

# Disparities in the Intensity of End-of-Life Care for Children With Cancer

Emily E. Johnston, MD,<sup>a</sup> Elysia Alvarez, MD, MPH,<sup>a</sup> Olga Saynina, MBA,<sup>b</sup> Lee Sanders, MD, MPH,<sup>b,c</sup> Smita Bhatia, MD, MPH,<sup>d</sup> Lisa J. Chamberlain, MD, MPH<sup>b,c</sup>

abstract

**BACKGROUND:** Many adult patients with cancer who know they are dying choose less intense care; additionally, high-intensity care is associated with worse caregiver outcomes. Little is known about intensity of end-of-life care in children with cancer.

**METHODS:** By using the California Office of Statewide Health Planning and Development administrative database, we performed a population-based analysis of patients with cancer aged 0 to 21 who died between 2000 and 2011. Rates of and sociodemographic and clinical factors associated with previously-defined end-of-life intensity indicators were determined. The intensity indicators included an intense medical intervention (cardiopulmonary resuscitation, intubation, ICU admission, or hemodialysis) within 30 days of death, intravenous chemotherapy within 14 days of death, and hospital death.

**RESULTS:** The 3732 patients were 34% non-Hispanic white, and 41% had hematologic malignancies. The most prevalent intensity indicators were hospital death (63%) and ICU admission (20%). Sixty-five percent had  $\geq 1$  intensity indicator, 23%  $\geq 2$ , and 22%  $\geq 1$  intense medical intervention. There was a bimodal association between age and intensity: ages <5 years and 15 to 21 years was associated with intense care. Patients with hematologic malignancies were more likely to have high-intensity end-of-life care, as were patients from underrepresented minorities, those who lived closer to the hospital, those who received care at a nonspecialty center (neither Children's Oncology Group nor National Cancer Institute Designated Cancer Center), and those receiving care after 2008.

**CONCLUSIONS:** Nearly two-thirds of children who died of cancer experienced intense end-of-life care. Further research needs to determine if these rates and disparities are consistent with patient and/or family goals.

Divisions of <sup>a</sup>Pediatric Hematology/Oncology and <sup>c</sup>General Pediatrics, Department of Pediatrics, School of Medicine, and <sup>b</sup>Center for Health Policy and the Center for Primary Care and Outcomes Research, Stanford University, Stanford, California; and <sup>d</sup>Institute for Cancer Outcomes and Survivorship, School of Medicine, University of Alabama at Birmingham, Birmingham, Alabama

Dr Johnston conceptualized and designed the study, conducted the initial data analysis, interpreted the data, and drafted the initial manuscript; Drs Alvarez, Sanders, Bhatia, and Chamberlain conceptualized and designed the study, interpreted the data, and reviewed and revised the manuscript; Ms Saynina acquired the data, conducted the final data analysis, and reviewed and revised the manuscript; and all authors approved the final manuscript as submitted.

**DOI:** <https://doi.org/10.1542/peds.2017-0671>

Accepted for publication Jul 14, 2017

Address correspondence to Emily E. Johnston, MD, Division of Pediatric Hematology/Oncology, Department of Pediatrics, Stanford University School of Medicine, 1000 Welch Rd, Suite 300, Palo Alto, CA 94304. E-mail: [emilyj@stanford.edu](mailto:emilyj@stanford.edu)

PEDIATRICS (ISSN Numbers: Print, 0031-4005; Online, 1098-4275).

**WHAT'S KNOWN ON THIS SUBJECT:** Many adult patients with cancer who know they are dying choose less intense care. High-intensity care is associated with worse caregiver outcomes. Little is known about the end-of-life care intensity of pediatric patients with cancer in the United States.

**WHAT THIS STUDY ADDS:** Nearly two-thirds of children with cancer received intense end-of-life care intervention. Patients <5 years, adolescents, racial and/or ethnic minorities, and patients with hematologic malignancies received more intense end-of-life care. It is unknown if these rates and disparities are consistent with care goals.

**To cite:** Johnston EE, Alvarez E, Saynina O, et al. Disparities in the Intensity of End-of-Life Care for Children With Cancer. *Pediatrics*. 2017;140(4):e20170671

Cancer is the leading cause of nonaccidental death in US children, with almost 2800 deaths annually,<sup>1</sup> making end-of-life studies in pediatric oncology critical. Despite pediatric palliative care becoming a board-certificated specialty and an increase in pediatric palliative care programs in the last decade,<sup>2</sup> pediatric patients with cancer are experiencing large end-of-life symptom burden.<sup>3</sup> In 1 study of children with advanced cancer, 48% had pain, 46% fatigue, and 37% irritability.<sup>3</sup> Therefore, novel approaches and studies are needed to understand and improve pediatric end-of-life care, including population-based studies.<sup>4</sup> Additionally, studies of pediatric oncology end-of-life care can lay groundwork for studying other disease-related causes of death in pediatrics.

Intensity of end-of-life care receives much attention in adult oncology because of concerns that it may not be consistent with patient goals and caregiver outcomes in addition to cost. The majority of older adults who know they are dying do not want life-extending measures,<sup>5,6</sup> and end-of-life care accounts for ~25% of Medicare spending.<sup>7-9</sup> Among adult caregivers of dying patients, more intense end-of-life care and hospital death are associated with worse caregiver outcomes (major depressive, posttraumatic stress, and prolonged grief disorders).<sup>10,11</sup> The American Academy of Pediatrics (AAP),<sup>12</sup> the American Society of Clinical Oncology,<sup>13</sup> and other professional organizations<sup>14-16</sup> call for a palliative approach to terminal illnesses.

Population-level studies of intensity of end-of-life care have been aided by the development and validation of administrative database intensity indicators, including ICU admission, hospital death, and procedures like intubation and hemodialysis within 30 days of death.<sup>17-19</sup> However, there are no population-level

studies of intensity of end-of-life care in pediatric oncology in the United States. Initial population-level pediatric oncology intensity studies were conducted in Taiwan<sup>20</sup> and Korea,<sup>21</sup> with almost 80% of children dying of cancer receiving intense care, but cultural and health care system differences limit US generalizability. Recently, the first North American population-based study of intensity of end-of-life care revealed that 41% of pediatric oncology patients receive intense end-of-life care in Ontario, Canada.<sup>22</sup> Again, differences in health care systems limit US generalizability. Therefore, we sought to determine the rates of and disparities in intensity of end-of-life in pediatric oncology through a population-based study in the United States (CA).

## METHODS

### Study Design and Oversight

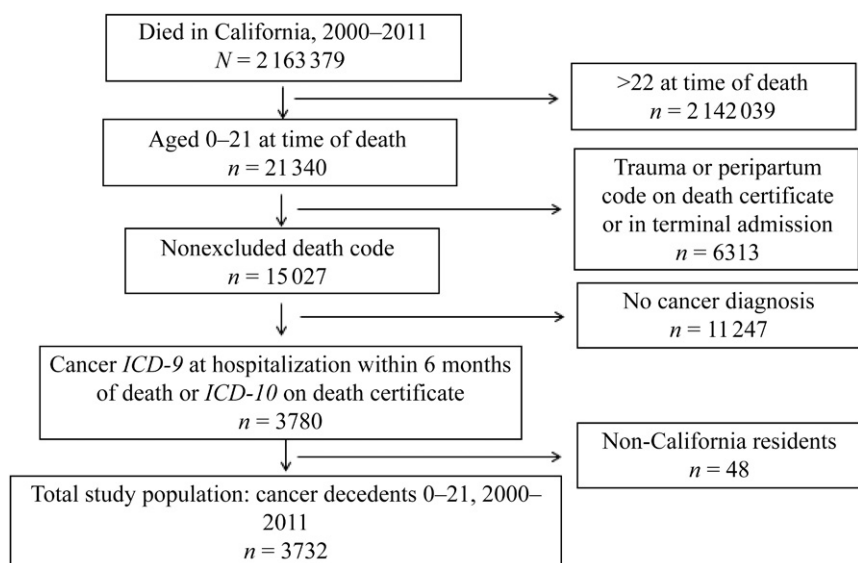
We conducted a retrospective (2000–2011) population-based analysis by using the California Office of Statewide Health Planning and Development (OSHPD) private patient discharge data database and vital statistics death certificate data. The database links a patient's final admission and death certificate, with 2000 to 2011 linked at the time of analysis. All California hospitals, except federal facilities and prison hospitals, must submit discharge information to OSHPD. OSHPD data includes: age, race and/or ethnicity, sex, residence zip code, payer, length of stay, and up to 24 *International Classification of Diseases, Ninth Revision* (ICD-9) codes. Stanford University Institutional Review Board and the California Committee for Protection of Human Subjects approved the study. Administrative data study reporting guidelines were followed.<sup>23</sup>

### Study Population

The study population included patients aged 0 to 21 years at the time of death, who died between 2000 and 2011, with an oncologic diagnosis during a hospitalization within 6 months of death or cancer as the death certificate cause of death (Fig 1). The list of oncologic ICD-9 codes were developed by combining oncologic diagnosis in the Clinical Classification Software<sup>24</sup> and oncologic ICD-9 codes previously used in OSHPD<sup>25</sup> and removing potential nonmalignant conditions (eg, carcinomas-in-situ and Langerhans cell histiocytosis). The resulting ICD-9 codes were grouped according to surveillance, epidemiology, and end results program adolescent young adult site categories.<sup>26</sup> Four pediatric oncologists reviewed the list. Death certificate cause of death categories for malignant neoplasms (C00–C97) were included but not benign or in situ neoplasms. Patients who died of accidents (except medical errors) or peripartum events were excluded.

### Dependent Variables

Indicators of inpatient intensity of end-of-life care were ICU admission, intubation or mechanical ventilation, tracheostomy placement, gastrostomy-tube placement, hemodialysis, or cardiopulmonary resuscitation (CPR) in the last 30 days of life, intravenous chemotherapy in the last 14 days of life, and hospital death.<sup>15,17-19</sup> ICD-9 codes for intensity were previously described for all but ICU admission, which is not directly coded.<sup>17</sup> ICU admission was determined by codes for intubation, mechanical ventilation by using an endotracheal tube or tracheostomy, arterial catheterization, or central venous pressure monitoring. Codes were included if they were present during an admission that took place entirely within the time frame of interest. Death location was determined



**FIGURE 1**

Study population: California residents in California between 2000 and 2011 at ages 0 to 21 who died of cancer (but not peripartum events or accidents). ICD-10, *International Classification of Diseases, Tenth Revision*.

from death certificates or hospital disposition of death. We calculated individual intensity indicator rates and composite measures including: (1) number of intense indicators for each patient (any of the above); (2) any medically-intense intervention (ICU admission, intubation or mechanical ventilation, hemodialysis, or CPR); and (3) technology-dependent condition (gastrostomy or tracheostomy tube placement).

### Independent Variables

Sociodemographic variables (payer status, death age, sex, race and/or ethnicity, median household income [zip code–level median household income categorized by the 2004 federal poverty level<sup>27</sup>], and metropolitan service area) were determined from death certificates when possible, otherwise from last admission. The distance between residence and last hospital, closest hospital, and closest specialty center was calculated from zip code centers. Primary cancer diagnoses were classified (as above) and then grouped into hematologic malignancies (leukemia and lymphoma) and nonhematologic

malignancies (solid tumors).

Specialty centers were defined as Children’s Oncology Group centers or National Cancer Institute designated comprehensive cancer centers. Patients were classified by number of nononcologic chronic condition categories by using categorizations of common causes of admission in children with chronic conditions.<sup>28</sup>

### Statistical Analysis

Descriptive statistics were calculated for each independent and dependent variable and number of intense indicators, receipt of a medically-intense intervention, and technology-dependent intervention. By using the a priori independent variables above, logistic regression models were constructed to determine factors associated with: (1) hospital death, (2) any medically-intense intervention, (3)  $\geq 2$  intensity indicators, and (4) intravenous chemotherapy. A model was not constructed for technology-dependent therapies given low rates. Because of collinearity concerns, the univariate results and population distribution, distance from residence to final hospital but not urban

and/or rural status, distance to closest hospital, or distance to specialty center was retained for the multivariable regression. Additional analyses used an interaction term between age and diagnosis. Results were presented as adjusted odds ratios and 95% confidence intervals. SAS version 9.1 (SAS Institute Inc, Cary, NC) was used.

## RESULTS

### Study Population Characteristics

The study population had 3732 patients (Fig 1) with the expected clinical and sociodemographic characteristic for a California cohort of pediatric patients dying of cancer (Table 1). The majority of patients had solid tumors (59%) with central nervous system tumors the most common (24%). Forty-one percent had a hematologic malignancy, with acute lymphoblastic leukemia the most common single hematologic malignancy (20%). The population was slightly older (with 43% being 15 to 21 years old) and diverse (with 45% Hispanic and 34% non-Hispanic white). Final hospitalization was at a specialty center for 78% of patients; however, it was more frequently at nonspecialty centers for older patients (Fig 2A).

### Intensity Rates

The most common intensity indicators were hospital death (63%), ICU admission (20%), and intubation or mechanical ventilation (20%) (Table 2). Overall, 35% had no intense indicators, 42% had 1, and 23% had  $\geq 2$ . Twenty-two percent received a medically-intense intervention, 4% cancer-directed therapy, and 0.5% a technology-dependent intervention. Hospital death, receipt of a medically-intense intervention, and  $\geq 2$  intensity indicators (but not chemotherapy receipt) showed a bimodal distribution with high rates in young patients, a slightly lower rate in

**TABLE 1** Demographics of the Study Population  
(Total N = 3732)

| Characteristic  | n (%)        |
|---|--------------|
| Death age   |              |
| <5 y  | 680 (18.2)   |
| 5–9 y   | 708 (19.0)   |
| 10–14 y   | 749 (20.1)   |
| 15–21 y   | 1595 (42.7)  |
| Insurance   |              |
| HMO   | 553 (14.8)   |
| Public or self  | 1971 (52.8)  |
| Private   | 1208 (32.4)  |
| Sex   |              |
| Female  | 1562 (41.9)  |
| Male  | 2170 (58.2)  |
| Race and/or ethnicity                                   |              |
| Non-Hispanic white                                      | 1271 (34.1)  |
| Hispanic  | 1695 (45.4)  |
| Asian American  | 350 (9.4)    |
| African American  | 258 (6.9)    |
| Other   | 158 (4.2)    |
| Income (in zip code of residence with reference to FPL) |              |
| Unknown   | 61 (1.6)     |
| <2 times FPL  | 910 (24.4)   |
| 2–4 times FPL   | 2301 (61.7)  |
| >4 times FPL  | 460 (12.3)   |
| Metropolitan statistical area                           |              |
| Urban   | 3465 (92.9)  |
| Rural   | 267 (7.2)    |
| Year of death   |              |
| 2000–2003   | 1362 (36.5)  |
| 2004–2007   | 1284 (34.4)  |
| 2008–2011   | 1086 (29.1)  |
| Diagnosis   |              |
| Hematologic malignancies                                | 1542 (41.3)  |
| Solid tumors  | 2190 (58.7)  |
| No. chronic conditions                                  |              |
| 0   | 2613 (70.0)  |
| 1   | 958 (25.7)   |
| ≥2  | 161 (4.3)    |
| Hospital type (at last hospitalization before death)    |              |
| Specialty center  | 2912 (78.0)  |
| Nonspecialty center                                     | 820 (22.0)   |
| Distance between home and closest hospital              |              |
| <1 mile   | 1578 (42.3)  |
| 1–2.9 miles   | 888 (23.8)   |
| ≥3 miles  | 1266 (33.9)  |
| Distance between home and closest specialty hospital    |              |
| <7.5 miles  | 1373 (36.8)  |
| 7.5–19.9 miles  | 1118 (30.0)  |
| ≥20 miles   | 1241 (33.3)  |
| Distance between home and last hospital                 |              |
| <10 miles   | 1225 (32.82) |
| 10–24.9 miles   | 1298 (34.8)  |
| ≥25 miles   | 1209 (32.4)  |

FPL, federal poverty level; HMO, health maintenance organization.

school-age children, and a second peak in the adolescent population (Fig 2 B–E).

### Factors Associated With High-Intensity End-of-Life Care

In multivariable regression, hospital death, ≥2 intensity indicators, and medically-intense interventions were associated with young (<5 years) and older age (15–21 years) as well as hematologic malignancies (Table 3). In particular, for patients <5 years old (versus patients 5–9 years old) the odds of hospital death were 1.7-fold higher, the odds of a medically-intense intervention were 1.4-fold higher, and the odds for ≥2 intensity indicators were 1.4-fold higher. For patients 15 to 21 years old (versus patients 5–9 years old), the odds of hospital death, medically-intense interventions, and >2 intensity markers were similarly higher. Patients with hematologic malignancies (versus solid tumors) had 3.6-fold higher odds of hospital death, 2.3-fold higher odds of medically-intense intervention, and 2.3-fold higher odds of ≥2 intensity indicators.

Nonspecialty center admission was associated with increased odds of medically-intense interventions and ≥2 intensity indicators but decreased odds of intravenous chemotherapy. African American, Hispanic, and Asian American race and/or ethnicity were more likely to have a hospital death. Hospital death, ≥2 intensity indicators, and receipt of medically-intense interventions were higher for patients residing closer to the hospital. After 2008, patients had higher odds of receipt of a medically-intense intervention or ≥2 intense indicators. There was also a significant interaction between age and diagnosis for hospital death, ≥2 intensity indicators, and any medically-intense intervention (all  $P < .003$ ). At each age, patients with hematologic malignancies had more intense care than those with solid

tumors. In general, the highest-intensity patients with hematologic malignancies were older, whereas the highest-intensity patients with solid tumors were younger (data not shown).

### DISCUSSION

Sixty-five percent of pediatric patients dying of cancer in California had at least 1 intensity indicator, 23% ≥2, and 22% received a medically-intense intervention at end of life. These rates were comparable to Ontario rates for most indicators, with ICU admission rate being 20.4% in California versus 21.7% in Ontario, and intravenous chemotherapy rates being 4.0% vs 7.9% (Ontario included outpatient intravenous chemotherapy).<sup>22</sup> Hospital death rates differed, with 43.4% in Ontario versus 63.4% in California. The drivers of hospital death rate variation are unknown, but may include different health care systems, availability of home health care, distance from the hospital, and cultural differences. In both studies, greater distance from the hospital was associated with decreased odds of hospital death,<sup>22</sup> and the geographic and population density differences between Ontario and California may be contributing to location of death.

The pediatric intensity rates exceed those in Medicare with cancer: 63% of pediatric patients had a hospital death versus 30% of Medicare patients; similarly, 20% of pediatric patients had ICU admission in the last month, compared with fewer than 10% of Medicare patients.<sup>29,30</sup> This is unsurprising because cancer diagnoses, prognosis, and child death vary significantly more than death in an older adult. The 5-year survival rates for invasive cancer is as low as 40% among older adults, but ~80% for children <15 years old.<sup>31,32</sup> Therefore, conversations and hope at diagnosis differ between children and



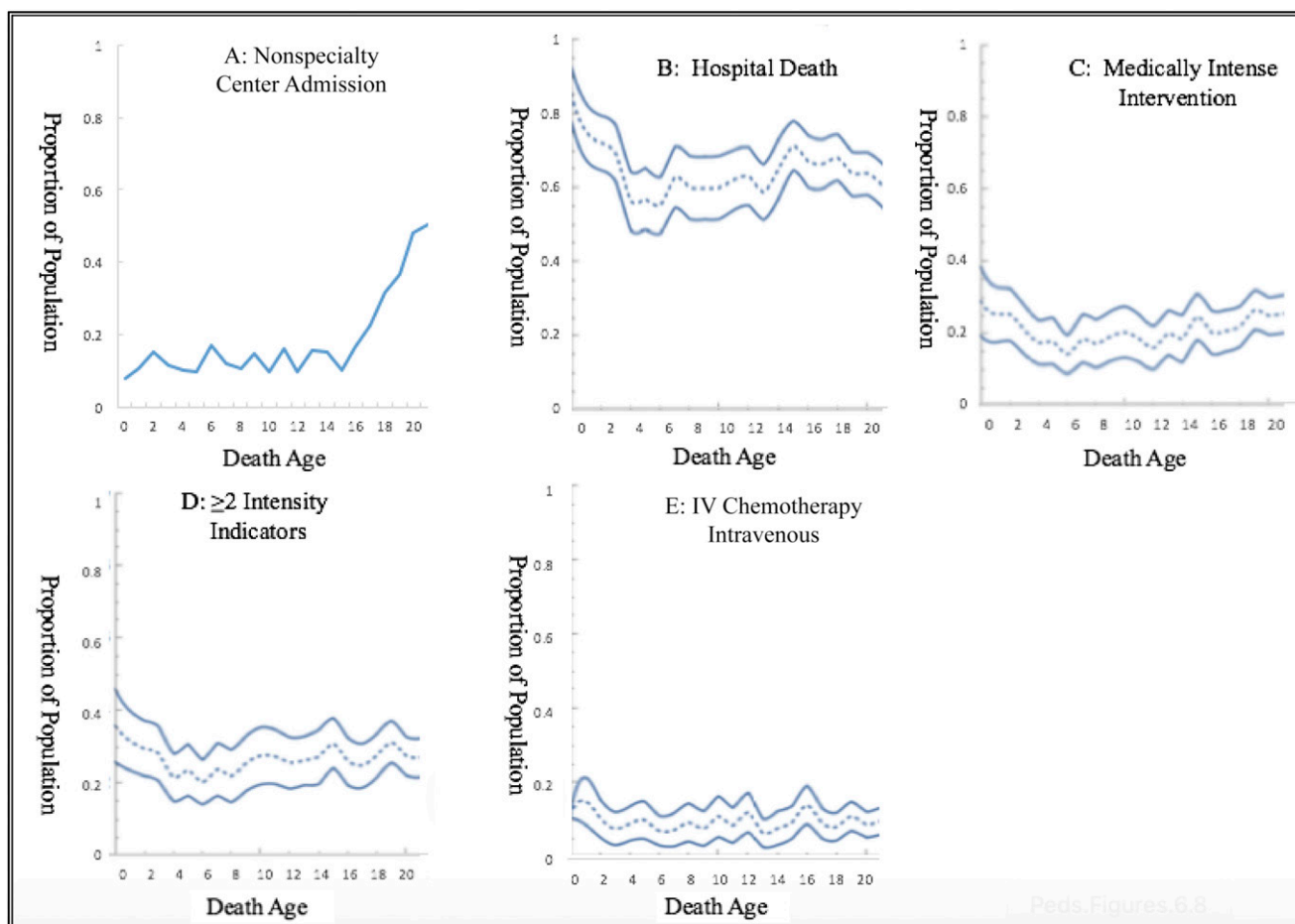
**TABLE 2** Rates of Each End-of-Life Intensity Indicator (N = 3732)

| Intensity Indicator                      | n (%)       |
|--|-------------|
| Hospital death                           | 2367 (63.4) |
| Medically intense intervention           | 812 (21.8)  |
| ICU admission                            | 763 (20.4)  |
| Intubation and/or mechanical ventilation | 742 (19.9)  |
| CPR                                      | 202 (5.4)   |
| Hemodialysis                             | 118 (3.2)   |
| Cancer-directed therapy                  |             |
| Inpatient intravenous chemotherapy       | 148 (4.0)   |
| Technology-dependent intervention        | 18 (0.5)    |
| Tracheostomy placed                      | 9 (0.24)    |
| Gastrostomy tube placed                  | 12 (0.32)   |
| Total no. intensity indicators           |             |
| 0  | 1316 (35.3) |
| 1  | 1547 (41.5) |
| 2  | 140 (3.8)   |
| 3  | 441 (11.8)  |
| ≥4                                       | 288 (7.7)   |

older adults, which has implications for transition to noncurative therapy. Parents' hope does not always reflect prognosis: 88% of parents who acknowledged their child's condition was terminal still hoped for a cure, and 66% hoped for a long life for their child.<sup>33</sup> Additionally, the life-years lost in the death of a child with cancer is greater than in an adult with cancer, potentially influencing how aggressively families and providers try for an elusive cure.<sup>34</sup> However, there is growing evidence that intense end-of-life care in older oncology patients is associated with worse end-of-life and bereaved family member outcomes. Adult patients with cancer who die in the hospital experience lower quality of

life, and their bereaved caregivers are at higher risk of psychiatric illness than those with home death.<sup>11</sup> Similarly, bereaved family members of adult patients with cancer report lower quality of end-of-life care when their family member had an ICU admission or hospital death.<sup>10</sup> More research is needed to determine if intense end-of-life care is associated with lower quality of life at end-of-life and worse bereaved family outcomes in the pediatric population.

Not all ages were equally likely to receive intense end-of-life care: there was bimodal distribution with highest intensity rates in <5-year-olds and in the adolescent population, which has not been shown previously. Kassam et al's<sup>22</sup> Ontario



**FIGURE 2** Location of end-of-life care and rates of intensity of end-of-life care and by death age. A, Proportion of final hospitalizations at nonspecialty centers. B, Hospital death. C, Receipt of any medically intense intervention. D, 2 or more intensity indicators. E, Receipt of intravenous chemotherapy. Panel A shows the population proportion at each age. Panels B–E show population proportion (dotted lines) and 95% confidence intervals at each age (solid lines).

**TABLE 3** Adjusted Odds of Receiving Intense End-of-Life Care

| Category (Reference)                       | Hospital Death   |        | Medically Intense |        | ≥2 Intensity Indicators |        | Inpatient Intravenous Chemotherapy |        |
|--|------------------|--------|-------------------|--------|-------------------------|--------|------------------------------------|--------|
|  | OR (95% CI)      | P      | OR (95% CI)       | P      | OR (95% CI)             | P      | OR (95% CI)                        | P      |
| Death age (5–9 y)                          |                  |        |                   |        |                         |        |                                    |        |
| <5 y                                       | 1.72 (1.36–2.17) | <.0001 | 1.42 (1.08–1.86)  | .01    | 1.37 (1.05–1.78)        | .02    | 1.03 (0.61–1.74)                   | .92    |
| 10–14 y                                    | 1.03 (0.82–1.29) | .80    | 1.05 (0.80–1.39)  | .71    | 1.07 (0.82–1.39)        | .63    | 0.95 (0.56–1.59)                   | .83    |
| 15–21 y                                    | 1.42 (1.16–1.73) | .0006  | 1.40 (1.11–1.77)  | .01    | 1.29 (1.02–1.62)        | .03    | 0.85 (0.54–1.36)                   | .51    |
| Insurance (HMO)                            |                  |        |                   |        |                         |        |                                    |        |
| Private insurance                          | 1.47 (1.17–1.83) | .0008  | 1.09 (0.84–1.42)  | .52    | 1.08 (0.84–1.40)        | .53    | 1.09 (0.65–1.80)                   | .95    |
| Public or self                             | 1.49 (1.20–1.84) | .0003  | 1.17 (0.91–1.50)  | .22    | 1.07 (0.84–1.36)        | .58    | 0.79 (0.48–1.30)                   | .22    |
| Sex (Male)                                 |                  |        |                   |        |                         |        |                                    |        |
| Female                                     | 1.22 (1.06–1.42) | .01    | 0.98 (0.83–1.16)  | .84    | 1.00 (0.85–1.17)        | .95    | 1.02 (0.72–1.43)                   | .93    |
| Race and/or ethnicity (non-Hispanic white) |                  |        |                   |        |                         |        |                                    |        |
| African American                           | 1.43 (1.05–1.94) | .02    | 1.29 (0.92–1.81)  | .13    | 1.22 (0.88–1.70)        | .23    | 0.82 (0.38–1.78)                   | .61    |
| Hispanic                                   | 1.43 (1.20–1.70) | <.0001 | 1.23 (1.00–1.50)  | .05    | 1.158 (0.97–1.44)       | .09    | 0.99 (0.66–1.49)                   | .95    |
| Asian American                             | 1.32 (1.01–1.72) | .04    | 1.07 (0.79–1.45)  | .67    | 0.95 (0.70–1.29)        | .74    | 1.00 (0.54–1.85)                   | .99    |
| Other                                      | 1.27 (0.88–1.85) | .20    | 1.18 (0.78–1.80)  | .43    | 1.05 (0.69–1.59)        | .83    | 0.81 (0.32–2.09)                   | .66    |
| Year of death (2000–2003)                  |                  |        |                   |        |                         |        |                                    |        |
| 2004–2007                                  | 1.03 (0.87–1.22) | .76    | 1.13 (0.93–1.38)  | .21    | 1.09 (0.90–1.31)        | .40    | 1.01 (0.68–1.50)                   | .97    |
| 2008–2011                                  | 1.15 (0.96–1.38) | .13    | 1.33 (1.09–1.63)  | .01    | 1.29 (1.06–1.57)        | .01    | 1.08 (0.71–1.64)                   | .72    |
| Diagnosis (solid tumors)                   |                  |        |                   |        |                         |        |                                    |        |
| Hematologic malignancies                   | 3.56 (3.04–4.17) | <.0001 | 2.31 (1.96–2.68)  | <.0001 | 2.25 (1.92–2.65)        | <.0001 | 2.21 (1.56–3.12)                   | <.0001 |
| No. chronic conditions (0 conditions)      |                  |        |                   |        |                         |        |                                    |        |
| 1 chronic condition                        | 1.27 (1.07–1.51) | .01    | 0.89 (0.74–1.08)  | .24    | 0.92 (0.76–1.10)        | .35    | 0.85 (0.57–1.25)                   | .40    |
| ≥2   | 0.99 (0.69–1.42) | .95    | 0.84 (0.56–1.26)  | .40    | 0.83 (0.56–1.24)        | .37    | 0.51 (0.18–1.43)                   | .20    |
| Last hospital (specialty center)           |                  |        |                   |        |                         |        |                                    |        |
| Nonspecialty center                        | 0.91 (0.75–1.09) | .29    | 1.34 (1.09–1.65)  | .01    | 1.29 (1.05–1.57)        | .01    | 0.56 (0.34–0.94)                   | .03    |
| Distance last hospital to home (<10 miles) |                  |        |                   |        |                         |        |                                    |        |
| 10–24.9 miles                              | 0.89 (0.73–1.05) | .14    | 0.81 (0.66–0.99)  | .04    | 0.79 (0.65–0.96)        | .02    | 0.79 (0.52–1.22)                   | .29    |
| ≥25 miles                                  | 0.64 (0.53–0.78) | <.0001 | 0.88 (0.71–1.08)  | .21    | 0.86 (0.70–1.05)        | .13    | 0.88 (0.58–1.35)                   | .56    |

Also in the model, but nonsignificant: zip code–level income. CI, confidence interval; HMO, health maintenance organization; OR, odds ratio.

study included patients up to 18, and previous studies of intensity in adolescents and young adults (AYAs) did not include younger children, thus limiting age comparison.<sup>35,36</sup> One AYA study revealed 15- to 24-year-olds were more likely than 35- to 39-year-olds to be admitted to the ICU,<sup>35</sup> and another found that being aged 15 to 21 at diagnosis was associated with more intense care and less hospice use than older age.<sup>36</sup> However, researchers for neither study examined how that compared with younger peers.<sup>35,36</sup> AYAs have presented challenges to the oncology community, with survival improvements lagging behind other age groups.<sup>31,32</sup> This survival gap has been partially attributed to less specialty center access.<sup>25,37,38</sup> We have shown that at end-of-life, AYAs also have

higher rates of hospitalization at nonspecialty centers than younger children. Palliative care involvement was recently found to be associated with lower rates of intense end-of-life care in AYA (ages 15–26) oncology patients and lower rates of hospital death.<sup>39</sup> Early palliative care has also been found to increase life expectancy in adult non-small cell lung carcinoma.<sup>40</sup> Therefore, for some conditions, early palliative care may both decrease intensity of end-of-life care and increase life expectancy, highlighting the importance of palliative care involvement. Despite extensive growth in palliative care programs, there is large regional and hospital variation: in 2009, 85% of hospitals with >300 beds had a palliative care program compared with 22% of hospitals with <50 beds.<sup>41</sup> How this

coverage correlates with end-of-life care of adolescents with cancer is unknown.

Disparities in indicators of intense end-of-life care related to insurance coverage and race and/or ethnicity were found. Insurance other than health maintenance organization insurance was associated with more hospital deaths, which may explain why California has higher hospital death rates than Canada, where a comprehensive, health maintenance organization–like universal system exists. Additionally, African Americans, Hispanics, and Asian Americans had higher rates of hospital death. In a previous AYA study, Asian Americans had higher rates of ICU admission,<sup>35</sup> and minority race and/or ethnicity has been associated with care

intensity in older adult studies.<sup>29,30,42,43</sup> However, Kassam et al<sup>22</sup> (the Ontario study) did not examine race and/or ethnicity. Higher intensity of end-of-life care in patients with hematologic malignancies have been seen in pediatric,<sup>22</sup> AYA,<sup>35,36</sup> and older adult studies.<sup>29</sup> More work needs to explore if these disparities are consistent with patients' and families' preferences or driven by timing of end-of-life conversations, hospice and palliative care availability, or other factors.

In this study, we establish rates of and disparities in intensity of end-of-life care in pediatric patients dying of cancer in the United States. There is evidence that early end-of-life conversations and palliative care involvement leads to less intense end-of-life care.<sup>39,44,45</sup> These findings support the AAP statement calling for a palliative approach to patients with terminal conditions.<sup>12</sup> However, pediatric palliative care is a relatively new specialty with recent growth, yet significant variation in access persists.<sup>2</sup> In this work, we examined 1 group of pediatric patients: children with terminal cancer. The AAP call for a palliative approach to patients with life-threatening illnesses<sup>12</sup> applies to the ~20 000 children who die annually of all disease-related causes.<sup>11</sup> In this study, we establish a methodology for studying intensity rates in children dying of disease-related causes. Universal versus disease-specific disparities may help establish if disparities are goal concurrent or due to health care system factors. In particular, we need to explore how palliative care access correlates with intensity of end-of-life care.

This study has limitations to thoughtfully consider. The population-based study is limited to California patients, but because >10% of the United States population resides in California

and California is diverse, it has important implications.<sup>46</sup> Our study was restricted to patients in the linked death certificate patient discharge database. However, the state's record linkage is conducted with full access to patients' information. Additionally, the rates, diagnoses, and age distribution are comparable to Kassam et al's<sup>22</sup> Ontario study, giving face validity to populations and rates. At the time of analysis, the state had only linked 2000 to 2011, so the results do not reflect the most recent changes in policy and treatment. The database does not include billing data, so surrogate ICD-9 codes for ICU admission were used. Not all ICU admissions will include mechanical ventilation, central venous pressure monitoring, or arterial catheterization; therefore, we are probably underestimating ICU admission rates. However, our ICU admission rates were similar to Kassam et al's<sup>22</sup> rates, which did not rely on surrogate ICU markers. Many studies of end-of-life intensity are restricted to patients with known terminal conditions (like relapse) to exclude patients who may have died of treatment-related mortality. Some cases of treatment-related mortality are acute and recovery is expected (provided the patient survives the acute episode), so intense care may be appropriate rather than potentially causing prolonged suffering at the end of life. We do not have such data granularity in OSHPD, but there are 3 reasons that highlight the value of this study despite this limitation. First, Kassam et al<sup>22</sup> evaluated treatment-related mortality in sensitivity analysis and had similar findings with or without it. Second, patients with leukemia will have some of the highest treatment-related mortality rates because of chemotherapy intensity. However, meta-analysis revealed that only 22% of deaths in pediatric patients with acute lymphoblastic leukemia were due

to nonrelapse mortality.<sup>47</sup> Third, the National Quality Forum has endorsed many intensity indicators for oncology deaths regardless of cause of death.<sup>15</sup> Other intensity indicators (hospice and emergency department use in the last month), are not available in the OSHPD database. However, we focused on inpatient intensity in this study, which may have different drivers than outpatient intensity.

## CONCLUSIONS

This is the first study in which intensity of end-of-life care in pediatric patients dying of cancer in the United States has been evaluated, and it has been revealed that the majority received a medically intense intervention. Additionally, there were disparities related to age, diagnosis, and race and/or ethnicity. It remains unknown if these rates and disparities are consistent with patient and/or family wishes or result from factors like palliative care access. In this study, we lay the groundwork for studies of pediatric end-of-life care outside of oncology. Understanding how rates differ between diagnoses may determine which disparities are due to patient preference versus the health care system and which groups may need targeted intervention to ensure they receive the care they desire and deserve.

## ABBREVIATIONS

AAP: American Academy of Pediatrics  
AYA: adolescent and young adult  
CPR: cardiopulmonary resuscitation  
ICD-9: *International Classification of Diseases, Ninth Revision*  
OSHPD: Office of Statewide Health Planning and Development

**FINANCIAL DISCLOSURE:** The authors have indicated they have no financial relationships relevant to this article to disclose.

**FUNDING:** Supported by a KL2 Mentored Career Development Award of the Stanford Clinical and Translational Science Award to Spectrum (NIH KL2 TR 001083 and NIH UL1 TR 001085) through salary support for Dr Johnston. The Stanford Center for Policy, Outcomes, and Prevention provided data access, programming, and statistical support.

**POTENTIAL CONFLICT OF INTEREST:** The authors have indicated they have no potential conflicts of interest to disclose.

**COMPANION PAPER:** A companion to this article can be found online at [www.pediatrics.org/cgi/doi/10.1542/peds.2017-1662](http://www.pediatrics.org/cgi/doi/10.1542/peds.2017-1662).

## REFERENCES

- Centers for Disease Control and Prevention. Ten leading causes of death and injury. 2013. Available at: [www.cdc.gov/injury/wisqars/leadingcauses.html](http://www.cdc.gov/injury/wisqars/leadingcauses.html). Accessed October 22, 2015
- Feudtner C, Womer J, Augustin R, et al. Pediatric palliative care programs in children's hospitals: a cross-sectional national survey. *Pediatrics*. 2013;132(6):1063–1070
- Wolfe J, Grier HE, Klar N, et al. Symptoms and suffering at the end of life in children with cancer. *N Engl J Med*. 2000;342(5):326–333
- Schenker Y, Arnold R. The next era of palliative care. *JAMA*. 2015;314(15):1565–1566
- Weeks JC, Cook EF, O'Day SJ, et al. Relationship between cancer patients' predictions of prognosis and their treatment preferences. *JAMA*. 1998;279(21):1709–1714
- McCarthy EP, Phillips RS, Zhong Z, Drews RE, Lynn J. Dying with cancer: patients' function, symptoms, and care preferences as death approaches. *J Am Geriatr Soc*. 2000;48(suppl 5):S110–S121
- Yabroff KR, Warren JL, Brown ML. Costs of cancer care in the USA: a descriptive review. *Nat Clin Pract Oncol*. 2007;4(11):643–656
- Riley GF, Lubitz JD. Long-term trends in Medicare payments in the last year of life. *Health Serv Res*. 2010;45(2):565–576
- Emanuel EJ, Ash A, Yu W, et al. Managed care, hospice use, site of death, and medical expenditures in the last year of life. *Arch Intern Med*. 2002;162(15):1722–1728
- Wright AA, Zhang B, Ray A, et al. Associations between end-of-life discussions, patient mental health, medical care near death, and caregiver bereavement adjustment. *JAMA*. 2008;300(14):1665–1673
- Wright AA, Keating NL, Balboni TA, Matulonis UA, Block SD, Prigerson HG. Place of death: correlations with quality of life of patients with cancer and predictors of bereaved caregivers' mental health. *J Clin Oncol*. 2010;28(29):4457–4464
- Section on Hospice and Palliative Medicine and Committee on Hospital Care. Pediatric palliative care and hospice care commitments, guidelines, and recommendations. *Pediatrics*. 2013;132(5):966–972
- Smith TJ, Temin S, Alesi ER, et al. American society of clinical oncology provisional clinical opinion: the integration of palliative care into standard oncology care. *J Clin Oncol*. 2012;30(8):880–887
- Field MJ, Behrman RE, eds. Institute of Medicine, Board on Health Sciences Policy, Committee on Palliative and End-of-Life Care for Children and Their Families. *When Children Die: Improving Palliative and End-of-Life Care for Children and Their Families*. Washington, DC: National Academies Press; 2003
- National Quality Forum. Home. Available at: [www.qualityforum.org/Home.aspx](http://www.qualityforum.org/Home.aspx). Accessed April 3, 2015
- Committee on Approaching Death: Addressing Key End-of-Life Issues, Institute of Medicine. *Dying in America: Improving Quality and Honoring Individual Preferences Near the End of Life*. Washington, DC: The National Academies Press; 2014
- Barnato AE, Farrell MH, Chang C-CH, Lave JR, Roberts MS, Angus DC. Development and validation of hospital "end-of-life" treatment intensity measures. *Med Care*. 2009;47(10):1098–1105
- Earle CC, Park ER, Lai B, Weeks JC, Ayanian JZ, Block S. Identifying potential indicators of the quality of end-of-life cancer care from administrative data. *J Clin Oncol*. 2003;21(6):1133–1138
- Earle CC, Neville BA, Landrum MB, et al. Evaluating claims-based indicators of the intensity of end-of-life cancer care. *Int J Qual Health Care*. 2005;17(6):505–509
- Tang ST, Wu S-C, Hung Y-N, Huang E-W, Chen J-S, Liu T-W. Trends in quality of end-of-life care for Taiwanese cancer patients who died in 2000-2006. *Ann Oncol*. 2009;20(2):343–348
- Park JD, Kang HJ, Kim YA, et al. Trends in the aggressiveness of end-of-life care for Korean pediatric cancer patients who died in 2007-2010. *PLoS One*. 2014;9(6):e99888
- Kassam A, Sutradhar R, Widger K, et al. Predictors of and trends in high-intensity end-of-life care among children with cancer: a population-based study using health services data. *J Clin Oncol*. 2017;35(2):236–242
- Benchimol EI, Smeeth L, Guttman A, et al; RECORD Working Committee. The REporting of studies Conducted using Observational Routinely-collected health Data (RECORD) statement. *PLoS Med*. 2015;12(10):e1001885
- Healthcare Cost and Utilization Project. Appendix A - clinical classification software - diagnoses (January 1980 through September 2015). 2014. Available at: <https://www.hcup-us.ahrq.gov/toolssoftware/ccs/AppendixASingleDX.txt>. Accessed November 3, 2015
- Chamberlain LJ, Pineda N, Winestone L, et al. Increased utilization of pediatric



- specialty care: a population study of pediatric oncology inpatients in California. *J Pediatr Hematol Oncol*. 2014;36(2):99–107
26. Surveillance, Epidemiology, and End Results Program. AYA site recode/WHO 2008 definition. 2008. Available at: <https://seer.cancer.gov/ayarecode/aya-who2008.html>. Accessed November 29, 2015
  27. Office of the Assistant Secretary for Planning and Evaluation. Prior HHS poverty guidelines and federal register references. Available at: <https://aspe.hhs.gov/prior-hhs-poverty-guidelines-and-federal-register-references>. Accessed December 7, 2015
  28. Chamberlain LJ, Chan J, Mahlow P, Huffman LC, Chan K, Wise PH. Variation in specialty care hospitalization for children with chronic conditions in California. *Pediatrics*. 2010;125(6):1190–1199
  29. Earle CC, Neville BA, Landrum MB, Ayanian JZ, Block SD, Weeks JC. Trends in the aggressiveness of cancer care near the end of life. *J Clin Oncol*. 2004;22(2):315–321
  30. Miesfeldt S, Murray K, Lucas L, Chang C-H, Goodman D, Morden NE. Association of age, gender, and race with intensity of end-of-life care for Medicare beneficiaries with cancer. *J Palliat Med*. 2012;15(5):548–554
  31. Keegan THM, Ries LAG, Barr RD, et al; National Cancer Institute Next Steps for Adolescent and Young Adult Oncology Epidemiology Working Group. Comparison of cancer survival trends in the United States of adolescents and young adults with those in children and older adults. *Cancer*. 2016;122(7):1009–1016
  32. Bleyer A, O’leary M, Barr R, Ries LAG, eds. *Cancer Epidemiology in Older Adolescents and Young Adults 15 to 29 Years of Age, Including SEER Incidence and Survival*. Bethesda, MD: National Cancer Institute; 2006
  33. Kamihara J, Nyborn JA, Olcese ME, Nickerson T, Mack JW. Parental hope for children with advanced cancer. *Pediatrics*. 2015;135(5):868–874
  34. Bleyer WA. The impact of childhood cancer on the United States and the world. *CA Cancer J Clin*. 1990;40(6):355–367
  35. Mack JW, Chen LH, Cannavale K, Sattayapiwat O, Cooper RM, Chao CR. End-of-life care intensity among adolescent and young adult patients with cancer in Kaiser Permanente Southern California. *JAMA Oncol*. 2015;1(5):592–600
  36. Mack JW, Chen K, Boscoe FP, et al. High intensity of end-of-life care among adolescent and young adult cancer patients in the New York State Medicaid program. *Med Care*. 2015;53(12):1018–1026
  37. Albritton KH, Wiggins CH, Nelson HE, Weeks JC. Site of oncologic specialty care for older adolescents in Utah. *J Clin Oncol*. 2007;25(29):4616–4621
  38. Howell DL, Ward KC, Austin HD, Young JL, Woods WG. Access to pediatric cancer care by age, race, and diagnosis, and outcomes of cancer treatment in pediatric and adolescent patients in the state of Georgia. *J Clin Oncol*. 2007;25(29):4610–4615
  39. Snaman JM, Kaye EC, Lu JJ, Sykes A, Baker JN. Palliative care involvement is associated with less intensive end-of-life care in adolescent and young adult oncology patients. *J Palliat Med*. 2017;20(5):509–516
  40. Temel JS, Greer JA, Muzikansky A, et al. Early palliative care for patients with metastatic non-small-cell lung cancer. *N Engl J Med*. 2010;363(8):733–742
  41. Center to Advance Palliative Care. Growth of palliative care in U.S. hospitals 2011 snapshot. 2011. Available at: [www.hhnmag.com/ext/resources/inc-hhn/pdfs/resources/capc-growth-analysis-snapshot-2011.pdf](http://www.hhnmag.com/ext/resources/inc-hhn/pdfs/resources/capc-growth-analysis-snapshot-2011.pdf). Accessed October 20, 2016
  42. Sharma G, Freeman J, Zhang D, Goodwin JS. Trends in end-of-life ICU use among older adults with advanced lung cancer. *Chest*. 2008;133(1):72–78
  43. Guadagnolo BA, Liao K-P, Giordano SH, Elting LS, Shih Y-CT. Variation in intensity and costs of care by payer and race for patients dying of cancer in Texas: an analysis of registry-linked Medicaid, Medicare, and dually eligible claims data. *Med Care*. 2015;53(7):591–598
  44. Mack JW, Cronin A, Keating NL, et al. Associations between end-of-life discussion characteristics and care received near death: a prospective cohort study. *J Clin Oncol*. 2012;30(35):4387–4395
  45. Ahluwalia SC, Tisnado DM, Walling AM, et al. Association of early patient-physician care planning discussions and end-of-life care intensity in advanced cancer. *J Palliat Med*. 2015;18(10):834–841
  46. US Census Bureau. Data. Available at: [www.census.gov/data.html](http://www.census.gov/data.html). Accessed February 15, 2016
  47. Blanco E, Beyene J, Maloney AM, et al. Non-relapse mortality in pediatric acute lymphoblastic leukemia: a systematic review and meta-analysis. *Leuk Lymphoma*. 2012;53(5):878–885

**Disparities in the Intensity of End-of-Life Care for Children With Cancer**  
Emily E. Johnston, Elysia Alvarez, Olga Saynina, Lee Sanders, Smita Bhatia and Lisa  
J. Chamberlain

*Pediatrics* 2017;140;

DOI: 10.1542/peds.2017-0671 originally published online September 28, 2017;

|   |   |
|---|---|
| <b>Updated Information &amp; Services</b> | including high resolution figures, can be found at:<br><a href="http://pediatrics.aappublications.org/content/140/4/e20170671">http://pediatrics.aappublications.org/content/140/4/e20170671</a>  |
| <b>References</b>                         | This article cites 37 articles, 11 of which you can access for free at:<br><a href="http://pediatrics.aappublications.org/content/140/4/e20170671#BIBL">http://pediatrics.aappublications.org/content/140/4/e20170671#BIBL</a>  |
| <b>Subspecialty Collections</b>           | This article, along with others on similar topics, appears in the following collection(s):<br><b>Hematology/Oncology</b><br><a href="http://www.aappublications.org/cgi/collection/hematology:oncology_sub">http://www.aappublications.org/cgi/collection/hematology:oncology_sub</a><br><b>Cancer/Neoplastic</b><br><a href="http://www.aappublications.org/cgi/collection/cancer:neoplastic_sub">http://www.aappublications.org/cgi/collection/cancer:neoplastic_sub</a><br><b>Hospice/Palliative Medicine</b><br><a href="http://www.aappublications.org/cgi/collection/hospice:palliative_medicine_sub">http://www.aappublications.org/cgi/collection/hospice:palliative_medicine_sub</a> |
| <b>Permissions &amp; Licensing</b>        | Information about reproducing this article in parts (figures, tables) or in its entirety can be found online at:<br><a href="http://www.aappublications.org/site/misc/Permissions.xhtml">http://www.aappublications.org/site/misc/Permissions.xhtml</a>   |
| <b>Reprints</b>                           | Information about ordering reprints can be found online:<br><a href="http://www.aappublications.org/site/misc/reprints.xhtml">http://www.aappublications.org/site/misc/reprints.xhtml</a>   |

American Academy of Pediatrics

DEDICATED TO THE HEALTH OF ALL CHILDREN™



# PEDIATRICS®

OFFICIAL JOURNAL OF THE AMERICAN ACADEMY OF PEDIATRICS

## **Disparities in the Intensity of End-of-Life Care for Children With Cancer**

Emily E. Johnston, Elysia Alvarez, Olga Saynina, Lee Sanders, Smita Bhatia and Lisa J. Chamberlain

*Pediatrics* 2017;140;

DOI: 10.1542/peds.2017-0671 originally published online September 28, 2017;

The online version of this article, along with updated information and services, is located on the World Wide Web at:

<http://pediatrics.aappublications.org/content/140/4/e20170671>

Pediatrics is the official journal of the American Academy of Pediatrics. A monthly publication, it has been published continuously since 1948. Pediatrics is owned, published, and trademarked by the American Academy of Pediatrics, 141 Northwest Point Boulevard, Elk Grove Village, Illinois, 60007. Copyright © 2017 by the American Academy of Pediatrics. All rights reserved. Print ISSN: 1073-0397.

American Academy of Pediatrics

DEDICATED TO THE HEALTH OF ALL CHILDREN™

