

Surgeon volume and hospital volume in endocrine neck surgery: how many procedures are needed for reaching a safety level and acceptable costs? A systematic narrative review

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SUMMARY: Surgeon volume and hospital volume in endocrine neck surgery: how many procedures are needed for reaching a safety level and acceptable costs? A systematic narrative review.

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The relationship between quality of care and provider's experience is well known in all fields of surgery. Even in thyroidectomies and parathyroidectomies, the emphasis on positive volume-outcome relationships is believed. It led us to an evaluation of volume activity's impact in terms of quality of care.

A systematic narrative review was performed. According to the

PRISMA criteria, we selected 87 paper and, after the study selection was performed, 22 studies were finally included in this review.

All articles included were unanimous in attributing to activity volume of surgeons as well as centers a substantial importance. Some differences in outcomes between these investigated categories have been found: best results of the high volume surgeon is evident especially in terms of complications, on the contrary best outcomes of a high volume center are mainly economics, such as hospital stay and general costs of the procedures.

A cut-off of 35-40 thyroidectomies per year for single surgeon, and 90-100 thyroidectomies for single center appears reasonable for identifying an adequate activity. Concerning parathyroidectomy, we can consider reasonable a cut off at 10-12 operations/year. More studies are needed in a European or more circumscribed perspective.

KEY WORDS: Thyroidectomy - Parathyroidectomy - High volume surgeon - High volume hospital.

Introduction

The strict relationship between quality of care and provider's experience was underlined until late 1970 by Luft et al. (1). Nowadays Endocrine Surgery is a distinct sub-specialty of general surgery dedicated to surgical treatment of thyroid, parathyroid and adrenal glands' disease and gastrointestinal and pancreatic neuroendocrine tumors. The advantages given from the sub-specialisation of a surgeon and/or a center are commonly accepted and a number of manuscripts concerning this aspect have been pub-

lished in the last decade (2-5). Since the improving in outcomes of high volume hospitals and surgeons was demonstrated in several studies, there is a worldwide trend towards a centralization of endocrine surgery procedures (4). The surgeons who had a specific interest for the surgical treatment of endocrine disorders founded the American Association of Endocrine Surgeons [AAES] in the early eighties. Since then, during the decades, several national and continental endocrine surgery societies were born (6-10). Some societies, such as AAES, created a fellowship for improving a specific training. At the same time, the European Union of Medical Specialists has arranged certification examinations in ES and, more recently, in Endocrine Neck Surgery (ENS) (11). Despite all these efforts in improving the training of Endocrine Surgeons, their real advantage is still unknown, anyway the emphasis on positive volume-

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outcome relationships is widely believed. It led us to an evaluation of volume activity's impact in terms of quality of care.

The aim of present review is to fix how many procedures are necessary for achieving optimal results in ENS (thyroid and parathyroid) and which specific outcomes are influenced by a high volume surgeon and hospital.

Methods

The systematic narrative review of the present manuscript is fully compliant with PRISMA criteria (12). According to these guidelines, the selection of the studies included in the present review has been conducted as follow.

Literature search strategy

An electronic literature review was performed on MEDLINE by using the medical subject headings (MESH) "high volume", "endocrine surgery" with the Boolean operator *and*. Three independent investigators (GM, CP, and RG) performed this research. The publications in English language of the past fifteen years were systematically included but the commonly referenced and/or highly regarded older publications were also considered. We also searched reference lists of articles identified by this search strategy and selected those we judged relevant.

Selection criteria

We took into consideration clinical trials, reviews and meta-analyses that investigate about surgeon and hospital volume, hospital costs, length of stay, survival as regards as *thyroid(ectomy)* and *parathyroid(ectomy)*.

Study selection

Eighty-nine papers were found according to this search strategy.

In the first stage, all titles and abstracts were read and selected according the mentioned selection criteria, and 16 abstracts were then excluded. Seventy-three articles were selected for further reading. We excluded 45 papers that did not meet quality criteria or evaluated a too small sample.

In this second stage, some full text was also obtained for relevant papers, as well as any citations for which a decision could not be made from the abstract.

Final decision regarding inclusion were based after reading full article and 28 papers was considered eligible for this review. Finally, 22 articles were selected.

We did not perform a metaanalysis of the collected data due to extreme variability of the samples, methods of data collection, subjects investigated and outcomes evaluated.

The search process was performed as in Figure 1.

Results

Among articles included in this review, surgical interventions/year threshold needed for reaching good outcomes in endocrine surgery procedures varies in accordance with the type of procedure (thyroidectomy, parathyroidectomy). Moreover, the cut-off to identify high volume surgeons differ from those stated for high volume centers. In these articles, we also found differences in outcomes (complications, costs, appropriateness or completeness of the procedure performed, recurrence rate). Concerning thyroidectomy, this cut-off ranges from ≥ 23 thyroidectomies/year per surgeon to ≥ 100 (13-16) thyroidectomies per surgeon. Some authors adjusted surgeon's volume per case-mix and calculated volume across a fixed period (6 years) (17). Minimum hospital volume needed for reaching a satisfying level of safety is less clear and ranges from 50 and 200 procedures per year (4, 18). These boundaries appear arbitrary, although reasonable, in some cases (14, 16). In other papers, it was stated on the basis of the number of thyroidectomies performed per year, as mean of cases number performed each year for each individual surgeon, for these years in which that surgeon performed at least one thyroid surgery procedure. (13, 15). A study recently published from Al-Qurayshi and coll. was led on the basis of American inpatients database sample (NIS) that involves about 8 million of hospital stays of around 1000 hospitals as a sample representative of 20% of community hospital in USA. Then, over 77.000 discharges corresponding to DRGs concerning the thyroid surgery were involved. On the basis of thyroidectomies performed per each year, surgeons were classified into low-volume (\leq 25th percentile: 1-3 thyroidectomies per year), intermediate volume (from 26th to \leq 75th percentile, 4-29 thyroidectomies per year) and high volume ($>$ 75th percentile, 30 or more thyroidectomies per year). Several potential biases, such as sex, race, age, socioeconomic

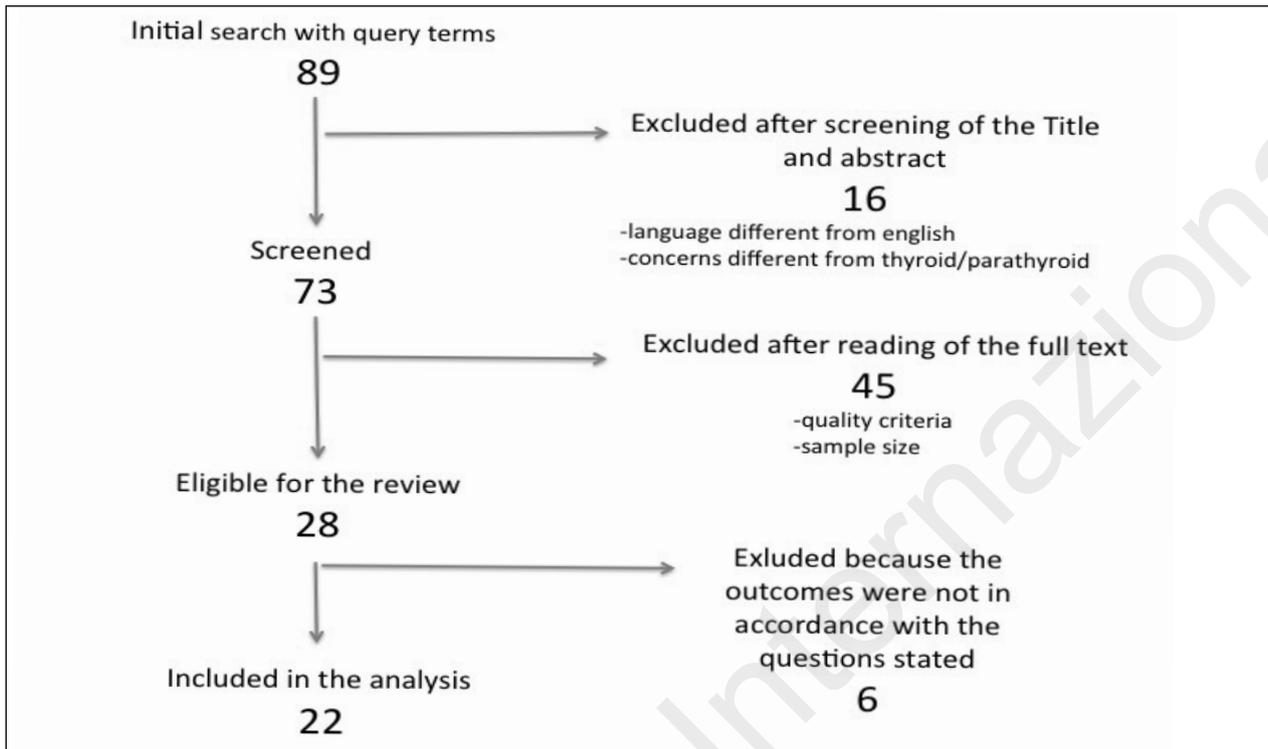


Figure 1- Search process.

characteristic, payers of health care services, obesity and other comorbidities, extent of surgical operation (unilateral, bilateral, neck dissection) hospital characteristics were also taken into account. This study showed that the complications' rate and even costs decrease significantly if the thyroid surgery is performed by higher volume surgeons (19). Adam et al. (20) used a multivariate logistic regression model with restricted cubic splines (RCS) to estimate the association between annual surgeon volume and incidence of the complications. This statistic model draws a flexible function with robust behaviour at the tails of predictor distributions. The use of this model was aimed to fix the range of annual surgeon volumes corresponding to a change in the relative log odds of experiencing any postoperative complication. This is the first study in which a statistical method has been used for establish activity volume threshold that resulted in 26 or more cases per year (21). In a study conducted at the Kaiser Permanente Northern California and Kaiser Permanente Southern California regions, nearly 200 surgeons that operated more than 15.000 patients from 2008 to 2013 for thyroid diseases were involved. Surgeons were categorized at first into three groups (low, intermediate and high volume) because of the dubi-

ousness in providing exactly the cut-off between low and high-volume. Then, surgeons' allocation in a specific group were done by creating similar volumes of patients as much as possible. The three resulting groups were low-volume (≤ 20 procedures per year), intermediate volume (21-40) and high volume surgeons (> 40 procedures per year). Afterwards, only patients operated by low and high volume surgeons were taken into consideration, and then matched for avoiding biases linked to differences between two series. The study showed advantages in favour of high volume surgeons in terms of length of surgery, length of stay, outpatient procedures rate and 30-days all cause readmission rate, but no significant changes in terms of specific complications (22). Only a few studies have been done outside the USA: in a systematic review and meta-analysis conducted in Taiwan, annual surgeon volume was categorized into dichotomous variable that were set by dividing the whole study population in two halves. Therefore, the exact cut-off were determined each study year, steadying around 70 cases per year. This study showed significant advantages of the high volume surgeon's group in terms of costs, length of stay but not in mortality rate (23). In a study from Nouraei et al., surgeon volume was calculated by dividing to-

tal number of thyroidectomies performed by an individual surgeon and number of years of specific activity. So, low volume (<10 thyroidectomies per year) and high volume surgeons (>50 thyroidectomies per year) categories were compared in a study involving more than 72.000 procedures performed between 2004 and 2012. Even in this study, patients' advantages operated by high volume surgeons were evident in terms of complication's rate and length of stay (24). One more study involving more than 147.000 patients from 2000 to 2009 concerned specifically neck hematoma following thyroid and parathyroid surgery. In this study, surgeons were classified into three categories and the advantages of high volume surgeons (100 or more thyroidectomies) were significant in comparison with low-volume ones (<10 procedures per year) (25). In a study focused on thyroid carcinoma outcomes, Adkisson et al. grouped surgeons into narrow thresholds of thyroidectomies per year: 10, 20, 25, 30, 50 and 100. Surgeons performing more than 30 thyroidectomies per year had better results in terms of completeness of surgical resection (≥ 50 cases/year for advanced cases) (26). Another study compared two groups of surgeons, general versus endocrine surgeons working in the same institution, in terms of surgeon's age, volume, years of practice, specialized training in neck endocrine surgery on postoperative complications (permanent RLN palsy and permanent hypocalcaemia). The study showed that high volume surgeons, performing > 40 procedures per year, have a lower incidence of postoperative complications such as vocal fold palsy and hypocalcaemia compared to general surgeons, performing 5 thyroidectomies per year. Moreover, surgical operations performed in each center resulted more complex in endocrine surgeons group that performed 19,5% of thyroidectomies *and* neck dissections, compared to none neck dissection of general surgeons group. The study also showed that surgeons aged between 35 and 50 years had better performances compared to younger or older colleagues; however, it was not able to define exactly the threshold of procedures needed for achieving optimal results. This *exact* minimum, defining a high volume surgeon, remains unknown (27). The cut-off values for hospital volume do not change in method of definition among the various studies examined compared with the methods for fixing the surgeon's volume ones. Most of the studies that focused advantages of high volume centers in reaching better re-

sults in thyroid surgery highlighted, in particular, an increased incidence of total thyroidectomy, case complexity, and cancer diagnoses (5, 14), a reduced incidence in avoidable reoperations (18), length of stay (23) and need in radioiodine ablative treatment (28). Table 1 summarizes the most relevant studies cited. Briefly, outcomes clearly connected with the hospital volume are mainly economic and managerial (hospital stay, costs). Moreover, a high volume center seem to be more performant in front of complex cases (completeness, reoperations, need of radioiodine ablative treatment). A high volume surgeon seems to be safer, promising a reduced incidence of complications. Concerning threshold for defining a high volume surgeon or centre, in the lack of consensus among the studies taken into consideration, it seems reasonable to fix them in >40-50 and >100-150 respectively for surgeon and hospital. Of course, high volume surgeon's performance should be considered in 7-10 years, whereas hospital volume should match surroundings 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 and more specialistic services are available (29).

Beyond thyroidectomy, parathyroid surgery needs a skilled team for managing cases frequently complex, from initial diagnosis to postoperative follow-up. We found very few studies that specifically concerned parathyroid surgery. High volume thyroid surgeons and centers seem to influence favourably parathyroid surgery results (18). Abdulla et al. categorized hospital volume into five groups, corresponding to rough quintiles: very low (1-4 procedures per year), low (5-9), medium (10-19), high (20-49), and very high (≥ 50). Complications rates (neck hematoma, vocal fold palsy, hypocalcemia) and reoperations decreased in high volume centers, so a realistic target caseload of around 15 cases annually was recommended (30) according to other studies (31). These papers are summarized in Table 2. We are convinced that a skill in endocrine neck surgery is a useful common ground for improving both thyroid and parathyroid surgery results.

Discussion

Results of endocrine neck surgical procedures depend on several factors most of whom (talent of the

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TABLE 1 - HIGH VOLUME THYROID SURGEONS AND HOSPITALS: CUT-OFF AND OUTCOMES.

Author	Patients	HVS	HVC	Outcomes
Mitchell, 2008	189 redo surgeries	-	81	Reoperations
Lifante, 2009	>20.000	-	≥100	Hospital stay Surgery completeness
Gourin, 2010	>21.000	>24	>100	Surgeons: complications Hospitals: completeness complexity
Schuessler, 2013	589 Hospitals	-	>35	Need of radioiodine treatment in cancer
González-Sánchez, 2013	225	>40	-	Complications Surgical complexity
Dehal, 2014	147.000	≥100	-	Neck hematoma
Adkisson, 2014	1249	>30	-	Resection completeness (thyroid cancers)
Adam, 2016	>16.000	≥26	-	Complications
Meltzer, 2016	>15.000	>40	-	Length surgery/stay, Readmission, Outpatient
Al-Qurayshi, 2016	>77.000	>30	-	Complications/Costs
Liang, 2016	>62.000	>70	>200	Length stay Costs Mortality
Nouraei, 2017	>72.000	>50	-	Vocal fold palsy Length of stay

TABLE 2 - HIGH VOLUME PARATHYROID HOSPITALS: CUT-OFF AND OUTCOMES.

Author	Patients	Cut-off	Outcomes
Mitchell, 2008	335	?	Avoidable reoperations
Yeh, 2011	1190	15	Persistence
Abdulla, 2015	17.082	10-20	Complications Reoperations

surgeon, hospital efficiency) are only supposable but not easily assessable. Moreover, only few papers included in this review came from Europe (14, 27), and any of these from Italy. This factor could influence somehow results.

In our personal experience, we observed a decrease of complications during the years of surgical practice (32-38) and slight and momentary new increase after the introduction of new techniques (39, 40), anyway non-significant, and, in the most part of the cases, introduction of new devices led us to a general improvement of results (41, 42). Moreover,

some sequelae of thyroid and parathyroid surgery (swallowing and voice complaints, chronic asthenia) are not related to specific procedure complications, but based on specific pathophysiologic mechanisms (43-46). In times of spending review, the indicators of quality are strongly put under observation. In this perspective, a value-based health care delivery system is needed for improving outcomes reducing, at the same time, costs. This could require an increasing in volume that could lead to a subspecialty surgical service (47). In the present review, all articles we looked up are unanimous in attributing to activ-

ity volume of surgeons as well as centers a substantial importance. Some differences in outcomes between these investigated categories have been found: best results of the high volume surgeon is evident especially in terms of complications, on the contrary best outcomes of high volume centers are mainly economics (hospital stay, general costs of the procedures) (4, 5, 14, 22).

Conclusions

Establishing some criteria to identify high volume surgeon and high volume center is a real need considering three main exigencies of the health delivery system, such as limiting medicolegal claims, reducing costs and improving results. These results can be reached only by specific surgical expertise and a consequent increase in competence of consulting units, first endocrinology unit but also radiology, nuclear medicine, cytopathology, oncology and any specialist involved in care process. A minimum volume of 35-40 thyroidectomies per year for single surgeon, and 90-100 thyroidectomies for single center appears a reasonable cut off for identifying an adequate activity. Concerning parathyroidectomy, which should be performed in high volume hospital for thyroidectomy, we can consider reasonable a cut off at 10-12 operations/year.

More studies developed in different European countries are needed for evaluating if local health delivery systems allow reaching an acceptable performance and if some suggestions could be useful for improving the specific results.

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