Can Patient Comorbidities Be Included in Clinical Performance Measures for Radiation Oncology?

By Jean B. Owen, PhD, Najma Khalid, MS, Alex Ho, MS, MA, Lisa A. Kachnic, MD, Ritsuko Komaki, MD, May Lin Tao, MD, MSHS, Adam Currey, MD, and J. Frank Wilson, MD

American College of Radiology Clinical Research Center, Philadelphia, PA; Boston Medical Center/Boston University School of Medicine, Boston, MA; The University of Texas MD Anderson Cancer Center, Houston, TX; Valley Radiotherapy Associates at Center for Radiation Therapy, Beverly Hills, CA; and Medical College of Wisconsin, Milwaukee, WI

Abstract

Purpose: Patient comorbidities may affect the applicability of performance measures that are inherent in multidisciplinary cancer treatment guidelines. This article describes the distribution of common comorbid conditions by disease site and by patient and facility characteristics in patients who received radiation therapy as part of treatment for cancer of the breast, cervix, lung, prostate, and stomach, and investigates the association of comorbidities with treatment decisions.

Materials and Methods: Stratified two-stage cluster sampling provided a random sample of radiation oncology facilities. Eligible patients were randomly sampled from each participating facility for each disease site, and data were abstracted from medical records. The Adult Comorbidity Evaluation Index (ACE-27) was used to measure comorbid conditions and their severity. National estimates were calculated using SUDAAN statistical software.

Results: Multivariable logistic regression models predicted the dependent variable “treatment changed or contraindicated due to comorbidities.” The final model showed that ACE-27 was highly associated with change in treatment for patients with severe or moderate index values compared to those with none or mild ($P < .001$). Two other covariates, age and medical coverage, had no (age) or little (medical coverage) significant contribution to predicting treatment change in the multivariable model. Disease site was associated with treatment change after adjusting for other covariates in the model.

Conclusions: ACE-27 is highly predictive of treatment modifications for patients treated for these cancers who receive radiation as part of their care. A standardized tool identifying patients who should be excluded from clinical performance measures allows more accurate use of these measures.

Introduction

Quality Research in Radiation Oncology (QRRO) conducted a national survey of quality of care received by patients treated with radiation therapy (RT) for cancer of the breast, cervix, lung, prostate, and stomach. QRRO evolved from the Patterns of Care Study, described in numerous publications.¹⁻² These programs have conducted surveys of the structure, process, outcomes, and quality of care for more than 40 years. Other reports provide national benchmark results for Clinical Performance Measures (CPM).³⁻⁵ CPMs define the patient population for whom the measure is applicable and the proportion of those within that group who received the recommended work-up or treatment. To allow use of CPMs for quality improvement and comparison across different providers, accurate quality measurement is important.⁶ A recent review of quality indicators in radiation oncology stated, “While target compliance rates should ideally have been closer to 100%, it was not reported why some patients did not receive the recommended fields; there may have been issues with comorbidities, patient refusal of treatment, or many other factors.”⁷ Oncology patients with comorbidities require close collaboration among all of their physicians. Although exceptional circumstances may make the goal of 100% compliance unattainable, CPMs are more credible because they contain objective measures of common exceptions. In defining CPMs, QRRO investigators emphasized

measures appropriate for quality improvement initiatives. The Data Supplement shows two examples with definitions and justification of CPMs for prostate cancer, one measuring the percentage of patients with nonmetastatic intermediate and high-risk prostate cancer treated with external beam radiotherapy alone who receive ≥ 75 Gy (or CGE), and the other androgen suppression therapy concurrent with external beam radiotherapy for high-risk disease (T3 or Gleason 8-10 or prostate-specific antigen > 20). Both measures exclude some patients because of comorbidities. If no criteria for excluding patients on the basis of comorbidities are defined, the appropriate level of compliance with the measure is unknown. Individual physician's assessments of comorbidities may use widely variable criteria. A standardized tool provides objectivity and consistency of criteria for measuring comorbidities.

To identify patients for exclusion because of comorbidity, QRRO collected data on comorbid conditions. Although commonly used comorbidity measures record the presence and number of important comorbidities, severity is also crucial. For this survey, investigators chose the Adult Comorbidity Evaluation Index (ACE-27) as part of the patient-specific data, recording the type, number, and severity of comorbid conditions in multiple organ systems that could affect treatment decisions or treatment completion. This instrument, developed specifically for use in cancer registries and research, was designed to calcu-

late an overall comorbidity index that summarizes comorbid conditions across organ systems, resulting in an overall measure of the level and severity of the patient's comorbid conditions. Reports on ACE-27 have described the definition, feasibility, and relationship of the index to survival, as well as the prognostic importance of comorbidities.^{8,9} A recent review article of methods used to measure comorbidity in cancer populations found that ACE-27 remains a good choice for measuring comorbidity if data collection from clinical notes is feasible.¹⁰

The objectives of this report are to describe the distribution of comorbidities by patient characteristics such as age, race/ethnicity, insurance status, and marital status for the selected diseases and to investigate the association of comorbid conditions with treatment decisions. Age was included because comorbidities tend to increase with age, and medical coverage was included because the Medicare category is likely to have more patients with comorbid conditions. Future reports will examine clinical factors in specific disease sites.

Methods

Survey Design and Data Collection

QRRO conducted observational surveys of processes of care in radiation oncology. Detailed information was collected by chart review and abstraction of patient and tumor characteristics, imaging, laboratory tests, treatment planning, surgery, radiation therapy, and systemic therapy, including data elements designed to measure quality of care and compare care actually received by patients to well-established clinical guidelines.

The survey used stratified two-stage cluster sampling of radiation oncology facilities from a master list of those operating in the United States in 2007, a random sample of facilities selected from each stratum, and a random sample of eligible patients for each disease site (cancer of the breast, cervix, lung, prostate, and stomach) selected from each participating facility. Facilities were classified into the following strata: academic (main teaching hospital of a medical school or National Cancer Institute–designated Comprehensive Cancer Center); large nonacademic (other facility with $\geq$ three linear accelerators actively used to treat patients), medium nonacademic (other facility with two linear accelerators), and small nonacademic (other facility with one linear accelerator). One hundred six facilities were selected and invited to participate in the survey, of which 45 (42%) participated in the study. Participating facilities included 14 academic, 13 large nonacademic, seven medium nonacademic, and 11 small nonacademic.

The American College of Radiology Institutional Review Board approved the study as qualifying for a waiver of consent under the Common Rule and a waiver of authorization under the Health Insurance Portability and Accountability Act. Participating facilities received approval from their institutional review boards or other boards according to their policies.

Case Eligibility and Study Samples

QRRO disease site committees defined eligibility criteria for each cancer site. For patients with breast cancer, inclusion cri-

teria were as follows: receipt of RT in 2007; female sex; any invasive breast disease; clinical stage I, II or IIIA; and mastectomy or lumpectomy as primary treatment. Exclusion criteria were bilateral lesions, prior or concurrent malignancies, or previous RT. For patients with cancer of the cervix, inclusion criteria were: receipt of RT in 2005 through 2007, and carcinoma of the cervix. Exclusion criteria were prior pelvic RT, distant metastases, prior or concurrent malignancies, or prior hysterectomy. For patients with prostate cancer, inclusion criteria were receipt of RT during 2007, and adenocarcinoma of the prostate. Exclusion criteria were distant metastases, prior or concurrent malignancies, previous chemotherapy or RT as a primary treatment, prostatectomy, histologically proven positive para-aortic nodes, or neoadjuvant hormonal therapy for more than 6 months before RT. For patients with gastric cancer, inclusion criteria were RT in 2005 through 2007; histology of adenocarcinoma, squamous, or adenosquamous; stage Ib, II, III, or IV (nonmetastatic); tumor in the stomach or gastroesophageal (GE) junction; and Karnofsky performance status $\geq$ 60. Exclusion criteria were distant metastases or prior malignancies within the past 5 years. Patients with lung cancer were divided into two separate groups: stage I, II or III non-small-cell lung cancer (NSCLC) and limited-stage small-cell lung cancer (SCLC). Inclusion criteria were RT from 2006 through 2007 and Karnofsky performance status $\geq$ 60. Exclusion criteria were distant metastases or malignant pleural effusion, prior thoracic radiotherapy, concurrent malignancy, or prior malignancy within 5 years. For all disease sites, patients with history of in situ or nonmelanoma skin cancers were eligible.

Using these eligibility criteria, participating facilities provided lists of all eligible patients for each disease site study. QRRO randomly selected the study samples from these lists, and abstractors reviewed each patient chart during the site visit for final determination of eligibility. From each facility, the first 10 randomly selected eligible patients were included in the prostate, breast, cervix, and gastric studies; the first eight randomly selected eligible patients in the NSCLC study; and the first five randomly selected eligible patients in the SCLC study. If a facility had fewer than the target number of patients for a study, all eligible patients were included.

Data Collection

Trained abstractors performed on-site reviews of medical records of the selected eligible patients and abstracted information for structured data elements on patient characteristics, tumor characteristics, staging work-up, comorbidities, and treatment into an online database.

Comorbidities

To assess and measure comorbid conditions, QRRO used the ACE-27 Index, a 27-item validated comorbidity index for use in patients with cancer that reflects not only a range of coexisting conditions relevant to cancer therapy choice and outcome, but also the severity of these conditions. It covers nine organ systems plus substance abuse, obesity, and a malignancy comorbidity score (not including the index cancer). Diseases are graded into three levels of

severity: grade 1 (mild), grade 2 (moderate), or grade 3 (severe), according to the level of individual organ decompensation and prognostic significance. From these data elements, the index can be computed to provide an overall comorbidity score of severe, moderate, mild, or none, based on the highest severity of a condition: severe in the case of one or more grade 3 scores or two or more grade 2 scores in different organ systems, moderate in the case of one grade 2 score, mild in the case of any number of grade 1 scores, or none. The two abstractors were trained and certified according to ACE-27 requirements.

For each patient, the data element, “Was treatment contra-indicated or changed due to comorbidities?” was recorded as “yes” if any note in the chart indicated that a change in treatment had occurred because of comorbidities and “no” otherwise. The CPMs in the Data Supplement provide examples of the type of treatment change most often encountered: using a lower dose or longer time for treatment or using sequential rather than concurrent treatment for different modalities. If the comorbidities were severe enough that no RT was performed at all, the patient would not have been in the study population because the eligibility criteria required that the patient had received RT. Both ACE-27 and change in treatment were analyzed to test whether ACE-27 is a good tool for standardized criteria for CPM exclusion due to comorbidities.

Data Analysis

National estimates were calculated using SAS v9.2 (SAS Institute, Cary, NC) and SAS-Callable SUDAAN v10.0 software (Research Triangle Institute, Research Triangle Park, NC), which incorporates design elements and weights reflecting the relative contribution of each patient in the analysis of this complex survey. Weights reflect the proportion of patients in the sample and population for each stratum to give appropriate point estimates and standard errors from which national averages of the measures can be derived. The sample frequency is reported as *n*, and the weighted estimate for the national practice is *N*. For each facility stratum, the calculation of *N* is based on the number of facilities in the sample and in the population, as well as the average number of patients per facility in each stratum. For each disease site, analysis includes descriptive and inferential statistics. *P* values less than .05 were considered statistically significant. The descriptive portion includes patient variables and prevalence of comorbidities. Multivariable logistic regression models were run to estimate the association of the ACE-27 index with change in treatment after adjusting for disease site and patient and insurance characteristics.

Results

Distribution of Patient Characteristics by Comorbidities

Table 1 shows the distribution of age, race/ethnicity, medical coverage, and marital status for each of the disease sites by severity of comorbidities as measured with the ACE-27. Overall, the presence of severe or moderate comorbidities was highest among patients with lung cancer and lowest among patients

with breast cancer. Age was significantly related to ACE-27 Index for patients with breast, cervix, NSCLC, and gastric cancer. Younger patients more often had no comorbidities, whereas older patients more often had severe comorbidities. Race/ethnicity is significantly related to ACE-27 index for the cervix, prostate, and NSCLC studies. Severe comorbidities were more frequent among black (not Hispanic) patients with cervix and prostate cancer and among white (not Hispanic) patients with NSCLC. Marital status was significantly related to ACE-27 index for the breast and cervix studies. Patients with no comorbidities were more often married or with a partner. The type of medical coverage was significantly related to ACE-27 Index for all sites except SCLC. Patients with severe comorbidities more often had Medicare. In addition to the factors shown in this table, as well as Table 2, similar distributions were computed (but not presented because of lack of relationships) for sex, US Census region, and facility stratum.

Change in Treatment Decisions by Patient Characteristics

Table 2 shows the distribution of the same set of characteristics by the variable “treatment contra-indicated or changed due to comorbidities.” Overall treatment changed most often for patients with NSCLC and least often for patients with breast cancer. Age was significantly related to treatment modification for patients with gastric cancer, with modification more frequent for older patients. Race/ethnicity was not significantly related to treatment modification. Marital status was significantly related to treatment modification in the cervix cancer study, more frequent among single patients. Medical coverage was significantly related to treatment modification for cervix, prostate, and gastric cancer studies. Patients with treatment modification more often had Medicare.

Logistic Model Predicting “Treatment Changed Due to Comorbidities”

To address the question of whether the standardized tool ACE-27 can consistently measure comorbidities in a way that is consistent with physicians’ independent judgments, multivariable logistic regression models were performed to show the association of patient factors with the dependent variable “treatment changed or contra-indicated due to comorbidities.” An initial model included as independent variables the factors presented in Tables 1 and 2: age, disease site, gender, race/ethnicity, medical coverage, and ACE-27 index. The final model shown in Table 3 includes those variables that showed substantial relationships in the initial model or in bivariate analyses. ACE-27 index was highly associated with treatment change for patients with severe or moderate index values compared to those with values of none or mild ($P < .001$). Age and medical coverage, two other variables that would be expected to be correlated with ACE-27 Index, made no (age) or little (medical coverage) significant contribution to predicting treatment change after ACE-27 was included in the multivariable model.

Table 1. Characteristics of Patients With Comorbidities Measured by the ACE-27 Index, by Disease Site

Disease Site and Level of Comorbidity	Weighted Patients		Age at Start of RT (years; %)			Race/Ethnicity (%)			Medical Coverage (%)*				Marital Status (%)†		
	No.	%	< 65	65-74	> = 75	White Not Hispanic	Black Not Hispanic	Hispanic/ Other‡	Medicare	Medicare+	Private/ Tricare	Medicaid/ Self	Married/ Partner	Single/ Alone	Unknown
Breast (n = 439)			<i>P</i> = .0011			<i>P</i> = .3201			<i>P</i> = .0006				<i>P</i> = .0001		
N (weighted) = 83,438															
None	33,963	41	78.1	15.2	6.7	80.8	9.8	9.4	5.1	14.6	76.8	3.5	71.3	20.7	8.0
Mild	35,551	43	53.8	26.9	19.3	68.0	20.3	11.7	13.3	31.3	49.7	5.7	59.3	25.5	15.1
Moderate	11,345	14	47.1	28.8	24.0	77.5	11.5	11.0	20.2	29.0	39.5	11.2	22.4	54.9	22.7
Severe	2,579	3	64.5	21.8	13.7	76.0	17.4	6.6	20.3	19.0	54.2	6.6	47.1	46.3	6.6
Cervix (n = 261)			<i>P</i> = .0003			<i>P</i> = .0322			<i>P</i> = .0004				<i>P</i> = .0370		
N (weighted) = 10,400															
None	4,991	48	92.7	3.1	4.2	60.9	11.2	27.9	2.8	6.1	61.0	30.0	43.8	31.6	24.6
Mild	2,716	26	58.4	14.9	26.7	51.9	32.3	15.9	12.8	25.3	47.5	14.3	33.6	56.3	10.1
Moderate	1,798	17	73.4	10.9	15.7	63.3	16.4	20.3	2.2	30.4	53.1	14.3	42.6	38.8	18.6
Severe	894	9	53.1	23.9	23.0	60.5	33.0	6.5	24.1	25.0	21.0	29.8	21.0	66.8	12.2
Prostate (n = 414)			<i>P</i> = .4510			<i>P</i> = .0145			<i>P</i> = .0183				<i>P</i> = .2480		
N (weighted) = 64,333															
None	13,888	22	36.2	45.0	18.8	69.2	13.5	17.3	23.6	17.2	56.8	2.4	82.5	10.0	7.5
Mild	31,794	49	29.7	43.8	26.5	71.6	18.3	10.1	23.9	37.0	36.9	2.2	76.5	14.0	9.5
Moderate	13,725	21	27.6	55.8	16.6	81.0	18.4	0.6	26.0	39.7	31.5	2.8	62.8	18.8	18.4
Severe	4,927	8	18.9	37.8	43.3	65.5	29.0	6.5	40.2	45.8	13.9	0.0	59.4	29.8	10.7
Lung (NSCLC) (n = 340)			<i>P</i> = .0090			<i>P</i> = .0104			<i>P</i> = .0012				<i>P</i> = .2830		
N (weighted) = 31,864															
None	3314	10	77.9	9.2	12.8	48.2	26.8	25.0	13.7	6.4	62.0	18.0	46.3	43.1	10.6
Mild	11,335	36	40.2	33.7	26.1	72.8	17.3	9.9	20.6	30.8	39.3	9.3	54.3	35.9	9.8
Moderate	8303	26	36.4	31.6	32.0	87.0	9.7	3.3	12.5	53.3	26.8	7.3	51.4	25.2	23.3
Severe	8912	28	33.0	34.8	32.2	81.6	15.4	2.9	24.9	36.3	28.7	10.1	50.5	35.6	14.0
Lung (SCLC) (n = 144)			<i>P</i> = .0575			<i>P</i> = .4858			<i>P</i> = .3894				<i>P</i> = .6024		
N (weighted) = 6,288															
None	784	13	70.7	5.0	24.3	89.6	8.6	1.8	1.8	29.3	63.5	5.4	42.2	47.4	10.4
Mild	2,520	40	50.0	42.8	7.3	77.2	11.2	11.5	7.7	19.9	59.1	13.2	60.3	35.0	4.7
Moderate	1,647	26	68.2	19.5	12.3	86.0	14.0	0.0	9.3	27.1	51.5	12.1	62.6	24.1	13.3
Severe	1,336	21	54.1	41.1	4.8	88.8	11.2	0.0	42.7	11.6	40.9	4.8	63.5	32.8	3.8
Gastric (n = 248)			<i>P</i> = .0002			<i>P</i> = .0873			<i>P</i> = .0224				<i>P</i> = .6595		
N (weighted) = 9,547															
None	3,078	32	83.7	11.5	4.9	59.5	15.5	24.9	5.6	13.8	65.0	15.6	66.2	18.0	15.8
Mild	4,143	43	48.0	34.9	17.1	52.8	22.5	24.7	14.3	24.3	51.0	10.4	74.8	18.5	6.7
Moderate	1,395	15	23.3	40.3	36.4	86.8	5.6	7.6	21.3	44.6	30.6	3.5	58.5	31.4	10.1
Severe	931	10	30.5	34.5	34.9	70.1	17.6	12.4	15.4	51.0	19.2	14.4	53.7	30.9	15.4

NOTE. Percentages are based on weighted number of patients.

* Medicare includes Medicare and Medicare health maintenance organization (HMO); Medicare+ includes Medicare plus supplemental insurance (Blue Cross/Blue Shield, HMO, Champus/VA/Tricare or Other insurance); Medicaid/Self includes Medical, etc, self-pay, and insurance status unknown.

† Single/Alone includes widowed, divorced, separated, never married, and unknown.

‡ Other includes Asian, Native Hawaiian or other Pacific Islander, American Indian or Native Alaskan, More than one race, Other, and Unknown.

Medicare with supplement was more likely to be associated with treatment change than private/TriCare/other insurance ($P = .0394$). Disease site was also highly associated with treatment change after adjusting for other variables in the model.

Compared with the reference category of breast cancer, patients with cervix ($P < .001$), NSCLC ($P < .001$), gastric ($P = .0020$), and prostate ($P < .001$) cancer were more likely to experience treatment changes as a result of comorbidities.

Table 2. Characteristics of Patients With Treatment Changed As a Result of Comorbidities, by Disease Site

Disease Site and Level of Comorbidity	Totals		Age at start of RT (years)			Race/Ethnicity			Medical Coverage*				Marital Status†		
	No.	%	< 65	65-74	≥ 75	White, Not Hispanic	Black, Not Hispanic	Hispanic/Other‡	Medicare	Medicare+ care+	Private/ Tricare	Medicaid/ Self	Married/ Partner	Single/ Alone	Unknown
Breast (n = 439)															
N (weighted) = 83,438			P = .3192			P = .4136			P = .3740				P = .1092		
Treatment changed	17	3.0	34.8	34.7	30.4	87.2	7.8	4.9	22.1	44.1	31.9	2.0	21.1	71.1	7.8
Treatment not changed (%)	422	97.0	64.0	21.9	14.2	74.3	15.0	10.7	10.8	23.2	60.3	5.7	60.0	26.9	13.1
Cervix (n = 261)															
N (weighted) = 10,400			P = .0605			P = .0711			P = .0341				P = .0375		
Treatment changed	27	13.2	50.3	25.5	24.2	60.9	30.7	8.5	23.6	35.5	29.4	11.6	18.8	70.5	10.7
Treatment not changed	234	86.8	81.1	6.9	12.1	58.6	17.8	23.6	4.6	14.1	56.2	25.0	42.0	38.0	19.9
Prostate (n = 414)															
N (weighted) = 64,333			P = .7627			P = .1226			P = .0227				P = .3342		
Treatment changed	85	19.5	27.3	43.9	28.8	73.8	22.1	4.2	30.6	48.0	19.8	1.6	66.2	23.1	10.7
Treatment not changed	329	80.5	30.4	46.7	22.8	72.2	17.2	10.6	24.3	30.6	42.7	2.3	75.4	13.5	11.1
Lung (NSCLC) (n = 340)															
N (weighted) = 31,864			P = .1281			P = .1455			P = .4171				P = .8875		
Treatment changed	115	29.8	33.6	30.4	36.0	80.9	15.2	3.9	21.9	39.8	28.5	9.8	51.4	32.5	16.1
Treatment not changed	225	70.2	44.3	31.2	24.5	74.5	16.1	9.4	17.8	33.9	38.3	10.0	51.7	34.3	13.9
Lung (SCLC) (n = 144)															
N (weighted) = 6,288			P = .7530			P = .1991			P = .1456				P = .1002		
Treatment changed	15	7.9	48.2	43.9	7.9	74.7	25.3	0.0	31.4	7.9	60.7	0.0	55.0	45.0	0.0
Treatment not changed	129	92.1	59.1	30.5	10.4	84.3	10.4	5.3	13.4	22.3	53.2	11.0	59.7	32.2	8.1
Gastric (n = 248)															
N (weighted) = 9,547			P = .0077			P = .3925			P = .0287				P = .7534		
Treatment changed	25	13.6	20.2	17.4	62.4	75.6	12.6	11.8	30.2	45.9	21.7	2.2	59.7	29.2	11.1
Treatment not changed	223	86.4	59.5	29.8	10.7	59.4	18.1	22.5	9.9	23.4	53.8	12.9	68.8	20.2	11.0

NOTE. Percentages based on weighted number of patients.

Abbreviations: NSCLC, non-small-cell lung cancer; RT, radiotherapy; SCLC, small-cell lung cancer.

* Medicare includes Medicare, and Medicare HMO; Medicare+ includes Medicare plus supplemental insurance (Blue Cross/Blue Shield, HMO, Champus/VA/Tricare or Other insurance); Medicaid/Self includes medical, etc., Self-pay and insurance status unknown.

† Single/Alone includes widowed, divorced, separated, never married, and unknown.

‡ Other includes Asian, Native Hawaiian or Other Pacific Islander, American Indian or Native Alaskan, more than one race, other, and unknown.

Discussion

CPMs might result in the exclusion of patients because of the presence of comorbid conditions, which can affect decision making of both physicians and patients, as well as the ability of patients to tolerate and benefit from standard treatment. The effects of comorbid conditions may lead physicians to rule out certain treatments or modify the intensity or method of delivery of a particular component of care. These modifications may affect the overall plan of care and its expected outcome in known or unanticipated ways. Comorbid conditions also may affect a patient's choice among treatment options. Even after the physician and patient have determined the planned treatment course, comorbid conditions may make it difficult for patients to complete prescribed treatment. Although these issues have been explored for cancer treatment decisions, this report provides more detailed information for radiation therapy.¹¹

The results described in this report show a strong relationship between ACE-27 index and changes in treatment as a result of comorbidities. For CPMs intended for quality improvement, ACE-27 is a validated tool that standardizes the

measurement of comorbidities. At the institution where the index, was developed cancer registrars have collected comorbidity data using the ACE-27 assessment during routine data abstraction on every newly diagnosed patient since 1995 (~9,000 per year). The average and usual time for abstraction of ACE-27 data is less than 3 minutes when done in conjunction with usual abstraction of Commission on Cancer–mandated information. An online calculator automatically uploads the comorbid ailments and overall score. Cancer registrars at other institutions have successfully collected ACE-27 data as part of routine data collection for the electronic medical record. (J. Piccirillo, personal communication, December 1, 2013).

Although physician notes that treatment was changed due to comorbidity were closely associated with ACE-27, criteria for notes were not objectively defined. Using a widely validated index provides objective criteria.

Growing observational evidence shows that comorbidities or patient age affect treatment options and outcomes for some cancers. Treatment advances such as postlumpectomy radiation and adjuvant chemotherapy have led to improved outcomes in

Table 3. Multivariable Logistic Regression Analysis Identifying Variables Associated With Treatment Changes or Contraindicated As a Result of Comorbidities

Characteristic	Treatment Changed or Contraindicated As a Result of Comorbidities		
	Odds Ratio	95% CI	P
Intercept	0.01	0.00 to 0.01	< .001
Disease site			
Breast	Reference		
Cervix	4.39	1.92 to 10.06	< .001
Prostate	7.41	3.39 to 16.21	< .001
Lung (NSCLC)	4.24	1.97 to 9.15	< .001
Lung (SCLC)	0.68	0.22 to 2.15	.5156
Gastric	4.07	1.68 to 9.90	.0020
ACE-27 index			
None/mild	Reference		
Moderate	11.08	6.08 to 20.18	< .001
Severe	71.49	34.86 to 146.59	< .001
Age at start of treatment, years			
< 65	Reference		
65-74	0.65	0.30 to 1.40	.2697
≥ 75	0.99	0.43 to 2.32	.9901
Medical coverage*			
Private/Tricare	Reference		
Medicare	1.95	0.88 to 4.30	.0994
Medicare+	2.25	1.04 to 4.88	.0394
Medicaid/self-pay/unknown	0.79	0.40 to 1.58	.5094

Abbreviations: ACE-27, Adult Comorbidity Evaluation Index; HMO, health maintenance organization; NSCLC, non-small-cell lung cancer; SCLC, small-cell lung cancer.

* Medicare includes Medicare, and Medicare HMO; Medicare+ includes Medicare plus supplemental insurance (Blue Cross/Blue Shield, HMO, CHAMPUS/Tricare or other insurance); Medicaid/Self-pay includes Medical, etc., Self-pay and insurance status unknown.

breast, colon, and lung cancer, yet older patients may not have the same degree of benefit from or tolerance of these treatments, especially in the presence of comorbidities.¹²⁻¹⁷ The proportion of adults 65 years and older is increasing, and the older population is at a greater risk of cancers, as well as comorbidities.¹⁸⁻²⁰ Guidelines from the National Comprehensive Cancer Network emphasize the need to assess and measure comorbid conditions, especially for senior adult oncology patients, a need that requires close collaboration among all physicians involved in the patient's care.²¹

More work is needed to investigate how comorbidity affects outcomes and how to incorporate it into CPMs. Patients with moderate or severe comorbidities face risks from the comorbid conditions themselves and may have poorer cancer-specific outcomes because of receipt of less aggressive treatment, yet such patients may not be able to tolerate aggressive treatment. For those with less aggressive cancers, the risk from the comorbid conditions may outweigh the risks from cancer. This report shows the relationship between comorbidity measured with a

severity index and treatment decisions for patients in disease sites where radiation therapy is included in the established multidisciplinary paradigm of care.

This study has several limitations. It did not attempt to describe the specific treatment changes resulting from comorbidities. Because of the eligibility requirements, the study did not include those who received no RT. To use ACE-27, someone must abstract or record the components from the patient record, either as part of the standard electronic medical record or registry or as part of a specific initiative. Abstractors must complete online training. After training, the additional burden of data collection is small if done in conjunction with data abstraction of other data elements for the patient, but substantial otherwise. CPMs based on claims data would generally not be able to use this comorbidity index. The 42% of invited facilities that actually participated in the study may differ from the nonparticipants. Numerous statistical comparisons were performed, and some comparisons may be positive by chance alone. Isolated positive results should be viewed with caution.

ACE-27 is highly predictive of changes in treatment due to comorbidities for patients receiving radiation as part of their cancer care. Other covariates, such as age or type of medical coverage, do little to predict the likelihood of a change in treatment once severity of comorbidities is considered. Use of ACE-27 to identify patients with comorbidities who should be excluded from CPMs would provide an objective tool leading to more accurate CPMs.

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The author(s) indicated no potential conflicts of interest.

Author Contributions

Conception and design: Jean B. Owen, Najma Khalid, Alex Ho, Lisa A. Kachnic, Ritsuko Komaki, Jesse F. Wilson

Collection and assembly of data: Jean B. Owen

Data analysis and interpretation: Jean B. Owen, Najma Khalid, Alex Ho, May Lin Tao, Adam Currey, Jesse F. Wilson

Manuscript writing: All authors

Final approval of manuscript: All authors

Corresponding author: Jean B. Owen, PhD, PO Box 1072, Westtown, PA 19395; e-mail: Jowen24@outlook.com.

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