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Latest Estimates of Survival Rates of the 24 Most Common Cancers in Adolescent and Young Adult Americans

Archie Bleyer, MD

Purpose: A need to examine survival trends of individual cancers in older adolescents and young adults (AYAs) is prompted by overall survival trends that have indicated a lack of progress in survival improvement for AYAs compared with both younger and older cancer patients. ***Patients and Methods:*** The most recent Surveillance, Epidemiology and End Results (SEER) data were used to ascertain survival trends of the 24 most frequent cancers in AYAs. ***Results:*** Of the 20 types of cancers in 15- to 39-year-olds evaluable for survival rate trends, only eight had evidence for a statistically significant improvement in their age-adjusted 5-year survival rate since 1985. As of 2000–2007, of the 24 most common types of cancer in American AYAs, nine had an age-adjusted 5-year survival rate in excess of 80% and eight had a survival rate below 60%. In 19 of 21 cancers for which a comparison of survival by gender is feasible, AYA males had a worse survival rate than females. Of the 23 types of cancer that are classifiable as distant disease, 13 had 5-year survival rates of less than 30%. ***Conclusion:*** While some progress has been made, the lack of improvement for some cancers with distant disease is disappointing. Increased survival of AYA cancer patients offers significant societal gains in terms of years of productivity compared to older adults. If the potential long-term economic impact of health in AYAs is considered, the need to improve the survival of AYAs with cancer is obvious.

Background

The adolescent and young adult age range of 15 to 39 years has been a focus of national cancer investigation in the United States since the National Cancer Institute (NCI) and Lance Armstrong Foundation's joint Progress Review Group (PRG) in Adolescent and Young Adult Oncology (AYAO) was convened five years ago. A quarter of a century ago, the diagnosis of cancer generally had a better prognosis in older adolescents and young adults (AYAs) than in younger or older persons. Today the situation is reversed relative to younger persons and approaching reversal relative to older persons.[1–4] In the 1950s, childhood cancer became a singular focus of treatment and research.[5] In 1971, the National Cancer Act added adults with cancer as a priority.[6] Meanwhile, substantially less attention has been given to the age group in between. As a result, the relative improvement in the survival rate in young adults has not kept pace with that achieved in younger patients. During the past five years, this deficit became the subject of a national focus and initiatives.[1–4] This article updates these issues with the most recent national survival data specific to 15- to 39-year-olds with cancer in the United States.

Methods

Survival data were obtained from the Surveillance, Epidemiology and End Results (SEER) program of the National Cancer Institute via SEER*Stat versions 6.4.4 and 6.6.2.[7] To evaluate survival trends from 1975 to 2002, the original nine SEER registries (SEER9) were used, consisting of Connecticut, Iowa, New Mexico, Utah, Hawaii, the metropolitan areas of Detroit, San Francisco-Oakland, and Atlanta, and 13 counties of the Seattle-Puget Sound region. By 1992, four additional registries (rural Georgia, Alaskan natives, Los Angeles, and the San Jose-Monterey area) were added to the original nine (SEER13), and in 2000 four more were added (the rest of the state of California, Kentucky, New Jersey, and Louisiana; SEER17), allowing an expanded database for analysis since 1992 and 2000, respectively. The SEER17 database, used in this report for all of the 2000–2007 survival analyses, represented 28% of the United States population.

The cancers evaluated were taken from the AYA classification system[8] adapted by SEER in November 2008. The SEER AYA site recode variable was updated from the original World Health Organization (WHO) International Classification of Diseases for Oncology second edition (ICD-O-2)-based classification scheme using ICD-O-3 definitions for cancer

St. Charles Health System, Bend, Oregon; Oregon Health & Science University, Portland, Oregon; and University of Texas Medical School at Houston, Texas.

morphology and topography. In the 15- to 39-year age range, the overall incidence of cancer increases exponentially as a function of age,[3] with most cancers, including all carcinomas, following this pattern. Other cancers have the opposite correlation, however, such as acute lymphoblastic leukemia and rhabdomyosarcoma.[3] Some have their incidence peak between 15 and 39 years of age and much lower rates at the beginning or end of the age range, such as Hodgkin lymphoma, the sarcomas other than rhabdomyosarcoma, and the germ cell tumors such as testicular carcinoma.[3] Thus when the entire age interval is analyzed, the over- and older representation of patients at different ages in the interval required adjustment for each cancer. This was accomplished by using the geometric mean of values for each 5-year age interval (five intervals for ages 15 to 39) and weighting the contribution of each interval by the proportion of patients in the interval.

During the HIV/AIDS epidemic of the 1980s and early 1990s, particularly virulent types of Kaposi sarcoma and non-Hodgkin lymphoma occurred in young adults, especially males, that affected the overall incidence and survival trends of soft tissue sarcomas and non-Hodgkin lymphomas. These cancers were thus evaluated separately, as was rhabdomyosarcoma because of its distinct pediatric age prevalence.

Results

During 2000–2007, of 24 different types of malignant disease in 15- to 39-year-old Americans, nine had an age-adjusted 5-year survival rate in excess of 80% and eight had a survival rate below 60% (Table 1). Those with 5-year survival rates below 50% were acute lymphoblastic leukemia, acute myeloid leukemia, rhabdomyosarcoma, and carcinomas of the lung, adrenal gland, and liver. Less than 40% of AYA rhabdomyosarcoma patients survived for more than five years (Table 1), in contradistinction to children younger than 15 who had a 5-year survival of 66% (data not shown). For acute lymphoblastic leukemia, the corresponding survival rates were 49% and 82%. Of the 21 cancers in which a comparison of survival by gender is feasible in the AYA age group, males had worse survival rates than females in all except breast cancer and Kaposi sarcoma (Table 1).

Of the 23 cancers in the AYA age group that are classifiable as having distant disease at diagnosis, 13 had 5-year survival rates of less than 30%, of which Ewing sarcoma and carcinomas of the lung and liver had 5-year survival rates of less than 10% (Table 2). Only three with distant disease at diagnosis—thyroid cancer, Hodgkin lymphoma, and testicular carcinoma—had 5-year survivals that exceeded 65%. Less than 20% of those with metastatic melanoma, Ewing sarcoma, rhabdomyosarcoma, non-rhabdomyosarcoma soft tissue sarcoma, colorectal cancer, and carcinomas of the kidney, lung, and liver survived more than five years (Table 2).

Of the 20 types of cancers in 15- to 39-year-olds evaluable for survival rate trends, only eight have evidence for having had a statistically significant improvement in their age-adjusted 5-year survival rate since 1985 (Table 3). These are acute lymphoblastic leukemia, acute myeloid leukemia, breast cancer, melanoma, colorectal and renal carcinomas, Hodgkin lymphoma, and brain tumors (Table 3). Others with high survival rates by 1975 have shown subsequent survival improvement but at slower rates: fibromatous sarcomas and germ cell tumors (Fig. 1). Thyroid cancer has had survival rates in excess of 95% since 1975. Those with the greatest sustained survival improvement are the two acute leukemias prevalent in the age group: acute lymphoblastic leukemia and acute myelogenous leukemia. Both have had a fourfold increase in 5-year survival rates among AYAs in the United States, from 12% in 1975 to 48% in 2000, albeit the rate of increase appears to have slowed since 1998 (Fig. 1).

The remaining 12 common cancers in 15- to 39-year-olds have had no significant evidence for survival improvement since at least 1985 (Table 3), and most have shown no progress since 1975 (Figs. 2 and 3). Cancers in the latter category include the soft tissue sarcomas Ewing sarcoma and rhabdomyosarcoma, and carcinomas of the ovary, cervix, lung, and head/neck (Fig. 2). Non-Hodgkin lymphoma not related to HIV/AIDS has shown survival improvement in that its survival rate has been higher after the HIV/AIDS epidemic than beforehand, but soft tissue sarcomas have not shown a post-HIV/AIDS survival improvement compared to rates before the epidemic (Fig. 3).

Table 1. 5-Year Age-Adjusted AYA Cancer Survival Rates by Rank Order, All Stages, 2000–2007

		5-year survival		
Cancer	N	M	SE	*Male: Female*
5-year survival 80–100%				
Thyroid carcinoma	15,509	99.0%	0.2%	0.99
Testicular carcinoma[a]	10,726	94.9%	0.6%	n/a
Malignant melanoma[b]	14,998	94.1%	0.5%	0.94
Fibromatous neoplasms	1554	93.9%	1.5%	0.96
Hodgkin lymphoma	7898	92.2%	0.8%	0.97
Chondrosarcoma	431	85.9%	4.4%	0.89
Renal carcinoma	2556	82.6%	1.8%	0.93
Breast carcinoma	19,281	82.5%	0.6%	1.00
Carcinoma of cervix[c]	6814	82.0%	1.0%	n/a
5-year survival 50–80%				
Head/neck carcinoma[d]	3083	79.2%	1.7%	0.91
Ovarian carcinoma[c]	2696	78.6%	1.9%	n/a
Non-Hodgkin lymphoma	8225	74.6%	1.2%	0.88
Soft tissue sarcoma[e]	2194	68.5%	2.6%	0.95
Colorectal carcinoma	6479	65.9%	1.4%	0.95
Osteosarcoma	755	65.8%	4.3%	0.87
CNS tumors	5728	64.6%	1.7%	0.88
Kaposi sarcoma	105	56.4%	2.9%	1.40
Ewing sarcoma	556	51.4%	5.5%	0.80
5-year survival <50%				
Acute myeloid leukemia	2347	49.4%	2.7%	0.93
Acute lymphoid leukemia	4345	49.1%	2.0%	0.95
Rhabdomyosarcoma	327	38.1%	6.0%	0.94
Lung carcinoma	2249	33.5%	2.1%	0.91
Adrenocortical carcinoma	105	30.8%	11.5%	0.47
Hepatic carcinoma	753	20.6%	3.9%	0.85

AYA, adolescent and young adult; CNS, central nervous system; M, mean; n/a, not applicable; SE, standard error.
[a]In males; [b]including invasive skin cancer; [c]in females; [d]excluding thyroid cancer; [e]excluding rhabdomyosarcoma.

Discussion

During the past decade, the gap in survival improvement among AYAs with cancer in comparison to younger and older

Table 2. 5-Year Age-Adjusted AYA Cancer Survival Rates by Rank Order, Distant Disease at Diagnosis,[a] 2000–2007

		5-year survival	
Cancer	N	M	SE
5-year survival 80–100%			
Thyroid carcinoma	460	89.7%	3.4%
Hodgkin lymphoma	2400	86.7%	1.9%
5-year survival 50–80%			
Testicular carcinoma[b]	1262	73.0%	3.2%
Non-Hodgkin lymphoma	3433	62.0%	2.0%
Head/neck carcinoma[c]	303	53.4%	8.7%
CNS tumors	125	51.1%	11.2%
5-year survival 20–50%			
Acute myeloid leukemia	2347	49.4%	2.7%
Acute lymphoid leukemia	4341	49.1%	2.0%
Ovarian carcinoma[d]	840	47.8%	4.4%
Breast carcinoma	1366	31.6%	2.9%
Osteosarcoma	140	27.9%	7.3%
Fibromatous neoplasms	44	27.8%	11.0%
Carcinoma of cervix[d]	392	21.9%	4.1%
Ewing tumor	183	21.8%	5.8%
Chondrosarcoma	31	21.6%	8.8%
5-year survival <20%			
Malignant melanoma[e]	282	19.4%	5.4%
Colorectal carcinoma	1525	18.9%	2.5%
Soft tissue sarcoma[f]	424	16.5%	5.1%
Rhabdomyosarcoma	131	14.3%	6.7%
Renal carcinoma	253	10.3%	3.9%
Ewing sarcoma	1206	6.9%	1.7%
Lung carcinoma	41	5.9%	5.4%
Hepatic carcinoma	211	3.8%	2.4%

AYA, adolescent and young adult; CNS, central nervous system; M, mean; SE, standard error.

[a]Distant metastases according to SEER Historic Stage A and Summary Stage 2000 (1988+);[7] [b]in males; [c]excluding thyroid cancer; [d]in females; [e]including invasive skin cancer; [f]excluding rhabdomyosarcoma.

Table 3. Average Annual Percent Change (AAPC) in 5-Year Age-Adjusted AYA Cancer Survival Rates by Rank Order and Era, 1985–2002

	AAPC	P *value*
1985–2002		
Acute myeloid leukemia	3.84	<0.0001
Acute lymphoid leukemia	3.06	<0.0001
Breast cancer	0.75	<0.0001
Melanoma[a]	0.29	<0.0001
Colorectal carcinoma	1.12	<0.001
Renal carcinoma	1.12	<0.001
Hodgkin lymphoma	0.35	<0.001
CNS tumors	0.70	<0.01
Hepatic carcinoma	3.63	NS
Chondrosarcoma	0.64	NS
Ewing sarcoma	−0.44	NS
Lung cancer	0.29	NS
Osteosarcoma	0.21	NS
Head and neck carcinoma[b]	0.12	NS
Thyroid cancer[c]	0.01	NS
Testicular carcinoma[c,d]	0.09	NS
Ovarian carcinoma[e]	0.07	NS
Cervix carcinoma[e]	0.11	NS
Adrenocortical carcinoma	0.71	NS
1997–2002[f]		
Non-Hodgkin lymphoma[g]	3.35	NS
Kaposi sarcoma[d]	−0.34	NS

AYA, adolescent and young adult; CNS, central nervous system; NS, not significant.

[a]Including invasive skin carcinoma; [b]excluding thyroid cancer; [c]the era-long high survival obviates evaluation of progress; [d]in males; [e]in females; [f]the HIV/AIDS epidemic prevents trend evaluation prior to 1997 for these cancers; [g]excluding Kaposi sarcoma.

patients has been the focus of a number of national and international initiatives. It is somewhat reassuring to observe recent progress in some cancers, particularly the acute leukemias, malignant melanoma, and breast cancer. Disappointing, however, is the lack of statistically significant evidence for progress in the majority of cancer types in AYAs and in virtually all of the solid tumors that present with metastatic disease. Many of the cancers that had evidence for survival improvement during the 1970s and 1980s have shown little to no evidence of progress since, such as testicular carcinoma, fibromatous neoplasm, osteosarcoma, chondrosarcoma, and brain tumors.

In older adults, the average survival after cancer diagnosis is 10 years. Among 15- to 39-year-olds, the number of years of life that can be spared is obviously much longer. The 20-year-old who survives cancer can live another 40 to 60 years longer—that is, four to six times greater in terms of patient-years affected or saved. And if one considers the potential long-term economic impact of health and attention to healthy behaviors in this age group—they are among the most productive members of society—the benefits of improving the duration and quality of survival in young adults is all the more obvious.

The reasons for the deficit in survival improvement span the gamut from the disease to the patient to providers to society.[9,10] The most important factors appear to be a lack of awareness of the cancer problem in this age group, lack of healthcare insurance coverage and access to healthcare services,[11] a deficit of clinical and translational research on cancer for AYAs, and challenges in psychosocial supportive care and dedicated healthcare facilities.[10] That males have a worse survival rate than females in 85% of the cancers that can be assessed for a gender difference implicates psychosocial factors such as lower adherence to treatment, higher risk-taking behavior, and greater feelings of invincibility.[12]

A worse prognosis in AYAs than in younger or older patients suggests that the biology of the cancer may differ in AYAs from what otherwise seems the same cancer in younger and older patients. Molecular, epidemiologic, and therapeutic outcome comparisons offer clues to this distinctiveness in most of the common cancers of AYAs, including leukemias, lymphomas, sarcomas, melanoma, and carcinomas of the breast, colon, rectum, and nasopharynx.[13] Some cancer types may have a better survival rate with increasing patient age, as was recently suggested for papillary thyroid cancer.[14] A starting point for improvement in outcomes should be that the biology of cancers and certainly of the host are different from other age groups, and the differences imply a need to tailor treatment strategies. Laboratory and clinical investigations to compare the biology as a function of age are in their infancy.

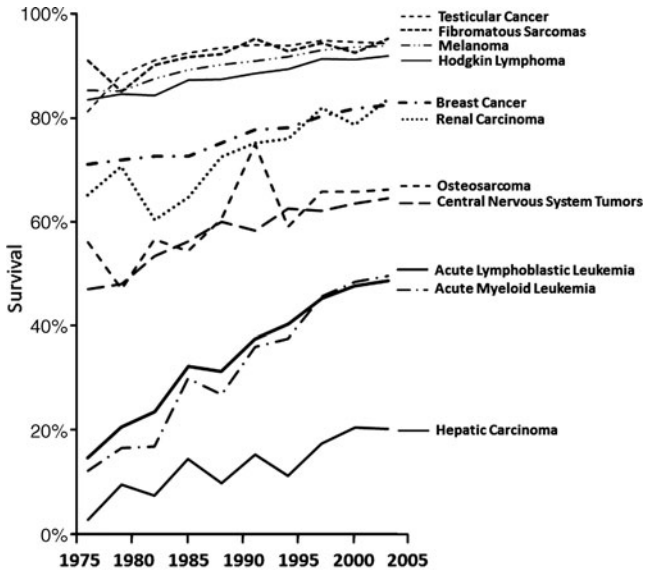

FIG. 1. Cancers in AYAs that have had a continuous improvement in the age-adjusted 5-year survival rate, by three calendar-year intervals since 1975, United States.

To address the overall problem, the NCI conducted a Progress Review Group in AYA Oncology (AYAO PRG) in 2005–2006 that was co-funded by the Lance Armstrong Foundation, as described elsewhere in this premier issue of *Journal of Adolescent and Young Adult Oncology*.[15] A particularly important problem cited by the PRG is the lack of clinical trial activity and participation among young adults with cancer.[4] The NCI-sponsored pediatric and adult cancer cooperative groups have launched a national initiative to improve the accrual of AYAs with cancer into clinical trials. The Children's Oncology Group (COG) AYA Committee, formed in 2000 to research the obstacles faced by AYA patients in conjunction with the adult cooperative groups in the United States, has resulted in a modest increase in the number of national clinical trials available to AYA cancer patients. A measure of success was achieved in 2005–2006, with increased accruals to cancer treatment trials in comparison to the two previous years among AYA patients and in comparison to both younger and older patients.[9,16] Other goals of the COG AYA Committee are to improve access to care through understanding barriers to participation in clinical trials overall; develop a cancer resource network that provides information about clinical trials to patients, families, providers, and the public; enhance AYA treatment adherence; and increase participation in sarcoma trials specifically designed for AYAs.

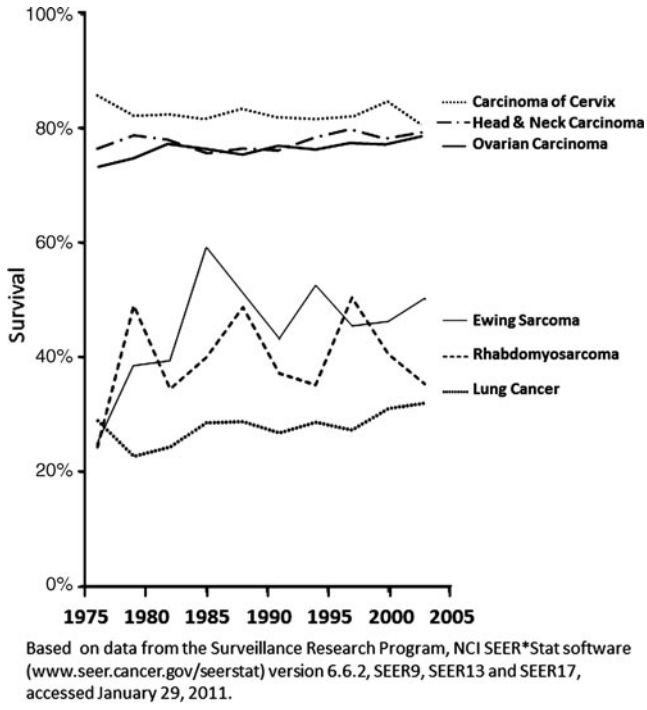

FIG. 2. Cancers in AYAs that have had no improvement in the age-adjusted 5-year survival rate since at least 1990 by three calendar-year intervals, United States.

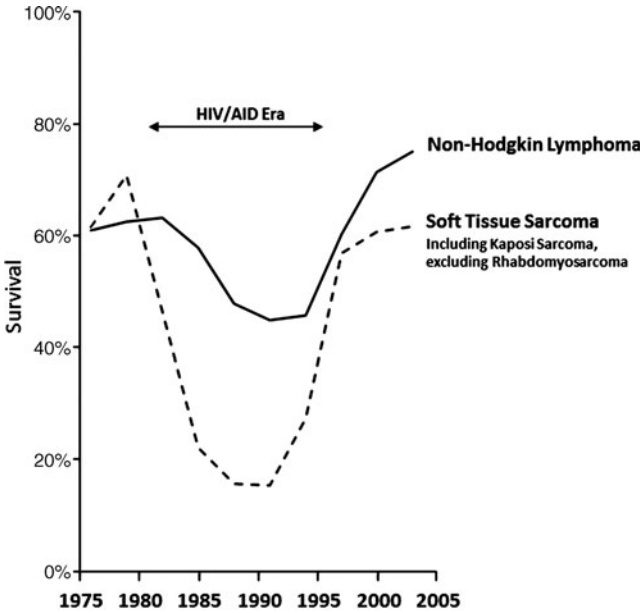

FIG. 3. Age-adjusted 5-year survival rates in AYAs with cancers that include HIV/AIDS-associated malignancies, by three calendar-year intervals since 1975, United States.

Another initiative in the United States is the LIVESTRONG Young Adult Alliance, founded in 2005 as a consortium of organizations devoted to assisting AYAs with cancer. The Alliance of more than 120 member organizations and a related initiative known as the Cancer Centers Working Group are described elsewhere in this issue of *Journal of Adolescent and Young Adult Oncology*.[15]

Finally, the Patient Protection and Affordable Care Act (ACA) of 2010 should have a favorable impact on helping eliminate the young adult cancer survival deficit. The health insurance industry is now required, with few exceptions, to cover young adults throughout the United States younger than 26 under a parent's insurance if the policy allows for

dependent coverage. The ACA also provides for the elimination of coverage denial for having had a prior diagnosis of cancer or other pre-existing conditions as a result of the cancer and its therapy, provision of a minimum health benefits package including preventive services, and professional counseling for obesity, alcohol and substance dependence, physical activity, and nutrition improvement. These and other provisions of the Act have the potential to lead to earlier diagnosis of cancer, less invasive cancer therapy, better quality of survival, and higher cure rates. In the long-term, it may also help prevent cancers that AYAs may develop later in life. A realistic appraisal of the obstacles to implementation of the Act in this age group may compromise many of the desired outcomes.[16] Nonetheless, the ACA has provisions that should reduce the cancer problem in AYA-aged Americans.

Eventually, resources will be devoted to educating the public, health professionals, insurers, and legislators about the special needs of the AYA cancer population. Ultimately, schools of medicine, osteopathy, nursing, dentistry, and pharmacy will better address the current lack of formal training in the unique health and healthcare problems of AYAs. Specific training programs in AYAO and the development of a formal discipline may eventuate.[17] Meanwhile, several practical suggestions should facilitate early detection of cancer in AYAs[18] and promote referral to a cancer center where clinical trials are a priority.

Disclosure Statement

Dr. Bleyer is a consultant for Sigma-Tau Pharmaceuticals, Inc.

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Address correspondence to:
Archie Bleyer, MD
2884 NW Horizon Drive
Bend, Oregon 97701

E-mail: ableyer@gmail.com

Commentary

The limited progress in improving survival rates among adolescents and young adults with cancer in the United States was reported first by Dr. Archie Bleyer several years ago. At that time, the index used was the average annual percent change (AAPC) in 5-year overall survival rates across the age spectrum. A closer look reveals three quite separate categories of disease in this regard:

- Those with survival rates exceeding 90% (Hodgkin lymphoma, melanoma, thyroid carcinoma, and testicular tumors)
- Those with notable improvement in survival rates, including the acute leukemias
- Those with low and unchanged survival rates (numerous forms of sarcoma and carcinoma)

(*Continued*)

Disaggregating the "big picture" helps to define an agenda for effecting change. Dr. Bleyer's current paper examines these issues in more detail and considers factors likely to contribute to the complexity. These span a broad range from biological distinctions to health insurance disparities (a particular issue in the United States). Identifying these elements affords opportunities for further study, as in the changing molecular genetic profile of acute lymphoblastic leukemia with age, and the development of interventions, exemplified by the recent legislation on health insurance in the United States.

Undertaking comparable investigations in other countries is likely to provide further clarification. A comparison of AAPC in 5-year survival rates is to be pursued in the United Kingdom, continental Europe (through the agency of EUROCARE), Australia, and Canada.

As emphasized by Dr. Bleyer, partnerships involving healthcare providers and the survivor/advocate community (such as LIVESTRONG's Young Adult Alliance, the Teenage Cancer Trust in the United Kingdom, and CanTeen in Australia), are proving to be highly effective in promoting the case for changes that will secure further gains in the prospects for survival of AYAs with cancer worldwide, a population estimated to grow by one million new patients each year.

—Ronald D. Barr, MB ChB, MD
McMaster University
Hamilton, Ontario
Canada

rbarr@mcmaster.ca