Surgeon Dependent Variation in Adenotonsillectomy Costs in Children

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What is This?
Surgeon Dependent Variation in Adenotonsillectomy Costs in Children

Jeremy D. Meier, MD1, Melanie Duval, MDCM, MSc1, Jacob Wilkes2, Seth Andrews, MBA3, E. Kent Korgenski, MS, MT2, Albert H. Park, MD1, and Rajendu Srivastava, MD, MPH4

Abstract

Objectives. To (1) identify the major expenses for same-day adenotonsillectomy (T&A) and the costs for postoperative complication encounters in a children’s hospital and (2) compare differences for variations in costs by surgeon.

Study Design. Observational cohort study.

Setting. Tertiary children’s hospital.

Subjects and Methods. A standardized activity-based hospital accounting system was used to determine total hospital costs per encounter (not including professional fees for surgeons or anesthetists) for T&A cases at a tertiary children’s hospital from 2007 to 2012. Hospital costs were subdivided into categories, including operating room (OR), OR supplies, postanesthesia care unit (PACU), same-day services (SDS), anesthesia, pharmacy, and other. Costs for postoperative complication encounters were included to identify a mean total cost per case per surgeon.

Results. The study cohort included 4824 T&As performed by 14 different surgeons. The mean cost per T&A was $1506 (95% confidence interval, $1492-$1519, with a range of $1156-$1828 for the lowest and highest cost per case per surgeon; P <.01). Including the cost for postoperative complications, the mean cost increased to $1599 ($1570-$1629). The largest cost categories included OR (31.9%), SDS (28.1%), and OR supplies (15.6%).

Conclusion. A large portion of T&A expenses are due to OR and supply costs. Significant differences in costs between surgeons for outpatient T&A were identified. Studies to understand the reasons for this variation and the impact on outcomes are needed. If this variation does not affect patient outcomes, then reducing this variation may improve health care value by limiting waste.

Keywords
tonsillectomy costs, surgeon variation

Variation in health care delivery occurs within and across providers, hospitals, and regional levels in the United States. Variation not explained by the type or severity of illness, patient preference, or the dictates of evidence-based medicine is defined as unwarranted variation. Unwarranted practice variation can lead to waste by increasing health care costs without improving patient health outcomes.

Adenotonsillectomy (T&A) is the most common major operation performed in children in the United States. More than 500,000 children undergo this procedure annually. Variation in tonsillectomy management is not new. In 1938, Glover identified a 10-fold difference in tonsillectomy incidence between different communities in the United Kingdom without any justifiable explanation. In 1973, Wennberg and Gittelsohn identified a similar 10-fold variation between communities in Vermont.

Today, despite national guidelines published by the American Academy of Otolaryngology—Head and Neck Surgery regarding the indications, preoperative workup, and perioperative management for children considered for tonsillectomy, significant practice variation remains. A recent study identified a 4-fold difference in tonsillectomy rates between different geographic regions of the country. The Pediatric Health Information System (PHIS) database contains detailed administrative and billing data from 43 children’s hospitals. A retrospective cohort study using the PHIS database identified tonsil and adenoid hypertrophy as the second most prevalent and ninth most costly pediatric inpatient condition. Surprisingly, this very prevalent condition had one of the

1Division of Otolaryngology—Head and Neck Surgery, University of Utah School of Medicine, Salt Lake City, Utah, USA
2Intermountain Healthcare, Pediatric Clinical Program; Department of Pediatrics University of Utah School of Medicine, Salt Lake City, Utah, USA
3Primary Children’s Hospital, Salt Lake City, Utah, USA
4Department of Pediatrics, University of Utah School of Medicine, Salt Lake City, Utah, USA

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Corresponding Author:
Jeremy D. Meier, MD, Assistant Professor, Division of Otolaryngology—Head and Neck Surgery, University of Utah, 50 North Medical Dr, Room 3C120, Salt Lake City, UT 84132, USA.
Email: jeremy.meier@imail.org
highest variations in costs per encounter of all conditions examined in this study. However, this study could not assess differences in costs or differences between surgeons.

The purpose of this study is to identify the major expenses for same-day T&A in a children’s hospital and evaluate differences between surgeons in costs per encounter at a single children’s hospital. Intermountain Healthcare (IH) is a not-for-profit, integrated health care system serving the Intermountain West that includes Primary Children’s Hospital (PCH), a tertiary care children’s hospital. Intermountain Healthcare maintains a large Enterprise Data Warehouse (EDW) that contains administrative, financial (including both costs and charges), and clinical data. The EDW is unique from many other databases containing financial data because it also contains clinical information in addition to hospital costs and not simply charges.

Methods

Subjects/Participants

This study was approved by the Institutional Review Boards at the University of Utah and IH. The EDW was queried for PCH encounters with International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM) procedure code 28.3 (tonsillectomy with adenoidectomy) for patients 1 to 18 years of age between January 1, 2007, and December 31, 2012. Subjects with additional ICD-9-CM procedure codes during the T&A encounter were excluded to ensure that patients undergoing additional procedures (eg, tympanostomy tubes, turbinate reduction, etc) during that encounter were excluded in the analysis. At PCH, patients can present for T&A with plans for same-day discharge, overnight observation, or planned inpatient admission. To limit confounding factors secondary to medical complexity, only patients listed as same-day discharges were included in the study cohort. In addition, 2 surgeons having performed respectively 1 and 4 T&A procedures over the specified period were excluded from the analysis since the number performed was too low to accurately estimate their average cost and complication rate.

Costs

Data collected included the total hospital cost of the encounter to IH adjusted to December 2012 dollars using the Bureau of Labor Statistic’s Seasonally Adjusted Consumer Price Index for All Urban Consumers (CPI) Medical Care inflation rate. Costs were subdivided into categories within the EDW of (a) operating room (OR), (b) OR supplies, (c) postanesthesia care unit (PACU), (d) same-day services (SDS), (e) anesthesia (not including professional fees), (f) pharmacy, and (g) other. Operating room supplies include only those greater than $25. Individual supplies less than $25 are bundled and included in the OR costs. Physician costs were not available and not included since these are contracted and billed separately from the hospital. The operative time (minutes) and time in the OR for each procedure were also collected.

Complications and/or T&A-Related Complication Visits

Approximately 85% to 90% of pediatric hospital admissions in Salt Lake County occur at PCH. However, to identify as many complications as possible, an EDW query was performed to identify patient encounters at any of the 22 IH hospitals that occurred within 21 days of the initial operation. These encounters included emergency department (ED) visits (including observation unit visits) or readmissions to any of the hospitals and operations for control of posttonsillectomy hemorrhage. To exclude visits unrelated to the T&A operation, common ICD-9-CM diagnosis codes identified in the cohort were reviewed, and only those deemed related to the adenotonsillectomy were included. Outpatient clinic visits were excluded. The rates of postoperative ED visits, hospital readmissions, and posttonsillectomy hemorrhage were calculated for each surgeon. The costs of these postoperative complication encounters were then averaged over the entire T&A cohort for each surgeon. The mean cost for complications was added to the mean cost per T&A encounter to obtain a mean bundled cost per T&A per surgeon. Analysis of variance was performed to determine significant variation between surgeons as it related to total costs, T&A (including subcategories) costs, and complication encounter costs. Differences in complication rates were determined using χ² analysis. Analysis of variance was used to determine whether there was a difference in costs between the different surgeons. As there were multiple comparisons (17) performed, a Bonferroni correction was applied to the P value, leading to P < .003 (.05/17) being considered the level of significance. All statistical analyses were performed using Stata version 12 (StataCorp LP, College Station, Texas).

Results

A total of 4824 T&A cases performed by 14 surgeons were included in the analysis. Five cases performed by 2 surgeons were excluded and 4 cases were excluded because some cost data were missing. The mean cost per T&A was $1506 (95% confidence interval [CI], $1492-$1519). Table 1 provides a breakdown of means costs per surgeon. By category, OR costs (31.9%) and OR supplies (15.6%) contributed a significant portion to the total hospital costs, with SDS (28.1%) also a major component to the costs. There were significant differences seen across all surgeons for the mean total costs per case in addition to each category (mean operative time, OR and supplies, PACU, SDS, anesthesia, and pharmacy), all P < .001. Mean costs per case among surgeons varied with a range of $1156 ($1142-1170) for surgeon 4 to $1828 ($1690-1967) for surgeon 12 (see Table 1). The category causing the most variation in operative costs was OR and supplies, with supply cost variation directly related to the tonsillectomy technique (Bovie cautery with or without microdebrider adenoidectomy, coagulation, or harmonic scalpel). These costs may vary between institutions based on individual contracts, but instruments
may cost several hundred dollars down to less than $10 for the Bovie cautery.

Complications added an additional $93 per T&A, increasing the total cost per case to $1599 ($1570-$1629). Overall, 372 of 4824 children (7.7%) had at least 1 postoperative complication encounter. In the study cohort, 0.4% had a hospital readmission, and 1.3% were treated in an outpatient observation unit. An additional 5.2% of the study cohort had an ED encounter without readmission or observation. An encounter due to postoperative hemorrhage was identified in 2.9%, with 1.5% of the cohort requiring a procedure to control the hemorrhage. Higher costs for the procedure did not correlate with fewer complications. Table 2 provides a breakdown by surgeon of the postoperative complications with the complication encounter costs. Each surgeon is identified by a consistent number throughout the tables.

**Discussion**

Health care value is defined as the health outcomes achieved relative to the costs spent to provide that care. Therefore, a surgeon attaining equal outcomes while performing the operation at a lower cost provides better valued care. This study demonstrates significant differences between surgeons in the mean costs spent per T&A. Correlating costs with outcomes was not the primary purpose of this study, and our study is likely underpowered to detect differences in these outcomes. However, using perioperative events such as hospital readmissions, ED visits, and hemorrhage rates as outcome measures, significant differences in outcomes were not seen between surgeons. Including the costs for postoperative complications in a total cost per T&A still demonstrated differences in costs between surgeons. The available data did not have patient-reported outcomes, long-term quality-of-life measures, or polysomnogram results. Patient-reported outcome measures would be beneficial for future studies to accurately determine the value of care provided for T&A on an individual provider level from the perspective of the patient and parent/caregiver.

Data from IH are unique by including a standardized cost-based accounting system that does not rely simply on hospital charges. Charge data, while commonly used in the literature for T&A,13,14 are difficult to demonstrate variation in resource utilization since the differences in charges may reflect different payment agreements between hospitals and the various insurers they negotiate with. Cost data allow for a more accurate assessment of actual resources used and avoid overestimating the true hospital-based costs. The costs from postoperative complications were included to obtain an overall cost per T&A case. As policy makers and third-party reimbursement move to more bundled payments for a given problem, understanding the entire cost, including those arising from complications, will become increasingly important. Although the data from our study provide a summary of those costs at our institution, one cannot apply precise dollar amounts to other hospitals because individual

### Table 1. Variation in Costs by Surgeon.

<table>
<thead>
<tr>
<th>Surgeon No.</th>
<th>No. of T&amp;As</th>
<th>Mean Operative Time, min</th>
<th>Preferred Technique</th>
<th>Operating Room, $</th>
<th>Operating Room Supplies, $</th>
<th>PACU, $</th>
<th>Same-Day Services, $</th>
<th>Anesthesia, $</th>
<th>Pharmacy, $</th>
<th>Other, $</th>
<th>Total Cost (95% CI), $</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>575</td>
<td>16.3</td>
<td>O</td>
<td>507</td>
<td>491</td>
<td>159</td>
<td>415</td>
<td>42</td>
<td>119</td>
<td>19</td>
<td>1752 (1720-1784)</td>
</tr>
<tr>
<td>2</td>
<td>362</td>
<td>17.3</td>
<td>E</td>
<td>513</td>
<td>47</td>
<td>155</td>
<td>536</td>
<td>43</td>
<td>171</td>
<td>41</td>
<td>1506 (1461-1551)</td>
</tr>
<tr>
<td>3</td>
<td>131</td>
<td>10.9</td>
<td>E</td>
<td>405</td>
<td>48</td>
<td>171</td>
<td>489</td>
<td>33</td>
<td>164</td>
<td>28</td>
<td>1338 (1268-1408)</td>
</tr>
<tr>
<td>4</td>
<td>1096</td>
<td>13</td>
<td>E</td>
<td>412</td>
<td>38</td>
<td>155</td>
<td>386</td>
<td>34</td>
<td>112</td>
<td>19</td>
<td>1156 (1142-1170)</td>
</tr>
<tr>
<td>5</td>
<td>115</td>
<td>10.2</td>
<td>E</td>
<td>414</td>
<td>4</td>
<td>201</td>
<td>548</td>
<td>35</td>
<td>184</td>
<td>24</td>
<td>1410 (1325-1495)</td>
</tr>
<tr>
<td>6</td>
<td>94</td>
<td>22.8</td>
<td>O</td>
<td>610</td>
<td>191</td>
<td>177</td>
<td>400</td>
<td>50</td>
<td>118</td>
<td>46</td>
<td>1591 (1504-1678)</td>
</tr>
<tr>
<td>7</td>
<td>218</td>
<td>22.1</td>
<td>O</td>
<td>582</td>
<td>206</td>
<td>172</td>
<td>449</td>
<td>48</td>
<td>124</td>
<td>55</td>
<td>1638 (1572-1704)</td>
</tr>
<tr>
<td>8</td>
<td>684</td>
<td>7.9</td>
<td>O</td>
<td>360</td>
<td>420</td>
<td>152</td>
<td>383</td>
<td>30</td>
<td>109</td>
<td>27</td>
<td>1481 (1454-1507)</td>
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<tr>
<td>9</td>
<td>569</td>
<td>21.2</td>
<td>O</td>
<td>594</td>
<td>275</td>
<td>167</td>
<td>414</td>
<td>49</td>
<td>124</td>
<td>74</td>
<td>1697 (1655-1739)</td>
</tr>
<tr>
<td>10</td>
<td>117</td>
<td>18.9</td>
<td>O</td>
<td>544</td>
<td>425</td>
<td>148</td>
<td>419</td>
<td>45</td>
<td>128</td>
<td>22</td>
<td>1728 (1678-1779)</td>
</tr>
<tr>
<td>11</td>
<td>705</td>
<td>17</td>
<td>O</td>
<td>519</td>
<td>255</td>
<td>167</td>
<td>429</td>
<td>43</td>
<td>126</td>
<td>86</td>
<td>1625 (1586-1664)</td>
</tr>
<tr>
<td>12</td>
<td>59</td>
<td>13.7</td>
<td>O</td>
<td>489</td>
<td>430</td>
<td>149</td>
<td>503</td>
<td>42</td>
<td>133</td>
<td>82</td>
<td>1828 (1690-1967)</td>
</tr>
<tr>
<td>13</td>
<td>81</td>
<td>21.3</td>
<td>O</td>
<td>612</td>
<td>260</td>
<td>153</td>
<td>464</td>
<td>56</td>
<td>114</td>
<td>9</td>
<td>1669 (1586-1752)</td>
</tr>
<tr>
<td>14</td>
<td>18</td>
<td>11.7</td>
<td>O</td>
<td>495</td>
<td>431</td>
<td>135</td>
<td>493</td>
<td>43</td>
<td>131</td>
<td>11</td>
<td>1739 (1556-1923)</td>
</tr>
<tr>
<td>Total</td>
<td>4824</td>
<td>15.3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1506 (1492-1519)</td>
</tr>
</tbody>
</table>

% of total cost 31.9 15.6 10.6 28.1 2.7 8.3 2.8

P value <.001 <.001 <.001 <.001 <.001 <.001 <.001 <.001

Abbreviations: CI, confidence interval; E, electrocautery; O, other (electrocautery with microdebrider adenoidectomy, coblation, or harmonic scalpel); PACU, postanesthesia care unit; T&A, adenotonsillectomy.

*P < .003 statistically significant.
supplies and facility depreciation costs will vary between institutions and regions across the United States.

The largest categories for variation in costs between surgeons were OR and supplies costs, accounting for 31.9% and 15.6% of the overall hospital costs. Mean costs for these categories ranged from $360 to $612 per surgeon for OR costs and $4 to $491 per surgeon for OR supplies. The most common T&A surgical techniques in our hospital included instruments such as monopolar cautery with or without the microdebrider, coblator, or harmonic scalpel. All surgeons who used monopolar electrocautery as the primary instrument had a global cost per case below the mean. The more expensive surgeons used an additional instrument, either the coblator, microdebrider (for adenoidectomy), or the harmonic scalpel. Outcomes were not compared between techniques in this study due to small sample size, and we could not definitively identify the instrument used for all cases. The current literature does not identify a technique with clearly superior outcomes.16-19 A prospective double-blind randomized study found statistically significant decreased postoperative pain with coblation tonsillectomy compared with monopolar electrocautery. However, this difference was determined to be clinically insignificant.20 A Cochrane review comparing coblation with other surgical techniques found inadequate evidence to determine whether coblation tonsillectomy is better or worse than other methods with regard to postoperative pain and speed and safety of recovery.16 A meta-analysis did not find any significant advantage of coblation or harmonic scalpel tonsillectomy compared with cold steel or electrocautery tonsillectomy when evaluating operative time, postoperative pain, or bleeding.17 Future studies will be necessary to determine whether improved outcomes (reduced ED visits and improved patient-reported pain scores) for certain techniques justify the additional expense incurred when using more expensive instruments and whether patients are willing to pay for them.

Operative time varied significantly between surgeons. Many assume that faster operative time directly correlates with lower costs. Although operative time does affect overall cost to the facility and there was a trend for faster surgeons to have lower overall costs, the fastest surgeon did not have the lowest cost. Some might expect the shorter operative times to lead to reduced costs. However, the reduced operative time does not appear to overcome the cost of more expensive instruments and does not dramatically decrease the costs. PCH serves as a tertiary care children’s hospital but is staffed by academic otolaryngologists who frequently have residents assisting in the operation as well as community otolaryngologists who operate independently. Undoubtedly, some of the variation in operative time is accounted for by resident involvement. A recent study identified the significant costs associated with resident teaching.21 However, not all the variation identified in this study is derived from resident involvement.

Our study was similar to other observational studies that have inherent limitations. We had to rely on accurate coding within the EDW. Fortunately, we did not find any significant outliers to suggest that patient miscoding would have significantly affected our results. Because patients and surgeons were deidentified, we could not confirm that postoperative visits were due to T&A complications but instead

<table>
<thead>
<tr>
<th>Surgeon</th>
<th>Complication Encounter, %</th>
<th>Hospital Readmission, %</th>
<th>Observation, %</th>
<th>ED Visit, %</th>
<th>Hemorrhage, %</th>
<th>Hemorrhage Requiring Procedure, %</th>
<th>Additional Costs for Complication Encounters, $</th>
<th>Global T&amp;A Costs, Including Complications, $</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>9.6</td>
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<td>2.6</td>
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<td>4.7</td>
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<td>0.3</td>
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<td>3.0</td>
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</tr>
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<td>4.6</td>
<td>1.4</td>
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<td>0.6</td>
<td>1.3</td>
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<td>2.8</td>
<td>0.9</td>
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<td>1579</td>
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<tr>
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<td>11.6</td>
<td>0.7</td>
<td>2.4</td>
<td>8.1</td>
<td>1.9</td>
<td>1.1</td>
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<td>1.7</td>
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<td>1.2</td>
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<td>5.6</td>
<td>19</td>
<td>1759</td>
</tr>
<tr>
<td>Total (95% CI)</td>
<td>7.7</td>
<td>0.4</td>
<td>1.3</td>
<td>5.2</td>
<td>2.9</td>
<td>1.5</td>
<td>93 (78-110)</td>
<td>1599 (1570-1629)</td>
</tr>
</tbody>
</table>

P value* <.001

Abbreviations: CI, confidence interval; ED, emergency department; T&A, adenotonsillectomy.

*P < .003 signifies statistically significant difference in rate of complication encounters between surgeons.
relied on diagnostic codes associated with the subsequent encounters. Additionally, we had data only for patients returning to an IH hospital. However, it is estimated that 85% to 90% of pediatric admissions among children in Salt Lake County occur at PCH.11 Intermountain Healthcare provides a majority of the hospital care in the surrounding area. Although patients with complications may have returned to another facility outside the network, particularly those with hemorrhage who would typically present to the hospital closest to home, we likely captured most of the complication encounters. However, we have no reason to suspect there is a systematic bias against a particular surgeon, and therefore this would be simply random bias. As mentioned before, some surgeons have resident involvement, while others do not, adding a potential confounding variable. Also, this study focused only on costs to the hospital. We did not examine the impact of these costs on third-party payer or patient out-of-pocket expenses. Investigating how the costs from this study affect patients’ insurance premiums and medical care expenses is needed. Finally, we did not control for variation in patient factors between surgeons. To limit patient comorbidities and medical complexities, all patients scheduled for inpatient admission or overnight observation after the T&A were excluded from the analysis. While this reduces much of the patient confounding variability, socioeconomic, ethnic, and age differences between surgeons’ patient populations may account for some differences in complication rates. These factors will be explored in future studies.

Conclusion
Same-day T&A hospital costs vary significantly between surgeons in a single hospital. Differences in OR and supply costs, particularly from instruments such as the harmonic scalpel, coblator, and microdebrider, account for much of this variation. The rate of postoperative T&A complication encounters varies significantly between surgeons, leading to differences in the mean costs for posttonsillectomy complications. Understanding the reasons, including surgeon, technique, and patient factors, for the variation in complication rates can lead to system process improvement. Limiting this variation may reduce waste by limiting the use of resources that do not provide improved outcomes. Identifying the ideal T&A technique that achieves the best patient outcomes at the lowest cost will improve health care value.

Author Contributions
Jeremy D. Meier, creating and designing the study, analyzing and interpreting the data, drafting the article, approval of the manuscript version submitted; Melanie Duval, analyzing and interpreting the data, revising the article, approval of the manuscript version submitted; Jacob Wilkes, acquiring the data, revising the article, approval of the manuscript version submitted; Seth Andrews, acquiring the data, revising the article, approval of the manuscript version submitted; E. Kent Korgenski, acquiring the data, revising the article, approval of the manuscript version submitted; Albert H. Park, analyzing and interpreting the data, revising the article, approval of the manuscript version submitted; Rajendu Srivastava, creating and designing the study, analyzing and interpreting the data, revising the article, approval of the manuscript version submitted.

Disclosures
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