The Effect of Duty Hour Regulation on Resident Surgical Case Volume in Otolaryngology
Stuart H. Curtis, Robert H. Miller, Cindy Weng and Richard K. Gurgel

Otolaryngology -- Head and Neck Surgery 2014 151: 599 originally published online 18 August 2014
DOI: 10.1177/0194599814546111

The online version of this article can be found at:
http://oto.sagepub.com/content/151/4/599

Published by:
SAGE
http://www.sagepublications.com

On behalf of:
AMERICAN ACADEMY OF
OTOLARYNGOLOGY--
HEAD AND NECK SURGERY

American Academy of Otolaryngology- Head and Neck Surgery

Additional services and information for Otolaryngology -- Head and Neck Surgery can be found at:

Email Alerts: http://oto.sagepub.com/cgi/alerts
Subscriptions: http://oto.sagepub.com/subscriptions
Reprints: http://www.sagepub.com/journalsReprints.nav
Permissions: http://www.sagepub.com/journalsPermissions.nav

>> Version of Record - Oct 1, 2014
OnlineFirst Version of Record - Aug 18, 2014
What is This?
The Effect of Duty Hour Regulation on Resident Surgical Case Volume in Otolaryngology

Stuart H. Curtis, MD¹, Robert H. Miller, MD², Cindy Weng³, and Richard K. Gurgel, MD¹

Sponsorships or competing interests that may be relevant to content are disclosed at the end of this article.

Abstract

Objective. Evaluate the effect of duty hour regulation on graduating otolaryngology resident surgical case volume and analyze trends in surgical case volume for Accreditation Council for Graduate Medical Education (ACGME) key indicator cases from 1996 to 2011.

Study Design. Time-trend analysis of surgical case volume.

Setting. Nationwide sample of otolaryngology residency programs.

Subjects. Operative logs from the American Board of Otolaryngology and ACGME for otolaryngology residents graduating in the years 1996 to 2011.

Methods. Key indicator volumes and grouped domain volumes before and after resident duty hour regulations (2003) were calculated and compared. Independent t test was performed to evaluate overall difference in operative volume. Wilcoxon rank sum test evaluated differences between procedures per time period. Linear regression evaluated trend.

Results. The average total number of key indicator cases per graduating resident was 440.8 in 1996-2003 compared to 500.4 cases in 2004-2011, and overall average per number of key indicators was 31.5 and 36.2, respectively (P = .067). Four key indicator cases showed statistically significant (P < .05) increases in volume after duty hour implementation. General/pediatrics was the only grouped domain to show a significant increase. In contrast, the rate of change in operative volume decreased post duty hour for only 2 key indicators (P < .05). The year-by-year trend in average operative volume showed significant increases for 5 key indicator cases (P < .05).

Conclusion. Implementation of the 2003 duty hour regulations has not reduced total volume of key indicator cases for graduating otolaryngology residents. The overall trend in operative volume is increasing for several specific key indicators.

Keywords
resident duty hours, otolaryngology, case volume, key indicators

Received September 18, 2013; revised June 13, 2014; accepted July 15, 2014.

Introduction

In 2003, the Accreditation Council for Graduate Medical Education (ACGME) implemented a duty hour mandate that placed limits on resident work hours. Since the implementation of the duty hour standards, there has been ongoing debate over balancing resident work hours for patient safety and resident well-being versus maximizing the learning experience for medical trainees. While reducing resident work hours theoretically decreases provider sleep deprivation and fatigue, thus increasing patient safety, it is conceivable that limiting the resident work hours comes at the expense of education in addition to patient safety concerns with the increased number of patient handoffs.1-6 The debate has intensified with the implementation of stricter duty hour regulations in July 2011.7,8

How has duty hour reform affected training in surgical specialty residency programs? In surgical education programs, residents’ training and experience can be measured in part by the number of procedures performed during their training period. Many studies have assessed the impact of...
the ACGME duty hour policy on resident operative experience in a variety of surgical specialties.\textsuperscript{9-15} Reports evaluating general surgery have shown a decrease in case volume since duty hour reform.\textsuperscript{10,12-14,16} Other studies have shown mixed results in various surgical specialties with resident operative volume increasing in some and decreasing in others.\textsuperscript{9,10}

What has been the effect of duty hour regulations on otolaryngology residents? While some subjective surveys have shown improved resident morale, many still feel that duty hour reform has had a negative impact on resident training, or at least has not resulted in the improvements anticipated.\textsuperscript{1,7-19} Intrinsic to this sentiment is the notion that operative volume of residents has diminished as a result of less time in the hospital. To our knowledge there has not been a study directly addressing this issue. Darrat et al\textsuperscript{20} observed an increase in otolaryngology resident operative volume from 2004 to 2011; however, their report did not compare post–duty hour reform case volume to pre–duty hour reform case volume. The purpose of our study was to evaluate the effect of the 2003 duty hour regulations on graduating otolaryngology resident surgical case volume by comparing 8 years pre and post 2003 duty hour regulation and to analyze trends in surgical case volume for each of the ACGME key indicator cases from 1996 to 2011.

Methods

Institutional review board approval was formally waived because the data analyzed are either de-identified or publically accessible. We obtained de-identified operative logs for otolaryngology residents graduating in the years 1996-2011. During this time period, data on operative case volumes were kept by 2 different organizations. For the years 1996-2004 operative logs were reported to and maintained by the American Board of Otolaryngology (ABOto), and from 2005-2011 the data were reported to and maintained by the ACGME Residency Review Committee (RRC) for otolaryngology. Permission to use both ACGME and ABOto operative volume data was obtained. In order to publish the data, the ACGME and ABOto required that the specific operative procedures be de-identified and randomly labeled alphabetically.

Beginning in 2006, the ACGME reported national resident operative case volume statistics corresponding to procedures performed in several different areas, or “key indicators.” The key indicators are a metric utilized by the RRC to assess surgical experience of residents at individual training programs. The 2009 key indicators classification applied retrospectively for this study separated cases into 4 categories and can be found in Table 1 along with the Current Procedural Terminology (CPT) codes included for each of the various procedures.

The 2009 key indicator categories reflect a change from the 3 previous years in respect to the category of general/pediatrics. Initially this category contained the following cases: direct laryngoscopy (pediatric), direct laryngoscopy with intervention (pediatric), ethmoidectomy, bronchoscopy, and tracheostomy (<2 years). The categories were subsequently changed to the following: airway (pediatric and adult), congenital neck masses, ethmoidectomy, and bronchoscopy.

The mean and median number of procedures performed by graduating otolaryngology resident physicians for each of the key indicators were collected for analysis. For years where the key indicator totals were not provided, each key indicator case volume was calculated using the CPT codes provided by the ACGME and summing the individual values for each CPT code within a given procedure. Starting in 2005, the CPT codes were no longer listed with the procedure name on the operative logs. For these years, the name of the procedure for each CPT code was found using the AMA CPT CodeManager.\textsuperscript{21} The procedure names were searched and the number of procedures summed. The majority of the data for the key indicators was reproducible from the CPT codes; however, there were 11 data points where uncertainty in totals prompted omission of these points in the statistical analysis.

To compare pre– and post–duty hour restriction time periods, a division point between the 2003 and 2004 academic years was selected. This was done because the duty hour regulations began after the end of the 2002-2003 academic year and began with the 2003-2004 academic year. The pre–duty hour period comprised data from the years 1996-2003 and the post–duty hour period comprised years 2004-2011.

Descriptive statistics using mean and standard deviation was used to describe the average number of operative cases per resident. Independent \textit{t} test was performed; otherwise, Wilcoxon rank sum test was used to evaluate the average change of operative volumes between 2 cohorts. Trend analysis was performed using multivariate general linear regression to examine the slope of the change in both cohorts. The effect of duty hours was adjusted in the model and the effect of duty hours by years of study interaction was adjusted in the model. Multiple comparison adjustment using Bonferroni method was applied to examine the effect of duty hours between 2 cohorts for individual key indicators. Two key indicator cases, procedure B and procedure E, were not examined using regression method due to missing observations for post–duty hour time periods. Key indicators were also analyzed according to their specific domains: head and neck, otology/audiology, facial plastics and reconstructive surgery, and general/pediatrics (see Table 1). Individual key indicators were averaged and then summed for each domain classified by pre– and post–duty hour time periods. A \textit{t} test and general linear regression (GLM) was performed to estimate difference between pre and post duty hours for each domain. Statistical significance was set at \(P < .05\). All of the statistical analysis was done using SAS 9.2 (SAS Inc, Cary, North Carolina).

Results

The mean total number of key indicator cases per graduating resident was 440.8 in 1996-2003 compared to 500.4 cases in 2004-2011, and the average number of key indicator cases (total key indicator cases divided by the number of key indicators categories for a given year) was 31.5 in 1996-2003 compared to 36.2 in 2004-2011 (\(P = .067\)) (Table 2). When evaluating year-to-year changes with a general linear regression method, the average difference between total number of operative cases was slightly
increased by 4.56, though not statistically significant (95% confidence interval [CI], –0.42 to 9.54, \(P = .073\)).

Analysis of each individual key indicator revealed several procedures with significant differences in pre– and post–duty hour time periods. There was a statistically significant increase in the number of key indicators performed for procedure C (\(P = .001\)), procedure F (\(P = .032\)), procedure K (\(P = .024\)), and procedure I (\(P = .001\)). There was no significant difference in the remaining key indicators when comparing the pre– and post–duty hour periods (Table 2).

Year-by-year trend analysis using multivariate general linear regression to examine the slope of the change in average number of key indicator cases per year was increased with an estimate of 1.13 (95% CI, 0.06-2.21, \(P = .039\)). Year-by-year trend analysis also showed increases in slope for procedure C (\(P = .017\)), procedure F (\(P = .001\)), procedure K (\(P = .001\)), procedure I (\(P = .001\)), and procedure M (\(P = .013\)) (Figure 1). Year-by-year trend analysis showed decreases in slope for procedure A (\(P = .011\)) and procedure H (\(P = .023\)) (Figure 2).

Analysis by domain showed a significant change in the number of procedures for general/pediatrics, which increased by 17.68 (95% CI, 4.83-30.51, \(P = .0079\)). Head and neck increased by 5.92 (95% CI, –2.87 to 14.71, \(P = .1834\)) but was not statistically significant (Figure 3). Otology/audiology and facial plastics and reconstructive surgery both decreased, –0.40 (95% CI, –6.88 to 6.072, \(P = .9008\)) and –2.13 (95% CI, –8.13 to 3.87, \(P = .4792\)), respectively; however, these changes were not significant.

**Discussion**

In 1984, Libby Zion, an 18-year-old college student, died in a New York Hospital ward in Manhattan due to a lethal drug interaction resulting in serotonin syndrome and cardiac arrest. Her death has largely been attributed to a medical error caused by a fatigued resident. This event was a catalyst in instigating duty hour regulation, first in New York and subsequently nationwide, in an attempt to reduce resident work hours and improve patient care. The AGCME implemented duty hour regulations in 2003. Since that time,
residents at ACGME-accredited programs are limited to work a maximum of 80 hours in a given week in addition to other specific rules that regulate shift duration and time between shifts. These restrictions have required training programs to make significant changes in resident workflow such as the institution of home call or night float systems, assigning responsibilities to residents on research rotations, and the hiring of physician assistants and nurse practitioners.23

Further duty hour limitations were imposed in 2011 with the goals of minimizing resident fatigue and improving patient safety. Changes included limiting interns (postgraduate year [PGY] 1) to a maximum of 16 consecutive hours on duty and PGY 2 and above to a maximum of 24 consecutive hours. Minimum time off between duty periods was set at 8 hours, except for certain circumstances during the final year of residency. Changes also included counting

---

### Table 2. Descriptive Statistics for Pre– and Post–Duty Hour Cohorts.\(^a\)

<table>
<thead>
<tr>
<th>Key Indicator Procedure</th>
<th>1996-2003</th>
<th>2004-2011</th>
<th>(P) Value(^b)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Average total key indicator</strong> (total key indicator case volume/number of key indicators per year)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>n</td>
<td>Mean (±SD)</td>
<td>n</td>
</tr>
<tr>
<td>A(^c)</td>
<td>8</td>
<td>34.6 (±17)</td>
<td>7</td>
</tr>
<tr>
<td>B(^c)</td>
<td>8</td>
<td>28.6 (±6.5)</td>
<td>4</td>
</tr>
<tr>
<td>C(^c)</td>
<td>8</td>
<td>60.0 (±6.9)</td>
<td>7</td>
</tr>
<tr>
<td>D</td>
<td>8</td>
<td>9.0 (±1.9)</td>
<td>8</td>
</tr>
<tr>
<td>E(^c)</td>
<td>8</td>
<td>9.9 (±2.9)</td>
<td>4</td>
</tr>
<tr>
<td>F</td>
<td>8</td>
<td>54.4 (±6.6)</td>
<td>8</td>
</tr>
<tr>
<td>G</td>
<td>8</td>
<td>16.3 (±1.1)</td>
<td>8</td>
</tr>
<tr>
<td>H</td>
<td>8</td>
<td>27.1 (±6.5)</td>
<td>8</td>
</tr>
<tr>
<td>I</td>
<td>8</td>
<td>26.9 (±7.2)</td>
<td>8</td>
</tr>
<tr>
<td>J</td>
<td>8</td>
<td>51.1 (±5.3)</td>
<td>8</td>
</tr>
<tr>
<td>K</td>
<td>8</td>
<td>18.1 (±2.0)</td>
<td>8</td>
</tr>
<tr>
<td>L</td>
<td>8</td>
<td>34.2 (±2.3)</td>
<td>8</td>
</tr>
<tr>
<td>M(^c)</td>
<td>8</td>
<td>29.1 (±2.5)</td>
<td>7</td>
</tr>
<tr>
<td>N</td>
<td>8</td>
<td>41.5 (±3.0)</td>
<td>8</td>
</tr>
</tbody>
</table>

\(n = \) the number of years with data available for analysis, and SD is the standard deviation.

\(^b\)Multiple comparison adjustment using Bonferroni method was applied.

\(^c\)Missing data during 2004 to 2011 academic year.

\(^d\)Indicates Wilcoxon rank sum test was performed; otherwise, independent \(t\) test.

---

![Figure 1. Trend for overall number of averaged key indicators cases per year. Also shown are key indicators that had a statistically significant trend (\(P < .05\)).](image1)

![Figure 2. Overall number of key indicators cases and de-identified key indicators with a statistically significant difference (\(P < .05\)) in rate of change between pre– and post–duty hour periods.](image2)
time moonlighting, both internal and external, toward the 80-hour work week. The reported effectiveness of the new duty hour regulations, however, has been mixed. In a study by Sen et al, residents reported no difference in well-being, depressive symptoms, and hours slept since the implementation of the 2011 duty hour restrictions. The study did however report an increase in self-reported medical errors. Additionally, the number of patient handoffs has increased in consequence of decreased duty hours, a practice that has inherent potential for communication errors.

Surgical residencies rely heavily on time in the operating room to teach the technical skills and intraoperative judgment necessary for competent, independent practice. There is a concern that surgical fields are uniquely impacted by duty hour regulations. Mattar et al illustrated this concept in a survey study administered to 91 subspecialty program directors who assessed the adequacy of general surgery training in preparing residents for fellowships. Survey responses showed that 21% of program directors felt new fellows arrived inadequately prepared for the operating room, and up to 66% felt they were unable to operate unsupervised for 30 minutes. Concerns were seen in various aspects of surgical training and also in the fellow’s ability to conduct research.

The reported impact of duty hour regulations on resident operative volume has been variable. In many surgical training programs, the decreased surgical time has been a limiting factor in the number of procedures residents have been able to complete during their training. Simien et al evaluated the operative log data for general surgery, plastic surgery, and urology 5 years after duty hours were instituted compared to the year prior. They found that within general surgery, there was an increase in case volume in some categories, while other categories showed a decrease. Urology showed an increase in operative volume, and plastic surgery remained the same. Evaluating a single institution’s experience, Watson et al reported on the effects of the 80-hour work week in general surgery by comparing 15 years prior to regulation and 5 years after and found that the total number of procedures performed at the hospital yearly increased; however, “major cases” and PGY 5 cases decreased. Similar results were found in other general surgery residencies as well as in an obstetrics and gynecology residency program. In contrast, a study by Baskies et al looking at orthopedic operative volume showed an increase in procedures performed post duty hour implementation. Overall, it appears that duty hour reform has had a variable impact on different surgical specialties.

Our results correlate with studies done by other surgical specialties showing an increase in the overall average number of procedures performed by residents during the post-duty hour time period. While the increase in overall average number of procedures performed during each time period was not statistically significant, the overall, linear year-by-year positive trend was significant. This was observed with an increasing trend in 5 key indicators, no change in 7 indicators, and a negative change in trend for 2 indicators.

A number of factors may contribute to the positive trend in average case volume per resident in otolaryngology. The increase might be due to the natural course of medicine within this specialty independent of duty hour regulation. As institutions grow and expand with increasing populations and specialty needs, more procedures become available to residents. Duty hour regulation itself may have also contributed to increased procedure availability. With the implementation of resident duty hours, institutions may have taken on additional ancillary staff to cover for resident time deficiencies, thus providing a larger infrastructure and volume capacity. Resident time that may have been allocated to outpatient clinics before duty hour restriction and may now be shifting to the operating room. This is a potential concern as most practicing otolaryngologists will spend more time in the clinic than the operating room. During this time period, there may have been an increased emphasis on unbundling cases, which is the practice when multiple key indicator cases are generated from 1 patient’s surgery. Unbundling a sinus surgery, for example, allows residents to code ethmoidectomies for both sides of the nasal cavity operated on. This practice is only used for resident case reporting only, as it is illegal to do this for billing purposes. Institutional focus on meeting case numbers within the key indicators may also result in this increase in key indicator cases while not an actual increase in total case volume.

Two key indicators experienced significant reductions in trend post duty hours. Other key indicators showed reductions in the number of procedures performed; however, these decreases were not statistically significant. A reduction in hours available for residents may have led to less participation in cases of longer duration and the preferential selection of certain cases over others. Aside from the direct effects of duty hour regulation, national trends for certain procedures may also play a role in changing resident surgical case volume. For example, it has been reported that the total number of stapes surgery being performed has decreased nationally, which undoubtedly could impact on academic medical centers and resident training.

**Figure 3.** Box-plot diagram of the distribution of the average number of procedures for each domain classified by pre- and post-duty hour time periods.
As noted previously, the ACGME implemented new duty hour restrictions in 2011. While our data indicate that resident case volume has not been negatively affected by duty hour regulation, this may not be the case if duty hours continue to be decreased. Ultimately, there will be a “breaking point” at which further work hour restrictions will negatively impact resident operative experience.

A limitation of this study is that operative case log data were compiled by 2 different entities—the ABOto and ACGME—during the time period evaluated. This problem is minimized, however, by the fact that the type of data that were collected by both agencies were very similar, namely, a parotidectomy, neck dissection, mastoidectomy, or any other key indicator was the same in 1996 as it was in 2011 or any of the other dates evaluated. Moreover, the data were collected in a similar fashion by graduating otolaryngology residents from accredited training programs. Another potential limitation of the study was that key indicator data from a majority of the years had to be constructed by summing the individual CPT codes that comprised each key indicator. Summary key indicator data were not provided until 2006, and ensuing changes led to some missing data and were thus omitted from analysis.

This study is also subject to errors in resident operative case log data entry. Residents may not reliably record case logs or may record in a delayed fashion, which make the data subject to recall bias. Residents may also record procedures and CPT codes inaccurately. Among different otolaryngology residencies, large discrepancies in resident operative volume have been reported. While this may simply reflect differences in training experience at different institutions, it also raises the possibility of variable reporting. Variable reporting among institutions should have minimal effect on the results of this study, however, since the same institutions were included each year and followed longitudinally.

Conclusions

Based on the data presented in this study, implementation of the 2003 ACGME duty hour regulations has not reduced the total volume of key indicator cases for graduating otolaryngology residents. Many specific key indicator operative volumes have increased, and only 2 key indicator cases have shown a significant decrease in trend in the post-duty hour period from 2003 to 2011. Though the impact of duty hour reform remains unclear for many aspects of residency training in otolaryngology, these results indicate that concerns about a decreasing operative case volume may be unwarranted.

Author Contributions

Stuart H. Curtis, data analysis, drafting, final approval; Robert H. Miller, data analysis, drafting, final approval; Cindy Weng, data analysis, drafting, final approval; Richard K. Gurgel, data analysis, drafting, final approval.

Disclosures

Competing interests: Robert H. Miller, ex officio member of the ACGME RRC for otolaryngology.

Sponsorships: None.

Funding source: In part from the National Center for Research Resources and the National Center for Advancing Translational Sciences, National Institutes of Health, through Grant 8UL1TR000105. Statistical design and analysis was done with collaboration from the University of Utah Study Design and Biostatistics Center, which is funded in part by the aforementioned entities.

References


