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Publication Date

2018-03-01

DOI

10.1016/j.jpeds.2017.10.038

Peer reviewed

Published in final edited form as:

J Pediatr. 2018 March ; 194: 218–224. doi:10.1016/j.jpeds.2017.10.038.

Hospitalizations for Ambulatory Care-Sensitive Conditions among Children with Chronic and Complex Diseases

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Abstract

Objective—To evaluate ambulatory-care sensitive (ACS) hospitalizations for children with non-complex chronic diseases (NC-CD) and children with medical complexity (CMC), and identify associations with ambulatory care characteristics. Although ACS hospitalizations are potentially preventable in general populations, the specific ambulatory care predictors and influence of medical complexity on them is poorly understood.

Study design—Retrospective cohort study of NC-CD and CMC hospitalizations at a children's hospital during 2007–2014, excluding labor/delivery and children over 21 years. Pediatric Medical Complexity Algorithm identified NC-CD or CMC. ACS hospitalizations were identified using Agency for Healthcare Research and Quality indicator definitions. Demographic and ambulatory care characteristics were compared between ACS and non-ACS hospitalizations with logistic regression clustered by patient. Measures of ambulatory care during 2 years prior to admission were explored with 20% random sample of general pediatrics discharges.

Results—Among 4,035 children with NC-CD, 14.6% of 4,926 hospitalizations were ACS hospitalizations. Among 5,084 CMC, 5.3% of 14,390 discharges were ACS hospitalizations. Among NC-CD discharges, ACS hospitalizations were more likely with no prior-year outpatient visits (OR 1.4, 95% CI 1.1–1.7) and less likely with timely well checks (OR 0.8, 95% CI 0.6–0.9)

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The authors declare no conflicts of interest.

and phone encounters in the month before admission (OR 0.5, 95% CI 0.2–1.0). Among CMC discharges, the only association observed was with provider continuity (OR 0.3, 95% CI 0.1–1.0).

Conclusions—Provider continuity may be associated with fewer CMC ACS hospitalizations, however measures of ambulatory care were more consistently associated with ACS hospitalizations for NC-CD. CMC may need more precise ACS hospitalization definitions.

Keywords

preventable hospitalizations; ambulatory care-sensitive conditions; medical complexity; chronic conditions

Ambulatory care-sensitive conditions (ACSC) are conditions for which high quality outpatient care can potentially prevent the need for hospitalization.(1) ACSCs were developed by expert consensus methods, have substantial face validity,(2, 3), and account for up to one-third of pediatric hospitalizations.(4) Examples of pediatric ACSCs include asthma, urinary tract infection, and dehydration. Previous research has suggested that less provider continuity, (5) adherence to preventive care schedules,(5), and insurance access(6) may be associated with ACS hospitalizations; however, limited empiric research has assessed a broad set of specific ambulatory care experiences and processes that predict them.

Moreover, several recent studies suggest that ACSCs may behave differently for children with more complex medical conditions. Children with medical complexity (CMC) are most commonly described as having severe chronic conditions, major functional limitations, high health resources utilization, and substantial health service needs.(7) Hospitalizations of CMC are less likely to be for ACSCs than hospitalizations of non-CMC.(4, 8) In one study, over 90% of patients with spina bifida and hospitalization for urinary tract infection had ambulatory claims in 7 days prior to admission.(9) These findings may not be surprising if one speculates that, simply because of fragility associated with unstable underlying diagnoses, CMC often require hospitalization for an ACSC no matter how optimally their ambulatory care is delivered.

Because hospital care accounts for one-third of US healthcare spending and represents the largest single component of healthcare expenditures,(10) reliable and valid tools to identify preventable hospitalizations are needed. Such tools are even more important for CMC. Despite being only 0.5–6% of children,(11, 12) their care accounts for 30% of total child health spending,(11) 50–80% of which is due to hospital care.(11–14) Understanding how ambulatory care predictors of ACS hospitalizations differ between children with non-complex chronic diseases and with medical complexity is an important first step to delivering more precise interventions to reduce hospital utilization in each population.

The objective of this 2-part study was to identify associations between characteristics of ambulatory care and ACS hospitalizations among children with varying underlying levels of health. We hypothesized that ambulatory care characteristics would have weaker relationships to ACS hospitalizations for CMC than for children with less complex chronic conditions. In the first phase, administrative data was used to examine predictors of ACS hospitalization; and in the second phase, chart review data among a smaller subset of

discharges was used to examine ambulatory care predictors of ACS hospitalization frequently unavailable in administrative data.

Methods

This retrospective cohort study included pediatric discharges from a tertiary children's hospital between 7/2007–7/2014. We used the Pediatric Medical Complexity Algorithm (PMCA) to categorize patients into 3 mutually exclusive groups: (1) non-chronic, (2) non-complex chronic, or (3) complex chronic disease.(15) We included encounters for patients with non-complex chronic (NC-CD) or complex chronic diseases (ie, CMC). NC-CD typically involve only a single body system, are non-progressive and are variable in severity (eg, asthma, depression); CMC involve multiple body systems and are progressive, frequently requiring technology assistance (eg, cerebral palsy, tracheostomy with ventilator dependence).

This study was conducted with 2 samples. The administrative sample represented all inpatient and observation hospital discharge encounters for patients ≤21 years old during the study period, excluding only neonatal and labor/delivery encounters. This administrative sample therefore included patients from all hospital services, including hospital medicine, subspecialty or surgical services, and intensive care.

The chart review sample was a random subset of the administrative sample chosen to facilitate collecting ambulatory care details beyond what is routinely available in administrative data. We restricted this sample to encounters of patients admitted only to the hospital medicine service who had a primary care provider within our health system, to ensure complete access to pertinent ambulatory care information. Therefore, the chart review dataset was comprised of a 20% stratified random sample of the 1370 encounters for NC-CD and CMC on the hospital medicine service who received primary care within our health system. A structured data abstraction protocol was developed after piloting on 5 encounters of NC-CD and CMC not included in our study.

All discharge encounters were categorized as ACS or non-ACS hospitalizations. We used pediatric ACSC definitions available from the Agency for Healthcare Research and Quality (AHRQ) Pediatric Quality Indicators Technical Specifications, version 5.0(16) – diabetes complications, perforated appendix, gastroenteritis, urinary tract infection, and asthma. As in previous studies,(4) we also included bacterial pneumonia, which is within the AHRQ's general Prevention Quality Indicator set.

We adapted existing pediatric measures of quality and access to care(6, 17–20) for this study, and assessed each up to 2 years prior to hospitalization. Measures were limited to those that were able to be abstracted from administrative or chart review sources; and not disease-specific, such that they could be applied to all encounters. Measures and data sources included the following: 1) Having a primary care provider at the time of hospitalization (administrative); 2) Having health insurance at the time of hospitalization (administrative); 3) Timely well checks (chart review); 4) Primary care provider continuity (chart review); 5) Childhood vaccination status (chart review); 6) Anthropometric

measurement (weight, length/height, body mass index; chart review); and 7) Outpatient visits – primary and specialty care (administrative and chart review).

Timely well checks were defined as the proportion of recommended well checks that were attended on time (based on American Academy of Pediatrics recommendations(21)), using an approach described previously.(5) Primary care provider continuity was assessed using a continuity of care index, K, described by Ejlertsson.(22, 23) We calculated the K index by dividing the difference in the number of well care visits and the number of different providers by the number of well care visits minus 1. Continuity was dichotomized as above or below the median because we observed bimodal peaks at 0 and 1. Continuity scores could only be calculated when patients had >1 well care visit in the 2 years prior to hospitalization. Vaccination status was categorized as up to date or not, based on Centers for Disease Control and Prevention recommendations at the time the child was 2 years old. Children under 2 were considered vaccinated if they were up to date based on their age at the time of assessment.

In addition, we sought to characterize ambulatory encounters in the 30 days leading up to each hospitalization. Ambulatory encounters were defined as patient-provider interactions documented in the electronic health record, whether by phone, electronic or in-person: Total encounters—phone, electronic (e.g., email, inbasket), or in-person (chart review) and encounters for the same problem as hospitalization, phone, electronic, or in-person (chart review).

We included covariates consistent with previous pediatric ACS and CMC utilization studies, (4, 24, 25) including age, sex, child's race/ethnicity, and primary language. Severity of illness was assessed using All-Patient Refined Diagnosis-Related Group (APR-DRG) severity, hospitalization length of stay, and past-year hospitalizations. We also included passive smoke exposure, which has been associated with increased pediatric hospital use in general(26) and among children with asthma (27) and is also associated with more severe pneumonia.(28) Smoke exposure was assessed routinely on admission using a nursing intake form. Although nearly 33% of responses were missing, there was no difference in missingness between children with non-complex chronic or complex chronic disease. We coded smoke exposure into three categories – yes, no, or missing.

Statistical Analyses

Descriptive statistics compared differences between ACS and non-ACS hospitalizations for NC-CD and CMC. The first phase analyzed the administrative sample, testing associations among ACS hospitalization, patient characteristics and ambulatory care measures with bivariate followed by multivariable logistic regression clustered by patient and stratified by NC-CD and CMC status. The second phase analyzed the chart review sample using bivariate logistic regression clustered by patient and stratified by NC-CD and CMC status. Analyses were completed using STATA version 14 (College Station, Texas). This study was approved by the institutional review board of the University of Wisconsin.

Results

Among 4,035 NC-CD, 14.6% of the 4,926 discharges were for ACSCs; whereas among 5,084 CMC, 5.3% of the 14,390 discharges were for ACSCs. The most common ACSCs were asthma in the NC-CD group and pneumonia in the CMC group (Figure 1). Encounter characteristics are summarized in Table 1. In the chart review sample, which was comprised of discharges from the hospital medicine service who received primary care within our health system, 118 children with NC-CD had 120 hospitalizations (38.3% for ACSCs) and 151 CMC had 180 hospitalizations (12.2% for ACSCs).

Predictors of ACS hospitalization differed substantially for children with non-complex chronic and complex chronic disease. More specifically, we identified essentially no predictors of ACS hospitalization for CMC, but several among NC-CD. The administrative analysis (Figure 2) highlights that among NC-CD, hospitalizations were more likely to be ACS hospitalizations when children had any non-white race/ethnicity, e.g., odds of hospitalizations for an ACSC among non-Hispanic black children were 3.4 times higher than non-Hispanic white children. Similarly, odds of hospitalizations for an ACSC were nearly 2 times higher for patients without insurance than those with insurance, and 1.4 times higher for patients with no outpatient visits in the previous year compared with >1 outpatient visit in the previous year. Hospitalizations were also more likely to be for ACSCs when children had passive smoke exposure. No relationships were observed between CMC hospitalizations and demographics, smoke exposure, insurance status, outpatient visits in previous year, or having a primary care provider.

The chart review analysis (Table II) highlights additional differences between NC-CD and CMC. Encounters for NC-CD were less likely to be for ACSCs when there were more timely well checks and when a higher proportion of recommended well checks occurred in the 2 years prior to hospitalization. Hospitalizations for CMC were more likely to be ACS hospitalizations when provider continuity was below the median continuity index score (OR 0.3, 95% CI 0.1–1.0). The latter finding represents the only association between study measures and ACS hospitalizations observed among CMC.

In the 2 years before the 46 ACS hospitalizations in the NC-CD group, there were 131 primary care visits and 18 specialist visits for the same ACSC which did not result in admission. In the CMC group, prior to the 22 ACS hospitalizations there were 64 primary care visits and 53 specialist visits for the same ACSC which did not result in admission.

In the month before hospitalization, ambulatory encounters were nearly universal for CMC (90.0% among CMC vs 75.8% among NC-CD, $P = .001$), with no difference prior to ACS or non-ACS hospitalizations. In-person encounters occurred before 81.7% of CMC hospitalizations, phone encounters before 78.3%, and both in-person and phone encounters before 70.0%. Among NC-CD, in-person encounters preceded 69.2% of hospitalizations while both and in-person and phone encounters preceded 48.3%. Having a phone encounter was associated with 50% lower odds of a hospitalization being for an ACSC for NC-CD. Among CMC, there were no associations between encounter type or frequency and ACS or non-ACS hospitalizations in the 30 days before admission.

Discussion

Despite the assumption that hospitalizations due to ACSCs are avoidable through high-quality ambulatory care, empiric support for this concept in pediatrics is needed. Our study findings suggest that measures of ambulatory care are related to ACS hospitalization but also suggest that underlying health status may be an important moderator of these relationships, and among CMC, hospitalizations for these conditions may be less sensitive to ambulatory care. Multiple ambulatory care measures were associated with ACS hospitalizations for children with NC-CD. Namely, we found that hospitalizations were more likely to be for ACSCs when patients had fewer timely well-checks in the past 2 years, lack of outpatient visits in prior year, and no phone encounters in the month prior to the hospitalization. We also observed more ACS hospitalizations when children were uninsured or had passive smoke exposure. Although the latter findings are indirect measures of ambulatory care, primary care providers may feel that attempting to help families reduce passive smoke exposure or overcome insurance barriers when possible falls within the scope of the medical home.

Aligned with our results, data from a large health plan in Hawaii observed that children with chronic disease and less adherence to the pediatric preventive care schedule had higher risk of ACS hospitalization.(5) Our findings are also reminiscent of research at one children's hospital which assessed primary care, inpatient physician, and parent perspectives on "preventability" during 554 acute ACS hospitalizations.(25) Respondents cited better outpatient primary care follow-up and better quality of care as key approaches for reducing these hospitalizations. A related study on asthma hospitalizations identified that failing to contact ambulatory physicians before the hospitalization was the greatest preventable risk factor for admission.(29)

Among CMC, it was notable that we observed that less primary care provider continuity was associated with ACS hospitalizations. Less continuity has been associated with ACS hospitalization risk previously(5); however, this question has not been examined among CMC specifically. Qualitative work has identified continuity as important for reducing hospital use in general by CMC caregivers.(30) A national expert panel identified a concept closely related to continuity, access to familiar providers, as a strategy expected to prevent hospitalizations among CMC.(31)

We were not surprised that other measures of ambulatory care were essentially unrelated to ACS hospitalizations for CMC. No research to date has reliably identified potentially preventable hospitalizations among CMC.(32) Analyses of national discharge databases demonstrate that CMC hospitalizations are less likely to be for ACSCs than hospitalizations of non-CMC.(4, 8) Medical complexity itself may simply overpower the influence of ambulatory care on hospitalization risk. This concept is also reflected, in part, through the exclusion criteria within some ACSC measure definitions themselves.(16) For example, patients with cystic fibrosis and anomalies of the respiratory system are excluded from the asthma ACSC admission rate precisely because these patients "represent highly complicated cases that may require hospitalization".(2)

The extent to which ambulatory care can prevent hospitalizations for CMC warrants additional study. It is possible that ambulatory care may exert a greater influence on CMC hospitalizations for a different set of conditions than the existing ACSCs. Expert consensus methods similar to those used to develop the ACSCs could generate an adapted list of ACSCs explicitly for CMC. Quantitative research could then both extend this list and provide validation to ACSCs identified by experts. As a first step, subsequent work could characterize the most common conditions among hospitalized CMC who have evidence of poorer ambulatory care access, experience, and quality.

Lastly, the NC-CD encounter patient characteristics we observed to be associated with ACS hospitalization complement findings from several recent studies. Population-based studies have found that children hospitalized for ACSCs tend to be younger, male, non-white, publicly insured or uninsured, and living in poorer areas or communities with more income inequality.(4, 24, 33–36) Extending the Medicaid redetermination period in California from 3 to 12 months, which presumably resulted in fewer gaps in insurance coverage, was associated with a > 25% reduction in ACS hospitalizations.(6)

Our results must be interpreted with several limitations in mind. The single-center design limits generalizability, and the observational study design limits our ability to draw causal inferences. Although our administrative sample included all hospitalizations, ambulatory encounters outside of our institution and those without documentation were missed, both of which could alter how ambulatory care was characterized. In addition, our chart review sample included only children admitted to the hospital medicine service whose primary care was within our system. Results may not generalize to those on other services or with primary care outside our system; associations may be different for CMC or NC-CD whose care is managed primarily within subspecialties. In general, our work identified the presence of encounters rather than visit content. Future prospective work should continue to refine measurement of the quality of ambulatory care during visits, including appropriateness of ACSC treatment in outpatient encounters. Because ambulatory care access, quality, and experience can fluctuate for individuals over time, modeling an individual’s ambulatory care is challenging.

In future research, analyses of combined inpatient and ambulatory data should aim to better quantify the overall denominator of ACSCs managed by health systems. Beyond understanding the rate of ACS hospitalizations within a population, it may be informative to understand the proportion of ACSC encounters which result in hospitalizations. For example, through a time-intensive chart review process, we observed many encounters (e.g., 64 primary and 53 subspecialty care encounters among CMC) for the same ACSC which did not lead to hospitalization over 2 years prior to admission. Moreover, although our administrative sample identified 90 ACS urinary tract infection admissions for CMC, our judgement of this number in context might differ if we knew whether there were 200 ACS urinary tract infections managed in ambulatory settings or 2,000. Additionally, future research should attempt to tease out the influence of the Affordable Care Act (ACA) on insurance coverage, access to ambulatory care, and potential downstream reductions in ACS hospitalizations. Because CMC and NC-CD have different access to insurance coverage and waiver programs, the ACA may have had differential effects on each population.

Our study has several implications. This study explores the intersection between ambulatory care and ACS hospitalizations for CMC. Researchers, clinicians, or policymakers interested in reducing hospital utilization by targeting ACSCs, may need to tailor interventions to the patient's underlying medical complexity. In addition, interventions designed to reduce disparities, address social determinants of health, eliminate secondhand smoke exposure, and improve access to care might prove to be effective at reducing ACS hospitalizations for children with NC-CD. ACS hospitalizations for NC-CD may be more "modifiable" than for CMC. Among CMC, however, if some hospitalizations may be avoided through better ambulatory care, interventions may either need to focus on provider continuity, identify different ambulatory care constructs, or target a different set of conditions altogether.

Acknowledgments

Supported in part by the Clinical and Translational Science Award (CTSA) program, through the National Institutes of Health National Center for Advancing Translational Sciences (NCATS) (UL1TR000427).

Abbreviations

ACSC	Ambulatory Care-Sensitive Condition
APR-DRG	All-Patient Refined Diagnosis-Related Group
CI	Confidence Interval
CMC	Children with Medical Complexity
DM	Diabetes Mellitus
IQR	Interquartile Range
NC-CD	Non-Complex Chronic Disease
OR	Odds Ratio
PMCA	Pediatric Medical Complexity Algorithm
SD	Standard Deviation
UTI	Urinary Tract Infection

References

1. Billings J, Zeitel L, Lukomnik J, Carey TS, Blank AE, Newman L. Impact of socioeconomic status on hospital use in New York City. Health affairs. 1993; 12(1):162–73.
2. McDonald K, Romano P, Davies S, Haberland C, Geppert J, Ku A, et al. Technical Report: Measures of Pediatric Health Care Quality Based on Hospital Administrative Data: The Pediatric Quality Indicators. AHRQ. 2006 Sep. Report No.
3. Sanderson C, Dixon J. Conditions for which onset or hospital admission is potentially preventable by timely and effective ambulatory care. J Health Serv Res Policy. 2000; 5(4):222–30. [PubMed: 11184959]
4. Lu S, Kuo DZ. Hospital charges of potentially preventable pediatric hospitalizations. Acad Pediatr. 2012; 12(5):436–44. [PubMed: 22922047]

5. Tom JO, Tseng CW, Davis J, Solomon C, Zhou C, Mangione-Smith R. Missed well-child care visits, low continuity of care, and risk of ambulatory care-sensitive hospitalizations in young children. Arch Pediatr Adolesc Med. 2010; 164(11):1052–8. [PubMed: 21041598]
6. Bindman AB, Chattopadhyay A, Auerback GM. Medicaid re-enrollment policies and children's risk of hospitalizations for ambulatory care sensitive conditions. Medical care. 2008; 46(10):1049–54. [PubMed: 18815526]
7. Cohen E, Kuo DZ, Agrawal R, Berry JG, Bhagat SK, Simon TD, et al. Children with medical complexity: an emerging population for clinical and research initiatives. Pediatrics. 2011; 127(3): 529–38. [PubMed: 21339266]
8. Berry JG, Hall DE, Kuo DZ, Cohen E, Agrawal R, Feudtner C, et al. Hospital utilization and characteristics of patients experiencing recurrent readmissions within children's hospitals. Jama. 2011; 305(7):682–90. [PubMed: 21325184]
9. Armour BS, Ouyang L, Thibadeau J, Grosse SD, Campbell VA, Joseph D. Hospitalization for urinary tract infections and the quality of preventive health care received by people with spina bifida. Disability and health journal. 2009; 2(3):145–52. [PubMed: 21122753]
10. Health Care Costs: A Primer. The Health J Kaiser Family Foundation. 2012 May 1.2012 Report No.
11. Berry, JG., Agrawal, RK., Cohen, E., Kuo, DZ. The Landscape of Medical Care for Children with Medical Complexity. Alexandria, VA, Overland Park, KS: Children's Hospital Association; 2013.
12. Berry JG, Hall M, Neff J, Goodman D, Cohen E, Agrawal R, et al. Children with medical complexity and Medicaid: spending and cost savings. Health affairs. 2014; 33(12):2199–206. [PubMed: 25489039]
13. Cohen E, Berry JG, Camacho X, Anderson G, Wodchis W, Guttmann A. Patterns and costs of health care use of children with medical complexity. Pediatrics. 2012; 130(6):e1463–70. [PubMed: 23184117]
14. Neff JM, Sharp VL, Muldoon J, Graham J, Myers K. Profile of medical charges for children by health status group and severity level in a Washington State Health Plan. Health Serv Res. 2004; 39(1):73–89. [PubMed: 14965078]
15. Simon TD, Cawthon ML, Stanford S, Popalisky J, Lyons D, Woodcox P, et al. Pediatric medical complexity algorithm: a new method to stratify children by medical complexity. Pediatrics. 2014; 133(6):e1647–54. [PubMed: 24819580]
16. Pediatric Quality Indicators Technical Specifications - Version 5.0. Agency for Healthcare Research and Quality AHRQ: Agency for Healthcare Research and Quality; Mar. 2015 [cited 2017 Jan 16]. Available from: http://www.qualityindicators.ahrq.gov/Modules/PDI_TechSpec.aspx
17. Chen AY, Schrager SM, Mangione-Smith R. Quality measures for primary care of complex pediatric patients. Pediatrics. 2012; 129(3):433–45. [PubMed: 22331338]
18. O'Malley AS, Rich EC, Maccarone A, DesRoches CM, Reid RJ. Disentangling the Linkage of Primary Care Features to Patient Outcomes: A Review of Current Literature, Data Sources, and Measurement Needs. J Gen Intern Med. 2015; 30(Suppl 3):S576–85. [PubMed: 26105671]
19. Mangione-Smith R, DeCristofaro AH, Setodji CM, Keesey J, Klein DJ, Adams JL, et al. The quality of ambulatory care delivered to children in the United States. N Engl J Med. 2007; 357(15):1515–23. [PubMed: 17928599]
20. Core Set of Children's Health Care Quality Measures for Medicaid and CHIP (Child Core Set): Center for Medicaid and CHIP Services. Centers for Medicare and Medicaid Services; 2017. [cited 2017 May] Available from: https://www.medicaid.gov/medicaid/quality-of-care/downloads/medicaid-and-chip-child-core-set-manual.pdf
21. 2015 Recommendations for Preventive Pediatric Health Care Committee on Practice and Ambulatory Medicine and Bright Futures Periodicity Schedule Workgroup. Pediatrics. 2015
22. Jee SH, Cabana MD. Indices for continuity of care: a systematic review of the literature. Med Care Res Rev. 2006; 63(2):158–88. [PubMed: 16595410]
23. Ejlertsson G, Berg S. Continuity-of-care measures. An analytic and empirical comparison. Medical care. 1984; 22(3):231–9. [PubMed: 6700286]

24. Shi L, Lu N. Individual sociodemographic characteristics associated with hospitalization for pediatric ambulatory care sensitive conditions. Journal of health care for the poor and underserved. 2000; 11(4):373–84. [PubMed: 11057054]
25. Flores G, Abreu M, Chaisson CE, Sun D. Keeping children out of hospitals: parents' and physicians' perspectives on how pediatric hospitalizations for ambulatory care-sensitive conditions can be avoided. Pediatrics. 2003; 112(5):1021–30. [PubMed: 14595041]
26. Merianos AL, Jandarov RA, Mahabee-Gittens EM. Secondhand Smoke Exposure and Pediatric Healthcare Visits and Hospitalizations. Am J Prev Med. 2017
27. Wang Z, May SM, Charoenlap S, Pyle R, Ott NL, Mohammed K, et al. Effects of secondhand smoke exposure on asthma morbidity and health care utilization in children: a systematic review and meta-analysis. Ann Allergy Asthma Immunol. 2015; 115(5):396–401e2. [PubMed: 26411971]
28. Ahn A, Edwards KM, Grijalva CG, Self WH, Zhu Y, Chappell JD, et al. Secondhand Smoke Exposure and Illness Severity among Children Hospitalized with Pneumonia. J Pediatr. 2015; 167(4):869–74e1. [PubMed: 26231828]
29. Flores G, Abreu M, Tomany-Korman S, Meurer J. Keeping children with asthma out of hospitals: parents' and physicians' perspectives on how pediatric asthma hospitalizations can be prevented. Pediatrics. 2005; 116(4):957–65. [PubMed: 16199708]
30. Nelson BB, Coller RJ, Saenz AA, Chung PJ, Kaplan A, Lerner CF, et al. How Avoidable are Hospitalizations for Children With Medical Complexity? Understanding Parent Perspectives. Acad Pediatr. 2016
31. Coller RJ, Nelson BB, Klitzner TS, Saenz AA, Shekelle PG, Lerner CF, et al. Strategies to Reduce Hospitalizations of Children with Medical Complexity through Complex Care: Expert Perspectives. Acad Pediatr. 2017
32. Coller RJ, Nelson BB, Sklansky DJ, Saenz AA, Klitzner TS, Lerner CF, et al. Preventing Hospitalizations in Children With Medical Complexity: A Systematic Review. Pediatrics. 2014; 134(6):e1628–e47. [PubMed: 25384492]
33. Garg A, Probst JC, Sease T, Samuels ME. Potentially preventable care: ambulatory care-sensitive pediatric hospitalizations in South Carolina in 1998. Southern medical journal. 2003; 96(9):850–8. [PubMed: 14513978]
34. Shi L, Samuels ME, Pease M, Bailey WP, Corley EH. Patient characteristics associated with hospitalizations for ambulatory care sensitive conditions in South Carolina. Southern medical journal. 1999; 92(10):989–98. [PubMed: 10548172]
35. Parker JD, Schoendorf KC. Variation in hospital discharges for ambulatory care-sensitive conditions among children. Pediatrics. 2000; 106(4 Suppl):942–8. [PubMed: 11044148]
36. Bettenhausen JL, Colvin JD, Berry JG, Puls HT, Markham JL, Plencner LM, et al. Association of Income Inequality With Pediatric Hospitalizations for Ambulatory Care-Sensitive Conditions. JAMA Pediatr. 2017; 171(6):e170322. [PubMed: 28384773]

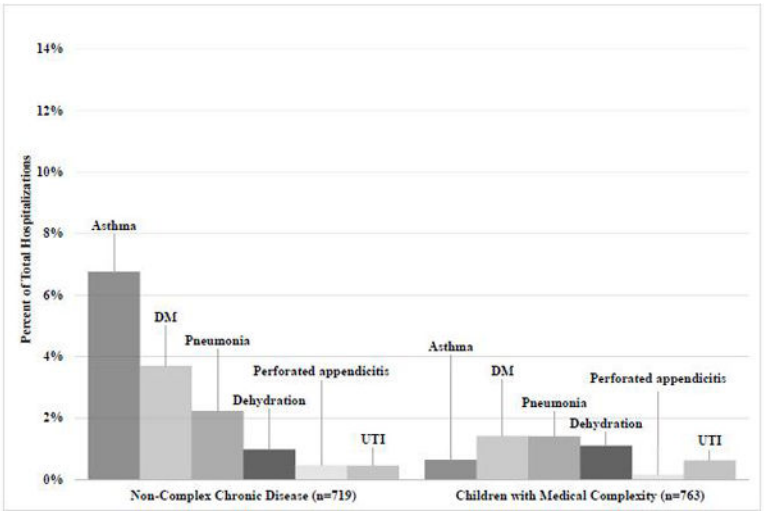

Figure 1. Frequencies of Specific Ambulatory Care Sensitive Conditions among Hospitalizations for Children with Non-Complex and Complex Chronic Disease

Distribution of Ambulatory Care-Sensitive Conditions as a proportion of all hospitalizations for children with non-complex chronic disease and medical complexity.

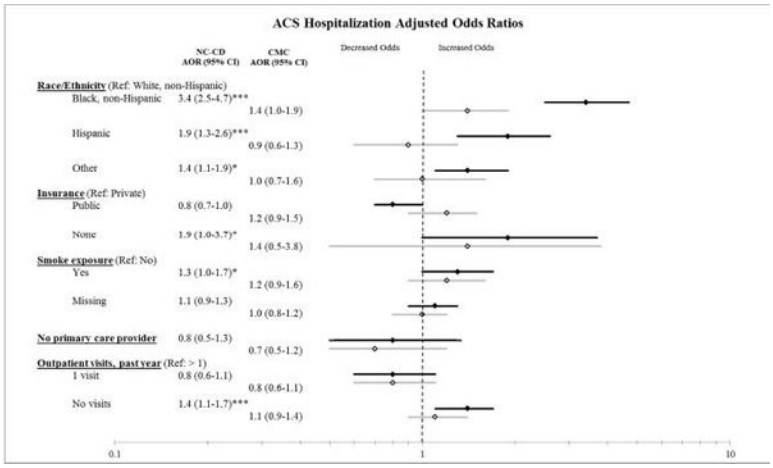

Figure 2. Adjusted Logistic Regression of Ambulatory Care-Sensitive Hospitalization on Hospital Encounter Characteristics, Clustered by Patient

Patient and ambulatory care characteristics associated with ambulatory care-sensitive hospitalizations for children with non-complex chronic disease and medical complexity.

Table 1

Encounter Characteristics of Hospitalizations due and not due to Ambulatory Care Sensitive Conditions

		Non-Complex Chronic Disease		Medical Complexity	
		Non-ACS n[1]=4207 (%)	**ACS n=719 (%)**	**Non ACS n=13,627 (%)**	**ACS n=763 (%)**
Gender	Female	1901 (45.2)	318 (44.2)	6212 (45.6)	370 (48.49)
Age (years)	mean (SD)	7.7 (6.3)	7.1 (4.6)	8.0 (6.2)	8.9 (6.0)
Race/Ethnicity					
	White, non-Hispanic	3170 (75.4)	437 (60.8)	10.567 (77.5)	572 (75.0)
	Black, non-Hispanic	290 (6.9)	128 (17.8)	1124 (8.3)	88 (11.5)
	Hispanic	338 (8.0)	76 (10.6)	1106 (8.1)	54 (7.1)
	Other	409 (9.7)	78 (10.9)	830 (6.1)	49 (6.4)
Primary Language	English	3655 (86.9)	650 (90.4)	12,590 (92.4)	704 (92.3)
Insurance Status					
	Private	2,938 (69.8)	478 (66.5)	8871 (65.1)	461 (60.4)
	Public	1215 (28.9)	223 (31.0)	4669 (34.3)	296 (38.8)
	None	54 (1.3)	18 (2.5)	87 (0.6)	6 (0.8)
Passive Smoke Exposure					
	Yes	647 (15.4)	140 (19.5)	1684 (12.4)	115 (15.1)
	Missing	1421 (33.8)	244 (33.9)	4439 (32.6)	248 (32.5)
No Primary Care Provider		236 (5.7)	40 (5.6)	467 (3.5)	21 (2.8)
Outpatient visits, prior year	median (IQR)	1.0 (0–3.0)	0.0 (0.0–3.0)	4.0 (1.0–8.0)	4.0 (1.0–8.0)
Hospitalizations, prior year	median (IQR)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	1.0 (0.0–3.0)	1.0 (0.0–2.0)
Length of stay (days)	median (IQR)	2.0 (1.0–3.8)	2.0 (1.0–3.0)	3.0 (1.8–6.0)	2.1 (1.5–4.0)
APR-DRG severity					
	Minor	1975 (47.0)	286 (39.8)	1999 (14.7)	45 (5.9)
	Moderate	1649 (39.2)	381 (53.0)	5481 (40.3)	374 (49.1)
	Major	460 (10.9)	45 (6.3)	4727 (34.7)	275 (36.1)
	Extreme	122 (2.9)	7 (1.0)	1412 (10.4)	68 (8.9)

[1]Sample (n) refers to hospitalizations and not individuals

ACS: Ambulatory Care-Sensitive

APR-DRG: All-Patient Refined Diagnosis-Related Group

SD: Standard Deviation

IQR: Interquartile Range

Table 2

Associations between Ambulatory Care and Ambulatory Care-Sensitive Hospitalizations among 20% Random Sample of Discharges from the Pediatric Hospital Medicine Service

	Non-Complex Chronic Disease	Medical Complexity
	ACSC OR (95% CI)	**ACSC OR (95% CI)**
Ambulatory Care - 2 Years before Hospitalization		
Total timely well checks	0.8 (0.6–0.9) **	1.1 (0.9–1.3)
Proportion recommended well checks occurred and timely	0.4 (0.1–1.0) *	3.2 (0.8–12.2)
Number of different providers seen for well-checks	0.6 (0.3–1.1)	1.6 (0.9–2.7)
Primary care continuity [a]	1.6 (0.5–5.5)	0.3 (0.1–1.0) *
Vaccines updated by age 2	1.0 (0.4–2.1)	1.4 (0.5–3.7)
Anthropometrics documented most recent well-check	1.2 (0.6–2.6)	2.2 (0.7–6.5)
Total primary care visits	1.0 (1.0–1.1)	1.0 (1.0–1.0)
Total specialty care visits	1.0 (0.9–1.0)	1.0 (1.0–1.0)
Ambulatory Care – 30 Days before Hospitalization		
Total encounters	0.9 (0.8–1.0)	1.0 (0.9–1.1)
Any encounter	0.6 (0.2–1.4)	0.7 (0.2–2.5)
Any in-person encounter	0.7 (0.3–1.7)	0.7 (0.2–2.2)
Any phone encounter	0.5 (0.2–1.0) *	0.9 (0.3–2.8)
Encounters for same problem: Total number	1.0 (0.7–1.2)	1.0 (0.8–1.2)
Encounter for same problem: At least one	0.4 (0.0–3.6)	1.0 (0.2–5.0)
Encounter for same problem: In-person	1.6 (0.7–3.3)	0.4 (0.1–1.0)
Encounter for same problem: Phone	0.6 (0.3–1.3)	1.0 (0.4–2.6)

* <0.05,

** <0.01,

*** <0.001

[a] Primary care continuity defined as being above or below the median of the continuity of care index described be Ejlertsson.[22]