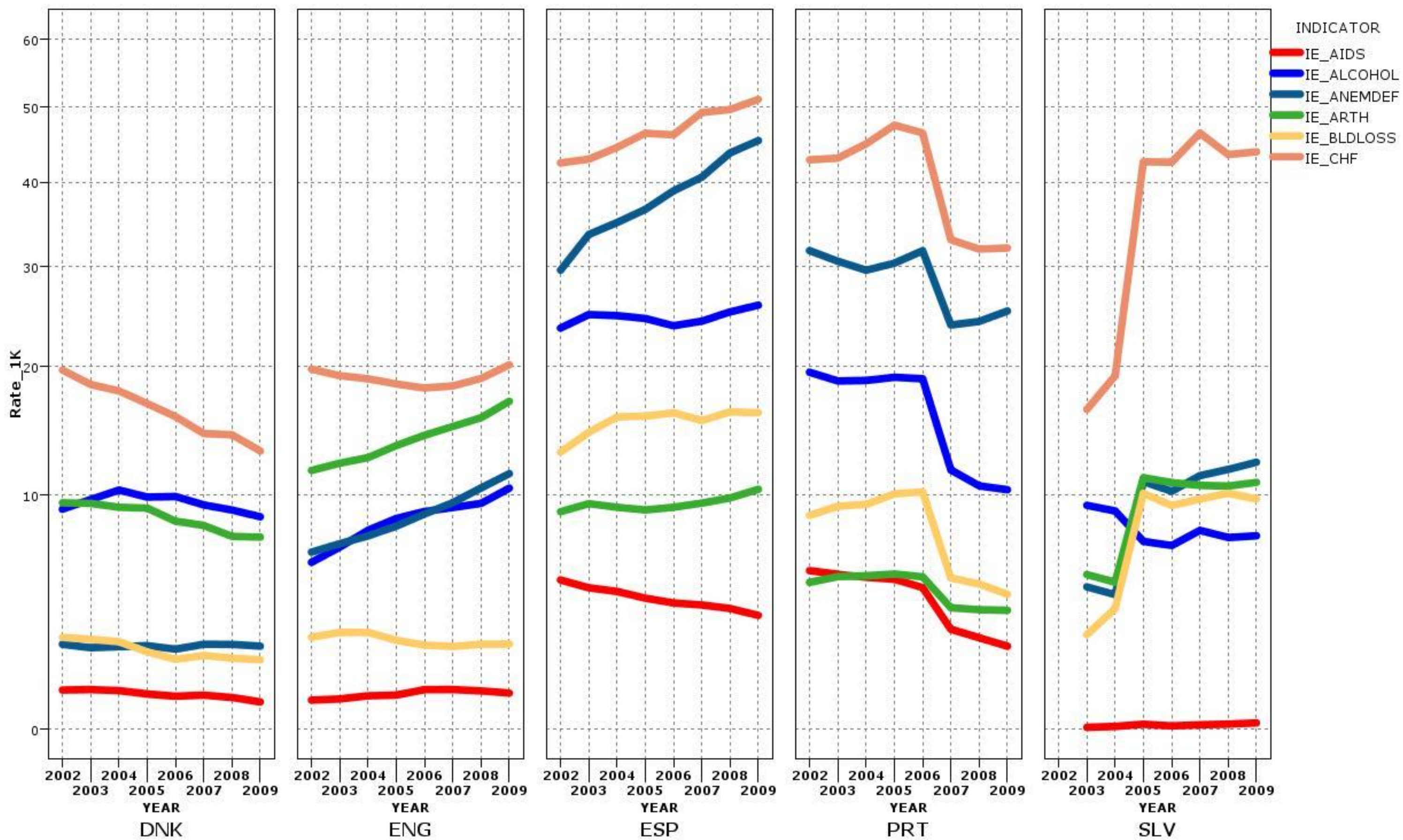
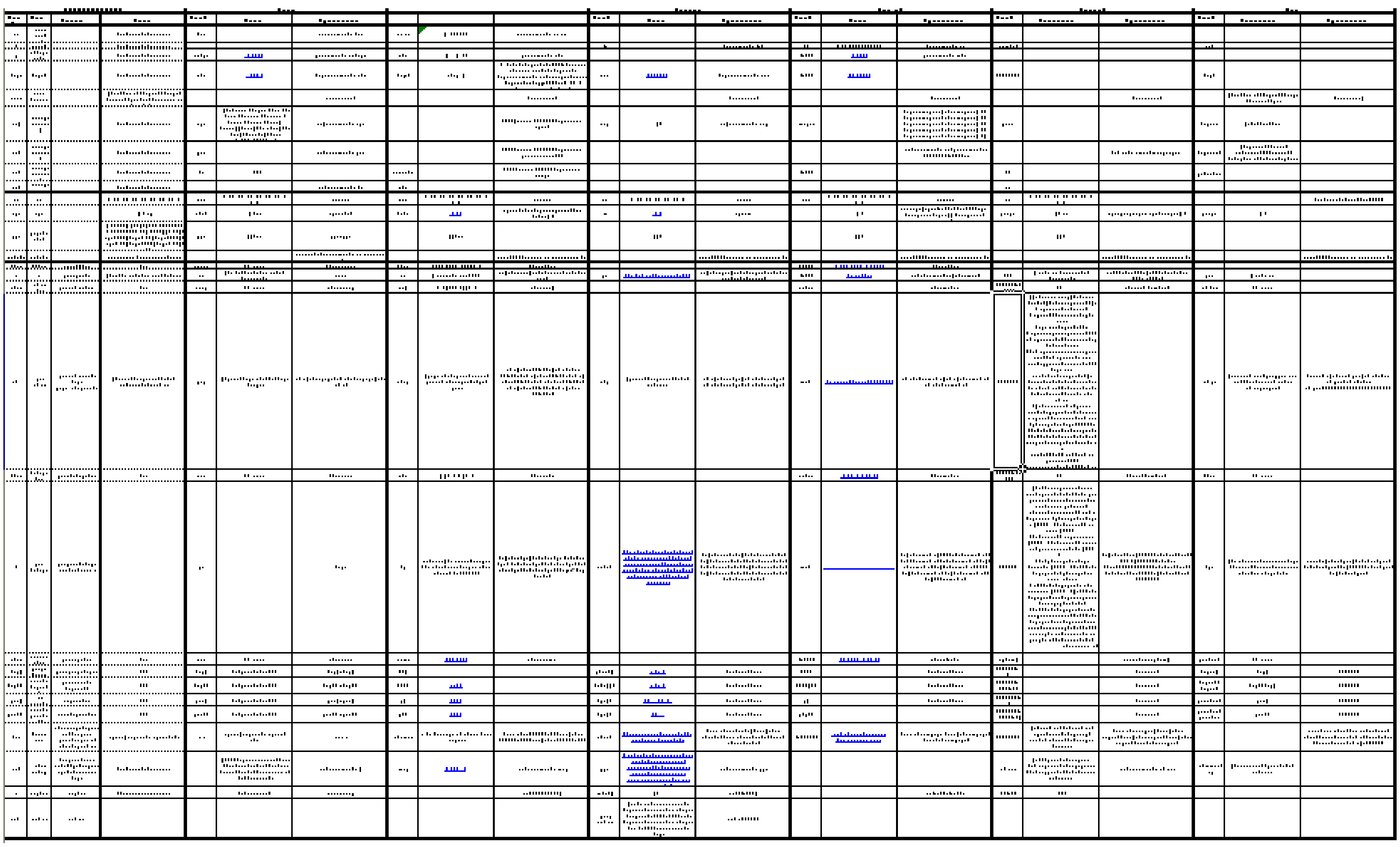


Figure 34. Rate of Elixhauser adjustment (IC) indicators per 1000 episodes by country and year.

ANNEX A



Click to see Annex A

ANNEX B

GROUP NAME	NAME	DESCRIPTION
Risk adjustment for CABG	Ic_circulap	CABG risk adjustment variable. Procedure codes for implantation of heart and circulatory assist system(s).
	Ic_qmayorp	CABG risk adjustment variable. Procedure codes for major heart structure surgery. Includes repair of atrial and ventricular septa, revision of such procedures, cardiotomy and pericardiotomy, pericardiectomy and excision of lesion of heart.
	Ic_qvalp	CABG risk adjustment variable. Procedure codes for valvular surgery: includes open and closed valvuloplasty and replacement.
Elixhauser Comorbidity Index	Ie_aids	Elixhauser risk adjustment variable: AIDS/HIV
	Ie_alcohol	Elixhauser risk adjustment variable: alcohol abuse
	Ie_anemdef	Elixhauser risk adjustment variable: deficiency anaemia
	Ie_arrithm	Elixhauser risk adjustment variable: cardiac arrhythmias
	Ie_arth	Elixhauser risk adjustment variable: rheumatoid arthritis/collagen vascular diseases
	Ie_bldloss	Elixhauser risk adjustment variable: blood loss anaemia
	Ie_chf	Elixhauser risk adjustment variable: congestive heart failure
	Ie_chrnlung	Elixhauser risk adjustment variable: chronic lung disease
	Ie_coag	Elixhauser risk adjustment variable: coagulopathy
	Ie_depress	Elixhauser risk adjustment variable: depression
	Ie_dm	Elixhauser risk adjustment variable: diabetes, without chronic complications
	Ie_dmcx	Elixhauser risk adjustment variable: diabetes, with chronic complication
	Ie_drug	Elixhauser risk adjustment variable: drug abuse
	Ie_hhrwchf	Elixhauser risk adjustment variable: hypertensive heart and renal disease with heart failure
	Ie_hhrwrf	Elixhauser risk adjustment variable: hypertensive heart and renal disease with renal failure
	Ie_hhwhrf	Elixhauser risk adjustment variable: hypertensive heart and renal disease with heart and renal failure
	Ie_hhworhrf	Elixhauser risk adjustment variable: hypertensive heart and renal disease without heart or renal failure
	Ie_hrenworf	Elixhauser risk adjustment variable: hypertensive renal disease without renal failure
	Ie_hrenwrf	Elixhauser risk adjustment variable: hypertensive renal disease with renal failure
	Ie_htn	Elixhauser risk adjustment variable: hypertension, uncomplicated
	Ie_htncx	Elixhauser risk adjustment variable: hypertension, complicated
	Ie_htnpreg	Elixhauser risk adjustment variable: pre-existing hypertension complicating pregnancy
	Ie_htnwchf	Elixhauser risk adjustment variable: hypertension with congestive Heart failure
	Ie_htnwochf	Elixhauser risk adjustment variable: without congestive Heart failure
	Ie_htn_c	Elixhauser risk adjustment variable: total hypertension disease
	Ie_hypothy	Elixhauser risk adjustment variable: hypothyroidism
	Ie_liver	Elixhauser risk adjustment variable: liver disease
	Ie_lymph	Elixhauser risk adjustment variable: lymphoma
	Ie_lytes	Elixhauser risk adjustment variable: fluid and electrolyte disorders
	Ie_mets	Elixhauser risk adjustment variable: metastatic cancer
	Ie_neuro	Elixhauser risk adjustment variable: other neurological disorders
	Ie_obese	Elixhauser risk adjustment variable: obesity
	Ie_ohtnpreg	Elixhauser risk adjustment variable: other hypertension in pregnancy
	Ie_para	Elixhauser risk adjustment variable: paralysis

	Ie_perivasc	Elixhauser risk adjustment variable: peripheral vascular disorders
	Ie_psych	Elixhauser risk adjustment variable: psychoses
	Ie_pulmcirc	Elixhauser risk adjustment variable: pulmonary circulation disorders
	Ie_renlfail	Elixhauser risk adjustment variable: renal failure
	Ie_tumor	Elixhauser risk adjustment variable: solid tumour without metastasis
	Ie_ulcer	Elixhauser risk adjustment variable: peptic ulcer disease excluding bleeding
	Ie_valve	Elixhauser risk adjustment variable: valvular disease
	Ie_wghtloss	Elixhauser risk adjustment variable: weight loss
Hospital Calibrators	Ih_cb_birthc	Discharges: women with diagnosis codes for deliveries with complications.
	Ih_cb_birthc_t	Discharges: women with diagnosis codes for deliveries with complications. Excluding transfers to another hospital.
Hospital Cardiovascular	Ih_cv_aaaadm_x	Discharges: patients aged 18 years and older with procedure code for AAA repair (any position). Excluding obstetric discharges.
	Ih_cv_aaaadm_xt	Discharges: patients aged 18 years and older with procedure code for AAA repair (any position). Excluding obstetric discharges and transfers to another hospital.
	Ih_cv_amiadm_x	Discharges: patients aged 18 years and older with a principal diagnosis code for AMI.
	Ih_cv_amiadm_xt	Discharges: patients aged 18 years and older with a principal diagnosis code for AMI. Excluding transfers to another hospital.
	Ih_cv_bicath	Discharges: patients aged 18 years and older with procedure code for bilateral cardiac catheterization (any position) and principal diagnosis of coronary artery heart disease.
	Ih_cv_cabgad_x	Discharges: patients over 40 with procedure code for CABG.
	Ih_cv_cabgad_xt	Discharges: patients over 40 with procedure code for CABG. Excluding transfers to another hospital.
	Ih_cv_iscstr_x	Discharges: patients over 40 with procedure code for CABG.
	Ih_cv_iscstr_xt	Discharges: patients over 40 with procedure code for CABG. Excluding transfers to another hospital.
	Ih_cv_ptcaad_x	Discharges: patients over 40 with procedure code for PTCA.
	Ih_cv_ptcaad_xt	Discharges: patients over 40 with procedure code for PTCA. Excluding transfers to another hospital.
Hospital Orthopedics	Ih_or_hiprpl_x	Discharges: patients aged 35 years and older with hip replacement procedure codes, either primary or revision. Excluding obstetric discharges.
	Ih_or_hiprpl_xt	Discharges: patients aged 35 years and older with hip replacement procedure codes, either primary or revision. Excluding obstetric discharges and transfers to another hospital.
Hospital PSIs	Ih_ps_popsep	Discharges: with codes for sepsis in any secondary diagnosis field. Excludes obstetric discharges.
	Ih_ps_popsep_e	Discharges: with codes for sepsis in any secondary diagnosis field. Excludes obstetric discharges and unplanned discharges.
	Ih_ps_pulmtr	All surgical discharges with a code for an operating room procedure, excluding cases in which vena cava interruption is the only procedure. Excludes obstetric discharges.
	Ih_ps_vagtra	Patients with 3rd and 4th degree obstetric trauma (perineum and vulva) during delivery without instrument.
Population Calibrators	Ip_cb_amiadm	Discharges with AMI codes as a principal diagnosis in patients aged 18 and older. Planned or unplanned.
	Ip_cb_amiadm_t	Discharges with AMI codes as a principal diagnosis in patients aged 18 and older. Excluding transfers to another hospital. Planned or unplanned.
	Ip_cb_amiadm_tu	Discharges with AMI codes as a principal diagnosis in patients aged 18 and older. Excluding transfers to another hospital. Unplanned.

	Ip_cb_amiadm_u	Discharges with AMI codes as a principal diagnosis in patients aged 18 and older. Unplanned.
	Ip_cb_hipfra	Discharges with hip fracture codes as a principal diagnosis in patients aged 35 and older. Excluding all transportation accidents due to external causes. Planned or unplanned.
	Ip_cb_hipfra_u	Discharges with hip fracture codes as a principal diagnosis in patients aged 35 and older. Excluding all transportation accidents external causes. Unplanned.
	Ip_cb_ischae	Discharges with AMI or angina as principal diagnosis in patients aged 18 years and older. Excluding planned discharges. Planned or unplanned.
	Ip_cb_ischae_t	Discharges with AMI or angina as principal diagnosis in patients aged 18 years and older. Excluding planned discharges and transfers to another hospital. Planned or unplanned.
	Ip_cb_ischae_tu	Discharges with AMI or angina as principal diagnosis in patients aged 18 years and older. Excluding planned discharges and transfers to another hospital. Unplanned.
	Ip_cb_ischae_u	Discharges with AMI or angina as principal diagnosis in patients aged 18 years and older. Excluding planned discharges. Unplanned.
	Ip_cb_utecan	Discharges women with uterine cancer diagnosis codes and hysterectomy procedure codes
	Ip_cb_utecan_t	Discharges: women with uterine cancer diagnosis codes and hysterectomy procedure codes. Excluding transfers to another hospital.
Population Cardiovascular	Ip_cv_cabgad	Discharges: patients over 40 with procedure code for CABG.
	Ip_cv_cabgad_t	Discharges: patients over 40 with procedure code for CABG. Excluding transfers to another hospital.
	Ip_cv_endart	Discharges: patients with procedure code for carotid endarterectomy.
	Ip_cv_endart_r	Discharges: patients with procedure code for carotid endarterectomy. Excluding patients aged below 18 and obstetrics discharges.
	Ip_cv_iscstr	Discharges: patients aged 18 years and older, with a principal diagnosis code for ischemic stroke.
	Ip_cv_iscstr_t	Discharges: patients aged 18 years and older, with a principal diagnosis code for ischemic stroke. Excludes transfers to another hospital.
	Ip_cv_iscstr_x	Deaths among patients aged 18 years and older, with a principal diagnosis code for ischemic stroke.
	Ip_cv_ptcaad	Discharges: patients aged over 40 with PTCA procedure codes
	Ip_cv_ptcaad_t	Discharges: patients over 40 with PTCA procedure codes. Excluding transfers to another hospital.
	Ip_cv_ptcaws	Discharges: patients over 40 with PTCA with stent procedure codes.
	Ip_cv_ptcaws_t	Discharges: patients over 40 with PTCA with stent procedure codes. Excluding transfers to another hospital.
Population Lower Value Care	Ip_lc_adeton	Discharges: patients aged 14 and younger with a procedure code for tonsillectomy and/or adenoidectomy.
	Ip_lc_arthro	Discharges: patients aged 20 and older, with any procedure code for arthrodesis excluding laminectomy or discectomy procedures, neoplasia, spondylopathies, osteomyelitis, fractures and accidents.
	Ip_lc_backsu	Discharges: for patients aged 20 years and older, with any procedure code for laminectomy or discectomy or arthrodesis, excluding neoplasia, spondylopathies, osteomyelitis, fractures and accidents.
	Ip_lc_breanc	Discharges: women with breast cancer diagnosis code and procedure code for non-conservative surgery.
	Ip_lc_breanc_t	Non-conservative surgery procedures in women with breast cancer, excluding transfers to another hospital.
	Ip_lc_csecti	Number of caesarean deliveries in female population aged 15-55.

	Ip_lc_cselrd	Number of caesarean deliveries among low risk deliveries (excludes deliveries with complications).
	Ip_lc_discec	Discharges: patients aged 20 years and older, with any procedure code for laminectomy or discectomy excluding neoplasia, spondylopathies, osteomyelitis, fractures and accidents.
	Ip_lc_hernia	Discharges: patients aged 18 years and older, with any procedure code for Inguinal, umbilical or femoral hernia repair.
	Ip_lc_hyster	Hysterectomy procedures in women aged 18 or older without cancer or trauma.
	Ip_lc_probph	Prostatectomy procedures in men aged 40 or older with benign prostatic hyperplasia.
	Ip_lc_probph_t	Prostatectomy procedures in men aged 40 or older with benign prostatic hyperplasia, excluding transfers to another hospital.
	Ip_lc_procan	Prostatectomy procedures in men aged 40 or older with prostate cancer.
	Ip_lc_procan_t	Prostatectomy procedures in men aged 40 or older with prostate cancer, excluding transfers to another hospital.
	Ip_lc_procto	Proctologic procedures in patients aged 18 or older.
Population Orthopedics	Ip_or_hiprev	Discharges: patients aged 35 years and older, with any procedure code for hip replacement revision excluding fractures and accidents.
	Ip_or_hiprpl	Discharges: patients aged 35 years and older, with any procedure code for hip replacement excluding revision procedures, fractures and accidents.
	Ip_or_knerev	Discharges: patients aged 45 years and older, with any procedure code for knee revision excluding fractures and accidents.
	Ip_or_knerpl	Discharges: patients aged 45 years and older, with any procedure code for knee replacement excluding revision procedures, fractures and accidents.
	Ip_or_shlrev	Discharges: patients aged 30 years and older, with any procedure code for shoulder revision excluding fractures and accidents.
	Ip_or_shlrpl	Discharges: patients aged 30 years and older, with any procedure code for shoulder replacement excluding revision procedures, fractures and accidents.
Population Potentially Avoidable Hospitalisations	Ip_hp_allpah	Sum of all cases across all conditions analysed as potentially avoidable hospitalisations (angina, asthma, COPD, DB, CHF and dehydration).
	Ip_hp_angwop	Discharges with a principal diagnosis of angina without a cardiac procedure in patients aged 40 years and older. Excludes cardiac procedures and obstetric discharges. Planned or Unplanned.
	Ip_hp_angwop_u	Discharges with a principal diagnosis of angina in patients without a cardiac procedure aged 40 years and older. Excludes cardiac procedures and obstetric discharges. Unplanned.
	Ip_hp_asthma	Discharges with principal diagnosis of asthma in patients aged 18 years and older. Excludes obstetric discharges and diagnosis codes for congestive heart failure, cystic fibrosis, mental disorders, respiratory diseases and COPD.
	Ip_hp_chfail	Discharges with a principal diagnosis of heart failure in patients aged 40 years and older. Excludes COPD, ischaemic heart disease and kidney failure diagnosis, also cardiac procedures and obstetric discharges.
	Ip_hp_copast	Discharges with principal diagnosis of COPD in patients aged 18 years and older. Excludes obstetric discharges and diagnosis codes for congestive heart failure, cystic fibrosis, and mental disorders.
	Ip_hp_copdad	Discharges with principal diagnosis of COPD or asthma in patients aged 18 years and older. Excludes obstetric discharges and diagnosis codes for congestive heart failure, cystic fibrosis and mental disorders.
	Ip_hp_dehydr	Discharges with a principal diagnosis of dehydration in patients aged 65 years and older.

	Ip_hp_diabcc	Discharges: patients aged 40 years and older with a principal diagnosis of diabetes with short-term complications. Excludes obstetric discharges and mental disorders.

ANNEX C

For further information see CROSSWALKS in HANDBOOK (http://www.echo-health.eu/handbook/)

ANNEX D

ECHO_CORE

Column	Description
discharge_id	**Primary key. Clinical record number.**
hosp_year	Year
hosp_hist	Historical hospital code
discharge_dcc	Day case care: 0, inpatient; 1, outpatient; 2, emergency; 3, other.
discharge_tadm	Type of admission: 1, planned; 2, unplanned; 3, other; 4, unknown; 5, obstetric admission.
discharge_tdis	Type of discharge: 1, home; 2, to other hospital; 3, elderly home or social institution; 4, discharged of own accord; 5, death; 6, to home care facilities; 7, discharged to die at home; 8, getaway; 9, unknown; 10, transfer to inpatient setting from outpatient setting; 11, transfer to a long-stay hospital; 12, others; 13, follow-up care; 14, in-hospital visit; 15, other countries ; 16, other hospital department.
discharge_date_adm	Patient's admission date
discharge_date_int	Patient's surgery date
discharge_date_dis	Patient's discharge date
discharge_los	Length of stay
patient_id	Patient ID
patient_sex	Patient's gender; 1, male; 2, female; 3, indeterminate; 9, unknown
patient_bdate	Patient's birth date
patient_age	Age of patient (discharge date), 0-105, missing
patient_mare4	**Patient's municipality code, or maximum level of territorial detail**
patient_mfund	Patient's modality of funding (each country has different values).
diag_1	Patient's principal diagnosis
diag_2-30	Patient's secondary diagnoses (max. 29 fields)
proc_1	Patient's main procedure
proc_2-30	Patient's secondary procedure (max. 29 fields)

ECHO_MARE

Column	Description
mare1	region code (political map); NUTS I
mare1_d	region description (political map); NUTS I
mare2	sub-region code or province code (political map); NUTS II
mare2_d	sub-region description or province description (political map); NUTS II
mare3	health area code or hospital area code (health map)
mare3_d	health area description or hospital area description (health map)
mare4	**municipality code, or maximum level of territorial detail (political map)**
mare4_d	municipality description, or maximum level of territorial detail (political map)

ECHO_MARE_POPULATION

Column	Description
mare4	**Municipality code, or maximum level of territorial detail**
Year	**Year**
Sex	**Patient's gender: 1,male; 2, female**
Gqe	**Age interval of population (1 - 18); 1, 0-04; 2, 05-09;…, 18, 85-max.**
population	Population in the age group and sex
year_pop	Current reporting years, sometimes not available in annual information (input required)

ECHO_MARE_SOCIOECONOMIC

Column	Description
mare4	**Municipality code, or maximum level of territorial detail (political map)**
Year	**Year**
population	Population total in mare4 - year
avinc	Annual per capita income
edu_pri	Percentage of the population with primary education or lower
edu_sec	Percentage of the population with secondary education/vocational training (not college education)
edu_uni	Percentage of population with university education or higher: degrees, doctorates *etc.*
un	Percentage of the population unemployed
un_m	Percentage of the population unemployed, men
un_w	Percentage of the population unemployed, women
un_0005	Percentage of the population unemployed, under 30
un_0610	Percentage of the unemployed population aged greater than or equal to 30 and less than 55 years
un_1118	Percentage of the population unemployed, aged 30 to 54 inclusive

ECHO_HOSP_HIST

Column	**Descriptive**
YEAR	Year of discharge code; …,10,11,12,13
HOSP_HIST	ECHO code historical hospital, composed of country, m4 address, actual hospital and sequential identifier.
HOSP_HIST_D	ECHO description of historical hospital.
MARE_ID_ADRESS	Location of the historical hospital address (not to be confused with hierarchical location).

ECHO_HOSP_HIST_ESRII

Column	**Descriptive**
HOSP_HIST	Historical hospital
YEAR	Year of discharge

HOSP_TERCIARITY	Tertiary hospital indicator
HOSP_UNIV	University hospital indicator
HOSP_PRIV	Private hospital indicator
HOSP_LONGSTAYPSY	Longstay or psychiatric hospital indicator,
HOSP_TERMINAL	Terminal hospital indicator
UNIT_CARTHOSUR	Cardiothoracic surgery units
UNIT_HEMO	Hemodynamic units
UNIT_LINAC	Linear accelerator units
UNIT_MIR	MIR, medical residents unit
UNIT_TRANSPLANT	Transplant units
BED_GO	Total number of gynaecology-obstetrics beds
BED_ICU	Total number of ICU beds excluding neonatal ICU beds
BED_NICU	Total number of neonatal ICU beds
BED_ORT	Total number of orthopaedic beds
BED_PSY	Total number of psychiatric beds
BED_SUR	Total number of surgical beds
BED_TOT	Total number of beds in the hospitals
DISCHARGE_GO	Total number of gynaecology-obstetrics discharges
DISCHARGE_HEMO	Total number of HEMO discharges
DISCHARGE_ICU	Total number of ICU discharges
DISCHARGE_MID	Total number of MID discharges
DISCHARGE_ORT	Total number of orthopaedics discharges
DISCHARGE_SUR	Total number of surgical discharges
DISCHARGE_TOT	Total number of discharges
STAFF_DOC	Number of medical and surgical doctors (irrespective of whether they are employees/independent and the number of hours worked per week)
STAFF_DOC36T	Number of doctors (medical and surgical) working full time in a hospital
STAFF_DOCS	Number of doctors in medical specialities (irrespective of whether they are employees/independent and the number of hours worked per week)
STAFF_DOCS36T	Number of doctors in medical specialities working full time in a hospital
STAFF_GO	Number of gynaecology-obstetrics doctors (irrespective of whether they are employees/independent and the number of hours worked per week)
STAFF_GO36T	Number of gynaecology-obstetrics doctors working full time
STAFF_MID	Number of MID doctors (irrespective of whether they are employees/independent and the number of hours per week)
STAFF_MID36T	Number of MID doctors working full time
STAFF_NUR	Number of nurses (irrespective of whether they are employees/independent and the number of hours worked per week)
STAFF_NUR36T	Number of nurses working full time
STAFF_ORT	Number of orthopaedic doctors (irrespective of whether they are employees/independent and the number of hours worked per week)
STAFF_ORT36T	Number of orthopaedic doctors working full time
STAFF_SUR	Number of surgeons doctors (irrespective of whether they are employees/independent and the number of hours worked per week)
STAFF_SUR36T	Number of surgeons doctors working full time
STAFF_TOT	Sum of healthcare professionals (numbers irrespective of whether they work full or part-time)

ECHO_HOSP_ACTUAL & ECHO_HOSP_ACTUAL_ESRII

Column	Description
YEAR	Year of discharge code; …,10,11,12,13
HOSP_HIST	Historical hospital
HOSP_ACTUAL	Actual hospital

CATALOG_DIAG

Column	Description
diag_catalog	Catalog description
diag_g0_cod	Chapter diagnosis code
diag_g0_des_eng	Chapter diagnosis description in English
diag_g0_des_esp	Chapter diagnosis description in Spanish
diag_g0_des_deu	Chapter diagnosis description in German
diag_g0_des_slv	Chapter diagnosis description in Slovenian
diag_cod	Diagnosis code large, with unnecessary signs. But useful depending on the subsequent process
diag_cod_short	Diagnosis code short, without unnecessary signs
diag_des_eng	Diagnosis description in English
diag_des_esp	Diagnosis description in Spanish
diag_des_deu	Diagnosis description in German
diag_des_slv	Diagnosis description in Slovenian

CATALOG_PROC

Column	Description
proc_catalog	Catalog description
proc_g0_cod	Chapter procedures code
proc_g0_des_eng	Chapter procedures description in English
proc_g0_des_esp	Chapter procedures description in Spanish
proc_g0_des_deu	Chapter procedures description in German
proc_g0_des_slv	Chapter procedures description in Slovenian
proc_cod	Diagnosis code large, with unnecessary signs. But useful depending on the subsequent process
proc_cod_short	Diagnosis code short, without unnecessary signs
proc_des_eng	Procedures description in English
proc_des_esp	Procedures description in Spanish
proc_des_deu	Procedures description in German
proc_des_slv	Procedures description in Slovenian