Emergency Department Visits by Adolescent and Young Adult Cancer Patients Compared with Pediatric Cancer Patients in the United States

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Purpose: Limited information exists on emergency department (ED) visits for adolescent and young adult (AYA) patients with cancer. We examined the clinical reasons for ED visits, and outcomes, for AYAs with cancer compared to pediatric cancer patients.

Methods: The 2013 Nationwide Emergency Department Sample data were used to identify 53,274 AYA (ages 15–39) and 6952 pediatric (ages 0–14) cancer ED visits. We evaluated patient (i.e., demographic and diagnosis) and hospital characteristics, and the ED event outcome (admitted to the same hospital or treated/released). Clinical reasons for visits were identified as procedures, infections, or noninfectious toxicities. Variables were compared between groups using chi-squared tests. Logistic regressions identified characteristics associated with the outcome between and within groups.

Results: AYA cancer visits were more likely to be self-paid (15.8% vs. 1.9%, $p < 0.001$), and be from low-income households and nonmetro counties than pediatric visits. Toxicity was the most prevalent reason for AYA visits (46.0%) and infections for pediatrics (47.3%, $p < 0.001$). AYA cancer visits were less likely to be admitted (OR = 0.84, 95% CI = 0.71–0.98; $p = 0.03$) than pediatric cancer. Among AYAs, self-paid visits were less likely to be admitted compared with privately insured visits (OR = 0.58, 95% CI: 0.52–0.66, $p < 0.001$). Self-pay did not affect the outcome for pediatric visits.

Conclusions: In the United States, compared with pediatric cancer patients, AYAs with cancer visit EDs more often for toxicity-related problems, and are more often self-paid and from poorer households. These distinctive features impacting health service use should be incorporated into care plans aimed at delineating effective care for these patients.

Keywords: emergency department visits, pediatric cancer, adolescent and young adult cancer, NEDS

Introduction

IN THE UNITED STATES, emergency departments (EDs) are considered to be imperative for timely delivery of care for urgent medical needs. A few studies have examined ED usage in adult¹ and pediatric oncology² settings; however,

less is known about ED usage by adolescent and young adult (AYA) patients with cancer. AYAs in the United States are more likely to lack access to health insurance when compared with other age-based populations.³ Furthermore, because of lack of access to primary care or usual source of care, patients with Medicaid (i.e., the joint

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state and federal health insurance program for low-income adults, children, pregnant women, the elderly, and the disabled) and those without insurance receive care in EDs at greater rates than those with private insurance.^{4,5} Yet, there is limited information on how these factors influence ED usage for AYAs with cancer.

A national workshop recommended leveraging existing data to investigate the pattern of healthcare use for AYA cancer patients, to better understand their needs and outcomes.⁶ AYA cancer patients are biologically, psychosocially, and socioeconomically distinct from their pediatric counterparts.^{7–10} Previous research indicates that AYAs with cancer may be faced with a higher risk of treatment-related toxicities than pediatric patients, even when treated with the same treatment regimen.⁹ Yet, there is limited information on how these important differences influence ED admission and discharge status between AYA and pediatric cancer patients.

We used the all-payers Nationwide Emergency Department Sample (NEDS) data to conduct a cross-sectional investigation of ED usage differences between AYA (ages 15–39) and pediatric (ages 0–14) cancer patients in the United States. Our study aims were to (1) identify the clinical reasons (e.g., procedures, infections, toxicity, or other) for ED visits for both patient groups, (2) investigate whether the reasons for ED visits differed between groups, and (3) examine patient (demographics and clinical reasons) and hospital characteristics associated with ED event outcome (treated and released vs. admitted to the same hospital), separately, within groups. A previous study on pediatric cancer ED visits found that clinical factors such as fever and neutropenia increased the likelihood of being admitted to the hospital.² In the same study, visits from higher household income and public payer patients resulted in being admitted more often than those with lower income and self-pay visits, respectively.² Based on these earlier findings, we hypothesize that the clinical reason (i.e., infections, procedures, or toxicity) for visits will be associated with the AYA cancer visit outcome, and that having higher household income and private insurance will increase the likelihood of being admitted.

Methods

Data

We used the 2013 NEDS—a database developed for the Healthcare Cost and Utilization Project (HCUP).¹¹ NEDS is the largest publicly available all-payer ED database in the United States, and as such these data allow examination of both common and uncommon health conditions.¹¹ The 2013 NEDS contains information on almost 30 million ED visits from 947 hospitals across 30 U.S. states. NEDS can only be used for visit-level analysis, as the unit of analysis is ED encounter and not patient. Since these data are publicly available human subject approval is not required.

AYA, and pediatric cancer ED visits

Refer to Figure 1 for visit identification criteria. In 2013, the NEDS core file contained information on 15,563,867 visits for AYA (ages 15–39) and pediatric (ages 0–14) pa-

tients. We used the HCUP's single-level Clinical Classifications Software (CCS) tool to examine patient diagnosis information. These CCS codes collapse ICD-9-CM diagnosis codes into a smaller number of clinically relevant categories, and in the 2013 data, NEDS provides up to 15 CCS diagnosis codes for each visit.

We followed Russell et al.'s method for identifying AYA and pediatric cancer visits and the clinical reasons for these visits.¹² Russell et al. developed a multistep algorithm that uses both procedure and diagnosis codes to identify clinically relevant (i.e., codes that reflect clinical practice) and meaningful (i.e., codes that may predict healthcare resource use) categories (e.g., cancer-related procedure, infections, and toxicity) for childhood cancer inpatient admissions. This method was developed for HCUP's KID database, which is a large administrative database similar to NEDS.

Similar to Russell et al.'s method, we defined cancer-related visits as those that had at least one of the 15 CCS codes, indicating a malignant cancer diagnosis (CCS codes 11–43).¹³ We included all 15 CCS codes, and not just the primary one, because, as shown by Russell et al., if we restrict our analysis to the primary code, we will miss information on a number of patients who may be admitted to the ED for a primary condition (e.g., infections or toxicities) that may have resulted from, but be distinct from, their cancer.

Using these identification criteria, we identified a total of 61,596 cancer ED visits for patients aged 0–39 years. Of the total cancer visits in the core file, 44 (0.1%) had missing information on the ED event outcome, and were therefore excluded. A very small proportion of visits resulted in transfer to other short-term hospitals or death. Therefore, these were also excluded from our analysis. The final sample consisted of 53,274 AYA and 6952 pediatric cancer visits (total = 60,226 visits).

ED event outcome

Our outcome was whether an ED visit resulted in patients being admitted to the same hospital, or patients being treated and released.

Covariates

Patient demographics and cancer diagnosis

We examined sex, primary payer, rural county of residence (metro vs. nonmetro), and household income quartile (NEDS provides national quartile of the median household annual income for the patient's ZIP Code). We also examined the timing of visits, that is, whether the ED visits were during the weekend, and the discharge quarter (January–March, April–June, July–September, or October–December).

We summarized cancer diagnoses for patients who had a unique cancer-specific CCS code. Hematologic malignancies such as leukemia or lymphoma (including both non-Hodgkin and Hodgkin's lymphoma) may be associated with immunocompromised status more often than solid malignancies; therefore, we evaluated diagnosis as leukemia or lymphoma versus others.

FIG. 1. Criteria for Identifying Pediatric and AYA Cancer Visits in NEDS Database. We report cancer diagnosis information only if the percent of cases was 1% or more. AYA, adolescent and young adult; NEDS, nationwide emergency department sample.

Reason for the ED visit

We adapted Russell et al.'s framework to conceptualize the reasons for each ED visit.¹² As per this framework, using both diagnosis and procedure codes, the intended treatment of cancer patients is classified into the following mutually exclusive categories: if any of the CCS codes indicated chemotherapy, then the primary intent is classified as chemotherapy. If there are no chemotherapy codes and any of

the codes indicates cancer-related procedures, the intent is procedure. Identification of procedures is followed by identification of infections, noninfectious toxicity, and "other" category (i.e., CCS codes that do not fall into any of the prior categories). In NEDS, CCS procedure codes for patients who are treated and released are reported using both the CPT/HCPSCS (up to 15 CCS codes for each visit) and ICD-9-CM (up to nine CCS codes) procedure codes. For patients admitted to the same hospital, up to nine CCS procedure codes

are available based on the ICD-9-CM procedure codes for each visit.

Since chemotherapy is mostly administered in hospital outpatient and inpatient settings, in our ED-based dataset, chemotherapy accounted for a very small proportion of visits (<1%) and was merged with the “other” category. Therefore, we were left with the following mutually exclusive categories: cancer-related procedures, infections, noninfectious toxicities, and “other” (including chemotherapy). Please refer to the Appendix Table A1 for the list of CCS codes used for identifying procedures, infections, and toxicity.

After categorizing each of the visits per Russell et al.’s method,¹² we reviewed the “other” category to identify additional CCS codes that should be included under procedures, infections, and toxicity. Russell et al.’s research focused on pediatric cancer patients; therefore, this review was conducted to identify other codes that may be relevant for AYAs with cancer. This process yielded a few CCS codes that were then added to our primary categories of procedures, infections, and toxicity. In the Appendix Table A1, we also provide these additional CCS codes identified in our review.

Hospital characteristics

We examined hospital teaching status, trauma designation, and region. NEDS provides information on trauma designation level I (comprehensive centers that care for the most severely injured, and provide leadership in trauma education and research) and level II (comprehensive centers that care for the most severely injured); however, no distinction can be made between level III (centers that provide prompt assessment and transfer to levels I and II centers) and nontrauma centers.¹¹ For our analysis, we compared trauma levels I and II versus III and nontrauma.

Statistical analysis

Summary statistics of visit characteristics and outcome were provided between AYA and pediatric cancer visits. Frequencies between groups were compared using chi-squared tests.

To examine whether the visit outcome differed between the two groups, we also estimated a logistic regression model for the pooled sample of AYA and pediatric cancer visits with the ED outcome (admitted to the same hospital vs. treated/released) as the dependent variable. The primary independent variable in this regression was an indicator for AYA versus pediatric visits. This model included all the covariates discussed above, namely patients’ sex, age, primary payer, county designation, income group, reasons for the visit, and unique cancer diagnosis (leukemia or lymphoma vs. other), and hospitals’ teaching status, trauma designation, region, quarter of ED admission, and weekend ED admission (yes or no). The odds ratio (OR) for our primary independent variable was significant, meaning that after adjusting for the other variables, the ED event outcome significantly differed between AYA and pediatric cancer visits. Therefore, we estimated logistic regressions stratified by pediatric and AYA cancer visits. By doing so, we identified associations between the ED

event outcomes and patients’, hospitals’, and visits’ characteristics listed above, separately for AYA and pediatric cancer visits.

All analyses were conducted in Stata 13.0 (College Station, TX). NEDS provides discharge weights (i.e., sampling weights to extrapolate NEDS sample ED visits to the universe of ED visits), stratum used to sample hospitals (based on geographic region, trauma, location/teaching status, and control), and unique hospital number (i.e., the primary sampling unit) for conducting weighted analyses.¹⁴ The “SVY” command was used for conducting weighted analyses and singleton units were scaled. *p*-values were considered statistically significant at $\alpha = 0.05$ (two sided).

Results

Patient characteristics

In Table 1, females represented two thirds of the AYA visits (67.9%), but only 45.5% of the pediatric visits. Compared to pediatric visits, a significantly higher proportion of the AYA cancer visits were self-pay, by residents of nonmetro counties, and from lower income groups.

Leukemia or lymphoma accounted for 24.6% of cases for AYA cancer visits and 59.5% of pediatric visits ($p < 0.001$). The most frequently reported cancers are shown in Figure 1. For AYA cancer visits, cervical cancer (17.3%), leukemias (11.0%), non-Hodgkin Lymphoma (8.5%), breast cancer (8.5%), and thyroid cancer (5.7%) were the top five diagnoses. In contrast, leukemias (52.0%), brain and nervous system cancers (13.7%), non-Hodgkin Lymphoma (6.0%), bone and connective tissue cancers (5.2%), and kidney and renal pelvis cancers (4.5%) were the top 5 diagnoses for pediatric visits.

Clinical reason for visit

In Table 1, noninfectious toxicity (46.0%) and infections (27.8%) were the most common reasons for AYA cancer visits. For pediatrics, infections were the most common (47.3%), followed by procedures (24.7%) and noninfectious toxicities (20.3%) ($p < 0.001$).

Timing of visit

About one-third of the ED cancer visits were classified as a weekend admission for both patient groups. Discharges were almost equally spread across the four quarters of the year.

Hospital characteristics

AYA cancer visits were less likely to be associated with metro-teaching (50.0% vs. 79.1%, $p < 0.001$) and trauma level I/II designated EDs (37.5% vs. 76.1%, $p < 0.001$) when compared with pediatric visits.

ED event outcome

In Figure 2, of the AYA visits, 30.2% resulted in being admitted to the same hospital versus 44.0% of pediatric visits ($p < 0.001$). Among both groups, procedures were most

TABLE 1. DESCRIPTIVE STATISTICS FOR PEDIATRIC AND ADOLESCENT, AND YOUNG ADULT CANCER EMERGENCY DEPARTMENT VISITS

<i>Patient characteristics</i>	<i>Pediatric cancer ages 0–14 years</i>		<i>AYA cancer ages 15–39 years</i>		<i>p</i>
	<i>n</i>	<i>Weighted%</i>	<i>n</i>	<i>Weighted%</i>	
Sex					
Male	3795	54.5	17,033	32.1	<0.001
Female	3157	45.5	36,237	67.9	
Primary payer					
Public	3269	46.8	24,691	46.2	<0.001
Private	3019	43.4	16,847	31.9	
Self-pay	133	1.9	8452	15.8	
No charge/other	527	7.9	3205	6.1	
County of residence					
Metro	5971	86.3	44,173	82.9	0.077
Micro or nonmetro	947	13.7	8608	17.1	
Household income quartile (\$)					
≤ 37,999	1730	24.9	17,689	33.6	0.002
38,000–47,999	1809	26.7	14,556	28.1	
48,000–63,999	1845	27.4	11,442	22.3	
≥ 64,000	1449	21.1	8295	16.0	
Cancer diagnosis ^a					
Leukemia and lymphoma	3828	59.5	11,196	24.6	<0.001
Other	2632	40.5	34,686	75.4	
Clinical reason for visit					
Procedures	1700	24.7	8123	15.2	<0.001
Infections	3285	47.3	14,788	27.8	
Noninfectious toxicity	1425	20.3	24,573	46.0	
Other	542	7.6	5790	11.0	
Timing of visit					
Weekend admission					
No	4795	69.0	38,865	72.9	<0.001
Yes	2157	31.0	14,408	27.1	
Discharge quarter					
January–March	1843	26.4	12,717	24.0	<0.001
April–June	1798	25.9	13,383	25.1	
July–September	1545	22.3	13,839	26.0	
October–December	1764	25.5	13,225	24.8	
Hospital characteristics					
Teaching status					
Nonteaching/nonmetro	1549	20.9	27,633	50.0	<0.001
Metro teaching	5403	79.1	25,641	50.0	
Trauma designation					
Level III or nontrauma	1778	23.9	33,307	62.5	<0.001
Level I/II	5174	76.1	19,967	37.5	
Region					
Northeast	568	8.2	6363	13.4	0.084
Midwest	1639	23.2	11,585	22.9	
South	2322	31.2	23,527	41.7	
West	2423	37.4	11,799	22.0	

Because of missing data, column sum may be different from the total number of visits identified for pediatric and AYA cancer.

^aCancer diagnosis information is reported for visits with a unique cancer-related CCS diagnosis code only. Please see the text for more detail. AYA, adolescent and young adult.

FIG. 2. ED Event Outcome—Admitted to the Same Hospital versus Treated or Released. ED, emergency department.

likely to result in being admitted, followed by infections and noninfectious toxicity.

Multivariable analysis

In the pooled regression model, after adjusting for all covariates, AYA cancer visits result in being admitted to the same hospital versus treated/released less often than pediatric cancer visits ($OR = 0.84$, 95% confidence interval $[CI] = 0.71-0.98$; $p = 0.03$; results not shown in tables).

Logistic regression results stratified by AYA and pediatric cancer visits are shown in Table 2. Among AYAs, female patients ($OR = 0.63$, $p < 0.001$) were less likely to be admitted to the same hospital versus released than males, and age was associated with a small increased likelihood of being ad-

mitted ($OR = 1.01$, $p < 0.001$). Visits indicating self-pay ($OR = 0.58$, $p < 0.001$) were less likely to be admitted than visits that indicated public insurance as the primary payer for AYA cancer patients. Micro or nonmetro County of residence ($OR = 0.85$, $p = 0.038$) was associated with lower likelihood of being admitted than metro county residence. Sex, age, primary payer, and county residence were not significantly associated with the ED outcome among pediatric cancer visits. Patients from high income quartile counties were more likely to be admitted than those with lower income quartiles within both groups.

Among AYA cancer visits, patients with leukemia and lymphoma ($OR = 1.38$, $p < 0.001$) were more likely to be admitted than those with other cancers. In contrast, among pediatric cancer visits, patients with leukemia and lymphoma ($OR = 0.87$, $p = 0.048$) were less likely to be admitted than

TABLE 2. REGRESSION ANALYSES FOR EMERGENCY DEPARTMENT EVENT OUTCOME

	<i>Pediatric cancer</i>			<i>AYA cancer</i>		
	<i>Odds ratio</i>	<i>95% confidence interval</i>	<i>p</i>	<i>Odds ratio</i>	<i>95% confidence interval</i>	<i>p</i>
Sex						
Male (ref)						
Female	0.93	0.81–1.07	0.314	0.63	0.59–0.68	<0.001
Age (years) ^a	1.00	0.97–1.02	0.746	1.01	1.01–1.02	<0.001
Primary payer						
Public (ref)						
Private	0.94	0.81–1.08	0.372	1.04	0.96–1.13	0.309
Self-Pay	0.73	0.39–1.38	0.333	0.58	0.52–0.66	<0.001
No charge/other	0.95	0.57–1.59	0.854	0.89	0.76–1.04	0.138
County of residence						
Metro (ref)						
Micro or nonmetro	1.10	0.78–1.56	0.572	0.85	0.72–0.99	0.038
Household income quartile (\$)						
≤ 37,999 (ref)						
38,000–47,999	1.31	1.04–1.65	0.020	1.05	0.94–1.18	0.397
48,000–63,999	1.42	1.04–1.95	0.030	1.17	1.03–1.33	0.020
≥ 64,000	1.38	0.99–1.93	0.060	1.16	0.99–1.37	0.069
Unique cancer diagnosis						
Other (ref)						
Leukemia and lymphoma	0.87	0.76–1.00	0.048	1.38	1.28–1.48	<0.001
Clinical diagnosis at visit						
Procedures (ref)						
Infections	0.05	0.04–0.07	<0.001	0.07	0.06–0.08	<0.001
Noninfectious toxicity	0.03	0.02–0.04	<0.001	0.04	0.03–0.04	<0.001
Other	0.01	0.003–0.1	<0.001	0.02	0.01–0.02	<0.001
Weekend admission						
No (ref)						
Yes	1.10	0.96–1.26	0.172	0.98	0.92–1.04	0.452
Discharge quarter						
January–March (ref)						
April–June	1.30	1.10–1.55	0.002	0.97	0.90–1.05	0.436
July–September	1.29	1.06–1.58	0.011	0.94	0.86–1.01	0.109
October–December	1.12	0.93–1.35	0.240	0.86	0.79–0.94	0.001
Teaching status						
Nonteaching/nonmetro (ref)						
Metro teaching	3.04	1.96–4.71	<0.001	1.34	1.11–1.60	0.002
Trauma designation						
Level III or nontrauma (ref)						
Level I/II	2.10	1.21–3.63	0.008	1.45	1.18–1.77	<0.001
Region						
Northeast (ref)						
Midwest	1.39	0.86–2.42	0.177	0.67	0.51–0.87	0.003
South	1.91	1.17–3.13	0.010	0.76	0.60–0.96	0.023
West	1.52	0.90–2.56	0.114	0.74	0.57–0.95	0.016

Weighted logistic regressions were estimated with ED event, that is, admitted to the same hospital versus treated and released, as the dependent variable.

^aIncluded as a continuous variable.

ED, emergency department.

those with other cancers. Within both groups, ED visits indicating cancer-related procedures were significantly more likely to result in being admitted than those indicating infections, toxicities, or other reasons.

ED visits to teaching hospitals, compared with nonteaching, resulted in being admitted more often in both groups. Similarly, visits to level I/II trauma designated EDs resulted in being admitted more often, compared with nontrauma or level III EDs.

Discussion

This article identified the clinical reasons for utilization of EDs, and examined the ED outcome (i.e., admitted to the same hospital or treated and released) and associated factors for AYA and pediatric cancer. In the 2013 NEDS data, we found that AYA cancer ED visits resulted in being admitted to the same hospital less often than pediatric cancer visits. Importantly, AYAs were commonly admitted to EDs for cancer-related toxicity, whereas pediatric visits were more likely for infections. Furthermore, 16% of the AYA cancer visits were self-paid (uninsured) versus 2% of pediatric cancer visits. AYA cancer visits were also more likely to be from poorer households and nonmetro counties. Our results support the need to investigate whether AYA cancer patients are at risk for receiving fragmented care, and, as a result, are admitted to EDs for health conditions that may be managed in ambulatory or outpatient care settings. These findings also warrant investigation in other health systems internationally to better determine if this is a reflection of the U.S. healthcare delivery system or has broader implications for AYAs around the globe.

Age-related differences in treatment-related toxicities among AYAs compared to pediatric patients have been documented.⁹ Often, AYAs experience higher toxicities than younger patients when treated with the same pediatric-type regimens.^{9,15,16} Within our analysis, we observed higher ED utilization for noninfectious toxicities among AYAs than pediatric cancer—46% of the AYA visits were for toxicities versus 21% of pediatric visits, and about 28% were for infections versus 47% of pediatric visits. Interestingly, among AYA cancer visits, 82% of toxicity-related visits did not result in hospital admissions, which may suggest that with adequate access, these issues could potentially be addressed in outpatient settings.

AYA cancer ED visits tended to be from lower income households more often than the pediatric cancer visits. Nationally, young adults are at a higher risk of being uninsured than children and older adults,^{3,17} and uninsured individuals report lacking access to other providers as the reason for their ED visits significantly more likely than those with private insurance.⁵ In our data, 16% of AYA cancer visits were self-paid. Healthcare costs and financial problems are a concern for many AYA cancer survivors, especially for those who are uninsured,^{10,18–21} and avoidable and costly ED visits may accentuate these problems. Improved coverage for young adults with cancer can help with better and timely access to their providers (primary care/specialists), which can reduce their dependence on EDs.²² Studies are needed to investigate

whether self-paid AYAs with cancer, who frequently visit EDs, can be managed in alternate settings (outpatient clinics, community health centers, etc.).

AYA female patients were less likely to be admitted compared with male patients. Based on the level of detail/data available, any conclusion regarding gender would be largely speculative. Possible reasons could include injury/trauma, which may be more common among males, or possibly due to differences in the distribution of cancer diagnoses and treatment between male and female patients. ED visits to teaching and level I/II hospitals resulted in being admitted more often compared with nonteaching and nontrauma/level III hospital, respectively, for both groups. Teaching status and trauma level designation may be correlated with higher level of care and specialist availability, which potentially explains the decision to readmit to the same hospital. Furthermore, patients from higher income households were more likely to be admitted in both groups.

For both groups, infections and toxicities were less likely to result in being admitted to the same hospital than cancer-related procedures. We found that pediatric cancer visits with hematological malignancies resulted in being treated/released more often than those with other malignancies. However, we observed an opposite effect for AYA cancer visits with hematologic malignancies, which resulted in being admitted more often. While it is difficult to explain this finding with our data, we speculate that many pediatric patients with leukemia or lymphoma may visit ED for health issues that would not necessitate hospital admissions (e.g., the top most common reason for pediatric visits with infection in our data was fever).

A few limitations of our analysis should be considered. NEDS only allows visit-level analysis, meaning that we cannot evaluate differences at the patient level. Yet, these analyses are important as they provide information on nationwide resource utilization that is difficult to capture by more detailed institutional-level data. NEDS does not provide age of patient at diagnosis, and we used the patient age at presentation to identify pediatric and AYA cancer visits. While we used 15–39 years as the age range to identify AYA visits, we understand that AYAs are likely heterogeneous in their resource use. While our study is prevalence based, future studies should, however, evaluate ED usage by age since diagnosis to understand differences that may occur during treatment versus survivorship.

Furthermore, whether cancer-related procedures for patients who were admitted to the same hospital occurred in the ED or in the hospital after the ED admission is unknown. Also, in Russell et al.'s analyses, procedures as the primary reasons for inpatient visits were restricted to the first 2 days of hospitalization¹²; however, information on the day of procedure is not available in NEDS. We did not evaluate whether the treated and released patients were sent to other facilities (e.g., home health, other healthcare facilities, etc.). Also, it is difficult to explain the association of lower SES (e.g., low income, without insurance, etc.) with higher likelihood of being treated/released from EDs. Patients from higher SES groups may

be admitted for severe illnesses (clinically necessary) that may increase the likelihood of being admitted, whereas patients from lower SES may be admitted to ED for conditions that may have been addressed in outpatient settings.² However, because of lack of detailed clinical information in administrative datasets, it is not clear whether these associations originate due to differences in clinical needs across patient groups. We also did not examine whether the decision to admit patients after the ED visit was based on actual need or other factors (e.g., higher likelihood of admission if it is a high-volume hospital). This could be examined in future studies with more homogenous populations (e.g., infections only).

In summary, our findings regarding ED utilization reveal important concepts: AYA cancer patients who visit EDs are there more often for treatment-related toxicities and are more likely to be uninsured than younger patients. AYA oncology programs are being implemented at multiple children's hospitals and cancer centers across the United States to address the unique needs of this patient population. In this context, our results are important for delineating care plans for AYAs with cancer and examining the efficacy of programs directed at altering cancer-related ED utilization.

Ethical Approval

This article does not contain any studies with human participants or animals performed by any of the authors. This study used a publicly available dataset; therefore, IRB approval was not needed as per the University of Texas Medical Branch.

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Author Disclosure Statement

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APPENDIX TABLE A1. A LIST OF NEDS CCS CODES USED TO IDENTIFY CANCER-RELATED PROCEDURES, INFECTIONS, AND NONINFECTIOUS TOXICITY

CCS procedure group	Description	CCS procedure group	Description	CCS procedure group	Description
Cancer-related procedures					
1	Incision and Excision of CNS	35	Tracheoscopy and laryngoscopy with biopsy	99	Other OR GI Therapeutic procedures
2	Insertion, replacement, or removal of extracranial ventricular shunt	36	Lobectomy or pneumonectomy	100	Endoscopy and endoscopic biopsy of the urinary tract
3	Laminectomy, excision intervertebral disc	37	Diagnostic bronchoscopy and biopsy of bronchus	101	Transurethral excision, drainage, or removal of urinary obstruction
4	Diagnostic Spinal tap	38	Other diagnostic procedures on lung and bronchus	103	Nephrotomy and nephrostomy
5	Insertion of catheter or spinal stimulator and injection into spinal canal	39	Incision of pleura, thoracentesis, chest drainage	104	Nephrectomy, partial or complete
7	Other diagnostic nervous system procedures	40	Other diagnostic procedures of respiratory tract and mediastinum	109	Procedures on the urethra
9	Other OR therapeutic nervous system procedures	42	Other OR Rx procedures on respiratory system and mediastinum	110	Other diagnostic procedures of urinary tract
10	Thyroidectomy, partial or complete	47	Diagnostic cardiac catheterization, coronary arteriography	112	Other OR therapeutic procedures of urinary tract
11	Diagnostic endocrine procedures	54	Other vascular catheterization, not heart	114	Open prostatectomy
12	Other therapeutic endocrine procedures	65	Bone marrow biopsy	116	Diagnostic procedures, male genital
15	Lens and cataract procedures	66	Procedures on spleen	118	Other OR therapeutic procedures, male genital
16	Repair of retinal tear, detachment	67	Other therapeutic procedures, heme and lymphatic system	119	Oophorectomy, unilateral and bilateral
17	Destruction of lesion of retina and choroid	71	Gastrostomy, temporary and permanent	120	Other operations on ovary
18	Diagnostic procedures on eye	72	Colostomy, temporary and permanent	124	Hysterectomy, abdominal or vaginal
19	Other therapeutic procedures on eyelids, conjunctiva cornea	73	Ileostomy and other enterostomy	125	Other excision of cervix and uterus
20	Other intraocular therapeutic procedures	74	Gastrectomy	130	Other diagnostic procedures, female organs
21	Other extraocular muscle and orbit therapeutic procedures	75	Small bowel resection	132	Other OR therapeutic procedures, female organs
22	Tympanoplasty	78	Colorectal resection	142	Partial excision of bone
24	Mastoidectomy	80	Local excision of large intestine lesion	157	Amputation of lower extremity
25	Diagnostic procedures on ear	83	Biopsy of liver	159	Other procedures on musculoskeletal system
26	Other therapeutic ear procedures	87	Laparoscopy	161	Other OR therapeutic procedures on bone
27	Control of epistaxis	89	Exploratory laparotomy	162	Other OR therapeutic procedures on joints
28	Plastic procedures on nose	90	Excision, lysis peritoneal adhesions	164	Other OR therapeutic procedures on musculoskeletal system
30	Tonsillectomy and/or adenoidectomy	92	Other bowel diagnostic procedures	165	Breast biopsy and other diagnostic procedures on breast
31	Diagnostic procedures on nose, mouth and pharynx	94	Other OR upper GI therapeutic procedures	166	Lupectomy, quadrantectomy of breast
33	Other OR therapeutic procedures on nose mouth and pharynx	96	Other OR lower GI therapeutic procedures	167	Mastectomy
34	Tracheostomy, temporary or permanent	97	Other GI diagnostic procedures	174	Other non-OR therapeutic procedures on skin and breast
222 ^b	Blood transfusion	211 ^b	Radiation therapy	70 ^b	Upper gastrointestinal endoscopy; biopsy
76 ^b	Colonoscopy and biopsy	77 ^b	Proctoscopy and anorectal biopsy	64 ^b	Bone marrow transplant

(continued)

APPENDIX TABLE A1. (CONTINUED)

<i>CCS diagnosis group</i>	<i>Description</i>	<i>CCS diagnosis group</i>	<i>Description</i>	<i>CCS diagnosis group</i>	<i>Description</i>
Infections					
1	Tuberculosis	90	Inflammation, infection of eye	147	Anal and rectal conditions
2	Septicemia (except in labor)	92	Otitis media and related conditions	148	Peritonitis and intestinal abscess
3	Bacterial infection, unspecified site	97	Peri, endo, and myocarditis, cardiomyopathy	159	Urinary tract infections
4	Mycoses	122	Pneumonia	197	Skin and subcutaneous tissue infections
6	Hepatitis	123	Influenza	201	Infective arthritis and osteomyelitis
7	Viral infection	125	Acute bronchitis	237 ^a	Complications of device, implant or graft
8	Other infections; including parasitic	126	Other upper respiratory infections	246	Fever of unknown origin
76	Meningitis	133	Other lower respiratory disease	247	Lymphadenitis
77	Encephalitis	134	Other upper respiratory disease	248	Gangrene
78	Other CNS infection and poliomyelitis	135	Intestinal infection	249	Shock
142 ^b	Appendicitis and other appendiceal conditions	124 ^b	Acute and chronic tonsillitis		
Noninfectious					
49	Diabetes mellitus without Complications	102	Nonspecific chest pain	152	Pancreatic disorders (not diabetes)
50	Diabetes mellitus with complications	103	Pulmonary heart disease	153	Gastrointestinal hemorrhage
51	Other endocrine deficiencies	108	Congestive heart failure; nonhypertensive	155	Other gastrointestinal disorders
52	Nutritional deficiencies	109	Acute cerebrovascular disease	157	Acute and unspecified renal failure
55	Fluid and electrolyte disorders	117	Other circulatory disease	162	Other diseases of bladder and urethra
59 ^c	Deficiency and other anemia	118	Phlebitis; thrombophlebitis and thromboembolism	163	Genitourinary symptoms and ill-defined conditions
60 ^c	Acute posthemorrhagic anemia	129	Aspiration pneumonia	207	Pathologic fracture
62 ^c	Coagulation and hemorrhagic disorders	130	Pleurisy, pneumothorax, pulmonary collapse	211	Other connective tissue disease
63 ^c	Diseases of white blood cells	131	Respiratory failure, insufficiency, arrest	212	Other bone disease and musculoskeletal deformities
64 ^c	Other hematologic conditions	137	Diseases of mouth	238	Complications of surgical procedures or medical care
81	Other hereditary and degenerative nervous system conditions	138	Disorders of esophagus	242	Poisoning by other medications and drugs
83	Epilepsy; convulsions	139	Gastrointestinal ulcer	244	Other injuries and conditions due to external causes
84	Headache, including migraine	140	Gastritis and duodenitis	250	Nausea and vomiting
95	Other nervous system disorders	141	Other disorders of stomach and duodenum	251	Abdominal pain
98	Essential hypertension	145	Intestinal obstruction without hernia	252	Malaise and fatigue
99	Hypertension with complications and secondary hypertension	151	Other liver diseases	253	Allergic reactions
154 ^b	Noninfectious gastroenteritis	57 ^b	Immunity disorders	186 ^b	Diabetes or abnormal glucose tolerance
112 ^b	Transient cerebral ischemia	48 ^b	Thyroid disorders	106 ^b	Cardiac dysrhythmias
158 ^b	Chronic renal failure	104 ^b	Other and ill-defined heart disease	156 ^b	Nephritis; nephrosis; renal sclerosis
174 ^b	Female infertility				

These codes are documented in the appendix section of Russell, et al. ^{A1} Please refer to the text for a detailed discussion of this method. Also, note that chemotherapy was combined with the other category in our analysis.

^aThe CCS diagnosis group 237 was divided into infection and noninfection by specifying ICD-9 codes. Please refer to the appendix files in Russell et al. ^{A1}

^bBased on our review, these codes are identified in addition to the CCS codes documented by Russell et al. ^{A1}

^cCCS groups included cytopenia diagnoses.

CCS, clinical classifications software; NEDS, nationwide emergency department sample; OR, odds ratio.

Appendix Reference: A1. Russell HV, Okcu MF, Kamdar K, et al. Algorithm for analysis of administrative pediatric cancer hospitalization data according to indication for admission. BMC Med Inform Decis Mak. 2014;14:88.