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Performance measurements for healthcare services

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A.

QUALITY CONTROL IN LOMBARDY HEALTH SYSTEM

1. Lombardy – some data

- 9.550.000 inhabitants (16% of Italian population);
- 23% of gross domestic product;
- 200 hospitals (70% public / 30% private);
- 2.000.000 of discharges from hospitals;
- 60.000.000 drug prescriptions;
- More than 10% of health care services delivered to people that don’t live in Lombardy;
- Around 16 billion euro budget for public healthcare (65% of regional total expenditure).

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2. Lombardy Health System Principles

VALUES Regional Law n. 31 - 11/07/97

Public Regional Service with services supplied by public and private structures.

Same rules regarding accreditation and controls about quality and appropriateness.

Tariffs established by Regional autority, reviewed annually.

Annual Budget for each producer managed by the local health authorities.
Purchaser/provider separation and distinction.

- Pro capita public health expenditure lower than the national average
- Public health expenditure on GDP lower than the national average (5% /6.97%)
- Balanced budget
- Cost of hospital admission lower than the national average
- Case Mix Index higher than the national average
- Reduction of inpatient admission and increase of day hospital

3. Lombardy – Regional information system

- Mandatory, standardized, for all suppliers.
- The information is the base for payment, quality and appropriateness evaluation and regional and local plannings.
- In the last fifteen years Lombardy Region invested a large amount of budget for health care quality improvement and evalutation.

4. Quality controls Laws

- Regional Law 31/97: regional accreditation process.
- Conformity to ISO 9000 standards.
- Resolution 46582 - 26.11.99: financial incentives for healthcare structures that developed quality improvement
- *Customer Satisfaction* Survey (D.G.R VII/8504, 22.3.02).
- Legislative Decree n. 8968 - 28.5.2004: regional program of quality improvement of diagnostic and clinical pathways.
- *Risk Management* activities
- (Guidelines for annual Risk Management Activities, 2005).
- II edition of “Medical Record Manual” (2007).
- Resolution 6682 - 27.2.2008: Indicators and methodology for quality evaluation of hospitals and rehabilitation structures.

5. Noc (Nuclei Operativi di Controllo)

They verify the appropriateness of the performance provided by hospital through a method based on a target and a random control.

Each Local Health Authorities (ASL) controls, and monthly, sends to the Region results that could modify remboursement.

Lombardy 2006 – 2008

Total Discharges			Total Controls			% Controls			Economic Value		
2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
N			N			%			€		
2.062.338	1.904.923	1.879.051	105.368	109.192	111.595	5,11	5,73	5,94	-14.414.309	-21.642.974	-24.958.186

Fonte: Direzione Generale Sanità. Regione Lombardia. Elaborazione: Sezione Regionale del Controllo della Corte dei conti.

Total of discharges controlled: **from 4,9% of 2004 to 5,9% of 2008**
(more in private than in public hospitals).
2008: **a distorsion in the value of 25% of the files controlled.**

6. *Ex ante* evaluation

Three years program for the implementation of the evaluation system of accredited healthcare organizations (public and private providers) developed in 2004-2007 and confirmed for 2008-2010.

The program put togheter different evaluation approaches of Lombardy health care providers:

- ***ex ante*** **(es: accreditation criteria, ISO, *risk management* activity)**
- **Quality performance evaluation (set of international *standard)***

The healthcare organizations compliance with standards was evaluated through quarterly self-evaluation of the organizations and in situ surveys carried out by the Joint Commission International team which won an international tender.

6. *Ex ante* evaluation

Creation of a set of standards in order to evaluate organizational behaviours

Hospitals	Local Health Authorities
58 standards, 5 areas: • **Patients rights, clinical care processes** • **Human resources development** • **Management of exchange processes of services** • **Information system** • **Quality improvement processes.**	**46 standards, 5 areas:** • **Protection** • **Control** • **Organization** • **General Practitioner and pediatrician** • **Healthcare services**

Results: High average score, Improvement over time, Positive impact of double assessment (self and Joint Commision team evaluation).
Best improvement: patient rights, continuity of clinical care process.
Variability between structures.
Most critical aspects: medical chart, quality programs, professional upgrade and criteria of the *triage.*

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7. *Ex post* evaluation

Customer Satisfaction

Efficiency analysis:
Economic and productivity performance evaluation

Effectiveness analysis
(CRISP project)

B.
EFFECTIVENESS
EX POST EVALUATION

1. *Ex Post* Evaluation: Relative Effectiveness

1. ***Healthcare outcome*****:** result on the state of patient well-being, generated by the delivery of a health service influenced by covariates concerning the "case mix" of the patients, and other characteristics of agents (Goldstein, Spiegelhalter, 1996).

2. With an approach similar to that of Clinical Trials:
comparisons between healthcare institutions,
Relative effectiveness**.**
Need to adjust comparisons for patient-specific and hospital-specific variables by means of
Risk adjustment statistical methods**.**

2. Risk Adjustment Methodology: Standardization

1) Direct standardization (Zaslavsky 2001)

y_{kj} health outcome observed on $w_{kj,}$ k-eth stratum of the population of patients in the j-eth health structure

$$\pi_{kj} = w_{kj} / \Sigma_k w_{kj} \qquad (k=1,\ldots,q) \qquad (1)$$

Observed adjusted outcome: the weighted sum:

$$y_j = \Sigma_k \pi_{kj} y_{kj} \qquad (2)$$

2) Indirect standardization

Given the *expected adjusted outcomes* weighted sum

$$y_j{}^* = \Sigma_k \pi_{kj}{}^* y_{kj} \qquad (3)$$

With the weights are obtained from a standard theoretical population,

Problems*:* 1 Stratum with no cases or missing cases
2 Concerning hospitals no patients,
3 expressed as frequencies
4 based only on outcomes and not on risk-adjustment variables:
selection bias and risk of adverse selection

3. Risk Adjustment Methodology: Linear and Logistic Models

1) **Covariance Models**

$$y_{ij} = \beta\, x_{ij} + u_j + e_{ij} \qquad (5)$$

$\mathbf{y_{ij}}$ quantitative outcome

$\mathbf{x_{ij}}$ patient characteristic(s)

(effects of individual characteristics X on outcomes, among patients of the same unit)

β fixed coefficients

$\mathbf{u_j}$ fixed parameter concerning average effectiveness of hospital j

$\mathbf{e_{ij}}$ error term

2) Dichotomic outcomes (such as hospital mortality risk)

Logistic Function Models (AHRQ,2003; CIHI,2003; NHS,2004; JCAHO, 2004) logit of the outcome p_{ij} as a linear function of the case mix variables x_k (k=1,…,p):

$$\ln\left(\frac{p_{ij}}{1-p_{ij}}\right) = \alpha + \beta_1 x_{1ij} + \beta_2 x_{2ij} + \ldots \beta_k x_{kij} = RS_{ij} \qquad (6)$$

which can be exposed in terms of probability:

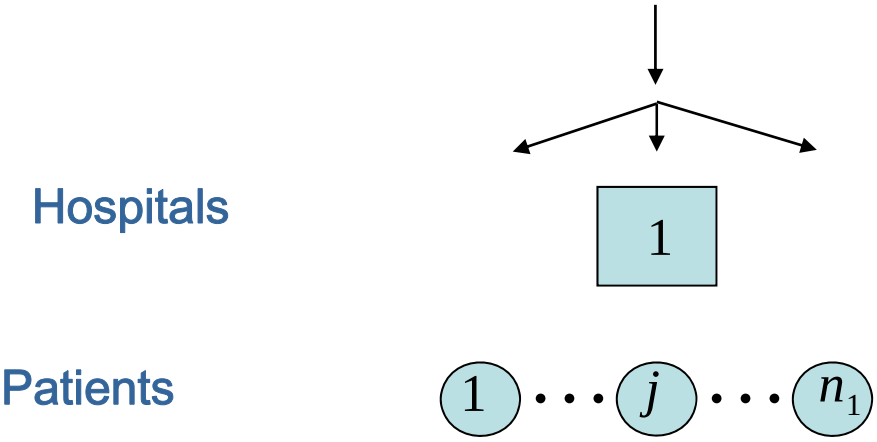
$$p_{ij} = \frac{e^{RS_{ij}}}{1 + e^{RS_{ij}}} \qquad (7)$$

By estimating the vector β and substituting in (7) we obtain the expected probability $\hat{p}_{ij}$ compared with observed probability:

$$k_j \quad \sum_i \hat{p}_{ij} \Big/ \sum_i (p_{ij}) \qquad (8)$$

The (8) k_j ratio estimates the effectiveness of the j-eth health structure

4. Hierarchical Data



When data is hierarchical, with a two stages sample the independence of observations belonging to the same subpopulation does not state. **It is likely that responses of patients from within the same hospital may be correlated, even after adjusting for the effects of age, gender, severity of illness and risk of mortality since they tend to share certain common characteristics due to the hospital background (organizational policies, medical culture, clinical guidlines, etc.). .**

$$y_{ij} = \alpha_0 + \Sigma_g \beta_{gj} x_{gij} + u_j + e_{ij}$$

Three risks (Hox, 1995 - Goldstein, 1995):

a) If correlation among variables concerning patients belonging to the same hospital grows sub estimation of standard errors of parameters b_j and their significativity grows.

b) ECOLOGICAL FALLACY (Robinson, 1950)

Variables defined at hospital level.

Estimation of parameters concerning patients.

c) ATOMISTIC FALLACY

Variables defined at patient level, (no hospital level).

Estimation of parameters concerning hospitals (Logistic case).

Hierarchical models, particularly

Multilevel Models:

relationships between outcomes (mortality, health, quality of life) and contextual variables complex hierarchical structures, both individual and aggregate levels of analysis:

covariance multilevel mixed model

(Thomas *et al.,* 1994; Normand *et al*., 1995; Morris, Christiansen, 1996; Goldstein, Spiegelhalter, 1996; Rice, Leyland, 1996; Leyland, Boddy, 1998; Marshall, Spiegelhalter, 2001; Dubois *et al*., 1987; Jencks *et al*., 1988; Epstein, 1995; Schneider, Epstein, 1996); Hox, (1995); Rodriguez, Goldman, (1995); Goldstein, (1995); Goldstein, Rasbash, (1996); Snejider , Bosker, (1999); Guo, Zao, (2000); Leyland Goldstein, (2001); Cohen *et al*., (2003); Hope, Shannon, (2005); Gelman, Hill, (2007).

5. Multilevel Modeling

$$y_{ij} = \alpha_0 + \Sigma_g \beta_{gj} x_{gij} + u_j + e_{ij}$$

where:

y_{ij} is the outcome regarding the i-th patient ($i=1,\ldots,n_j$; $N=n_1++n_j+\ldots+n_Q$) hospitalised in the j-th hospital ($j = 1,\ldots,Q$),

α_0 is the intercept,

β_{gj} is a fixed coefficient associated with patient-specific covariate x_{gij} ($g=1,\ldots,G$),

u_j is a random residual associated with the j-th hospital and indicates its '**relative effectiveness**' adjusted for patient-specific and hospital-specific characteristics.

e_{ij} is a random disturbance associated with the i-th patient in the j-th hospital

$$E(e_{ij})=0 \; ; \; Var(e_{ij})=\sigma^2; \; Cov(e_{1j} \; , \; e_{2j}) = 0$$

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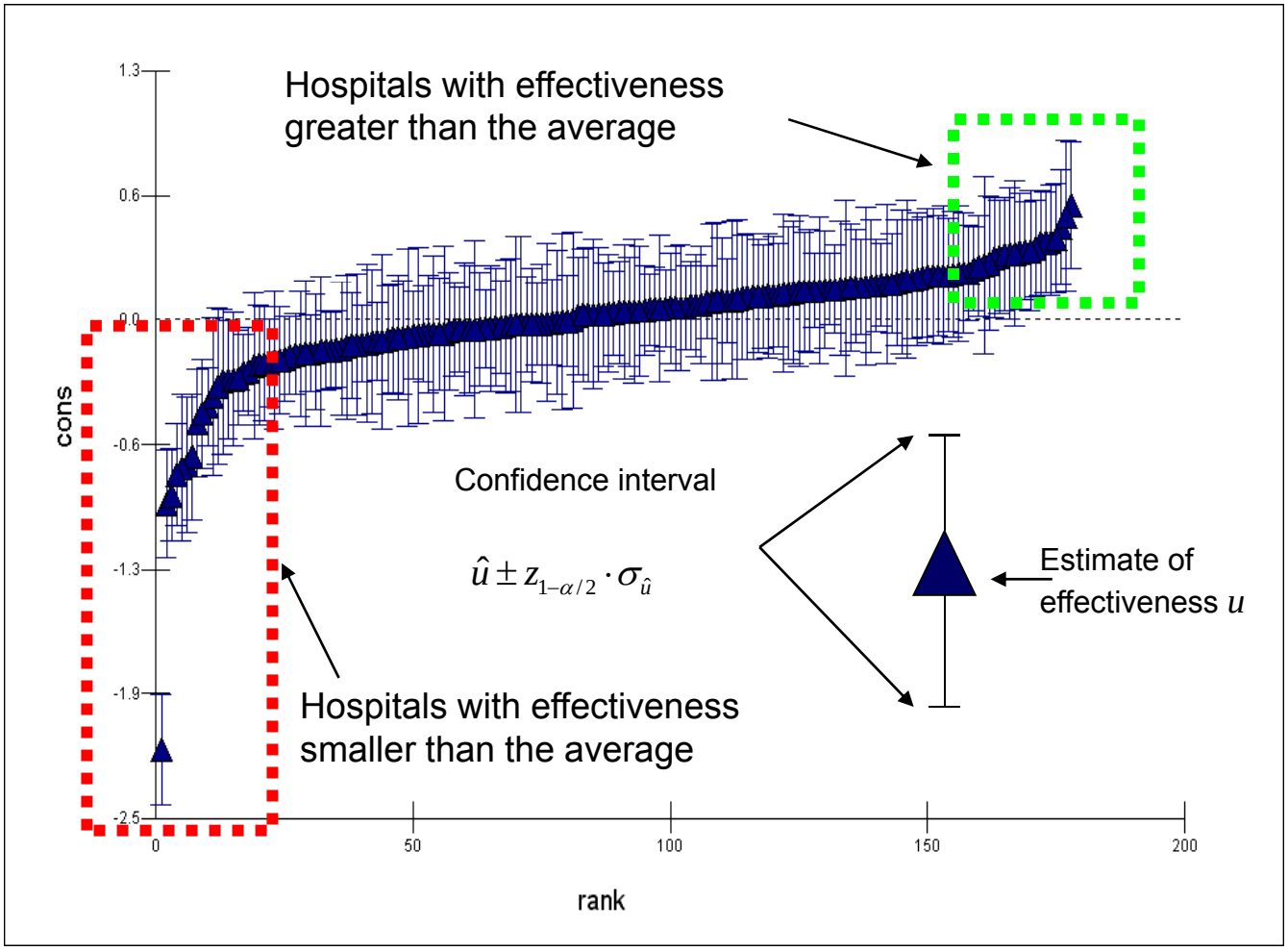
Hospital Ranking by Multilevel Modeling



League table from "hospitals comparisons"

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Resolved problems

1)“fallacy” problems
2) Different amounts of patients in hospitals: Shrinkage factor
3) Randomized rankings (by means of interval confidence)

Prior proposal (Goldstein Spiegelhalter 1996)

a) One outcome
b) Binomial distribution of outcome; multinormal distribution of u_j
c) Static model
d) No hospital-specific covariates.

Possible generalisations:

a) Simultaneous dependency of covariance from multiple outcomes
b) Bayesan approach: non binomial (normal) distribution of outcome and multinormal for random parameters of effectiveness
c) Longitudinal hierarchical models: dynamic panel data models
d) Hospital covariates. Only patient covariates: general effectiveness 2 level covariates: effectiveness net to resources

C.
CRITICISM TO METHODS OF RISK ADJUSTMENT

Mant e Hicks 1996;
Lilford *et al.* 2004;
Lilford Pronovost 2010.

1. Criticism to rankings / a

The use of rankings of hospitals based on random residuals of Multilevel Models has been strongly criticised

a) Criticism to benchmarking health structures

"The sensitivity of an institution's position in league tables to the method of risk adjustment used suggests that comparisons of outcomes are unlikely to tell us about the quality of care dissemination of a database for best practice" (Lilford Spiegelhalter, 2004).

Risk adjustment methods do not show the unexplained difference in mortality rate (Jencks,1994).

b) Variability of effectiveness within hospitals width of confidence intervals) can be very large. This may be **due to the heterogeneity of patients within-hospitals**: the comparison between hospitals is very difficult because the ranking not robust.

1. Criticism to rankings / b

c) Little samples and particular diseases: a sort of biomedical and clinical studies utilized for evaluation goals of big hospitals and patients population.

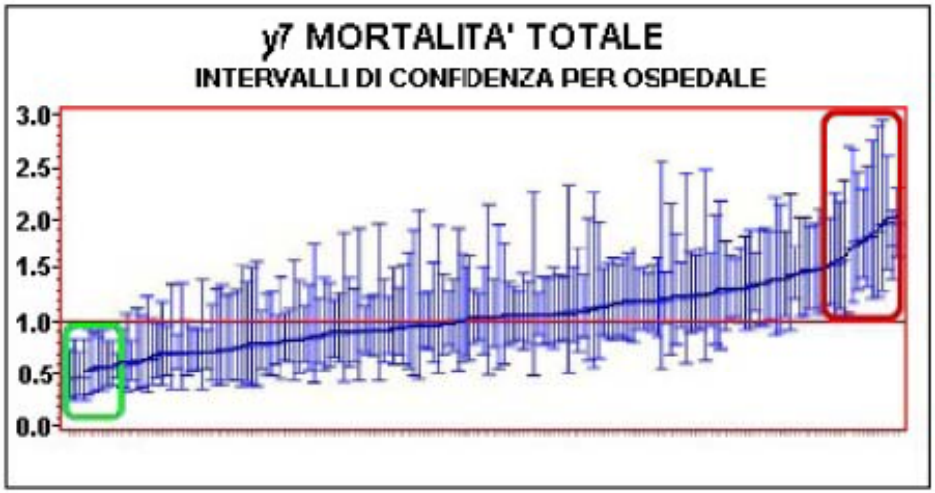
d) Doubts on death rate as health outcome
"The relationship of death rates to quality of care remains controversial (Iezzoni *et al*., 1996). Use of intrahospital mortality.

e) Criticism to a violent utilizazion of ranking for league tables.

f) Comparison of multilevel model based on observational and epidemiological data.

2. Answers

a. Risk adjustment for drg or for groups of drg concerning single ward
b. Evaluation of within and between variance by means of confidence intervals of random parameters: non league tables but **division in 3 categories** on the basis of their percentile distribution.



c. Administrative data The agencies should facilitate the development and dissemination of a (computerized) data base for best practice and improvement based on the results for primary and secondary research (Damberg *et al.,*2003, Rand Manual)

d. Outcomes

a) Clinical outcomes and risk adjustment

Quality of treatment in pathological conditions.

Problems: identification of patients, standard format in handwritten medical records, cost and time in the abstraction process, lack of information.

b) Proxy of clinical outcomes and risk adjustment, i.e. Sentinel event

Problems: Same problems of clinical outcomes.

c) Quality of life (SF-36; FIM)

General condition of health collected by means of survey data.

Problems: Cost; Cross sectional studies; Bias.

d) Context outcomes

From administrative data.

Problems: Only necessary conditions for effectiveness; no accuracy of diagnostic process; Differences of diagnostic codes but useful with big populations.

Relationships with 30 days deaths,

relations between risk adjustment covariates and outcomes

HDC outcomes

Voluntary Discharges

Discharge patient to another hospital

Readmission to operating room

Readmission

Overall mortality (intrahospital mortality + 30 days mortality)

HDC: risk adjustment patients covariates

TABLE 2: - Case mix patient variables

x1	Sex
x2	Age
x3	Health Plan
x4	Civil Status
x5	Profession
x6	Sentinel Diagnosis
x7	Residential Health Zone
x8	Lenght of Hospital Stay
x9	Lenght of Hospital Stay
x10	Weight USA
x11	MDC
x12	Cardiovascular Diagnosis
x13	Tumor Diagnosis
x14	Co-existing diseasis

HDC: risk adjustment hospitals covariates

Table 3 Case mix hospital variables

z1	**Hospital Size**
z2	**Percentage of Beds utilized**
z4	**Number of operating Room utilized**
z5	**Number of Hours operating Room utilized**
z6	**Average Number of Hours operating Room utilized**
z8	**Number operative Units**
z9	**High Surgical Case Mix**
z10	**Low Surgical Case mix**
z11	**High Physician Case mix**
z12	**Low Physician Case mix**

30 days mortality rate

linkage between Hdo e Istat mortality register

quality data index

Non linked admissions / Total admissions * 100

HDC 2004 linkage 94%

HDC 2008 linkage 97%

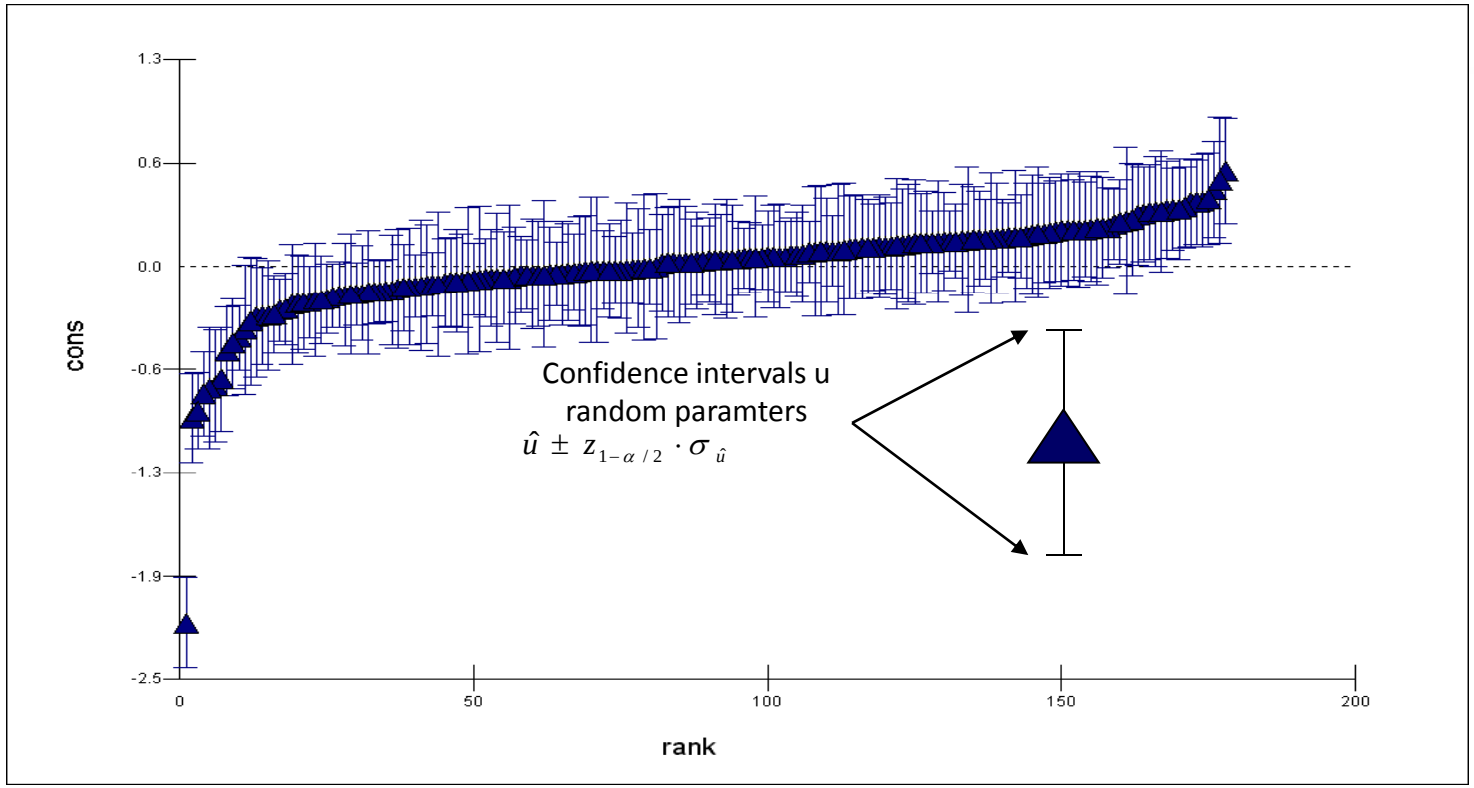
5 non ranking and league table but information to improve quality for hospitals and practioners

e. Rankings Instead of ranking and general league tables information for self improvement on the basis of relative position of hospital in regional situation (under average, average, over average) of different outcomes.

f. Potential outcomes The goal is not to verify the utility of a method or of a drug respect to the case of non its utilization but a comparison of hospitals in order to verify their RELATIVE position respect other hospitals.

D.
EFFECTIVENESS RESULTS

1. General results



Left less effectiveness right more effectiveness

If the interpolant slope is bigger hospital effectiveness is more different

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General remarks

Fixed effects:

More significative variables: age, case mix, urgency.

Diagnostic of rationality of the model.

Random effectiveness effect:

1) The slope of the interpolant decreases: reduction of effectiveness differences.

2) **homogeneity** of **hospitals with different ownership.**

3) **monospecialistic hospitals are better than general.**

First level covariates model

Less effectiveness: little, non specialized hospitals.

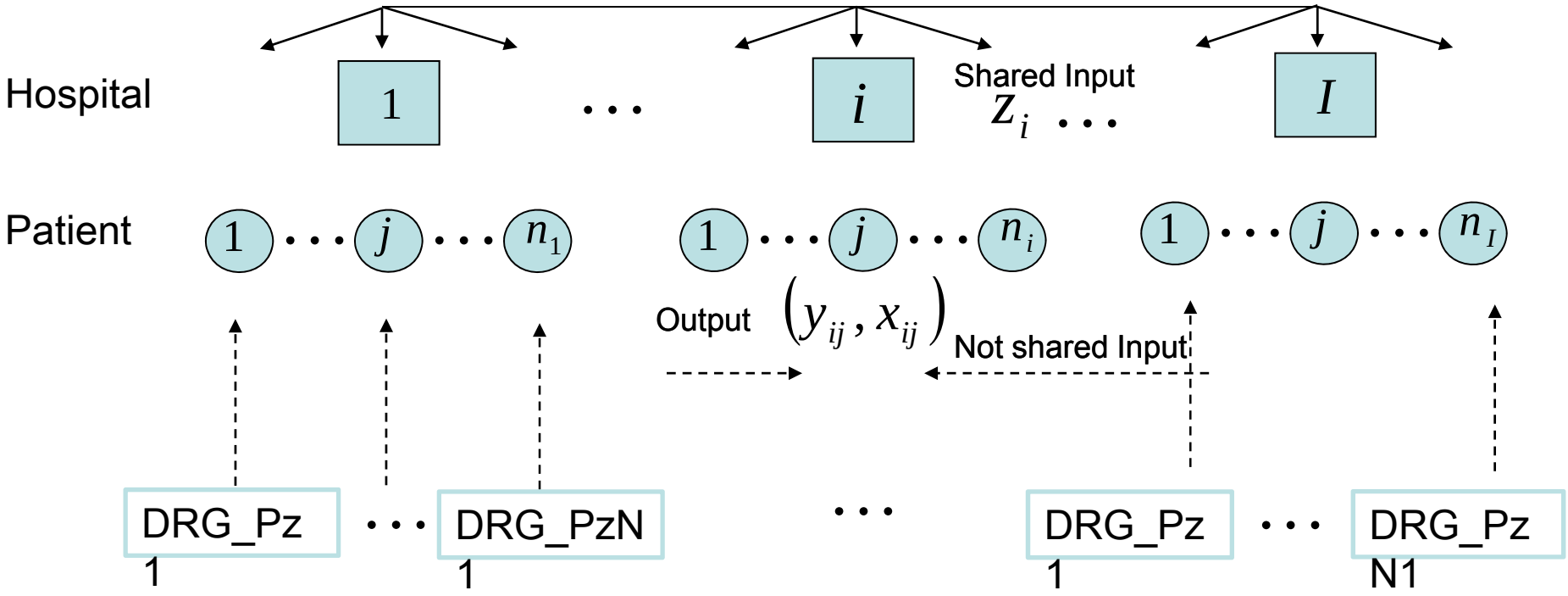
3. The DRG's effectiveness hospital analysis

- It consists on the analysis of hospital effectiveness with respect to all the DRGs provided in Lombardy Region.
- It allows to identify the critical aspects of the hospital activity.
- It is a strategic tool for the health management to use alongside the other performance indicators in working to do things better.
- X variables at the Patient level, Z variables at the Hospital level and K variables at the DRG level.

Methodological problem due to data structure

In the present analysis the data have not a perfect hierarchical structure

It's important to consider this aspect during the model selection



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- The DRG level could not be considered a genuine level, instead in the present study it is defined as being a Pseudo-Level (Levin, Leyland 2005 – Stweart 2010).
- The pseudo-level is a specific characteristic of the data (at the patient level) for which we want to control the variability.
- One of the difficulty is to adapt the setting of the multilevel software to allow for the pseudo level.

$$Y_{ijk} = \alpha_{000} + \Sigma_g \beta_g X_{gijk} + \gamma_j DRG_j + v_{0jk} + u_{00k} + e_{ijk}$$

i= 1, …, n Patients - j = 1, ….J DRGs - k = 1, … , K Hospitals

- γ_j is a fixed coefficient associated with DRG-specific dummy variable
- v_{0jk} is a random residual associated with the j-th DRG and k-th hospital
- u_{00k} is a random residual associated with the k-th hospital

Exclusion criteria:

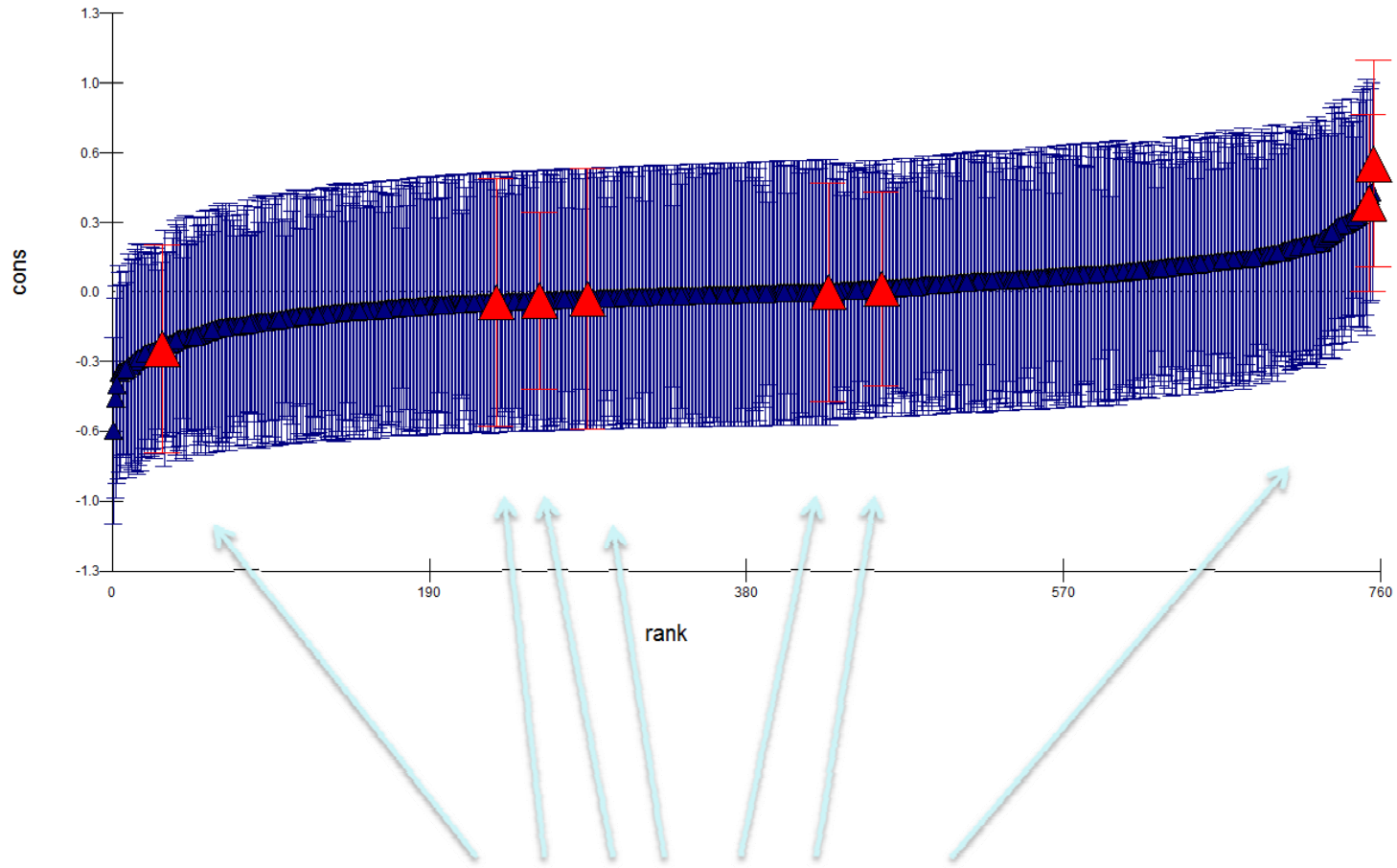
The DRGs provided less then 30 times and in less then 3 hospitals in the year.

The DRGs for which mortality is not observed.

Results:

The model results provided to managers are divided in 3 categories on the basis of their percentile distribution and are given the following symbols: +, – and =

- One symbol identify the internal comparison (Fixed the hospital we compare the performance between different DRGs)
- One symbol identify the external comparison (Fixed the DRG we compare the performance between different Hospitals)



Comparison between different j-DRGs provided in same hospital

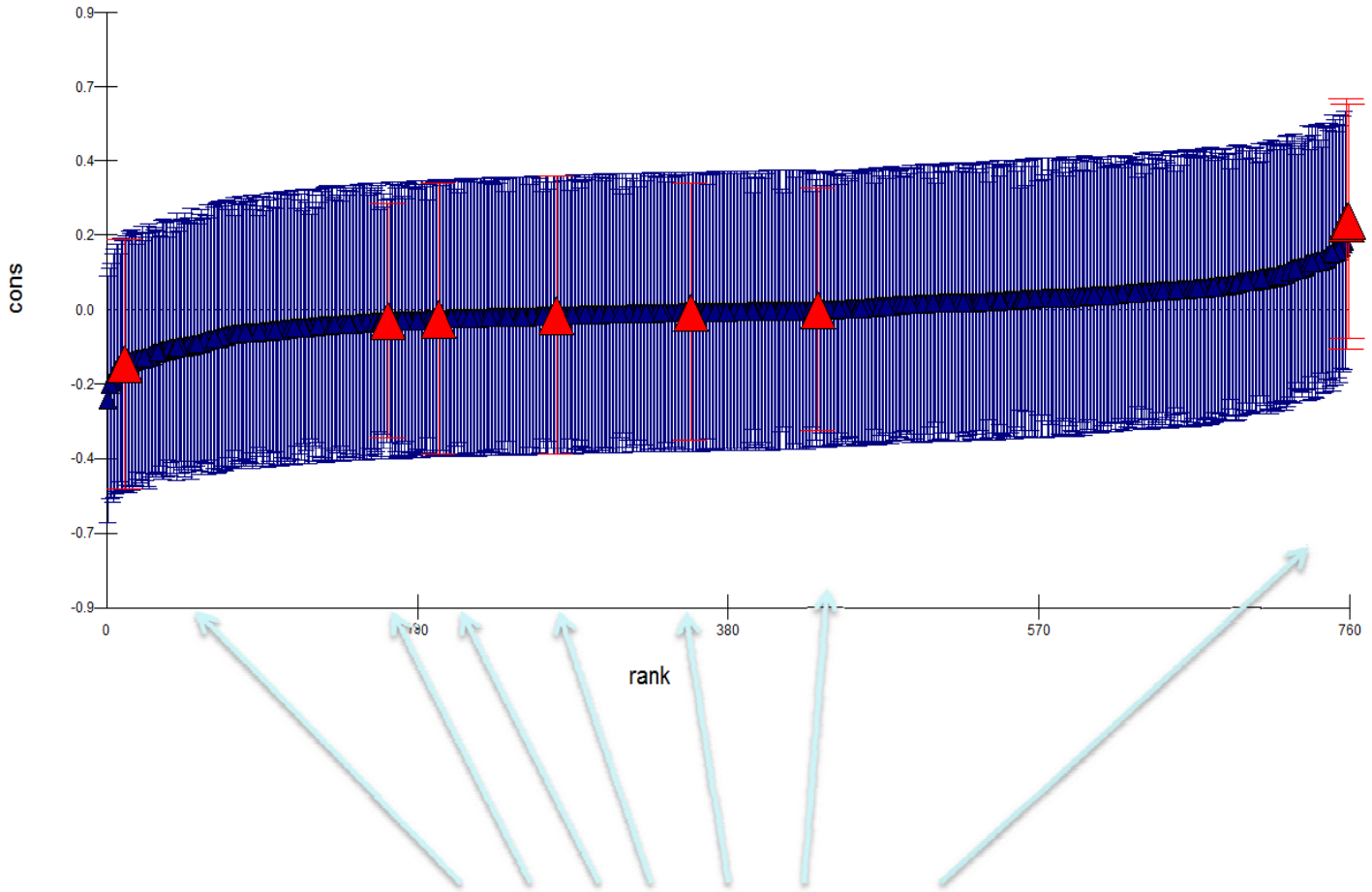
(v_{0jk} with fixed k-th hospital)

The second way to compare the DRG performance is the following

$$Y_{ijk} = \alpha_{0j0} + \Sigma_g \beta_g X_{gijk} + \gamma_j DRG_j + v_{0jk} + e_{ijk}$$

i= 1, …, n Patients - j = 1, ….J DRGs - k = 1, … , K Hospitals

- γ_j is a fixed coefficient associated with DRG-specific dummy variable
  - α_{0j0} is a random intercept associated with the j-th DRG
  - v_{0jk} is a random residual associated with the j-th DRG and k-th hospital



Comparison between the same DRG provided in different k- hospitals (v_{0jk} with j-th DRG fixed)

DRG	DESCRIZIONE	PUNTEGGI
012	Malattie degenerative del sist. nervoso	==
014	Malattie cerebrovascolari specifiche escl. TIA	--
088	Malattia polmonare cronico-ostruttiva	+=
090	Polmonite semplice e pleurite, eta' >17 senza CC	--
104	Interventi su valvole card. e altri interv. maggiori cardiotoracici con cateterismo card.	=-
105	Interventi su valvole card. e altri interv. maggiori cardiotoracici senza cateterismo card.	--
110	Interventi maggiori su sist. cardiovascolare con CC	-=
116	Impianto PM cardiaco permanente con altre patologie	--
131	Mal. vascolari periferiche senza CC	++
138	Aritmia e alterazioni conduzione cardiaca con CC	--
139	Aritmia e alterazioni conduzione cardiaca senza CC	==
142	Sincope e collasso senza CC	+=
148	Interventi maggiori su intestino crasso e tenue con CC	--
174	Emorragia gastrointestinale con CC	--
294	Diabete, eta' >35	=+
297	Disturbi nutrizione e metabolismo, eta' >17senza CC	=
323	Calcolosi urinaria con CC e/o litotripsia ESW	--
395	Anomalie globuli rossi, eta' >17	==
410	Chemioterapia senza dia. secondaria di leucemia acuta	=-
478	Altri interventi vascolari con CC	--
483	Tracheostomia escl. per disturbi orali, laringei o faringei	=+
516	Interventi su sist. cardiovascolare per via percutanea con IMA	==

4.Effectiveness Analysis

Multilevel Model Ward – Patient: one model for each outcome and each ward (50).

Analysed Departments	Evaluated Outcome
Surgery	Voluntary Discharges
Medicine	Discharge patient to another hospital
Cardiology	Readmission to operating room
Cardiac surgery	Readmission
Neurology	Overall mortality (intrahospital mortality + 30 days mortality)
Neurosurgery	
Urology	
Gynecology	
Oncology	
Ortopedics	

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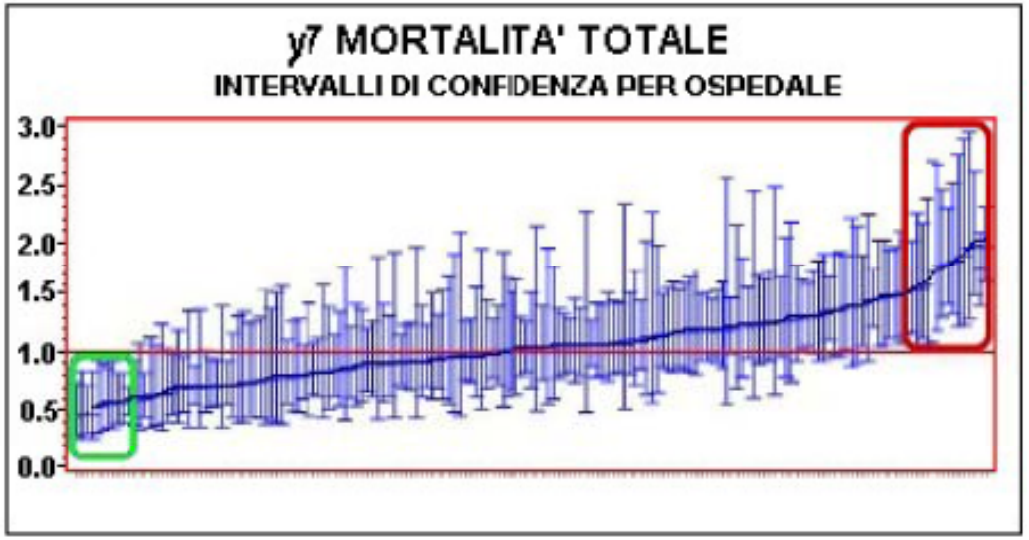
Multilevel Model Ward – Patient: one model for each outcome and each ward (50).

Department Level Variables	Patient Level Variables
N° Operating Rooms	Sex
N° Wards	Age
Type of Emergency Department	Length of Stay
Average Age of the Ward	Admission in Emergency
Average Length of Stay of the Ward	Cardiological discharge
% Emergency Admission for Ward	Oncological discharge
% Oncolgical Discharges for Ward	Comorbidity (Elixhauser Index)
% Cardiological Discharges for Ward	Stay in Intensive Care Unit (ICU)
Average Ward Comorbidity (Elixhauser Index)	Rembourment for the discharge

✓Multilevel Model Ward – Patient: 1 model for each outcome and each ward (50).

✓Confidence Interval Analysis:



✓Setting a score according to the significance of the odds ratio:

- Hospitals in the **green area** = 3
- Hospitals in the **red area** = 1
- Hospitals in the middle of signifiance= 2.

E.

SET OF INDICATORS FOR AN OVERALL ASSESSMENT FOR DEPARTMENTS

1. Development of evaluation system (CRISP project)

Summary hospital activity:

10 departments analysed and evaluated in the following dimensions

- Effectiveness
- Appropriateness
- Standard Evaluation
- Efficiency
- Access

-Scores from 1 to 3 according to quality level: 3 it's a good performance and 1 it's a bad performance.

Departments

- Surgery
- Cardiology
- Neurology
- Urology
- Oncology
- Medicine
- Cardiac surgery
- Neurosurgery
- Gynecology
- Ortopedics

2. Analysis of Hospital Appropriateness

Surgery

Medicine

Cardiology

Cardiac surgery

Neurology

Neurosurgery

Urology

Gynecology

Oncology

Ortopedics

Analysed Departments

Cream Skimming

Upcoding

Riadmission in 30 days for the same MDC

Local Health Authorities Control (NOC)

Dimensions

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Cream Skimming:

- DRG Provided (net of exclusion criteria)

Upcoding:

- Rate of Complicated DRG for departments related to the pairs of DRG Complicated/Not Complicated
- Rate between Departement index and Regional Index
- Standadised by Comorbidity Index

Riadmission in 30 days for the same MDC

Health Care Authorities Control:

- Average Positive Control

3. Analisys of Hospial Efficiency and Standard Evaluation

Tecnical Efficiency:

- Analysis for hospital.
- Obtained through the Stocastic Frontier

Standard Evaluation:

- Analysis for hospital.
- Average score for area of the Joint Commission indicator related to the Patient Safety.

4. Access Analysis

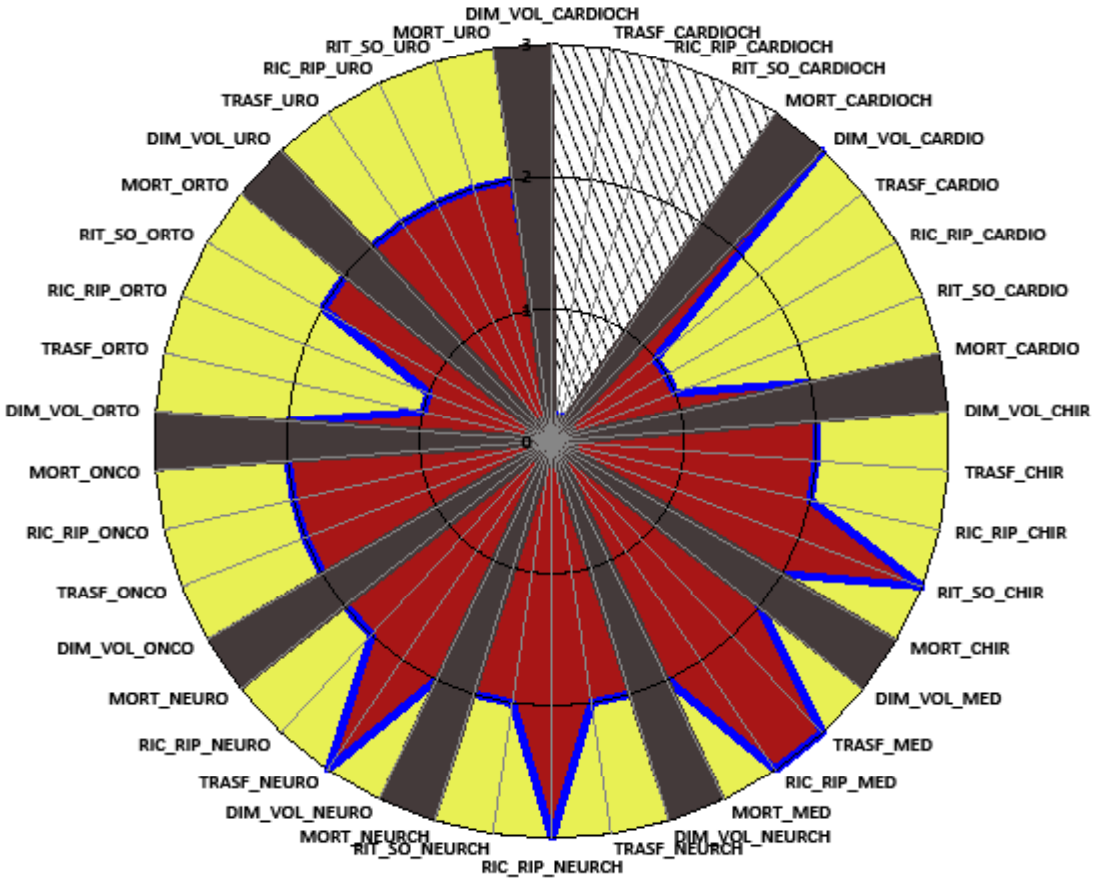
Customer satisfaction analysis:

- Considering 2 questions from the Lombardy customer satisfaction survey: the first question is related to the satisfaction for the medical activity. The second one is related to the satisfaction for the nursey service.
- Analysis for hospital.

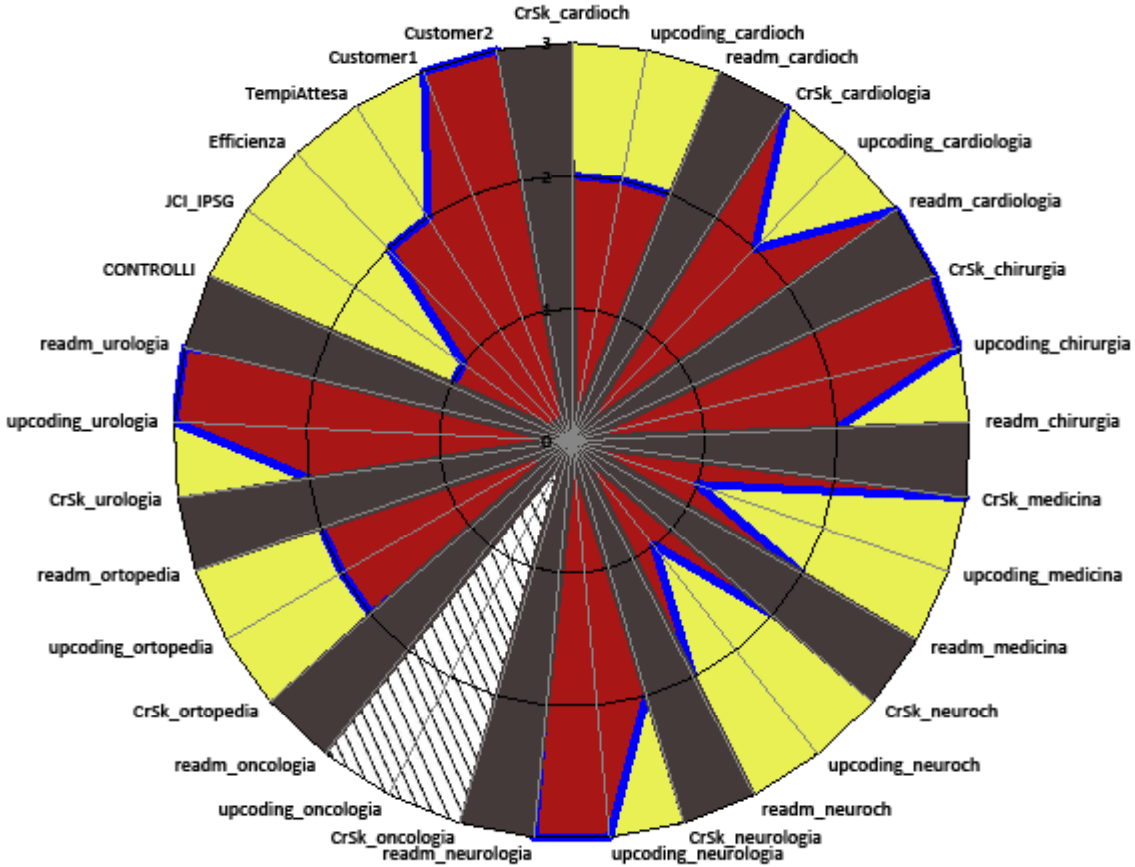
Waiting List analysis:

- Analysis for hospital.
- Average waiting list considering regional goals for each procedures.

5a. Radar chart for hospital results:



5b. Radar chart for hospital results



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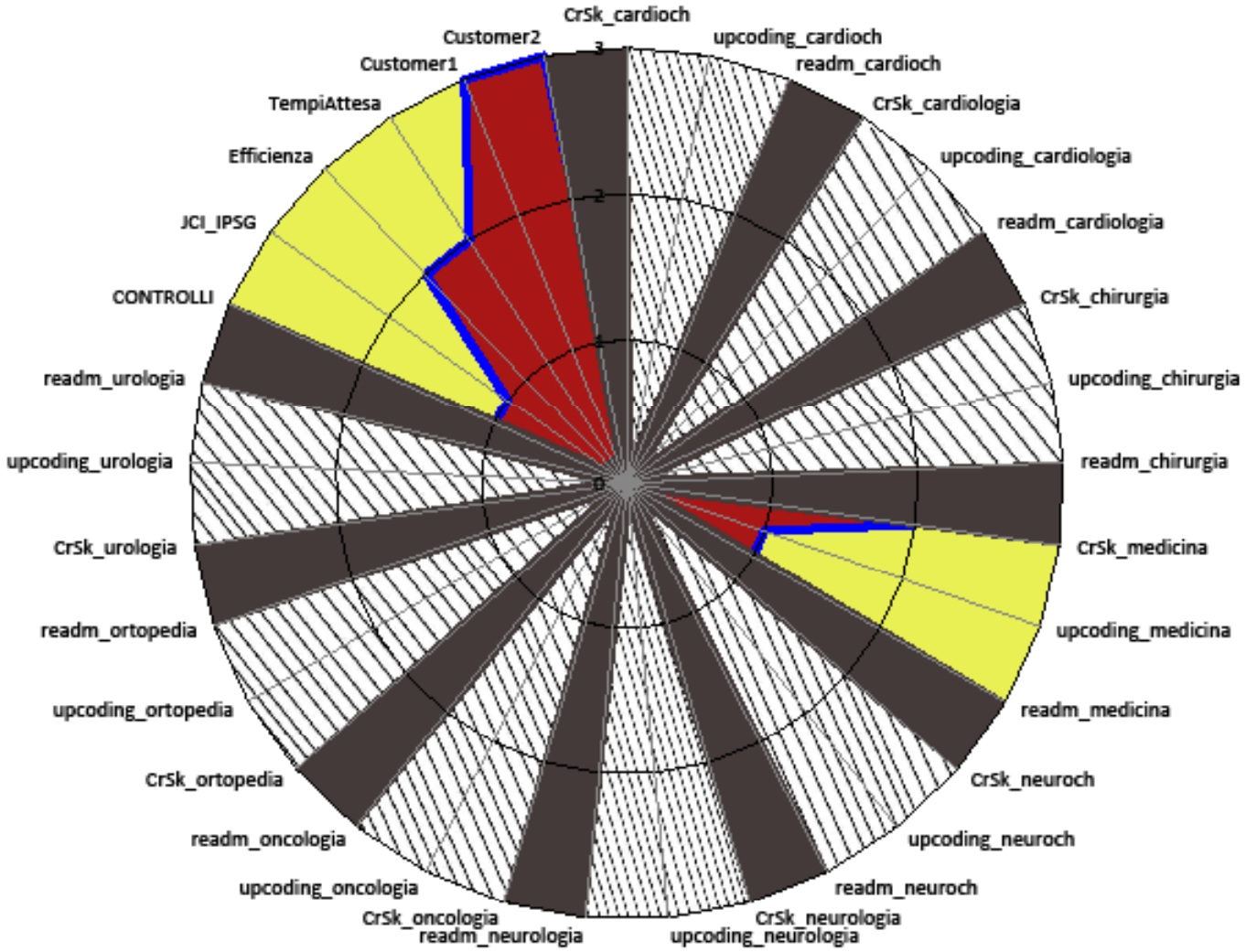
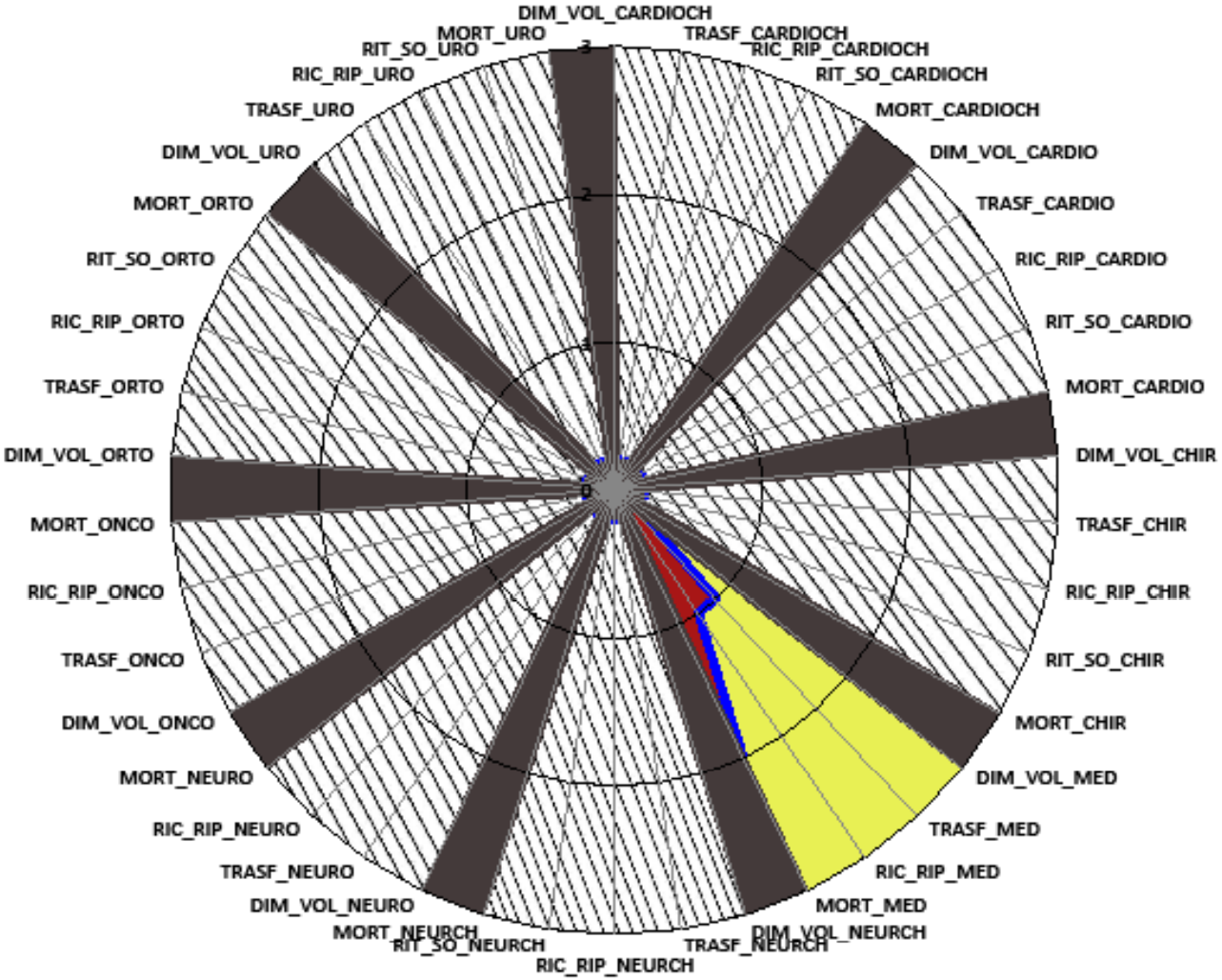
a.1 Small Hospital



a.2 Small Hospital



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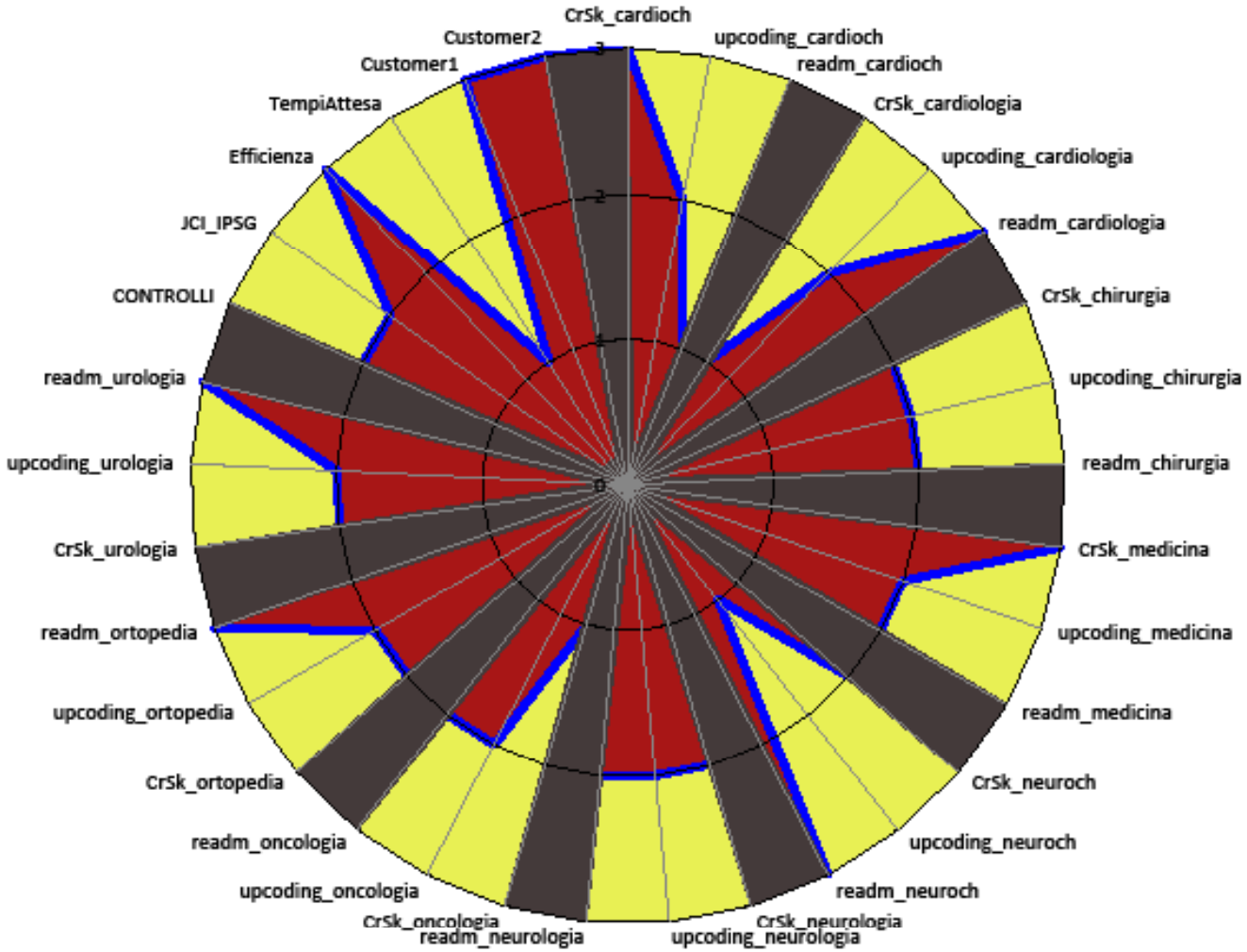
b.1 Big Hospital



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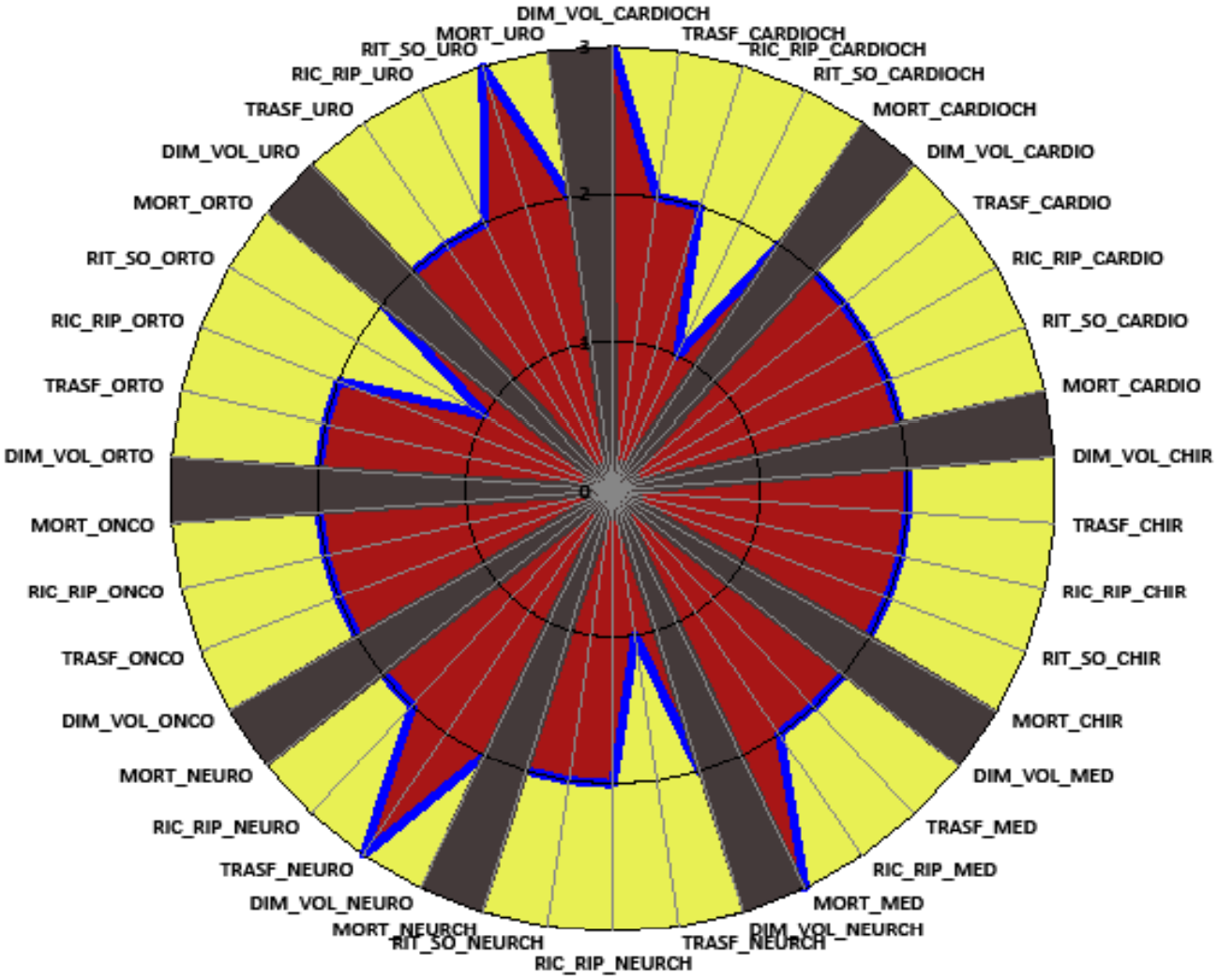
b.2 Big Hospital



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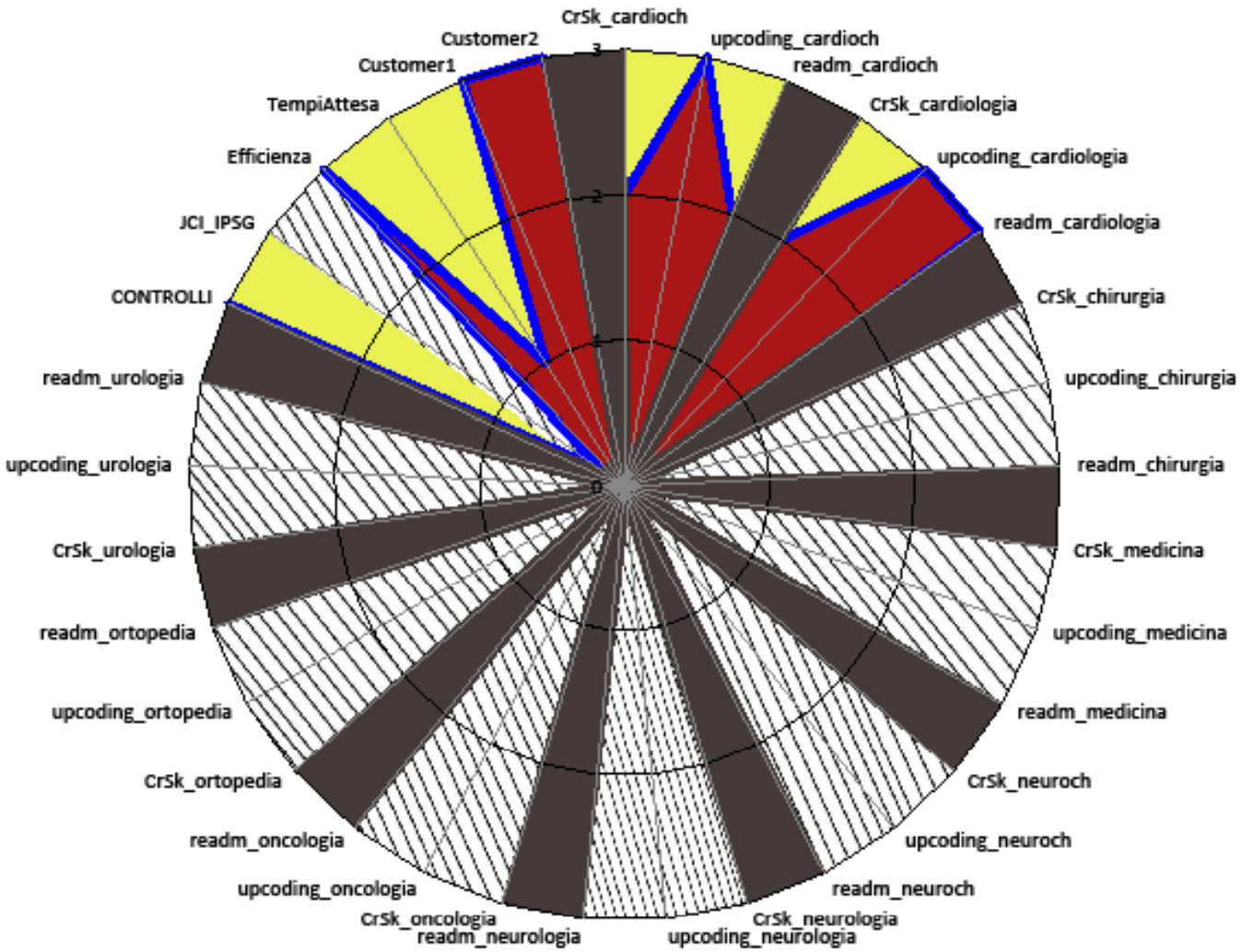
c.1 Specialized Hospital



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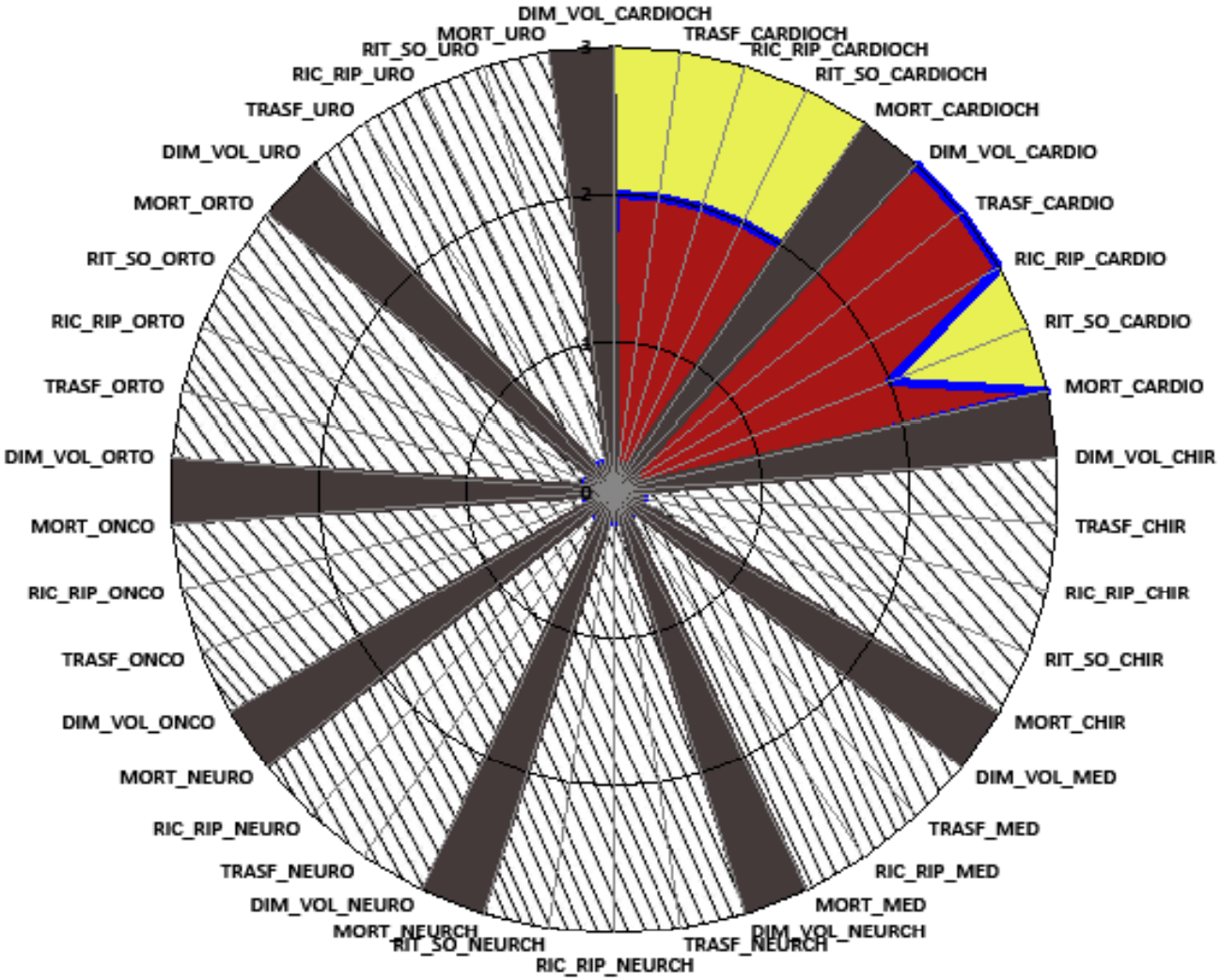
c.2 Specialized Hospital



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