Clinical and Economic Outcomes of Thyroid and Parathyroid Surgery in Children

Julie Ann Sosa, Charles T. Tuggle, Tracy S. Wang, Daniel C. Thomas, Leon Boudourakis, Scott Rivkees, and Sanziana A. Roman

Departments of Surgery (J.A.S., C.T.T., D.C.T., L.B., S.A.R.) and Pediatrics (S.R.), Yale University School of Medicine, New Haven, Connecticut 06510; and Department of Surgery (T.S.W.), Medical College of Wisconsin, Milwaukee, Wisconsin 53226

Context: Clinical and economic outcomes after thyroidectomy/parathyroidectomy in adults have demonstrated disparities based on patient age and race/ethnicity; there is a paucity of literature on pediatric endocrine outcomes.

Objective: The objective was to examine the clinical and demographic predictors of outcomes after pediatric thyroidectomy/parathyroidectomy.

Design: This study is a cross-sectional analysis of Healthcare Cost and Utilization Project–National Inpatient Sample hospital discharge information from 1999–2005. All patients who underwent thyroidectomy/parathyroidectomy were included. Bivariate and multivariate analyses were performed to identify independent predictors of patient outcomes.

Subjects: Subjects included 1199 patients 17 yr old or younger undergoing thyroidectomy/parathyroidectomy.

Main Outcome Measures: Outcome measures included in-hospital patient complications, length of stay (LOS), and inpatient hospital costs.

Results: The majority of patients were female (76%), aged 13–17 yr (71%), and White (69%). Whites were more often in the highest income group (80% *vs.* 8% for Hispanic and 6% for Black; $P < 0.01$) and had private/HMO insurance (76% *vs.* 10% for Hispanic and 5% for Black; $P < 0.001$) rather than Medicaid (13% *vs.* 32% for Hispanic and 41% for Black; $P < 0.001$). Ninety-one percent of procedures were thyroidectomies and 9% parathyroidectomies. Children aged 0–6 yr had higher complication rates (22% *vs.* 15% for 7–12 yr and 11% for 13–17 yr; $P < 0.01$), LOS (3.3 d *vs.* 2.3 for 7–12 yr and 1.8 for 13–17 yr; $P < 0.01$), and higher costs. Compared with children from higher-income families, those from lower-income families had higher complication rates (11.5 *vs.* 7.7%; $P < 0.05$), longer LOS (2.7 *vs.* 1.7 d; $P < 0.01$), and higher costs. Children had higher endocrine-specific complication rates than adults after parathyroidectomy (15.2 *vs.* 6.2%; $P < 0.01$) and thyroidectomy (9.1 *vs.* 6.3%; $P < 0.01$).

Conclusions: Children undergoing thyroidectomy/parathyroidectomy have higher complication rates than adult patients. Outcomes were optimized when surgeries were performed by high-volume surgeons. There appears to be disparity in access to high-volume surgeons for children from low-income families, Blacks, and Hispanics. (***J Clin Endocrinol Metab*** **93: 3058–3065, 2008)**

Endocrine diseases requiring surgery are relatively rare in children but can have significant health implications for life. Sporadic well-differentiated thyroid cancer is the most common endocrine malignancy, accounting for 1% of pediatric cancers in the prepubertal age group and up to 7% of cancers in adolescents aged 15–19 yr (1). Graves' disease is the most common cause

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Abbreviations: APRDRG-3M, All Patient Refined Diagnosis Related Group; HCUP-NIS, Healthcare Cost and Utilization Project National Inpatient Sample; ICD, International Classification of Diseases; LOS, length of stay; SCHIP, State Children's Health Insurance Program.

of pediatric hyperthyroidism, with an incidence of 0.02%; symptoms of nervousness, fatigue, sleep disturbances, and behavioral and/or learning disorders can have a profound impact on a child's physical and psychosocial development (2–4). The incidence of primary hyperparathyroidism is just two to five per 100,000 children; however, the rarity of the disease often leads to a delay in diagnosis until end-organ pathology has occurred (5).

Health care disparities among children are well documented in the literature. Racial and/or ethnic minorities often have compromised access to high-quality healthcare. These disparities have been associated with sociodemographic factors, health insurance, cultural differences, the potential lack of cultural competency among providers, and other healthcare system barriers to access (6–11). Racial and ethnic minorities have been noted to have higher rates of ruptured appendicitis and lower rates of laparoscopic *vs.* open appendectomy (12–15). Hospital volume has been associated with outcome disparities, such that children treated at higher-volume centers tend to fare better (12, 16–18).

For adults, several recent studies have measured clinical and economic outcomes after endocrine surgery; for children, there is a paucity of outcomes literature, with studies focusing primarily on thyroid cancer (19–24). To address this issue, we have performed the first population-based study to examine the clinical and economic outcomes after pediatric thyroid and parathyroid procedures for both benign and malignant disease.

Subjects and Methods

Data source

This study is a cross-sectional analysis of 1999–2005 hospital discharge information from the Healthcare Cost and Utilization Project National Inpatient Sample (HCUP-NIS) database, a stratified 20% sample of inpatient admissions to acute care hospitals maintained by the Agency for Healthcare Research and Quality. HCUP-NIS is the largest all-payer inpatient database in the United States. Patients under the age of 18 yr were the focus of our analysis; adult patients were defined as at 18 yr or older. International Classification of Diseases (ICD-9) procedure codes for nine primary surgical procedures were used to abstract all patients who underwent thyroidectomy or parathyroidectomy (Table 1). Thyroidectomy included partial (lobectomy, partial thyroid resection, and excision of thyroid lesion), total, and substernal thyroidectomy. Parathyroidectomy included total and subtotal parathyroid resection.

Independent demographic variables included age (0–6, 7–12, 13–17, and ≥18 yr), gender, race (White, Black, Hispanic, and other, which included but was not limited to Asians, Pacific Islanders, and Native Americans), median household income ($1–35,999, $36,000–44,999, $45,000–59,000, and more than $59,000), admission type (routine *vs.* nonroutine), and payer (private/HMO, Medicaid, self-pay, Medicare, no charge, and other). Children with Medicare included those with end-stage renal disease who underwent parathyroidectomy for secondary hyperparathyroidism. Thyroid diagnoses were divided into benign and malignant. Patient comorbidity was categorized as minor, moderate, or major loss of function based on the All Patient Refined Diagnosis Related Group (APRDRG-3M) severity of illness measure.

Independent hospital-provider variables included hospital region (Northwest, Midwest, South, and West), hospital location (urban *vs.* rural), teaching status (teaching *vs.* nonteaching), and hospital volume. Hospital volume was based on the annual number of pediatric and adult thyroid and parathyroid procedures. High-volume hospitals were in the top 10% based on their volume of thyroidectomies and parathyroidectomies (>51 procedures/yr). Surgeons were divided into three categories: high-volume, pediatric, and other. High-volume surgeons performed more than 30 cervical endocrine procedures per year in adults and children combined. Pediatric surgeons restricted more than 90% of their practice to patients 17 yr old or younger. Other surgeons fell into neither category. There was no overlap between these groups; in particular, there were no pediatric surgeons in the high-volume group.

Outcome variables

Primary outcomes of interest were 1) in-hospital patient complications, 2) mean length of stay (LOS), and 3) total inpatient hospital costs. Postoperative complications were categorized as general (cardiovascular, endocrine, gastrointestinal, hematological, vascular, neurologicl, urological, respiratory, infections, and wound) or endocrine-specific (recurrent laryngeal nerve injury, voice disturbance, hypoparathyroidism, hypocalcemia, and tetany). Complications were treated as a dichotomous variable (none *vs.* one or more); information regarding severity was not available. Total inpatient costs were calculated using the HCUP-NIS-adjusted, hospital-specific cost-to-charge ratios. Costs were then adjusted for inflation, converting all costs to 2005 dollars, using rates from the Bureau of Labor Statistics (25).

Data analysis

Bivariate analysis of the independent variables by our outcomes of interest was performed by χ^2 statistical analysis for categorical variables and ANOVA for continuous variables. Multivariate linear regression models were used to adjust for significant independent variables for LOS and total inpatient costs. Multivariate logistic regression models were used to adjust for independent variables for both general and endocrine complications. Data analysis and management were performed using SPSS version 14.0 (Chicago, IL). All tests were two sided, with statistical significance set at a probability value of ≤0.05. This study was deemed exempt from Institutional Review Board approval at our institution because HCUP-NIS is a public database with no personal identifying information.

TABLE 1. ICD-9 thyroid and parathyroid procedure codes

ICD-9	Procedure
6.2	Unilateral thyroid lobectomy
6.31	Excision of lesion of thyroid
6.39	Partial thyroidectomy
6.4	Total thyroidectomy
6.50	Substernal thyroidectomy
6.51	Partial substernal thyroidectomy
6.52	Total substernal thyroidectomy
6.81	Total parathyroidectomy
6.89	Other parathyroidectomy

Results

Demographic and clinical characteristics

From 1999–2005, 1199 children who underwent thyroid and parathyroid procedures were identified in HCUP-NIS. The majority of patients were female (76%) and between 13 and 17 yr (71%), 22% were 7–12 yr, and 7% were 0–6 yr (Table 2). The majority of children were White (69%); Hispanics represented 14%, Blacks 8%, and others 9%. Children from families with the highest median annual income (more than $59,000) comprised 42% of cases. Eighty percent of children in the highest median

TABLE 2. Characteristics of children undergoing thyroid and parathyroid procedures, 1999–2005 (n = 1199)

Patient characteristics	n (%)
Demographic	
Gender: female	903 (76.2)
Age (yr)	
0–6	79 (6.6)
7–12	270 (22.5)
13–17	850 (70.9)
Race	
White	606 (69.3)
Black	67 (7.7)
Hispanic	124 (14.2)
Other	78 (8.9)
Household income ($)	
<36,000	109 (20.8)
36,000–45,000	128 (24.5)
45,001–59,000	143 (27.3)
>59,000	143 (27.3)
Payer	
Private/HMO	881 (73.6)
Medicaid	214 (17.9)
Self-pay	28 (2.3)
Medicare	14 (1.2)
Other	60 (5.0)
Clinical	
Admission type: routine	1146 (97.7)
Loss of function	
Minor	517 (74.8)
Moderate	150 (21.7)
Major	24 (3.5)
Thyroid diagnosis: malignant	329 (27.4)
Procedure type	
Partial thyroidectomy	616 (51.4)
Total thyroidectomy	478 (39.9)
Parathyroidectomy	105 (8.8)
Provider	
Hospital region	
Northeast	253 (21.1)
Midwest	312 (26.0)
South	343 (28.6)
West	291 (24.3)
Hospital location: urban	1148 (95.7)
Hospital teaching status: teaching	910 (75.9)
Hospital volume: high	507 (42.3)
Surgeon group	
High-volume	126 (20.8)
Pediatric	164 (27.0)
Other	317 (52.2)

household income group were White; just 8% were Hispanic, and 6% were Black ($P < 0.01$). In contrast, 58% of children in the lowest income group were Black, and 46% were Hispanic; just 16% were White. Most children had private/HMO insurance (74%); 76% were White, 10% Hispanic, and 5% Black. Among the 18% of children covered by Medicaid, 41% were Black, 32% Hispanic, and 13% White ($P < 0.001$).

Children were more likely to have procedures performed at teaching hospitals (76%) and in urban settings (96%). Forty-two percent of procedures were performed at high-volume hospitals. High-volume surgeons performed 21% of procedures, pediatric surgeons 27%, and other surgeons 21%. Partial thyroidectomy was performed in 51% of patients and total thyroidectomy in 40%; the majority of thyroidectomies were done for benign disease (73%). These included nontoxic goiter (n = 290), benign neoplasm and thyroid cyst (n = 222), hyperthyroidism/thyrotoxicosis (n = 174), thyroiditis (n = 97), and a family history of an endocrine-related malignancy (n = 33). Parathyroidectomy was performed in 9% of patients.

Access to high-volume surgeons

Surgeon identifiers were available for 607 of 1199 children. There were no significant differences in patients with or without surgeon identifiers with respect to other demographic and clinical predictors of outcomes.

There were apparent differences in access to high-volume surgeons based on race and other measures of socioeconomic status (Table 3). White children more often underwent thyroidectomy or parathyroidectomy by high-volume surgeons compared with Black and Hispanic children (23.4 *vs.* 15.2 and 9.7%, respectively; $P < 0.05$). Similarly, children from families with median household incomes higher than $59,000 had significantly better access to high-volume surgeons compared with children from lower-income families ($P < 0.01$). Although differences in access by primary payer were not significant, there was a trend toward children with Medicaid having less access to high-volume surgeons ($P = 0.07$; nonsignificant).

Unadjusted patient outcomes

The most common complications after thyroidectomy and parathyroidectomy in children were endocrine specific. Hypocalcemia accounted for 68.6% of all complications, voice disturbance overall represented 6.2%, and frank stridor was seen in 2.3% of children. The next most common postoperative complications were related to respiratory issues (5.2%) and bleeding (3.4%).

There were significant differences in unadjusted clinical and economic outcomes among children undergoing thyroidectomy and parathyroidectomy (Table 4). Overall, children aged 0–6 yr had more general complications (22%) than children aged 7–12 yr (15%) and 13–17 yr (11%, $P < 0.01$). Notably, the rates of recurrent laryngeal nerve-related injuries were highest for the 0–6 yr group at 3.8%, followed by the 7–12 yr group (1.1%) and the 13–17 yr group (0.6%, $P < 0.05$). Hypocalcemia was higher in children undergoing total thyroidectomy (15.7%) and parathyroidectomy (15.2%) compared with partial thyroidectomy (3.4%; $P < 0.01$). Children who sustained a complication had a significantly longer LOS (4.2 *vs.* 1.7 d; $P < 0.01$).

Children aged 0–6 yr had significantly longer LOS (3.3 *vs.* 2.3 d for ages 7–12 yr and 1.8 d for ages 13–17 yr; $P < 0.01$) and tended to have higher costs. Other groups with significantly higher general complication rates included children on Medicare (57%) with nonroutine admissions (33 *vs.* 12% routine; $P < 0.01$), major loss of function (52 *vs.* 38% moderate and 4% minor; $P < 0.01$), and thyroid cancer (19 *vs.* 10% benign; $P < 0.01$). Similar patterns were seen for endocrine complications, where rates tended to be higher for children from lowest-income families compared with highest-income families.

TABLE 3. Access to high-volume surgeons by race, income, and payer, 1999–2005 (n = 607)

Patient characteristics	Surgeon group (%)			*P* value
	High-volume (n = 126)	Pediatric (n = 164)	Other (n = 317)	
Race				<0.05
White	23.4	26.3	50.3	
Black	15.2	23.9	60.9	
Hispanic	9.7	38.9	51.4	
Other	30.6	30.6	38.9	
Median household income ($)				<0.01
<35,999	15.9	15.9	68.1	
36,000–44,999	13.8	23.1	63.1	
45,000–58,999	17.1	18.6	64.3	
>59,000	38.4	21.9	39.7	
Primary payer				NS
Private/HMO	23.6	25.7	50.7	
Medicaid	9.2	32.8	58.0	
Self-pay	20.0	33.3	46.7	
Medicare	28.6	0.0	71.4	
Other	25.0	25.0	50.0	

NS, Not significant.

LOS was significantly shorter for White children (1.9 *vs.* 2.5 d for Black and 2.6 d for Hispanic), children from the highest-income families (1.6 *vs.* 2.9 d for lowest income), and children with routine admissions (1.3 *vs.* 8.3 d for nonroutine), children with minor loss of function (1.5 *vs.* 2.7 d for moderate and 7.5 d for major), and children who underwent partial thyroidectomy (1.6 *vs.* 2.2 d for total thyroidectomy and 3.4 d for parathyroidectomy) (all $P < 0.01$). Nonteaching hospitals had shorter LOS (1.7 *vs.* 2.1 d), as did high-volume thyroid surgeons compared with pediatric and other surgeons (1.5 *vs.* 2.3 and 2 d, respectively; $P < 0.01$). High-volume hospitals had fewer general (10 *vs.* 14%; $P < 0.05$) and endocrine-specific complications (8 *vs.* 11%; $P < 0.05$). They also had shorter LOS (1.8 *vs.* 2.1 d; $P \leq 0.05$).

Costs were significantly higher for children on Medicare ($32,945 *vs.* $14,381 private/HMO and $16,973 Medicaid; $P < 0.01$), with nonroutine admissions, major loss of function, and undergoing parathyroidectomy or thyroidectomy for cancer. In addition, thyroidectomy and parathyroidectomy in children cost more in the Northeast and West ($17,218 and $16,908, respectively; $P < 0.01$). Teaching hospitals and hospitals in urban locations had significantly higher costs; similarly, pediatric surgeons had higher costs than high-volume and other surgeons. All these findings were highly significant ($P < 0.01$).

Adjusted patient outcomes

All variables found to be significant on bivariate analyses were included in a multivariate regression analysis to identify independent predictors of clinical and economic outcomes after thyroidectomy and parathyroidectomy in the pediatric population. Eleven children were excluded from the multivariate analysis because their LOS and costs were greater than 3 SD above the mean values. Six were aged 0–6 yr, 10 had surgery at teaching hospitals, and all were at urban centers. Only three children were White.

In the multivariate analysis, independent predictors of longer LOS included lower median household income, higher APRDRG status, procedure type (total thyroidectomy), hospital teaching status, and surgery performed by a non-high-volume surgeon (Tables 5 and 6). Independent predictors of higher costs included higher APRDRG status, procedure type (total thyroidectomy), hospital teaching status, and surgery by a non-high-volume surgeon (Tables 5 and 6).

After adjustment for all predictors of complications on bivariate analysis, only APRDRG remained predictive of outcome. Children with moderate and major loss of function had odds ratios for sustaining a postoperative complication of 13.8 and 24.6, respectively, compared with children with only minor loss of function.

Pediatric *vs.* adult outcomes

To benchmark our findings, complications, LOS, and costs for the cohort of 1199 children were compared with 96,002 adults who underwent the same thyroid and parathyroid procedures during our study period (Fig. 1). Although the most common complications in children were endocrine specific, bleeding and respiratory-related events were most frequent in adults. Compared with adults, children had significantly higher general (21.0 *vs.* 12.0%; $P < 0.01$) and endocrine-specific complication rates (15.2 *vs.* 6.2%; $P < 0.01$) after parathyroidectomy. Their endocrine-specific complication rates also were higher after thyroidectomy (9.1 *vs.* 6.3%, $P < 0.01$), although the overall complication rates after thyroidectomy were comparable (11.6 *vs.* 10.7%; nonsignificant). Notably, the rate of hypocalcemia was higher among children (9.3%) than adults (5.7%; $P < 0.01$). There was no difference in the rate of recurrent laryngeal nerve-related complications.

No significant differences with respect to LOS or costs were found between the pediatric and adult populations.

Discussion

This study is the first to examine clinical and economic outcomes from thyroidectomy and parathyroidectomy in children and the first to identify clinical and demographic predictors of outcomes. It is striking that complication rates after cervical endocrine sur-

TABLE 4. Pediatric endocrine surgery outcomes by patient and provider characteristics, 1999–2005 (n = 1199)

	Complications (%)				LOS		Cost	
Patient characteristics	**General**	***P***	**Endocrine**	***P***	**d**	***P***	**$**	***P***
Demographic								
Gender		NS		NS		NS		NS
Female	12.5		9.7		1.9		14,631	
Male	12.8		9.9		2.2		16,424	
Age (yr)		<0.01		NS		<0.01		<0.01
0–6	21.5		7.6		3.3		24,112	
7–12	14.8		12.6		2.3		15,496	
13–17	10.8		8.9		1.8		14,168	
Race		NS		NS		<0.01		<0.01
White	11.9		9.7		1.9		14,694	
Black	16.4		11.9		2.5		15,691	
Hispanic	16.1		10.5		2.6		19,780	
Other	15.4		12.8		2.0		16,968	
Household income ($)		NS		NS		<0.01		NS
<36,000	17.4		11.0		2.9		20,636	
36,000–45,000	14.8		11.7		2.1		15,615	
45,001–59,000	11.9		10.5		1.8		17,192	
>59,000	11.9		9.8		1.6		17,041	
Payer		<0.01		<0.05		<0.01		<0.01
Private/HMO	11.2		8.9		1.8		14,381	
Medicaid	14.5		11.7		2.4		16,973	
Self-pay	10.7		7.1		2.4		10,461	
Medicare	57.1		35.7		6.8		32,945	
Other	13.3		10.0		1.8		16,866	
Clinical								
Admission type		<0.01		NS		<0.01		<0.01
Routine	11.9		9.5		1.3		14,712	
Nonroutine	33.3		11.1		8.3		37,278	
Loss of function		<0.01		<0.01		<0.01		<0.01
Minor	4.1		1.7		1.5		13,509	
Moderate	38.0		34.7		2.7		20,933	
Major	54.2		33.3		7.5		45,207	
Thyroid diagnosis		<0.01		<0.01		<0.05		<0.01
Benign	8.7		5.9		1.8		13,366	
Malignant	18.3		16.8		2.1		17,242	
Procedure type		<0.01		<0.01		<0.01		<0.01
Partial thyroidectomy	7.0		3.6		1.6		12,942	
Total thyroidectomy	17.6		16.3		2.2		16,580	
Parathyroidectomy	21.0		15.2		3.4		21,292	
Provider								
Region		NS		NS		NS		<0.01
Northeast	10.7		7.9		2.2		17,218	
Midwest	12.5		9.6		1.9		12,704	
South	14.0		11.1		2.1		14,300	
West	12.0		9.6		1.9		16,908	
Hospital location		NS		NS		NS		<0.01
Urban	12.5		9.8		2.0		15,371	
Rural	9.8		5.9		1.5		9,533	
Hospital teaching status		NS		NS		<0.01		<0.01
Teaching	12.7		10.1		2.1		15,789	
Nonteaching	11.4		8.3		1.7		13,007	
Hospital volume		<0.05		<0.05		≤0.05		NS
High	10.1		7.7		1.8		14,789	
Low	14.2		11.1		2.1		15,354	
Surgeon group		NS		NS		≤0.01		<0.01
High-volume	8.7		5.6		1.5		12,743	
Pediatric	13.4		11.0		2.3		19,594	
Other	13.2		9.5		2.0		13,614	

NS, Not significant.

TABLE 5. Multivariate regression analysis of factors associated with pediatric thyroid and parathyroid procedures, 1999–2005 (n = 1199): LOS

Explanatory variables	β-Coefficient (days)	P
Intercept	0.6	<0.01
Income ($)		
<36,000	0.4	≤0.01
36,000–45,000	0.2	NS
45,001–59,000	0.0	NS
APRDRG		
Moderate loss of function	0.5	<0.01
Major loss of function	2.8	<0.01
Procedure type		
Parathyroidectomy	0.4	NS
Total thyroidectomy	0.3	<0.01
Hospital teaching status		
Teaching	0.3	<0.05
Surgeon group		
Pediatric	0.4	<0.05
Other	0.4	<0.01

Reference comparisons were income more than $59,000, minor loss of function, partial thyroidectomy, nonteaching hospitals, and high-volume surgeon group. NS, Not significant.

gery are in excess of 10%; for children under the age of 6 yr, the overall complication rate is over 21%. Parathyroidectomy and total thyroidectomy, as well as thyroidectomy for thyroid cancer, were associated with more complications and longer, costly hospital stays. Among the most powerful predictors of worse outcome were lower median household income and having surgery by a low-volume thyroid or parathyroid surgeon. These findings were robust, in that differences persisted even after adjustment for all other independent demographic and clinical predictors. Overall, children have significantly higher complication rates than adults after cervical endocrine procedures; this is especially true for parathyroidectomy.

According to the 2000 Census Bureau, there are 72.3 million children in the United States who comprise one quarter of the population (25). Racial/ethnic minorities account for 40%; 17% live in families with incomes below the federal poverty level (26). The National Healthcare Disparities Report, published by the Agency for Healthcare Research and Quality and the U.S. Department of Health and Human Services, cited children as a priority population. Disparities were pervasive with regard to access to care and, as a result, quality of care (27). Elimination of these disparities was a primary goal of the Healthy People 2010 initiative (28).

TABLE 6. Multivariate regression analysis of factors associated with pediatric thyroid and parathyroid procedures, 1999–2005 (n = 1199): Costs

Explanatory variables	β-Coefficient ($)	P
Intercept	6,914	NS
APRDRG		
Moderate loss of function	4,184	<0.01
Major loss of function	13,537	<0.01
Procedure type		
Parathyroidectomy	1,456	NS
Total thyroidectomy	3,305	<0.01
Hospital teaching status		
Teaching	2,376	<0.01
Surgeon Group		
Pediatric	5,146	<0.01
Other	3,042	<0.01

Reference comparisons were minor loss of function, partial thyroidectomy, nonteaching hospitals, and high-volume surgeon group. NS, Not significant.

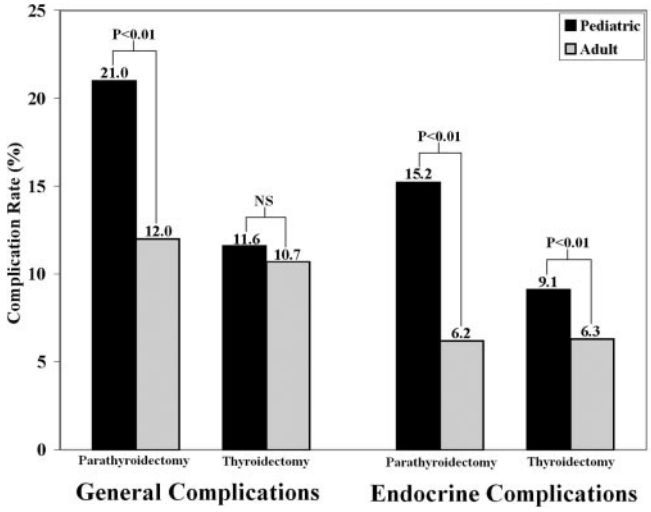

FIG. 1. Pediatric *vs.* adult general and endocrine complication rates after thyroid and parathyroid procedures, 1999–2005 (n = 97,201). NS, Not significant.

The etiology of these disparities is complex, as education, income, and race/ethnicity are closely intertwined. Public policy programs, such as the State Children's Health Insurance Program (SCHIP), have been implemented to provide health insurance to low-income children who are not eligible for Medicaid and do not have private coverage. According to a 2007 Congressional Budget Office report, 5–6 million children eligible for Medicaid and/or SCHIP remain uninsured (29).

Weineck and Krauss (7) examined the relationships between health insurance and socioeconomic status in disparities in access to care using the Medical Expenditure Panel Survey. In multivariate analyses, racial and ethnic differences remained independent predictors of lack of routine access to healthcare, particularly for Black and Hispanic children. In a study of trends in asthma, Akinbami and Schoendorf (30) found that although the overall burden of disease plateaued, the division of the burden of disease was disproportionate; Black children were more than three times as likely to be hospitalized and more than four times as likely to die from asthma as White children. This was attributed in part to the fact that minority children with asthma are less likely to receive continuity of quality preventive care.

Cultural issues are a factor in health disparities among racial/ethnic minority children. Gaps in cultural competence exist between patients and providers and include differing paradigms of illness, health illiteracy, and differences in cultural beliefs resulting in mistrust of healthcare providers and/or the healthcare system. Cultural competence training is crucial for bridging cross-cultural gaps between patients and providers (11, 31). In a study of 1-yr-old Medicaid-enrolled infants over a 21-month period, Cohen and Christakis (10) found that infants of parents whose

primary language was not English were half as likely to receive all recommended visits when compared with parents whose primary language was English.

Racial/ethnic disparities have been observed in the diagnosis and management of surgical diseases in children. Smink *et al.* (12) analyzed HCUP–Kids' Inpatient Database to determine the association of perforated appendicitis with race and insurance status in 33,184 children with acute appendicitis. On multivariate analyses, race and insurance status were independent predictors of higher rates of perforation; this was particularly true for Black and Hispanic children and children enrolled in Medicaid. This was corroborated by Jablonski and Guagliardo (13), who found that Black children had a 38% higher rate of appendiceal rupture than White children; relative odds for Hispanic and Asian children were 24 and 32% higher, respectively. Furthermore, with 97% higher mean total hospital charges and 175% longer mean LOS, the burden of appendiceal rupture appeared to fall disproportionately on minority children.

Hagendorf *et al.* (15) identified 72,189 children in the HCUP-NIS who underwent appendectomy for appendicitis; 11,714 (16%) underwent laparoscopic appendectomy. White children were more likely to undergo laparoscopic appendectomy than Black children ($P = 0.01$). Children with Medicaid/Medicare treated at non-children's hospitals were less likely to undergo a laparoscopic procedure than those with private insurance ($P < 0.001$), whereas children with Medicaid/Medicare or private insurance at the children's unit of an adult hospital were more likely to undergo laparoscopic appendectomy ($P < 0.01$) (15).

Berry *et al.* (18) examined the relationship between hospital volume and outcomes for common pediatric specialty operations. For tracheostomy and posterior spinal fusion, at least one fourth of hospitals performed only one procedure per year; half of all hospitals treated fewer than four per year. A trend toward higher postoperative complication and mortality rates was seen in children who underwent tracheostomy in lower-volume hospitals. In a separate study, children with pyloric stenosis had significantly lower mucosal perforation rates and shorter LOS when treated by high-volume surgeons and in high-volume hospitals (17).

Disparities after endocrine surgery in adults appear to be associated with surgeon and/or hospital volume and patient race/ethnicity (19–22); few studies exist for outcomes in pediatric endocrine surgery. In a study of HCUP-NIS data over 7 yr, Tuggle *et al.* (23) looked at outcomes among high-volume endocrine surgeons, pediatric surgeons, and other general surgeons. High-volume endocrine surgeons had significantly shorter LOS (1.5 *vs.* 2.3 d for pediatric, 2.0 for other; $P = 0.01$) and lower costs ($12,474 *vs.* $19,594 for pediatric, $13,614 for other; $P < 0.01$) than both pediatric and other surgeons. High-volume endocrine surgeons also had fewer complications, although the difference was not significant (23).

In our study, children appear to have worse outcomes than adults. One in five children (21%) undergoing parathyroidectomy have a postoperative complication; the rate in adults is 12% ($P < 0.01$). Endocrine complications are also significantly higher for both thyroidectomy and parathyroidectomy in children. Children aged 0–6 yr fare worse than older children, with higher complication rates and longer LOS.

Children may fare worse after thyroidectomy and parathyroidectomy for several reasons. There may be a reticence to operate on children for benign disease, given the quality of life implications of recurrent laryngeal nerve injury and hypoparathyroidism. Therefore, they may present for surgery at a later stage of endocrine disease (3, 4). In a population of 52 children with primary hyperparathyroidism, Kollars *et al.* (5) found that 79% were symptomatic at presentation, 33% had nephrolithiasis, 7% had pancreatitis, and one third of children had fractures and/or radiological evidence of bone involvement. Hypocalcemia is the most common complication after thyroidectomy and parathyroidectomy; postoperative management of hypocalcemia in children can be challenging, because it is difficult to ensure that young children comply with oral calcium and vitamin D supplementation. As a result, treatment may require iv calcium, necessitating extended inpatient stays.

Complication rates and LOS after thyroidectomy and parathyroidectomy were higher for Blacks, Hispanics, and children from lower-income families. It is unclear whether outcome disparities can be muted by providing health insurance to children who are otherwise uninsured. In a telephone survey of parents after enrollment in the New York State SCHIP program, Szilagyi *et al.* (32) found that enrollment led to improved access, continuity, and quality of care. In a similar study stratified by race/ethnicity, SCHIP enrollment led to an elimination of disparities in access, unmet needs, and continuity of care; discrepancies in quality remained (9).

There are limitations to our study, including those inherent to the use of a large administrative database. Although HCUP-NIS is widely used in health services research, it constitutes only a 20% sample of U.S. hospitals, exclusive of federal hospitals. This consideration is less pertinent for this study, because Veterans Administration hospitals are less likely to treat children. Other measures of socioeconomic status, such as patient education, and parents' occupation and wealth, are unavailable. It is not possible to follow longitudinally a patient's course of disease; readmission for postoperative complications, for example, is an independent admission. Therefore, complication rates may be underestimated.

In summary, this is the first description at the population level of pediatric clinical and economic outcomes after thyroidectomy and parathyroidectomy in the United States. Overall, children appear to have higher complication rates than adults. Our observations illustrate major limitations in extrapolating adult outcome data to the pediatric population.

Children undergoing endocrine surgery appear to do better in the hands of high-volume surgeons. In particular, total thyroidectomy for malignancy, parathyroidectomy, and surgery in the youngest children are fraught with risk. For example, surgery in patients with hereditary neonatal hyperparathyroidism or multiple endocrine neoplasia types 2A and 2B is unavoidable; therefore, referral should be made to the highest-volume surgeons.

The unfortunate reality is that minority children and children from lower socioeconomic status have compromised access to these providers. More data are needed to clarify the association

between these factors and outcomes to move toward improved equity in pediatric endocrine surgery delivery. These efforts will need to involve collaboration on the part of families, providers, payers, and policymakers.

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Address all correspondence and requests for reprints to: Tracy S. Wang, M.D., M.P.H., Department of Surgery, Medical College of Wisconsin, 9200 West Wisconsin Avenue, Milwaukee, Wisconsin 53226. E-mail: tswang@mcw.edu.

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