ECHO
EUROPEAN COLLABORATION FOR HEALTHCARE OPTIMIZATION

Coronary revascularisation in Spain

I. EXECUTIVE SUMMARY

Mortality and morbidity from cardiovascular disease are considered a public health issue. In fact, coronary ischaemic disease is one of the leading causes of death in Europe.

The study of systematic variation on its surgical management, and associated outcomes, offers a critical view on how healthcare organizations provide care to patients.

- This report analyses the magnitude and the variation of ischaemic coronary disease surgical management. To this end, the analysis is twofold: on the one hand, examines population exposure to revascularisation surgery; and, on the other hand, evaluates hospital quality, in terms of hospital differences in case fatality rates.

- Percutaneous Coronary Intervention (PCI, commonly named as coronary angioplasty) and Coronary Artery Bypass Graft (CABG) are effective and safe revascularisation procedures that have improved survival and quality of life in the last decades. PCI has been proven to be a better option at reducing the risk of death; particularly, primary PCI supersedes any other alternative in the treatment of acute myocardial infarction. Nevertheless, CABG is still considered more effective when dealing with multivessel disease (3 or more vessels implied).

Exposure to surgical revascularization

- In 2009, 78,585 CID hospitalisations occurred in Spain, representing 1 admission per 485 Spanish adult inhabitants. This figure was among the lowest found in ECHO countries. Besides, up to 2.6-fold difference was detected between *healthcare areas* with extreme high and low CID rates while systematic variation was moderate: 10% above that randomly expected. More than half of CID admissions were labelled as AMI and in that case, the difference between *healthcare areas* with extreme rates (EQ_{5-95}) was close to 3-fold.

- The same year, 48,368 PCI interventions and 7,068 CABG surgeries were performed. These figures were again among the lowest among the ECHO countries. PCI rate was similar to that detected in Portugal and less than half the rate found in Slovenia, the country with the highest rate; while CABG rate was the lowest, 3 times less than the one found in Denmark.

- The ratio across *healthcare areas* with extremes rates reached 4.5-fold and almost 9.3-fold difference in PCI and CABG, respectively, and variation not deemed random was in both cases moderate: 19 and 22% above that expected. Besides, in both PCI and CABG, region explained more than 40% of the observed variation, which may suggest certain relevant role of regions in modulating the provision of this intervention.

- In the geographical approach, the mismatching between patterns of burden of coronary ischaemic disease (CID) and intensity of use of revascularization procedures is examined. It is patent the variation in exposure to revascularisation interventions across healthcare areas, and how this variation is hardly affected by the burden of ischemic disease.
- At regional level inverse relation between CABG and PCI procedures was detected. This seems to point out to early adopting regions where progressively higher levels of PCI would lead to a decrease in CABG utilisation.
- From 2002 to 2009, coronary ischaemic disease admissions barely decreased by 11%, from 1 admission per 392 to 1 admission per 429 adult inhabitants. Of these hospitalisations, those corresponding to AMI remained almost constant.
- Along the same period, PCI utilisation rates increased by 75%, from 1 admission per 791 to 1 admission per 413 inhabitants. In turn, CABG rate remained stable over the same period, – from 1 admission per 2,899 to 1 admission per 2,857 inhabitants aged 40 or older. Exposure across the territory for both interventions was heterogeneous as pointed out by their moderate and constant over time systematic variation.
- From 2002 to 2009, significant more CID admissions occurred in most deprived healthcare areas than in wealthier ones; and specifically AMI admissions were more frequent in worse-off than in better-off ones becoming the gap between extreme quintiles wider over time. This finding could represent a reflection of a proper response to population's need.
- PCI utilisation has increased in all wealth levels, but above all in most deprived areas leading to a significant higher PCI utilisation in those less affluent areas. Conversely, CABG exposure was higher in wealthier areas and has remained stable in all quintiles.

Differences in hospital case-fatality rates

- Differences in the risk-adjusted case fatality rates (CFR) after both revascularisation procedures are noticeable, with huge variation across hospitals. "Volume" (amount of interventions carried out in a year) has been argued as a plausible factor of these differences.

- Spanish risk-adjusted CFR for AMI, after experiencing a sharp decline, was, in 2009, 93.75 per 1,000 patients aged 18 and older; the lowest rate, 5.3 per thousand points below the ECHO average. In terms of exposure, only 5.2% of all Spanish AMI patients were treated at poor performing hospitals –also the lowest share of patients among ECHO countries. On the other hand, almost 40% of AMI patients were admitted to hospitals flagged as "good" or even "excellent" performers –slightly above ECHO average.

- Regarding the revascularisation procedures, in-hospital mortality after PCI in Spain has experienced a net increase of 5 per thousand points. In 2009, the risk-adjusted CFR was 25.6 per 1,000 patients aged 40 and older, far the highest among ECHO countries, almost 6 per thousand points above ECHO average. Besides, 34% of patients undergoing a PCI were treated at "alarm" hospitals, while only 4% of patients were intervened at hospitals pointed out as "good performers" (the lowest share for this procedure among ECHO countries).

- Even though in-hospital mortality after CABG seemed to decrease intensively the last period, the risk-adjusted CFR after CABG surgery in Spain, in 2009, was also by far the highest among ECHO countries -66 per 1,000 patients aged 40 and older, more than doubling the English rate and 16 per thousand points above the ECHO's average. Besides, only 21% of all Spanish patients undergoing CABG surgery in 2009 were intervened at high-volume centres (above 250 procedures/year), far the lowest share across ECHO countries, 60 percentage points below average. In addition, 20.8% of patients were intervened at "*alert/alarm performers*" hospitals, again by far the highest share among ECHO countries.

II. INTERNATIONAL COMPARISON

The cross-country comparison of the geographical population exposure to revascularization procedures provides the basis for flagging situations of over and under-use.

The benchmarking of hospitals' case fatality rates adds a dimension of quality and safety of the care provided and its variation within each country.

International comparison provides a wider perspective, boosting assessment beyond national inertias.

This chapter offers a view as to how Spain behaves compared to the other ECHO countries when it comes to ischaemic coronary disease and its surgical treatment. To this end, the analysis is two-fold:

a. Geographic approach: it examines population exposure to revascularization surgery, both the magnitude and the variation;

b. Hospital approach: it examines the quality of hospital care in terms of case fatality rates for patients with acute myocardial infarction (AMI) and after revascularization procedures. These outcomes are used to benchmark all hospitals across ECHO, providing a view of where Spanish hospitals' outcomes seat compared to those in the other ECHO countries.

a. Geographic approach

This section offers a rough picture of the incidence of coronary ischaemic disease (CID) and AMI admissions taken as a proxy of burden of coronary disease; it also examines the intensity of use of the alternative revascularization procedures in Spain compared to what happens at the other ECHO countries.

The geographic approach is focused on population exposure. The key question for analysis is how the risk of coronary disease and access to revascularisation procedures correlate, depending on the place where individuals live.

All through this section, paired dot plots are used to show results. The chart on the left is always intended to give the reader a sense of the magnitude of burden of disease or utilisation of revascularisation procedures in each country; the image on the right provides an idea of the actual variation comparable across countries. Note that each dot represents the relevant health care geographic unit in each country.

Coronary Ischaemic Disease (CID)

In 2009, Spain had the fourth CID admission rate among ECHO countries– 1 admission per 420 adult inhabitants. This figure was 33% higher than the lowest one, found in Portugal and 30% lower than the highest rate, found in England (see table 1 in appendix 1.a).

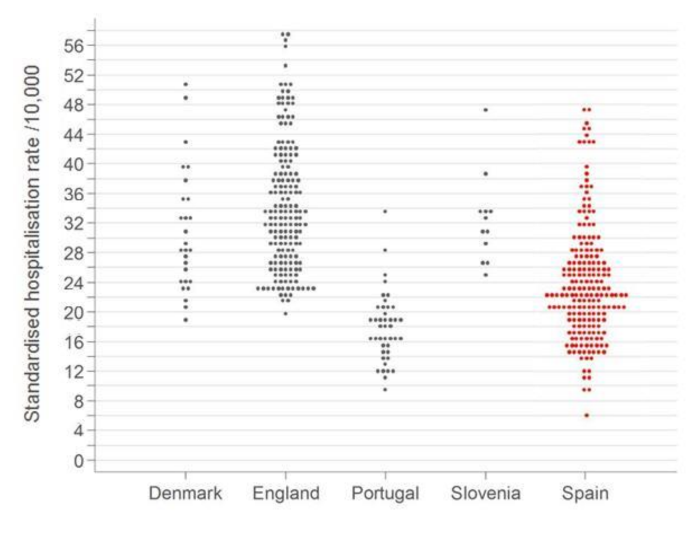

Figure 1.a. Age-sex standardised hospitalisation rates of CID per 10,000 inhabitants (natural scale to compare actual rates). Year 2009

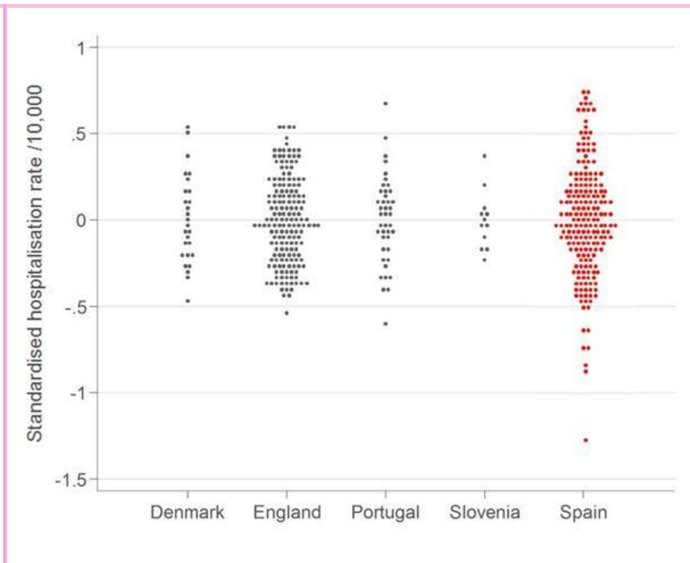

Figure 1.b. Age-sex standardised hospitalisation rates of CID per 10,000 inhabitants (normalised scale to compare degree of variation). Year 2009

Each dot represents the relevant healthcare administrative area in each ECHO country (Healthcare areas in Spain). The y-axis charts the administrative areas standardised rate per 10,000 inhabitants (+18 age). The figure is built over the total amount of CID hospitalisations in 2009 in ECHO countries. In Figure 1b admission rates have been normalised to ease comparison of the degree of variation across countries.

In Spain, residents in areas with the highest rates underwent three times the probability of CID admission than those living in areas with the lowest. In turn, lower and similar ratios around twice were detected in Denmark, Slovenia, England and Portugal.

On the other hand, systematic variation not deemed random was moderate to low in all countries, ranging from 9% (Slovenia) to 24% (England) beyond that expected.

Acute Myocardial Infarction (AMI)

AMI admission rates were quite similar among ECHO countries, although the Spanish rate showed, close to the Portuguese, to be the lowest, - 1 hospitalisation per 726 adults. Slovenia showed the highest rate -1 admission per 449 adult inhabitants- followed by England -1 in 597 adults. Differences between areas with extreme rates of AMI hospitalisations are around 2 fold in all ECHO countries.

The part of the observed variation not amenable to chance was low to moderate, except in Slovenia where it reached 34% above that randomly expected. In Spain 11% of variation exceeded what could be randomly expected value (see table 2 in appendix 1.a).

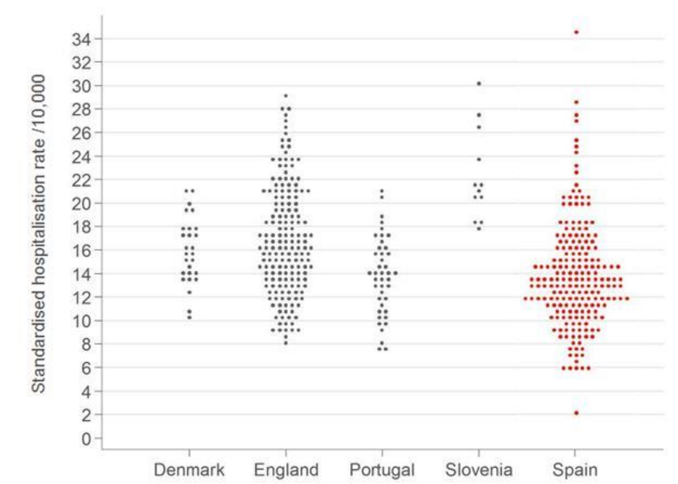

Figure 2.a. Age-sex standardised hospitalisation rates of AMI per 10,000 inhabitants (natural scale to compare actual rates). Year 2009

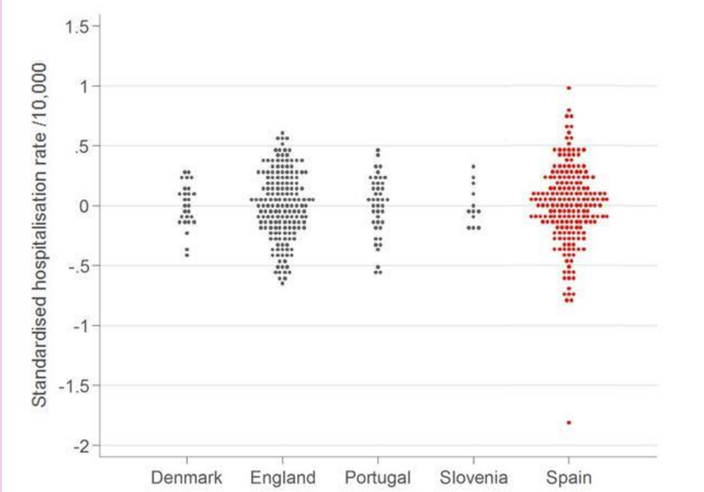

Figure 2.b. Age-sex standardised hospitalisation rates of AMI per 10,000 inhabitants (normalised scale to compare degree of variation). Year 2009

Each dot represents the relevant healthcare administrative area in each ECHO country (Healthcare areas in Spain). The y-axis charts the administrative area standardised rate per 10,000 inhabitants (+18 age). The figure is built over the total amount of AMI hospitalisations held in 2009 in the ECHO countries. In Figure 2b admission rates have been normalised to ease comparison of the degree of variation across countries.

Percutaneous Coronary Interventions (PCI)

Spain, together with Portugal, exhibited the lowest PCI rate among ECHO countries, 1 admission per 419 inhabitants aged 40 or older. That represented less than half the rate found in Slovenia, the country with the highest rate. Despite its low PCI rate, residents in those healthcare areas with the highest rates had close to 5-fold chance of undergoing a PCI intervention than those living in areas with the lowest rate, pointing out acute differences in PCI utilisation across the Spanish territory. In Slovenia, England and Portugal the ratio between the highest and lowest PCI rate found at local level had similar values (ranging from 2.2 to 2.6).

Systematic variation ranged from just 8% above that expected by chance in England and Portugal to 1.8 times greater than expected in Slovenia. Spain had an average value, exceeding 22% that expected by chance (see table 3 in appendix 1.a).

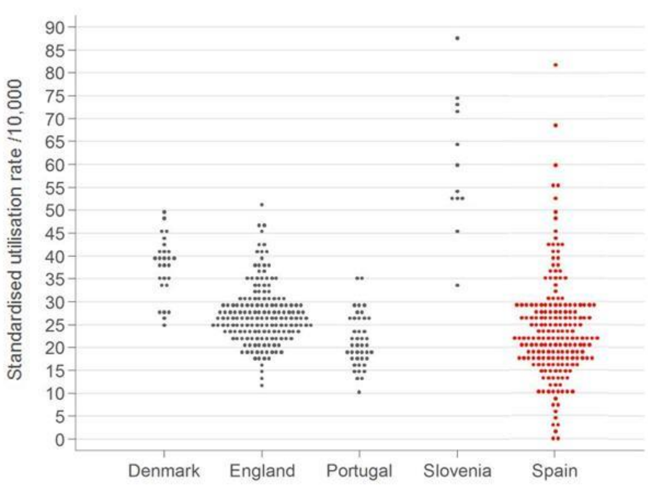

Figure 3.a. Age-sex standardised utilisation rates in PCI per 10,000 inhabitants (natural scale to compare actual rates). Year 2009

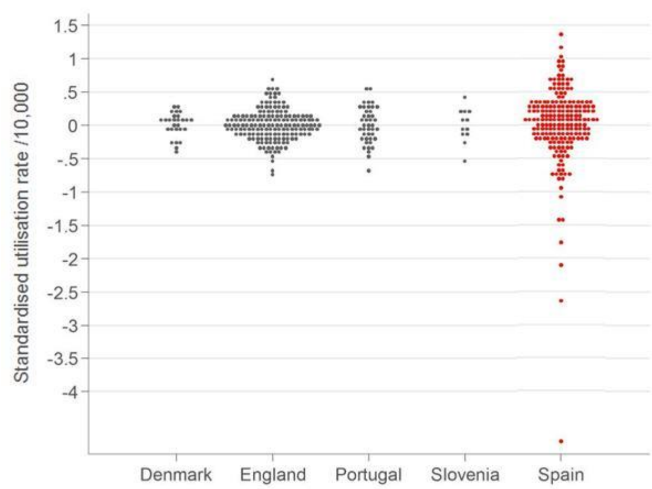

Figure 3.b. Age-sex standardised utilisation rates in PCI per 10,000 inhabitants (normalised scale to compare degree of variation). Year 2009

Each dot represents the relevant healthcare administrative area in each ECHO country (Healthcare areas in Spain). The y-axis charts the administrative areas' standardised rate per 10,000 inhabitants (+40 age). The figure is built over the total amount of PCI procedures held in 2009 in the ECHO countries. In Figure 3b intervention rates have been normalised to ease comparison of the degree of variation across countries.

Coronary Artery Bypass Grafting (CABG)

Spain showed the lowest CABG rate among ECHO countries – 1 admission per 2959 inhabitants aged 40 or older. This was 3 times less the rate found in Denmark, the country with the highest rate.

Conversely, the ratio between the highest and lowest CABG rate found at local level was the biggest: close to 10 fold chance of undergoing a CABG intervention for residents in those healthcare areas with the highest rates. In Denmark and England, this ratio was around 2-fold chance.

The systematic part of this variation was high in all countries, going up to 27% above that randomly expected in Spain (see table 4 in appendix 1.a).

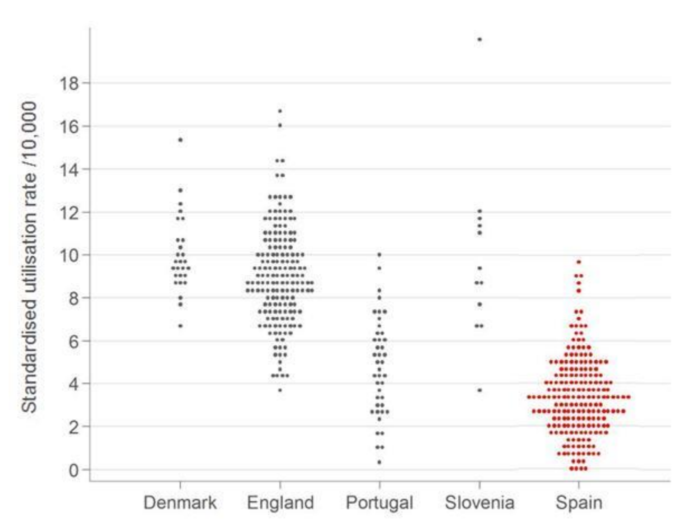

Figure 4.a. Age-sex standardised utilisation rates in CABG per 10,000 inhabitants (natural scale to compare actual rates). Year 2009

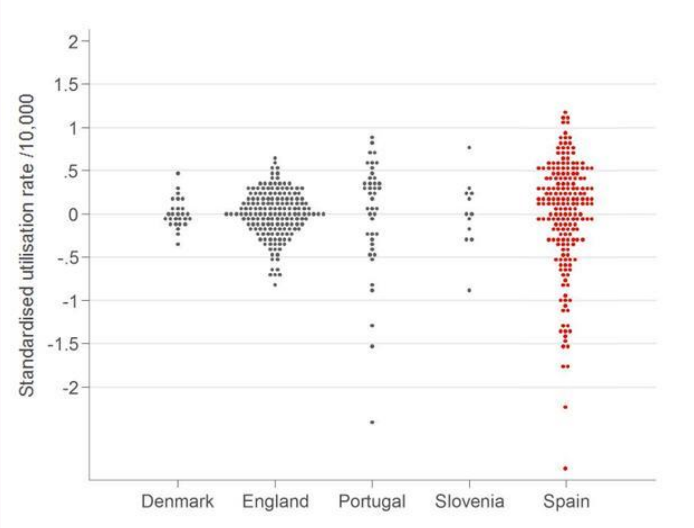

Figure 4.b. Age-sex standardised utilisation rates in CABG per 10,000 inhabitants (normalised scale to compare degree of variation). Year 2009

Each dot represents the relevant healthcare administrative area in each ECHO country (Healthcare areas in Spain). The y-axis charts the administrative area standardised rate per 10,000 inhabitants (+40 age). The figure is built over the total amount of CABG interventions held in 2009 in the ECHO countries. In Figure 4b intervention rates have been normalised to ease comparison of the degree of variation across countries.

b. Hospital approach

Different healthcare systems across Europe, with different organizational features, might obtain different outcomes in dealing with ischaemic coronary disease.

Comparing the outcomes across individual hospitals provides insights as to where interventions might be targeted to improve case fatality rate for patients with coronary conditions.

International comparison adds a complementary view to the usual national-based benchmarks.

Through this section, analyses will focus on providers, benchmarking for 3 quality outcome indicators. Two insights to be retained are: the actual value of the hospital case-fatality rate (CFR), and the relative position compared to the ECHO benchmark and its confidence interval limits (95 and 99% levels) built into a funnel plot. This relative position allows for an assessment of the hospital performance categorized as average, good, excellent, alarm and alert.

ECHO benchmark is built as the expected average behaviour, using data from all hospitals in the 5 countries analysed (multilevel regression modelling). All CFR are risk-adjusted for sex, age, severity of the underlying condition and comorbidities (Elixhauser index). This way, differences across providers should not be amenable to patient characteristics affecting their inherent probability of dying after admission or surgery (appendix 4 provides details as to the variables included in risk-adjustment).

Hospitals treating less than 30 patients at risk (admitted or undergoing surgery) per year have been excluded from the analysis in order to avoid random noise (table 5, appendix 1.b, details the number of hospitals, per indicator, excluded under this criterion and its percentage of treated patients).

Funnel plots enable the assessment of individual hospital performance against the international benchmark. Each hospital (dot) is represented with the risk-adjusted case fatality rate for a specific volume of patients at risk (admitted or undergoing surgery). The benchmark is built on the ECHO hospitals average CFR (risk-adjusted) and its 95% and 99% CIs. The solid grey line represents the ECHO CFR, while red lines correspond to the 95% confidence interval control limits and the dashed blue lines to the 99% limits. Those thresholds represent the boundary between *expected* variation in outcomes (not significantly different from average) and *significant variation*. Hospitals beyond the upper thresholds are flagged as poorer performers (in the alert or alarm position); hospitals below the bottom limits signal hospitals as good or excellent performers. Whichever the direction, outliers warrant further investigation and analysis to identify underlying factors and either tackle them or use as examples of good practice.

In-hospital mortality in Acute Myocardial Infarction (AMI)

In-hospital risk-adjusted CFR per 1,000 AMI patients (urgent admission in patients 18 and older) is a widely used indicator of the quality and safety of the care provided in a hospital.

In 2009, at the ECHO countries, 146,859 hospital admissions in patients 18 and older were flagged as Acute Myocardial infarctions. From those, 12,582 passed away. After risk-adjustment, these figures place the ECHO average CFR at 99.03 per 1,000 hospitalised patients, which means that 1 in each 10 AMI admissions resulted in dead.

In Spain, 1 in 10.7 AMI patients admitted to a hospital died in 2009 (risk-adjusted CFR 93.75 per 1,000), the lowest among ECHO countries, 5.3 per thousand points below the ECHO average.

The total amount of ECHO hospitals analysed is 435; 55% of them, flagged as *high volume hospitals* (more than 250 AMI patients in a year*)*, took care of 82.5% of the total AMI hospitalised patients.

With regard to Spanish hospitals, 82 out of 202 centres were *high volume* hospitals in 2009, taking care of the 70.6% of all AMI hospitalised patients; actually Spain had, together with Denmark the second lowest share of AMI patients treated at high volume hospitals among the ECHO countries.

15 out of the 202 Spanish centres were flagged as “alert” or “alarm” performers in terms of adjusted-CFR. In terms of exposure, 5.2% of all AMI patients were treated at those “alert”/ “alarm” hospitals -still, the smallest percentage among all ECHO countries. Nevertheless, it is also true that 39.82% of all AMI patients were admitted to hospitals placed as “good” or even “excellent performance” (see table 6, appendix 1.b, for further details).

Figure 5 shows the risk-adjusted CFR in each of the ECHO hospitals, drawing their relative position to the ECHO benchmark in the funnel plot.

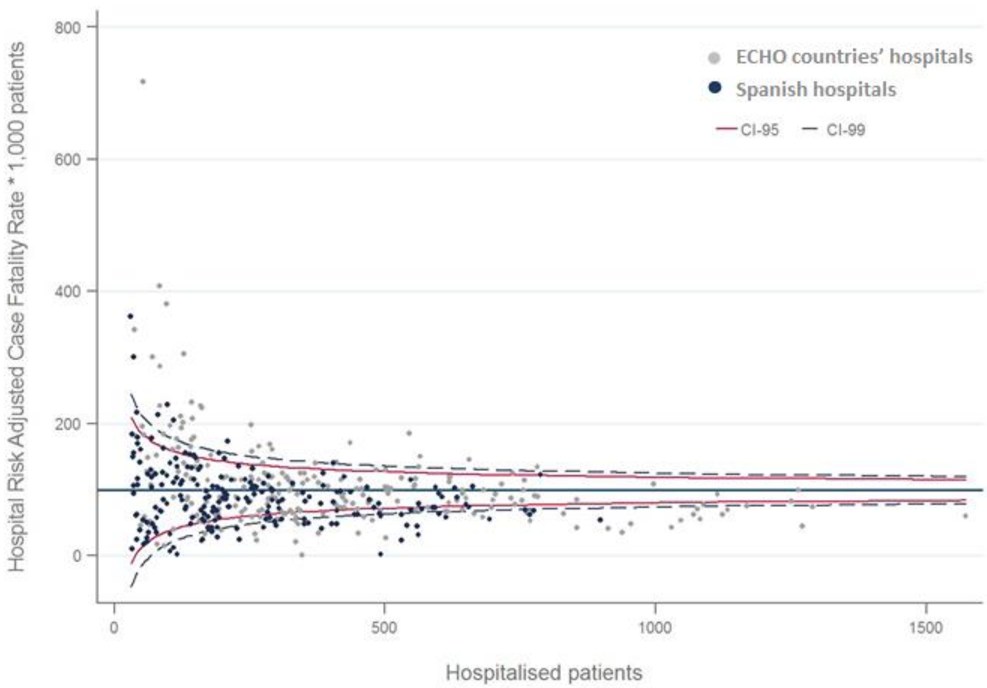

Figure 5. In-hospital case fatality rate for AMI admissions across hospitals in ECHO countries. Year 2009.

Each dot represents one of the ECHO hospitals that treated more than 30 AMI cases in that year. The expected number of deceases per 1,000 hospitalised patients is built on the average across ECHO hospitals. In blue are represented Spanish hospitals.

Outcomes shown in the funnel indicate a rather good performance, where almost 67% of hospitals are at the average position indicating a risk-adjusted in-hospital mortality not significantly different from ECHO benchmark.

All but one of the Spanish hospitals flagged as “alarm” and “alert” treat less than 250 AMI patients in a year.

In-hospital mortality after Percutaneous Coronary Intervention (PCI)

In 2009, 132,737 patients aged 40 and older underwent PCI procedure at one of the ECHO hospitals. 2,623 of them passed away, that is, 1 in each 51 intervened patients. These figures represent an ECHO risk-adjusted CFR of 19.86 per 1,000 patients at risk. That year, Spain had by far the highest risk-adjusted CFR, 5.7 per thousand points above ECHO benchmark, and almost 12 per thousand points above the English CFR, the country with the smallest rate.

Within the ECHO framework, 80% of the hospitals performing PCI procedures were *high volume* and took care of 95.44% of patients undergoing that procedure. In Spain that figure descended to 94.5% (see tables 5 and 7 in appendix 1.b).

Unlike what might be expected, the bulk of Spanish "alarm" hospitals are performing a larger number of angioplasties and get worse risk-adjusted case fatality rates than those performing fewer interventions. As a result, all but one of those alert to alarm hospitals were high volume and intervened almost 34% of all patients, while only a 4% of patients were intervened at hospitals pointed out as "good performers", the lowest share across ECHO countries (See table 7, appendix 1.b, for further details).

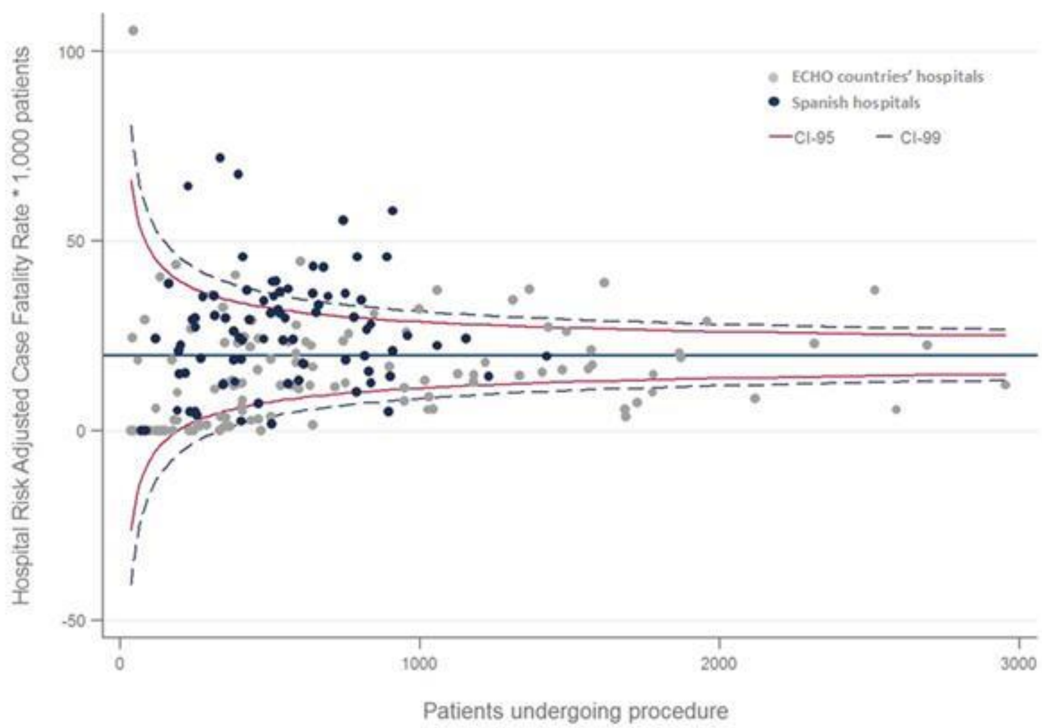

Figure 6. In-hospital case fatality rate after Percutaneous Coronary Intervention across hospitals in ECHO countries. Year 2009.

Each dot represents one of the ECHO hospitals that performed more than 30 PCI in that year. The expected number of deceases per 1,000 hospitalised patients is built on the average across ECHO hospitals. In blue are represented Spanish hospitals.

In-hospital mortality after Coronary Artery Bypass Graft (CABG)

In the 89 ECHO hospitals performing CABG surgery, 33,683 patients, aged 40 and older, were intervened in 2009 and almost 4% of them passed away. In terms of risk-adjusted CFR, this means 1 in 20 patients undergoing CABG. More than half of those 89 centres were categorised as "high volume", and they treated the 82.16% of total CABG performed that year at ECHO countries.

The 61.3% of all patients were intervened at hospitals placed in the "*good/excellence performance*" area, versus the 5.6% treated at hospitals flagged as "*alert/alarm*".

Spain shows quite a different picture. The percentage of Spanish patients undergoing CABG surgery treated at higher volume hospitals descended to 20.9% and none of them was flagged as “excellent” in performance while 26% of their hospitals performing CABG were pointed as “alert” or “alarm”.

The scenario of the risk-adjusted case fatality rate after CABG shown in figure 7, places Spain at a deficient level of performance in 2009. All but two of the alert/alarm hospitals in this international comparison are Spanish. Compared to the ECHO benchmark, the Spanish risk-adjusted CFR for CABG is by far the highest, 15.7 per thousand points above the ECHO average and more than double the English one, the country with the lowest rate.

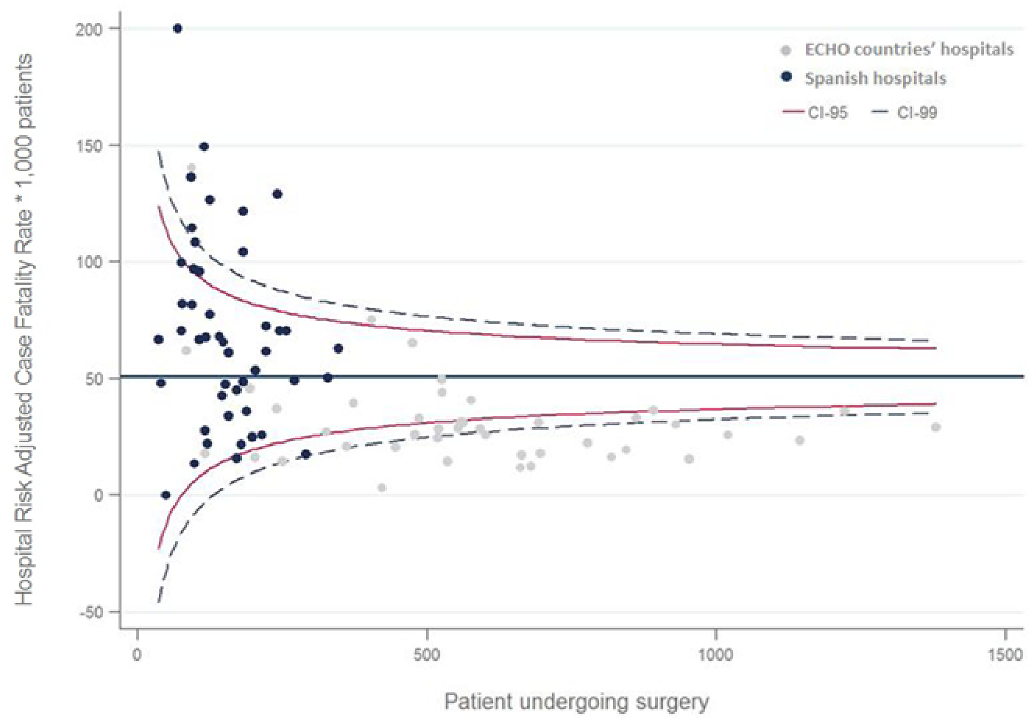

Figure 7. In-hospital case fatality rate after CABG across hospitals in ECHO countries. Year 2009.

Each dot represents one of the ECHO hospitals that performed more than 30 BYPAS surgeries in that year. The expected number of deceases per 1,000 hospitalised patients is built on the average across ECHO hospitals. Blue dots represent Spanish hospitals.

III. IN COUNTRY VARIATION

CID admissions are considered a proxy of the burden of cardiovascular disease at a geographical level.

In the ECHO framework this indicator is used as "calibrator" and helps to interpret results about intensity of population exposure to revascularization options: coronary artery bypass graft and percutaneous coronary intervention.

At this section, the incidence of coronary ischaemic disease as well as the intensity of use of the alternative revascularization procedures performed in Spain will be analysed from an internal perspective, comparing what happens at the different health care areas (geographic approach) or hospitals (providers approach) within the country.

Following the same structure as the previous chapter, the analysis is two-fold:

a. Geographic approach: it compares the population burden of disease and the exposure to intensity of treatment, depending on the place of residence (both the magnitude and the variation) across healthcare areas (*áreas sanitarias*) and regions;

b. Hospital approach: it examines the quality of hospital care in terms of their case fatality rates for patients with acute myocardial infarction (AMI) and for revascularization procedures. These outcomes are used to benchmark individual Spanish hospitals.

a. Geographic approach

The magnitude and the variation in CID and/or revascularization procedures across the country will be mapped out following the two health relevant tiers: 199 *Healthcare Areas* and 17 *Regions* or *Comunidades Autónomas*. While healthcare area would represent local provision of care, regions are used as a surrogate for regional policies affecting all the healthcare areas within each one.

Coronary Ischaemic Disease admissions (CID)

In 2009, 78,585 CID admissions occurred in Spain, which meant 1 admission per 485 Spanish adult inhabitants.

Up to 2.6-fold difference in chances to experience a CID admission was found between healthcare areas with extreme high and low rates. The systematic part of variation was just 10% above that randomly expected, and region explained up to a 28% of the variation not explained by the healthcare areas (see tables 9 and 10 at the appendix 2.a).

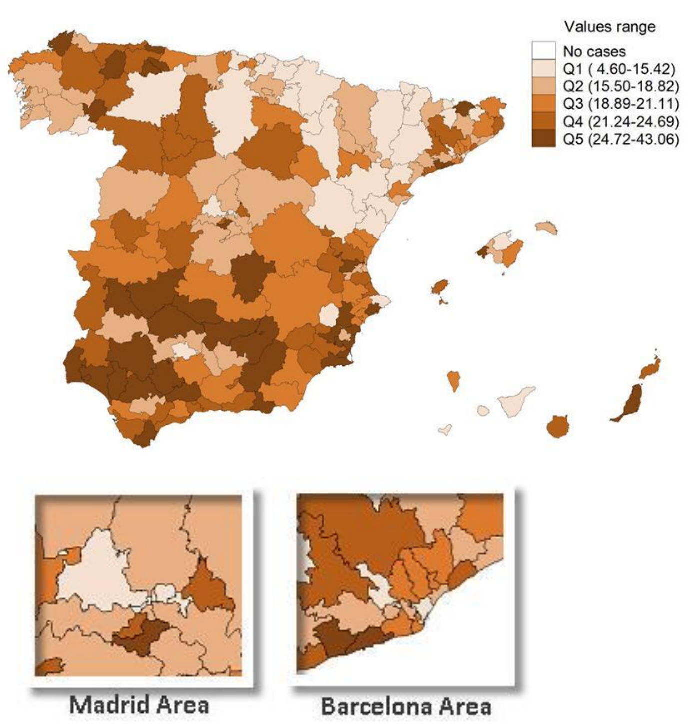

Figure 8. Age-sex standardised CID hospitalisation rate per 10,000 inhabitants by *healthcare areas*. Year 2009

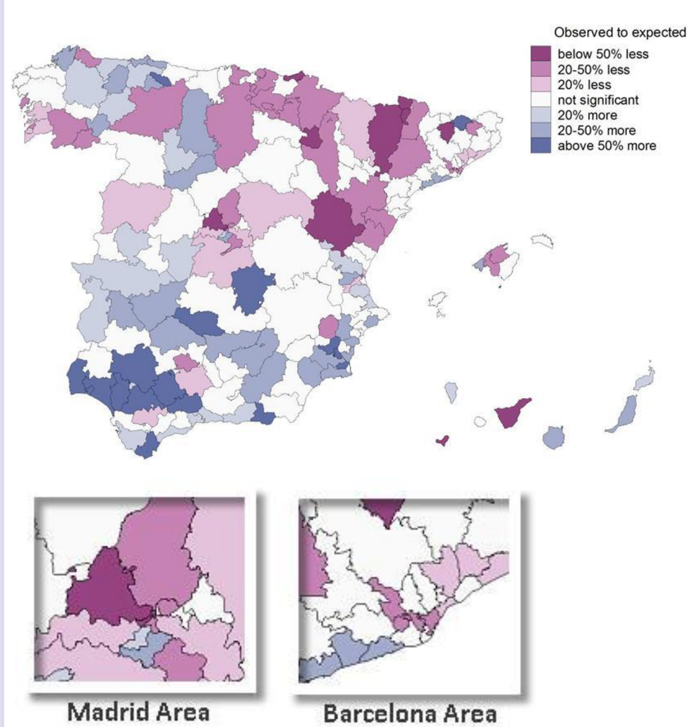

Figure 9. CID Admission ratio (observed to expected) by *healthcare areas*. Year 2009

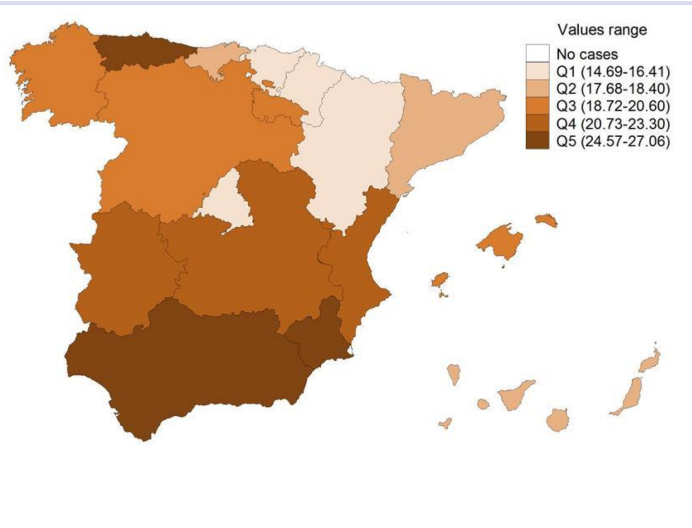

Figure 10. Age-sex standardised CID hospitalisation rate per 10,000 inhabitants by regions. Year 2009

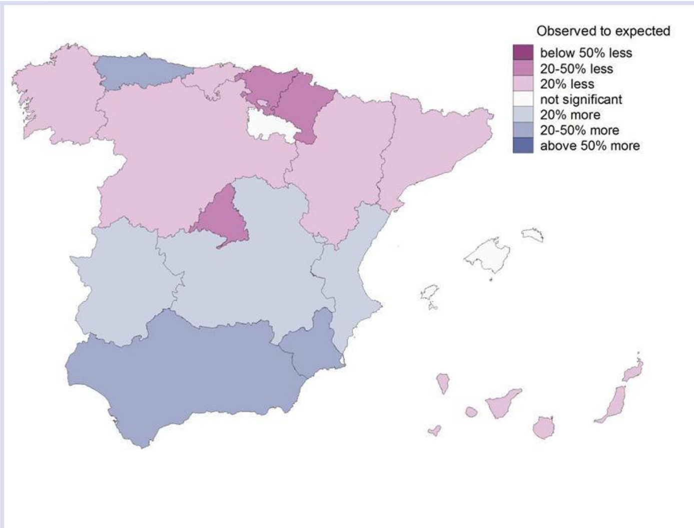

Figure 11. CID admissions ratio (observed to expected), by region. Year 2009

Maps on the left (standardised rates) merely represent the amount of admissions flagged as CID admissions -the darker the colour, the higher the amount of admissions (always per 10,000 adult inhabitants). Areas are clustered into 5 quintiles according to their rate value (Q1 to Q5) –legend within the maps provides the range of standardised rates within each quintile. Maps on the right represent relative risk of hospitalization at each area using as a proxy the ratio observed to expected number of CID hospitalisations. Population living at areas with values above 1 (bluish) mean to experience higher risk of CID hospitalisations; population at areas with a ratio below 1 (pink) mean to experience lesser risk of CID hospitalisations.

Healthcare areas with high CID admission rates were found in the southern half of Spain (figure 8). Residents in most of these areas experienced at least 20% more risk of CID admission than national average (bluish areas in figure 9). On the contrary healthcare areas with low rates where residents have lower risk of CID hospitalisations were found in the North-eastern part of the country.

At regional level, residents in *Andalucia, Murcia and Asturias* had the highest risk of CID hospitalisations in the country (dark blue areas in figure 11). In turn, population living in *País Vasco, Navarra* and *Madrid* had the least risk of CID admissions in the territory (purple areas in figure 11).

Percutaneous Coronary Interventions (PCI) and its comparison with the burden of Coronary Ischaemic Disease (CID)

During 2009, 48,368 PCI interventions were performed in Spain - 1 procedure per 495 inhabitants aged 40 or older.

More than 4-fold difference in exposure to the procedure was found between healthcare areas with extreme rates. Moreover systematic variation was 19% above that randomly expected, and region explained up to a 44%, which may suggest certain relevant role of regions in modulating the provision of this intervention (see tables 9 and 10 in appendix 2.a).

One could expect some overlapping between intensity of PCI utilisation and risk of CID admissions, considering CID admission as a proxy of burden of coronary disease. However, burden of ischemic disease barely explained the 16% of the PCI variation across healthcare areas. When looking at regional level, some correlation was observed in *Andalucia, Murcia, Extremadura* and *Castilla-La Mancha* regions, (high rates of PCI coincide with higher risk of CID admissions) and *País Vasco, Navarra, Aragón, Castilla-León* (low rates of PCI matched low risk for CID admissions). However residents in *Madrid, Cataluña, Galicia* or *Canary Island*, bore high PCI rates concurrent with low risk for CID admissions, and, conversely, *Asturias* with more risk of CID admissions experienced low exposure to PCI (figures 14 and 15).

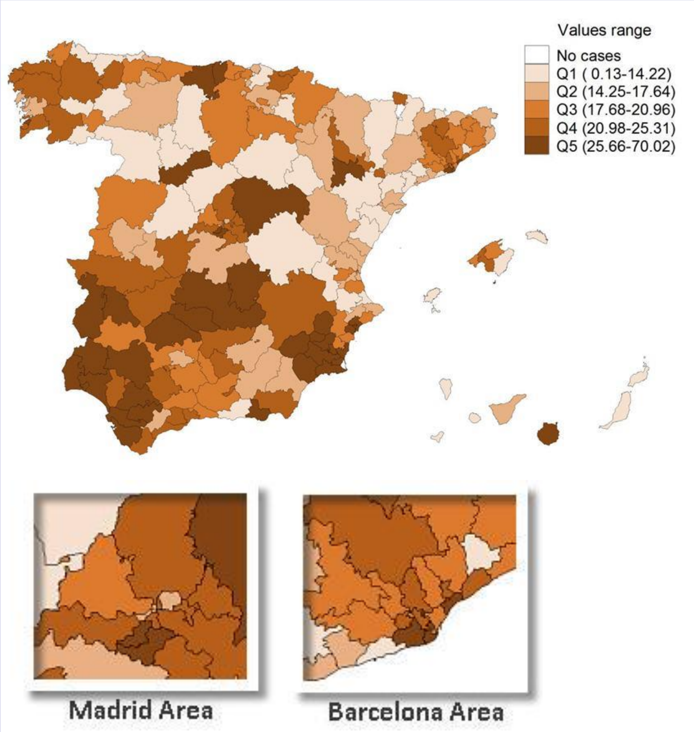

Figure 12. Age-sex standardised PCI utilisation rate per 10,000 inhabitants by *healthcare areas*. Year 2009

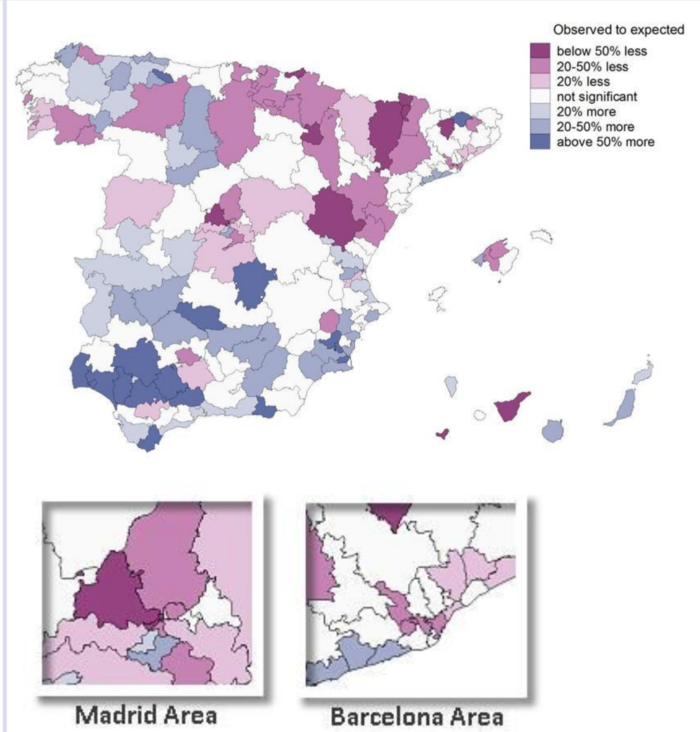

Figure 13. CID admissions ratio (observed to expected), by healthcare areas. Year 2009

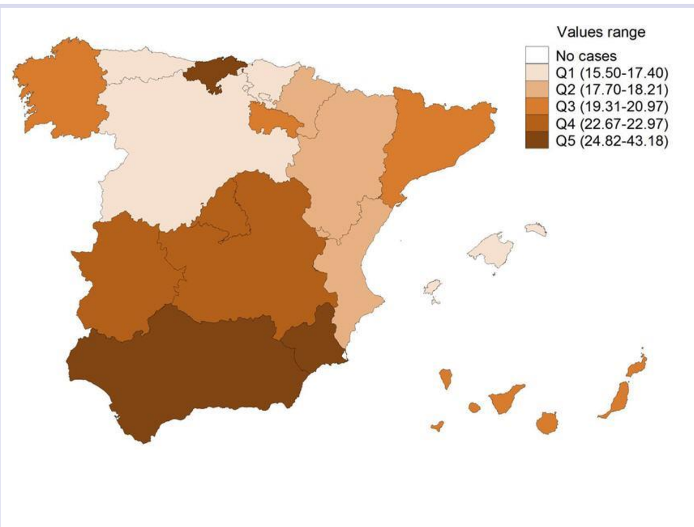

Figure 14. Age-sex standardised PCI utilisation rate per 10,000 inhabitants by regions. Year 2009

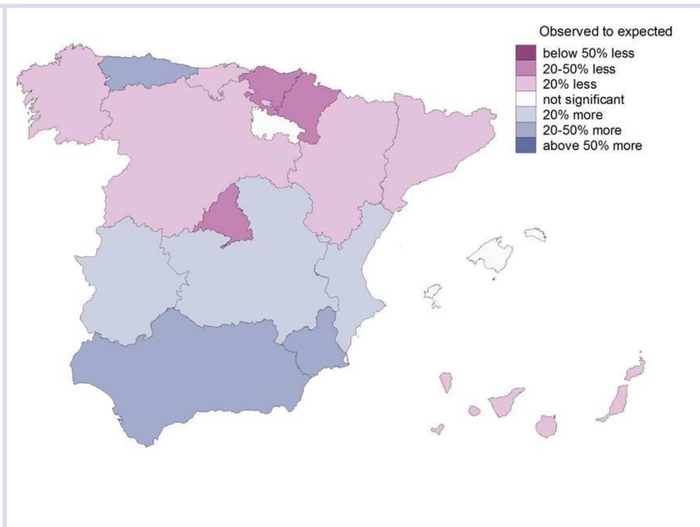

Figure 15. CID admissions ratio (*observed to expected),* by regions. Year 2009

Maps on the left (standardised rates) merely represent the amount of procedures flagged as Percutaneous Coronary Intervention -the darker the colour, the higher the amount of procedures performed, per 10,000 inhabitants over 40 years old. Areas are clustered into 5 quintiles according to their rate value (Q1 to Q5) –legend within the maps provides the range of standardised rates within each quintile. Maps on the right represent relative risk of hospitalization at each area using as a proxy the ratio observed to expected number of CID hospitalisations. Population living at areas with values above 1 (bluish) mean to have a higher risk of CID hospitalisation; population at areas with a ratio below 1 (pink) mean have lower risk of CID admission.

Coronary Artery Bypass Graft (CABG) and its comparison with the burden of Coronary Ischaemic Disease (CID)

Along 2009, 7,068 CABG procedures were performed in Spain, which represents 1 surgery per 3,378 inhabitants aged 40 or older.

The ratio across *healthcare areas* with extreme rates reached 9.3-fold difference, and up to 22% of this variation could not be deemed random. As occurred with PCI utilisation, variation in CABG surgery was highly explained by regions, up to 43% of the observed variation could be related to a regional effect (see tables 9 and 10 in appendix 2.a).

There was a certain pattern of healthcare areas with high rates in the North-western part of the country. CABG utilisation did not correlate with the burden of disease in the same area, with a few exceptions (figure 16 and 17). Taking the analysis to the regional level, CABG procedures and the risk of CID hospitalisation seemed to be inversely related, with the exception of *Asturias*, where residents had a higher risk of CID admissions and CABG rate was among the highest in the country. Nevertheless in general, lower CABG rates seemed to appear in regions with higher risk of CID hospitalisations as in *Andalucia, Murcia* or *Castilla-La Mancha* (figures 18 and 19).

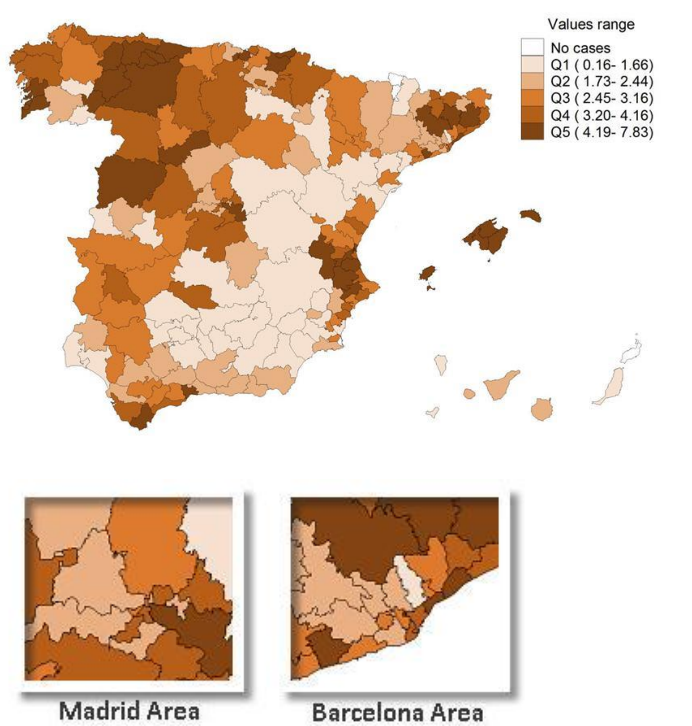

Figure 16. Age-sex standardised CABG utilisation rate per 10,000 inhabitants by *healthcare areas*. Year 2009

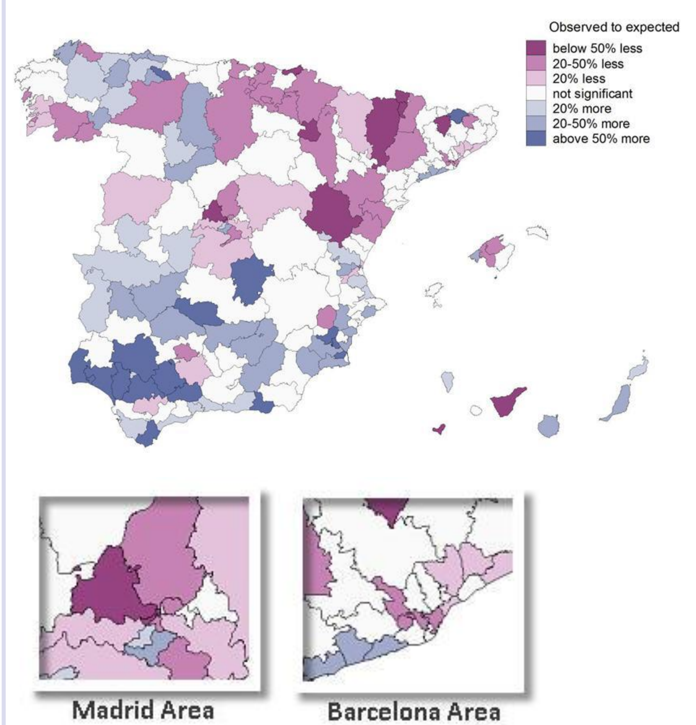

Figure 17. CID admissions ratio (*observed to expected)* by *healthcare areas*. Year 2009

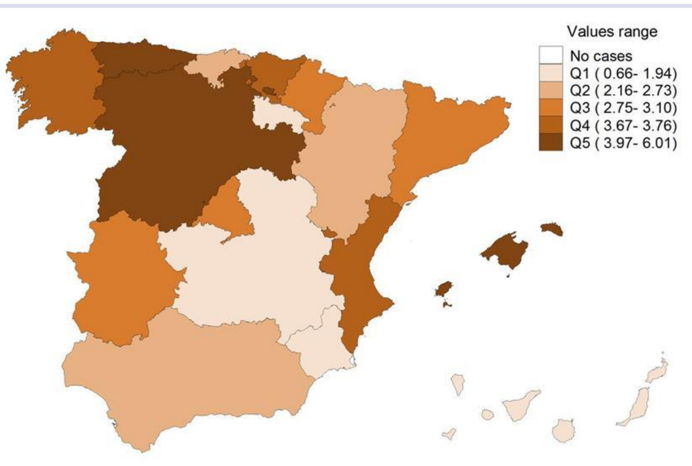

Figure 18. Age-sex standardised CABG utilisation rate per 10,000 inhabitants by regions. Year 2009

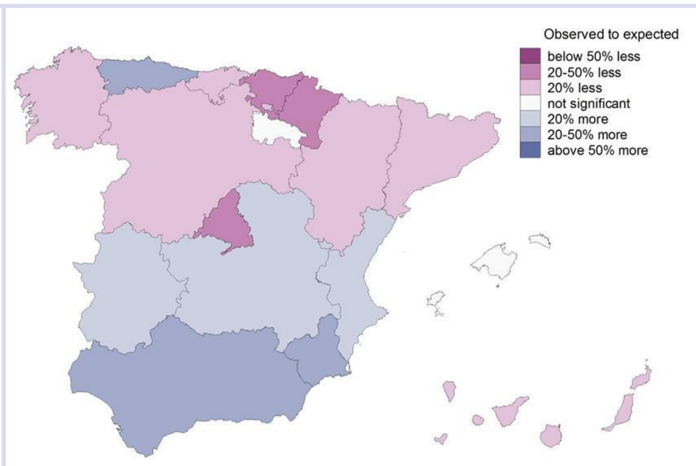

Figure 19. CID admissions ratio (observed to expected) by regions. Year 2009

Maps on the left (standardised rates) merely represent the amount of procedures flagged as Coronary Artery Bypass Graft -the darker the colour, the higher the amount of surgeries performed, per 10,000 inhabitants over 40 years old. Areas are clustered into 5 quintiles according to their rate value (Q1 to Q5) –legend within the maps provides the range of standardised rates within each quintile. Maps on the right represent relative risk of hospitalization at each area using as a proxy the ratio observed to expected number of CID hospitalisations. Population living at areas with values above 1 (bluish) mean to have a higher risk of CID hospitalisation; population at areas with a ratio below 1 (pink) mean have lower risk of CID admission.

Percutaneous Coronary Interventions (PCI) vs. Coronary Artery Bypass Graft (CABG)

PCI and CABG are effective and safe revascularization procedures that have improved survival and quality of life in the last decades. PCI has been proven the best option at reducing the risk of death, mostly when the number of affected blood vessels is less than three, and in the very onset of a myocardial infarction. In turn, CABG is still considered more effective when dealing with multivessel disease (3 or more vessels implied).

To a certain extent these procedures could be acting as two interventions with different clinical indications, or, alternatively, as “substitute” approaches to the same clinical condition. Therefore, considering together their patterns of utilisation may shed some light as to how populations are being served. Trends in the same direction for both procedures may discard the “substitution” hypothesis; opposed patterns, on the other hand, may suggest different PCI adoption speed across areas, and a certain degree of compensation – although procedures are unequally effective.

In Spain, although substitution effect is observed at regional level, this phenomenon was hardly relevant at healthcare are level (figures 22 and 23) - negative correlation of -0.09.

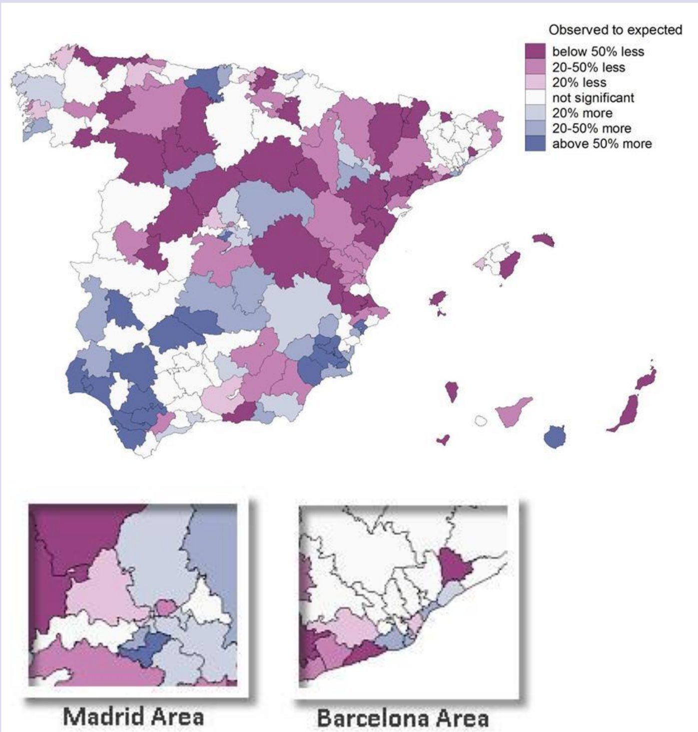

Figure 20. PCI utilisation ratio (*observed to expected), by healthcare areas*. Year 2009

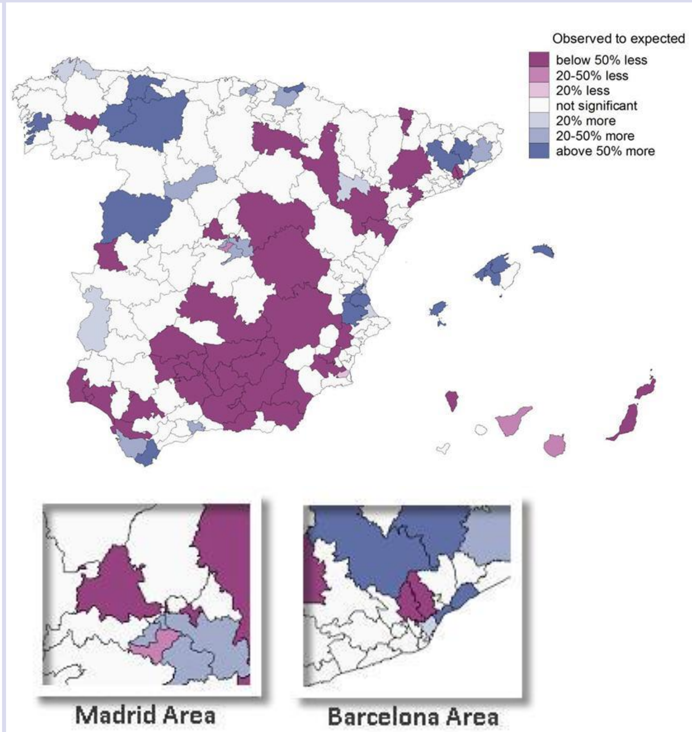

Figure 21. CABG utilisation ratio (*observed to expected),* by *healthcare areas*. Year 2009

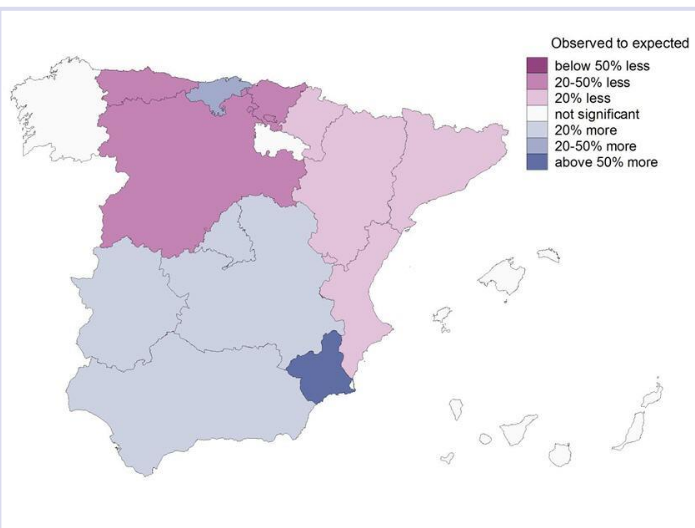

Figure 22. PCI utilisation ratio (observed to expected), by regions. Year 2009

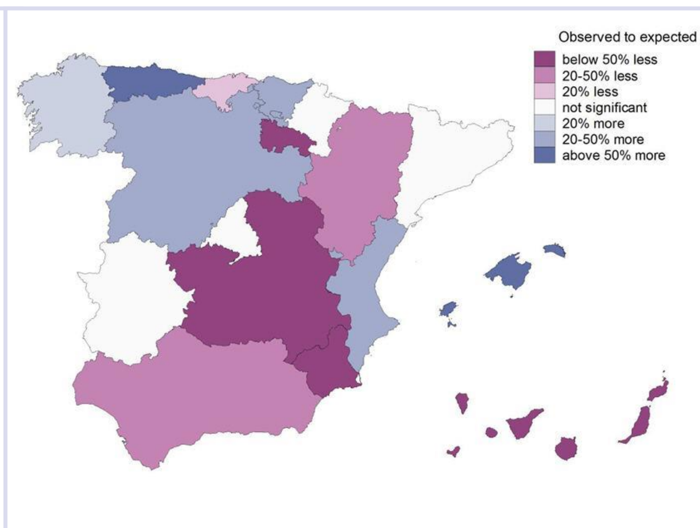

Figure 23. CABG utilisation ratio (observed to expected), by regions. Year 2009

These maps represent the level of utilization, using the ratio "observed to expected" number of revascularisation procedures. Population living at areas with values above 1 (bluish) mean to be overexposed to a certain revascularization procedure; population at areas with a ratio below 1 (pink) mean to be underexposed to a certain revascularization procedure.

b. Hospital approach

Higher hospital risk-adjusted case fatality rates might signal lower quality of care for coronary ischemic conditions.

The following sections will deal with in-hospital case fatality rates (CFR) after admission from Acute Myocardial Infarction (AMI) and after one of the revascularization procedures, percutaneous coronary intervention (PCI) or coronary bypass surgery (CABG), across Spanish hospitals.

Along this section, funnel plots are used to represent Spanish hospitals performance against their national standard or benchmark, at a glance.

Each hospital (dot and numerical code) is charted using the risk-adjusted case fatality rate and the volume of patients at risk (admitted or undergoing surgery) in a year. The benchmark is built upon the Spanish hospitals average CFR (risk-adjusted) and its 95% and 99% CIs. The solid grey line represents the Spanish CFR, while red lines correspond to the 95% confidence interval control limits and the dashed blue lines to the 99% limits. Those thresholds represent the boundary between *expected* variation (not significantly different from average) and *unwarranted variation*. Hospitals beyond the upper thresholds might be considered as poorer performers (in the alert or alarm position); hospitals below the bottom limits would signal hospitals as good or excellent performers. Whichever the direction, outliers warrant further investigation and analysis to identify underlying factors and either tackle them or use as examples of good practice.

To avoid random noise, hospitals with less than 30 episodes or procedures per year have been excluded from the analysis.

In-hospital case fatality rate for Acute Myocardial Infarction patients

In 2009, 52,683 Acute Myocardial Infarctions were admitted at the 271 Spanish hospitals. From those hospitals, 69 (25.5% -the largest share in ECHO) treated less than 30 patients each (1.38% of total AMI patients), so they were excluded from the analysis.

Out of the 51,955 admissions analysed across the 202 remaining hospitals, 4,210 patients died –8% of patients. The overall risk-adjusted CFR adds up to 1 death per 10.7 AMI admissions, setting the Spanish average at 93.75 per 1,000 patients aged 18 and older, 5.3 per thousand points below ECHO benchmark.

Individual hospitals' risk-adjusted CFR ranged from 23.23 (percentile 5) to 181.2 (percentile 95) per 1,000 AMI patients; thus, depending on the centre where they were treated, AMI patients could bear up to a 7.8-fold higher probability of dying. (See table 11 at the appendix 2.b for further details).

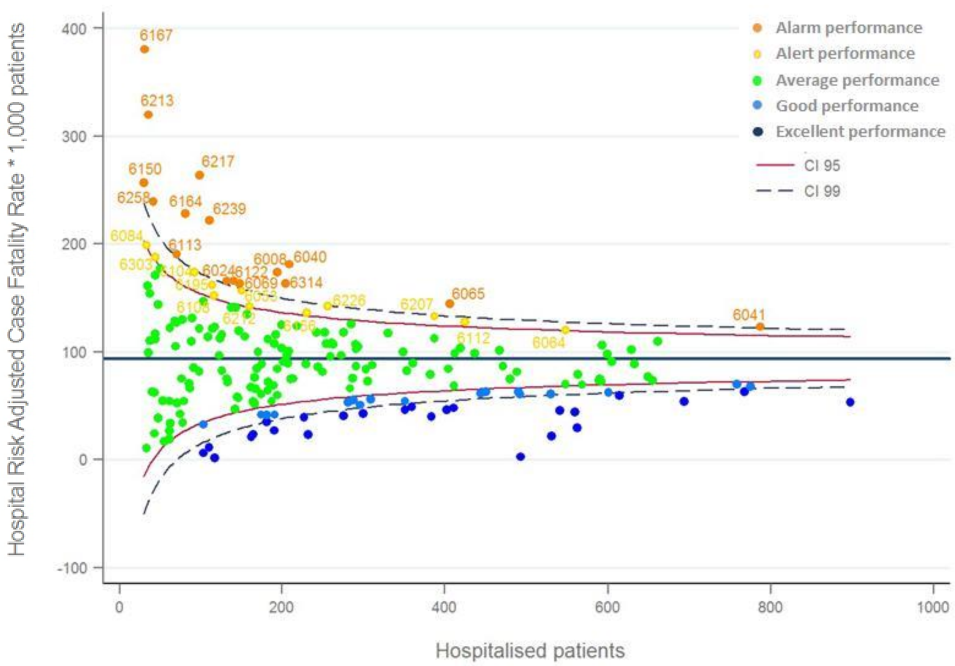

Figure 24. In-hospital mortality after AMI admission at Spanish hospitals. Year 2009.

Each dot represents one of the hospitals in the country treating more than 30 AMI cases. The expected number of deceases per 1,000 hospitalised patients is built on the adjusted average rate across Spanish hospitals.

Examining the funnel in figure 24, the results of national benchmarking differ slightly from those shown in the international comparison (figure 5, section II.b). Using the national benchmark, 28 hospitals are flagged as alert/alarm (instead of the 15 by ECHO standards) and 42 as good/excellent performers (instead of 52).

In 2009, less than three quarters of the Spanish hospitals showed an annual volume of AMI patients above 250 (70.6% of the hospitals), which in ECHO terms was set as the threshold for low vs. high activity volume. Moreover, a certain trend to reduce the share of AMI patients treated in high volume hospitals can still be observed. Actually, except in 5 out of the 28 cases, the poorest performers (showing risk-adjusted CFR up to 4 times larger than the national average) are far below the low volume threshold (table 12 at the Appendix 2.b provides detailed information on each hospital).

However, showing the ECHOs lowest in-hospital risk-adjusted mortality rate for AMI, Spanish hospitals outcomes in 2009 still indicate a reasonably good performance; only 10.1% of patients were hospitalised at alert/alarm centres while 31.4% of patients were at good or excellent centres. 65.5% of hospitals were at the average position indicating risk-adjusted CFR not significantly different from benchmark.

In-hospital case fatality rate for Percutaneous Coronary Interventions

In 2009, 43,868 PCI procedures were performed across 81 Spanish hospitals, yielding a risk-adjusted case fatality rate of 1 death per each 39 interventions in patients aged 40 or older.

PCI CFRs varied widely across hospitals in a range from cero to 79 deaths in 1,000 patients, i.e. depending on the hospital where the procedure was performed, patients faced almost 17-times higher probability of dying (EQ_{5-95}) (see tables 11 and 13 at the appendix 2.b for further details).

Since Spanish in-country benchmark for PCI was at a higher rate than ECHO's, Spanish hospitals' performance drew a less strict scenario compared to the international comparison. Figure 25 shows how, when nationally benchmarked, 11 hospitals were flagged as alert/alarm (instead of 25 in the ECHO benchmarking), while 14 were assessed as good or excellent performers (instead of just 3).

Those 11 hospitals in the alert/alarm position (13.6% of the total) took care of 15% of all undergoing PCI patients, while hospitals flagged as good/excellent provided PCI for 20% of patients.

Unlike expected, for this particular procedure in Spain, the "volume effect" seems all but reversed: there was a wide dispersion of high-volume activity hospitals labelled as alert. The proportion of hospitals carrying on between 500 and 1,000 procedures/year was the same among those flagged as alert/alarm than among good or excellent performers.

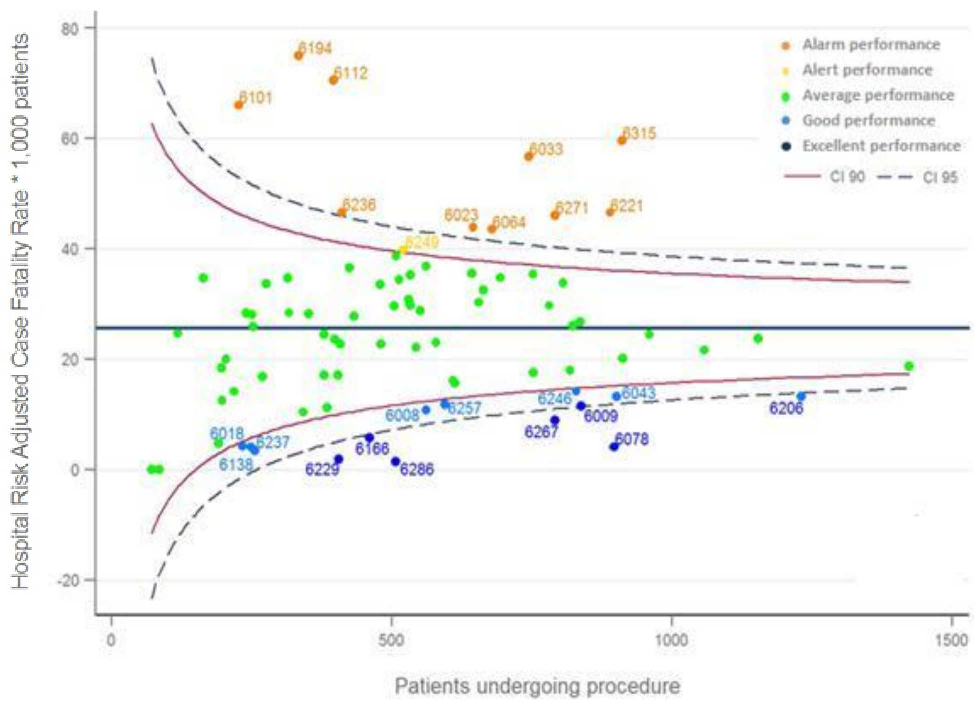

Figure 25. In-hospital mortality after a PCI procedure at Spanish hospitals. Year 2009.

Each dot represents one of the hospitals in the country performing more than 30 interventions during the period of analysis. The expected number of deceases per 1,000 hospitalised patients is built on the adjusted average rate across Spanish hospitals.

In-Hospital case fatality rate for Coronary Artery Bypass Graft procedure

In 2009, 71,147 CABG surgeries were performed at 46 Spanish hospitals, of which 5.9% resulted in death. As for risk-adjusted hospital CFR, this meant 1 death in 15 interventions for patients aged 40 or older.

In terms of individual hospitals, CABG CFRs took values from 11 (quintile 5) to 145 (quintile 95) deaths per 1,000 interventions, so patients undergoing CABG surgery could be bearing 13 times higher probability of death (risk-adjusted), depending on the hospital they are treated (See tables 11 and 14 at the appendix 2.b for further details).

Average hospital risk-adjusted CFR for CABG in Spain was in 2009 much higher than ECHO's, as seen in section II.b; therefore in-country benchmarking turns to be, once again, laxer than international comparison. As shown in figure 26, national benchmarking flagged 7 hospitals as alert/alarm performers (instead of 12 labelled as such in the ECHO benchmarking) while 8 were assessed as good or excellent performers (vs. 2 in ECHO's). 67.4% of hospitals were at the average level of performance, indicating risk-adjusted in-hospital mortality not significantly different from benchmark. 13% of patients were intervened at alert/alarm centres, while another 20.5% underwent their surgery at good or excellent hospitals.

An important aspect to highlight is the amazingly low percentage of high activity volume hospitals (11%) and hence the low percentage of patients undergoing CABG surgery at those centres, only 21%. Moreover, all but one of the high volume hospitals were set at the average performing area, meaning that their risk-adjusted CFR did not statistically differ from benchmark. (See table 14 at the appendix 2.b for further details).

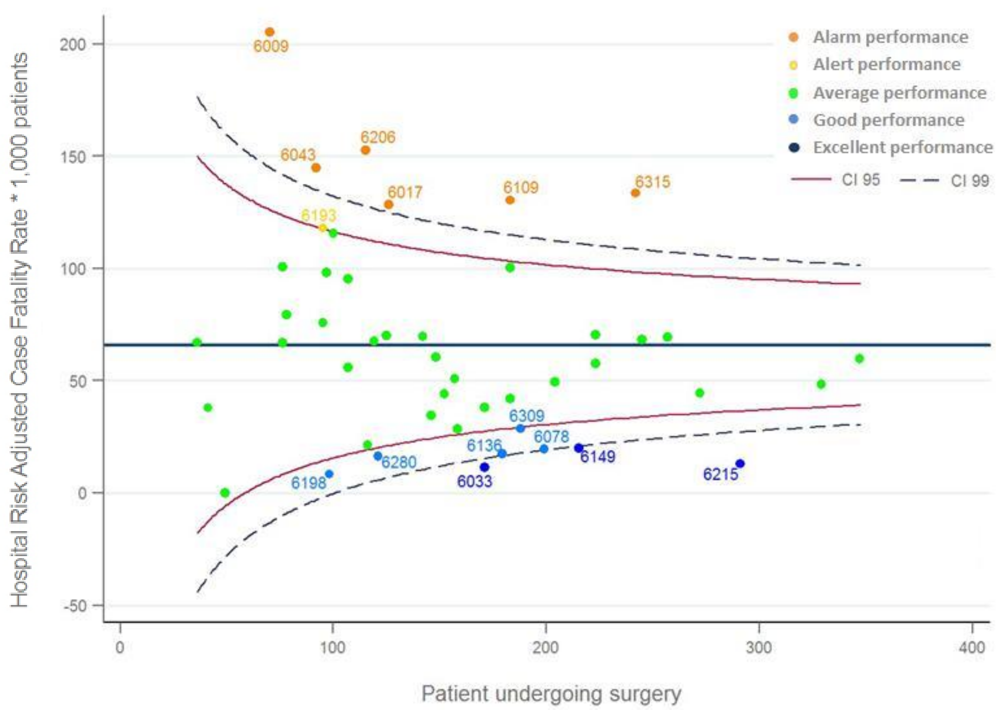

Figure 26. In-hospital mortality after CABG surgery at Spain hospitals. Year 2009.

Each dot represents one of the hospitals in the country performing more than 30 interventions during the period of analysis. Given the limited number of centres the risk-adjusted case fatality rates per 1,000 patients undergoing CAGB surgery is depicted in respect of the ECHO's average.

IV. EVOLUTION OVER TIME

Along the period 2002-2009, hospitalisations from coronary ischaemic disease have stayed quite stable contrasting with the huge increase in PCI utilisation.

In terms of hospital outcomes, average risk-adjusted CFRs for AMI patients and following CABG have been improving over the period; but not so for PCI whose CFRs sustainedly increased since 2006. Nevertheless, individually considered, there are hospital where the evolution warrants further investigation to identify both, success and failure factors.

a. Geographic approach

From 2002 to 2009, coronary ischaemic disease admissions barely decreased by 11%, from 1 admission per 392 to 1 admission per 429 adult inhabitants. Systematic part of variation remained moderate with values around 11% above that randomly expected (see table 15 in appendix 3.a).

Besides, CID admissions labelled as AMI stayed almost constant ranging from 1 admission per 764 to 1 admission per 742 adult inhabitants. Its variation not deemed random also remained moderate and stable (see table 16 in appendix 3.a).

Along the same period, PCI increased by a 75%, almost doubling their values from 1 admission per 791 to 1 admission per 413 inhabitants. Conversely, systematic variation remained constant over this period, around 22% above that expected by chance (see table 17 in appendix 3.a). Thus, differences in exposure across the territory remained, despite PCI having almost doubled its overall rate.

Establishing the trend (upwards, downwards or flat) in revascularisation surgery over time is helpful in understanding the overall dynamic of adoption, established use or withdrawal of a surgical procedure, concurrent with the evolution of the burden of ischemic disease.

Increasing trends in both, PCI and CABG could be considered as a symptom of a growing overexposure, if the burden of ischemic disease does not experiment an equivalent increase. A decrease in PCI rates not accompanied by an equivalent reduction in CID rates could represent underexposure. In turn, a reduction in CABG rates should be observed along with the PCI rates change. If PCI rates concurrently rise, further analysis should determine whether PCI adoption is substituting CABG. If this is not the case, any decrease should be considered as underexposure if CID admissions do not follow an equivalent reduction.

The degree of systematic variation denotes how homogeneous population's exposure to the procedure has been at each point in time: the higher the SCV, the broader the unwarranted variation in exposure to the procedure across residents in different *healthcare areas*.

In turn, CABG rate remained stable over the same period, – from 1 admission per 2,899 to 1 admission per 2,857 inhabitants aged 40 or older. Systematic variation in CABG utilisation, as occurred in PCI, also stayed constant and moderate along the period.

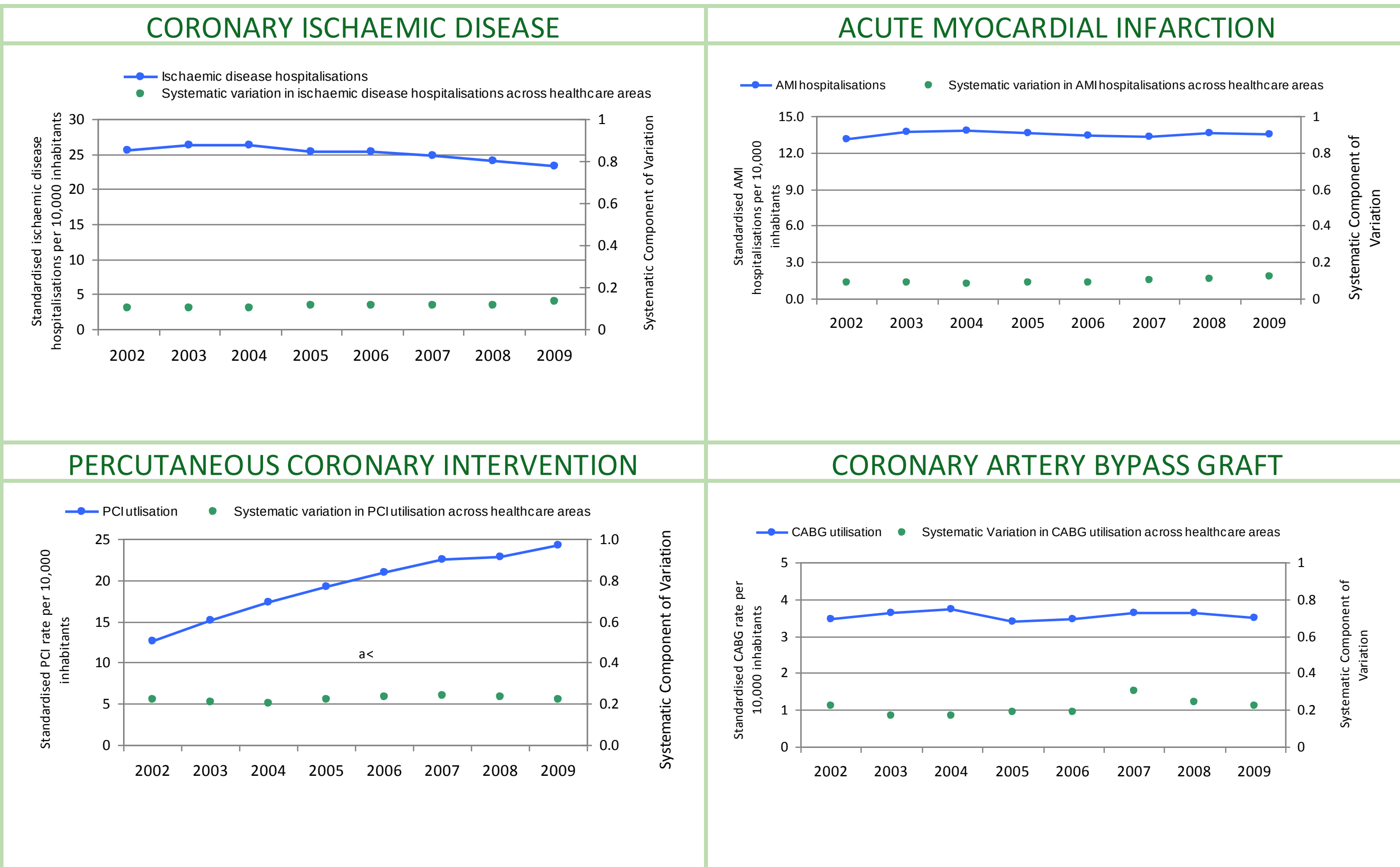

Figure 27. Temporal evolution of cardiovascular indicators from a geographical approach

Trends at those healthcare administrative areas within the lowest and highest quintiles of utilisation rates for PCI and CABG.

This section offers only a few selected examples, but individual *healthcare areas*' evolution over time can be tracked in their original dynamic charts at

http://echo-health.eu/handbook/quintiles_cv_spn.html

Besides the specific examples of change in revascularisation rates, it is also relevant to consider the spread of bubbles in 2009; since they all started at the same utilisation quintile in 2002, the variety of colours they have taken up by the final year (one for each quintile of utilisation intensity), provides a flavour of how established might be the medical practice underpinning such utilisation and how homogeneous or diversely shaped over time and across healthcare areas.

As mentioned above, Spanish PCI rate had sharply increased over the period 2002-2009. Analysing evolution of *healthcare areas* whose PCI rates were among the lowest at the beginning of the period (Q1), we see that they spread across all utilisation quintiles over time (figure 28). For example, in ***Guadalajara*** rates have increased over time until reaching the fourth quintile in 2009. Instead, ***Xàtiva*** remained having the lowest rates for the whole period. Figure 29 portraits the same phenomenon, but for *healthcare areas* starting in the opposite side, at the top of the utilisation range (Q5). In this case, most areas stayed in the higher utilisation quintiles (Q5 or Q4) as occurred in ***Bahía de Cádiz***. While, others, as ***Bilbao***, have had their rates decreased until the lowest quintile of PCI utilisation.

Similar patterns can be observed in CABG surgery. Taking as an example ***Zaragoza-Clínico*** and ***Son Dureta***, both areas showed low rates in 2002 but their evolution was extremely uneven. While ***Zaragoza*** remained among the lowest quintiles, ***Son Dureta*** reached the highest utilisation levels by the end of the period (figure 30).

Finally, it can be observed that areas with highest CABG utilisation in 2002 (Q5 in orange) also experienced uneven evolution over the period, despite most of them, for example ***Oviedo**,* remained in top utilisation quintiles. Conversely, the CABG rate in a few areas, as ***Vallès Occidental**,* decreased steadily over time until the lowest quintile of exposure (figure 31).

You can track the evolution of individual healthcare areas at:

http://www.echo-health.eu/handbook/quintiles_cv_spn.html

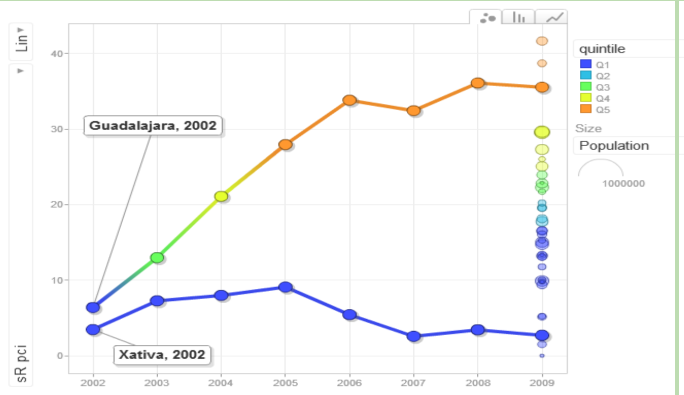

Figure 28. Trends in utilisation rates of PCI in those *healthcare areas* showing the lowest rates at the beginning of the 2period.

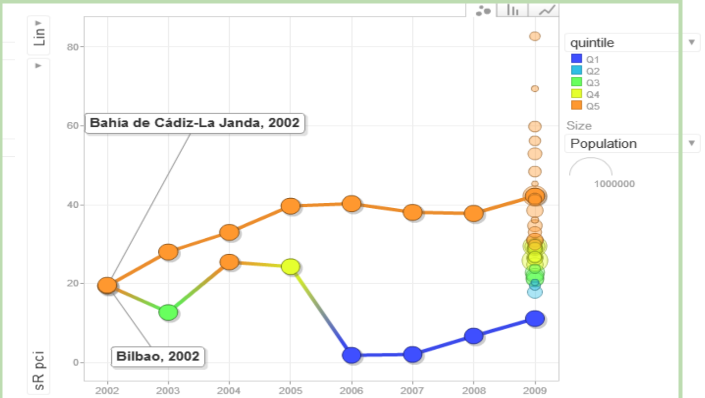

Figure 29. Trends in utilisation rates of PCI in those *healthcare areas* showing the highest rates at the beginning of the period.

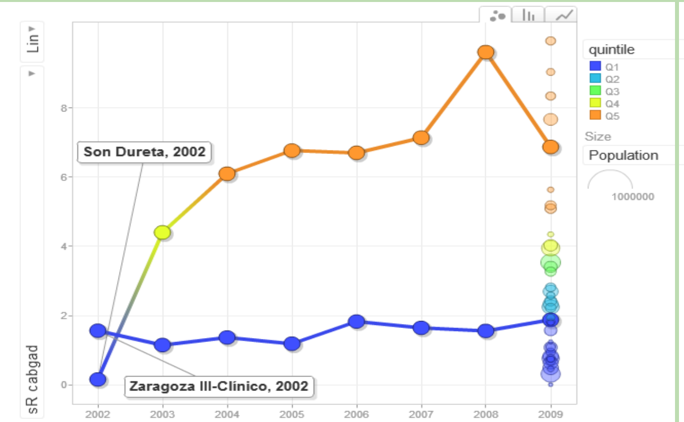

Figure 30. Trends in utilisation rates of CABG in those *healthcare areas* showing the lowest rates at the beginning of the period.

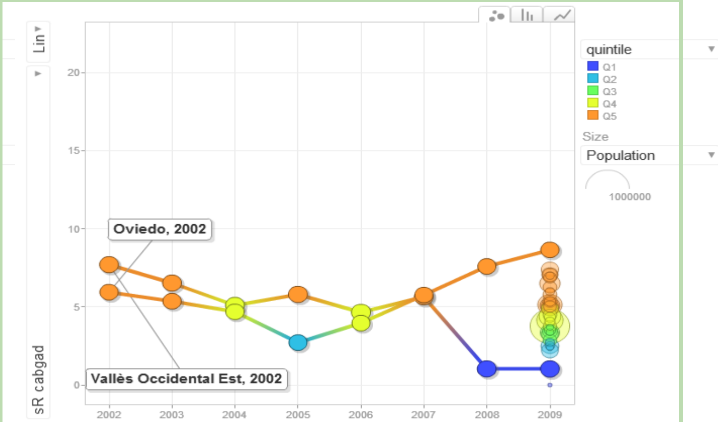

Figure 31. Trends in utilisation rates of CABG in those *healthcare areas* showing the highest rates at the beginning of the period.

b. Hospital approach

In order to study how in-hospital mortality behaved along the period of analysis, some examples are offered showing the evolution of hospitals with the lowest or the highest rates at the beginning of the period.

For further details, please, look at the dynamic graphics where you can track individual hospitals' behaviour from 2002 to 2009:

http://echo-health.eu/handbook/hospital_cv_spn.html

Bubble dynamic graphs show the sequence of results from funnel plots assessing outcomes annually along the period of analysis. The size of the bubble is proportional to the amount of patients or interventions. Hospitals flagged as good or even excellence performers (blue coloured bubbles) in 2002 are expected to remain blue all along the period. However, those hospitals identified as poorer performers, in alert or alarm position at the beginning of the period (orange coloured bubbles) should have improved their results along time (turning into green –average- or ideally bluish).

Departures from this pattern of change can be considered undesirable trends, warranting further investigation.

In-hospital case fatality rate trends for Acute Myocardial Infarction patients, period 2002-2009.

Regarding the behaviour of hospital risk-adjusted CFR for AMI patients, figure 32 shows four examples of hospitals which improve or worsen their performance along the analysed period or which remain in the same position.

For instance, ***Puerta de hierro (Majadahonda)*** which starts from an "*average performance*" improved to "*excellent*" along the period. Both, ***Hospital Universitario Central de Asturias*** (high activity volume) and ***Can Misses*** (low activity volume -*note that the size of the bubble is proportional to the amount of cases treated*), started at the excellent and good performance position respectively, but the first, after some years of sustained performance, evolved to "alert" while the other behaved erratically fluctuating from average to a "less safe" performance position. On the other hand, ***Hospital Universitario Reina Sofia*** is an example of a hospital that has improved its performance along the period of analysis, starting as "alert" and ending at an average performing position. Further details of the evolution of Spanish hospitals' relative performance for AMI admissions, along this period, are in table19, appendix 3.b.

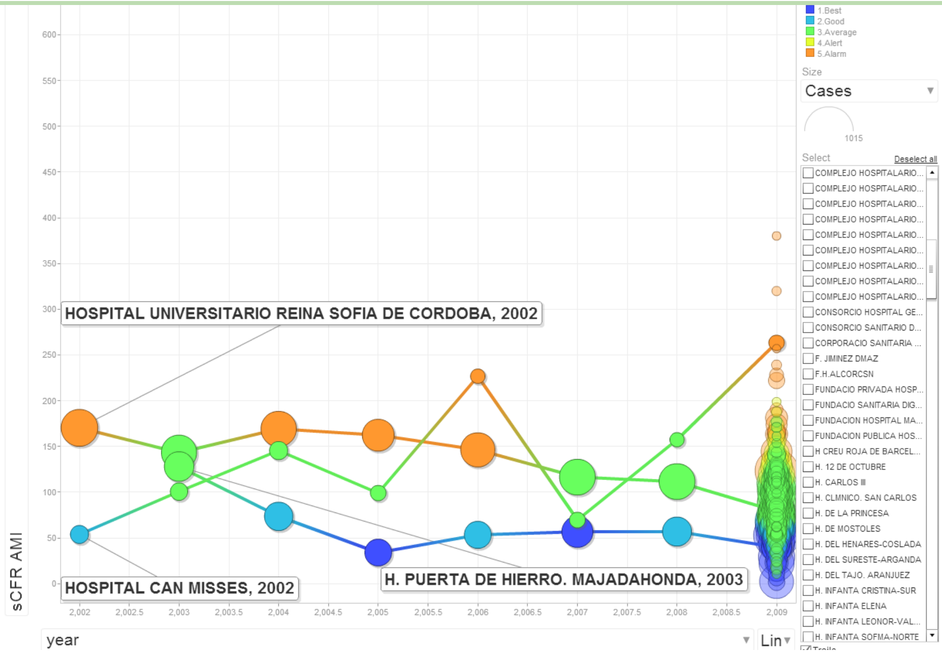

Figure 32. In-Hospital mortality trends of AMI, 2002-2009, showing some of the highest and lowest rates and their evolution.

Bubbles represent hospitals: the broader the bubble, the larger the amount of AMI hospitalised patients at that hospital. Dark-blue bubbles represent hospitals with risk-adjusted case fatality rates below the CI-99% limit, so then pointed as an "excellent performance". Light-blue bubbles represent hospitals with risk-adjusted case fatality rates below the CI-95% limit, so then pointed as a "good performance". Yellow bubbles represent hospitals with risk-adjusted case fatality rates above the CI-95% limit, so then pointed as "alert positioned". Orange bubbles represent hospitals with risk-adjusted case fatality rates above the CI-99% limit, so then pointed as "alarm positioned".

In-hospital case fatality rate for Percutaneous Coronary Intervention, period 2002-2009.

In this case, as shown in figure 33, we find hospitals starting and ending at an "alert/alarm performance" after some fluctuations around average position (***Hospital Universitario Gregorio Marañón***); hospitals drastically evolving from the areas of non-significant differences to "alarm performance" (***Hospital Universitario de la Fe***), but also, hospitals improving from "alert" to an "excellent" performance while increasing their volume of activity (***Hospital Puerta del Hierro***). The ***Hospital Reina Sofia*** is an example of fluctuating evolution, passing over the years from average to excellent performance position but, then again, back to average and so on. Further details of the evolution of Spanish hospitals' relative performance for PCI, along this period, are in table 20, appendix 3.b.

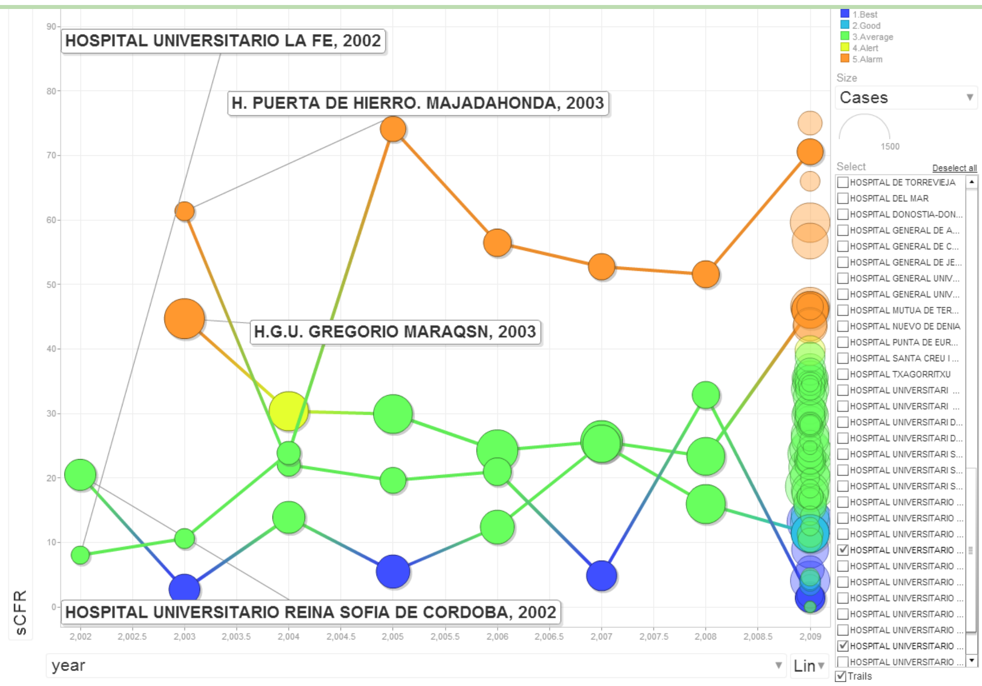

Figure 33. In-Hospital mortality trends of PCI -2002-2009, showing some of the highest and lowest rates and their evolution

Bubbles represent hospitals: the broader the bubble, the larger the amount of patients undergoing a PCI, at that hospital. Dark-blue bubbles represent hospitals with risk-adjusted case fatality rates below the CI-99% limit, so then pointed as an "excellent performance". Light-blue bubbles represent hospitals with risk-adjusted case fatality rates below the CI-95% limit, so then pointed as a "good performance". Yellow bubbles represent hospitals with risk-adjusted case fatality rates above the CI-95% limit, so then pointed as "alert positioned". Orange bubbles represent hospitals with risk-adjusted case fatality rates above the CI-99% limit, so then pointed as "alarm positioned".

In-hospital case fatality rate trends for Coronary Artery Bypass Graft surgery, period 2002-2009.

Concerning the coronary artery bypass procedure, there are some hospitals that remarkably changed position during the period. Figure 34 shows two examples: ***Complejo Universitario de Badajoz*** whose risk-adjusted CFR deeply decreased after several years in the "alert" position to end up as a "good/excellent" performer; or ***Hospital Clínico Universitario***, whose performance started at "average", fluctuated to "excellent "performance, worsen back to average, ending up at "alarm position". On the other hand, ***Hospital Universitario Reina Sofia*** did not leave the area of "alert/alarm", while ***Complejo Asistencial Son Dureta*** instead, remained steady at "*excellent performance*" position all along the analysed period. Further details of the evolution of English hospitals' relative performance for CABG, along this period, are in table 21, appendix 3.b.

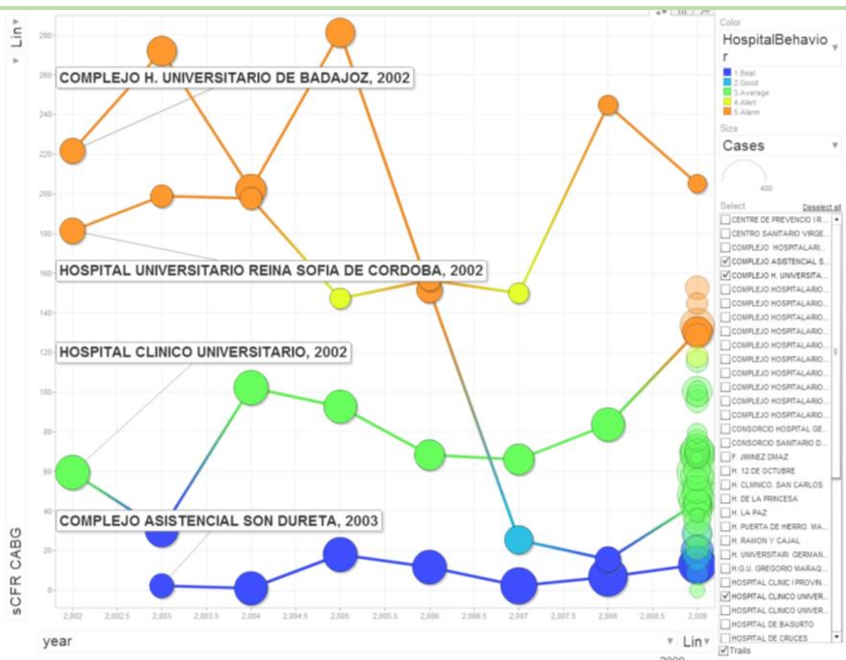

Figure 34. In-Hospital mortality trends of CABG -2002-2009, showing some of the highest and lowest rates and their evolution

Bubbles represent hospitals: the broader the bubble, the larger the amount of patients undergoing a PCI, at that hospital. Dark-blue bubbles represent hospitals with risk-adjusted case fatality rates below the CI-99% limit, so then pointed as an "excellent performance". Light-blue bubbles represent hospitals with risk-adjusted case fatality rates below the CI-95% limit, so then pointed as a "good performance". Yellow bubbles represent hospitals with risk-adjusted case fatality rates above the CI-95% limit, so then pointed as "alert positioned". Orange bubbles represent hospitals with risk-adjusted case fatality rates above the CI-99% limit, so then pointed as "alarm positioned".

V. SOCIAL GRADIENT

Most deprived healthcare areas had more CID admission and showed significant higher PCI utilisation rates than most affluent ones. On the contrary, CABG utilisation was higher in wealthier areas than in the worse-off ones.

Significant more CID admissions occurred in most deprived healthcare areas (Q1) than in wealthier ones (Q5). When analysing specifically those CID admissions labelled as AMI, again worse-off areas showed more admissions than better-off ones becoming the gap between extreme quintiles wider over time.

When analysing PCI utilisation, most deprived areas showed significant higher rates than those more affluent since 2006. Moreover the gap between extreme quintiles became wider over time. It's worth noting that utilisation rates growth in more deprived areas was 2.5 times larger than in more affluent ones (see table 17 in appendix 3.a).

Just the opposite occurred with CABG surgery, being significantly more frequent in wealthier areas than in worse-off ones, from 2004 to 2009. Again, the gap between extreme quintiles became slightly wider over time, due this time to a little increase in CABG utilisation in better-off areas. Nevertheless, although significant, the difference absolute value between extreme quintiles was quite small, reaching 1.6 admissions/per 10,000 inhabitants (see table 18 in appendix 3.a)

Graphs in this section aim at providing some sense of the behaviour of CID admissions and revascularization procedures depending on the average level of affluence in the *healthcare areas*. At a glance, it will show whether there are differences between the better-off and the worse-off areas, and if these differences vary over time.

The wider the gap between most and least affluent quintile lines, the more inequitably distributed the exposure to revascularisation surgery will be. It is also relevant to keep track of the 95% confident interval (whiskers) drawn around the annual rates estimated for quintiles 1 and 5. Only those not overlapping signal a statistically significant difference between wealthier and deprived areas.

The desirable pattern will show no statistically significant differences across healthcare areas amenable to their wealth. As a second best, any eventual existing gap should disappear over time.

Therefore, variation in CID admissions across areas described in previous sections seems to be related to income area level. Since, worse-off areas bear more CID admissions and, specifically, more AMI hospitalisations, we could expect that they have higher need for health care than high income areas. This happened wit PCI use, but not with CABG since they were more frequent in wealthier areas. Despite the huge increase in PCI utilisation in deprived areas, the higher number of CID admissions and the growing rate in AMI in these areas would warrant further investigation to elucidate if there is some equity barrier in access to CABG procedures, or to other treatments.

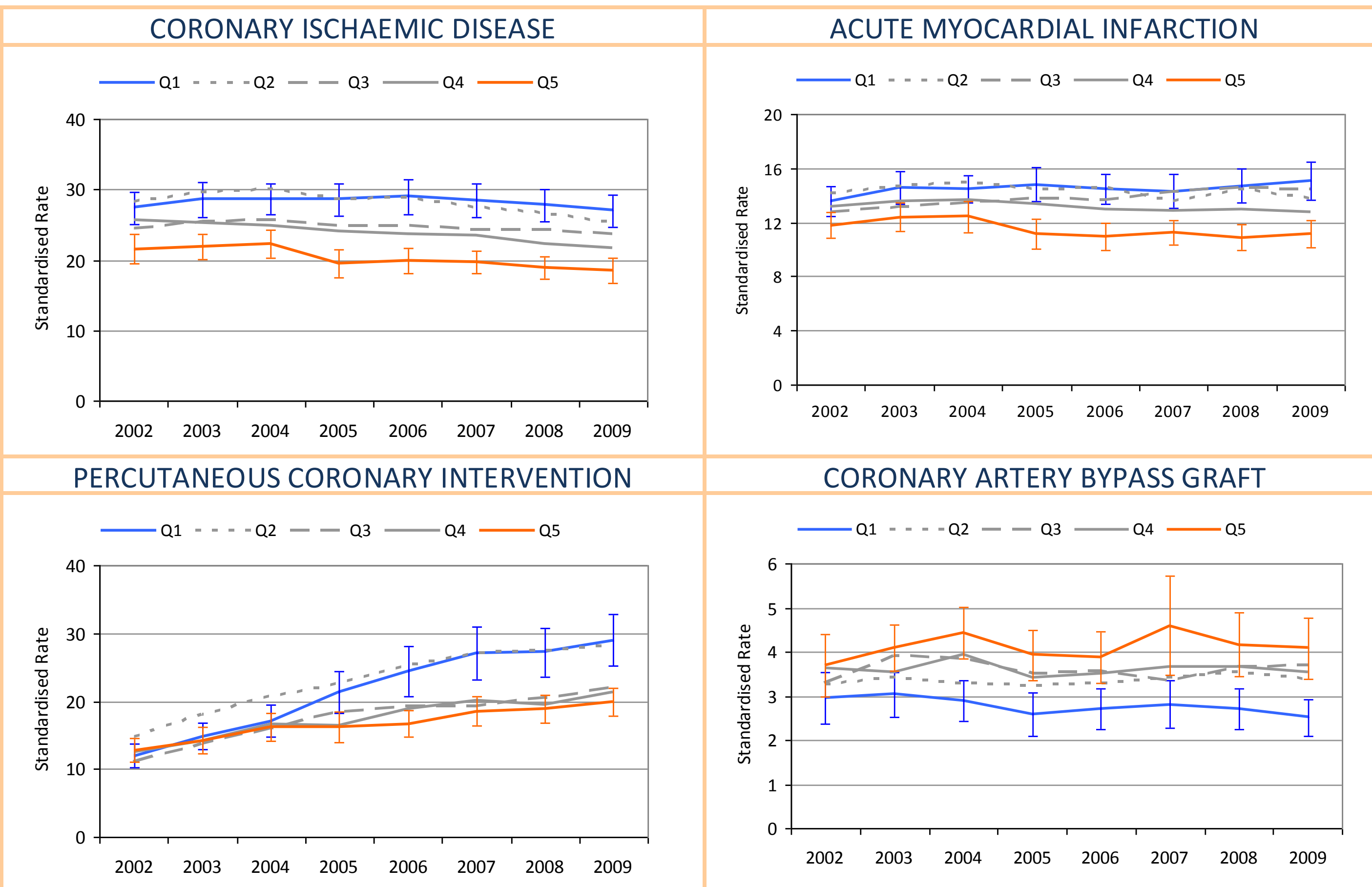

Figure 35. Trends in standardised rate by income quintiles.

VI. POLICY IMPLICATIONS

Coronary ischaemic disease is one of the leading causes of death, disability and decreased quality of life in Europe; particularly, together with cancer, the main cause of death in Spain in 2009. It is also a leading cause of premature death in men, generating important social costs associated to potential years of life lost. Hence, mortality and morbidity from cardiovascular disease have become a relevant issue for all health systems in Europe, as well as an important driver of health expenditure.

Several studies in the last decade showed that the incidence of coronary heart disease in the northern half of Europe, particularly Scandinavian countries, is higher than in the south. Even though hospitalisations for ischemic heart disease show a decreasing trend, rates showed higher figures in England and Denmark (in this order) than in Spain and Portugal. This factor should be taken into account when assessing and comparing hospitalisation rates and the intensity of consequent interventions; nevertheless this section will highlight elements in the Spanish healthcare system and/or the organisational processes that may underpin the observed results and thus, might be worth a closer examination.

The mapping out of burden of coronary disease and PCI intensity of use produces in some cases contradicting patterns: *Healthcare Areas* counting among the highest PCI utilisation rates could show either lower relative risk of CID hospitalisation or come along with the highest risks. Given the potential benefit of primary PCI, two hypotheses are at play (perhaps concomitant, rather than alternative): a higher amount of early interventions might be preventing hospitalisation at further stages of the disease, and thus, reducing the corresponding admission rate. But, at the same time, the local risk of suffering a hospitalisation from CID should be also leading the need for PCI procedures and, thus, the local intensity of use; if that were not the case, such high intensity of PCI revascularisation unrelated to need might be pointing out over-utilisation of the procedure, that is, populations being over-exposed and thus, subject to inadequate provision of care.

The geographical analysis also revealed a relevant role for the regional tier in explaining the variation in the population’s exposure to PCI or CABG -regions explained more than 40% of the variation beyond that explained by the areas. This may be due to the application of different regional health plans or differing implementation of the national strategy at local level[1] highlighting the relevant role of regions at modulating certain health policies and consequently the provision of these interventions. Alternatively, the existence of a concentration of early adopters -high-tech hospitals acting as referral hospitals for all the citizens within a region- could also explain this great deal of variation explained by the region.

At *Healthcare area* level, only PCI utilisation pattern seems to be positively associated with the burden of disease. However, this association was small. The joint analysis of the utilisation patterns for both revascularisation procedures (PCI and CABG) provides some grounds to induce a general (in terms of regions) substitution utilisation. Nevertheless, a case-by-case further analysis of discrepant trends may shed some light. It would be important to find in those cases, the factors other than need or technological changes that might be at play in explaining revascularisation rates.

Looking now at case fatality rates at hospital level, Spanish risk-adjusted in-hospital mortality for AMI patients has shown an important decrease since 2002, being the lowest among ECHO countries in 2009. Detailed analysis reveals that most Spanish hospitals, nearly 65.5%, provide care for AMI patients within the expected (average) levels of quality and safety. Nevertheless, this fact coexists with two other extreme patterns of care provision: on the one hand, 13.8% of hospitals -treating close to 10% of all Spanish AMI patients- obtained in-hospital mortality results significantly higher than expected, and were consequently flagged as alert or alarm; meanwhile, another 20.7% of them -treating 31.4% of total AMI patients -were flagged as good or excellent in performance with risk-adjusted CFR significantly lower than expected. The quantified effect on variation amenable to the hospital of treatment was 1.25[2]. In the case of AMI, it indicates that comparing pairs of similar patients from two different hospitals, randomly chosen, they would have a 25% different risk of dying depending on where the patient was hospitalised.

Concerning the in-hospital mortality after the revascularisation procedures, the situation gets more worrisome. Risk-adjusted CFR for PCI and CABG were both, in 2009, the highest across ECHO countries. Emphasize two specific aspects to be concerned about, the increasing trend of the risk-adjusted CFR after PCI together with the highest share in ECHO of hospitals performing PCI and CABG set at the alarm position. In the case of PCI, similar patients treated in different hospital

[1] Ministerio de Sanidad y Consumo. *Estrategia en Cardiopatía Isquémica del SNS*. 2006
[2] Calculated throughout the Median Odds Ratio [MOR]

would have a differential risk of dying as high as a 44%. When it comes to CABG, the differential of risk amenable to the hospital of treatment rises up to a 65%.

Volume has been argued as one of the plausible factors underpinning these differences. In fact, the vast majority of Spanish hospitals registered a volume of annual patients well below the ECHO threshold for high volume. The lower the volume the higher the probability of worse outcomes. Other countries in ECHO, like Denmark, have recently implemented some reforms which pursue the idea of encouraging centralisation of specialised interventions into fewer centres, so the minimum amount of procedures per centre is guaranteed to maintain high level of expertise and consequent quality. In the case of England, a provision was billed where hospitals were required to perform more than 300 CABG a year to get the accreditation.

The literature, as well as the *Spanish National Strategy for Coronary Ischaemic Disease*, recommends assessing a number of factors critical to explain differences in hospital outcomes (both at local and global levels); these include pre-hospital diagnosis and planning of urgent transportation to the appropriate medical centre. In this respect, assessing the relationship to the eventual hospital of reference could provide relevant insights as to whether there is a well-defined, stable and fluid bypass circuit for severe patients or special techniques and if transfer to reference centres takes place immediately or within 24 hours, depending on the severity of the situation. Such are key elements of care in successful treatment and, thus, their further understanding could be very helpful in improving patient outcomes as well as overall costs for the health system.

The analysis conducted, suggests that there is plenty of room for enhancing outcomes in the Spanish system. Burden of disease and revascularisation rates are generally lower as compared with other ECHO countries; however, in some healthcare areas they do not seem to relate to each other, suggesting that factors other than need or technological change might be driving the revascularisation intensity.

On the other hand Spanish hospitals' surgical outcomes come out rather poor according to the international benchmarking picture. Besides, the comparatively poorer results of some Spanish hospitals according to the national benchmark, when it comes to PCI and CABG patients, warrant some closer look. The fact that only 21% of the patients undergoing CABG procedure were treated in high-volume hospitals deserves further consideration.

APPENDIX 1.a:

International Comparison

2009

Table 1. General descriptive statistics for burden of disease: CID admissions

	CORONARY ISCHAEMIC DISEASE				
	DENMARK	ENGLAND	PORTUGAL	SLOVENIA	SPAIN
Cases	13225	141167	14526	4288	78585
Stand. Rate	30.68	34.32	17.86	32.40	23.79
EQ5-95	2.32	2.16	2.12	1.89	3.04
SCV	0.14	0.24	0.15	0.09	0.10

Stand. Rate: Age-sex Standardised Rate (Reference population: ECHO countries 2009); EQ: Extremal Quotient; SCV: Systematic Component of Variation.

Table 2. General descriptive statistics for burden of disease: AMI admissions

	ACUTE MYOCARDIAL INFARCTION				
	DENMARK	ENGLAND	PORTUGAL	SLOVENIA	SPAIN
Cases	6711	69713	11365	2911	46206
Stand. Rate	15.90	16.76	13.80	22.29	13.78
EQ5-95	1.91	2.63	2.37	1.67	2.98
SCV	0.05	0.15	0.05	0.34	0.11

Stand. Rate: Age-sex Standardised Rate (Reference population: ECHO countries 2009); EQ: Extremal Quotient; SCV: Systematic Component of Variation.

Table 3. General descriptive statistics for utilisation of PCI procedure

	PERCUTANEOUS CORONARY INTERVENTION				
	DENMARK	ENGLAND	PORTUGAL	SLOVENIA	SPAIN
Cases	9253	63220	10587	5025	48368
Stand. Rate	37.50	27.18	21.37	60.16	23.89
EQ5-95	1.86	2.20	2.24	2.61	4.71
SCV	0.33	0.08	0.08	1.97	0.22

Stand. Rate: Age-sex Standardised Rate (Reference population: ECHO countries 2009); EQ: Extremal Quotient; SCV: Systematic Component of Variation.

Table 4. General descriptive statistics for utilisation of CABG surgery

	CORONARY ARTERY BYPASS GRAFT				
	DENMARK	ENGLAND	PORTUGAL	SLOVENIA	SPAIN
Cases	2371	20434	2446	774	7068
Stand. Rate	9.99	9.00	4.77	9.77	3.38
EQ5-95	1.71	2.33	7.42	5.32	9.83
SCV	0.50	0.41	0.19	0.74	0.27

Stand. Rate: Age-sex Standardised Rate (Reference population: ECHO countries 2009); EQ: Extremal Quotient; SCV: Systematic Component of Variation.

APPENDIX 1.b:

International Comparison

2009

Table 5. Data description of hospitals and patients included* in the analysis.

	ECHO	DENMARK	ENGLAND	PORTUGAL	SLOVENIA	SPAIN
	ACUTE MYOCARDIAL INFARCTION					
Total discharges	147670	8124	71001	12391	3471	52683
Total nº hospitals	522	35	154	46	16	271
hospitals excluded	87	5	5	6	2	69
(% patients excluded)	0.55%	0.48%	0.01%	0.28%	0.06%	1.38%
Discharges analysed	146859	8085	70994	12356	3469	51955
Nº Hospitals analysed	435	30	149	40	14	202
	PERCUTANEOUS CORONARY INTERVENTION					
Total discharges	133161	9306	64253	10760	4817	44025
Total nº hospitals	283	25	97	39	9	113
hospitals excluded	84	18	24	9	1	32
% patients excluded	0.32%	0.43%	0.18%	0.92%	0.29%	0.36%
Discharges analysed	132737	9266	64139	10661	4803	43868
Nº Hospitals analysed	199	7	73	30	8	81
	CORONARY ARTERY BYPASS GRAFT					
Total discharges	33765	2390	21036	2496	678	7165
Total nº hospitals	145	17	53	10	2	63
hospitals excluded	56	11	24	4	---	17
% patients excluded	0.24%	1.26%	0.14%	0.16%	---	0.25%
Discharges analysed	33683	2360	21006	2492	678	7147
Nº Hospitals analysed	89	6	29	6	2	46

Hospitals treating less than 30 patients (admitted or undergoing any procedure in a year) have been excluded from the analysis in order to avoid random noise when estimating risk-adjustment within logistic multivariate modelling.

Table 6: ECHO hospitals' description and relative performance per country for AMI hospitalised patients. (ECHO benchmark estimation)

	ACUTE MYOCARDIAL INFARCTION					
	ECHO	DENMARK	ENGLAND	PORTUGAL	SLOVENIA	SPAIN
Discharges	146859	8085	70994	12356	3469	51955
Deceased	12582	674	6281	1183	240	4204
Nº Hospitals	435	30	149	40	14	202
Hospitals > 250 (% patients treated)	239 (82.47%)	6 (70.3%)	125 (93.9%)	23 (79%)	3 (66.59%)	82 (70.59%)
Average expected Risk-adjusted CFR	99.03	133.45	94.41	109.57	101.58	93.75
hosp. Alarm position (% patients treated)	40 (5.83%)	10 (21.13%)	9 (4.30%)	10 (20.31%)	3 (7.81%)	6 (1.09%)
hosp. Alert position (% patients treated)	18 (3.19%)	3 (3.45%)	6 (3.54%)	1 (1.45%)	1 (1.59%)	9 (4.09%)
hosp. Good performers (% patients treated)	42 (11.42%)	2 (3.15%)	14 (10.65%)	3 (9.43%)	2 (5.85%)	20 (13.97%)
hosp. Excellent performers (% patients treated)	67 (26.7%)	5 (60.63%)	22 (23.6%)	5 (19.06%)	3 (51.14%)	32 (25.85%)

Hospitals>250: Hospitals above the activity threshold of 250 AMI hospitalisations a year; Alarm position: hospitals above the CI-99 limit; Alert position: hospitals above the CI-95 limit; Good performers: hospitals below the CI-95 limit; Excellent performers: hospitals below the CI-99 limit. In brackets, the percentage of AMI patients in the country hospitalised at those hospitals.

APPENDIX 1.b:

International Comparison

2009

Table 7: ECHO hospitals' description and relative performance per country for patients undergoing PCI. (ECHO benchmark estimation)

	PERCUTANEOUS CORONARY INTERVENTION					
	ECHO	DENMARK	ENGLAND	PORTUGAL	SLOVENIA	SPAIN
Discharges	132737	9266	64139	10661	4803	43868
Deceased	2623	255	924	188	143	1113
Nº Hospitals	199	7	73	30	8	81
Hospitals > 250 (% patients treated)	159 (95.44%)	7 (100%)	64 (97.17%)	15 (84.05%)	5 (97.04%)	68 (94.53%)
Average expected Risk-adjusted CFR	19.86	22.78	13.70	20.77	15.61	25.59
hosp. Alarm position (% patients treated)	28 (17.26%)	4 (67.47%)	1 (1.55%)	3 (9.69%)	2 (74.47%)	18 (25.19%)
hosp. Alert position (% patients treated)	10 (3.9%)	--- ---	2 (1.80%)	1 (1.76%)	--- ---	7 (8.74%)
hosp. Good performers (% patients treated)	17 (4.8%)	2 (7.52%)	13 (7.80%)	--- ---	1 (5.58%)	1 (0.92%)
hosp. Excellent performers (% patients treated)	15 (15.51%)	--- ---	12 (28.27%)	1 (9.80%)	--- ---	2 (3.20%)

Hospitals>250: Hospitals above the activity threshold of 250 PCI a year; Alarm position: hospitals above the CI-99 limit; Alert position: hospitals above the CI-95 limit; Good performers: hospitals below the CI-95 limit; Excellent performers: hospitals below the CI-99 limit. In brackets, the percentage of AMI patients in the country hospitalised at those hospitals.

Table 8: ECHO hospitals' description and relative performance per country for patients undergoing CABG. (ECHO benchmark estimation)

	CORONARY ARTERY BYPASS GRAFT					
	ECHO	DENMARK	ENGLAND	PORTUGAL	SLOVENIA	SPAIN
Discharges	33683	2360	21006	2492	678	7147
Deceased	1212	96	571	87	37	421
Nº Hospitals	89	6	29	6	2	46
Hospitals > 250 (% patients treated)	46 (82.16%)	5 (93.43%)	29 (100%)	6 (100%)	1 (70.06%)	5 (20.93%)
Average expected Risk-adjusted CFR	50.33	44.54	27.81	33.55	44.97	66
hosp. Alarm position (% patients treated)	9 (3.58%)	--- ---	--- ---	--- ---	--- ---	9 (16.87%)
hosp. Alert position (% patients treated)	4 (2.03%)	--- ---	--- ---	1 (16.21%)	--- ---	3 (3.92%)
hosp. Good performers (% patients treated)	13 (20.65%)	--- ---	8 (26.09%)	2 (32.58%)	1 (29.94%)	2 (6.46%)
hosp. Excellent performers (% patients treated)	18 (40.61%)	1 (24.79%)	16 (60.32%)	1 (16.97%)	--- ---	--- ---

Hospitals>250: Hospitals above the activity threshold of 250 CABG a year; Alarm position: hospitals above the CI-99 limit; Alert position: hospitals above the CI-95 limit; Good performers: hospitals below the CI-95 limit; Excellent performers: hospitals below the CI-99 limit. In brackets, the percentage of AMI patients in the country hospitalised at those hospitals.

APPENDIX 2.a:

Spain, 2009

Table 9: Descriptive Statistics of burden of coronary disease and use of revascularisation procedures across *healthcare areas*.

	CID	AMI	PCI	CABG
Cases	78,585	46,206	48,368	7,068
Population	39,808,144	39,808,144	22,988,560	22,988,560
Crude Rate	21.22	12.22	20.21	2.97
Stand. Rate	20.63	11.91	20.22	2.96
sR Min.	4.6	1.5	0.13	0.16
sR Max.	43.06	23.15	70.02	7.83
sR. P5	12.45	6.36	7.92	0.66
sR. P25	16.37	9.45	14.96	1.88
sR. P50	20.03	11.59	19.27	2.82
sR. P75	23.58	13.96	23.65	3.84
sR. P95	32.56	18.46	35.74	6.09
EQ5-95	2.61	2.9	4.51	9.28
EQ25-75	1.44	1.48	1.58	2.04
ICC	0.28	0.14	0.44	0.43

Stand. Rate & sR: Age-sex Standardised Rate (Reference population: national 2009); sR Px: percentile x of sR distribution; EQ: Extreme Quotient; ICC: Intra class Correlation Coefficient

Table 10: Relative risk of exposure to coronary disease and revascularisation procedures across healthcare areas.

	CID	AMI	PCI	CABG
SUR Min.	0.25	0.21	0.01	0.07
SUR Max.	2.17	2	3.28	2.54
SUR P5	0.63	0.54	0.39	0.21
SUR P25	0.83	0.81	0.7	0.6
SUR P50	1.02	0.99	0.91	0.92
SUR P75	1.19	1.19	1.14	1.25
SUR P95	1.63	1.57	1.72	1.96
SCV	0.1	0.09	0.19	0.22

SUR: Standardised admission/Utilization Ratio (observed/expected); SUR Px: percentile x of the SUR distribution; SCV: Systematic Component of Variation.

APPENDIX 2.b:

Spain, 2009

Table 11: Descriptive statistics of hospital activity and outcomes.

	AMI in-hospital mortality	PCI in-hospital mortality	CABG in-hospital mortality
Deceased	4210	1113	421
N. hospitals	203	81	46
Crude CFR	88.60	24.62	61.57
Risk-adjusted CFR	93.75	25.59	66.00
R-adj CFR_5	23.23	3.41	11.29
R-adj CFR_{95}	181.20	56.75	144.72
Rho Statistic	0.016	0.042	0.077
MOR	1.25	1.44	1.65

CFR: Case Fatality Rate per 1,000 hospitalised patients or patients undergoing procedure; R-adj CFRx: risk-adjusted CFR of the percentile x of the CFR distribution; Rho Statistic: cluster effect. MOR (median odds ratio): variation between clusters.

Table 12: Hospital outcomes for Acute Myocardial Infarction patients, year 2009. National benchmark estimation.

Hospital					Expected Rate		Relative Position		Expected Rate		Relative Position	
Code	Name	AMI cases (i)	Hospital CFR	Hospital sCFR	UCI 95%	LCI 95%	Above IC95	Below IC95	UCI 99%	LCI 99%	Above IC99	Below IC99
6167	HOSPITAL PROVINCIAL SANTA CATERINA	31	258,06	380,17	201,53	-14,03	*		235,40	-47,90	*	
6213	HOSPITAL LOS ARCOS	36	222,22	319,86	193,77	-6,27	*		225,19	-37,70	*	
6217	HOSPITAL CAN MISSES	99	161,62	263,43	154,06	33,44	*		173,01	14,48	*	
6150	HOSPITAL MUNICIPAL DE BADALONA	30	200,00	256,94	203,31	-15,82	*		237,74	-50,24	*	
6258	HOSPITAL GUTIERREZ ORTEGA	42	190,48	239,09	186,35	1,15	*		215,44	-27,95	*	
6164	HOSPITAL DE FIGUERES	81	185,19	228,25	160,43	27,07	*		181,38	6,12	*	
6239	COMPLEJO HOSPITALARIO LLERENA-ZAFRA	111	171,17	222,03	150,71	36,79	*		168,61	18,89	*	
6084	CLINICA SANTA MARIA DE LA ASUNCION	33	121,21	198,81	198,21	-10,72	*		231,04	-43,54		
6113	HOSPITAL GENERAL DE REQUENA	70	128,57	190,69	165,48	22,02	*		188,01	-0,52	*	
6303	H. DEL TAJO. ARANJUEZ	44	136,36	187,61	184,22	3,28	*		212,65	-25,15		
6040	HOSPITAL DE LA MERCED	209	157,89	181,20	135,26	52,24	*		148,30	39,19	*	
6220	HOSPITAL INCA	50	140,00	177,24	178,62	8,88			205,28	-17,79		
6008	HOSPITAL GENERAL DE JEREZ DE LA FRONTERA	194	123,71	173,75	136,83	50,66	*		150,37	37,12	*	
6104	HOSPITAL COMARCAL DE VINAROS	92	130,43	173,62	156,31	31,18	*		175,97	11,52		
6127	HOSPITAL COMARCAL DE L ALT PENEDES	44	159,09	170,90	184,22	3,28			212,65	-25,15		
6024	HOSPITAL ALTO GUADALQUIVIR	132	128,79	165,65	145,98	41,52	*		162,39	25,10	*	
6122	FUNDACIO SANITARIA DIGUALADA F.P.	140	135,71	165,51	144,47	43,03	*		160,40	27,09	*	
6069	HOSPITAL VALLE DEL NALON	148	135,14	163,45	143,08	44,42	*		158,58	28,92	*	
6314	HOSPITAL UNIVERSITARIO RIO HORTEGA DE VALLADOLID	204	122,55	163,42	135,76	51,73	*		148,97	38,53	*	
6195	HOSPITAL GENERAL DE LA PALMA	114	131,58	161,61	149,95	37,54	*		167,61	19,88		
6061	HOSPITAL COMARCAL DE JARRIO	35	114,29	161,27	195,19	-7,69			227,06	-39,56		
6053	HOSPITAL TOYO VILLANOVA	150	126,67	156,45	142,75	44,75	*		158,14	29,35		
6157	FUNDACIO PRIVADA HOSPITAL DE MOLLET	37	135,14	153,70	192,41	-4,91			223,41	-35,91		
6108	HOSPITAL DE SAGUNTO	116	103,45	152,30	149,47	38,03	*		166,98	20,52		
6218	FUNDACION HOSPITAL MANACOR	103	135,92	146,41	152,88	34,62			171,46	16,04		
6065	HOSPITAL DE CABUEQES	406	133,00	144,15	123,53	63,97	*		132,89	54,61	*	
6182	HOSPITAL DEL VENDRELL/BAIXPENEDES	48	125,00	143,82	180,37	7,13			207,58	-20,09		
6226	COMPLEJO HOSPITALARIO XERAL - CALDE DE LUGO	256	117,19	142,57	131,26	56,24	*		143,04	44,46		
6212	HOSPITAL GENERAL UNIVERSITARIO DE MURCIA	160	118,75	142,07	141,19	46,31	*		156,10	31,40		
6184	HOSPITAL DE SANT PAU I SANTA TECLA	137	116,79	140,90	145,02	42,48			161,13	26,37		
6208	HOSPITAL RAFAEL MENDEZ	143	118,88	140,49	143,93	43,56			159,70	27,80		
6156	HOSPITAL DE MATARO	230	134,78	136,01	133,32	54,18	*		145,75	41,74		
6119	HOSPITAL LLUIS ALCANYIS	157	114,65	134,24	141,64	45,85			156,69	30,81		

APPENDIX 2.b:

Spain, 2009

6207	HOSPITAL GENERAL DE AREA SANTA MARIA DEL ROSELL	387	113,70	133,02	124,25	63,24	*		133,84	53,66		
6216	HOSPITAL MATEU ORFILA DE MENORCA	89	112,36	131,06	157,36	30,14			177,35	10,15		
6066	HOSPITAL DE JOVE	77	116,88	129,81	162,14	25,36			183,63	3,87		
6250	HOSPITAL DE HELLIN	68	117,65	128,28	166,52	20,97			189,39	-1,89		
6112	HOSPITAL UNIVERSITARIO LA FE	425	108,24	127,91	122,86	64,64	*		132,00	55,49		
6133	HOSPITAL DE SANT BOI	70	114,29	126,62	165,48	22,02			188,01	-0,52		
6005	HOSPITAL PUNTA DE EUROPA	285	112,28	125,29	129,30	58,20			140,47	47,03		
6020	HOSPITAL INFANTA ELENA	199	105,53	124,80	136,29	51,21			149,66	37,84		
6095	HOSPITAL NUEVO DE DENIA	218	100,92	123,62	134,39	53,10			147,16	40,33		
6015	HOSPITAL GENERAL BASICO DE BAZA	117	111,11	123,46	149,23	38,27			166,66	20,84		
6041	COMPLEJO HOSPITALARIO VIRGEN MACARENA	787	120,71	123,39	115,14	72,36	*		121,86	65,64	*	
6163	HOSPITAL DE PALAMOS	62	145,16	122,06	169,96	17,53			193,91	-6,41		
6013	HOSPITAL VALLE DE LOS PEDROCHES	98	122,45	121,70	154,37	33,13			173,42	14,08		
6152	HOSPITAL DE LESPERIT SANT	115	113,04	121,24	149,71	37,79			167,29	20,20		
6064	HOSPITAL UNIVERSITARIO CENTRAL DE ASTURIAS	548	109,49	119,66	119,38	68,11	*		127,44	60,06		
6125	HOSPITAL GENERAL DE VIC	147	115,65	118,99	143,24	44,25			158,80	28,70		
6085	HOSPITAL DE BASURTO	276	101,45	118,14	129,87	57,63			141,22	46,28		
6238	HOSPITAL DON BENITO-VILLANUEVA DE LA SERENA	242	111,57	118,07	132,32	55,17			144,45	43,05		
6105	HOSPITAL GENERAL DE CASTELLO	252	99,21	117,84	131,55	55,95			143,43	44,07		
6101	HOSPITAL GENERAL UNIVERSITARIO DE ELCHE	330	100,00	117,24	126,78	60,71			137,16	50,33		
6205	HOSPITAL GARCIA ORCOYEN	44	113,64	116,45	184,22	3,28			212,65	-25,15		
6193	CONSORCIO SANITARIO DE TENERIFE	192	83,33	115,66	137,06	50,44			150,67	36,83		
6044	HOSPITAL GENERAL SAN JORGE	126	111,11	115,57	147,21	40,29			164,01	23,49		
6294	H. DE MOSTOLES	154	103,90	114,38	142,11	45,39			157,30	30,20		
6071	HOSPITAL SANTIAGO APOSTOL	109	110,09	113,33	151,23	36,27			169,29	18,21		
6115	HOSPITAL UNIVERSITARIO DR. PESET	387	100,78	112,55	124,25	63,24			133,84	53,66		
6107	HOSPITAL DE LA PLANA	124	96,77	112,38	147,64	39,86			164,57	22,92		
6302	H. INFANTA ELENA	44	90,91	112,00	184,22	3,28			212,65	-25,15		
6099	HOSPITAL GENERAL DE ELDA	182	98,90	111,62	138,23	49,27			152,21	35,29		
6067	HOSPITAL DEL ORIENTE DE ASTURIAS FRANCISCO COVIAN-PAR	37	108,11	110,15	192,41	-4,91			223,41	-35,91		
6161	HOSPITAL DE TERRASSA	88	113,64	109,67	157,72	29,78			177,82	9,68		
6315	HOSPITAL CLINICO UNIVERSITARIO DE VALLADOLID	662	98,19	109,32	117,07	70,42			124,40	63,10		
6223	COMPLEJO HOSPITALARIO ARQUITECTO MARCIDE - FERROL	261	103,45	108,30	130,89	56,60			142,57	44,93		
6038	HOSPITAL SAN JUAN DE DIOS DEL ALJARAFE	258	108,53	107,56	131,11	56,39			142,85	44,65		
6123	HOSPITALES MANRESA	254	94,49	107,04	131,40	56,09			143,23	44,26		
6304	COMPLEJO ASISTENCIAL DE AVILA	190	105,26	107,04	137,28	50,21			150,97	36,53		
6229	COMPLEJO HOSPITALARIO DE OURENSE	290	96,55	106,83	128,99	58,51			140,06	47,44		
6021	AREA HOSPITALARIA JUAN RAMON JIMENEZ	263	98,86	106,58	130,75	56,74			142,38	45,12		
6032	COMPLEJO HOSPITALARIO CARLOS HAYA	593	97,81	106,02	118,39	69,10			126,14	61,36		
6145	H CREU ROJA DE BARCELONA	69	115,94	104,94	165,99	21,50			188,69	-1,20		
6305	COMPLEJO ASISTENCIAL DE BURGOS	293	95,56	104,67	128,81	58,69			139,82	47,67		
6023	COMPLEJO HOSPITALARIO DE JAEN	419	90,69	103,62	123,07	64,43			132,28	55,22		
6279	H. PRINCIPE DE ASTURIAS	200	100,00	103,62	136,18	51,31			149,52	37,98		
6006	HOSPITAL UNIVERSITARIO PUERTA DEL MAR	291	92,78	102,08	128,93	58,57			139,98	47,52		
6311	COMPLEJO HOSPITALARIO DE SALAMANCA	629	103,34	101,89	117,68	69,82			125,20	62,30		
6035	COMPLEJO HOSPITALARIO NUESTRA SEQORA DE VALME	467	107,07	101,18	121,52	65,98			130,24	57,25		
6117	HOSPITAL FRANCESC DE BORJA	208	81,73	100,52	135,36	52,14			148,43	39,06		
6236	COMPLEJO H. UNIVERSITARIO DE BADAJOZ	349	91,69	100,08	125,87	61,63			135,97	51,53		
6312	COMPLEJO ASISTENCIAL DE SEGOVIA	170	94,12	99,87	139,77	47,72			154,24	33,26		
6124	HOSPITAL DE SANT BERNABE	36	111,11	98,80	193,77	-6,27			225,19	-37,70		
6017	COMPLEJO HOSPITALARIO VIRGEN DE LAS NIEVES	437	93,82	98,40	122,46	65,04			131,48	56,02		
6244	COMPLEJO HOSPITALARIO SAN MILLAN-SAN PEDRO	412	94,66	98,25	123,31	64,18			132,60	54,89		
6033	COMPLEJO HOSPITALARIO VIRGEN DE LA VICTORIA	599	90,15	97,77	118,27	69,23			125,97	61,52		
6243	HOSPITAL VIRGEN DEL PUERTO-PLASENCIA	206	92,23	97,36	135,56	51,94			148,70	38,80		
6310	HOSPITAL RIO CARRION	273	98,90	96,31	130,07	57,43			141,48	46,02		
6034	HOSPITAL DE LA SERRANIA	123	89,43	96,28	147,86	39,64			164,86	22,64		
6092	HOSPITAL DE GALDAKAO	259	88,80	95,33	131,04	56,46			142,75	44,74		
6271	H.G.U. GREGORIO MARAQSN	605	87,60	91,05	118,15	69,35			125,81	61,68		
6265	HOSPITAL NUESTRA SEQORA DEL PRADO	201	89,55	90,52	136,08	51,42			149,38	38,12		
6018	HOSPITAL UNIVERSITARIO SAN CECILIO	361	91,41	89,28	125,33	62,16			135,26	52,24		
6007	HOSPITAL UNIVERSITARIO PUERTO REAL	207	82,13	89,20	135,46	52,04			148,57	38,93		
6308	HOSPITAL EL BIERZO	229	82,97	88,59	133,40	54,09			145,87	41,63		
6096	HOSPITAL VIRGEN DE LOS LIRIOS	175	91,43	88,56	139,11	48,38			153,37	34,13		
6057	HOSPITAL UNIVERSITARIO MIGUEL SERVET	633	88,47	88,45	117,60	69,90			125,10	62,40		
6240	COMPLEJO HOSPITALARIO DE CACERES	310	83,87	87,49	127,83	59,66			138,54	48,95		
6116	HOSPITAL DE LA RIBERA	471	84,93	86,59	121,40	66,10			130,09	57,41		
6098	HOSPITAL UNIVERSITARI SANT JOAN DALACANT	291	82,47	86,59	128,93	58,57			139,98	47,52		
6291	F. JIMINEZ DMAZ	244	94,26	85,88	132,17	55,33			144,24	43,26		
6260	HOSPITAL SANTA BARBARA	91	87,91	85,52	156,66	30,84			176,42	11,07		
6130	HOSPITAL DE L HOSPITALET-CONSOIRCI SANI	169	94,67	84,40	139,91	47,59			154,42	33,08		
6014	HOSPITAL GENERAL BASICO SANTA ANA DE MOTRIL	194	77,32	84,05	136,83	50,66			150,37	37,12		
6194	HOSPITAL UNIVERSITARIO NTRA SRA DE CANDELARIA	404	76,73	84,05	123,60	63,89			132,99	54,51		

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6111	HOSPITAL ARNAU DE VILANOVA	303	79,21	83,28	128,22	59,27			139,06	48,44		
6114	CONSORCIO HOSPITAL GENERAL UNIVERSITARIO	353	82,15	82,67	125,69	61,81			135,73	51,77		
6313	COMPLEJO ASISTENCIAL DE SORIA	126	95,24	82,38	147,21	40,29			164,01	23,49		
6300	H. INFANTA CRISTINA-SUR	98	81,63	82,02	154,37	33,13			173,42	14,08		
6109	HOSPITAL CLINICO UNIVERSITARIO	489	79,75	81,44	120,89	66,61			129,41	58,08		
6026	HOSPITAL SAN JUAN DE LA CRUZ DE UBEDA	249	84,34	81,16	131,78	55,72			143,73	43,77		
6280	H. RAMON Y CAJAL	382	81,15	79,22	124,45	63,04			134,10	53,40		
6009	HOSPITAL UNIVERSITARIO REINA SOFIA DE CORDOBA	563	78,15	79,12	119,04	68,46			126,99	60,51		
6246	HOSPITAL UNIVERSITARIO MARQUES DE VALDECILLA	650	78,46	76,68	117,29	70,21			124,68	62,81		
6028	HOSPITAL DE ANTEQUERA	166	72,29	76,27	140,33	47,17			154,96	32,54		
6030	HOSPITAL COSTA DEL SOL	286	73,43	75,65	129,23	58,26			140,38	47,11		
6102	HOSPITAL DEL S.V.S. VEGA BAJA	132	68,18	75,03	145,98	41,52			162,39	25,10		
6278	H. DEL HENARES-COSLADA	76	78,95	74,98	162,59	24,91			184,22	3,28		
6254	COMPLEJO HOSPITALARIO LA MANCHA CENTRO	213	79,81	74,79	134,87	52,63			147,79	39,71		
6219	HOSPITAL SON LLATZER	210	80,95	74,74	135,16	52,34			148,17	39,32		
6189	COMPLEJO HOSPITALARIO DR. NEGRIN	590	72,88	74,64	118,45	69,04			126,22	61,28		
6074	HOSPITAL DONOSTIA-DONOSTIA OSPITALEA	480	72,92	74,19	121,14	66,36			129,75	57,75		
6137	HOSPITAL CLINIC I PROVINCIAL DE BARCELONA	655	74,81	73,29	117,20	70,30			124,56	62,93		
6136	HOSPITALS VALL DHEBRON	589	73,01	73,17	118,48	69,02			126,25	61,25		
6276	H. DE LA PRINCESA	305	72,13	73,03	128,11	59,39			138,91	48,59		
6058	HOSPITAL CLINICO UNIVERSITARIO LOZANO BLESA	592	74,32	72,17	118,41	69,08			126,16	61,33		
6149	H. UNIVERSITARI GERMANS TRIAS I PUJOL	133	90,23	71,88	145,78	41,71			162,14	25,36		
6063	HOSPITAL SAN AGUSTIN DE AVILES	183	76,50	71,56	138,11	49,39			152,05	35,45		
6227	HOSPITAL DA COSTA	85	70,59	70,78	158,84	28,66			179,29	8,20		
6139	HOSPITAL SANTA CREU I SANT PAU	548	71,17	70,21	119,38	68,11			127,44	60,06		
6290	H. CLMNICO. SAN CARLOS	759	69,83	69,72	115,53	71,97		*	122,38	65,12		
6309	COMPLEJO HOSPITALARIO DE LEON	568	72,18	69,43	118,93	68,57			126,84	60,66		
6029	HOSPITAL COMARCAL DE LA AXARQUIA	189	68,78	69,08	137,40	50,10			151,12	36,38		
6089	HOSPITAL DE CRUCES	411	68,13	68,10	123,35	64,15			132,65	54,85		
6221	COMPLEJO HOSPITALARIO JUAN CANALEJO - CORUQA	775	68,39	67,62	115,30	72,19		*	122,08	65,42		
6261	HOSPITAL GENERAL VIRGEN DE LA LUZ	161	74,53	67,15	141,04	46,45			155,90	31,59		
6051	HOSPITAL OBISPO POLANCO	87	80,46	65,94	158,09	29,41			178,30	9,19		
6097	HOSPITAL DE LA MARINA BAIXA	283	70,67	65,76	129,42	58,08			140,63	46,87		
6297	HOSPITAL FUENLABRADA	167	71,86	65,52	140,19	47,31			154,78	32,72		
6186	HOSPITAL DE TORTOSA VERGE DE LA CINTA	182	76,92	64,03	138,23	49,27			152,21	35,29		
6001	COMPLEJO HOSPITALARIO TORRECARDENAS	450	62,22	62,79	122,04	65,46		*	130,93	56,57		
6043	HOSPITALES UNIVERSITARIOS VIRGEN DEL ROCIO	768	62,50	62,53	115,40	72,09		*	122,21	65,29		*
6230	HOSPITAL COMARCAL VALDEORRAS	40	75,00	62,45	188,63	-1,14			218,45	-30,95		
6301	H. 12 DE OCTUBRE	490	65,31	62,43	120,86	66,64		*	129,38	58,12		
6256	HOSPITAL GENERAL DE TOMELLOSO	43	93,02	61,81	185,26	2,23			214,02	-26,52		
6282	H. LA PAZ	601	66,56	61,79	118,23	69,27		*	125,92	61,58		
6249	COMPLEJO HOSPITALARIO UNIVERSITARIO DE ALBACETE	444	65,32	61,64	122,23	65,27		*	131,18	56,32		
6180	HOSPITAL UNIVERSITARI SANT JOAN DE REUS	174	63,22	60,99	139,24	48,25			153,54	33,96		
6222	COMPLEJO HOSPITALARIO UNIVERSITARIO DE SANTIAGO	530	66,04	60,90	119,82	67,68		*	128,01	59,49		
6232	COMPLEJO HOSPITALARIO XERAL-CIES-MEIXOEIRO	492	63,01	60,49	120,80	66,69		*	129,30	58,19		
6003	HOSPITAL LA INMACULADA	194	56,70	59,67	136,83	50,66			150,37	37,12		
6100	HOSPITAL GENERAL UNIVERSITARIO DE ALICANTE	614	58,63	59,40	117,97	69,53		*	125,58	61,92		*
6010	HOSPITAL INFANTA MARGARITA	145	62,07	57,92	143,58	43,91			159,24	28,25		
6248	HOSPITAL SIERRALLANA	146	68,49	56,71	143,41	44,08			159,02	28,48		
6070	HOSPITAL TXAGORRITXU	309	58,25	55,70	127,89	59,61		*	138,61	48,88		
6317	COMPLEJO ASISTENCIAL DE ZAMORA	288	65,97	55,04	129,11	58,39		*	140,22	47,28		
6132	HOSPITAL DE VILADECANS	53	75,47	54,88	176,18	11,32			202,08	-14,58		
6103	HOSPITAL DE TORREVIEJA	351	59,83	54,12	125,78	61,72		*	135,84	51,65		
6011	HOSPITAL DE MONTILLA	79	75,95	53,96	161,27	26,23			182,48	5,02		
6237	HOSPITAL DE MERIDA	187	58,82	53,89	137,63	49,86			151,42	36,07		
6209	HOSPITAL COMARCAL DEL NOROESTE DE LA REGION DE MURC	61	65,57	53,82	170,58	16,91			194,73	-7,23		
6215	COMPLEJO ASISTENCIAL SON DURETA	694	59,08	53,65	116,53	70,97		*	123,69	63,81		*
6154	HOSPITAL RESIDENCIA SANT CAMIL	164	67,07	53,46	140,61	46,89			155,33	32,16		
6263	HOSPITAL UNIVERSITARIO GUADALAJARA	281	67,62	53,00	129,55	57,95		*	140,80	46,70		
6129	HOSPITAL UNIVERSITARI DE BELLVITGE	898	55,68	52,75	113,77	73,72		*	120,07	67,43		*
6275	H. DEL SURESTE-ARGANDA	71	56,34	52,50	164,97	22,53			187,35	0,15		
6296	H. SEVERO OCHOA	166	60,24	51,59	140,33	47,17			154,96	32,54		
6233	COMPLEJO HOSPITALARIO DE PONTEVEDRA	296	57,43	50,62	128,63	58,87		*	139,59	47,91		
6175	HOSPITAL UNIVERSITARI ARNAU DE VILANOVA	359	55,71	48,78	125,42	62,08		*	135,37	52,12		*
6183	HOSPITAL UNIVERSITARI DE TARRAGONA JOAN	410	51,22	47,88	123,39	64,11		*	132,70	54,80		*
6235	POLICLINICO VIGO, S.A. (POVISA)	142	56,34	46,69	144,11	43,39			159,93	27,56		
6198	HOSPITAL DE NAVARRA	402	57,21	46,18	123,68	63,82		*	133,08	54,41		*
6257	COMPLEJO HOSPITALARIO DE CIUDAD REAL	351	56,98	46,01	125,78	61,72		*	135,84	51,65		*
6190	COMPLEJO HOSPITALARIO MATERNO-INSULAR	541	48,06	45,45	119,55	67,95		*	127,66	59,84		*
6267	COMPLEJO HOSPITALARIO DE TOLEDO	559	50,09	43,73	119,13	68,37		*	127,11	60,39		*
6158	CORPORACIO SANITARIA PARC TAULI	300	56,67	42,98	128,40	59,10		*	139,28	48,21		*
6019	HOSPITAL DE RIOTINTO	75	53,33	42,02	163,04	24,45			184,82	2,68		

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6025	HOSPITAL SAN AGUSTIN DE LINARES	174	51,72	41,49	139,24	48,25		*	153,54	33,96		
6299	H. UNIV. DE GETAFE	191	52,36	41,36	137,17	50,33		*	150,82	36,68		
6120	HOSPITAL DE MANISES	181	55,25	41,20	138,35	49,14		*	152,37	35,13		
6211	HOSPITAL GENERAL UNIVERSITARIO MORALES MESEGUER	276	54,35	40,45	129,87	57,63		*	141,22	46,28		*
6286	H. PUERTA DE HIERRO. MAJADAHONDA	383	47,00	39,83	124,41	63,08		*	134,05	53,45		*
6160	HOSPITAL MUTUA DE TERRASA	227	52,86	39,10	133,58	53,92		*	146,09	41,40		*
6140	HOSPITAL UNIVERSITARI SAGRAT COR-L4ALIANGA	48	62,50	38,44	180,37	7,13			207,58	-20,09		
6004	HOSPITAL DE PONIENTE	181	44,20	34,96	138,35	49,14		*	152,37	35,13		*
6062	HOSPITAL CARMEN Y SEVERO OCHOA	78	51,28	34,41	161,70	25,80			183,05	4,45		
6121	HOSPITAL BLANES-CALELLA	63	63,49	33,89	169,36	18,14			193,11	-5,62		
6191	HOSPITAL GENERAL DE FUERTEVENTURA	103	38,83	32,34	152,88	34,62		*	171,46	16,04		
6206	HOSPITAL UNIVERSITARIO VIRGEN DE LA ARRIXACA	562	37,37	29,31	119,06	68,43		*	127,02	60,48		*
6155	HOSPITAL GENERAL DE GRANOLLERS	190	42,11	26,78	137,28	50,21		*	150,97	36,53		*
6204	HOSPITAL REINA SOFIA DE TUDELA	61	49,18	26,29	170,58	16,91			194,73	-7,23		
6060	HOSPITAL ERNEST LLUCH MARTIN	43	46,51	23,80	185,26	2,23			214,02	-26,52		
6293	F.H.ALCORCSN	164	42,68	23,23	140,61	46,89		*	155,33	32,16		*
6138	HOSPITAL DEL MAR	232	38,79	23,14	133,15	54,35		*	145,53	41,97		*
6166	HOSPITAL UNIVERSITARI DE GIRONA DR JOSE	531	30,13	22,00	119,79	67,71		*	127,97	59,52		*
6274	H. INFANTA LEONOR-VALLECAS	162	37,04	21,34	140,90	46,60		*	155,71	31,78		*
6165	HOSPITAL DE SANT JAUME OLOT	61	49,18	18,92	170,58	16,91			194,73	-7,23		
6199	HOSPITAL VIRGEN DEL CAMINO	55	36,36	16,44	174,67	12,83			200,09	-12,60		
6068	HOSPITAL V. ALVAREZ BUYLLA	110	27,27	11,30	150,97	36,53		*	168,95	18,55		*
6307	HOSPITAL SANTOS REYES	33	30,30	10,43	198,21	-10,72			231,04	-43,54		
6284	H. INFANTA SOFMA-NORTE	103	19,42	6,08	152,88	34,62		*	171,46	16,04		*
6078	CENTRO SANITARIO VIRGEN DEL PILAR	493	8,11	2,40	120,78	66,72		*	129,27	58,23		*
6192	HOSPITAL GENERAL DE LANZAROTE	117	8,55	1,62	149,23	38,27		*	166,66	20,84		*

(i) Total amount of AMI admissions per hospital accumulated during the period of analysis.
Hospitals with less than 30 AMI admissions per year are dropped from the analysis.
CFR: Crude case fatality rate per 1,000 AMI hospitalised patients; sCFR: Risk-adjusted Case Fatality Rate per 1,000 AMI hospitalised patients. Hospitals above the CI-99 limit are considered in "Alarm position"; hospitals above the CI-95 limit are considered in an "Alert position"; hospitals below the CI-95 limit are considered "Good performers" and hospitals below the CI-99 limit are considered "Excellent performers".

Table 13: Hospital outcomes for Percutaneous Coronary Interventions, year 2009. National benchmark estimation.

Hospital					Expected Rate		Relative Position		Expected Rate		Relative Position	
Code	Name	PCI cases (i)	Hospital CFR	Hospital sCFR	UCI 95%	LCI 95%	Above IC95	Below IC95	UCI 99%	LCI 99%	Above IC99	Below IC99
6194	HOSPITAL UNIVERSITARIO NTRA SRA DE CANDELARIA	334	56,89	75,03	42,75	8,44	*		48,14	3,05	*	
6112	HOSPITAL UNIVERSITARIO LA FE	396	53,03	70,58	41,35	9,84	*		46,30	4,89	*	
6101	HOSPITAL GENERAL UNIVERSITARIO DE ELCHE	227	44,05	66,01	46,40	4,78	*		52,94	-1,76	*	
6315	HOSPITAL CLINICO UNIVERSITARIO DE VALLADOLID	911	52,69	59,61	35,98	15,20	*		39,25	11,94	*	
6033	COMPLEJO HOSPITALARIO VIRGEN DE LA VICTORIA	745	49,66	56,75	37,08	14,11	*		40,69	10,50	*	
6236	COMPLEJO H. UNIVERSITARIO DE BADAJOZ	411	38,93	46,58	41,06	10,13	*		45,92	5,27	*	
6221	COMPLEJO HOSPITALARIO JUAN CANALEJO - CORUQA	890	41,57	46,55	36,10	15,08	*		39,41	11,78	*	
6271	H.G.U. GREGORIO MARAQSN	792	42,93	46,07	36,73	14,45	*		40,24	10,95	*	
6023	COMPLEJO HOSPITALARIO DE JAEN	645	37,21	43,85	37,94	13,25	*		41,82	9,37	*	
6064	HOSPITAL UNIVERSITARIO CENTRAL DE ASTURIAS	679	38,29	43,51	37,63	13,56	*		41,41	9,78	*	
6249	COMPLEJO HOSPITALARIO UNIVERSITARIO DE ALBACETE	521	36,47	39,76	39,33	11,86	*		43,65	7,54		
6207	HOSPITAL GENERAL DE AREA SANTA MARIA DEL ROSELL	508	35,43	38,77	39,50	11,68			43,88	7,31		
6017	COMPLEJO HOSPITALARIO VIRGEN DE LAS NIEVES	561	33,87	36,87	38,83	12,35			42,99	8,20		
6305	COMPLEJO ASISTENCIAL DE BURGOS	425	32,94	36,51	40,80	10,38			45,58	5,60		
6021	AREA HOSPITALARIA JUAN RAMON JIMENEZ	643	34,21	35,56	37,96	13,23			41,84	9,34		
6282	H. LA PAZ	753	34,53	35,42	37,02	14,17			40,61	10,58		
6311	COMPLEJO HOSPITALARIO DE SALAMANCA	534	35,58	35,19	39,16	12,02			43,43	7,76		
6057	HOSPITAL UNIVERSITARIO MIGUEL SERVET	694	33,14	34,80	37,50	13,69			41,24	9,95		
6095	HOSPITAL NUEVO DE DENIA	164	30,49	34,66	50,08	1,11			57,77	-6,58		
6193	CONSORCIO SANITARIO DE TENERIFE	315	28,57	34,60	43,26	7,93			48,81	2,38		
6309	COMPLEJO HOSPITALARIO DE LEON	513	31,19	34,38	39,44	11,75			43,79	7,40		
6041	COMPLEJO HOSPITALARIO VIRGEN MACARENA	806	32,26	33,81	36,64	14,55			40,11	11,08		
6175	HOSPITAL UNIVERSITARI ARNAU DE VILANOVA	277	32,49	33,73	44,43	6,75			50,35	0,83		
6190	COMPLEJO HOSPITALARIO MATERNO-INSULAR	480	29,17	33,56	39,90	11,28			44,40	6,78		
6222	COMPLEJO HOSPITALARIO UNIVERSITARIO DE SANTIAGO	664	30,12	32,53	37,76	13,42			41,58	9,60		
6089	HOSPITAL DE CRUCES	530	28,30	30,73	39,21	11,97			43,49	7,69		
6301	H. 12 DE OCTUBRE	655	29,01	30,35	37,84	13,34			41,69	9,49		
6276	H. DE LA PRINCESA	534	28,09	29,89	39,16	12,02			43,43	7,76		
6189	COMPLEJO HOSPITALARIO DR. NEGRIN	782	26,85	29,70	36,81	14,38			40,33	10,86		
6035	COMPLEJO HOSPITALARIO NUESTRA SEQORA DE VALME	505	31,68	29,58	39,55	11,64			43,93	7,26		
6058	HOSPITAL CLINICO UNIVERSITARIO LOZANO BLESA	551	27,22	28,79	38,95	12,24			43,15	8,04		
6070	HOSPITAL TXAGORRITXU	317	25,24	28,42	43,20	7,98			48,74	2,45		
6115	HOSPITAL UNIVERSITARIO DR. PESET	241	24,90	28,30	45,79	5,40			52,14	-0,95		

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Spain, 2009

6160	HOSPITAL MUTUA DE TERRASA	352	28,41	28,16	42,31	8,88			47,56	3,63		
6291	F. JIMINEZ DMAZ	251	31,87	28,08	45,38	5,80			51,60	-0,42		
6109	HOSPITAL CLINICO UNIVERSITARIO	433	25,40	27,77	40,66	10,52			45,40	5,79		
6215	COMPLEJO ASISTENCIAL SON DURETA	837	27,48	26,77	36,43	14,76			39,84	11,35		
6136	HOSPITALS VALL DHEBRON	823	25,52	26,07	36,52	14,66			39,96	11,23		
6183	HOSPITAL UNIVERSITARI DE TARRAGONA JOAN	253	23,72	25,80	45,31	5,88			51,50	-0,31		
6235	POLICLINICO VIGO, S.A. (POVISA)	118	25,42	24,71	54,46	-3,27			63,53	-12,34		
6240	COMPLEJO HOSPITALARIO DE CACERES	380	23,68	24,50	41,68	9,51			46,73	4,45		
6139	HOSPITAL SANTA CREU I SANT PAU	960	23,96	24,43	35,71	15,47			38,89	12,29		
6290	H. CLMNICO. SAN CARLOS	1154	23,40	23,75	34,82	16,36			37,72	13,46		
6280	H. RAMON Y CAJAL	399	22,56	23,57	41,29	9,90			46,22	4,96		
6006	HOSPITAL UNIVERSITARIO PUERTA DEL MAR	579	22,45	23,04	38,62	12,56			42,72	8,47		
6198	HOSPITAL DE NAVARRA	481	24,95	22,74	39,89	11,30			44,38	6,80		
6007	HOSPITAL UNIVERSITARIO PUERTO REAL	409	22,00	22,66	41,10	10,09			45,97	5,22		
6032	COMPLEJO HOSPITALARIO CARLOS HAYA	544	22,06	22,14	39,04	12,15			43,26	7,93		
6137	HOSPITAL CLINIC I PROVINCIAL DE BARCELONA	1058	21,74	21,65	35,23	15,95			38,26	12,92		
6100	HOSPITAL GENERAL UNIVERSITARIO DE ALICANTE	912	19,74	20,13	35,98	15,21			39,24	11,95		
6085	HOSPITAL DE BASURTO	204	19,61	20,05	47,55	3,64			54,44	-3,26		
6129	HOSPITAL UNIVERSITARI DE BELLVITGE	1424	19,66	18,66	33,90	17,28			36,51	14,67		
6296	H. SEVERO OCHOA	197	20,30	18,32	47,93	3,25			54,95	-3,77		
6149	H. UNIVERSITARI GERMANS TRIAS I PUJOL	818	22,00	18,04	36,56	14,63			40,00	11,19		
6232	COMPLEJO HOSPITALARIO XERAL-CIES-MEIXOEIRO	754	18,57	17,54	37,01	14,17			40,60	10,59		
6263	HOSPITAL UNIVERSITARIO GUADALAJARA	379	21,11	17,11	41,70	9,49			46,76	4,43		
6030	HOSPITAL COSTA DEL SOL	404	17,33	17,10	41,19	9,99			46,09	5,09		
6116	HOSPITAL DE LA RIBERA	270	18,52	16,82	44,68	6,51			50,67	0,51		
6001	COMPLEJO HOSPITALARIO TORRECARDENAS	609	18,06	16,18	38,30	12,89			42,29	8,89		
6098	HOSPITAL UNIVERSITARI SANT JOAN DALACANT	613	17,94	15,68	38,26	12,93			42,24	8,95		
6246	HOSPITAL UNIVERSITARIO MARQUES DE VALDECILLA	830	15,66	14,20	36,48	14,71		*	39,90	11,29		
6293	F.H.ALCORCSN	219	18,26	14,16	46,78	4,41			53,44	-2,25		
6206	HOSPITAL UNIVERSITARIO VIRGEN DE LA ARRIXACA	1231	14,62	13,18	34,53	16,66		*	37,34	13,85		*
6043	HOSPITALES UNIVERSITARIOS VIRGEN DEL ROCIO	902	14,41	13,16	36,03	15,15		*	39,31	11,87		
6105	HOSPITAL GENERAL DE CASTELLO	198	15,15	12,48	47,88	3,31			54,88	-3,69		
6257	COMPLEJO HOSPITALARIO DE CIUDAD REAL	595	15,13	11,74	38,45	12,74		*	42,49	8,70		
6009	HOSPITAL UNIVERSITARIO REINA SOFIA DE CORDOBA	838	13,13	11,41	36,42	14,76		*	39,83	11,36		
6103	HOSPITAL DE TORREVIEJA	385	15,58	11,25	41,57	9,61			46,59	4,59		
6008	HOSPITAL GENERAL DE JEREZ DE LA FRONTERA	561	12,48	10,76	38,83	12,35		*	42,99	8,20		
6114	CONSORCIO HOSPITAL GENERAL UNIVERSITARIO	343	14,58	10,38	42,52	8,66			47,84	3,34		
6267	COMPLEJO HOSPITALARIO DE TOLEDO	791	11,38	8,91	36,74	14,44		*	40,24	10,94		*
6166	HOSPITAL UNIVERSITARI DE GIRONA DR JOSE	461	8,68	5,77	40,20	10,99		*	44,79	6,40		*
6158	CORPORACIO SANITARIA PARC TAULI	191	10,47	4,65	48,28	2,91			55,41	-4,22		
6018	HOSPITAL UNIVERSITARIO SAN CECILIO	234	8,55	4,22	46,09	5,10		*	52,53	-1,35		
6078	CENTRO SANITARIO VIRGEN DEL PILAR	897	6,69	4,08	36,06	15,12		*	39,35	11,83		*
6237	HOSPITAL DE MERIDA	249	8,03	4,07	45,46	5,72		*	51,71	-0,52		
6138	HOSPITAL DEL MAR	256	7,81	3,41	45,19	6,00		*	51,35	-0,16		
6229	COMPLEJO HOSPITALARIO DE OURENSE	405	4,94	1,89	41,17	10,01		*	46,07	5,12		*
6286	H. PUERTA DE HIERRO. MAJADAHONDA	507	3,94	1,41	39,52	11,67		*	43,89	7,29		*
6005	HOSPITAL PUNTA DE EUROPA	86	0,00	0,00	59,40	-8,22			70,03	-18,84		
6140	HOSPITAL UNIVERSITARI SAGRAT COR-L4ALIANGA	71	0,00	0,00	62,80	-11,62			74,50	-23,31		

(i) Total amount of interventions per hospital accumulated during the period of analysis.
Hospitals performing less than 30 interventions per year are dropped from the analysis
CFR: Crude case fatality rate per 1,000 patients undergoing PCI procedure; sCFR: Risk-adjusted Case Fatality Rate per 1,000 patients undergoing PCI procedure. Hospitals above the CI-99 limit are considered in "Alarm position"; hospitals above the CI-95 limit are considered in an "Alert position"; hospitals below the CI-95 limit are considered "Good performers" and hospitals below the CI-99 limit are considered "Excellent performers".

APPENDIX 2.b:

Spain, 2009

Table 14: Hospital outcomes for Coronary Artery Bypass Graft, year 2009. National benchmark estimation*

Hospital					Expected Rate		Relative Position		Expected Rate		Relative Position	
Code	Name	CABG cases (i)	Hospital CFR	Hospital sCFR	UCI 95%	LCI 95%	Above IC95	Below IC95	UCI 99%	LCI 99%	Above IC99	Below IC99
6009	HOSPITAL UNIVERSITARIO REINA SOFIA DE CORDOBA	70	171,43	205,16	126,19	5,82	*		145,10	-13,09	*	
6206	HOSPITAL UNIVERSITARIO VIRGEN DE LA ARRIXACA	115	130,43	152,66	112,96	19,05	*		127,71	4,29	*	
6043	HOSPITALES UNIVERSITARIOS VIRGEN DEL ROCIO	92	108,70	144,72	118,50	13,51	*		135,00	-2,99	*	
6315	HOSPITAL CLINICO UNIVERSITARIO DE VALLADOLID	242	119,83	133,55	98,37	33,63	*		108,54	23,46	*	
6109	HOSPITAL CLINICO UNIVERSITARIO	183	109,29	130,48	103,23	28,78	*		114,92	17,08	*	
6017	COMPLEJO HOSPITALARIO VIRGEN DE LAS NIEVES	126	111,11	128,40	110,86	21,14	*		124,96	7,05	*	
6193	CONSORCIO SANITARIO DE TENERIFE	95	94,74	118,03	117,66	14,34	*		133,90	-1,89		
6116	HOSPITAL DE LA RIBERA	100	90,00	115,63	116,36	15,65			132,18	-0,17		
6276	H. DE LA PRINCESA	76	78,95	100,75	123,76	8,24			141,91	-9,91		
6271	H.G.U. GREGORIO MARAQSN	183	98,36	100,40	103,23	28,78			114,92	17,08		
6041	COMPLEJO HOSPITALARIO VIRGEN MACARENA	97	82,47	98,15	117,13	14,88			133,19	-1,19		
6085	HOSPITAL DE BASURTO	107	84,11	95,47	114,68	17,32			129,98	2,03		
6189	COMPLEJO HOSPITALARIO DR. NEGRIN	78	64,10	79,31	123,02	8,99			140,93	-8,93		
6282	H. LA PAZ	95	73,68	75,62	117,66	14,34			133,90	-1,89		
6221	COMPLEJO HOSPITALARIO JUAN CANALEJO - CORUQA	223	67,26	70,46	99,72	32,28			110,32	21,69		
6222	COMPLEJO HOSPITALARIO UNIVERSITARIO DE SANTIAGO	125	72,00	69,95	111,04	20,97			125,19	6,81		
6100	HOSPITAL GENERAL UNIVERSITARIO DE ALICANTE	142	56,34	69,67	108,26	23,75			121,54	10,47		
6139	HOSPITAL SANTA CREU I SANT PAU	257	66,15	69,40	97,41	34,59			107,28	24,72		
6137	HOSPITAL CLINIC I PROVINCIAL DE BARCELONA	245	65,31	68,20	98,17	33,83			108,28	23,72		
6267	COMPLEJO HOSPITALARIO DE TOLEDO	119	58,82	67,61	112,16	19,84			126,67	5,34		
6140	HOSPITAL UNIVERSITARI SAGRAT COR-L4ALIANGA	36	55,56	67,01	149,93	-17,92			176,30	-44,29		
6286	H. PUERTA DE HIERRO. MAJADAHONDA	76	52,63	66,86	123,76	8,24			141,91	-9,91		
6089	HOSPITAL DE CRUCES	148	60,81	60,53	107,39	24,61			120,40	11,61		
6064	HOSPITAL UNIVERSITARIO CENTRAL DE ASTURIAS	347	60,52	59,89	93,03	38,97			101,53	30,48		
6290	H. CLMNICO. SAN CARLOS	223	58,30	57,56	99,72	32,28			110,32	21,69		
6246	HOSPITAL UNIVERSITARIO MARQUES DE VALDECILLA	107	65,42	55,92	114,68	17,32			129,98	2,03		
6129	HOSPITAL UNIVERSITARI DE BELLVITGE	157	57,32	50,85	106,19	25,82			118,82	13,19		
6112	HOSPITAL UNIVERSITARIO LA FE	204	49,02	49,56	101,26	30,75			112,34	19,67		
6114	CONSORCIO HOSPITAL GENERAL UNIVERSITARIO	329	48,63	48,20	93,76	38,24			102,49	29,52		
6232	COMPLEJO HOSPITALARIO XERAL-CIES-MEIXOEIRO	272	47,79	44,60	96,53	35,47			106,13	25,88		
6236	COMPLEJO H. UNIVERSITARIO DE BADAJOZ	152	39,47	44,29	106,84	25,16			119,68	12,33		
6311	COMPLEJO HOSPITALARIO DE SALAMANCA	183	49,18	41,98	103,23	28,78			114,92	17,08		
6057	HOSPITAL UNIVERSITARIO MIGUEL SERVET	171	40,94	38,23	104,51	27,50			116,61	15,40		
6291	F. JIMINEZ DMAZ	41	48,78	37,77	144,64	-12,64			169,35	-37,35		
6301	H. 12 DE OCTUBRE	146	41,10	34,47	107,68	24,33			120,77	11,24		
6309	COMPLEJO HOSPITALARIO DE LEON	188	37,23	28,65	102,73	29,28		*	114,27	17,74		
6006	HOSPITAL UNIVERSITARIO PUERTA DEL MAR	158	31,65	28,31	106,06	25,94			118,65	13,36		
6032	COMPLEJO HOSPITALARIO CARLOS HAYA	116	25,86	21,47	112,75	19,25			127,45	4,56		
6149	H. UNIVERSITARI GERMANS TRIAS I PUJOL	215	27,91	20,10	100,34	31,66		*	111,13	20,87		*
6078	CENTRO SANITARIO VIRGEN DEL PILAR	199	25,13	19,72	101,70	30,31		*	112,91	19,09		
6136	HOSPITALS VALL DHEBRON	179	22,35	17,39	103,64	28,37		*	115,46	16,54		
6280	H. RAMON Y CAJAL	121	24,79	16,38	111,78	20,23		*	126,16	5,84		
6215	COMPLEJO ASISTENCIAL SON DURETA	291	20,62	13,01	95,52	36,49		*	104,80	27,21		*
6033	COMPLEJO HOSPITALARIO VIRGEN DE LA VICTORIA	171	17,54	11,29	104,51	27,50		*	116,61	15,40		*
6198	HOSPITAL DE NAVARRA	98	20,41	8,44	116,87	15,14		*	132,85	-0,84		
6166	HOSPITAL UNIVERSITARI DE GIRONA DR JOSE	49	0,00	0,00	137,94	-5,93			160,54	-28,53		

(i) Total amount of interventions per hospital accumulated during the period of analysis.
Hospitals performing less than 30 interventions per year are dropped from the analysis.
CFR: Crude case fatality rate per 1,000 patients undergoing CABG surgery; sCFR: Risk-adjusted Case Fatality Rate per 1,000 patients undergoing CABG surgery. Hospitals above the CI-99 limit are considered in "Alarm position"; hospitals above the CI-95 limit are considered in an "Alert position"; hospitals below the CI-95 limit are considered "Good performers" and hospitals below the CI-99 limit are considered "Excellent performers".

APPENDIX 3.a:

Spain, 2002-2009

Table 15. Spanish descriptive statistics over time for burden of disease: CID

	CORONARY ISCHAEMIC							
	2002	2003	2004	2005	2006	2007	2008	2009
Cases	88670	89838	88899	86158	85239	83756	81265	78585
Stand. Rate	25.5	26.22	26.29	25.28	25.29	24.7	24.05	23.31
sR Q1.	27.38	28.60	28.61	28.59	28.98	28.43	27.83	27.02
sR Q5.	21.54	21.89	22.22	19.45	19.90	19.69	18.89	18.48
SCV	0.1	0.1	0.1	0.11	0.11	0.11	0.11	0.13

Stand. Rate & sR: Age-sex Standardised Rate (Reference population: national 2002); sR Qx: quintile x of sR distribution; SCV: Systematic Component of Variation.

Table 16. Spanish descriptive statistics over time for burden of disease: AMI

	ACUTE MYOCARDIAL INFARCTION							
	2002	2003	2004	2005	2006	2007	2008	2009
Cases	45834	47225	47427	47144	46020	45684	46447	46206
Stand. Rate	13.09	13.68	13.81	13.59	13.35	13.28	13.55	13.48
sR Q1.	13.58	14.55	14.48	14.79	14.48	14.31	14.72	15.08
sR Q5.	11.79	12.41	12.42	11.15	10.97	11.28	10.89	11.14
SCV	0.09	0.09	0.08	0.09	0.09	0.1	0.11	0.12

Stand. Rate & sR: Age-sex Standardised Rate (Reference population: national 2002); sR Qx: quintile x of sR distribution; SCV: Systematic Component of Variation.

Table 17. Spanish descriptive statistics over time for procedure utilisation: PCI

	PERCUTANEOUS CORONARY INTERVENTION							
	2002	2003	2004	2005	2006	2007	2008	2009
Cases	27566	31919	35837	39624	42696	45320	45557	48368
Stand. Rate	12.64	15.07	17.37	19.19	20.95	22.45	22.75	24.19
sR Q1.	11.96	14.85	17.06	21.26	24.43	27.07	27.23	28.95
sR Q5.	12.79	14.20	16.20	16.17	16.67	18.53	18.83	19.88
SCV	0.22	0.21	0.2	0.22	0.23	0.24	0.23	0.22

Stand. Rate & sR: Age-sex Standardised Rate (Reference population: national 2002); sR Qx: quintile x of sR distribution; SCV: Systematic Component of Variation.

Table 18. Spanish descriptive statistics over time for procedure utilisation: CABG

	CORONARY ARTERY BYPASS GRAFT							
	2002	2003	2004	2005	2006	2007	2008	2009
Cases	7396	7756	7663	7175	7078	7264	7326	7068
Stand. Rate	3.45	3.63	3.73	3.39	3.46	3.63	3.63	3.5
sR Q1.	2.95	3.04	2.89	2.58	2.70	2.81	2.70	2.51
sR Q5.	3.70	4.09	4.43	3.93	3.88	4.60	4.16	4.08
SCV	0.22	0.17	0.17	0.19	0.19	0.3	0.24	0.22

Stand. Rate & sR: Age-sex Standardised Rate (Reference population: national 2002); sR Qx: quintile x of sR distribution; SCV: Systematic Component of Variation.

APPENDIX 3.b:

Spain, 2002-2009

Table 19. Evolution of the Spanish hospitals' relative performance for AMI admissions. (In-country benchmark estimation).

	ACUTE MYOCARDIAL INFARCTION							
	2002	2003	2004	2005	2006	2007	2008	2009
Discharges	46732	53303	53245	53183	51719	51790	52388	51985
Deceased	5224	5810	5432	5271	4675	4673	4584	4210
Nº Hospitals	184	200	201	203	195	197	203	203
Hospitals > 250 (% patients treated)	78 (73.32%)	88 (73.5%)	88 (73.65%)	89 (73.97%)	90 (74.58%)	82 (70.62%)	86 (72.64%)	82 (70.55%)
Average expected Risk-adjusted CFR	120.43	117.16	110.26	107.22	98.70	101.35	94.70	93.75
hosp. Alarm position (% patients treated)	18 (10.1%)	18 (6.62%)	20 (7.34%)	18 (9.23%)	15 (5.04%)	17 (6.29%)	17 (6.28%)	16 (5.23%)
hosp. Alert position (% patients treated)	9 (4.36%)	9 (3.43%)	6 (3.39%)	11 (4.79%)	16 (6.05%)	6 (1.67%)	9 (3.75%)	12 (4.91%)
hosp. Good performers (% patients treated)	10 (6.94%)	14 (5.46%)	10 (4.45%)	13 (6.6%)	16 (9.86%)	8 (4.72%)	15 (10.76%)	17 (12.92%)
hosp. Excellent performers (% patients treated)	18 (18.3%)	21 (17.24%)	23 (21.31%)	21 (19.37%)	22 (17.26%)	25 (20.51%)	15 (9.03%)	25 (18.52%)

Hospitals>250: Hospitals above the activity threshold of 250 AMI hospitalisations a year; Alarm position: hospitals above the CI-99 limit; Alert position: hospitals above the CI-95 limit; Good performers: hospitals below the CI-95 limit; Excellent performers: hospitals below the CI-99 limit. In brackets, the percentage of AMI patients in the country hospitalised at those hospitals.

Table 20. Evolution of the Spanish hospitals' relative performance for patients undergoing PCI procedure. (In-country benchmark estimation)

	PERCUTANEOUS CORONARY INTERVENTION							
	2002	2003	2004	2005	2006	2007	2008	2009
Discharges	22662	30826	34026	38022	40580	42161	42287	43868
Deceased	465	705	737	895	888	956	1033	1113
Nº Hospitals	61	75	78	77	79	79	80	81
Hospitals > 250 (% patients treated)	35 (83.92%)	48 (87.71%)	51 (87.82%)	60 (92.16%)	66 (95.23%)	65 (94.11%)	68 (95.24%)	68 (94.53%)
Average expected Risk-adjusted CFR	20.22	23.07	20.53	23.55	22.14	23.31	24.70	25.59
hosp. Alarm position (% patients treated)	9 (16.77%)	11 (16.32%)	10 (14.92%)	9 (14.13%)	10 (13.79%)	11 (13.93%)	12 (14.44%)	10 (13.75%)
hosp. Alert position (% patients treated)	2 (3.76%)	1 (1.47%)	3 (7.66%)	4 (4.84%)	3 (3.98%)	4 (4.31%)	3 (3.1%)	1 (1.19%)
hosp. Good performers (% patients treated)	4 (8.19%)	8 (13.67%)	4 (4.83%)	5 (5.8%)	8 (12.20%)	9 (9.47%)	8 (11.2%)	8 (10.18%)
hosp. Excellent performers (% patients treated)	2 (7.82%)	3 (5.02%)	2 (5.34%)	5 (9.99%)	3 (4.93%)	3 (5.66%)	4 (5.26%)	6 (9.78%)

Hospitals>250: Hospitals above the activity threshold of 250 PCI a year; Alarm position: hospitals above the CI-99 limit; Alert position: hospitals above the CI-95 limit; Good performers: hospitals below the CI-95 limit; Excellent performers: hospitals below the CI-99 limit. In brackets, the percentage of AMI patients in the country hospitalised at those hospitals.

APPENDIX 3.b:

Spain, 2002-2009

Table 21. Evolution of the Spanish hospitals' relative performance for patients undergoing CABG surgery. (In-country benchmark estimation)

	CORONARY ARTERY BYPASS GRAFT							
	2002	2003	2004	2005	2006	2007	2008	2009
Discharges	6732	8000	7881	7355	7265	7257	7457	7147
Deceased	531	616	580	539	524	510	534	421
Nº Hospitals	35	44	44	45	45	45	45	46
Hospitals > 250 (% patients treated)	9 (38.19%)	9 (32.59%)	8 (30.97%)	5 (19.71%)	4 (15.36%)	7 (26.87%)	6 (23.63%)	5 (20.93%)
Average expected Risk-adjusted CFR	88.12	85.54	81.31	80.58	81.38	77.25	82.44	66.00
hosp. Alarm position (% patients treated)	4 (7.77%)	5 (9.09%)	6 (10.3%)	4 (8.67%)	4 (6.28%)	3 (4.46%)	4 (4.69%)	6 (11.59%)
hosp. Alert position (% patients treated)	3 (7.58%)	2 (3.79%)	1 (1.42%)	2 (2.38%)	3 (5.2%)	2 (5.43%)	2 (3.66%)	1 (1.33%)
hosp. Good performers (% patients treated)	4 (12.4%)	7 (22.55%)	6 (15.05%)	4 (10.65%)	--- ---	2 (5.43%)	6 (17.58%)	5 (10.98%)
hosp. Excellent performers (% patients treated)	4 (15.29%)	6 (18.11%)	4 (12.65%)	6 (17.59%)	5 (14.21%)	4 (11.97%)	4 (10.31%)	3 (9.47%)

Hospitals>250: Hospitals above the activity threshold of 250 CABG a year; Alarm position: hospitals above the CI-99 limit; Alert position: hospitals above the CI-95 limit; Good performers: hospitals below the CI-95 limit; Excellent performers: hospitals below the CI-99 limit. In brackets, the percentage of AMI patients in the country hospitalised at those hospitals.

APPENDIX 4:

Technical note

Cardiovascular Ischaemic Disease and AMI, as well as revascularisation procedures, PCI and CABG, are conceived as geographical and hospital-specific indicators, within the ECHO performance model.

First of all, from a geographical perspective, this approach entails some implications, both for methodology and in interpreting results. The report is based on ecologic analyses –data aggregated at a certain geographical level which becomes the unit of analysis; thus, the correct interpretation of the findings highlights the risk of being exposed to hospitalisations due to cardiovascular conditions or revascularisation procedures for the population living in a certain area (as opposed to the risk for an individual patient). Afterwards, from a provider perspective, individual data is analysed and risk-adjusted within multivariate logistic hierarchical modelling, so then patients are clustered into hospitals, where the interpretation would be the risk of dying after being hospitalised and/or intervened in a specific hospital compared to the national adjusted average of the ECHO benchmark.

Main endpoints:

This report maps out standardised utilisation rates per geographical area as well as the risk-adjusted case fatality rates per provider, analysing events amenable to healthcare quality. As a summary measure of variation, the report includes the classical statistics Ratio of Variation between extremes, Component of Systematic Variation, Rho Statistic (cluster effect) and the Median Odds Ratio (MOR) statistic, a measure of the variation among hospitals that compares pairs of patients with the same risks from two, randomly chosen, different hospitals. MOR provides information on how heterogeneity across hospitals increases the individual odds of experiencing the outcome of interest – case-fatalities.

Instruments:

In the geographical approach, being an ecologic study, each admission was allocated to the place of residence of the patient, which in turn was referred to a policy relevant geographic unit – the 199 *healthcare areas* and the 17 Regions building up the Spanish National Health System.

For the risk-adjustment of the hospital approach within the multivariate logistic hierarchical modelling, the following variables have been included as independent variables: age, sex, whether the patient had a primary diagnosis of AMI (distinguishing whether the AMI was transmural (with ST segment elevation,

APPENDIX 4:

Technical note

STEMI), non-STEMI or unclassified; whether the patient underwent heart valve replacement and/or implantation of a cardiac or circulatory assistance device, or was a major structural surgery (including repair or revision of atrial and ventricular septa, cardiotomy, pericardiotomy, pericardiectomy and excision of a heart lesion) and the concomitant comorbidities taking the Elixhauser conditions, such as:

Cardiac arrhythmias	Drugs abuse
Valvular disease	Lymphoma
Congestive heart failure	Solid tumor without metastasis
Chronic lung disease	Metastatic cancer
Hypertension, uncomplicated	Weight loss
Hypertension, complicated	Psychoses
Total hypertension disease	Depression
Pulmonary circulation disorders	AIDS/HIV
Renal failure	Fluid and electrolyte disorders
Pre-existing hypertension complicating pregnancy	Peptic ulcer disease excluding bleeding
Other hypertension in pregnancy	Deficiency anemia
Diabetes, without chronic complications	Blood loss anemia
Diabetes, with chronic complications	Coagulopathy
Hypothyroidism	Rheumatoid arthritis/collagen vascular diseases
Liver disease	Peripheral vascular disorders
Obesity	Paralysis
Alcohol abuse	Other neurological disorders

For both approaches, the operational definitions for each indicator are detailed in the coding table in appendix 5. Indicators are based on those in use in the international arena, as those proposed by AHRQ and OECD. For its use in the analysis of variations across countries they were subject to a construct validity process developed by the Atlas VPM project in Spain and cross-walking across different diseases and procedures classifications underwent a face-validation carried out as a task within the ECHO project.

This report is based on the hospital admissions registered in the Spanish National Discharges Dataset (CMBD). Cross- and in-country sections were built upon 2009 discharges, whereas time-trends and social gradient analyses used 2002 to 2009 data.

Social gradient data were obtained from the Atlas VPM dataset, after original data by *La Caixa* 2003 annual report.

APPENDIX 5:

Definitions

	Diagnosis and procedures codes ICD9-CM					
	Primary diagnosis		Secondary diagnosis2-30		Procedures	
	Inclusions	Exclusions	Inclusions	Exclusions	Inclusions	Exclusions
Ischaemic Disease +18 Age Type of admission unplanned	410.*, 411.1, 411.8, 413.* 414.01 (IF DX2-30 411.1)*					410.*, 411.1, 411.8, 413.* 414.01 (IF DX2-30 411.1)*
Acute Myocardial Infarction (AMI) +18 Age Type of admission unplanned	410.*					410.*
Percutaneus Coronary Interventions (PCI) +40 Age					36.01, 36.02, 36.05, 36.06, 36.07, 36.08, 36.09, 00.66	
Coronary Artery Bypass Grafting (CABG) +40 Age					36.10, 36.11, 36.12, 36.13, 36.14, 36.15, 36.16, 36.17, 36.19	

APPENDIX 5:

Definitions

	Diagnosis and procedures codes ICD9-CM					
	Primary diagnosis		Secondary diagnosis2-30		Procedures	
	Inclusions	Exclusions	Inclusions	Exclusions	Inclusions	Exclusions
Acute Myocardial Infarction in Hospital Mortality +18 Age	410.*	630.*-677.*		630.*-677.*		
Percutaneus Coronary Interventions in Hospital Mortality +40 Age		630.*-677.*		630.*-677.*	36.01, 36.02, 36.05, 36.06, 36.07, 36.08, 36.09, 00.66	
Coronary Artery Bypass Grafting in Hospital Mortality +40 Age		630.*-677.*		630.*-677.*	36.10, 36.11, 36.12, 36.13, 36.14, 36.15, 36.16, 36.17, 36.19	