Title

The rising cost of hospital care for children with gastroparesis: 2004–2013

Journal

Neurogastroenterology & Motility, 28(11)

ISSN

1350-1925

Authors

Lu, PL

Moore-Clingenpeel, M

Yacob, D

et al.

Publication Date

2016-11-01

DOI

10.1111/nmo.12869

Peer reviewed

Neurogastroenterology & Motility

Neurogastroenterol Motil (2016) **28,** 1698–1704 doi: 10.1111/nmo.12869

The rising cost of hospital care for children with gastroparesis: 2004–2013

P. L. LU,* M. MOORE-CLINGENPEEL,† D. YACOB,* C. DI LORENZO* & H. M. MOUSA‡

*Division of Pediatric Gastroenterology, Hepatology and Nutrition, Department of Pediatrics, Nationwide Children's Hospital, Columbus, OH, USA

†Biostatistics Core, Nationwide Children's Hospital Research Institute, Columbus, OH, USA

‡Division of Pediatric Gastroenterology, Hepatology and Nutrition, Department of Pediatrics, University of California, San Diego, Rady Children's Hospital, San Diego, CA, USA

Key Points

- The cost of hospital care for adults with gastroparesis (GP) has been increasing over time. Our objective was to evaluate the cost of hospital care for children with GP.
- The annual cost of hospitalization for children with GP increased by nearly sixfold from 2004 to 2013, driven by a rise in the number of hospitalizations for GP.
- The rising cost of hospital care for children with GP despite decreases in pediatric hospitalization overall emphasizes the importance of cost-effective evaluation and management of GP.

ABSTRACT

Background *The cost of hospital care for adults with gastroparesis (GP) is increasing. Our objective was to evaluate the cost of hospital care for children with GP.* ***Methods*** *Using the Pediatric Health Information System, we selected hospitalizations with a diagnosis of GP (ICD-9 536.3), dyspepsia and other specified disorders of function of stomach (DYS, 536.8) and unspecified functional disorder of stomach (UFD, 536.9) from 2004 to 2013. We recorded dates of hospitalization, demographics, costs, and length of stay (LOS).* ***Key Results*** *From 2004 to 2013, 4015 patients were admitted for GP (54.2% female, median age 8 years). Total cost of hospitalization for GP increased 5.8 fold from $6 185 390 to $35 654 075 ($p = 0.0001$). Cost per hospitalization did not change. Cost of initial hospitalization was highest in patients 0–5 years and lowest in patients 16–21 years ($p < 0.0001$). Number of hospitalizations each year for GP increased from 252 to 1310 ($p < 0.0001$) and unique patients hospitalized increased from 174 to 723 ($p < 0.0001$). Number of hospitalizations and unique patients for DYS/UFD also increased ($p < 0.0001$). LOS for GP did not change with time. Females and younger GP patients had more repeat hospitalizations ($p < 0.0001$, $p < 0.0001$).* ***Conclusions & Inferences*** *The financial burden of hospitalization for pediatric GP has increased dramatically from 2004 to 2013, driven by a rise in number of hospitalizations and unique patients hospitalized each year. Cost and LOS per hospitalization remain stable. Unlike in adults, hospitalizations for DYS/UFD have also increased, suggesting that the increase in hospitalizations for GP is not secondary to changing diagnostic practices.*

Keywords *gastroparesis, hospitalization, pediatrics.*

Abbreviations: GP, gastroparesis; PHIS, Pediatric Health Information System; DYS, dyspepsia and other specified disorders of function of stomach; UFD, unspecified functional disorder of stomach; LOS, length of stay.

Address for Correspondence
Peter L. Lu, Division of Pediatric Gastroenterology, Hepatology and Nutrition, Department of Pediatrics, Nationwide Children's Hospital, 700 Children's Drive, Columbus, OH 43205, USA.
Tel: (614) 722-3421; fax: (614) 722-3454;
e-mail: peter.lu@nationwidechildrens.org

View the podcast on this paper at the following sites:
iTunes: https://itunes.apple.com/gb/podcast/neurogastroenterology-motility/id1161316294
YouTube: https://www.youtube.com/watch?v=HeFM5_LAJD4&feature=youtu.be

Received: 24 January 2016
Accepted for publication: 4 May 2016

Gastroparesis (GP) is defined as a delay in gastric emptying in the absence of mechanical obstruction. GP can lead to a number of gastrointestinal symptoms, including nausea, vomiting, early satiety, upper abdominal pain, and weight loss. Although primarily described in adults, recognition of GP in children is increasing. The prevalence of GP in children is unknown and the epidemiology of GP in children has not been well described.[1] In retrospective reviews of children with GP, investigators found that GP affected all ages, with female predominance increasing with age.[2–4] The prevalence of GP in adults has been difficult to estimate. Using a medical record database in Olmsted County, Minnesota, Jung and colleagues found that definite GP, defined as typical symptoms and delayed gastric emptying by scintigraphy, had a prevalence of 24.2 per 100 000 persons. They did not find a significant increase in incidence from 1996 through 2006.[5] Recognizing that a significant proportion of patients with GP may not have had a gastric emptying study, Rey *et al.*[6] used a symptom-based model to predict gastric emptying and found that the prevalence of GP may be closer to 1.8%.

Although the prevalence of GP remains unclear, the number of hospitalizations and the associated cost of care for adults with GP have been increasing over the past 2 decades. Wang *et al.* showed an increase of 158% in the number of hospitalizations with a primary diagnosis of GP from 1995 to 2004. The average cost of each hospitalization increased over this time period as well, from $12 311 in 1995 to $20 573 in 2004.[7] Nusrat *et al.* found an even more striking increase in the number of hospitalizations for GP, with an 18-fold increase from 1993 to 2009. They postulated that part of this increase was due to increased awareness of GP, which was supported by a concurrent 50% decrease in admissions for functional disorders of the stomach over the time period studied.[8] There is no corresponding information on hospital care for children with GP. The aim of our study was to evaluate the cost of hospital care for children with GP. We hypothesized that the number of hospitalizations and associated cost of hospital care for children with GP have been increasing over the past decade in parallel with increases among adults with GP. We also hypothesized that this rise was in part secondary to increasing disease awareness and changes in diagnostic classification.

MATERIALS AND METHODS

We performed a review of the Pediatric Health Information System (PHIS) database, an administrative database managed by the Children's Hospital Association. The PHIS database includes demographic information, diagnostic codes, procedure codes, and billing information from hospital encounters at over 40 academic pediatric hospitals across North America. We included patients up to 21 years of age. We selected inpatient encounters with a primary or secondary diagnosis of GP (ICD-9 536.3), dyspepsia and other specified disorders of function of stomach (DYS, ICD-9 536.8), and unspecified functional disorder of stomach (UFD, ICD-9 536.9) from 2004 through 2013. The latter two diagnoses were included because of the overlap in presentation of these diagnoses with GP. We included these diagnoses in our analysis in an effort to understand the effect of changing diagnostic practices on our findings. For each hospitalization, we recorded dates of hospitalization, demographic information, hospital costs, length of stay (LOS), and region of the admitting institution based on the United States Census Bureau census regions. Hospital costs were based upon each hospital's ratio of cost to charges and were adjusted for hospital location using the Centers for Medicare & Medicaid Services wage/price index. Yearly aggregate hospital charges were adjusted for inflation using the Consumer Price Index.[9] Each patient was assigned a unique identifier, allowing us to identify repeat hospitalizations during the time period of interest.

We evaluated group comparisons using chi-squared tests for categorical variables and one-way ANOVA or Kruskal–Wallis tests, as appropriate, for continuous variables. Where there was a significant overall group effect, we performed pairwise comparisons and adjusted for multiplicity using a Bonferroni–Holm correction. We used linear regression models to determine significance of trends over time, Poisson regression to examine predictors of number of hospitalizations, and gamma regression with a log link function to assess factors associated with cost of hospitalization. Model selection for all multivariable models was based on stepwise selection using a $p < 0.10$ as the selection criterion.

RESULTS

Patient characteristics

From 2004 to 2013, 4015 unique patients were hospitalized with a diagnosis of GP compared to 18 114 with DYS and 676 with UFD. Patient characteristics are shown in Table 1. Although 54.2% of GP patients were

Table 1 Patient characteristics for all diagnoses

Diagnosis	Number of unique patients	% Female	Median age (IQR)	Region (%)
Gastroparesis (GP)	4015	54.2	8 years (2–14)	Midwest (27.7) Northeast (15.4) South (40.4) West (16.6)
Dyspepsia (DYS)	18 114	51.6*	6 years (1–12)*	Midwest (31.3)* Northeast (8.4)* South (32.8)* West (27.4)*
Unspecified functional disorder (UFD)	676	53.3*	7 years (1–13)*	Midwest (39.3)* Northeast (9.6)* South (29.2)* West (22.0)*

*Statistically significant difference when compared to GP, $p < 0.05$.

female, this predominance was not statistically significant. The percentage of GP patients who were female did not change significantly from 2004 through 2013. The proportion of patients who were female was significantly greater for GP and UFD than DYS ($p < 0.05$). The median age of GP patients was 8 years (IQR 2–14 years), which was older than patients with DYS or UFD ($p < 0.05$, $p < 0.05$). At the time of their first visit, 43.5% of GP patients were between 0 and 5 years of age and only 13.0% were 16–21 years of age. The age distribution of GP patients is shown in Fig. 1. The median age of GP patients did not change significantly from 2004 to 2013. Regional differences in hospitalization between each diagnosis were statistically significant, with 40.4% of GP patients hospitalized in the South region.

Cost of hospitalization

As shown in Fig. 2, the total annual cost of hospitalizations with a diagnosis of GP increased at a rate of about $3.4 million per year from 2004 to 2013 after correcting for inflation ($p = 0.0001$). The total annual cost of hospitalizations with a diagnosis of DYS increased at a rate of about $920 000 per year ($p < 0.0001$) and total annual cost with UFD increased about $443 000 per year ($p < 0.001$). Compared to total annual cost in 2004, total annual cost in 2013 was about 5.8 times greater for GP, 6.3 times greater for DYS, and 14.2 times greater for UFD.

As shown in Fig. 3, there was no statistically significant increase in the inflation-adjusted cost per hospitalization with a diagnosis of GP from 2004 to 2013. However, costs per hospitalization with DYS and UFD increased significantly over this time period ($p < 0.001$, $p < 0.01$, respectively). The overall mean

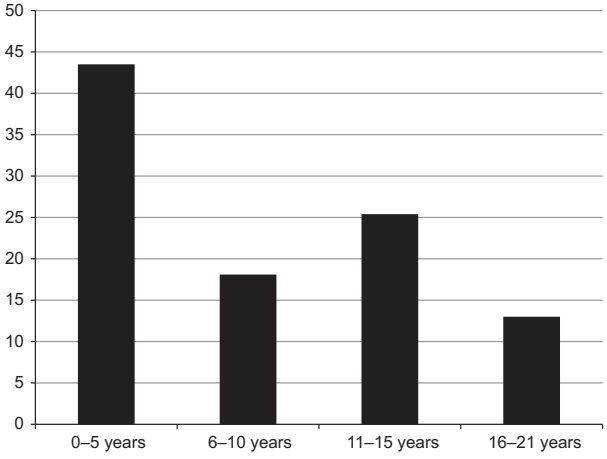

Figure 1 Age distribution of GP patients (%). GP, gastroparesis.

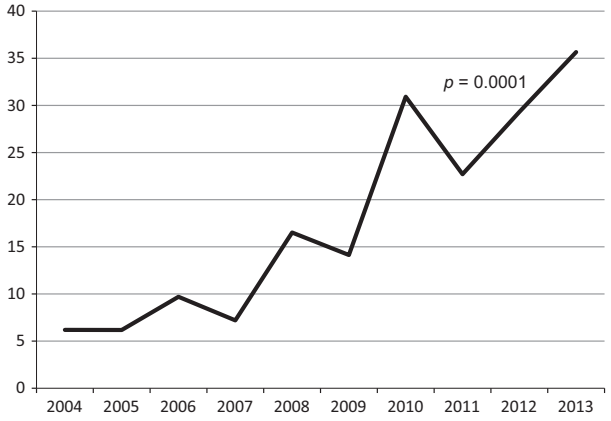

Figure 2 Total cost of hospitalizations for GP over time (millions USD). GP, gastroparesis.

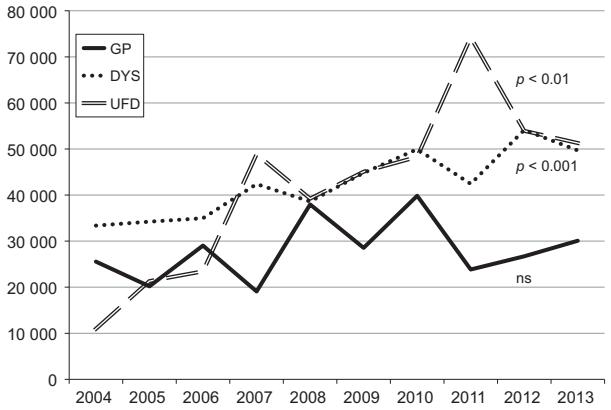

Figure 3 Mean cost per hospitalization for GP, DYS, and UFD over time (USD). GP, gastroparesis; DYS, dyspepsia and other specified disorders of function of stomach; UFD, unspecified functional disorder of stomach.

cost per hospitalization with a diagnosis of GP was $28 089 (SD $6756), which was significantly less than hospitalization with DYS ($p < 0.05$), but was not significantly different than hospitalization with UFD. Mean costs per hospitalization with DYS and UFD were not significantly different at $42 460 (SD $7238) and $41 662 (SD $18 579), respectively.

To better understand what factors influence the cost per hospitalization, we examined the effects of age, gender, and region on cost per hospitalization with each of the three diagnoses. To account for differences between a patient's initial hospitalization for a given diagnosis and repeat hospitalizations with the same diagnosis, we studied both the initial and third hospitalizations for a given patient with a given diagnosis during the time period studied. Exploratory analyses showed that the effects of age, gender, and region were generally stable after the third visit, which accounted for

7% of hospitalizations. Among GP patients, males had a significantly higher cost of initial hospitalization compared to females ($47 674 *vs* $40 629, $p < 0.05$). Cost of initial hospitalization was highest in the 0–5 year age group at $61 536 and lowest in the 16–21 year age group at $27 946 ($p < 0.0001$). Cost of initial hospitalization with a diagnosis of GP was highest in the West and Midwest at $54 448 and $51 052 compared to the South and Northeast at $40 543 and $29 752, respectively ($p < 0.0001$). However, gender, age, and region-based differences in hospitalization cost were no longer significant at the third hospitalization.

Rate of hospitalization

As shown in Fig. 4, the number of hospitalizations per year with a diagnosis of GP increased significantly at a rate of about 130 additional hospitalizations each year ($p < 0.0001$). The number of hospitalizations with a diagnosis of GP in 2013 was 5.2 times greater than in 2004. The number of unique patients hospitalized with GP each year increased significantly as well, from 174 to 723 over the time period studied ($p < 0.0001$). The number of hospitalizations each year with a diagnosis of DYS or UFD increased significantly during this time period ($p < 0.0001$, $p < 0.0001$) and the number of unique patients hospitalized with these two diagnoses each year increased significantly as well ($p < 0.0001$, $p < 0.0001$). The number of hospitalizations each year with DYS was significantly greater than for GP or UFD, with an average of 2413 hospitalizations each year compared to 682 for GP and 78 for UFD ($p < 0.05$, $p < 0.05$). These differences remain when we look at the number of unique patients admitted each year with each diagnosis, with 2071 patients admitted with a diagnosis of DYS compared to 532 patients with GP and 77 patients with UFD ($p < 0.05$, $p < 0.05$).

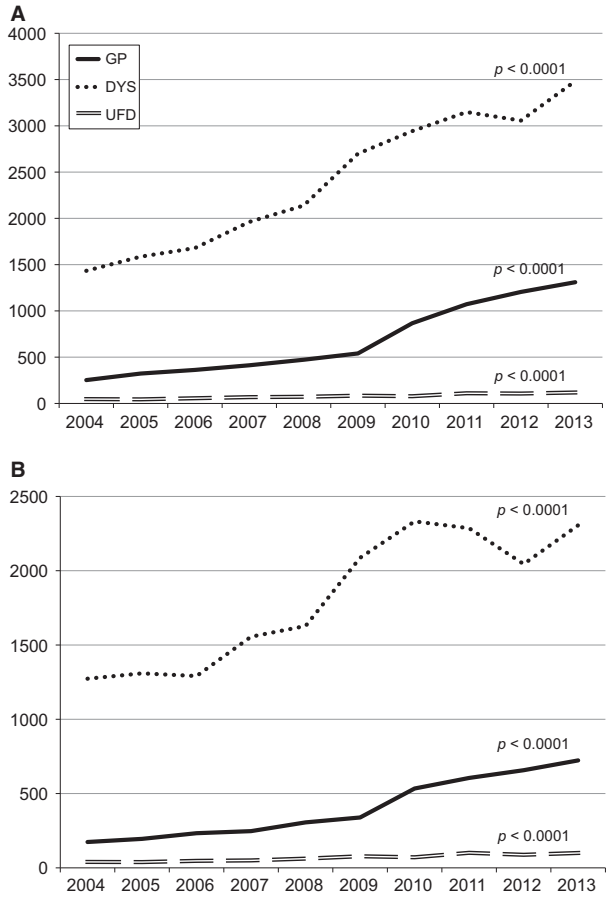

Figure 4 (A) Number of hospitalizations each year for GP, DYS, and UFD over time. (B) Unique patients hospitalized each year for GP, DYS, and UFD over time. GP, gastroparesis; DYS, dyspepsia and other specified disorders of function of stomach; UFD, unspecified functional disorder of stomach.

Repeat hospitalizations

Seventeen percent of patients were hospitalized more than once during the time period studied. GP patients had the most repeat hospitalizations, with a mean of 1.7 hospitalizations per unique patient from 2004 to 2013. This was significantly more hospitalizations than for DYS and UFD with 1.3 and 1.2 hospitalizations per patient, respectively (<0.05). Among GP patients, females had a mean of 1.8 hospitalizations per patient, which was significantly greater than males, who had 1.5 hospitalizations per patient ($p < 0.0001$). After controlling for age, females had 1.1 times more hospitalizations than males ($p < 0.0001$). When we divide patients by age at the time of initial hospitalization during the time period studied, the mean number of hospitalizations per patient by the end of the time period was lowest in the 0–5 year age group at 1.4 and steadily increased with age to 2.0 in the 16–21 year age group ($p < 0.0001$). After controlling for gender, the 16–21 year age group still had significantly more hospitalizations with a diagnosis of GP than any of the other age groups (1.35, 1.21, and 1.09 times more than the 0–5, 6–10, and 11–15 year age groups, respectively; $p < 0.0001$, $p < 0.0001$, $p < 0.05$). The number of hospitalizations with a diagnosis of GP per patient did not differ significantly by region. For DYS and UFD, after controlling for region neither gender nor age had a significant effect on the number of hospitalizations per patient.

Length of stay

The median LOS for GP hospitalizations was 5 days (IQR 2–11 days, mean 11.7 days, SD 25.1 days) and did

not change significantly from 2004 to 2013. The median LOS for GP hospitalizations was not significantly different from the median LOS for DYS hospitalizations, which was 3 days (IQR 1–12 days). The median LOS for both GP and DYS hospitalizations was significantly greater than for UFD, which was 2 days (IQR 1–5 days, $p < 0.05$). The median LOS for GP hospitalizations gradually decreased with repeat hospitalizations from 5 days at the initial hospitalization to 4 days (IQR 2–10 days) at the third hospitalization and 4 days (IQR 2–9 days) at the fifth hospitalization, but this change was not substantially different from visit to visit.

DISCUSSION

In this first evaluation of the cost of hospital care for children with GP, we found that the financial burden of hospitalizations with a diagnosis of GP has been increasing dramatically over the past decade. The annual cost of hospitalization for children with GP has increased by nearly sixfold from 2004 to 2013, primarily driven by a steady rise in both the number of hospitalizations with a diagnosis of GP and the number of unique patients admitted with GP over this time period. The mean cost per hospitalization with a diagnosis of GP has not changed significantly over this time period. In contrast with findings in adults, the number of hospitalizations with a diagnosis of DYS and UFD has also been rising over this time period, suggesting that the increase in hospitalizations with GP is not secondary solely to increasing recognition and changes in diagnostic coding.

In contrast to what has been demonstrated in studies of adults with GP, we did not find a statistically significant female predominance among children hospitalized with a diagnosis of GP. This is consistent with the findings of prior studies of children with GP.[1,3] We found that children younger than 5 years of age had the most hospitalizations with a diagnosis of GP over the time period studied followed by children 11–15 years of age, 6–10 years of age, and 16–21 years of age. This is similar to the age distribution described by Waseem *et al.*[3] in a review of 239 children with delayed gastric emptying based on scintigraphy. Hospitalizations with a diagnosis of GP were more common in the South, whereas DYS and UFD were more common in the Midwest. While this may represent regional variation in diagnostic practices as has been described in adults with GP, regional variation of GP prevalence in children may allow us to better understand the causes of GP in children, particularly those currently classified as idiopathic.[10]

In order to better understand the rising number of hospitalizations for children with GP, it is important to consider overall hospitalization trends for children. Based on data from the Healthcare Cost and Utilization Project (HCUP), hospitalizations for patients 0–17 years of age have decreased from 6.35 million discharges in 2000 to 5.85 million in 2012. From 2000 to 2012, the rate of hospitalization for children with digestive disorders decreased 23.7%.[11,12] However, our study used data gathered from a select group of academic pediatric hospitals, in contrast to the broader group of hospitals included in HCUP.

In a study of pediatric inpatient encounters from 2004 through 2009 using the PHIS database, Berry *et al.* found increases in both the number of hospitalizations and unique patients admitted. They describe an average year-to-year increase of 3.3% in unique patients admitted over this time period. In comparison, our study found an average year-to-year increase of 18.0% in unique patients admitted for GP from 2004 through 2013. If we limit our data to the time period used by Berry *et al.*,[13] we find an average year-to-year increase of 13.6% from 2004 through 2009. Both the number of hospitalizations with a diagnosis of GP and the number of unique patients admitted have been increasing at a greater rate than for pediatric patients overall. Our findings parallel the rising number of hospitalizations for adults with GP described by Wang *et al.*[7] and Nusrat *et al.*[8]

Our mean cost per hospitalization with a diagnosis of GP is comparable to that described by Wang *et al.*, who found a mean cost of $20 455 in 2004.[7,8] We found a mean cost of $25 559 in 2004 after correcting for inflation and this did not change significantly over the following decade. In comparison, the average pediatric hospitalization charge increased from $9945 in 2003 to $21 272 in 2012 based on HCUP data.[11] Our mean LOS was considerably longer than both what had been described previously in adults with GP and for pediatric hospitalizations in general. The mean LOS was 11.7 days, nearly three times the mean LOS of 4.6 days for adult GP admissions.[7] Our mean LOS was also longer than for pediatric hospitalizations overall, which in 2012 was 4.2 days after excluding neonatal and maternal stays.[12]

Our evaluation of hospital care trends for two diagnoses that can present with symptoms similar to those of GP, namely DYS and UFD, suggests that the increase in admissions for children with GP is not secondary to changes in diagnostic or coding practices between these disorders. In contrast to the findings by Nusrat *et al.*, we found that admissions with our two related diagnoses have been increasing significantly

over the past decade rather than decreasing.[8] In fact, we found that hospitalizations for children with DYS have been increasing at an even greater rate than GP and that DYS is responsible for significantly more hospitalizations at a significantly higher average cost than GP. Unlike GP, the average cost per hospitalization for children with DYS has been increasing significantly over the past decade. However, the possibility remains that increasing awareness of all three of the included diagnoses could contribute to the increases in hospitalization that we observed.

There are a number of factors that may be contributing to the increasing number of hospitalizations for children with GP. First of all, a true increase in the prevalence of GP in children over time could certainly lead to increases in hospitalizations and individual patients admitted each year. An increase in the overall severity of GP in children over time could also contribute to increased hospitalizations even if the prevalence of GP remained stable. Future studies evaluating both outpatient and inpatient care for children with GP would be helpful in determining whether this is the case. Finally, because our study used data from a cohort of children's hospitals, a shift from seeking care in community hospitals toward academic children's hospitals could contribute to the changes we described. Further research is needed before we can confidently identify factors that explain the findings of our study.

It is important that we acknowledge the limitations to our study, some of which are inherent to any study utilizing a large healthcare database. We do not have reliable information on how each ICD-9 code-based diagnosis was made. The PHIS database does not differentiate between preexisting diagnoses and new diagnoses made during the encounter. The PHIS database also collects information from a select cohort of children's hospitals, which may not accurately represent national hospitalization trends.

The rising cost of hospital care for children with GP over the past decade despite decreases in pediatric hospitalization overall emphasizes the importance of cost-effective evaluation and management of children with GP. This is particularly important in females and adolescents, who have significantly more repeat hospitalizations. We found an even more dramatic increase in the cost of hospital care for children with DYS, which suggests that cost-effective care is critical not only for children with GP but all motility and functional gastrointestinal disorders. Further studies are needed to understand the factors contributing to the trends we observed, specifically by measuring the prevalence of GP in children, evaluating the cost of outpatient care for children with GP, and comparing the cost-effectiveness of various diagnostic and treatment strategies.

ACKNOWLEDGMENTS

Preliminary findings of this study were previously presented at the 17th Neurogastroenterology & Motility Scientific Meeting and published in abstract form.[14]

FUNDING

This study was done without specific support.

CONFLICT OF INTEREST

The authors have no conflict of interest.

AUTHOR CONTRIBUTION

PLL, DY, CD, and HM designed the study; PLL and MM collected and analyzed the data; PLL wrote the initial manuscript; and PLL, MM, DY, CD, and HM critically reviewed and revised the manuscript. All authors approved the final manuscript as submitted.

REFERENCES

1 Islam S. Gastroparesis in children. *Curr Opin Pediatr* 2015; **27**: 377–82.
2 Rodriguez L, Irani K, Jiang H, Goldstein AM. Clinical presentation, response to therapy, and outcome of gastroparesis in children. *J Pediatr Gastroenterol Nutr* 2012; **55**: 185–90.
3 Waseem S, Islam S, Kahn G, Moshiree B, Talley NJ. Spectrum of gastroparesis in children. *J Pediatr Gastroenterol Nutr* 2012; **55**: 166–72.
4 Saliakellis E, Fotoulaki M. Gastroparesis in children. *Ann Gastroenterol* 2013; **26**: 204–11.
5 Jung HK, Choung RS, Locke GR 3rd, Schleck CD, Zinsmeister AR, Szarka LA, Mullan B, Talley NJ. The incidence, prevalence, and outcomes of patients with gastroparesis in Olmsted County, Minnesota, from 1996 to 2006. *Gastroenterology* 2009; **136**: 1225–33.
6 Rey E, Choung RS, Schleck CD, Zinsmeister AR, Talley NJ, Locke GR 3rd. Prevalence of hidden gastroparesis in the community: the gastroparesis "iceberg". *J Neurogastroenterol Motil* 2012; **18**: 34–42.
7 Wang YR, Fisher RS, Parkman HP. Gastroparesis-related hospitalizations in the United States: trends, characteristics, and outcomes, 1995-2004. *Am J Gastroenterol* 2008; **103**: 313–22.
8 Nusrat S, Bielefeldt K. Gastroparesis on the rise: incidence vs awareness? *Neurogastroenterol Motil* 2013; **25**: 16–22.

9 Consumer Price Index. US Bureau of labor statistics. Available at: http://www.bls.gov/cpi/ (accessed January 14, 2015).
10 Bielefeldt K. Regional differences in healthcare delivery for gastroparesis. *Dig Dis Sci* 2013; **58**: 2789–98.
11 H-CUPnet. Agency for Healthcare Research and Quality. Available at: http://hcupnet.ahrq.gov (accessed January 14, 2015).
12 Witt W, Weiss AJ, Elixhauser A. Overview of hospital stays for children in the United States, 2012. HCUP Statistical Brief #187. 2014. Rockville, MD.
13 Berry JG, Hall M, Hall DE, Kuo DZ, Cohen E, Agrawal R, Mandl KD, Clifton H. *et al.* Inpatient growth and resource use in 28 children's hospitals: a longitudinal, multi-institutional study. *JAMA Pediatrics* 2013; **167**: 170–7.
14 Lu PL, Schaffner E, Alhajj T, Skaggs B, di Lorenzo C, Mousa HM. The cost of care for children with gastroparesis. *Neurogastroenterol Motil* 2013; **25**: 12.