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ORIGINAL ARTICLE

Short- and Long-Term Antireflux and Asthma Medication Use in Children After Nissen Fundoplication

Steven L Lee, MD, FACS, FAAP

Abstract

Purpose: We sought to determine antireflux and asthma medication use after Nissen fundoplication (NF).

Methods: We performed a retrospective study using hospital discharge and pharmacy data from 1996 through 2005. A total of 342 pediatric patients had ≥1 NF; 336 of those had complete medication data. Use of antireflux medications and asthma medications were reviewed before and after NF.

Results: Short-term (one year after NF) use of antireflux medications decreased (odds ratio [OR] = 0.35; 95% confidence interval [CI], 0.26–0.45). During the entire study period, the decrease in antireflux medication use after NF remained in place (233 to 197 patients; OR = 0.63; 95% CI, 0.47–0.84). Use of antireflux medications decreased in neurologically healthy patients (n = 186) after NF but remained the same in neurologically impaired patients. Short-term use of inhaled and systemic asthma medications did not change (OR = 1.16 [95% CI, 0.89–1.51] and 0.90 [95% CI, 0.69–1.18]), respectively. During the entire study period, inhaled and systemic asthma medication use increased after NF (OR = 2.11 [95% CI, 1.63–2.74] and 1.85 [95% CI, 1.43–2.41]), respectively. Inhaled and systemic asthma medication use increased in both neurologically healthy and impaired children. In older children (age >5 years), short-term use of inhaled and systemic asthma medications decreased after NF (OR = 0.39 [95% CI, 0.25–0.60] and 0.31 [95% CI, 0.19–0.53]), respectively. However, during the entire study period, inhaled and systemic asthma medication use in older children remained the same.

Conclusion: NF decreased antireflux medication use in the short and long term, particularly in neurologically healthy children. Inhaled and systemic asthma medication use increased after NF in neurologically healthy and impaired children. NF provided a short-term decrease in inhaled and systemic asthma medication use in older children but showed no change in the long term.

Introduction

Excellent symptomatic results after Nissen fundoplication (NF) in children have been shown in large retrospective studies.[1,2] Furthermore, laparoscopic NF has also been shown to be safe in children as small as 1.2 kg and as young as five days.[1] However, few studies have demonstrated long-term objective outcomes after NF in children. We previously looked at the number of hospitalizations for complications related to gastroesophageal reflux disease (GERD) to determine long-term effectiveness after NF.[3] There was no change in the number of patients hospitalized for pulmonary symptoms and failure to thrive before and after NF.[3] We also showed that long-term use of antireflux medications decreased by 37% in children after NF.[4] However, these studies were criticized because patients of all ages were grouped together regardless of neurologic status. Many believe that reflux disease in a young child with an underlying neurologic disorder and repeat hospitalizations for pneumonia or failure to thrive may be different from the disease in an older, neurologically healthy child with significant reactive air-

Steven L Lee, MD, FACS, FAAP, is Chief of Pediatric Surgery, Associate Program Director of General Surgery, and Education Chair for the Department of Surgery at the Los Angeles Medical Center and volunteer faculty at the Harbor-UCLA Medical Center in Los Angeles, CA. E-mail: steven.l.lee@kp.org.

way disease. Thus, endpoints after NF may be different in such vastly dissimilar patient populations. The purpose of this study was to address this criticism by analyzing the short- and long-term effects after NF in children. Specifically, this study analyzes the use of antireflux medication and asthma medication on the basis of patient age and neurologic status.

Materials and Methods

The Southern California Kaiser Permanente (KP) Discharge Abstract Database (PDAB) was used to identify pediatric patients (those <19 years old) hospitalized in 12 acute-care hospitals with diagnosed GERD that was treated with NF between January 1, 1996, and December 31, 2005. Surgical therapy was determined according to the guidelines for the *Current Procedural Terminology,* fourth edition (*CPT*)[5] procedure code for NF. This study was approved by the institutional review board of KP Southern California, protocol numbers 3934 and 5040.

Patients' data were then analyzed using the KP Southern California Pharmacy database for use of antireflux medications. Specifically, use of antireflux medication (H_2-blockers and proton pump inhibitors) and asthma medication (systemic steroids, inhaled β-agonists, and inhaled steroids) were analyzed. The pre-Nissen period was defined as the period from birth to first NF, and post-Nissen period was defined as the time from first NF to death or to the end of the study, whichever came first. The number of patients using antireflux and asthma medications was recorded before and after NF at six-month intervals. Short-term use was defined as restarting medication within one year of NF. Long-term use was defined as restarting medication at the end of the study period, with a mean follow-up period of 4.5 years.

The data from PDAB were exported to SAS statistical software (version 9.13, SAS Institute, Inc, Cary, NC, USA) for subsequent analyses. Use of antireflux and asthma medication before and after NF was compared using χ^2 analysis. Odds ratios (ORs) were calculated using logistic regression. In addition to NF, age and underlying neurologic disorder were also included in the regression model. Estimates were considered statistically significant if the 95% confidence interval did not overlap 1.0 and if p values were <0.05.

Results

A total of 342 patients were identified as having undergone NF during the study period. Medication data were available for 336 of those, and 154 (45%) patients had an associated neurologic disorder. Mean patient age at time of NF was 3.9 ± 4.8 years (median age, one year; range, 0–17 years) with a male-to-female ratio of 1.19 to 1. Mean duration of follow-up monitoring was 4.5 years.

Table 1. Short-term and long-term use of antireflux medication after Nissen fundoplication in children

All children in study	OR (95% CI)	p value
All ages (n = 336)		
Short-term (within 1 year of NF)	0.35 (0.26–0.47)	<0.0001
Long-term (>1 year after NF)	0.63 (0.47–0.84)	0.0015
<1 year (n = 140)		
Short-term (within 1 year of NF)	0.59 (0.37–0.95)	0.0282
Long-term (>1 year after NF)	1.06 (0.67–1.69)	0.7995
1 year ≤ age < 5 years (n = 99)		
Short-term (within 1 year of NF)	0.18 (0.10–0.34)	<0.0001
Long-term (>1 year after NF)	0.28 (0.15–0.51)	<0.0001
≥5 years (n = 97)		
Short-term (within 1 year of NF)	0.23 (0.13–0.42)	<0.0001
Long-term (>1 year after NF)	0.49 (0.28–0.87)	0.0136

CI = confidence interval; OR = odds ratio; NF = Nissen fundoplication.

Table 2. Short-term and long-term use of antireflux medication after Nissen fundoplication in neurologically healthy children

Neurologically healthy children	OR (95% CI)	p value
All ages (n = 186)		
Short-term (within 1 year of NF)	0.22 (0.15–0.34)	<0.0001
Long-term (>1 year after NF)	0.38 (0.26–0.57)	<0.0001
<1 year (n = 82)		
Short-term (within 1 year of NF)	0.45 (0.25–0.81)	0.0084
Long-term (>1 year after NF)	0.82 (0.46–1.43)	0.4791
1 year ≤ age < 5 years (n = 50)		
Short-term (within 1 year of NF)	0.11 (0.04–0.26)	<0.0001
Long-term (>1 year after NF)	0.15 (0.06–0.35)	<0.0001
≥5 years (n = 54)		
Short-term (within 1 year of NF)	0.09 (0.04–0.21)	<0.0001
Long-term (>1 year after NF)	0.17 (0.07–0.40)	<0.0001

CI = confidence interval; OR = odds ratio; NF = Nissen fundoplication.

… long-term use of antireflux medication after NF [remained the same] in neurologically impaired children.

Antireflux Medication Use After Nissen Fundoplication

Table 1 summarizes short- and long-term use of antireflux medication after NF in all patients. Overall short-term use of antireflux medication decreased in children after NF. With respect to age, short-term use of antireflux medication decreased in children of all ages after NF. Overall, long-term use of antireflux medication remained decreased for all patients (233 to 197 patients). Of the 233 patients requiring antireflux medication before NF, 150 required medication after NF; 75.6% of all patients who restarted antireflux medication did so within one year after NF. An additional 47 patients with no prior requirement of antireflux medication were given medication after NF. With respect to age, long-term use of antireflux medications remained decreased in children one year of age and older.

Table 2 summarizes short- and long-term use of antireflux medication after NF in neurologically healthy children. Overall short-term use of antireflux medication decreased in neurologically healthy children after NF. With respect to age, short-term use of antireflux medications decreased in neurologically healthy children of all ages and long-term use remained decreased in neurologically healthy children one year of age and older. Overall, long-term use decreased in neurologically healthy patients (140 to 101).

Table 3 summarizes short- and long-term use of antireflux medication after NF in neurologically impaired children. Overall short-term use of antireflux medication decreased in neurologically impaired children after NF. With respect to age, short-term use of antireflux medication decreased in neurologically impaired children between the ages of 1 and 5 years. Long-term use remained the same in neurologically impaired children of all ages (93 to 96).

Table 3. Short-term and long-term use of antireflux medication after Nissen fundoplication in neurologically impaired children

Neurologically impaired children	OR (95% CI)	p value
All ages (n = 150)		
Short-term (within 1 year of NF)	0.58 (0.37–0.90)	0.0145
Long-term (>1 year after NF)	1.09 (0.71–1.68)	0.6961
<1 year (n = 58)		
Short-term (within 1 year of NF)	0.87 (0.41–1.86)	0.7149
Long-term (>1 year after NF)	1.56 (0.71–3.43)	0.2735
1 year ≤ age < 5 years (n = 49)		
Short-term (within 1 year of NF)	0.33 (0.17–0.73)	0.0061
Long-term (>1 year after NF)	0.62 (0.30–1.29)	0.2028
≥ 5 years (n = 43)		
Short-term (within 1 year of NF)	0.52 (0.22–1.20)	0.1230
Long-term (>1 year after NF)	1.10 (0.49–2.48)	0.8185

CI = confidence interval; OR = odds ratio; NF = Nissen fundoplication.

Table 4. Short-term and long-term use of inhaled steroids after Nissen fundoplication in children

All children in study	OR (95% CI)	p value
All ages (n = 336)		
Short-term (within 1 year of NF)	1.31 (0.95–1.80)	0.1056
Long-term (>1 year after NF)	3.24 (2.34–4.49)	<0.0001
<1 year (n = 140)		
Short-term (within 1 year of NF)	11.80 (4.36–31.94)	<0.0001
Long-term (>1 year after NF)	4.96 (1.90–13.00)	0.0011
1 year ≤ age < 5 years (n = 99)		
Short-term (within 1 year of NF)	1.31 (0.80–2.13)	0.2842
Long-term (>1 year after NF)	3.69 (2.15–6.35)	<0.0001
≥5 years (n = 97)		
Short-term (within 1 year of NF)	0.67 (0.38–1.17)	0.1557
Long-term (>1 year after NF)	1.73 (0.99–3.03)	0.0562

CI = confidence interval; OR = odds ratio; NF = Nissen fundoplication.

Asthma Medication Use After Nissen Fundoplication

Table 4 summarizes short- and long-term use of inhaled steroids after NF in all patients. Overall short-term use of inhaled steroids remained unchanged in children after NF. With respect to age, short-term use of inhaled steroids increased in children younger than one year and remained unchanged in children older than one year after NF. Overall, long-term use of inhaled steroids increased for all patients (44 to 109). Of the 44 patients requiring inhaled steroids before NF, 31 required medication afterward; 50.5% of all patients who restarted inhaled steroids did so within one year after NF. An additional 78 patients with no prior requirement of inhaled steroids were given medication after NF. With respect to age, long-term use of inhaled steroids increased in children younger than five years and remained the same in children older than five years.

Table 5 summarizes short- and

long-term use of inhaled steroids after NF in neurologically healthy children. Overall short-term use of inhaled steroids remained the same in neurologically healthy children after NF. With respect to age, short-term use of inhaled steroids increased in neurologically healthy children younger than one year and remained the same in children older than one year, and long-term use increased in neurologically healthy children younger than five years and remained the same in children older than five years. Overall, long-term use of inhaled steroids increased in neurologically healthy patients (29 to 59).

Table 6 summarizes short- and long-term use of inhaled steroids after NF in neurologically impaired children. Overall, short-term use of inhaled steroids increased in neurologically impaired children after NF. With respect to age, short-term use increased in neurologically impaired children younger than five years and remained the same in children older than five years, and long-term use increased in neurologically impaired children younger than five years and remained the same in children older than five years. Overall, long-term use increased in neurologically impaired patients (15 to 50).

Table 7 summarizes short- and long-term use of inhaled β-agonists after NF in all patients. Overall short-term use of inhaled β-agonists remained unchanged in children after NF. With respect to age, short-term use of β-agonists increased in children younger than one year and decreased in children older than five years after NF. Overall, long-term use of inhaled β-agonists increased for all patients (162 to 219). Of the 162 patients requiring inhaled β-agonists before NF, 131 required medication after NF; 79.0% of all

Table 5. Short-term and long-term use of inhaled steroids after Nissen fundoplication in neurologically healthy children

Neurologically healthy children	OR (95% CI)	p value
All ages (n = 186)	1.04 (0.67–1.62)	
Short-term (within 1 year of NF)		0.8476
Long-term (>1 year after NF)	2.69 (1.77–4.09)	<0.0001
<1 year (n = 82)		
Short-term (within 1 year of NF)	5.60 (1.57–19.91)	0.0078
Long-term (>1 year after NF)	10.53 (2.78–39.96)	0.0005
1 year ≤ age < 5 years (n = 50)		
Short-term (within 1 year of NF)	0.73 (0.31–1.73)	0.4804
Long-term (>1 year after NF)	2.41 (1.10–5.31)	0.0282
≥ 5 years (n = 54)		
Short-term (within 1 year of NF)	0.63 (0.35–1.14)	0.1281
Long-term (>1 year after NF)	1.73 (0.93–3.21)	0.0844

CI = confidence interval; OR = odds ratio; NF = Nissen fundoplication.

Table 6. Short-term and long-term use of inhaled steroids after Nissen fundoplication in neurologically impaired children

Neurologically impaired children	OR (95% CI)	p value
All ages (n = 150)		
Short-term (within 1 year of NF)	1.80 (1.08–3.02)	0.0254
Long-term (>1 year after NF)	4.54 (2.57–8.01)	<0.0001
<1 year (n = 58)		
Short-term (within 1 year of NF)	4.77 (0.98–23.25)	0.0533
Long-term (>1 year after NF)	15.08 (3.36–67.62)	0.0004
1 year ≤ age < 5 years (n = 49)		
Short-term (within 1 year of NF)	2.05 (1.19–3.55)	0.0102
Long-term (>1 year after NF)	5.42 (2.65–11.10)	<0.0001
≥5 years (n = 43)		
Short-term (within 1 year of NF)	0.78 (0.21–2.85)	0.7054
Long-term (>1 year after NF)	1.74 (0.52–5.83)	0.3677

CI = confidence interval; OR = odds ratio; NF = Nissen fundoplication.

Table 7. Short-term and long-term use of inhaled β-agonists after Nissen fundoplication in children

All children in study	OR (95% CI)	p value
All ages (n = 336)		
Short-term (within 1 year of NF)	1.14 (0.88–1.49)	0.3129
Long-term (>1 year after NF)	2.04 (1.57–2.64)	<0.0001
<1 year (n = 140)		
Short-term (within 1 year of NF)	3.34 (2.10–5.32)	<0.0001
Long-term (>1 year after NF)	5.72 (3.45–9.49)	<0.0001
1 year ≤ age < 5 years (n = 99)		
Short-term (within 1 year of NF)	0.81 (0.49–1.32)	0.3976
Long-term (>1 year after NF)	1.43 (0.89–2.31)	0.1412
≥5 years (n = 97)		
Short-term (within 1 year of NF)	0.42 (0.27–0.66)	0.0001
Long-term (>1 year after NF)	0.84 (0.56–1.25)	0.3927

CI = confidence interval; OR = odds ratio; NF = Nissen fundoplication.

Table 8. Short-term and long-term use of inhaled β-agonists after Nissen fundoplication in neurologically healthy children

Neurologically healthy children	OR (95% CI)	p value
All ages (n = 186)		
Short-term (within 1 year of NF)	0.80 (0.57–1.13)	0.2106
Long-term (>1 year after NF)	1.78 (1.27–2.49)	0.0008
<1 year (n = 82)		
Short-term (within 1 year of NF)	2.11 (1.23–3.64)	0.0069
Long-term (>1 year after NF)	3.87 (2.15–6.99)	<0.0001
1 year ≤ age < 5 years (n = 50)		
Short-term (within 1 year of NF)	0.57 (0.29–1.12)	0.1037
Long-term (>1 year after NF)	1.18 (0.61–2.27)	0.6165
≥ 5 years (n = 54)		
Short-term (within 1 year of NF)	0.29 (0.16–0.55)	0.0001
Long-term (>1 year after NF)	0.92 (0.55–1.54)	0.7629

CI = confidence interval; OR = odds ratio; NF = Nissen fundoplication.

Table 9. Short-term and long-term use of inhaled β-agonists after Nissen fundoplication in neurologically impaired children

Neurologically impaired children	OR (95% CI)	p value
All ages (n = 150)		
Short-term (within 1 year of NF)	1.79 (1.20–2.66)	0.0042
Long-term (>1 year after NF)	2.44 (1.61–3.70)	<0.0001
<1 year (n = 58)		
Short-term (within 1 year of NF)	6.53 (2.78–15.35)	<0.0001
Long-term (>1 year after NF)	11.07 (4.09–29.97)	<0.0001
1 year ≤ age < 5 years (n = 49)		
Short-term (within 1 year of NF)	1.20 (0.59–2.44)	0.6168
Long-term (>1 year after NF)	1.80 (0.88–3.69)	0.1053
≥ 5 years (n = 43)		
Short-term (within 1 year of NF)	0.68 (0.37–1.23)	0.2013
Long-term (>1 year after NF)	0.74 (0.39–1.41)	0.3631

CI = confidence interval; OR = odds ratio; NF = Nissen fundoplication.

patients who restarted β-agonists did so within one year after NF. An additional 88 patients with no prior requirement for inhaled β-agonists were given medication after NF. With respect to age, long-term use of inhaled β-agonists increased in children younger than one year and remained decreased in children older than one year.

Table 8 summarizes short- and long-term use of inhaled β-agonists after NF in neurologically healthy children. Overall short-term use increased in neurologically healthy children after NF. With respect to age, short-term use increased in neurologically healthy children younger than one year and decreased in children older than five years, and long-term use increased in neurologically healthy children younger than one year and remained the same in children older than one year. Overall, long-term use increased in neurologically healthy patients (85 to 111).

Table 9 summarizes short- and long-term use of inhaled β-agonists after NF in neurologically impaired children. Overall short-term use increased in neurologically impaired children after NF. With respect to age, short-term use increased in neurologically impaired children younger than one year and remained the same in children older than one year, and long-term use increased in neurologically impaired children younger than one year of age and remained the same in children older than one year. Overall, long-term use increased in neurologically impaired patients (77 to 108).

Table 10 summarizes short- and long-term use of systemic steroids after NF in all patients. Overall short-term use remained unchanged in children after NF. With respect to age, short-term use increased in children younger than one year of age and decreased in children older than one year after NF. Overall, long-term use increased for all patients (102 to 150). Of the 102 patients requiring systemic steroids before NF, 70 required medication after NF; 63.3% of all patients who restarted systemic steroids did so within one year after NF. An additional 80 patients with no prior requirement of systemic steroids were given medication after NF. With respect to age, long-term use of systemic steroids increased in children younger than one year of age and remained the same in children older than one year.

Table 11 summarizes short- and long-term use of systemic steroids after NF in neurologically healthy children. Overall short-term use remained the same in neurologically healthy children after NF. With respect to age, short-term use increased in neurologically healthy children younger than one year and decreased in children older than one year, and long-term use increased in neurologically healthy children younger than one year of age and remained the same in children older than one year. Overall, long-term use increased

in neurologically healthy patients (59 to 75).

Table 12 summarizes short- and long-term use of systemic steroids after NF in neurologically impaired children. Overall short-term use remained the same in neurologically impaired children after NF. With respect to age, short-term use increased in neurologically impaired children younger than one year of age and decreased in children older than one year, and long-term use increased in neurologically impaired children younger than one year and remained the same in children older than one year. Overall, long-term use of systemic steroids increased in neurologically impaired patients (43 to 75).

Revision Fundoplication and Mortality

Twenty-six (7.6%) patients had more than one fundoplication operation performed. Fifty-one patients (14.9%) died during the study period. The causes of death included aspiration pneumonia for one patient, other pneumonia for one patient, and respiratory distress for two patients. All other deaths did not appear to be associated with GERD-related complications.

Discussion

Antireflux surgery has been a mainstay in the treatment of GERD for many decades. However, with new and more potent antireflux medications available, the long-term outcome after antireflux procedures has recently come into question.[6] Previous studies have shown that antireflux procedures are successful in relieving reflux symptoms in children.[4] In a multi-institutional review of 7467 patients, good to excellent resolution of symptoms was reported in 95% of neurologically healthy children and 85% resolution

Table 10. Short-term and long-term use of systemic steroids after Nissen fundoplication in children

All children in study	OR (95% CI)	p value
All ages (n = 336)		
Short-term (within 1 year of NF)	0.90 (0.69–1.18)	0.4630
Long-term (>1 year after NF)	1.85 (1.43–2.41)	<0.0001
<1 year (n = 140)		
Short-term (within 1 year of NF)	3.19 (1.99–5.12)	<0.0001
Long-term (>1 year after NF)	6.04 (3.66–9.97)	<0.001
1 year ≤ age < 5 years (n = 99)		
Short-term (within 1 year of NF)	0.57 (0.38–0.87)	0.0089
Long-term (>1 year after NF)	1.23 (0.79–1.92)	0.3520
≥ 5 years (n = 97)		
Short-term (within 1 year of NF)	0.31 (0.19–0.53)	<0.0001
Long-term (>1 year after NF)	0.77 (0.50–1.19)	0.2377

CI = confidence interval; OR = odds ratio; NF = Nissen fundoplication.

Table 11. Short-term and long-term use of systemic steroids after Nissen fundoplication in neurologically healthy children

Neurologically healthy children	OR (95% CI)	p value
All ages (n = 186)		
Short-term (within 1 year of NF)	0.77 (0.54–1.11)	0.1567
Long-term (>1 year after NF)	1.46 (1.03–2.06)	0.0343
<1 year (n = 82)		
Short-term (within 1 year of NF)	2.44 (1.34–4.43)	0.0034
Long-term (>1 year after NF)	3.68 (1.97–6.87)	<0.0001
1 year ≤ age < 5 years (n = 50)		
Short-term (within 1 year of NF)	0.39 (0.21–0.71)	0.0023
Long-term (>1 year after NF)	0.92 (0.51–1.66)	0.7814
≥5 years (n = 54)		
Short-term (within 1 year of NF)	0.32 (0.16–0.63)	0.0011
Long-term (>1 year after NF)	0.73 (0.40–1.34)	0.3152

CI = confidence interval; OR = odds ratio; NF = Nissen fundoplication.

Table 12. Short-term and long-term use of systemic steroids after Nissen fundoplication in neurologically impaired children

Neurologically impaired children	OR (95% CI)	p value
All ages (n = 150)		
Short-term (within 1 year of NF)	0.77 (0.54–1.11)	0.1567
Long-term (>1 year after NF)	1.46 (1.03–2.06)	0.0343
<1 year (n = 58)		
Short-term (within 1 year of NF)	2.44 (1.34–4.43)	0.0034
Long-term (>1 year after NF)	3.68 (1.97–6.87)	<0.0001
1 year ≤ age < 5 years (n = 49)		
Short-term (within 1 year of NF)	0.39 (0.21–0.71)	0.0023
Long-term (>1 year after NF)	0.92 (0.51–1.66)	0.7814
≥ 5 years (n = 43)		
Short-term (within 1 year of NF)	0.32 (0.16–0.63)	0.0011
Long-term (>1 year after NF)	0.73 (0.40–1.34)	0.3152

CI = confidence interval; OR = odds ratio; NF = Nissen fundoplication.

in neurologically impaired children after NF.[2] However, these subjective outcomes were not clearly defined, and there were no objective outcome measures in that study.

Few studies have documented objective endpoints after NF in children. Conversely, in adult patients, long-term follow-up monitoring that compared medical and surgical management of GERD showed no difference in grade of esophagitis, frequency of treatment of esophageal stricture, scores on the Medical Outcomes Study 36-Item Short-Form Health Survey, and overall satisfaction with antireflux therapy.[7] Such endpoints after NF are difficult to reproduce in children because not all children being treated for GERD routinely undergo endoscopy to document esophagitis or stricture. Furthermore, existing quality-of-life surveys used in adults are not applicable to children.

… it is unlikely that asthma medication use will be eliminated after NF, but there is a trend toward decreased use of rescue asthma medications …

In an attempt to provide objective follow-up after NF, we previously looked at the number of hospitalizations for GERD-related complications to determine long-term effectiveness after NF. There was no change in the frequency of hospitalizations, number of hospitalizations, or number of patients hospitalized for pulmonary symptoms and failure to thrive before and after NF.[3] Similar results were seen in a population-based study.[8] In another attempt to look at objective outcomes after NF, we studied the long-term use of antireflux medications after NF and showed that NF decreased use of antireflux medications by 37%.[4] However, both of these studies were criticized because all patients were grouped together. Many suggested that GERD may affect children differently depending on age and underlying neurologic status. In addition, the goals of treatment may also be significantly different because of age and associated comorbidities. It is well known that patients with underlying neurologic disorders have a higher complication rate after NF, including a higher reoperation rate for wrap disruption and increased risk of hospitalization for GERD-related complications after NF.[3,8–11] Thus, to address these issues, we specifically looked at short- and long-term use of antireflux medications and asthma medications on the basis of age and neurologic status.

Antireflux medication use significantly decreased in both the short term and the long term for all patients. Only neurologically healthy children older than one year had significant long-term decrease in medication use. Children with associated neurologic impairment and who were younger than one year of age demonstrated a short-term decrease in antireflux medication use, but this trend did not continue over the long term. Although these findings are significant and provide valuable information to better counsel parents regarding antireflux medication use in their children after NF, we still have not answered the question of whether the goals of the antireflux procedure, as determined by the parents or caregivers, were met. It may be that parents of children younger than one year or children with associated neurologic impairment consider NF to be successful despite the need to restart antireflux medications as long as other benefits of NF, such as improved weight gain or administration of bolus feedings, are achieved. Further study is needed to develop and validate quality-of-life indicators and surveys specifically for parents of these children.

An obvious goal for performing NF in patients with GERD and severe reactive airway disease is to eliminate or decrease the use of asthma medications. Our study showed that use of inhaled steroids increased in the long term for all patients. This increase was seen more in neurologically healthy children younger than one year of age and neurologically impaired children younger than five years of age. With respect to inhaled β-agonists, there was a decrease in use in the short term for older, neurologically healthy children. Similar findings were seen with respect to systemic steroids use. These findings indicate that it is unlikely that asthma medication use will be eliminated after NF, but there is a trend toward decreased use of rescue asthma medications (systemic steroids and inhaled β-agonists) in the short term. These findings further support the belief that outcomes after NF vary with patient age and neurologic status.

Our study had several limitations. Our data came from a discharge abstract database, and the *CPT* coding or coding according to the *International Classification of Diseases,* ninth revision (ICD-9), of each diagnosis and procedure was not independently validated. Thus, we were not able to determine the exact indications for NF. Some patients with underlying neurologic or cardiac anomalies underwent NF because of their perceived risk of developing GERD. Also, technical details of the procedure were not available, such as length of wrap, crural approximation, or open versus laparoscopic. Another limitation of this study was that indications for administration of antireflux and asthma medications were not reviewed and are not known.

Previous studies have shown that antireflux medications may be overprescribed in children;[12,13] they have been prescribed without adequate workup and without documented GERD. Although not previously studied, this may also be the case with respect to asthma medications. In our study, we also did not know how compliant patients were in taking the antireflux and asthma medications. Our pharmacy database represents dispensed medications, so we cannot be sure that the patients were taking what was prescribed.

Overall, our findings demonstrated a slight decrease in antireflux medication use after NF. In children with neurologic impairment, there was no decrease in antireflux medication use after NF. Thus, NF should not be performed with the expectation that patients will no longer need antireflux medications. Furthermore, with respect to asthma medications, it appears that only older, neurologically healthy children may potentially benefit from NF. These findings suggest that GERD and GERD-related complications may be significantly different depending on age and associated neurologic status. Finally, endpoints indicating successful NF may also be different depending on age and neurologic status. ❖

Disclosure Statement

The author(s) have no conflicts of interest to disclose.

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All States of Life

The first fit of the asthma has been experienced at all times, from the earliest infancy to extreme old age, and in every intermediate stage of life.

— Commentaries on the History and Cure of Diseases, *William Heberden, 1710-1801, English physician*