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Clinical Trial Enrollment is Associated With Improved Follow-up Rates Among Survivors of Childhood Cancer

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Summary

Fortunately > 80% of children diagnosed with cancer become long-term survivors; however, this population is at a significantly increased risk of morbidity and mortality as a result of their previous cancer therapy, and long-term follow-up (LTFU) is critical. Multiple barriers to receiving adequate LTFU care have been studied. We investigated whether lack of enrollment in a therapeutic clinical trial may be a barrier to receiving LTFU care. We conducted a review of 353 patient records at the Children's Hospital of Michigan enrolled in our Children's Oncology Group registry between January 1, 2005 and December 31, 2010. In total, 71 patients were excluded (death before follow-up, n= 61; currently receiving therapy, n= 5; known transfer of care, n =4; insufficient information, n =1). In total, 158 (56%) patients were enrolled in a therapeutic clinical trial. Follow-up rates at 1-, 2- and 5-years following completion of therapy for patients enrolled in a therapeutic clinical trial were 96.8% (153/158), 93.7% (148/158), and 81.7% (103/126), respectively, compared with 83.1% (103/124; $P<0.001$), 74.2% (92/124; $P<0.001$), and 66.7% (72/108; $P=0.001$) for patients not enrolled. Our findings suggest patients enrolled in a therapeutic clinical trial have better LTFU rates and supports the importance of patient enrollment in therapeutic clinical trials when possible. Additional resources may be warranted to improve LTFU for patients not enrolled.

Keywords

pediatric oncology; late effects; clinical trials; survivorship

Childhood cancer treatment outcomes have improved substantially over the past 40 to 50 years with 5-year overall survival rates reaching > 80% for children and adolescents, compared with rates of 50% to 60% in the 1970s.¹ As of 2011, nearly 400,000 survivors of childhood cancer were alive in the United States.² It is now well known that survivors are at significantly increased risk of long-term complications from their previous cancer treatment,

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and that long-term follow-up (LTFU) is critical.³⁻⁷ The majority of survivors will develop adverse chronic health conditions within 30 years of their cancer diagnosis and are 10 times more likely than their siblings to develop a serious chronic disease.⁴ The development of late effects is dependent on a multitude of factors, such as age at diagnosis, type of malignancy, treatment modalities utilized during therapy (ie, chemotherapy, radiation, surgery, hematopoietic stem cell transplant), and the presence of preexisting underlying comorbid conditions.^{3,8,9} Despite the known increased morbidity and early mortality associated with childhood cancer survivorship, the majority of survivors may not be receiving adequate survivor-focused LTFU care.¹⁰⁻¹²

In 2003, the Institute of Medicine recognized survivors of childhood and adolescent cancer as a vulnerable population in need of evidence-based guidelines for survivorship care.³ As a result, the Children's Oncology Group (COG) established risk-based guidelines for survivors of childhood, adolescent and young adult (AYA) cancer to aid in improving the care of this population.^{13,14} Outcomes from utilizing these guidelines are being studied and have shown to be of high-yield for a number of screening modalities, such as assessing pulmonary and thyroid function in high-risk groups.¹⁵ Unfortunately, multiple barriers and obstacles have been identified that may prevent survivors from receiving this necessary follow-up care.¹⁶ One in particular is that many survivors of childhood and adolescent cancer are unaware that they are at risk of serious health problems as a result of their previous cancer diagnosis and treatment.^{16,17} Barriers range from those pertaining specifically to the survivor, such as this lack of knowledge, to other barriers involving health care providers and the health care system itself, such as lack of provider knowledge concerning survivors' care needs and a lack of insurance to afford follow-up care, respectively.^{9,16}

Specific factors have been studied in an attempt to determine which patients may be at the greatest risk of not receiving adequate follow-up care. Risk factors that are associated with decreased LTFU rates include those such as lack of health insurance, male sex, lack of concern for future health, living at an increased distance from a cancer treatment center and increased time since completion of therapy.^{10-12,18-20} Nathan et al¹¹ reported that based on the results from the Childhood Cancer Survivor Study (CCSS), which has been previously described elsewhere,²¹ only 13.7% of the 8522 survivors reported having received general survivor-focused care within the 2-year study period, and only 17.8% reported having received risk-based, survivor-focused care. Patients more likely to have received general or risk-based, survivor-focused care were those diagnosed with central nervous system tumors. Patients who were male, were uninsured or had a household income of <\$40,000 per year were less likely to have received any type of medical care.¹¹

Additional factors may contribute to decreased followup rates that have not yet been identified. Although many young children diagnosed with cancer are enrolled in clinical trials, the AYA population historically enrolls at a much lower rate for a variety of reasons.²² The aim of our study was to therefore determine whether lack of enrollment in a therapeutic clinical trial may be a barrier to receiving LTFU care among survivors of childhood and adolescent cancer.

MATERIALS AND METHODS

The Children's Hospital of Michigan is a tertiary care medical center located in Detroit, Michigan that delivers care to a racially and economically diverse patient population. After Institutional Review Board approval, a retrospective chart review of patients at the Children's Hospital of Michigan who were enrolled in our COG registry was conducted by a single investigator. Patients that are included in our COG registry consist of those who have consented to at least 1 clinical trial. These trials include—but are not limited to—biology and other nontherapeutic clinical trials, as well as therapeutic clinical trials (ie, prospective treatment trials). The patients who did not sign informed consent forms for various reasons (patient/family preference, family not offered, etc.) are included in a separate database. Patient records analyzed in the study include patients who were diagnosed with cancer at the Children's Hospital of Michigan between January 1, 2005 and December 31, 2010 and were 25 years of age or below at time of diagnosis. Descriptive data including sex, age at diagnosis, race (black, Middle Eastern, white, or other), ethnicity (Hispanic or non-Hispanic), cancer diagnosis (brain tumor, leukemia, lymphoma, solid tumor, or other), economic status based on median income for zip code (low, middle, or high), insurance type (private or public), and enrollment in a therapeutic clinical trial (yes or no) were collected and analyzed. Electronic and paper medical records were utilized to collect data. Follow-up dates at 1-, 2- and 5-years postcompletion of therapy were manually recorded. Data analysis was conducted using SPSS version 24 (IBM Inc., Chicago, IL). Statistical significance was set at a $P < 0.05$ using a nonparametric 2-tailed Fisher exact test and the Pearson χ^2 test. Separate logistic regression analyses were then conducted among all collected patient variables for each of the 3 timepoints (1-, 2-, and 5-years postcompletion of therapy). Odds ratios (ORs) and their 95% confidence intervals (CIs) were obtained and reported for variables found to be significant predictors in the model, as well as for those that trended toward a P -value of 0.05.

RESULTS

Patient Characteristics

A total of 353 patients were enrolled in the registry and available for review. In total, 282 patient charts were included for analysis after 71 patients were excluded at 1- and 2-years postcompletion of therapy (died before follow-up, $n=61$; still on therapy, $n=5$; known transfer of care, $n=4$; insufficient information, $n=1$). In total, 234 patients were included for analysis at 5-years postcompletion of therapy (48 of the original 282 patients were still within 5 years of completing therapy). Demographic information for the patients included in the analysis is noted in Table 1. In total, 158 (56%) patients were enrolled in a therapeutic clinical trial. In total, 185 (65.6%) patients were below 10 years of age at time of diagnosis. In total, 158 (56%) patients were male. The majority of patients were identified as white (152 patients, 53.9%), whereas 91 (32.3%) were identified as black. Almost all (269 patients, 95.4%) patients were identified as non-Hispanic. In total, 204 (72.3%) patients were categorized within the middle economic subgroup. The majority of diagnoses include solid tumors (106 patients, 37.6%) and leukemia (96 patients, 34%). Although 51.1% (144) of patients had private insurance, 48.2% (136) had public insurance. In total, 87% (245) of

patients resided in the greater Detroit Tri-County area (Macomb, Oakland, and Wayne Counties).

Follow-up Outcomes

Patients enrolled in a therapeutic clinical trial had significantly better follow-up rates at 1- (96.8%, n= 153/158), 2- (93.7%, n= 148/158), and 5-years (81.7%, n= 103/126) postcompletion of therapy compared with those not enrolled in a therapeutic clinical trial (ie, those who consented to and were enrolled in a nontherapeutic clinical trial only) (83.1%, n= 103/124, $P<0.001$; 74.2%, n=92/124, $P<0.001$; 66.7%, n=72/108, $P= 0.01$, at 1-, 2- and 5-years, respectively) (Table 2). Significantly higher follow-up was also noted among patients with private versus public insurance at 2- and 5-years postcompletion of therapy (Table 2). Patients diagnosed with malignancies other than solid tumors had significantly improved follow-up visit rates at 1-year postcompletion of therapy, as well as follow-up rates that trended toward significance at 2- and 5-years (Table 2). Patients who were younger than 10 years of age at time of diagnosis, as well as patients who were categorized within the higher economic status trended toward having improved follow-up rates at the various timepoints, although they were not statistically significant (Table 2). To discern if there was a difference specifically between children and the AYA population, patients were dichotomized into groups comparing those <15 and 15 years of age and above; however, there was a significantly unbalanced sample size, with ~88% of patients being below 15 years of age at time of diagnosis. Patients' race and sex did not have an effect on LTFU rates (Table 2). The single best predictor of follow-up at each of the 3 timepoints was enrollment in a therapeutic clinical trial when all variables were analyzed using a logistic regression model (1-year OR, 0.18, 95% CI, 0.06–0.49, $P<0.05$; 2-years OR, 0.19, 95% CI, 0.09–0.41, $P<0.05$; 5-years OR, 0.42, 95% CI, 0.23–0.79, $P<0.05$).

The demographic data were then compared between the 2 groups of patients based on their therapeutic clinical trial enrollment status (Table 3). Analyses were conducted between the group of 282 patients included at 1- and 2-years postcompletion of therapy based on enrollment status in a therapeutic clinical trial (Table 3A), as well as between the 234 patients evaluable at 5-years postcompletion of therapy (Table 3B). In the 1- and 2-year follow-up cohort, demographics were similar between the 2 groups with regard to age at diagnosis, sex, race, economic status, and type of insurance. There was an increased percentage of patients with types of malignancies other than solid tumors who were enrolled in a therapeutic clinical trial (39% of total cohort, 110 patients) compared with the percentage of patients with malignancies other than solids tumors who were not enrolled (23% of total cohort, 66 patients) (Table 3A). Patient demographic data in the 5-year cohort were similar for all variables when comparing patients enrolled to those not enrolled in a therapeutic clinical trial (Table 3B).

DISCUSSION

Survivors of childhood and AYA cancer are at increased risk of excess morbidity and early mortality. Unfortunately, many survivors are not receiving adequate risk-based, survivor-focused care. Multiple barriers have been shown to be associated with lack of LTFU. There

was a significant increase in follow-up rates at 1-, 2- and 5-years postcompletion of therapy for patients enrolled in a therapeutic clinical trial compared with patients who were not among a cohort of survivors of childhood and AYA cancer at our institution. These data suggest that patients who are treated without being enrolled in a therapeutic clinical trial may not only be at risk of decreased survival rates and poorer quality of life as has been previously reported,²² but may also receive inferior LTFU care which could then ultimately lead to increased morbidity and early mortality. Additional factors that were noted to be associated with increased rates of LTFU in this study included younger age at diagnosis, having private insurance, being diagnosed with a malignancy other than a solid tumor, and categorization in the high economic subgroup.

Patients who enrolled in nontherapeutic clinical trials alone at our institution may have been due to the lack of an open therapeutic clinical trial at the time of diagnosis. This finding was recently showed in a population-based study among Canadian children between 0 and 14 years of age diagnosed with cancer.²³ Pole et al²³ found that 27.5% (2533/9204) of children in their Canadian database between 2001 and 2012 were enrolled in a therapeutic clinical trial. The primary reason documented as to why patients were not enrolled was due to lack of an open therapeutic clinical trial at time of diagnosis (52.2%) followed by physician choice (11.2%). Although the specific reasoning as to why each individual not enrolled in a therapeutic clinical trial at our institution is unknown, it is estimated that when open therapeutic clinical trials are available for a given patient's diagnosis > 90% of patients elect to enroll. This is important to recognize, particularly for adolescents and young adults diagnosed with cancer. It has been suggested that improved survival rates for childhood cancer over the years may in part be attributed to enrollment in clinical trials; however, improvements in the AYA population has not been as significant.^{24,25} One speculation as to why this is may be due to the lack of trial enrollment among the AYA population.^{24,26} The Division of Cancer Prevention and Control at the Centers for Disease Control and Prevention developed a working group of researchers and health care providers to study barriers to this population enrolling in clinical trials.²⁷ Barriers such as lack of an open available therapeutic clinical trial due to the type of cancer diagnosis, lack of knowledge from the providers' perspectives as to the importance of enrolling in a therapeutic trial, lack of collaboration between pediatric and adult oncology groups as well as between community and academic centers, and patient-specific barriers related to psychosocial issues and lack of insurance have been identified.^{26,27} The need for expanded access and accrual into therapeutic clinical trials has been recommended to increase not only scientific knowledge, but also treatment efficacy and to decrease treatment-associated morbidity.^{24,25}

Many survivors may not be aware of the adverse sequelae that can result from their prior cancer history and treatment.^{17,28} Both survivors and their physicians have recognized the importance of survivors knowing details about their past diagnosis so that they are able to self-advocate and participate in their own health care.^{16,29} Numerous collaborative and single-institution research efforts among survivors have been conducted to study the health issues faced by this population and support the need for ongoing, life-long follow-up, as well as further research to identify patients at greatest risk of adverse effects.^{30,31} It is recommended that to improve risk-based care for this vulnerable population interventions such as additional education for survivors and primary care physicians, as well as improved

communication among survivors, their cancer centers and primary care physicians be developed.¹⁰ This is of utmost importance as many primary care providers lack knowledge regarding the needs of survivors of childhood and adolescent cancer and feel uncomfortable taking care of this population.^{8,32} It is critical to be able to ensure adequate, quality follow-up for all patients, and determining specific barriers that put particular survivors at greatest risk of not seeking LTFU care is imperative so to focus on interventions that may help those most in need.

Our report is not without several limitations. First is the inherent nature of a retrospective review which may be associated with selection bias and confounding factors that were not accounted for in the analyses. Charts were obtained from the institution's COG registry but did not include patients who elected not to consent for a research study. Our data may therefore represent an overestimation of patients following-up at the given timepoints, as well as an overrepresentation of patients enrolled in a therapeutic clinical trial at our institution; however, including the patients not enrolled in any form of research study may have led to an even greater difference in LTFU rates between patients enrolled and not enrolled in a therapeutic clinical trial. A second limitation is that the data were collected from a single-institution by a single investigator. Given that this was an exploratory study, results still note an important association between LTFU rates and enrollment in therapeutic clinical trials and supports further investigation with a collaboration of institutions on this topic. Thirdly, follow-up data recorded in this study included any follow-up noted within our health care system and is not specific to risk-based, survivor-focused follow-up. In addition, there was a difference between the percentage of patients with malignancies other than solid tumors enrolled versus not enrolled in a therapeutic clinical trial at our institution for the 1- and 2-year cohort, which may confound the results and potentially skew the impact of inserting this variable into the model. Finally one cannot determine based on the data why patients who were not enrolled in a therapeutic clinical trial had decreased LTFU rates compared with those who were enrolled; however, one may speculate that a systems-based barrier may exist in that patients enrolled are closely followed to ensure adequate follow-up and reporting to the COG, which may provide increased assistance for those particular survivors.

In conclusion, our findings show that patients enrolled in a therapeutic clinical trial have significantly better LTFU rates compared with patients enrolled in nontherapeutic clinical trials alone. These data suggest that additional resources may be needed to improve LTFU for patients not enrolled in therapeutic clinical trials, as well as to ensure standardized institutional guidelines for monitoring the follow-up of all patients regardless of clinical trial enrollment status. These results support the importance of enrolling patients diagnosed with cancer in therapeutic clinical trials whenever possible. As the prevalence of survivors of childhood and adolescent cancer continues to increase, focus on improving health care follow-up rates should be a priority to provide necessary prevention and education for this vulnerable population. Further prospective research to determine possible reasons for lack of LTFU among survivors of childhood cancer including participation in clinical trials is warranted.

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REFERENCES

1. Siegel RL, Miller KD, Jemal A. Cancer statistics, 2017. *CA Cancer J Clin*. 2017;67:7–30. [PubMed: 28055103]
2. Phillips SM, Padgett LS, Leisenring WM, et al. Survivors of childhood cancer in the United States: prevalence and burden of morbidity. *Cancer Epidemiol Biomarkers Prev*. 2015;24: 653–663. [PubMed: 25834148]
3. Institute of Medicine (US) National Research Council (US) National Cancer Policy Board, Hewitt M, Weiner SL, Simone JV. Institute of Medicine (US) National Research Council (US) National Cancer Policy Board Childhood Cancer Survivorship: Improving Care and Quality of Life. Washington, DC: National Academies Press (US); 2003.
4. Oeffinger KC, Mertens AC, Sklar CA, et al. Chronic health conditions in adult survivors of childhood cancer. *N Engl J Med*. 2006;355:1572–1582. [PubMed: 17035650]
5. Mertens AC, Liu Q, Neglia P, et al. Cause-specific late mortality among 5-year survivors of childhood cancer: the childhood cancer survivor study. *J Natl Cancer Inst*. 2008; 100:1368–1379. [PubMed: 18812549]
6. Wasilewski-Masker K, Mertens AC, Patterson B, et al. Severity of health conditions identified in a pediatric cancer survivor program. *Pediatr Blood Cancer*. 2010;54:976–982. [PubMed: 20108334]
7. Hudson MM, Ness KK, Gurney JG, et al. Clinical ascertainment of health outcomes among adults treated for childhood cancer: a report from the St. Jude lifetime cohort study. *JAMA*. 2013;309:2371–2381. [PubMed: 23757085]
8. Hudson MM. A model for care across the cancer continuum. *Cancer*. 2005;104:2638–2642. [PubMed: 16258932]
9. Robison LL, Hudson MM. Survivors of childhood and adolescent cancer: life-long risks and responsibilities. *Nat Rev Cancer*. 2014;14:61–70. [PubMed: 24304873]
10. Oeffinger KC, Mertens AC, Hudson MM, et al. Health care of young adult survivors of childhood cancer: a report from the childhood cancer survivor study. *Ann Fam Med*. 2004;2: 61–70. [PubMed: 15053285]
11. Nathan PC, Greenberg ML, Ness KK, et al. Medical care in long-term survivors of childhood cancer: a report from the childhood cancer survivor study. *J Clin Oncol*. 2008;26: 4401–4409. [PubMed: 18802152]
12. Zheng DJ, Sint K, Mitchell HR, et al. Patterns and predictors of survivorship clinic attendance in a population-based sample of pediatric and young adult childhood cancer survivors. *J Cancer Surviv*. 2016;10:505–513. [PubMed: 26572903]
13. Landier W, Bhatia S, Eshelman DA, et al. Development of risk-based guidelines for pediatric cancer survivors: the Children's Oncology Group Long-Term Follow-up Guidelines from the Children's Oncology Group Late Effects Committee and Nursing Discipline. *J Clin Oncol*. 2004;22:4979–4990. [PubMed: 15576413]
14. Children's Oncology Group (COG). Long-term follow-up guidelines for survivors of childhood, adolescent, and young adult cancers, version 4.0. Children's Oncology Group, Monrovia, CA 2013 Available at: www.survivorshipguidelines.org. Accessed January 15, 2017.
15. Landier W, Armenian SH, Lee J, et al. Yield of screening for long-term complications using the children's oncology group long-term follow-up guidelines. *J Clin Oncol*. 2012;30: 4401–4408. [PubMed: 23091100]
16. Zebrack BJ, Eshelman DA, Hudson MM, et al. Health care for childhood cancer survivors. *Cancer*. 2004;100:843–850. [PubMed: 14770443]
17. Kadan-Lottick NS, Robison LL, Gurney JG, et al. Childhood cancer survivors' knowledge about their past diagnosis and treatment. *JAMA*. 2002;287:1832–1839. [PubMed: 11939869]

18. Casillas J, Castellino SM, Hudson MM, et al. Impact of insurance type on survivor-focused and general preventative health care utilization in adult survivors of childhood cancer: the Childhood Cancer Survivor Study (CCSS). *Cancer*. 2011;117: 1966–1975. [PubMed: 21509774]
19. Barakat LP, Schwartz LA, Szabo MM, et al. Factors that contribute to post-treatment follow-up care for survivors of childhood cancer. *J Cancer Surviv*. 2012;6:155–162. [PubMed: 22170442]
20. Nathan PC, Agha M, Pole JD, et al. Predictors of attendance at specialized survivor clinics in a population-based cohort of adult survivors of childhood cancer. *J Cancer Surviv*. 2016;10: 611–618. [PubMed: 26868681]
21. Robison LL, Mertens AC, Boice JD, et al. Study design and cohort characteristics of the childhood cancer survivor study: a multi-institutional collaborative project. *Med Pediatr Oncol*. 2002; 38:229–239. [PubMed: 11920786]
22. Ferrari A, Bleyer A. Participation of adolescents with cancer in clinical trials. *Cancer Treat Rev*. 2007;33:603–608. [PubMed: 17250970]
23. Pole JD, Barber R, Bergeron RE, et al. Most children with cancer are not enrolled on a clinical trial in Canada: a population-based study. *BMC Cancer*. 2017;17:402. [PubMed: 28583094]
24. Ferrari A, Montello M, Budd T, et al. The challenges of clinical trials for adolescents and young adults with cancer. *Pediatr Blood Cancer*. 2008;50:1101–1104. [PubMed: 18360838]
25. Bleyer A, Ferrari A, Whelan J, et al. Global assessment of cancer incidence and survival in adolescents and young adults. *Pediatr Blood Cancer*. 2017:e26497.
26. Burke ME, Albritton K, Marina N. Challenges in the recruitment of adolescents and young adults to cancer clinical trials. *Cancer*. 2007;110:2385–2393. [PubMed: 17918260]
27. Tai E, Buchanan N, Eliman D, et al. Understanding and addressing the lack of clinical trial enrollment among adolescents with cancer. *Pediatrics*. 2014;133:S98–S103. [PubMed: 24918214]
28. Tonorezos ES, Henderson TO. Clinical guidelines for the care of childhood cancer survivors. *Children*. 2014;1: 227–240. [PubMed: 27417477]
29. Zebrack B, Bleyer A, Albritton K, et al. Assessing the health care needs of adolescent and young adult cancer patients and survivors. *Cancer*. 2006;107:2915–2923. [PubMed: 17103383]
30. Landier W, Armenian SH, Bhatia S. Late effects of childhood cancer and its treatment. *Pediatr Clin North Am*. 2015;62:275–300. [PubMed: 25435123]
31. Bhatia S, Armenian SH, Armstrong GT, et al. Collaborative research in childhood cancer survivorship: the current landscape. *J Clin Oncol*. 2015;33:3055–3064. [PubMed: 26304891]
32. Suh E, Daugherty CK, Wroblewski K, et al. General internists' preferences and knowledge about the care of adult survivors of childhood cancer: a cross-sectional survey. *Ann Intern Med*. 2014;160:11–17. [PubMed: 24573662]

TABLE 1.

Distribution of Patients Based on Demographic Data Extracted From Medical Records and the COG Registry at the Children's Hospital of Michigan

Patient Demographic Information	No. Patients (%) [*]
Enrolled in therapeutic clinical trial	
Yes	158 (56)
No	124 (44)
Age at diagnosis (y)	
< 10	185 (65.6)
10–14	63 (22.3)
15–19	33 (11.7)
20–25	1 (0.4)
Sex	
Male	158 (56)
Female	124 (44)
Race [†]	
White	152 (53.9)
Black	91 (32.3)
Other	29 (10.3)
Middle Eastern	10 (3.5)
Ethnicity	
Non-Hispanic	269 (95.4)
Hispanic	13 (4.6)
Economic status [‡]	
Middle	204 (72.3)
Low	64 (22.7)
High	14 (5)
Type of malignancy [§]	
Solid tumor	106 (37.6)
Leukemia	96 (34)
Brain tumor	42 (14.9)
Lymphoma	32 (11.3)
Other	6 (2.1)
Insurance type	
Private	144 (51.1)
Public	136 (48.2)
Unknown	2 (0.7)

^{*} In total, 48 patients were not included for 5-year analysis as these patients have been below 5 years since time of completion of their therapy.

[†] Other includes Indian, Asian, Biracial.

[‡]Economic status was determined based on the median income for the patients' zip codes taken from www.incomebyzipcode.com/michigan. Median income was based on results from the US Census Bureau's 2013 American Community Survey. The median income for Michigan was \$48,273, with low-middle income being \$32,182 and upper-middle being \$96,546.

[§]"Solid Tumor" includes retinoblastoma, soft tissue sarcomas, neuroblastoma, Wilms tumor, osteosarcoma, Ewing sarcoma, thyroid cancer, germ cell tumor. "Other" includes Langerhans cell histiocytosis, transient myeloproliferative disorder, hemophagocytic lymphohistiocytosis.

COG indicates Children's Oncology Group.

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TABLE 2.

Univariate Analyses of Follow-up Rates at 1-, 2-, and 5-Years Postcompletion of Therapy Comparing Clinical Variables (ie, Enrollment in a Therapeutic Clinic Trial, Age at Diagnosis, Insurance Type, Sex, Race, Malignancy, and Economic Status)

Follow-up Rates at 1-, 2-, and 5-Years Postcompletion of Therapy (n/N [%])*			
	1-Year	2-Years	5-Years
Therapeutic clinical trial enrollment status			
Enrolled	153/158 (96.8)	148/158 (93.7)	103/126 (81.7)
Nonenrolled	103/124 (83.1)	92/124 (74.2)	72/108 (66.7)
<i>P</i>	< 0.001	< 0.001	0.01
Age at time of diagnosis (y)			
< 10	169/185 (91.4)	161/185 (87)	118/150 (78.7)
> 10	87/97 (89.7)	79/97 (81.4)	57/84 (67.9)
<i>P</i>	0.668	0.222	0.084
Insurance			
Private	134/144 (93.1)	129/144 (89.6)	98/121 (81)
Public	121/136 (89)	110/136 (80.9)	76/111 (68.5)
<i>P</i>	0.295	0.044	0.034
Sex			
Male	142/158 (89.9)	132/158 (83.5)	92/125 (73.6)
Female	114/124 (91.9)	108/124 (87.1)	83/109 (76.1)
<i>P</i>	0.679	0.501	0.763
Race			
White	136/152 (89.5)	130/152 (85.5)	92/125 (73.6)
Black	87/91 (95.6)	79/91 (86.8)	59/75 (78.7)
Middle Eastern	9/10 (90)	9/10 (90)	6/7 (85.7)
Other	24/29 (82.8)	22/29 (75.9)	18/27 (66.7)
<i>P</i>	0.166	0.498	0.556
Type of malignancy			
Solid tumor	91/106 (85.8)	86/106 (81.1)	70/101 (69.3)
Other	165/176 (93.8)	154/176 (87.5)	105/133 (78.9)
<i>P</i>	0.033	0.168	0.097
Economic status			
High	14/14 (100)	14/14 (100)	11/12 (91.7)
Middle	184/204 (90.2)	174/204 (85.3)	124/167 (74.3)
Low	58/64 (90.6)	52/64 (81.3)	40/55 (72.7)
<i>P</i>	0.471	0.201	0.375

* Patients enrolled in a therapeutic clinical trial had statistically greater follow-up at each of the 3 timepoints than patients not enrolled in a therapeutic clinical trial. Patients with private insurance had statistically greater follow-up at 2- and 5-years compared with patients with public insurance. The specific types of insurance were obtained from each medical record and then subcategorized as private or public. Patients with "other" forms of malignancy had greater follow-up rates at 1-year compared with patients with solid tumors. In the analyses, "solid tumor" includes retinoblastoma, soft tissue sarcomas, neuroblastoma, Wilms tumor, osteosarcoma, Ewing sarcoma, thyroid cancer, and germ cell tumor, whereas "other" includes patients with leukemia, brain tumors, lymphoma, Langerhans cell histiocytosis, transient myeloproliferative disorder, or

hemophagocytic lymphohistiocytosis. Younger age at diagnosis trended toward improved follow-up rates. Race and sex did not significantly affect follow-up rates.

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TABLE 3.

Comparison of Demographic Data for Patients Enrolled and Not Enrolled in a Therapeutic Clinical Trial

	n (%)	
	Enrolled	Not Enrolled
A. Demographic information comparing patients enrolled vs. patients not enrolled in a therapeutic clinical trial at 1- and 2-years postcompletion of therapy (total N = 282)		
Age at diagnosis (y)		
< 10	98 (35)	87 (31)
> 10	60 (21)	37 (13)
Sex		
Male	90 (32)	68 (24)
Female	68 (24)	56 (20)
Race		
White	84 (30)	68 (24)
Black	55 (20)	36 (13)
Other	15(5)	14(5)
Middle Eastern	4(1)	6 (2)
Economic status		
Low	39 (14)	25 (9)
Middle	110 (39)	94 (33)
High	9(3)	5 (2)
Type of malignancy *		
Solid tumor	48 (17)	58 (21)
Others	110 (39)	66 (23)
Type of insurance †		
Private	79 (28)	65 (23)
Public	78 (28)	58 (21)
B. Demographic information comparing patients enrolled vs. patients not enrolled in a therapeutic clinical trial at 5-years postcompletion of therapy (total n = 234)		
Age at diagnosis (y)		
< 10	75 (32)	75 (32)
> 10	51 (22)	33 (14)
Sex		
Male	66 (28)	59 (25)
Female	60 (26)	49 (21)
Race		
White	65 (28)	60 (26)
Black	45 (19)	30 (13)
Other	13 (6)	14(6)
Middle Eastern	3(1)	4 (2)
Economic status		
Low	35 (15)	20 (9)
Middle	83 (35)	84 (36)

	n (%)	
	Enrolled	Not Enrolled
High	8 (3)	4 (2)
Type of malignancy *		
Solid tumor	46 (20)	55 (24)
Others	80 (34)	53 (23)
Type of insurance)		
Private	65 (28)	56 (24)
Public	60 (26)	51 (22)

* Solid tumor includes retinoblastoma, soft tissue sarcomas, neuroblastoma, Wilms tumor, osteosarcoma, Ewing sarcoma, thyroid cancer, and germ cell tumor, whereas “other” includes patients with leukemia, brain tumors, lymphoma, Langerhans cell histiocytosis, transient myeloproliferative disorder, or hemophagocytic lymphohistiocytosis.

† Two patients with unknown insurance status and therefore were removed from analysis for type of insurance (total n = 232).