

## Mapping the centers performing endocrine neck surgery in Italy

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**SUMMARY: Mapping the centers performing endocrine neck surgery in Italy.**

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**Background.** Quality of care and provider's experience seem to be strictly connected in any field of surgery. Aim of this study is to identify a method to classify the centers on the basis of the number of thyroidectomies and parathyroidectomies performed.

**Methods.** We listed 666 centers performing endocrine neck surgery in 2015, from the database of the Italian Health Ministry. We performed a descriptive statistic analysis with a dedicated software. We identified the outliers, according to a previous literature review, in those centers performing >1000 and < 10 thyroidectomies, >100 and < 3 parathyroidectomies and we excluded them to our analysis. The remaining centers were grouped in a box-plot. Third quartile, median, procedures performed/3<sup>rd</sup> quartile value ratio (Standardized Hospitalization Ratio, SHR, superior cut-off),

median/3<sup>rd</sup> quartile values ratio (inferior cut-off) were calculated. These centers were charted in a bar graph and three zones were identified: "excellence" (SHR>1.1), "SHR", "alert" (between the two cut-offs) and "risk" (under the lower cut-off).

**Results.** 35743 thyroidectomies and 2306 parathyroidectomies were performed in Italy in 2015. After the outliers' exclusion, 407 and 157 centers performing respectively thyroidectomies and parathyroidectomies were analysed. A median value of respectively 37 thyroidectomies and 6 parathyroidectomies, and a 3<sup>rd</sup> quartile cut-off of respectively 85 and 12 were calculated. Concerning all the 666 centers, we found: 95 excellence centers for thyroidectomy and 33 for parathyroidectomy, respectively 18 and 17 falling into superior cut-off line, 100 and 29 in the alert zone, 453 and 587 in the risk zone.

**Conclusions.** Our method, according to the literature data, highlighted a number of thyroidectomies and parathyroidectomies performed in low volume centers. Looking for an optimization in health organization, we can consider some measures such as a net of tutorship of the "alert" hospitals by the excellence ones and a discouragement of the "risk" hospitals in performing endocrine neck surgery.

KEY WORDS: Endocrine neck surgery - Thyroidectomy - Parathyroidectomy - High volume center - High volume surgeon.

## Background

Since the late seventies, the association between results in the health care process and experience of the provider has been supposed. The concept of "learning curve" was widely introduced in common medical language as the improvement of results as a

function of the increasing in number of cases treated (1). Nearly twenty years later, this strict relationship was showed in the specific field of endocrine neck surgery, particularly thyroid surgery, and the lower complication's rate were significantly associated with a surgeon's volume > 100 procedures per year (2). Nowadays there is a wide acceptance of this assumption and, subsequently, a number of dedicated units of endocrine surgery were created all over the world (3-7), with an activity sometime restricted to endocrine neck surgical procedures and even only thyroid cancer or parathyroid diseases. Despite the efforts in specializing a narrow circle of surgeons in endocrine surgery, it is not clear if this trend gives some advantages, anyway the emphasis on positive volume-outcome relationships is commonly be-

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lieved. In a previous review, we showed that activity volume of surgeons and centers is crucial for improving the results and reducing costs in thyroid and parathyroid surgery, and then we fixed a reasonable cut-off of procedures needed for defining a high volume center for this surgical specialty (8). Aim of the present study is to identify a method of classification applied at all surgical Italian centers performing endocrine neck surgery based on the number of procedures carried out during a reference year.

## Method

### *Acquisition of data*

A formal application was emailed at the Italian Health Ministry – General Management of health planning – Hospital Discharges data bank. The request concerned the DRG codes corresponding to parathyroid and thyroid diseases. We chose the 2015 reference year, which was the last year in which the data were completely available at the time of our request. The data were obtained in .txt form and concerned regional codes, institution codes and subcodes, DRG codes, main diagnose and main surgical procedure, that corresponded to the 289 (parathyroidectomy) and 290 (thyroidectomy) codes, according to the ICD-9-CM evolution system actually in use in Italy. In compliance with provisions in privacy matters, the data were processed in aggregate form, as requested from Departmental Office. Moreover, these were considered per institution and not separated per single unit. For the statistical analysis, these data were transformed in a .pdf file.

### *Identifying the cut-off for defining the activity of each center “adequate”*

For defining the minimum activity values of a center of endocrine neck surgery, we had previously performed a systematic narrative review fully compliant with PRISMA criteria, in which 22 papers had been selected. A meta-analysis had not been performed because of the extreme variability of the samples, the differences in data collection, subjects investigated and outcomes evaluated. So, the cut-off identified could not be precisely defined, anyway we had concluded that a minimum volume of 35-40 thyroidectomies per year for a single surgeon, and

90-100 thyroidectomies for a single center seem most likely the cut-off for identifying an adequate activity. Moreover we had affirmed that parathyroid surgery should be performed in high volume hospital for thyroidectomy and we had considered reasonable the value of 10-12 operations/year as cut-off.

### *Analysis of data*

A descriptive statistical method was adopted. We carried in a box plot graphic the performance data of each surgical Italian center performing at least 1 procedure (DRG code 289 and/or 290). We fixed the superior outlier in 1000 or more procedures per year and the inferior one in 10 or less for the DRG 290. Concerning the DRG 289, these limits were fixed respectively in 100 and 3. These outliers were excluded from the cut-off evaluation. In the box plot graphics we identified the 3<sup>rd</sup> quartiles (equivalent to the superior cut-off) and the medians (ME, equivalent to the inferior cut-off). Moreover, the data were carried in a bar diagram in which the standardized hospitalization ratio (SHR) was calculated as ratio between the number of discharges performed in each center and the 3<sup>rd</sup> quartile. The ratio = 1 was the superior cut-off; the ratio between ME and 3<sup>rd</sup> quartile (different between the two DRGs) was the inferior one. These two values were traced as horizontal line for intercepting the performances of each center. This procedure allowed us to identify three zones of the bar graphic: the “Excellence” zone, with a SHR>1,10; the “Alert” zone between the SHR = 1 and the inferior cut-off; the “risk” zone below the inferior cut off of each DRG. For this analysis, an Rstudio IDE (33) software version 3.4.1 (2017-06-30) was used.

## Results

A total amount of 35743 thyroidectomies (thyroid lobectomies and total thyroidectomies) and 2306 parathyroidectomies were performed in Italy in 2015. We will analyse separately the two procedures.

### *Thyroidectomy*

Among the 666 surgical units that performed at least 1 endocrine neck surgery procedure during the

2015, we excluded 2 superior and 257 inferior outliers for thyroidectomy. Then, 407 centers were grouped in creating the box plot (Figure 1) that allowed us to calculate 3<sup>rd</sup> quartile and ME. The 3<sup>rd</sup> quartile could be understood as estimate of the expected result and equals 85 that is surprisingly slightly lower of the value esteemed in our previous review (90-100) as the cut-off for defining a “high volume center”. The ME resulted 37 procedures per year, so the inferior cut-off was  $(37/85) = 0,43$  (Figure 2).

### Parathyroidectomy

The same list of centers was taken into consideration. After the exclusion of the outliers for parathyroid surgery, 157 centers were included in the box plot (Figure 3). The 3<sup>rd</sup> quartile was = 12, the median = 6 parathyroidectomies per year. After the performances of each center were carried in the bar diagram, the superior cut-off were = 1 and the inferior one = 0,50 (Figure 4). Interestingly, 30/33 (91%) excellence Italian centers for DRG 289 were also excellent for the 290. Table 1 summarizes overall data of all Italian hospital classified on the basis of the cut-off identified. Table 2 summarizes the average of thyroidectomies and parathyroidectomies performed in each class of hospitals.

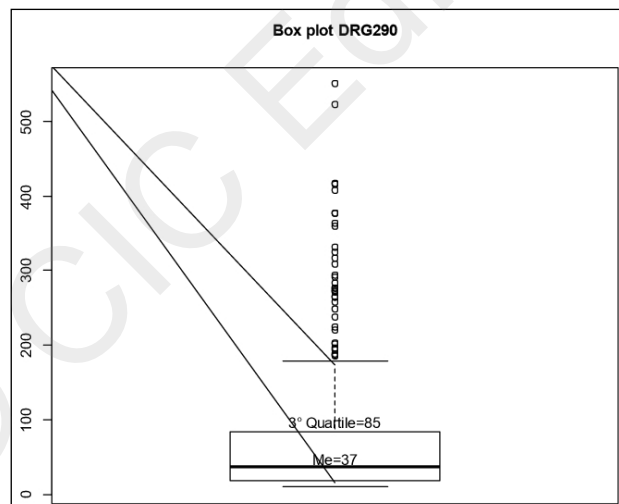


Figure 1 - Box plot graphic representing distribution of activity volume of the 407 Italian centers performing thyroidectomies after removal of superior and inferior outliers. Median and third quartile have been calculated.

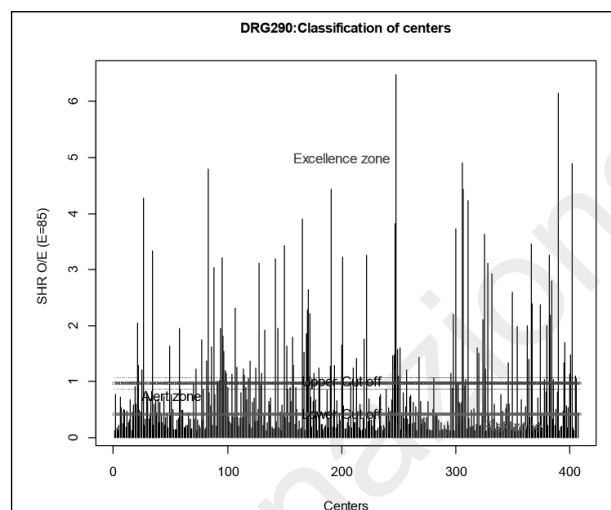


Figure 2 - Linear representation of activity volume of each Italian center performing thyroidectomies.

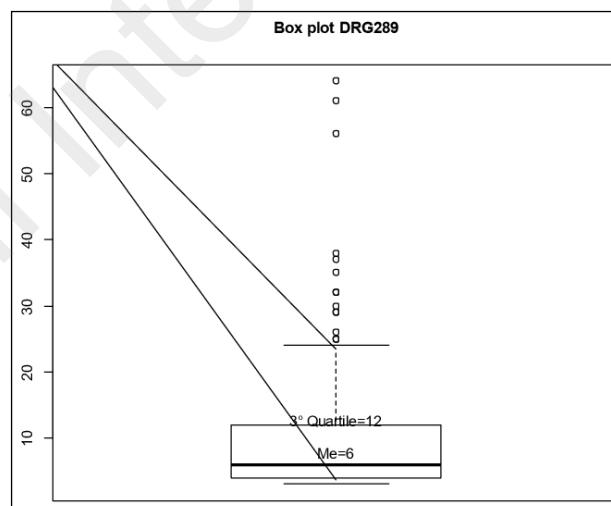


Figure 3 - Box plot graphic representing distribution of activity volume of the 157 Italian centers performing parathyroidectomies after removal of superior and inferior outliers. Median and third quartile have been calculated.

## Discussion

Thyroid surgery is one of the most common surgical procedures all over the world. The importance of the concentration of a specific activity is often affirmed but rarely practiced. Parathyroid surgery is less common (according to the data obtained for the present study, the ratio is approximately 1/15) but it is intuitive that both procedures need similar knowledges and skills. The literature concerning the relationship between volume and outcome in endocrine neck surgery is still limited (9, 10) and came mainly

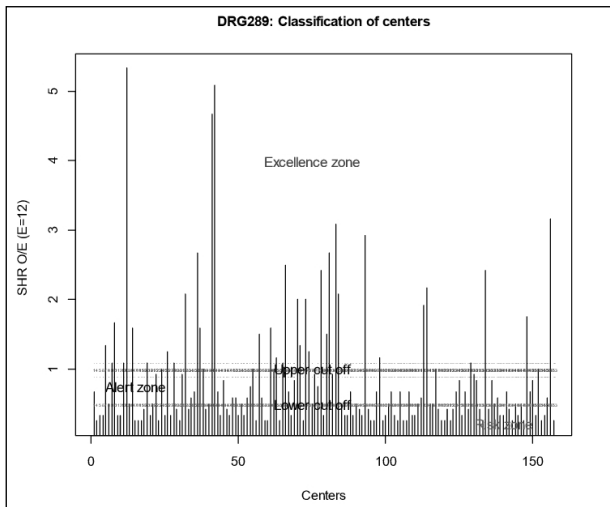


Figure 4 - Linear representation of activity volume of each Italian center performing parathyroidectomies.

from American centers (11-14). These experiences affirm that there are many reasons for encouraging the development of surgical sub-specialties: a high specific volume allows an improvement in knowl-

edge concerning the specific subject, larger opportunities in teaching and researching, better quality of performances and subsequently better outcomes (15). Overall, the continuous increasing of knowledge and the large diffusion of new surgical techniques and procedures (16-28) can be better dominated with a specific application and training (15). There is a substantial agreement in affirming that the high volume surgeons and hospitals produce a wide range of positive effects in outcomes, such as complications, costs, appropriateness or completeness of the procedure performed, recurrence rate and reoperations, length of stay, need of radioiodine ablative treatment (29-36). These advantages are clear especially in thyroidectomy for malignancy (37-39). The results of high volume surgeons should be evaluated considering 7-10 years of activity. An adequate hospital volume needs the presence of specialties, such as endocrinology, Nuclear Medicine, Radiology in which a service of CT and NMRI is available, Oncology, ORL, ICU and, at least a network in which a thoracic surgery etc. is available (8). Con-

TABLE 1 - CENTERS CLASSIFIED ACCORDING THE CUT-OFF.

Hospitals	DRG 290	DRG 290%	DRG 289	DRG 289%
Excellence	95	14	33	5
Standard	18	3	17	3
Alert	100	15	29	4
Risk	453	68	587	88
<b>TOTAL</b>	<b>666</b>	<b>100</b>	<b>666</b>	<b>100</b>

Among the 33 excellence hospital for DRG 289, 30 are excellent also for 290. Data available at the Italian Health Office.

TABLE 2 - ENDOCRINE NECK SURGERY PROCEDURES IN EACH GROUP OF CENTERS.

Hospitals	DRG 290	DRG 290%	DRG 289	DRG 289%
Excellence *	22585	63	1524	66
Alert	6785	19	294	13
Risk	6373	18	488	21
<b>TOTAL</b>	<b>35743</b>	<b>100</b>	<b>2306</b>	<b>100</b>

The number of surgical procedures that corresponds to \* in this Table results from the Excellence *plus* standard hospitals. Data available at the Italian Health Office.

cerning parathyroidectomy, it could show complex cases with a relevant frequency. Then, a skilled team is needed. Anyway, high volume thyroid surgeons and centers seem to give positive effects in outcomes (40).

In spite of these considerations and data of literature, the total amount of thyroidectomies performed in high volume centers in USA are a minority: in 1998-2000, 85% of thyroidectomies and 78% of parathyroidectomies were performed from surgeons with an endocrine surgery volume of less than 25% of its total activity (29). This average increased of 23% in the next 15 years, and consequently the complications rate decreased from 7,9 to 4,9% (3). In this point of view, in Italy we found 14% "excellence hospitals" for thyroidectomy that perform 63% of procedures, and 5% of excellence hospitals for parathyroidectomy performing 66% of procedures. It could be considered a good result, but there is also a large number of thyroidectomies (more than 6000, 18%) and parathyroidectomies (nearly 500, 21%) performed in "risk" hospitals that means, according to the evidences of literature, higher probability of complications with higher costs (8). We have not aimed this study to investigate the correlation between activity volume and outcomes, instead we analysed the volume of thyroidectomies and parathyroidectomies performed in all Italian surgery units and then we tried of estimating the expected number of procedures for classifying these units based on the surgical procedures performed. For proceeding in this estimation, we introduced several arbitrary parameters, such as the coefficient of 1.10, utilized for calculating the cut-off of SHR for excellence zone and the average median/3<sup>rd</sup> quartile for identifying the cut-off for 3<sup>rd</sup> quartile. Overall, the cut-offs coming from the review (8) are useful and reliable, but its estimation is frequently based only on reasonable considerations rather than exact calculations. It is still unclear if the relationship volume/outcomes depends on the improvement of results after a practice extended over the time or the attraction of better outcomes driven on patients (2, 14).

Our method could be considered a useful tool for quality control in endocrine neck surgery, and its use could be extended to other fields of surgical practice: surgical volume could be considered a crude measure of quality that can be easily estimated

by application of modern monitoring instrument widely diffused in health care (41). The wide computerization of data available at the different levels of health government institutions (hospital management, Regional Council Office, Central Ministry) allows its complete monitoring and control, and any intervention depends only on political will. Of course, the monitoring of outcomes could be the most reliable way for evaluating the quality of care, but it is well known that some data concerning complications are not immediately available and, in some cases, not always pointed out (42, 43). The application of our method for evaluating the centers performing a specific surgical activity (in the present case, endocrine neck surgery) have some limitations. It do not take into consideration the complexity of cases treated (44, 45). In this perspective, hemithyroidectomy for benign nodule has the same main code of total thyroidectomy plus bilateral neck dissection in case of advanced/aggressive malignancy, although it is well known that there are clear differences in terms of length of surgery, complication's rate and costs. The character of the database considered (health care administration) is an important limitation. Moreover, the present study is retrospective, and it has the typical limitations of these studies. Nonetheless, any database that includes the complications is not extended to the late ones and readmissions, so the estimate of adverse events cannot be careful (46). Since we only considered the DRGs Database of the Ministry of Health, an evaluation concerning the *real* incidence of complications matched to the distribution of procedures was not possible. Moreover, the real clinical impact of each complication is also difficult to esteem. In addition, no studies concerning this matter are available in literature. Finally, since the data available concerned only the performance of a single center, but not the volume of activity of a single surgeon, some or all surgeons could fall below the high-volume threshold if the activity is parcelled out several professionals working at the same institution. On the other hand, for relatively small institutions with one single thyroid surgeon, it could be the opposite.

In this perspective, our proposal of method for evaluating globally the performances of centers performing endocrine neck surgery only describes the distribution of activity in the whole Italian territory. In spite of that, it seems able to minimize these bi-

ases, and the results could be useful as a starting point for leading politics of improvement of outcomes in this specific field. On the other hand, specialization in surgery do not mean only perform with repetitiveness specific surgical techniques, but also promote synergy with other specialties, introduce innovations, improve diagnostic, enrich knowledges (47-53). We are conscious that initiatives aimed to highest concentration of all health care procedures in highest volume centers are not feasible. Many variables, such as patient's choice, geographic specificities, need for homogeneous distribution of health services, could be given into account (14). Nonetheless, some strategies for optimizing the outcomes are to be hoped. In our study, we found that the number of the Italian excellence centers is similar to that the "alert" hospitals: this evidence could lead to a tutorship program carried out, if possible on a regional or inter-regional perspective, according to the specific situations. Considering the data available in literature, as suggested in other fields of surgery, public health authorities could provide at least a wide diffusion of guidelines for defining the minimal requirements for endocrine neck surgery practice and the adoption of strict accreditation criteria (54). Finally, the reimbursement system should exclude the lowest outliers ("risk hospitals") in the absence of a specific program of implementation.

## Conclusions

Endocrine neck surgery is associated with a non-negligible morbidity and even mortality, failure in cure rate, under- and overtreatment, avoidable reoperations. This can result in increase of economic and biological costs for any health system.

The present study attempted to design a method to fix the cut-off for classifying neck endocrine surgery centers according to the activity volume. Stated that it is a reliable measurement of efficacy in terms of expected outcomes, more criteria, such as close application of the team in training and education, quality of research, relationship with esteemed national and international centres, intrinsic qualities of the leader and components are needed for defining an "excellence" centre. In this perspective, the activity volume could be considered a necessary but

not sufficient quality criterion. Anyway this study suggests of addressing the public health authorities towards a centralization of this specific field of surgery and, if possible, a discouragement of the lowest volume hospital in performing endocrine neck surgery. According to the large majority of the data of literature, this new trend, than could appear dirigist, could be justified taking into consideration the improvements of all outcomes. Moreover, it could release resources for improving public health service, first by implementing technology. Expected goals should be a correct use of resources and a decrease in misdiagnoses and overtreatments. An increase in efforts by public health administration as well as scientific societies is needed for a process of transfer of knowledges and skills from the "hubs" (excellence hospitals) to the "spokes" with the aim of a widespread diffusion of best practices.

## List of abbreviations

HVC = High Volume Centers; HVS = High Volume Surgeon; SHR = Standardized Hospitalization Ratio; ICD-9-CM = International Classification of Diseases – 9<sup>th</sup> revision – Clinical Modification; ME = Median; DRG = Diagnosis Related Groups; CT = Computed Tomography; NMRI = Nuclear Magnetic Resonance Imaging; ORL = Otorhinolaryngology.

## Declarations

### *Ethical approval and consent to participate*

Not applicable.

### *Consent for publication*

Not applicable.

### *Availability of data and materials*

The data was requested to Italian Health Ministry – General Management of health planning – Hospital Discharges data bank.

### *Competing interests*

The Authors declare that they have no competing interests.

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### **Author's contribution**

All of the Authors have read and approved the final manuscript.

SG: participated in the study conception and design and data collection; helped to draft the manuscript.

MG: participated in the study conception and design, helped to draft the manuscript.

RC: participated in data interpretation.

AA: participated in data interpretation.

MS: data analysis.

PC: participated in data interpretation.

TR: participated in data interpretation.

FT: participated in data interpretation and reference collection and analysis.

PNC: participated in data interpretation and reference collection and analysis.

GE: participated in data interpretation and analysis.

SG: participated in the study conception and design, helped to draft and revising the manuscript.

CG: participated in study conception and substantially revised the manuscript for final approving.

### **Aknowledgements**

Not applicable.

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