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Research Article

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Impact of the AYA HOPE Comorbidity Index on Assessing Health Care Service Needs and Health Status among Adolescents and Young Adults with Cancer

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Abstract

Background: Existing comorbidity indices were not developed for adolescent and young adults (AYA) 15 to 39 years of age. The aim of this study was to assess impact of comorbidities on health care service needs and health status among AYA cancer survivors using the newly developed AYA HOPE comorbidity index in comparison with the existing indices.

Methods: Data on comorbid conditions were obtained from medical records and service needs and health status were from a survey of AYA cancer survivors. Prevalence of comorbidities was based on the AYA HOPE index. Charlson and NCI indices were compared. Multivariable logistic regression was used.

Results: Of the 485 patients, 14.6% had ≥2 comorbidities based on the AYA HOPE Index. Prevalence of mental illness and obesity/overweight, which were not included in existing indices, were 8.2% and 5.8%, respectively. Prevalence of cardiovascular, endocrine, gastrointestinal, and neurologic conditions were higher with the AYA HOPE Index than the other two indices. Forty percent of AYA patients reported service needs, particularly for mental health services (25.2%) and support groups (17.7%). Having ≥2 comorbidities on the AYA index was associated with higher mental health service needs [OR, 2.05; 95% confidence interval (CI), 1.10–3.82] adjusting for demographic and clinical factors. Comorbidities were associated with fair/poor self-reported health status.

Conclusion: The AYA HOPE Index is a more comprehensive comorbidity index for AYA cancer patients than existing indices, and the number of comorbidities is associated with service needs and health status.

Impact: The AYA HOPE index could identify patients' additional service needs early in therapy. *Cancer Epidemiol Biomarkers Prev; 24(12); 1844–9. ©2015 AACR.*

Introduction

Cancer is the leading cause of disease-related death in adolescents and young adult (AYA) population (1). Nearly 70,000 AYAs aged 15–39 years are diagnosed with cancer annually in the United States (2). While strides have been made in improving survival of children and adults with cancer, patients diagnosed with cancer between 15 and 39 years have lower survival improvements relative to pediatric and adult populations (3, 4).

Prior studies have found that comorbidities adversely affect treatment, quality of life, service needs, and survivorship care in adult cancer survivors (5–7), as comorbidities may increase the toxicity of specific treatments, increase hospitalizations, create difficulties with treatment, and lead to higher health care costs and mortality (8–11). It has been reported that 30% of AYA patients self-report comorbidities at the time of their cancer diagnosis (12, 13), and 56% to 75% of AYA cancer survivors need certain kinds of healthcare services, such as pain management services, mental health services, or support groups (14). It is unclear, however, if comorbidities predict health services needs among AYA cancer survivors because there is little such information in the literature.

Specific comorbidity indices have been developed and used for adult patients with cancer (i.e., Charlson and National Cancer Institute (NCI) indices; refs. 5–7, 15, 16) and children (17). However, existing indices are not suitable to AYA cancer patients who are in a different stage of cognitive and physiological development from middle-aged and older adults. Furthermore, comorbid conditions among AYAs may be in earlier, less severe stages compared with their adult counterparts. The aim of this study was to assess the impact of comorbidities on healthcare service needs and general health status among AYA cancer survivors using the

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Note: Supplementary data for this article are available at Cancer Epidemiology, Biomarkers & Prevention Online (http://cebp.aacrjournals.org/).

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newly developed AYA HOPE comorbidity index in comparison with the existing indices.

Materials and Methods

Study population

Patients were identified and recruited through seven population-based Surveillance, Epidemiology and End Results (SEER) program's cancer registries, including Detroit in Michigan, Seattle/Puget Sound in Washington, Los Angeles County, San Francisco/Oakland, and Greater California (13 counties around Sacramento plus Orange County) in California and the states of Iowa and Louisiana. Details regarding study methods and patient recruitment have been published previously (18).

Briefly, eligible patients were 15–39 years old at diagnosis, able to read English, residents of the registries' catchment areas, and newly diagnosed with a first invasive, microscopically confirmed germ cell cancer (e.g., testicular or ovarian), non-Hodgkin lymphoma, Hodgkin lymphoma, acute lymphoblastic leukemia, Ewing sarcoma, osteosarcoma, or rhabdomyosarcoma (excluding tumors arising in the central nervous system) between July 1, 2007 and October 31, 2008. All participating registries and the NCI obtained Institutional Review Board approval prior to study initiation.

Data collection

Six to 14 months after diagnosis, eligible patients were mailed a baseline paper survey (and link to an online version), a request for release of medical records, and a healthcare utilization form asking for the health facility and providers consulted. Of the 524 who completed that survey, medical record data were obtained for 489 patients, allowing for comorbidity assessment. We excluded 4 patients from data analysis because of missing data or invalid selections on the health status portion of the survey. Survey design and validation has been previously described in detail elsewhere (18). The survey is available online (http://outcomes.cancer.gov/surveys/aya).

Identification of comorbidities

All comorbidities were abstracted with a standardized data acquisition form, utilized in prior SEER Patterns of Care studies (http://appliedresearch.cancer.gov/poc/). Briefly, abstractors were instructed to review participant's entire medical records and list all comorbid conditions, including histories of disease or health problems, noted at the time of initial diagnosis and during the first course of treatment. If a condition was reported as a "history of," history is recorded with the condition. The text information on comorbid conditions was then coded centrally using ICD-9 codes; a lead letter "H" indicates it was a "history of" condition (Supplementary Table S1).

AYA HOPE comorbidity index. The AYA comorbidity index was created on the basis of the 14 categories of conditions classified by Parsons and colleagues (i.e., cardiovascular, hypertension, asthma/respiratory, endocrine, diabetes mellitus, liver, gastrointestinal, hematologic, HIV/AIDS, mental health, neurologic, obesity/overweight, renal, and rheumatologic/autoimmune; ref. 13). A pediatric oncologist (P.K. Prasad, co-author) reviewed comorbid conditions to exclude acute/self-limiting comorbid conditions or conditions that were possible side effects of cancer treatment were excluded from the 14 categories (i.e., neutropenia, central line infections). We defined acute or self-limiting conditions as those that normally exist for less than 6 weeks, although we did not have information on the disease duration. Because a patient could have more than one chronic comorbid condition within the same category (e.g., cardiovascular), the pediatric oncologist reviewed all chronic conditions and determined whether they should be counted as separate and clinically different comorbid conditions. Generally, if the first two digits of the ICD-9 codes were the same, then the conditions were considered one comorbid condition. For example, a patient with ischemic heart disease (ICD-9 code = 410) and mitral valve problems (ICD-9 code = 424) was considered as having two separate cardiovascular comorbid conditions in the AYA HOPE index. But, if a patient had ischemic heart disease (ICD-9 code = 410) and heart attack (ICD-9 code = 414), both of these conditions were considered ischemic heart disease and the patient was counted as having one cardiovascular comorbid condition. A list of the specific conditions in the AYA HOPE comorbidity index is included in Supplementary Table S1. Comorbid conditions were then summed to create a final AYA comorbidity index (0, 1, or $\geq$2) and (0, 1, 2–3, $\geq$4) for each patient. Because of small numbers for the comorbidity group $\geq$4, we only used the three comorbidity groupings in tables. We presented comorbid conditions as an unweighted count in AYA HOPE index to estimate the overall burden of comorbid diseases for each patient.

Charlson and NCI comorbidity indices. For comparison, we also grouped comorbid conditions using the unweighted Charlson and NCI indices (6, 16). Briefly, the Charlson comorbidity index assesses mortality and was designed for use in in-patient settings, and the NCI index incorporates inpatient and outpatient Medicare claims for breast and prostate patients to assess short-term mortality and treatment choices.

Supportive care health services and self-reported health status

On the baseline survey (6–14 months after diagnosis), AYA HOPE participants were asked whether they needed any of the following services: (i) have a nurse come to your home (nurse comes to home), (ii) participate in a support group (support group), (iii) see a psychiatrist, psychologist, social worker or mental health worker (mental health services), (iv) see a physical or occupational therapist for rehabilitation (physical/occupational therapy), and (v) see a pain management expert (pain management specialist). Participants who did not answer these questions about service needs were excluded from the multivariable analyses. Participants were also asked to report their general health status as excellent, very good, good, fair or poor. The general health question was from the general health subdomains of the SF-12 (19, 20). General health responses were collapsed into two categories (fair/poor vs. good/very good/excellent).

Analysis

Comorbidities (frequency, percent) among AYA cancer survivors were compared using the AYA HOPE, Charlson and NCI Comorbidity indices. The association of the number of comorbidities with each reported service need and health status was examined using χ^2 tests. Multivariable logistic regression models were used to obtain ORs and 95% confidence intervals (CI) for the association of each service needed (vs. service not needed) or fair/poor (vs. good, very good, and excellent) health status with the comorbidity index ($\geq$2, 1 vs. 0 and $\geq$4, 2–3, 1 vs. 0). Multivariable models controlled for demographic and clinical variables that

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were significantly associated with comorbidities and service needs or general health status. All analyses were performed using SAS software (version 9.3; SAS Institute). All tests of significance were assessed with two-sided and $P < 0.05$ was considered significant.

Results

Of the 485 participants in the AYA HOPE study, the majority were male, of white race/ethnicity, and had health insurance (Table 1). Almost 40% of AYAs reported needs for certain type of supportive care service. The most common service needed was mental health (25.2%), followed by support group (17.7%), physical/occupational therapy (14.0%), pain management (12.2%), and nurse come to home (6.2%). The majority of AYAs (83%) had a good, very good, or excellent health status.

The frequencies of diabetes, HIV/AIDS, liver, asthma/respiratory, and rheumatologic/autoimmune comorbidities were the same across the three indices (Table 2). Hypertension and endocrine comorbidities were included in AYA HOPE and Charlson indices, but not the NCI index. Mental health, obesity/overweight, and hematologic comorbidities were not included in the Charlson and the NCI indices. The prevalence of mental health comorbidities was 8.2%, with 17 of the 40 mental health comorbidities (42.5%) being depressive disorder. Also, the prevalence of obesity/overweight was 5.8%. Although cardiovascular, gastrointestinal, neurologic, and renal categories were included in all three indices, the frequencies were much higher with the AYA HOPE index because this index included more clinical diagnoses in each main category. For example, the AYA HOPE index counted 42 comorbidities in the neurologic category, whereas only fewer than 5 comorbidities were counted in the Charlson and NCI indices. The frequency of comorbid conditions also varied across the indices at 292, 142, and 98 for AYA HOPE, Charlson index, and NCI index, respectively. Approximately 15% of AYAs had $\geq$2 comorbid conditions using the AYA HOPE index (12% had 2–3 comorbid conditions and 2.6% had $\geq$4), which was much higher than percentages based on the Charlson (4.1% and 0.8%, respectively) and NCI indices (2.5% and 0.2%, respectively).

In multivariable analyses, AYA patients with $\geq$2 comorbidities based on the AYA HOPE index had twice the odds of needing mental health services as those without comorbidities (OR, 2.05; 95% CI, 1.10–3.82; Table 3). Such a significant association was not identified with either the Charlson or the NCI index. AYA patients with one comorbidity had 2.6 times the odds of requiring pain management specialist (OR, 2.56; 95% CI, 1.30–5.04; vs. no comorbidities), with the Charlson and the NCI indices showing similar associations. AYA patients with $\geq$2 comorbidities have over three times the odds of reporting their health status as fair/poor (OR, 3.16; 95% CI, 1.58–6.33; vs. no comorbidities) using the AYA HOPE Index; similar, strong associations were found using Charlson (OR, 5.59; 95% CI, 2.05–15.2) and the NCI Index (OR, 8.88; 95% CI, 2.44–32.3), but the 95% CIs for the Charlson and NCI indices indicate they were less precise. We ran multivariable analysis using comorbidity categories 0, 1, 2–3, and $\geq$4 (data not shown). The results were similar to the findings with the three comorbidity groups (0, 1, $\geq$2).

Discussion

We developed the AYA HOPE index to assess the impact of comorbid conditions on healthcare service needs and general health status among AYA cancer survivors, a population that may

Table 1. Characteristics of AYA HOPE participants

	Frequency	%
Sociodemographic variables		
Age at diagnosis, y		
15–19	62	12.8
20–29	211	43.5
30–39	212	43.7
Sex		
Male	303	62.5
Female	182	37.5
Race/ethnicity		
White	394	81.2
Black	39	8.0
Asian	36	7.4
Unknown[a]	16	3.3
Health insurance status		
Yes	442	91.1
No	36	7.4
Unknown	7	1.5
Service needed		
Nurse comes to home		
Yes	30	6.2
No	434	89.5
Unknown	21	4.3
Support groups		
Yes	86	17.7
No	374	77.1
Unknown	25	5.2
Mental health services		
Yes	122	25.2
No	341	70.3
Unknown	22	4.5
Physical/occupational therapy		
Yes	68	14.0
No	391	80.6
Unknown	26	5.4
Pain management specialist		
Yes	59	12.2
No	404	83.3
Unknown	22	4.5
Any service needed		
Yes	192	39.6
No	293	60.4
Clinical variables		
Health status		
Good/very good/excellent	404	83.3
Fair/poor	81	16.7
Cancer type		
Germ cell tumor	189	39.0
Hodgkin lymphoma	134	27.6
Leukemia	21	4.3
Non-Hodgkin lymphoma	117	24.1
Sarcoma	24	5.0
Cancer stage		
All cancers combined		
Stage I	161	33.2
Stage II	139	28.7
Stage III	66	13.6
Stage IV	50	10.3
Unknown	69	14.2
Treatment received		
Surgery		
Yes	59	12.2
No	426	87.8
Radiation		
Yes	52	10.7
No	433	89.3
Chemotherapy		
Yes	238	49.1
No	247	50.9

[a]Unknown race includes selections for American Indian/Alaskan Native.

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Table 2. Frequency (*n*) and percentage of comorbidities in AYA HOPE participants, by comorbidity index

	Comorbidity index		
	AYA HOPE *n* **(%)**	**Charlson** *n* **(%)**	**NCI** *n* **(%)**
Comorbidity categories			
Cardiovascular	30 (6.2)	12 (2.5)	[b]
Diabetes	18 (3.7)	18 (3.7)	18 (3.7)
Endocrine	10 (2.1)	[b]	[a]
Gastrointestinal	20 (4.1)	6 (1.2)	5 (1.0)
HIV/AIDS	18 (3.7)	18 (3.7)	18 (3.7)
Hypertension	29 (6.0)	29 (6.0)	[a]
Liver	13 (2.7)	13 (2.7)	13 (2.7)
Mental health	40 (8.2)	[a]	[a]
Neurologic	42 (8.7)	[b]	[b]
Obesity/overweight	28 (5.8)	[a]	[a]
Renal	5 (1.0)	[b]	[b]
Asthma/respiratory	30 (6.1)	30 (6.1)	30 (6.1)
Rhematologic/autoimmune	5 (1.0)	5 (1.0)	5 (1.0)
Hematologic	[b]	[a]	[a]
Distribution of number of comorbidities			
0	320 (66.4)	381 (78.6)	406 (83.7)
1	94 (19.4)	80 (16.5)	66 (13.6)
≥2	71 (14.6)	24 (4.9)	13 (2.7)

NOTE: All indices are shown unweighted for accurate frequency comparisons.
[a]The index does not include this comorbid condition.
[b]Suppressed because of fewer than 5 cases with this comorbid condition.

have earlier, less severe comorbidities compared with older adults. The AYA HOPE index expanded the existing cardiovascular, neurologic, gastrointestinal, and renal categories in the Charlson and NCI indices and added mental health and obesity/overweight categories that have not been included in the existing comorbidity indices but are important to health outcomes and can affect treatment, service needs, and survival for AYA cancer patients (21–24). For example, the AYA HOPE index captured neurologic conditions, such as neuropathy, extremity issues, epilepsy, syncope, and cranial nerve issues that may influence therapy or be associated with needs for health services and quality of life in AYA cancer survivors. Our study is the first, to our knowledge, to examine the association of comorbidities and service needs and found that AYA cancer survivors with comorbidities identified by AYA HOPE index were more likely than those without comorbidities to need mental health and pain management services and AYA survivors with more than 2 comorbidities were more likely than those without comorbidity to have fair/poor general health status.

Mental health disorders were prevalent among AYA cancer patients in our study, as expected in a group of young patients confronted with a life-threatening diagnosis and possibility of treatment-related complications, such as infertility (2). Data from the 2009 Behavioral Factor Surveillance System (BRFSS) found that 20% of AYA cancer survivors reported having more than 14 poor mental health days in the past month compared with only 10% of the general population (25). Previous studies in psychiatry suggest that mental health disorders increase the risk of death, not only from suicide but also from other diseases (8). Mental health disorders, including primary affective and anxiety disorders, are seen in a significant proportion of persons with cancer at different stages of the disease (24, 26, 27). Patients with more intense treatments (possibly refractory disease or high-risk disease) are prone to anxiety and avoidance with less overall health competence, perception, and cognitive competence. Our study supports these results with respect to mental health service needs. Counseling specific to sexuality/fertility, social support, and health competency may be successful targets for health care

Table 3. Multivariable adjusted ORs and 95% CIs for each of the services needed and health status, by comorbidity index

Comorbidity count **Service needed/health status[a]**	**AYA HOPE[b]** **OR (95% CI)**	**Charlson[b]** **OR (95% CI)**	**NCI[b]** **OR (95% CI)**
Nurse come to home			
0	1.00	1.00	1.00
1	1.37 (0.53–3.53)	1.10 (0.39–3.08)	1.65 (0.62–4.35)
≥2	1.20 (0.40–3.57)	2.44 (0.63–9.37)	[c]
Support group			
0	1.00	1.00	1.00
1	1.06 (0.55–2.03)	1.53 (0.82–2.88)	1.15 (0.57–2.29)
≥2	1.56 (0.80–3.05)	0.86 (0.28–2.61)	0.64 (0.12–3.34)
Mental health services			
0	1.00	1.00	1.00
1	1.62 (0.93–2.84)	**2.01 (1.14–3.53)**	**2.26 (1.24–4.11)**
≥2	**2.05 (1.10–3.82)**	1.53 (0.58–4.00)	0.68 (0.16–2.86)
Physical/occupational therapy			
0	1.00	1.00	1.00
1	1.08 (0.54–2.17)	1.43 (0.72–2.84)	1.55 (0.75–3.18)
≥2	1.12 (0.50–2.44)	1.21 (0.39–3.79)	0.70 (0.13–3.75)
Pain management specialist			
0	1.00	1.00	1.00
1	**2.56 (1.30–5.04)**	**2.18 (1.09–4.37)**	**2.07 (1.00–4.27)**
≥2	1.75 (0.78–3.92)	1.84 (0.60–5.67)	0.48 (0.05–4.08)
Health status			
0	1.00	1.00	1.00
1	1.70 (0.87–3.33)	**2.35 (1.23–4.52)**	**3.17 (1.61–6.26)**
≥2	**3.16 (1.58–6.33)**	**5.59 (2.05–15.2)**	**8.88 (2.44–32.3)**

NOTE: Significant ORs and 95% CI are in bold.
[a]Service needed: yes versus no; health status: fair/poor versus good/very good/excellent.
[b]Models are adjusted for both clinical factors (i.e., cancer type, health status, treatment) and demographic factors (i.e., age, sex, and race/ethnicity).
[c]Not able to get statistics because of small number of cases.

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professionals treating this unique population. Thus, the AYA HOPE index may be a helpful tool to predict service needs with the goal of improving outcomes in this group.

Our study revealed that 5.8% of the AYA HOPE participants were overweight or obese. Although this prevalence was lower than the general population, obesity prevalence is increasing in all age groups in the United States with nearly 40% of adults and more than 25% of children considered obese (28, 29). Obesity in adulthood is associated with multiple comorbidities; most notably type 2 diabetes and cardiovascular disease (30). However, our understanding of long-term health effects of being overweight or obese on AYAs diagnosed with cancer is incomplete. A high body mass index (defined as greater than 85th percentile on the basis of the Center for Disease Control and Prevention) was associated with inferior survival in pediatric osteosarcoma patients and those with acute myeloid leukemia (31–33). Similarly, obesity is associated with inferior survival among adult cancer patients with common malignancies (34). As the prevalence of obesity increases in the AYA population, it is imperative to learn of its consequences on treatment, morbidity, and mortality.

In our study, AYA cancer survivors with comorbidities were more likely than those without comorbidities to need mental health services and a pain management specialist, which is consistent with findings in a previous examination of this AYA HOPE cohort that revealed that 56% to 75% of the AYA population did not receive specific supportive care services including support group, pain management, physical or occupational therapy, or mental health services (14). Therefore, the AYA HOPE Index may be a useful metric to identify subgroups of AYA cancer patients that should be directed to healthcare services. We also found that AYA cancer survivors with comorbidities were more likely than those without comorbidities to self-report their health status as fair or poor, consistent with previous findings that poor functional status is associated with increased comorbidities (35).

While this study utilized one of the largest population-based studies of AYA cancer patients to date, we recognize several limitations. First, the AYA HOPE comorbidity index may not be generalizable to all AYA cancer patients because it utilized data from AYA patients with selected cancer types. Different response rates across sociodemographic groups and small numbers of cases may also affect the generalizability of the findings (18). Second, this index was based on conditions identified in medical records at the time of initial diagnosis and during the first course of treatment among AYA HOPE participants and did not necessarily represent a complete list of comorbid conditions that may occur in the entire AYA population. The comorbidities reported in the AYA HOPE population may not be indicative of other AYA cancer patients assessed only at initial diagnosis, later in disease progression or following completion of therapy and subsequent survivorship. For example, patients experiencing first course of therapy for cancer may experience depression symptoms as a result of their diagnosis, but as they have time to adjust to their diagnosis, the depressive symptoms may abate and not be a chronic issue. Future research is needed to validate the AYA HOPE index in longitudinal studies and broader AYA populations and to assess the association of comorbidities at different times throughout cancer survivorship with quality of life and survival. Furthermore, data were limited to conditions identified by the physicians as significant enough to record and may be an undercount of some conditions, such as obesity. However, the AYA HOPE index does include additional categories and conditions within categories that are not included in the Charlson or NCI indices. Third, the Charlson and the NCI indices are weighted indices that take into account both the number and the severity of the comorbid diseases. Because the AYA population has fewer of the conditions that are weighted in the Charlson index (e.g., severe renal disease or diabetes with end organ damage), the AYA HOPE Index does not weight conditions and instead estimates the overall burden of comorbid diseases for each patient, a strategy utilized by the original Charlson article (16). Future studies may expand upon our work to assign weights, based on patients' burden, to individual conditions in the AYA HOPE index.

The AYA HOPE index, which was built on the AYA HOPE comorbidity categories that Parson and colleagues created (13), is the first comorbidity index to be developed specifically for AYA cancer patients. Compared with the Charlson and NCI indices, the AYA HOPE index includes mental health conditions and obesity and expands categories in the existing indices. AYA cancer survivors with $\geq$2 comorbidities utilizing our index were more likely to need mental health and pain management services and rate their health as fair or poor, suggesting that this index could identify patients that need additional services early in therapy. The development of AYA HOPE comorbidity index serves as a starting point to quantify the breadth of comorbidities AYA cancer survivors may face as they progress through treatment and survivorship. Future studies should expand the AYA HOPE index and examine the validity of this index in larger, more diverse AYA populations.

AYA HOPE Study

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No potential conflicts of interest were disclosed.

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Disclaimer

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