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Characteristics of Children With Cancer Discharged or Admitted From the Emergency Department

Emily L. Mueller, MD, MSc,[1,2*] Matthew Hall, PhD,[3] Samir S. Shah, MD, MSCE,[4] Keith J. August, MD, MS,[5] Mohamed A. Radhi, MD,[5] and Michelle L. Macy, MD, MS[6,7]

Background. Emergency department (ED) utilization by children with cancer is poorly understood. Among children with cancer, we explored reasons for ED visits and factors associated with admission within U.S. children's hospitals. ***Methods.*** A retrospective study of the 2011–2013 Pediatric Health Information System (PHIS) was conducted. Eligible ED visits included those within 365 days from the first inpatient encounter with an International Classification of Diseases, Ninth Edition, Clinical Modification (ICD-9-CM) code for cancer. Patient characteristics and reasons for ED visits were assessed. Factors associated with admission from the ED were examined with multivariable regression. ***Results.*** There were 26,770 ED visits by 17,943 children with cancer at 39 children's hospitals during the study period. Half of children with cancer visited the ED within 1 year after their first cancer hospitalization in PHIS. Fifty-six percent of ED visits resulted in admission. Fever or neutropenia accounted for the largest proportion of reasons for visits (34.6%). Risk factors for admission were as follows: "Other" race/ethnicity as compared to white, non-Hispanic (odds ratio [OR] = 1.4, 95% confidence interval [CI] 1.2–1.6), history of transplant (OR = 1.7, 95% CI 1.4–2.1), and ED visits reasons including neutropenia (OR = 43.4, 95% CI 36.0–52.3), blood stream infection (OR = 3.3, 95% CI 2.8–3.9), pancytopenia (OR = 28.8, 95% CI 18.1–45.9), dehydration (OR = 2.3, 95% CI 1.9–2.9), or pneumonia (OR = 3.8, 95% CI 2.8–5.1). ***Conclusions.*** Children with cancer have high ED usage within 1 year after their first cancer hospitalization. Age, demographic factors, and reasons for ED visits significantly impacted admission from the ED. Further research should focus on ED utilization among children with cancer. Pediatr Blood Cancer 2016;63:853–858. © 2015 Wiley Periodicals, Inc.

Key words: adolescent; child; febrile neutropenia; oncology; supportive care

BACKGROUND

Children with cancer represent a high-risk population for disease- and treatment-related complications that require urgent or emergent medical care.[1–4] These children are frequently referred to emergency departments (EDs) for evaluation of high risk, time-sensitive conditions such as febrile neutropenia (FN) and sepsis.

Improved understanding of the ED utilization of children with cancer could lead to optimization of ED referral practices and ED management through targeted interventions aimed at the most common reasons for ED visits and admissions. While admission rates for children with cancer vary by reason for the ED visit,[5] the role of patient level factors on the decision to hospitalize is poorly defined.

The objectives of this study were to (i) assess ED utilization by pediatric patients with cancer and evaluate the reasons why children with cancer visit the ED, and (ii) assess factors associated with admission versus discharge from the ED at children's hospitals in the United States, including patient-specific factors unavailable in previously analyzed datasets.

METHODS

Study Design and Setting

We conducted a retrospective cohort study using data from the Pediatric Health Information System (PHIS), an administrative and resource utilization database from 45 freestanding children's hospitals. Participating hospitals are located in non-competing markets of 27 states plus the District of Columbia and account for ~15% of all pediatric hospitalizations in the United States. Hospitals were included if they provided inpatient and ED data between January 1, 2011 and September 30, 2013, without interruption, resulting in the inclusion of 39 hospitals. The PHIS database contains the following: patient medical record data (demographic characteristics, up to 41 diagnoses, and up to 41 procedures) and billing data (all medication, diagnostic imaging, laboratory, and supply charges to individual patients). Diagnoses are coded after discharge, so we are unable to separate ED versus inpatient diagnoses for those patients who were admitted. Data are deidentified before inclusion in the database; however, encrypted medical record numbers allow for tracking of individual patients across multiple encounters at the same hospital. The Children's Hospital Association (Overland Park, KS) and participating hospitals jointly monitor the quality

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Abbreviations: ALL, acute lymphoblastic leukemia; CI, confidence interval; CNS, central nervous system; ED, emergency department; FN, febrile neutropenia; ICD-9-CM, International Classification of Diseases, Ninth Edition, Clinical Modification; NHL, non-Hodgkin lymphoma; OR, odds ratio; PHIS, Pediatric Health Information System; SCT, stem cell transplant

[1]Section of Pediatric Hematology Oncology, Department of Pediatrics, Indiana University, Indianapolis, Indiana; [2]Center for Pediatric and Adolescent Comparative Effectiveness Research, Indiana University, Indianapolis, Indiana; [3]Children's Hospital Association, Overland Park, Kansas; [4]Division of Hospital Medicine, Department of Pediatrics, University of Cincinnati, Cincinnati, Ohio; [5]Section of Pediatric Hematology/Oncology/Stem Cell Transplantation, University of Missouri, Kansas City, Missouri; [6]Child, Health Evaluation and Research (CHEAR) Unit, Division of General Pediatrics, Department of Pediatrics and Communicable Diseases, University of Michigan, Ann Arbor, Michigan; [7]Department of Emergency Medicine, University of Michigan, Ann Arbor, Michigan

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*Correspondence to: Emily L. Mueller, MD, MSc, Department of Pediatrics, Indiana University School or Medicine, 410 West 10th Street, Suite 4099C, Indianapolis, IN 46202. E-mail: elmuelle@iu.edu

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and integrity of data, described previously.[6] The analysis was based on deidentified data and was therefore considered exempt from institutional review board approval by Indiana University School of Medicine.

Study Population/Identification of Cases

Children with cancer were defined based on the identification of an inpatient encounter that included an International Classification of Diseases, Ninth Edition, Clinical Modification (ICD-9-CM) code for cancer (140.x–209.x, 235.x–239.x), as described previously.[5] The index inpatient encounter was defined as the first inpatient encounter with an ICD-9-CM code for cancer in the study period only if there were no previous hospitalizations with cancer diagnoses within 365 days prior. We then identified all ED visits that occurred in the 365 days following the index hospitalization. We restricted our analysis to those patients between 0 and 19 years of age.

Outcome and Exploratory Variables

Patient characteristics that were evaluated included gender, age (<1 year, 1–4 years, 5–9 years, 10–14 years, 15–19 years—based on clinical differences in types of cancers and development differences), race/ethnicity (non-Hispanic white, non-Hispanic black, Hispanic, Asian, or other), type of cancer (acute lymphoblastic leukemia [ALL], acute myelogenous leukemia, central nervous system (CNS) tumors, solid tumors (non-CNS), Hodgkin lymphoma, and non-Hodgkin lymphoma (NHL)), transplant status flag (defined using Feudtner's complex chronic condition codes, including stem cell transplant [SCT])[7], primary payer (public/governmental, private, other), median income quartile per ZIP code, and urban/rural patient residence (based on the Rural Urban Commuting Area (RUCA) code of the patient's home ZIP code).[8] We also included an indicator variable for frequent ED visitor, which was defined as four or more visits (greater than the 90th percentile among the study population of children with cancer) during the year (365 days) following the index admission.

For the logistic regression, the primary outcome of interest was whether an ED visit resulted in admission to the same institution versus discharged to home (patient treated and released from the ED). Deaths occurring in the ED were excluded from this analysis; there were only seven ED deaths in the time period analyzed.

Reason for ED Visit

The reason prompting an ED visit was defined by the primary ICD-9-CM discharge diagnosis associated with the encounter, unless the primary diagnosis was a cancer diagnosis (ICD-9-CM Codes 140–239). In cases where a cancer diagnosis was the primary diagnosis, the second listed ICD-9-CM diagnosis was considered to be the reason prompting the ED visit. Cancer diagnoses were not considered the reason prompting an ED visit in order to focus on symptoms or complications associated with ED visits made by pediatric patients with cancer. A rank list of diagnoses was generated by frequency. Diagnoses with similar codes were collapsed into single categories, for example, "neutropenia, unspecified" (288.00) and "drug induced neutropenia" (288.03) were collapsed into a single "neutropenia" variable. After collapsing the similar codes, the top 10 diagnoses were analyzed.

Statistical Analyses

Hospital and patient characteristics were summarized using frequencies and percentages, and compared across groups (admitted vs. discharged from the ED) using chi-square tests. The number of ED visits and corresponding disposition status (admitted or discharged) were analyzed. The top 10 reasons for ED visits by disposition status (admitted or discharged)

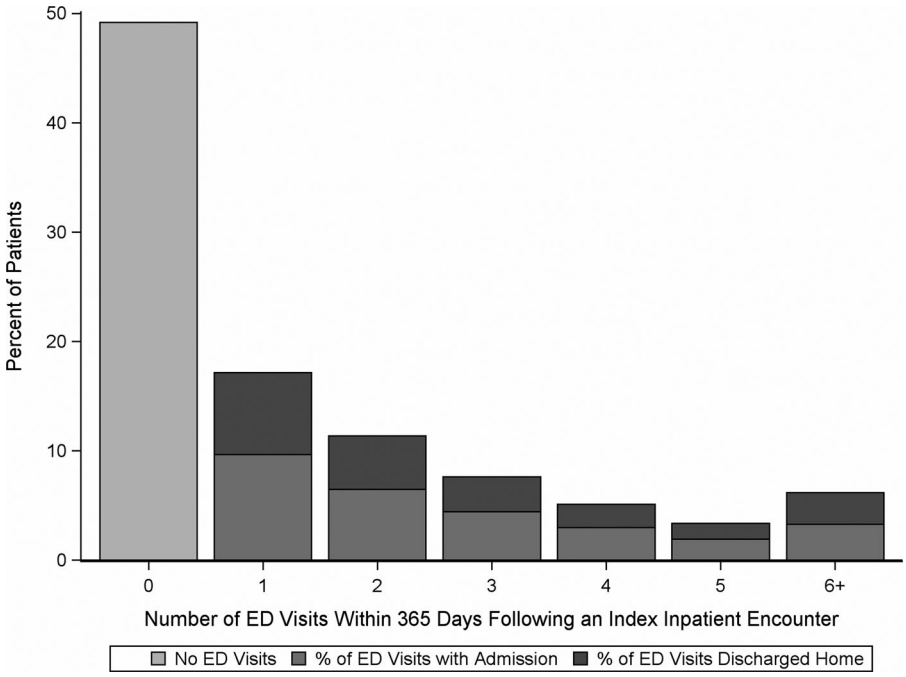

Fig. 1. Distribution of the number of ED encounters.

TABLE I. Encounter Level Characteristics of Children with Cancer Presenting to the Emergency Department, by Admission Status (January 2011–September 2013)

	N (% Column)	N (% Row)		
	Overall n = 26,770	Admitted n = 15,022	Discharged n = 11,748	*P*-value
Patient characteristics				
Gender				0.230
Female	12,491 (46.7)	5,433 (43.5)	7,058 (56.5)	
Male	14,279 (53.3)	6,315 (44.2)	7,964 (55.8)	
Age				<0.001
<1 year	4,306 (16.1)	2,065 (48.0)	2,241 (52.0)	
1–4 years	7,370 (27.5)	3,400 (46.1)	3,970 (53.9)	
5–9 years	5,979 (22.3)	2,659 (44.5)	3,320 (55.5)	
10–14 years	5,021 (18.8)	2,045 (40.7)	2,976 (59.3)	
15–19 years	4,094 (15.3)	1,579 (38.6)	2,515 (61.4)	
Race/ethnicity				<0.001
White, non-Hispanic	14,311 (53.5)	6,299 (44)	8,012 (56)	
Black, non-Hispanic	2,728 (10.2)	1,332 (48.8)	1,396 (51.2)	
Hispanic	6,196 (23.1)	2727 (44.0)	3,469 (56.0)	
Asian	817 (3.1)	371 (45.4)	446 (54.6)	
Other	2,718 (10.2)	1,019 (37.5)	1,699 (62.5)	
Type of cancer				<0.001
Acute lymphoblastic leukemia	9,510 (35.5)	4,259 (44.8)	5,251 (55.2)	
Acute myelogenous leukemia	1,324 (4.9)	608 (45.9)	716 (54.1)	
Solid tumor	8,621 (32.2)	3,601 (41.8)	5,020 (58.2)	
Central nervous system tumor	4,712 (17.6)	2,212 (46.9)	2,500 (53.1)	
Hodgkin lymphoma	784 (2.9)	326 (41.6)	458 (58.4)	
Non-Hodgkin lymphoma	1,819 (6.8)	742 (40.8)	1,077 (59.2)	
Transplant				<0.001
Yes	693 (2.6)	255 (36.8)	438 (63.2)	
No	26,077 (97.4)	11,493 (44.1)	14,584 (55.9)	
Frequent ED user				<0.001
Yes	15,519 (58.0)	6,943 (44.7)	8,576 (55.3)	
No	11,251 (42.0)	4,805 (42.7)	6,446 (57.3)	
Socioeconomic characteristics				
Primary payer				0.095
Public/governmental	13,308 (49.7)	5,833 (43.8)	7,475 (56.2)	
Private	12,038 (45.0)	5,251 (43.6)	6,787 (56.4)	
Other	1,424 (5.3)	664 (46.6)	760 (53.4)	
Median household income per ZIP code				0.001
First quartile	5,546 (21.3)	2,341 (42.2)	3,205 (57.8)	
Second quartile	6,160 (23.7)	2,688 (43.6)	3,472 (56.4)	
Third quartile	6,585 (25.3)	2,864 (43.5)	3,721 (56.5)	
Fourth quartile	7,723 (29.7)	3,528 (45.7)	4,195 (54.3)	
Urban versus rural patient residence				<0.001
Urban	23,051 (86.1)	10,354 (44.9)	12,697 (55.1)	
Rural	3,719 (13.9)	1,394 (37.5)	2,325 (62.5)	

were calculated by frequencies and proportions. Multivariable regression was performed using generalized linear mixed effects models to estimate factors associated with admission for pediatric patients with cancer while accounting for clustering of patients within hospitals through the inclusion of a random hospital intercept. Variables included were based on our defined model: gender, patient's age category, type of cancer, presence of a transplant flag, primary expected payer, median income quartile per ZIP code, urban/rural patient residence, a dichotomous indicator variable for frequent ED visitors, and variables for the presence or absence of each of the top 10 most common visit diagnoses. All analyses were performed using SAS v9.4 (SAS Institute, Cary, NC), and *P*-values <0.05 were considered statistically significant.

RESULTS

Characteristic of the Study Population

We identified 17,943 children with cancer who received inpatient care with associated ICD-9-CM codes for cancer at 39 children's hospitals in the United States, from January 2011 to September 2013. There were a total of 26,770 ED visits in the year following the index hospitalization among 9,114 (50.8%) of the identified children with cancer. The range for the number of ED visits per patient was 0–24, the distribution as shown in Figure 1. Among all of the ED visits, 56.1% (n = 15,022) were admitted and 43.9% (n = 11,748) were discharged to home; there were no transfers to other institutions.

TABLE II. Top Reasons Prompting ED Visits Among Pediatric Cancer Patients—Rank and Disposition Status by Frequent ED Visitor Status

		N (% Column) Overall	N (% Row) Disposition status	
Rank	Diagnosis	n = 26,770	Admitted to hospital	Discharged to home
1	Neutropenia	5,189 (19.4)	5,061 (97.5)	128 (2.5)
2	Fever	4,057 (15.2)	940 (23.2)	3,117 (76.8)
3	Blood stream infection	883 (3.3)	667 (75.5)	216 (24.5)
4	Nausea or vomiting	611 (2.3)	169 (27.7)	442 (72.3)
5	Pancytopenia	557 (2.1)	537 (96.4)	20 (3.6)
6	Acute URI	501 (1.9)	196 (39.1)	305 (60.9)
7	Dehydration	497 (1.9)	346 (69.6)	151 (30.4)
8	Complication of vascular device	485 (1.8)	97 (20)	388 (80)
9	Headache	450 (1.7)	90 (20)	360 (80)
10	Pneumonia	310 (1.2)	242 (78.1)	68 (21.9)

URI, upper respiratory infection.

Table I demonstrates the encounter characteristics of children with cancer who presented to the ED, stratified by admission versus discharge from the ED. Overall, most ED visits were for children ages 0–9 years (65.9%), white, non-Hispanic (53.5%), and residing in urban areas (86.1%). There were significant differences between encounters resulting in admission versus discharge for all factors investigated, except for primary payer.

The 10 most common reasons prompting an ED visit for the children with cancer (Table II) accounted for one-half (50.8%) of all noncancer primary diagnoses for ED visits among children with cancer. A diagnosis of fever or neutropenia, common complications of cancer therapy, accounted for the largest percentage of visits (34.6%).

Variation in ED disposition was found across diagnoses. Children with cancer were admitted the majority of the time if their reasons for ED visit was neutropenia (97.5%), pancytopenia (96.4%), blood stream infections (75.5%), pneumonia (78.1%), and dehydration (69.6%). The lowest admission rates were for principal diagnoses of fever (23.3%), complication of a vascular device (20.0%), and headache (20.0%).

Factors Affecting Admission Versus Discharge Among Children With Cancer

In a multivariable analysis, patient factors associated with significantly increased odds of admission included "Other" race/ethnicity as compared to white, non-Hispanic (odds ratio [OR] = 1.4, 95% confidence interval [CI] 1.2–1.6) or having a history of transplant (OR = 1.7, 95% CI 1.4–2.1), as shown in Table III. Conversely, all age groups had significantly decreased odds of admission when compared with the patient encounters for those ages 15–19 years. Among the cancer diagnoses, none of the categories had significantly increased odds of admission when compared to the reference of ALL. Meeting criteria for a frequent ED user also did not increase the odds of admission.

Patients who lived in urban settings had decreased odds of admission (OR = 0.7, 95% CI 0.6–0.8) compared with those living in a rural residence.

ED visit diagnoses associated with increased odds of admission included neutropenia (OR = 43.4, 95% CI 36.0–52.3), blood stream infection (OR = 3.3, 95% CI 2.8–3.9), pancytopenia (OR = 28.8, 95% CI 18.1–45.9), dehydration (OR = 2.3, 95% CI 1.9–2.9), or pneumonia (OR = 3.8, 95% CI 2.8–5.1).

DISCUSSION

In this study using administrative data from 39 U.S. children's hospitals, half of children with cancer visited the ED within 1 year of their index inpatient encounter in the study period. Over half of these ED visits resulted in hospital admission, which is a higher rate than the general pediatric population (about 10%).[9,10] Consistent with our previous analysis of a nationally representative sample of ED visits, we found that there was significant variation in admission rates across the wide range of reasons for ED visits in this patient population.[5] Though the variation cannot be fully explained using administrative data, we have confirmed that admission rates are highest for those with neutropenia and lowest for those with headaches. This analysis highlights two potential areas for future intervention. For ED visit reasons that had high admission rates, research endeavors could focus understanding the patient experience and improving patient-centered outcomes. Conversely, research concentrated on those reasons with low admission rates could aim to improve anticipatory guidance given to caregivers to decrease reliance on the ED.

Consistent with our prior research, there was a wide range of reasons for ED visits among children with cancer.[5] We chose to focus on only the primary diagnosis, or the second diagnosis code if the first was a cancer diagnosis, in order to ascertain the reason for the ED visit. Yet, it is likely that children with cancer can present to the ED with more than one medical issue. FN is a clinically important entity, but is not a single diagnostic code. We also found similar admission rates between patients with a primary ED visit diagnosis of neutropenia and FN (when we identified a combination of fever and neutropenia among all diagnostic fields). To truly understand ED utilization for children with cancer who experience fever in the setting of neutropenia, datasets will need to include chief complaints and laboratory data.

While children with cancer are a small subset of all children who visit the ED (0.2%),[5] there are important distinctions regarding the care for this unique population. Counter to ED

TABLE III. Multivariate Logistic Regression to Evaluate Factors Associated With Admission Versus Discharge From the ED Among Pediatric Cancer Patients

Factors	Adj. odds ratio (OR)	95% CI	*P*-value
Patient characteristics			
Gender			
Female	1.1	1.0–1.1	0.114
Age			
15–19 years	Ref		
10–14 years	0.9	0.8–1.0	0.012
5–9 years	0.7	0.6–0.8	<0.001
1–4 years	0.6	0.6–0.7	<0.001
<1 year	0.7	0.6–0.8	<0.001
Race/ethnicity			
White, non-Hispanic	Ref		
Black, non-Hispanic	0.9	0.8–1.0	0.049
Hispanic	1.1	1.0–1.2	0.089
Asian	1.2	1.0–1.5	0.121
Other	**1.4**	**1.2–1.6**	**<0.001**
Type of cancer			
Acute lymphoblastic leukemia	Ref		
Acute myelogenous leukemia	0.9	0.8–1.1	0.304
Solid tumors	0.9	0.9–1.0	0.173
Central nervous system tumor	1.1	1.0–1.2	0.221
Hodgkin lymphoma	0.7	0.6–0.9	0.005
Non-Hodgkin lymphoma	0.9	0.8–1.1	0.191
Transplant			
Yes	**1.7**	**1.4–2.1**	**<0.001**
Frequent ED visitor			
Yes	0.9	0.9–1.0	0.124
Socioeconomic characteristics			
Primary Payer			
Public/governmental	Ref		
Private	0.9	0.9–1.0	0.103
Other	0.8	0.6–0.9	0.001
Median household income per ZIP code			
Fourth quartile	Ref		
Third quartile	**1.1**	**1.0–1.2**	**0.017**
Second quartile	1.1	1.0–1.2	0.267
First quartile	1.0	0.9–1.2	0.400
Urban versus rural patient residence			
Urban	0.7	0.6–0.8	<0.001
ED visit characteristics			
Top 10 ED visit diagnoses (in descending order)			
Neutropenia	**43.4**	**36.0–52.3**	**<0.001**
Pancytopenia	**28.8**	**18.1–45.9**	**<0.001**
Pneumonia	**3.8**	**2.8–5.1**	**<0.001**
Blood stream infection	**3.3**	**2.8–3.9**	**<0.001**
Dehydration	**2.3**	**1.9–2.9**	**<0.001**
Acute URI	0.7	0.6–0.9	0.001
Nausea or vomiting	0.4	0.3–0.4	<0.001
Fever	0.3	0.3–0.3	<0.001
Complication of vascular device	0.2	0.2–0.3	<0.001
Headache	0.2	0.2–0.3	<0.001

Bold values indicate significant factors associated with admission versus discharge. ED, emergency department; URI, upper respiratory infection; Ref, reference group.

admission patterns for common pediatric conditions, children with cancer who were younger (as compared to the 15–19 year olds) had decreased odds of admission. This finding lends itself to future research regarding reasons for these differences. Possible explanations include adolescents waiting to visit the ED only when they have reached the point where their condition requires inpatient admission or, alternatively, young children may be taken to the ED early in the course of an acute illness due to their limited ability to explain their symptoms. Also, ALL occurs more commonly in younger children and requires the longest duration of active chemotherapy, but the majority of therapy is maintenance chemotherapy with low risk for substantial immunosuppression. Further research that includes greater patient detail regarding the reason for seeking ED care will be needed to improve our understanding of this dynamic.

Socioeconomic factors appeared to impact the disposition of children with cancer from the ED. Patients who lived in an urban location had decreased odds of admission, which may be because patients who live in urban areas may live closer to the free-standing children's hospitals that contributed to this analysis. Therefore, patients living in closer urban areas are more easily able to return for re-evaluation if their condition worsens. Those who live further away, in rural areas, may experience hardship related to travel including lack of adequate means of transportation, the cost of traveling, or lodging nearby. This may result in longer hospital admissions to ensure stability prior to discharge or visits to other hospitals with subsequent transfer only if admission is deemed necessary. Of note, risk stratification schemas for the management of FN among children with cancer do not take into account the differences in patient proximity to the treating hospital.[11–13]

The PHIS database has several unique features that revealed important information in this study. First, we had the ability to identify patients with a comorbid condition of transplant. Within the population of patients with cancer diagnoses, this most commonly represents a SCT.[7] We found that children with cancer with SCT had an increased odds of admission when evaluated in the ED. Patients who receive a SCT are a uniquely vulnerable population of patients with high rates of complications that can require emergent evaluation.[14,15] SCT patients tend to be followed very closely as outpatients and remain within close proximity to the treating institution (for those who do not live nearby) for a period of time after discharge. Due to the prolonged immunocompromised status and high readmission rates of SCT patients, further analysis of the ED utilization of this specific population of patients may yield information that could be used to implement improved outpatient or phone triaging practices or provide targets for anticipatory guidance.

A second unique feature of the PHIS database is the ability to identify children with cancer who visited the ED frequently in the year following their index admission. Frequent ED users among children with cancer deserve additional study to gain an understanding of the reasons for their higher levels of ED utilization. Our analysis determined that meeting the frequent ED user criterion was not associated with increased odds of admission. Further research to characterize why this population is seeking care in the ED could lead to targetable interventions to decrease reliance on the ED.

While this analysis contributes to the knowledge of ED utilization by children with cancer, it has also highlighted areas that deserve further evaluation. We did not have the clinical information that would allow us to ascertain the appropriateness of ED use by this population. The care of urgent medical issues among children with cancer occurs along a continuum, from outpatient triage regarding the need for in-person evaluation to urgent evaluation to inpatient admission. Most research among children with cancer to date has focused on what happens after admission,[16–18] but we poorly understand the events or processes that occur prior to the ED visit and admission decision. The decision-making process for patients and their caregivers is complex and includes many facets that need to be better understood including decisions on when to seek care, where to seek care, and who to be contacted regarding these issues. Lastly, both patient/caregiver and provider perspectives play a role in triaging and decision making regarding ED use or disposition and should be addressed. All of these areas will need to be further explored in order to improve the care of children with cancer within the ED.

LIMITATIONS

While this study adds insight into ED utilization by children with cancer, there are several important limitations. For our analysis, we captured children with cancer by identifying the first inpatient encounter with an associated ICD-9-CM code for cancer in the study period and then followed these patients for 365 days. It is possible that we are not accurately evaluating all patients with cancer at these institutions since a proportion of patients with cancer are diagnosed and initiated on therapy as outpatients. For example, many of our Hodgkin lymphoma patients are evaluated and diagnosed as outpatients, though this is a small population. Unfortunately, PHIS does not include information related to disease status, type of therapy, or time since last treatment for the patient at the time they visit the ED. This information should be included in prospective data collection regarding ED utilization in order to provide context and help to delineate associations between types of therapy and reasons for seeking urgent evaluation in an ED.

Our analyses relied on discharge ICD-9-CM codes. This limits our understanding of the chief complaint that brought the child to seek care in the ED and therefore we are missing key information for future interventions aimed at anticipatory guidance. Also, we extrapolated the reason for the ED visit from ICD-9-CM codes rather than the initial chief complaint, which was not available in this dataset. For those patients who were admitted to the inpatient hospital from the ED, the diagnosis codes evaluated are from the entirety of the encounter and cannot be differentiated between diagnoses associated with the ED versus diagnoses that arose during the inpatient stay. Only a single diagnosis was evaluated per patient encounter, yet children with cancer may present to the ED with multiple complications or concerns.

CONCLUSIONS

In conclusion, half of children with cancer will visit the ED at a tertiary care institution within 1 year after the index inpatient admission for cancer. Factors that significantly impacted whether a child with cancer was admitted versus discharged from the ED included age, demographic factors, and reasons for the ED visits. Knowledge of reasons for visits and patient characteristics may be used to target common diagnoses or design health system modifications to improve the care of children with cancer who visit the ED.

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