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National Cancer Registrars Association
1340 Braddock Place, Suite 203
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Address all editorial correspondence to:
Reda J. Wilson, MPH, RHIT, CTR, Editor
CDC/NCCDPHP/DCPC/CSB
4770 Buford Drive, MS K-53
Atlanta, GA 30341-3717
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Original Article

Survival and Time Interval from Surgery to Start of Chemotherapy among Colon Cancer Patients

Rachel Zeig-Owens, MPH[a,b]; Susan T. Gershman, MS, MPH, PhD, CTR[a]; Richard Knowlton, MS[a]; Judith S. Jacobson, MBA, DrPH[b]

Abstract: Background. Colon cancer is one of the most common cancers diagnosed within the United States. Survival with stage III colon cancer has improved with the addition of adjuvant chemotherapy as a component of treatment. Some patients with stage II colon cancer also receive chemotherapy. There has been a dearth of research about the effect of the timing of chemotherapy on survival. Recent studies have shown a possible link between the length of time between surgery and chemotherapy treatment and probability of survival. The present study investigated the association of chemotherapy with survival, and the association of initiating treatment within 45 days vs. more than 45 days after surgery with survival. Methods. We used Kaplan-Meier methods and multivariable Cox proportional hazards models to analyze the association of treatment and its timing with survival among patients who were listed as diagnosed with and having surgery for stage II or III colon cancer from 1997 to 1999 in the Massachusetts Cancer Registry. All tests were two-sided. Results. Of the 3,006 patients who met the eligibility criteria, 61% were still alive on December 31, 2003. Patients who received chemotherapy after surgery were more likely to survive than those who received surgery alone. However, those who received chemotherapy within 45 days did not have better survival than those who began treatment later (hazard ratio 1.16, 95% CI 0.92–1.47). Among stage II colon cancer patients alone, those who received chemotherapy after surgery had significantly lower mortality than those who received surgery alone (hazard ratio 0.75, 95% CI 0.58–0.96). Conclusions. Adjuvant chemotherapy treatment after surgery for stage II and III colon cancer cases, but not the timing of its initiation, was associated with improved survival. Our study shows a benefit of chemotherapy for patients with stage II disease.

Key words: *colon cancer, epidemiology, survival study*

Introduction

According to the National Cancer Institute's (NCI) Surveillance, Epidemiology, and End Results (SEER) Program cancer surveillance data, approximately 108,070 people in the United States were diagnosed with colon cancer in 2008.[1] During the period 2001–2005, the Commonwealth of Massachusetts reported an average annual age-adjusted incidence rate of 40.2 per 100,000 for colon cancer,[2] slightly higher than the corresponding SEER rate of 36.6 per 100,000.[3] Not only is colon cancer one of the most commonly diagnosed cancers in the United States, it has the third highest mortality rate as well.[4] However, incidence and mortality rates have been declining for more than two decades.[3]

The stage of colon cancer at diagnosis is an important predictor of survival. Stage (I = early and localized disease, IV = advanced and metastatic disease) reflects the size and number of tumors, the spread of cancer to lymph nodes, and metastasis or spread to other organs. In a study of survival by stage, based on the most current American Joint Committee on Cancer (AJCC) staging system national data, the probability of survival to 5 years after diagnosis ranged from 72.2% to 84.7% for stage II colon cancer and from 44.3% to 83.4% for stage III colon cancer.[5] The overlap in 5-year survival between stage II and stage III was attributed to treatment differences between stage IIb and stage IIIa.[5] More patients with stage III than with stage II colon cancer receive adjuvant chemotherapy.[5]

For almost 20 years, the NCI has recommended adjuvant chemotherapy for the treatment of stage III colon cancer.[6] This recommendation followed the findings from a large randomized controlled clinical trial,[7] that found that subjects with stage III colon cancer who received fluorouracil plus levamisole after surgery had a 33% reduction in mortality after a 5-year follow-up.[8] More recent trials have involved different treatment agents, combinations of agents, or treatment schedules. In some trials, patients began treatment soon after surgery,[8–10] while in others treatment could begin up to 8[11, 12] or even 12[13] weeks after surgery. However, patients treated outside a clinical trial setting may not necessarily initiate chemotherapy on schedule. Only a few studies have examined the time interval from surgery to the initiation of chemotherapy as a predictor of survival. In a randomized trial, patients who received their first chemotherapy treatment 8 to 12 weeks after surgery had a 1.37 times significantly higher

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"Survival and Time Interval from Surgery to Start of Chemotherapy among Colon Cancer Patients"

[a]Massachusetts Cancer Registry, Massachusetts Department of Public Health, Boston, MA. [b]Department of Epidemiology, Mailman School of Public Health, Columbia University, New York, NY.

Address correspondence to Rachel Zeig-Owens, MPH; New York City Fire Department, Bureau of Health Services, 9 Metrotech Center—5th floor, 5E—12-K, Brooklyn, NY 11201. Telephone: (718) 999-0734. Email: raz2108@columbia.edu.

risk of dying than those who had chemotherapy earlier, after adjustment for other variables.[13] However, the trial participants were not randomly assigned to timing of chemotherapy and therefore bias may have been introduced. Circumstances such as surgical complications or comorbid conditions may have resulted in treatment delay and been associated with survival.

Two additional randomized trials of various chemotherapy combinations have suggested that the amount of time between surgery and beginning chemotherapy may also influence survival. One study reported that tumor recurrence was less likely (P=.01) among patients who initiated chemotherapy within 27 days after surgery than among those who did so later, but that time interval was not associated with survival.[14] An analysis of several clinical trials was unable to conclude that patients with colon or rectal cancer who received surgery plus chemotherapy had better survival than patients who received surgery alone. The authors suggested that they might have failed to find a benefit for chemotherapy because the median time between surgery and chemotherapy was longer among the patients in their study than in many other studies in which adjuvant chemotherapy appeared to improve survival.[15] One observational study among patients 65 years of age or older diagnosed with stage III colon cancer found that those who initiated chemotherapy within 1 month after surgery had better survival than those who initiated chemotherapy 2 months or more after surgery, when age, race, and socioeconomic status were taken into account.[16] The study sample, however, although population-based, was limited to elderly patients because it came from the linked SEER-Medicare database and thus may not be comparable with other study populations. A review of this study along with other studies of colon cancer treatment found chemotherapy should be started as soon as possible to be the most beneficial.[17]

In a population-based sample of patients with stage II colon cancer in Western Australia, receipt of chemotherapy was associated with improved survival.[18] However, few stage II colon cancer patients received adjuvant treatment, and the factors that determined which patients received treatment may also have been predictive of survival. No studies of the association between timing of chemotherapy and survival in stage II colon cancer have been published.

We used data on patients with stage II or stage III colon cancer from the Massachusetts Cancer Registry (MCR) to investigate the association of chemotherapy with survival and, among patients who received chemotherapy, the association of initiating treatment within 45 days vs. more than 45 days after surgery with survival, controlling for other variables.

Methods

Study Population

The subjects in this study were colon cancer patients who were Massachusetts residents reported to the population-based MCR. The MCR has received gold certification for diagnosis years 1997 through 2005 from the North American Association of Central Cancer Registries (NAACCR) for complete, timely, and high quality data. Subjects with rectal cancer were not included in the study because treatment recommendations for rectal cancer differ from those for colon cancer. This study received Institutional Review Board approval from the Massachusetts Department of Public Health.

Massachusetts residents who were newly diagnosed with colon cancer between January 1, 1997 and December 31, 1999, were included in this study. The time interval was selected because the MCR had complete vital status data through December 31, 2003, permitting at least 4 years of follow-up, and because recommendations for colon cancer treatment were fairly consistent during this time period. In the years 1997–1999, 76 facilities (75 acute care hospitals and one medical practice association) reported cancer cases to the MCR.[19] Data from all Massachusetts facilities were included for analysis, with the exception of five Veterans Affairs hospitals that are not allowed to release personal level data for analyses.

Cases included in this analysis were those with *International Classification of Disease for Oncology, Third Edition (ICD-O-3)*[20] codes C18.0–C18.9 (colon cancer), with any histology code except 9590–9989 (lymphomas), an ICD-O-3 behavior code of 3 (malignant), and AJCC stage II or III.

Cases were excluded if they were listed in the MCR as having been diagnosed with any primary cancer prior to the diagnosis that met the other eligibility criteria. For subjects who had two primary cases of colon cancer diagnosed between 1997 and 1999, only factors related to the first diagnosis were analyzed. Among cases diagnosed with two cancers on the same day, the tumor corresponding to the first primary case within the MCR records was included. Subjects were excluded from analysis if their survival time was less than 8 months because subjects who died early did not have the opportunity to benefit from chemotherapy and those who did not receive timely chemotherapy because of comorbid conditions or complications of surgery were likely to be overrepresented in that group. Cases were also excluded if their chemotherapy treatment was initiated more than a year after their surgery because such treatment may have been a response to cancer recurrence rather than adjuvant to the surgery. To control for possible confounding by additional treatments, subjects were also excluded if they received radiation therapy in the first year.

Variables of Interest

The primary independent variables of interest in this study are receipt of chemotherapy following colon cancer surgery and the interval of time between surgery and initiation of adjuvant chemotherapy treatment. The outcome variable is survival. Covariates included in the analysis were age, sex, race/ethnicity, year of diagnosis, stage, and type of hospital (teaching vs. non-teaching).

For each individual case in its database, the MCR collects data on the first course of treatment following diagnosis and surgery, if performed. The MCR records data

only in text fields on the type of chemotherapy received, and does not collect data on the duration of treatment. In order to be included in the analysis, a case record had to include dates with month, day, and year for both colon cancer surgery and first adjuvant chemotherapy, if any. Subjects were categorized as not receiving chemotherapy, receiving chemotherapy within the first 45 days after surgery, or receiving chemotherapy more than 45 days after surgery.

The MCR obtains death dates from the Massachusetts Registry of Vital Records and Statistics (MRVRS) and the National Death Index (NDI). At the time of the study, data from the MRVRS and NDI were available through December 31, 2003. Causes of death were not analyzed for this report because the data on causes were not considered complete. Overall mortality was the only outcome variable analyzed. Subjects were censored on December 31, 2003, the last day for which complete vital status information was available. Each subject's survival time was calculated from date of diagnosis until death date or censored date.

Age in years at the time of colon cancer diagnosis was analyzed as a categorical variable. The age groups were less than 65 years, 65 to 69 years, 70 to 74 years, 75 to 79 years, and 80 years or more.

The subject's sex and year of diagnosis were analyzed as they were reported to the MCR. Both males and females were included in the analysis. Year of diagnosis was analyzed as 1997, 1998, or 1999.

Race/ethnicity is defined using two reported variables in the registry. The variable race, as defined in the MCR coding manual, is combined with the information provided in the Spanish/Hispanic origin variable. For this analysis, race/ethnicity was categorized as white, non-Hispanic; black, non-Hispanic; or other/unknown. Hispanics were included in the other/unknown group because of small numbers.

Colon cancers were staged according to the *AJCC Cancer Staging Manual, Fourth Edition*[21] for 1997 colon cancer data and the *AJCC Cancer Staging Manual, Fifth Edition*[22] for 1998–1999 colon cancer data. Stage IIa and IIb cancers are reported to the MCR as Stage II, and Stage IIIa, IIIb, and IIIc cancers are reported as Stage III.

Hospitals were classified as either teaching or non-teaching based on the Massachusetts Division of Health Care Finance and Policy *Acute Annual Hospital Financial Report FY05, July 2006*.[23] Hospitals reporting cancer cases to the MCR between 1997 and 1999 that were not included in that report because of closures or mergers were classified as "unknown." Cases reported to the registry by a large medical group practice were classified as "other." For this analysis the unknown and other groups were combined.

Statistical Analysis

The demographic and clinical characteristics of patients were compared by chemotherapy groups (no chemotherapy, 45 days or less, or greater than 45 days). To assess the statistical significance of group differences, we used analysis of variance to compare the means of normally distributed continuous variables and chi-square tests to compare distributions of categorical variables. Logistic regression was performed to determine which factors were independent predictors of treatment.

The relationship between timing of chemotherapy after surgery and duration of survival was analyzed using Kaplan-Meier methods. Multivariable Cox proportional hazards regression models were then used to analyze the association of treatment and the timing of treatment with mortality, adjusting for factors associated with treatment in univariate analysis. Based on the Wald test, non-significant variables were not included in the final model unless thought to be medically relevant. The log rank test was performed to test the effect of the added variables on the model's predictiveness. Interactions between the exposure variables were also investigated within the regression models. All categorical variables were entered into the model as multiple dummy variables with one category representing the reference group. The same analyses were conducted within stage (II and III) and age groups (<65 and ≥65).

All associations were considered to be statistically significant if the two-sided P value was .05 or less. All data analyses were performed using the statistical software SAS for Windows (version 9.1.3; SAS Institute, Inc., Cary, NC).

Results

Among 4,311 cases of stage II or III colon cancer diagnosed between January 1, 1997 and December 31, 1999, 663 cases were excluded because of previously diagnosed cancers. Additionally, 72 subjects were diagnosed with two tumors on the same day; these subjects were included in the study population on the basis of the first tumor reported. Of the remaining cases, 388 were excluded because they died within 8 months of surgery, 3 because they began chemotherapy over a year after surgery, and 179 because they received radiation therapy. All subjects had complete information for the variables of interest; none were excluded because of incomplete information. A total of 3,006 people were included in the analysis.

Of the 3,006 subjects, 1,363 (45.3%) were male and 1,643 (54.7%) were female; 2,778 (92.4%) were white, non-Hispanic. The mean age at diagnosis was about 72 years. A total of 945 (31.6%) received chemotherapy after surgery. Those who did not receive chemotherapy were on average about 10 years older, and were more likely to have stage II disease, than those who did receive it (Table 1a). Subjects who began adjuvant chemotherapy treatments more than 45 days after surgery were slightly but significantly older than those who began treatment soon after surgery (P=.006, results not shown). Of patients with stage II disease, 86% received no chemotherapy. Of patients with stage III disease, 44% received no chemotherapy (see Tables 1b and 1c).

About 39% of the subjects are known to have died during the 6-year study period (Table 1a). A total of 1,843 subjects were censored. Of the censored subjects, 1,209 (56%) never received chemotherapy after surgery, 404 (22%) began chemotherapy within 45 days of surgery, and 230 (12%) subjects initiated chemotherapy after 45 days of surgery. The proportion of subjects who died by December

Table 1a. Demographic and Clinical Characteristics of Study Population: All Cases					
	Chemotherapy received				
	None	**≤45 days after surgery**	**>45 days after surgery**	**Total**	**P value**
	n (%)	n (%)	n (%)	n	
Total subjects	2,061 (68)	596 (20)	349 (12)	3,006	
Sex					
Male	879 (43)	322 (54)	162 (46)	1,363	<.0001[a]
Female	1,182 (57)	274 (46)	187 (54)	1,643	
Age in years					
Median	76	67	68	74	
Mean (SD)	74.61 (10.94)	64.53 (11.56)	66.64 (11.04)	71.69	<.0001[b]
Age groups (years)					
<65	316 (15)	260 (44)	120 (34)	696	<.0001[a]
65–69	231 (11)	107 (18)	72 (21)	410	
70–74	335 (16)	115 (19)	72 (21)	522	
75–79	429 (21)	79 (13)	55 (16)	563	
≥80	750 (37)	35 (6)	30 (8)	815	
Race/ethnicity					
White, non-Hispanic	1,911 (93)	545 (91)	322 (92)	2,778	.0442[a]
Black, non-Hispanic	60 (3)	22 (4)	19 (6)	101	
Other/unknown	90 (4)	29 (5)	8 (2)	127	
Stage					
II	1,514 (73)	136 (23)	120 (34)	1,770	<.0001[a]
III	547 (27)	460 (77)	229 (66)	1,236	
Year of diagnosis					
1997	686 (33)	188 (32)	101 (29)	975	.3312[a]
1998	688 (34)	202 (34)	113 (32)	1,003	
1999	687 (33)	206 (34)	135 (39)	1,028	
Hospital					
Teaching	1,280 (62)	391 (66)	211 (60)	1,882	.0250[a]
Non-teaching	647 (31)	170 (29)	127 (37)	944	
Other/unknown	134 (7)	35 (6)	11 (3)	180	
Vital status*					
Alive	1,209 (59)	404 (68)	230 (66)	1,843	<.0001[a]
Deceased	852 (41)	192 (32)	119 (34)	1,163	

* As of December 31, 2003
[a] Chi-square P value
[b] ANOVA P value

Table 1b. Demographic and Clinical Characteristics of Study Population: Stage II Colon Cancer Cases					
	Chemotherapy received				
	None	**≤45 days after surgery**	**>45 days after surgery**	**Total**	**P value**
	n (%)	n (%)	n (%)	n	
Total subjects	1,514 (86)	136 (7)	120 (7)	1,770	
Sex					
Male	649 (43)	73 (54)	59 (49)	781	.0268[a]
Female	865 (57)	63 (46)	61 (51)	989	
Age in years					
Median	76	64	66	75	
Mean (SD)	74.36 (10.80)	62.93 (11.93)	62.98 (12.06)	72.71	<.0001[b]
Age groups (years)					
<65	232 (15)	70 (51)	55 (46)	357	<.0001[a]
65–69	181 (12)	19 (14)	29 (24)	229	
70–74	249 (16)	24 (18)	20 (17)	293	
75–79	330 (22)	17 (13)	13 (11)	360	
≥80	522 (35)	6 (4)	3 (2)	531	
Race/ethnicity					
White, non-Hispanic	1,411 (93)	130 (96)	107 (89)	1,648	.0491[a]
Black, non-Hispanic	43 (3)	3 (2)	9 (8)	55	
Other/unknown	60 (4)	3 (2)	4 (3)	67	
Year of diagnosis					
1997	504 (33)	41 (30)	36 (30)	581	.8833[a]
1998	506 (34)	46 (34)	41 (34)	593	
1999	504 (33)	49 (36)	43 (36)	596	
Hospital					
Teaching	924 (61)	107 (79)	72 (60)	1,103	.0250[a]
Non-teaching	496 (33)	27 (20)	42 (35)	565	
Other/unknown	94 (6)	2 (1)	6 (5)	102	
Vital status*					
Alive	965 (64)	109 (80)	102 (85)	1,176	<.0001[a]
Deceased	549 (36)	27 (20)	18 (15)	594	

* As of December 31, 2003
[a] Chi-square P value
[b] ANOVA P value

Table 1c. Demographic and Clinical Characteristics of Study Population: Stage III Colon Cancer Cases					
	Chemotherapy received				
	None	**≤45 days after surgery**	**>45 days after surgery**	**Total**	**P value**
	n (%)	n (%)	n (%)	n	
Total subjects	547 (44)	460 (37)	229 (19)	1,236	
Sex					
Male	230 (42)	249 (54)	103 (45)	582	.0005[a]
Female	317 (58)	211 (46)	126 (55)	654	
Age in years					
Median	77	67	71	72	
Mean (SD)	75.28 (11.33)	65.01 (11.42)	68.55 (9.96)	70.21	<.0001[b]
Age groups (years)					
<65	84 (15)	190 (41)	65 (28)	339	<.0001[a]
65–69	50 (9)	88 (19)	43 (19)	181	
70–74	86 (16)	91 (20)	52 (23)	229	
75–79	99 (18)	62 (13)	42 (18)	203	
≥80	228 (42)	29 (6)	27 (12)	284	
Race/ethnicity					
White, non-Hispanic	500 (91)	415 (90)	215 (94)	1,130	.1442[a]
Black, non-Hispanic	17 (3)	19 (4)	10 (4)	46	
Other/unknown	30 (6)	26 (6)	4 (2)	60	
Year of diagnosis					
1997	182 (33)	147 (32)	65 (28)	394	.4448[a]
1998	182 (33)	156 (34)	72 (32)	410	
1999	183 (34)	157 (34)	92 (40)	432	
Hospital					
Teaching	356 (65)	284 (62)	139 (61)	779	.0109[a]
Non-teaching	151 (28)	143 (31)	85 (37)	379	
Other/unknown	40 (7)	33 (7)	5 (2)	78	
Vital status*					
Alive	244 (45)	295 (64)	128 (56)	667	<.0001[a]
Deceased	303 (55)	165 (36)	101 (44)	569	

* As of December 31, 2003
[a] Chi-square P value
[b] ANOVA P value

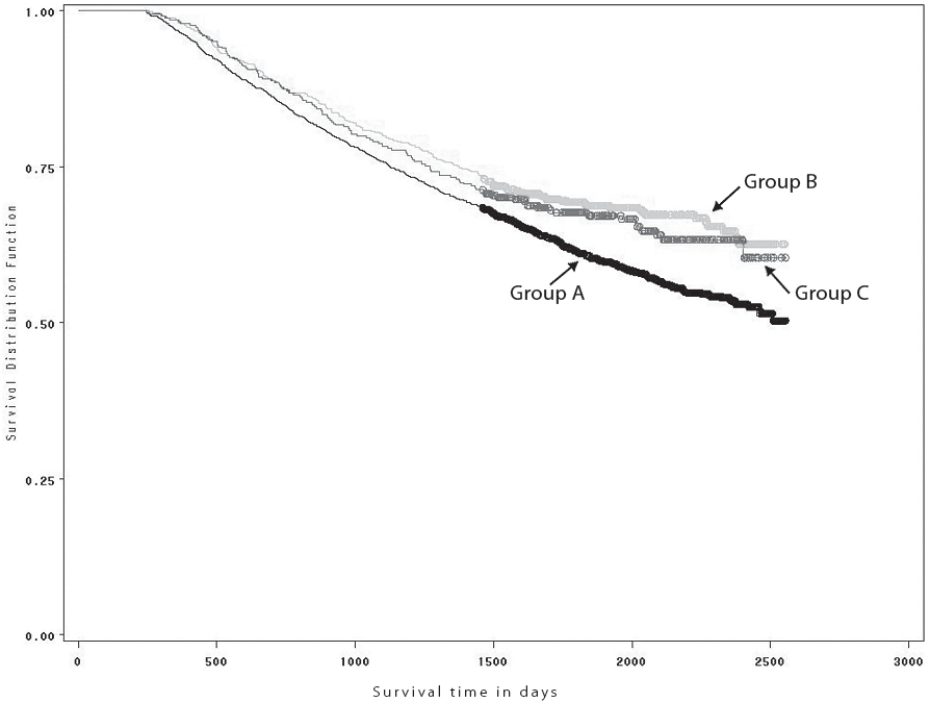
31, 2003 was significantly lower in patients who received treatment than in patients who did not (overall and within stage, see Tables 1a, 1b, and 1c).

In a logistic regression model, subjects who were diagnosed with stage III colon cancer were nearly 9 times as likely to receive chemotherapy as those with stage II disease, after adjusting for other confounders (odds ratio 8.81, 95% CI 7.26–10.70). Younger subjects were also more likely to receive chemotherapy than older subjects after adjusting for other variables. Sex, year of diagnosis, and type of hospital did not significantly predict whether chemotherapy was initiated after surgery or not (data not shown).

Kaplan-Meier survival analysis showed that the subjects who received no chemotherapy had poorer survival than those who were treated, and that subjects treated less than 45 days after surgery had better survival than those treated later than 45 days after surgery (log rank P=.0002) (Figure 1).

In multivariable Cox proportional hazards regression models the same variables remained statistically significant (Table 2). The final model was adjusted for stage at

Figure 1. Survival among stage II and III colon cancer patients, stratified by treatment group



Group A—*Never received chemotherapy*
Group B—*Chemotherapy initiated within 45 days after surgery*
Group C—*Chemotherapy initiated more than 45 days after surgery*
o *Censored subjects in each group*

Table 2. Multivariable Cox Proportional Hazard Models for Study Population: All Cases

	Models				
	Unadjusted	*Model 1*	*Model 2*	*Model 3*	*Final Model*
Variables	*Hazard Ratio (CI)**	*Hazard Ratio (CI)*	*Hazard Ratio (CI)*	*Hazard Ratio (CI)*	*Hazard Ratio (CI)*
Chemotherapy					
No chemo	1.00 (Referent)	1.00 (Referent)	1.00 (Referent)	1.00 (Referent)	1.00 (Referent)
≤45 days	0.74 (0.63, 0.87)	0.52 (0.44, 0.61)	0.74 (0.62, 0.88)	0.72 (0.60, 0.86)	0.72 (0.60, 0.86)
>45 days	0.80 (0.66, 0.97)	0.61 (0.50, 0.74)	0.82 (0.66, 1.00)	0.82 (0.66, 1.00)	0.81 (0.66, 0.99)
Stage					
Stage II		1.00 (Referent)	1.00 (Referent)	1.00 (Referent)	1.00 (Referent)
Stage III		2.03 (1.79, 2.30)	1.94 (1.71, 2.20)	1.95 (1.72, 2.22)	1.95 (1.72, 2.22)
Age groups (years)					
<65			1.00 (Referent)	1.00 (Referent)	1.00 (Referent)
65–69			1.16 (0.92, 1.47)	1.16 (0.92, 1.46)	1.17 (0.92, 1.47)
70–74			1.50 (1.22, 1.85)	1.51 (1.22, 1.86)	1.52 (1.23, 1.87)
75–79			1.80 (1.47, 2.20)	1.83 (1.49, 2.24)	1.84 (1.50, 2.26)
≥80			2.86 (2.38, 3.45)	3.00 (2.49, 3.62)	3.03 (2.50, 3.66)
Sex					
Female				1.00 (Referent)	1.00 (Referent)
Male				1.27 (1.13, 1.43)	1.27 (1.13, 1.43)
Race/ethnicity					
White, non-Hispanic					1.00 (Referent)
Black, non-Hispanic					1.18 (0.86, 1.64)
Other/unknown					0.99 (0.73, 1.36)

* 95% confidence interval (CI)

diagnosis, age, sex, and race/ethnicity. Race/ethnicity did not significantly improve the predictiveness of the model, but was thought to be medically important based on different national mortality rates across the groups and was kept in the model. Subjects who received chemotherapy within the first 45 days after surgery were 28% less likely to die within the first 4 years, and subjects who initiated chemotherapy more than 45 days after surgery were 19% less likely to die within the first 4 years, than those who did not receive chemotherapy, taking into account stage, year of diagnosis, sex, and age at diagnosis (Table 2). However, neither the Kaplan-Meier analysis (log rank P>.50) (Figure 2) nor the Cox regression model, with adjustment for possible confounders, provided evidence that patients who initiated chemotherapy more than 45 days after surgery had a higher risk of dying within the 4 years after diagnosis than those who initiated chemotherapy within 45 days (hazard ratio 1.16, 95% CI 0.92–1.47). The interaction between treatment and age at diagnosis was not statistically significant and was not included in the model (Table 3).

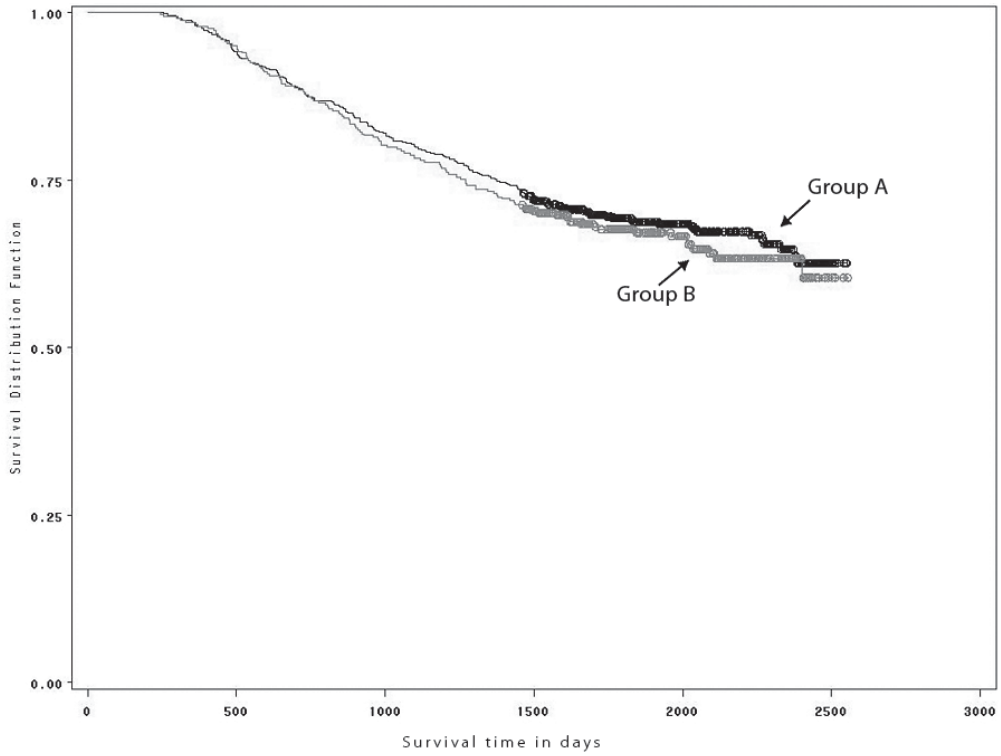
Among subjects with stage II colon cancer, those who received chemotherapy after surgery were less likely to die during follow-up than those who did not (log rank P<.0001) (Figure 3). After adjustment for age, sex, and race/ethnicity, the relationship remained significant. Treated patients had significantly lower mortality than untreated patients (hazard ratio [HR] 0.75, 95% CI 0.58–0.96) (Table 4).

Discussion

Among men and women diagnosed with stage II or III colon cancer, patients who received chemotherapy after surgery were less likely to die within the period of study than untreated patients, regardless of the timing of the chemotherapy. Stage III diagnosis, older age, and being male were all found to significantly decrease the probability of survival, after adjusting for treatment. Patients with stage III disease were almost twice as likely to die as those with stage II disease (HR 1.98, 95% CI 1.74–2.25). However, after adjusting for these factors, adjuvant chemotherapy was still associated with better survival.

These findings support current studies and current NCI recommendations for adjuvant chemotherapy treatment of stage III colon cancer.[6] Since those 1990 recommendations, researchers have developed modifications of chemotherapy for colon cancer patients to further improve survival.[24] However, chemotherapy treatment is not recommended currently for most cases of stage II colon cancer.[25]

Figure 2. Survival among stage II and III colon cancer patients who received chemotherapy, stratified by treatment initiation time

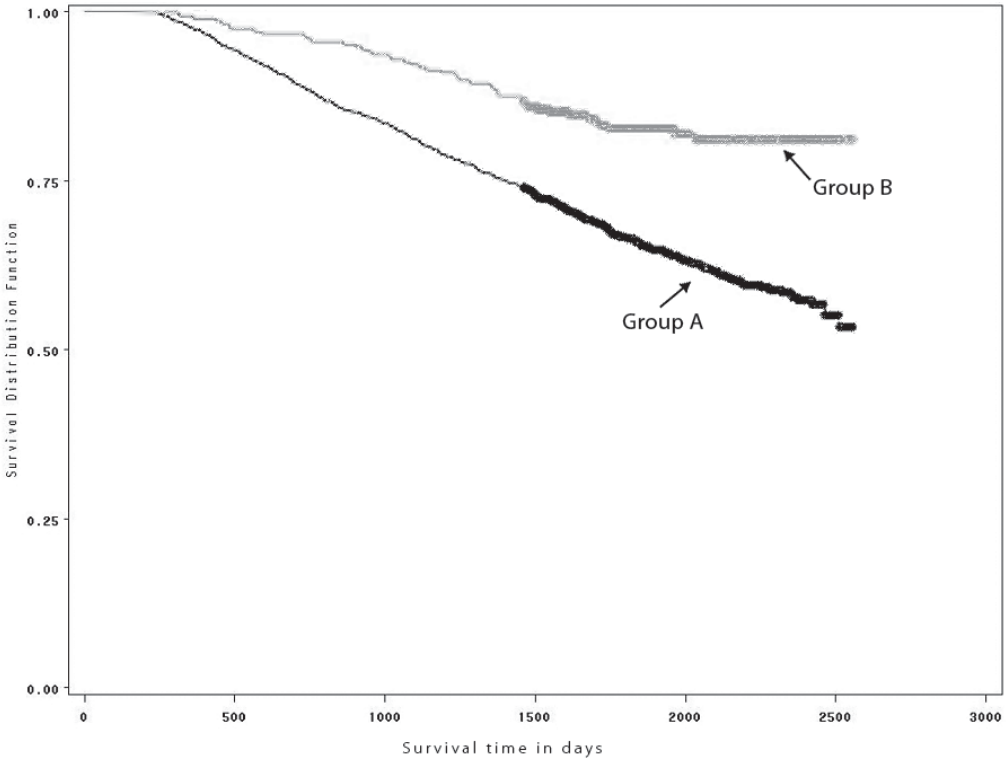


Group A—*Chemotherapy initiated within 45 days after surgery*
Group B—*Chemotherapy initiated more than 45 days after surgery*
o *Censored subjects in each group*

Table 3. Multivariable Cox Proportional Hazard Models for Stages II and III Colon Cancer Patients Who Received Chemotherapy					
			Models		
	Unadjusted	*Model 1*	*Model 2*	*Model 3*	*Final Model*
Variables	*Hazard Ratio (CI)**	*Hazard Ratio (CI)*	*Hazard Ratio (CI)*	*Hazard Ratio (CI)*	*Hazard Ratio (CI)*
Chemotherapy					
≤45 days	1.00 (Referent)	1.00 (Referent)	1.00 (Referent)	1.00 (Referent)	1.00 (Referent)
>45 days	1.08 (0.86, 1.36)	1.21 (0.96, 1.53)	1.16 (0.92, 1.46)	1.18 (0.93, 1.49)	1.16 (0.92, 1.47)
Stage					
Stage II		1.00 (Referent)	1.00 (Referent)	1.00 (Referent)	1.00 (Referent)
Stage III		2.67 (1.94, 3.67)	2.50 (1.81, 3.44)	2.52 (1.83, 3.47)	2.53 (1.84, 3.50)
Age groups (years)					
<65			1.00 (Referent)	1.00 (Referent)	1.00 (Referent)
65–69			1.10 (0.79, 1.52)	1.11 (0.80, 1.53)	1.13 (0.82, 1.57)
70–74			1.28 (0.94, 1.75)	1.29 (0.95, 1.76)	1.30 (0.95, 1.78)
75–80			1.31 (0.93, 1.85)	1.33 (0.94, 1.87)	1.33 (0.94, 1.88)
≥80			1.95 (1.33, 2.86)	1.98 (1.35, 2.91)	2.04 (1.38, 3.00)
Sex					
Female				1.00 (Referent)	1.00 (Referent)
Male				1.19 (0.96, 1.50)	1.19 (0.95, 1.50)
Race/ethnicity					
White, non-Hispanic					1.00 (Referent)
Black, non-Hispanic					1.72 (1.07, 2.78)
Other/unknown					0.72 (0.37, 1.41)

* 95% confidence interval (CI)

Figure 3. Survival among stage II colon cancer patients, stratified by treatment group



Group A—*Never received chemotherapy*
Group B—*Received chemotherapy after surgery*
o *Censored subjects in each group*

Table 4. Multivariable Cox Proportional Hazard Models for Stage II Colon Cancer Patients Who Received Chemotherapy				
		Models		
	Unadjusted	*Model 1*	*Model 2*	*Final Model*
Variables	*Hazard Ratio (CI)**	*Hazard Ratio (CI)*	*Hazard Ratio (CI)*	*Hazard Ratio (CI)*
Treatment				
Surgery only	1.00 (Referent)	1.00 (Referent)	1.00 (Referent)	1.00 (Referent)
Chemotherapy and surgery	0.42 (0.31, 0.57)	0.69 (0.50, 0.95)	0.75 (0.58, 0.96)	0.75 (0.58, 0.96)
Age groups (years)				
<65		1.00 (Referent)	1.00 (Referent)	1.00 (Referent)
65–69		1.22 (0.83, 1.78)	1.38 (1.01, 1.87)	1.36 (1.00, 1.85)
70–74		1.72 (1.23, 2.41)	1.97 (1.49, 2.61)	1.95 (1.47, 2.57)
75–80		2.08 (1.51, 2.85)	2.33 (1.79, 3.03)	2.31 (1.78, 3.01)
≥80		3.77 (2.81, 5.06)	4.71 (3.68, 6.03)	4.67 (3.64, 5.99)
Sex				
Female			1.00 (Referent)	1.00 (Referent)
Male			1.23 (1.08, 1.41)	1.24 (1.08, 1.41)
Race/ethnicity				
White, non-Hispanic				1.00 (Referent)
Black, non-Hispanic				0.70 (0.44, 1.11)
Other/unknown				1.02 (0.69, 1.51)

* 95% confidence interval (CI)

This study found that among stage II colon cancer cases, subjects who received chemotherapy had a 25% lower risk of mortality than those who did not after adjusting for age at diagnosis, sex, and race/ethnicity. Our study found an increase in survival among stage II colon cancer patients receiving adjuvant chemotherapy within a US population. Based on these findings, as well as previous studies of stage II colon cancer,[18, 25] additional research on adjuvant chemotherapy for stage II colon cancer patients should be conducted.

Unlike previous studies, this study found no association of mortality with timing of chemotherapy treatment after surgery overall (Table 3), when stage, age at diagnosis, sex, and race/ethnicity were taken into account. Those treated more than 45 days after surgery had a 16% higher mortality rate, with age, sex, and race/ethnicity taken into account, but the difference was not statistically significant.

One possible reason for the difference in results between this study and previous studies is the difference in definition of early and late chemotherapy initiation times. This study compared those who received chemotherapy more than 45 days after surgery to those who received it earlier. Hershman et al found a statistically significant difference in mortality between patients who initiated chemotherapy more than 3 months after surgery and those who did so within the first month after surgery.[16] Chau et al found that those who received chemotherapy within the first 8 weeks after surgery had a lower risk of mortality than those who received it later.[13]

Data on the types of chemotherapy administered and the duration of chemotherapy treatment were not available for analysis. We confirmed that subjects who received at least one dose of chemotherapy had a greater probability of survival than subjects who never received chemotherapy. If duration could have been analyzed as well, we might have learned still more about the relationship of treatment with survival in addition to how well the chemotherapy was tolerated. Also, analysis on the various types of chemotherapy could have provided a greater understanding about how to increase survival.

Another factor that influences survival is cancer stage. Within this data set, stage was defined as stage II or III because the new AJCC tumor stages were not released until 2003.5 It has been shown that within stages II and III, survival can vary dramatically. This variation within staging groups could not be investigated in this study. Grade, histology, and number of lymph nodes involved also affect survival. These factors were not analyzed, but could be included in future studies.

Patients may choose or their physicians may advise them not to receive adjuvant chemotherapy for many reasons, among them comorbid conditions. Chemotherapeutic drugs may have serious side effects; in a patient with cardiac disease, diabetes, or other common conditions associated with aging, chemotherapy may be life-threatening. This study could not investigate comorbidity as a factor influencing the relationship between treatment and survival because comorbid conditions are

not reported to the MCR. The purpose of the exclusion of subjects who survived less than 8 months after surgery from this analysis was to eliminate some of the bias resulting from lack of information about comorbid conditions. In addition, this study excluded 663 subjects who had previous diagnoses of cancer. Excluding such subjects is common in analyses of cancer registry data, but prevented us from analyzing the association between a prior diagnosis and survival.

As with most surveillance research like this study survival may be overestimated. While this study was linked to the NDI, it was not possible to learn of deaths that occurred outside of the United States. The number of deaths known for this study might be underestimated; however, there is no reason to believe this possible bias was systematic. There does not seem to be any reason why treatment would be related to death outside of the United States.

The type of facility in which a patient was treated for colon cancer has been shown to affect survival as well; patients treated in teaching hospitals had higher survival rates.[16] In this study, this relationship was not statistically significant. However, the variable used for our analysis identified only the hospital that first reported the case to the MCR, which may not necessarily be the hospital where the patient was treated. Patients may be seen at many different hospitals in the years following their diagnosis, but only one facility code remains in the consolidated record. Moreover, since the late 1990s, several hospitals in Massachusetts have closed or merged with other institutions. These changes made it difficult to determine if a facility was a teaching or non-teaching hospital. Within this study, at least 60% of subjects in each treatment group were on record as receiving their care from a teaching hospital.

Cancer registries are an important component of cancer research, and the timeliness of their follow-up data is of key importance when conducting survival analysis. Linkage of cancer registry data with the NDI is an important component of this process. Unfortunately, resources available at the time of this study did not permit us to update vital status beyond 2003. This lack of additional follow-up time, and more complete survival data, might have affected our findings.

In summary, the study found that chemotherapy treatment after surgery improves the probability of survival for patients with stage II as well as stage III colon cancer. The study did not find strong evidence that the time interval between surgery and start of chemotherapy affects survival. Further research on the relationship between treatment and survival, doses, durations, and types of chemotherapeutic agents is needed, especially as treatments and technology improve.

Acknowledgments

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Original Article

Validation of Ethnicity in Cancer Data: Which Hispanics Are We Misclassifying?

Paulo S. Pinheiro, MD, MSc, CTR[a]; Recinda Sherman, MPH, CTR[b]; Lora E. Fleming, MD, PhD, MPH, MSc[a]; Orlando Gomez-Marin, PhD, MSc[a]; Youjie Huang, MD, DrPH, MPH[c]; David J. Lee, PhD[a]; Frank J. Penedo, PhD[d]

Abstract: The study of cancer in Hispanics in the United States has been hindered by misclassification of Hispanics as non-Hispanic and by the convenient practice of aggregating the diverse Hispanic subgroups into a general Hispanic category. The Hispanic Origin Identification Algorithm (HOIA) was developed to improve the identification of both the general Hispanic ethnicity and the specific Hispanic subgroup in cancer incidence data. Using an independent study of prostate cancer cases from South Florida as the "gold standard" and the Florida incident cancer registry data, we validated this algorithm and studied the characteristics of those Hispanics whose ethnicity was commonly missed in the cancer registry records. Overall, agreement between the gold standard information (derived from self-report) and HOIA derived ethnicity was 97%. For Hispanic subgroup, among a subset of subjects with known birthplace, the percent agreement was 98%. After HOIA, age-adjusted Hispanic cancer rates reflected an increase of 8% in males and 10% in females. Hispanics born in the United States were 4.6 times more likely to be misclassified as non-Hispanic than foreign-born Hispanics; black Hispanics 2.5 times more than whites; and women 1.3 times more than men. HOIA is a valid and effective tool for improving the accuracy of both general Hispanic ethnicity and Hispanic subgroup data in cancer registries. Improved procedures for identifying and recording ethnicity in health facilities are recommended, particularly focusing on improving the information gathered on Hispanics born in the United States, or who are black or female.

Key words: *algorithm, cancer, classification, Hispanic, validation*

Introduction

Cancer incidence data for Hispanics in the United States have been available at the national and state level through the National Cancer Institute's (NCI) Surveillance, Epidemiology and End Results (SEER) Program and through the Centers for Disease Control and Prevention's (CDC) National Program for Cancer Registries (NPCR).

General Hispanic ethnicity (ie, whether someone is Hispanic or not) is ideally assessed through self-identification.[1] However, in population-based health registries, self-identified ethnicity is rarely available.

Health registries are comprised of data abstracted from medical records. These data are, therefore, subject to inaccuracy[1] and largely beyond the influence of the cancer registry community. In hospitals and clinics, Hispanic ethnicity is usually recorded by administrative personnel during admission for purposes such as billing rather than patient care or research. Its classification involves subjective appraisals rather than direct questioning of the patient. In turn, tumor registrars abstract information on ethnicity from the medical chart. At both steps, uncertainty or lack of information makes ethnicity more likely to be assigned to that of the majority of the US population, ie, non-Hispanic. As a result, cancer cases among the Hispanic population are often undercounted,[2–4] resulting in incidence rates that are, in general, artificially low.

The situation is amplified for specific Hispanic subgroup (whether someone is of Mexican, Puerto Rican, Cuban, South or Central American, Spanish, or Dominican origin). In this case, when the information is missing in the medical records, the subject is classified as "Hispanic, not otherwise specified."[5] As a result, there have been no reliable cancer reports on cancer incidence rates among Hispanic subgroups.

In the most comprehensive study to date, the *Annual Report on the Status of Cancer 1975–2003* included proportional incidence ratios calculated for each Hispanic subgroup based on available data from 30 states.[6] However, Hispanics of unknown subgroup accounted for 62% in males and 63% in females, arguably affecting the validity of those analyses.

To make a contribution to the characterization of cancer among Hispanics and, in particular, to the Hispanic population of Florida, we designed a new algorithm, the Hispanic Origin Identification Algorithm (HOIA), which is largely based on the existing NAACCR Hispanic Identification Algorithm (NHIA).[7] Historically, Florida has not used NHIA. As such, the conventional registry methods in the state do not include NHIA and are limited to the information available in

"Validation of Ethnicity in Cancer Data: Which Hispanics Are We Misclassifying?"

[a]Department of Epidemiology and Public Health, University of Miami Miller School of Medicine, Miami, FL. [b]Florida Cancer Data System, Sylvester Comprehensive Cancer Center, University of Miami Miller School of Medicine, Miami, FL. [c]Bureau of Epidemiology, Florida Department of Health, Tallahassee, FL. [d]Department of Psychology and Sylvester Comprehensive Cancer Center, University of Miami, FL.

Address correspondence to Paulo S. Pinheiro, MD, MSc, CTR; Florida Cancer Data System, University of Miami School of Medicine, P.O. Box 016960, (D4-11), Miami, FL 33101. Telephone: (305) 243-2600. Email: ppinheiro@med.miami.edu.

the medical records. HOIA takes into account all information routinely available to cancer registries and all non-Hispanic cases are matched to a Hispanic surname list.[8] HOIA is available online at **http://fcds.med.miami.edu** and has been described in detail in a previous publication.[9] A comparison between results from HOIA and NHIA has been made previously.[10] In these reports we assessed HOIA's impact on the Florida cancer data, but ethnicity and subgroup were obtained from the registry data and not a result of self-report.[9, 10]

The aim of the current study is to validate HOIA in a sample from the cancer population of Florida. A secondary aim is to study the demographic characteristics of those who are routinely being missed as Hispanic in Florida. Further, we compare the incidence rates for Hispanics, non-Hispanic whites and non-Hispanic blacks obtained directly from the cancer registry data with the respective incidence rates obtained by using HOIA.

Methods

To validate HOIA, we used two sets of data: one from an independent non-registry study, PC-SMART,[11] funded by the National Cancer Institute, which tested the efficacy of a group-based psychosocial intervention in improving quality of life among men treated for localized prostate cancer, and the other from the Florida Cancer Data System (FCDS). The FCDS is the legislatively-mandated, population-based central cancer registry for Florida.

PC-SMART provided data from a baseline face-to-face interview in which the participants were asked to identify their ethnicity (Hispanic or non-Hispanic) and their country of origin. This self-reported ethnicity and Hispanic subgroup was our "gold standard." The participants in PC-SMART were linked with the data from the Florida Cancer Registry. HOIA was then applied to the matched cases and, through this process, for each cancer case a HOIA-derived ethnicity and subgroup was obtained. The agreement between the self-reported ethnicity and subgroup from PC-SMART and the reassigned HOIA ethnicity and subgroup were then analyzed.

We assessed the performance of HOIA on two levels. First, the detection of Hispanic ethnicity was analyzed using percent agreement, sensitivity, specificity, and positive predictive values. The McNemar test for symmetry was used to test for differential misclassification between our gold standard and HOIA.

We then assessed HOIA's performance for the detection of a specific Hispanic subgroup using percent agreement and kappa statistics. For this analysis Hispanics of Mexican, Puerto Rican, Dominican, and Spanish (from Spain) origin were grouped together in the category "Other Hispanics" due to low numbers. The Bowker test for symmetry was used to test for the differential misclassification between self-report and HOIA-derived Hispanic subgroup.[12]

All subjects classified as Hispanic by HOIA and who were of either black or white race were selected for further analysis. A multivariate logistic model was used to assess which factors were associated with misclassification of Hispanic ethnicity, ie, which Hispanics detected by HOIA were more likely to have been missed by conventional registry methods of recording ethnicity. The analyzed factors included age, race, place of birth, gender, and vital status. Vital status (dead or alive) was used to adjust for the fact that death certificate information was available when HOIA was applied but not generally available to cancer registrars when they abstract the cancer details from the medical record.

Finally, age-adjusted incidence rates for the three largest populations of Florida (Hispanics, non-Hispanic whites, and non-Hispanic blacks) and respective gamma confidence intervals from the initial cancer registry data and after applying HOIA were compared.

This study was approved by the Human Subjects Committees of both the University of Miami School of Medicine and the Florida Department of Health.

Results

HOIA Validation

PC-SMART, the gold standard study, involved 268 prostate cancer survivors, 236 of them were successfully matched to data records of the Florida Cancer Registry. The validation of HOIA was performed using the linked data from these 236 matched subjects, for whom the median age at diagnosis was 65 years. One hundred and three of the participants self-reported as Hispanic. Of these, 59 were of Cuban origin (57%), 30 of South or Central American origin (29%), and the remaining 14 (14%) of other Hispanic origin.

The percent agreement between self-reported Hispanic ethnicity, the gold standard, and Hispanic ethnicity collected by the cancer registry was 94% (Table 1). After HOIA, the same percent agreement was 97% (Table 2). The sensitivity of HOIA to detect a truly Hispanic individual was 98.1%,

Table 1. Classification of Ethnicity in 236 Subjects from Cancer Registry Records Compared to Self-report (Gold Standard) and Respective Statistics*

	Self-report		
Initial Registry Data	*Hispanic*	*Non-Hispanic*	**Total**
Hispanic	95	5	100
Non-Hispanic	8	128	136
Total	103	133	236

* Percent agreement 94.5%, sensitivity 92.2%, specificity 96.2%, and positive predictive value 95.0%

Table 2. Classification of Ethnicity in 236 Subjects by HOIA Compared to Self-report (Gold Standard) and Respective Statistics*

	Self-report		
HOIA	*Hispanic*	*Non-Hispanic*	**Total**
Hispanic	101	6	107
Non-Hispanic	2	127	129
Total	103	133	236

* Percent agreement 96.6%, sensitivity 98.2%, specificity 95.5%, and positive predictive value 94.4%

Table 3. Hispanic Subgroup in 200 Participants in PC-SMART with Information on Birthplace or Hispanic Subgroup by Self-report and as Assigned by HOIA

	Self-report				
HOIA	*Non-Hispanic*	*Cuban*	*South and Central American*	*Other Hispanics*	**Total**
Non-Hispanic	127	0	0	0	127
Cuban	2	44	0	0	46
South and Central American	0	0	15	0	15
Other Hispanics	4	1	0	7*	12
Total	133	45	15	7	200

* No misclassification between the different subgroups composing category "Other Hispanics" was observed. All seven cases that reported as Spanish, Dominican, Puerto Rican, or Mexican were identified as belonging to exactly the same subgroup by HOIA.

the positive predictive value was 94.4%, and specificity was 95.5% (Table 2). A relative bias[2] of 0.04 meant that only a negligible overestimation of Hispanic ethnicity occurred in this sample. The kappa coefficient was 0.93 (95% confidence interval (CI) 0.883–0.979), revealing excellent agreement. The McNemar test did not show differential misclassification (p=0.16), between self-report and HOIA-derived ethnicity.

Two hundred out of the 236 matched cases had sufficient information (birthplace or other) to enable the HOIA to derive Hispanic subgroup. The percent agreement between Hispanic subgroup based on self-report and Hispanic subgroup derived from HOIA was 97% (Table 3). The kappa coefficient was very high at 0.93 (95% CI 0.885–0.981); the Bowker test showed no evidence of differential misclassification (p=0.32) between self-report and HOIA-derived subgroup. Only one Cuban subject and none of the South or Central Americans were misclassified into another Hispanic subgroup by HOIA.

Missed Hispanics

To assess the impact of the algorithm, HOIA was used to reclassify the Hispanic subgroup in all 301,994 Florida cancer cases diagnosed from 1999 to 2001. HOIA increased the number of individuals of Hispanic ethnicity by 9%, from 27,683 to 30,238 (Table 4). In total, 2,701 non-Hispanics were reclassified by HOIA as Hispanic. One hundred and forty-six cases, e.g., those born in Brazil, Italy, or Portugal, originally classified as Hispanic, were reclassified to non-Hispanic.

All cases classified as Hispanic by HOIA and who were either black or white race (29,677 cases) were analyzed to identify which Hispanics were more likely to be missed by conventional registry methods of ethnicity (see Table 5).

Hispanics born in the United States were 4.6 times more likely to be misclassified as non-Hispanic than those born in a Hispanic country. Hispanics with unknown birthplace were also more often missed (2.7 times) than those born in Hispanic countries. Black Hispanics were substantially misclassified: 2.5 times more likely than white Hispanics. Patients aged <25 years were also more likely to be misclassified: 1.4 times more than those in the oldest age group, aged 75 years or more. Finally, compared to males, females were 1.3 times more likely to be misclassified.

Table 4. Reclassification of Ethnicity Using HOIA among 301,994 Cancer Registry Records Diagnosed from 1999 to 2001

	Cancer Registry Records		
HOIA	*Non-Hispanic*	*Hispanic*	**Total**
Non-Hispanic	271,610	146	271,756
Hispanic	2,701	27,537	30,238
Total	274,311 (91%)	27,683 (9%)	301,994 (100%)

Table 5. Patient Characteristics Associated with Missed Hispanic Ethnicity When Using Conventional Registry Methods

	Characteristics	*OR**	*95% CI*
Birthplace	Reference: Hispanic Country**	1	
	Unknown birthplace	2.7	2.34–3.16
	United States	4.6	4.21–4.98
Race	Black vs. White	2.5	2.19–2.97
Age Group (years)	Reference: 75+	1	
	0–24	1.3	1.10–1.65
	25–54	0.9	0.84–1.02
	55–74	0.8	0.73–0.87
Gender	Female vs. Male	1.3	1.17–1.35

*Adjusted for vital status, dead or alive.

**Hispanic countries include Puerto Rico and all independent countries where the official language is Spanish.

Table 6. Age-adjusted Incidence Rates* before (Cancer Registry Alone) and after Application of HOIA, Florida 1999–2001			
	Population	*Cancer Registry alone Rate (95% CI)***	*After HOIA*** Rate (95% CI)***
Males	Non-Hispanic White	606.4 (600.6–612.2)	601.1 (595.4–606.9)
	Non-Hispanic Black	656.8 (636.2–677.9)	650.4 (629.9–671.4)
	Hispanic	496.0 (481.8–510.6)	537.4 (522.5–552.5)
Females	Non-Hispanic White	465.9 (461.0–470.9)	460.4 (455.6–465.4)
	Non-Hispanic Black	386.6 (373.9–399.7)	382.0 (369.4–395.0)
	Hispanic	340.8 (330.7–351.1)	376.2 (365.6–387.1)

* Per 100,000, US 2000 Standard Population
** Tiwari Confidence Interval[13]
*** Cancer registry records, death certificates, and Hispanic surname match

The impact of HOIA on age-adjusted incidence rates for the three populations can be seen in Table 6. As expected, incidence rates for non-Hispanic whites and non-Hispanic blacks decreased slightly, whereas for Hispanics, significantly higher incidence rates (non-overlapping CIs) were observed for both sexes; 8% higher in males and 10% higher in females.

Discussion

A new algorithm, HOIA, for the determination of specific Hispanic ethnicity and subgroup in cancer registries was validated. The novelty of HOIA is, first, the use of birthplace to facilitate in identifying the correct Hispanic subgroup and, second, the inclusion of death certificates as an extra source of useful information (ethnicity, specific origin, birthplace, maiden name). The use of the death certificate information is amply justified. Hispanic ethnicity has shown to be accurately ascertained in death certificates, especially for immigrants.[14,15] Furthermore, death certificates, usually completed with the assistance of family members or friends of the deceased, contain more accurate data on ethnicity than registry data.[16]

HOIA shows excellent properties in detecting Hispanic ethnicity: sensitivity of 98%, compared to 92% for the initial cancer registry data and with stable specificity and positive predictive value. Because the largest problem in cancer registry population-based studies on ethnicity is the misclassification of Hispanic subjects as non-Hispanic,[2–4] sensitivity is an important statistic for any algorithm used in the identification of Hispanics. For the specific Hispanic subgroups, the proportion of Cubans and South and Central Americans identified by HOIA that matched the self-reported country of origin was also very high, suggesting that HOIA is accurately detecting these two Hispanic subgroups.

Despite these good results, our study shows that the accurate determination of Hispanic ethnicity remains a challenging issue. In our matched sample, among all those subjects with a known birthplace, 69 subjects were known to be born in Spanish-speaking countries. Six of these (9%) all correspond to false-positive results by HOIA (see Table 2), despite having very common Hispanic names like Rodriguez and Gonzalez (landing in the heavily Hispanic category in the surname list) and being born in countries like Cuba, self-reported as non-Hispanic. Based on the available information on birthplace and surname, it would be very difficult or even impossible for any algorithm to extrapolate such self-report results. Furthermore, on a population basis, the impact of this atypical self-report may change calculated incidence rates for Hispanics across studies and reports.

In addition, Hispanics tend to report themselves differently over time, sometimes Hispanic, other times non-Hispanic.[16–18] In this context, our study, like others,[19] supports the use of the Hispanic surname list in an algorithm as a supplementary tool essential for standardizing the classification of Hispanic ethnicity over time and by registry.

The present validation study has some limitations. It was based on a relatively small sample (n=236) and its Hispanic diversity was mostly restricted to Cubans and South and Central Americans. It was a male population, so issues relevant to marital names were not subject to direct validation. This may raise questions as to how suitable HOIA is for women since sensitivity and specificity of Hispanic ethnicity in cancer registries using surnames is lower for women.[20] As is intuitive, misclassification is more common among married women, because of the acquisition of marital names.[1,21]

The study of those for whom Hispanic ethnicity was missed showed that birth in the United States was the most important factor influencing the likelihood of a Hispanic subject being recorded as non-Hispanic. As others have shown, US-born Hispanics have lower probability of being properly classified as Hispanic.[22–24] Similar to findings in California,[21] women in Florida were also more likely to be missed as Hispanic, again due to the use of non-Hispanic surnames when married.

For the combination of black race and Hispanic ethnicity, our study suggests that once a subject is classified as black, as opposed to white, the question of ethnicity (whether the person of black race is Hispanic or not) is frequently overlooked by either the conventional registration methods or in the medical records. Race and ethnicity are two distinct concepts which ought to be considered separately and recorded with accuracy. This particular type of misclassification, black Hispanics being classified as non-Hispanic blacks, deserves further attention. It is likely to bias not only incidence, but survival and mortality indicators. In terms of prognosis, such bias will artificially dilute cancer disparities between Hispanics and non-Hispanic whites and accentuate between Hispanics and non-Hispanic

blacks. As a result, procedures should be designed to accurately describe the ethnicity of the black population and of the Spanish-speaking population born in the United States.

HOIA had a substantial impact on the identification of Hispanics in the 1999–2001 Florida cancer data, detecting 9% more Hispanics, previously classified as non-Hispanic by conventional registry methods.[9, 10] As a result, the cancer rates for Hispanics may in reality be higher than previously thought. Our study shows a significant 8% to 10% increase in male and female Hispanics in Florida, respectively.

Furthermore, the use of algorithms such as HOIA may result in closing the existing information gap in terms of characterization of cancer among Hispanics as a whole, and Hispanic subgroups. HOIA uses death certificate information in a systematic way, complementing the information on ethnicity and subgroup collected by the cancer registry. Because information on ethnicity and subgroup from death certificates is not used uniformly by State Cancer Registries, the use of HOIA may improve the accuracy and comparability in cancer rates for Hispanics between different states.

With better identification of Hispanic subgroup, the research community will be able to study and characterize the cancer experience of each Hispanic subgroup separately. This is imperative as Mexicans, Puerto Ricans, Cubans, Central Americans, and South Americans represent a myriad of communities who vary in their risk behaviors, geography, environment, and access to health services.[25]

Particularly for cancers with low survival, e.g., liver, pancreas, lung, and stomach, high percentages of known Hispanic subgroup may be attained by using HOIA. Incidence rates can therefore be estimated with acceptable accuracy and precision. HOIA will also allow for more in-depth assessment of the Hispanic paradox,[4, 26] that is better than expected incidence and mortality indicators in Hispanics in spite of their lower socioeconomic level, and how it applies, if at all, to each Hispanic subgroup.

Finally, it is the role of cancer registries to monitor all populations and carry out cancer surveillance to the best of their ability. The present analysis suggests that HOIA is a potent tool for this purpose. HOIA uses all information that is available to cancer registries. The study of cancer in the Hispanic population and in its subgroups requires a nationwide push for improvement of data quality, especially of birthplace, ethnicity, and surname in cancer registries, as well as better methods of data collection.

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Original Article

Economic Assessment of Central Cancer Registry Operations. Part II: Developing and Testing a Cost Assessment Tool

Sujha Subramanian, PhD[a]; Florence Tangka, PhD[b]; Jeremy Green, BA[a]; Hannah Weir, PhD[b]; Frances Michaud, CTR[b]

Abstract: Economic evaluations are becoming increasingly important to assess cost-effectiveness and identify approaches to increase efficiency in program operations. Standardized data collection tools are required to obtain reliable resource use and cost data from central cancer registries in order to perform economic evaluations. In this study, we describe the development of a new cost data collection instrument, the National Program of Cancer Registries' Cost Assessment Tool (NPCR-CAT), which was pilot tested with a representative group of seven registries. The registries were asked to complete the Excel-based NPCR-CAT retrospectively with information on expenditure incurred in program year 2005. The majority of the registries were able to provide detailed data required to assign costs to specific activities performed by the registries. The challenges faced in completing the NPCR-CAT include lack of continuity due to staff turnover and complicated structures of decentralized programs that requires data collection from multiple entities. The lessons learned from pilot testing the NPCR-CAT will help tailor future data collection efforts to ensure high quality data are obtained from all registries.

Key words: *cancer registry, cost, data collection tool, economics*

Introduction

Economic evaluations of programs are becoming increasingly important to assess cost-effectiveness and identify approaches to increase efficiency in program operations.[1] With the introduction of the mandated Program Assessment Rating Tool (PART) for federally-funded programs in 2004, which specifically emphasizes cost and cost-effectiveness assessments, the urgency in performing economic studies has increased further.[2]

Cancer registries, including those supported by the Centers for Disease Control and Prevention's (CDC) National Program of Cancer Registries (NPCR), play a critical role in the effort to reduce the burden of cancer. These central cancer registries collect information on the incidence and outcomes related to cancer which are necessary to track trends and assess disparities in cancer, and target comprehensive cancer control efforts to reduce cancer burden. To date, there has been no comprehensive study of the true economic costs incurred by the NPCR. Such an assessment is essential to estimate the costs associated with program activities, identify approaches to improve program efficiency, and assess the additional funding required to expand program activities. Economic evaluations have been successfully performed in other federally-funded programs, for example those related to substance abuse and HIV/AIDS interventions,[3–5] to identify the most cost-effective approaches.

In 2005, CDC initiated a comprehensive economic assessment of the cancer registries supported by the NPCR. We previously reported on the methods and the framework that was developed to guide the economic evaluation of central cancer registry operations.[6] In this present study, we describe the development and testing of an instrument to collect cost data from central cancer registries. The objective was to develop a data collection tool that could be used to obtain valid and high-quality cost data from cancer registries. Using a standardized instrument to collect cost data from the registries will allow for systematic comparisons between the registries to identify true differences and explore the factors that impact the cost of registry operations by analyzing pooled data from all registries in the NPCR.

Methods

Developing the Cost Data Collection Tool

We developed a cost data collection instrument, the National Program of Cancer Registries' Cost Assessment Tool (NPCR-CAT) based on well-established methods for collecting cost data for health care program evaluation.[7–10] We tailored the information collected to ensure that data pertinent to central cancer registry operations were collected by incorporating findings from site visits to four diverse registries. The registries were selected to ensure organizational (directly administered by the health department or managed by a designee) and geographical diversity that would be representative of national NPCR-funded central cancer registries. We used a detailed protocol and interview guide to ensure comparability in the information collected across the registries visited.

"Economic Assessment of Central Cancer Registry Operations. Part II: Developing and Testing a Cost Assessment Tool"

[a]RTI International, Waltham, MA. [b]Centers for Disease Control and Prevention, Atlanta, GA.

Address correspondence to Sujha Subramanian, PhD; RTI International, 1440 Main St., Suite 310, Waltham, MA 02451-1623. Email: ssubramanian@rti.org.

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

Table 1. Data Collection Modules

1) Total expenditure by funding source
2) In-kind contributions
3) Personnel expenditures
4) Personnel activities
5) Consultant expenditures
6) Costs associated with computers, travel, and training
7) Software licensing costs
8) Administrative costs
9) Other factors affecting costs, effectiveness, and data collection

As indicated in Table 1, the tool consisted of several data collection modules or sections and was designed to collect and estimate cost from the program perspective rather than the perspective of a specific funder. Funding for registry operations is often interlinked, that is, funding from multiple sources are used to fund many of the key program activities, and it is not practical to attempt to track activities funded by a specific source. For example, programs often receive direct financial support from both NPCR and their state health department to perform surveillance activities. In addition, programs may also receive in-kind support from state entities in lieu of direct state funding. Therefore, we collected details on expenditure from all funding sources combined. In Modules 1 and 2 of the tool, details on funds received and expended from all sources, including in-kind labor and non-labor contributions, were collected. The in-kind contributions were collected as a separate module to ensure that these contributions to overall program operations were fully captured. Modules 3 to 8 were designed to collect data in budget groupings that were familiar to registry management. These groupings included personnel expenditure; consultant expenditure; costs associated with computers, travel, and training; software licensing costs; and administrative costs.

In Module 9, information on selected factors that can affect the cost and effectiveness of registry operations that are not currently available are collected. To reduce duplication of effort, we specifically chose not to collect information that can be readily obtained from other sources. A complete list of factors that can impact registry operations have been described previously.[6] The information collected in the tool included the consolidation percentage to assess the effort required to compile abstracts into valid incidence cases, total number of cancer tumor registrars (CTRs) at reporting facilities, and proportion of facilities passing automated edits during their initial data submission. We also requested details on the proportion of data received through specific data collection or reporting methods including paper, diskettes, Web-based, file transfer protocol (FTP), and other electronic transfers. In addition, we collected the percentage of data abstracted directly by the registry and the total number of non-resident cases identified and provided to and from neighboring state registries.

The tool is designed to collect data in a manner that would facilitate the generation of activity-based costs, which is the approach in which all costs related to performing specific activities are systematically calculated. The activity-based data collection allowed for in-depth evaluation of central cancer registry operations that has not been possible previously using budget information and federal expenditure.[11] The main advantage of activity-based cost estimation is that the cost of specific activities can be quantified. Unlike budget or total federal spending, the activity-based data will provide details on all resources expended on specific activities and provide an estimation of the "economic cost" incurred by the registries.[12–13]

In addition to the cost and resource use parameters, the NPCR-CAT also collects information on the specific activities related to each type of expenditure. Details are requested both for surveillance activities and enhanced data collection and analysis activities. Surveillance activities are core tasks that have to be performed to compile the cancer registry data while enhanced data collection and analysis activities include all other non-core tasks performed by the registry. Details on the specific activities included in these categories are provided in Table 2. These activity categories were derived based on input received

Table 2. Surveillance Activities and Data Enhancement and Analysis Activities

Surveillance activities (core registry activities)	
Management	Developing analytic files
Administration	Analyzing and generating reports
Training of registry staff	Sharing cases
Training of others by registry staff	Electronic case reporting
Database management	and data encryption
IT support	Reporting requirements to
Case ascertainment	CDC, NAACCR, and state
Death certificate clearance	Automatic casefinding using
Data collection/abstraction	electronic linkage
Quality assurance and improvement	Geocoding cancer cases
Data enhancement and analysis activities	
Linking records to other statewide or national databases	Research studies and advanced analysis using registry data
Implementing a cancer inquiry response system	Publication of research studies using registry data
Active follow-up	

Table 3. Characteristics of Registries Selected to Pilot Test the NPCR-CAT

	Registry						
	1	2	3	4	5	6	7
Organizational structure[1]	Private organization	Private organization	Health department	Health department	Private organization	Health department	Health department
Region	Southern	Midwest	Northeast	West	Northeast	Southern	Southern
Size of area served[2, 3]	Medium	Large	Small	Large	Small	Large	Medium
Presence of rural areas[2, 4]	Low	High	Low	High	Medium	Medium	High
Volume of cases[2, 5]	High	Medium	Low	Low	Low	High	Medium

[1] Private organizations (for example, universities) are those who perform data collection and reporting activities under subcontract from the health department or with funding directly from the CDC. None of these registries received SEER funding.
[2] "Low" was assigned to values up to the 33rd percentile, "medium" from 34th to 66th percentile, and "high" for those above the 66th percentile.
[3] Based on the square miles in each state (33rd percentile: 44,453; 66th percentile: 70,684)
[4] Determined on the basis of the population density (residents per square mile) in the state (33rd percentile: 58; 66th percentile: 147)
[5] Based on the volume of cancer cases reported in each state (33rd percentile: 10,455; 66th percentile: 26,558)

from selected NPCR funded registries, CDC staff, and experts in registry operations. Since staffing accounts for a high proportion of total registry expenditure, we obtained detailed information on the percent of their time spent on each surveillance activity and data enhancement and analysis activities by individual staff members, to ensure that the costs associated with salaries could be appropriately assigned to specific registry activities. The NPCR-CAT was designed to be completed primarily by the program director (or designee) at each registry with assistance from fiscal staff as required. To further ensure accuracy, the time spent on specific program activities are obtained directly from each staff member.

Selection of Registries for Pilot Testing

We pilot tested the tool with a select group of seven NPCR-funded registries. The registries were selected to be representative so results could be generalized to all central cancer registries. Specifically, we ensured that there was a mix between registries administered directly by health departments and those managed by their designees. As shown in Table 3, the registries also varied by regional location, size of area served, presence of rural areas, and volume of cases. Both the tool (an Excel-based CAT) and user's guide were pilot tested with these seven registries to assess the ability to provide the data requested and identify approaches to ensure high quality data is available for analysis. We held an initial conference call to introduce the tool to the registries, perform an interactive training section, and respond to questions. The registries were asked to complete the tool retrospectively with details on expenditure incurred in program year 2005 (July 1, 2004 to June 30, 2005). We also organized additional calls with the registries to offer technical assistance and to solicit comments on the tool and user's guide.

Analysis of Data

To assess the feasibility of collecting quality data for economic assessments using the tool, we determined whether the total cost derived from the NPCR-CAT was accurate based on information provided by the programs on funds expended in their Financial Status Report (FSR), which is submitted annually as a condition of federal support. We compared the total funds expended or spent reported in the FSR with the total cost allocated to specific activities based on the information provided in the NPCR-CAT. The FSRs for each registry were reviewed to verify the total dollars expended during the 2005 program year. The total amount of funding for program year 2005, the amount unobligated from program year 2004, and the amount carried over to program year 2006 were verified to identify the total amount expended. For several registries, the FSR contained details of several federal programs combined and, therefore, in these instances we requested and reviewed supplemental documents that provided funding details broken out by each federal program. We excluded in-kind contributions from this analysis since the FSRs only provide accurate data on funds directly received and expended. We report the difference in dollar terms and as a proportion for each individual program's total expenditure to assess the extent to which the programs were able to provide complete cost data in the NPCR-CAT.

We also calculated the amount of in-kind contributions reported by the programs. Both labor and non-labor contributions were included. The proportion of these costs in relation to the total cost of registry operations is also reported. In addition, we summarize the information reported by the registries for the factors impacting cost and effectiveness to assess the completeness of reporting of these data elements. We report the proportions reported by each registry for each response category separately in order to compare and contrast the factors among the registries.

Table 4. Proportion of Cost Allocated to Specific Registry Activities							
	Registry						
	1	2	3	4	5	6	7
Funds Expended							
Federal Funds	$1,452,618	$665,668	$1,341,016	$242,727	$677,678	$2,081,946	$887,681
Non-Federal Funds	$585,950	$95,180	$446,576	$64,427	$228,559	$1,104,347	$68,947
Total Funds Expended	$2,038,568	$760,848	$1,787,592	$307,154	$906,237	$3,186,293	$956,628
Total Cost Allocated to Registry Activities*	$2,034,644	$760,048	$1,787,592	$307,154	$897,739	$2,700,044	$741,859
Amount Unallocated	$3,924	$800	$0	$0	$8,498	$486,249	$214,769
Percent of total Funds Unallocated	0.19%	0.11%	0.00%	0.00%	0.94%	15.26%	22.45%

* Based on information on cost and activities reported in the CAT

Results

Ability to Allocate Cost to Specific Activities

Table 4 presents the total cost (amount spent by the cancer registries from all funding sources excluding in-kind contributions) and the cost allocated to specific program activities based on information provided in the NPCR-CAT. The total program cost across the seven registries ranged from $307,154 to $ 3,186,293. All registries reported receiving non-federal funds, generally state funding, in addition to the federal funds received through the NPCR. The amount that was unallocated to specific activities based on data provided in the NPCR-CAT, ranged from $0 to $8,498 or 0.00% to 0.94% for registries 1 through 5. These registries were able to allocate all or a very high proportion of their total cost to specific activities performed by the registry. Registries 6 and 7 had much larger proportions of funds, 15.26% and 22.45% respectively, that were spent during the annual period but not allocated to specific activities.

In-kind Contributions

All registries reported receiving both in-kind labor and non-labor contributions. The types of contributions reported include IT support, hospital-based cancer registration and data collection, time provided by retired oncologist, rent, administrative support, and waived indirect cost. These contributions ranged from $31,200 to $1,725,088 or 3% to 68% of the total program cost.

Factors Impacting Cost, Effectiveness, and Data Collection

All programs were able to provide information on each of the factors that was specifically collected in the NPCR-CAT. Consolidation refers to the process of combining data from two or more linked records for the same patient and tumor to produce a single "best" value for each patient and tumor variable. The consolidation percent refers to the percent of patients in the registry's database with two or more linked records. The consolidation percent ranges from 57% to 77% for each registry. In many central registries, record consolidation is still largely a manual process. The RegistryPlus software[14] products provided by CDC include a Tumor Linkage and Consolidation (TLC) function. The TLC function supports the linkage of incoming abstracts against the existing database and provides automation of consolidation of data items from multiple case reports into incidence records. Central registries with higher percentages of consolidation would be expected to have a higher the cost of processing data. The number of CTRs at the reporting facility varied widely across the registries as may be expected. Registry 1 had the highest number of CTRs at reporting facilities at 125, and Registry 4 had the smallest number of 11. In general, registries with larger volumes, that is, large number of cases, reported higher numbers of CTRs at reporting facilities than smaller registries.

The seven registries varied substantially in the proportion of facilities passing automated edits for the initial submission, the method of data transmission, and the proportion of records abstracted directly by the cancer registry (Table 5). Passing automated edits is an NPCR program standard and also a publication criterion for inclusion in the United States Cancer Statistics (USCS) report. The USCS criteria states that at least 97% central cancer registry records passed a set of computerized edits. Registry 1 reported that 100% of facilities pass automated edits. Registries 3 and 4 report 90% and 80% of the facilities, respectively, pass the automated edits. Other registries were much more likely to have a high proportion of facilities not passing edits, with Registry 6 reporting that less than 50% of the facilities pass automated edits. The most common method of data transmission was via diskettes with the exception of Registry 1 which reported that all data was collected via the Web and Registry 6 which reported that FTP (7%) was the predominant method. The proportion of data abstracted directly ranged from 0% to 47%.

All seven registries reported that they exchanged information with other registries on cancer patients who were diagnosed or treated in a neighboring state. Data exchange between states is critical for complete case ascertainment and is a recognized program activity. The total number of cases exchanged annually ranged from 300 cases to 7,455 cases, which generally represents <1% of the total abstracts processed.

Table 5. Program Factors and Characteristics Reported in the NPCR-CAT							
	Registry						
	1	2	3	4	5	6	7
Abstracts, Incidence Cases, and Consolidation							
Total Number of Incident Cases	96,000	17,000	39,000	5,887	8,971	100,741	15,743
Total Number of Abstracts Received	155,000	29,923	52,000	7,673	14,000	171,164	23,391
Consolidation Effort %	62%	57%	75%	77%	64%	59%	67%
Total CTRs at Reporting Hospitals	125	17	72	11	20	67	20
Proportion of facilities passing automated edits:							
100%	100%	1%	90%	80%	0%	32%	4%
97 - 99%	0%	75%	0%	10%	90%	15%	6%
90 - 96%	0%	15%	8%	10%	0%	14%	25%
80 - 89%	0%	8%	0%	0%	0%	5%	38%
50 - 79%	0%	1%	2%	0%	10%	8%	19%
< 50%	0%	0%	0%	0%	0%	27%	8%
Methods of Data Reporting or Collection:							
Paper	0%	40%	2%	15%	0%	2%	2%
Diskettes	0%	60%	97%	85%	12%	20%	51%
Web-based	100%	0%	0%	0%	0%	0%	0%
FTP	0%	0%	0%	0%	0%	79%	0%
Other Electronic Linkages	0%	0%	1%	0%	88%	0%	47%
% Data Abstracted Directly	1%	20%	0%	0%	6%	< 5%	47%
Non-Resident Cases and Data Exchanges:							
Collecting and reporting non-residents?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Total number of cases exchanged	5,100	3,305	1,600	300	1,736	7,455	1,535

Discussion

We found that in general the NPCR-CAT can be effectively used to collect valid information on resource use and cost on an annual basis from central cancer registries. Five out of the seven registries were able to provide comprehensive information that could be used to allocate almost all of their total cost to specific registry activities. For these five registries, an extremely high level of completeness was achieved with only <1% of the cost not allocated to specific activities.

The remaining two registries were able to complete the majority of the information requested but were unable to provide all the details required to allocate costs to specific registry activities. The processes of obtaining cost and resource use data from these two registries provide several lessons for future data collection. One of the registries was unable to provide all the requested details on what activities the funds were expended on because of staff changes during the course of completing the NPCR-CAT. In subsequent data collection efforts CDC plans to train several staff members in reporting cost data using the NPCR-CAT to ensure continuity in the event of staff turnover. In addition, CDC will host training seminars on a continual basis and have training materials readily accessible to ensure that staff can familiarize themselves with the NPCR-CAT, as needed. The other registry was a large decentralized program, and the central office had difficulty gathering all the details required from the regional registries. Potential solution for future data collection would be to request that each regional registry complete specific NPCR-CAT modules with data relevant to their registry and provide it to the central office or NPCR-CAT administrator to collapse into a single submission for the state.

The pilot testing also yielded other valuable findings to tailor data collection to ensure high quality information can be obtained from the registries. First, in instances where registry operations are performed by private organization under contract to the state registry, the NPCR-CAT needs to be completed by both organizations to ensure that complete data are collected. This was successfully performed during the pilot testing of the tool and is the approach that will be used in the future. Second, cooperation from fiscal staff is critical to ensure that cost information is provided to the registries in a timely manner to complete the NPCR-CAT. Early communication with the fiscal office is the key to ensure that all necessary data can be obtained within the specified data collection timeframe. Third, detailed records, in addition to those provided by the fiscal office, are usually necessary to complete the NPCR-CAT and some registries do

not maintain internal records at the level of detail required. Beginning with program year 2008, as stated in the cooperative agreement, all NPCR registries are required to provide resource use and cost data for assessing cost of registry activities and for improving efficiencies in program operations and, therefore, registries are aware of the need to maintain detailed records. Fourth, in addition to the traditional funding sources, registries often receive large in-kind contributions and therefore these data should be collected. Fifth, the seven registries that participated in the pilot testing differed in many of the factors hypothesized to impact cost or effectiveness of registry operations that were collected in the NPCR-CAT. Therefore, these factors should be used along with other factors previously identified[3] and quantified from other data systems such as the Annual Program Evaluation Instrument (APEI) to study what factors impact total cost and effectiveness of registry operations in future analysis. In the previous manuscript[6] we used information from APEI to determine the number and types of facilities that report cancer cases to the central registries.

Overall, the results from the pilot testing indicate that the NPCR-CAT is a user-friendly tool that can be used to collect detailed, high-quality cost data with generally minimal burden to the programs. CDC plans to incorporate lessons learned from the pilot testing to collect annual cost data from all NPCR funded programs in late 2008. The data will be collected using a Web-enabled NPCR-CAT (currently under development) to reduce respondent burden, data collection errors, and delays in receiving data. The detailed activity-based costs generated by the tool will enable an assessment of the true cost of registry operations, identify factors that impact cost, and perform cost-effectiveness analysis. Such information will provide the CDC and the registries with better tools for improving efficiency and making resource allocation decisions that meet program priorities.

Acknowledgement

We would like to thank the seven NPCR programs that participated in pilot testing the NPCR-CAT.

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Special Feature

Write On!

C. Kay Smith-Akin, MEd

Editor's Note: As a way to help staff improve their writing skills, or remind them of the rules, the Centers for Disease Control and Prevention's Office of Workforce and Career Development (OWCD) recently began distributing helpful tidbits, in the form of a quiz. With their permission, we are including those tidbits in the Journal *as a benefit to our readers.*

Do you ever puzzle over where to place an apostrophe or a comma? Do you sometimes wonder why someone has capitalized a word for no apparent reason? These tidbits are in the form of a quiz so that you can test your skills; but not to worry, you can keep your scores confidential. The correct answers are included, accompanied by explanations of why one usage is preferred over another. Ideas for these quizzes come from inquiries received by OWCD, or from some of the mass-distribution messages we receive and wonder, "Didn't anyone check this announcement before it was distributed?"

Here is the first quiz to get us started (the first question *should* be easy):

1. Match the part of speech or type of sentence on the left with its definition on the right. (*Give yourself 3 points for each correct answer.)*

A. Noun ____	1. Expresses action or a state of being.
B. Pronoun ____	2. Describes or modifies a noun or pronoun.
C. Verb ____	3. Connects words, phrases, or clauses.
D. Adverb ____	4. Names a person, place, thing, or idea.
E. Adjective ____	5. Indicates excitement or strong feelings.
F. Conjunction ____	6. Describes or modifies verbs, adjectives, or other adverbs.
G. Preposition ____	7. Takes the place of a previously mentioned noun.
H. Interjection ____	8. Sets up an association between a noun or pronoun and another word in the sentence.
I. Simple ____	9. Contains one dependent clause and two or more independent clauses. *Although we do not have another Monday holiday until May, we will enjoy it then; many of us will take leave the remainder of that week.*
J. Compound ____	10. Contains one independent clause and one dependent clause. *Although we do not have another Monday holiday until May, we will enjoy it then.*
K. Complex _____	11. Contains one complete thought. *Monday holidays are great!*
L. Compound-complex ____	12. Contains a subject, a verb, or both, but is not a complete thought. *Although Monday holidays are preferable.*
M. Fragment _____	13. Contains two complete thoughts, usually joined by a coordinating conjunction (e.g., *and*, *but*, or *or*). *Monday holidays are great, but we do not have another one until May.*

2. In the following sentence, which is the correct pronoun usage? (*3 points*)

Please visit the shop in it's/its new location.

3. Can you spot the error in the following sentence? (*4 points*)

Driving down the highway, the windows were open, and the dog's ears flapped in the wind.

4. Choose the correct verb in the following sentence. (*3 points*)

None of the players was/were wearing the new team insignia.

5. What is the difference in usage between *ensure* and *assure*? (*8 points*)

6. Choose the correct adjectives in the following sentence. *(3 points each)*

Less/Fewer students attended the financial planning class, and more of them said they had less/fewer dollars to invest.

7. Which apostrophes are correct in the following sentence? *(4 points each)*

During the late 1700's/1700s, members of King Louis XVI's/King Louis XVIs army helped the Americans in their fight against the British.

8. Can you spot the error in the following sentence? *(3 points)*

Please tell me what the book is about.

9. Which is the correct use of capitalization in the following sentence? *(2 points each)*

Mary Smith became Director/director of the Evaluation Division/evaluation division last year and has since reorganized the Division/division teams.

10. Please punctuate the following sentences. *(Each correctly punctuated sentence is worth 2 points.)*

a. The outbreak resulted in 216 illnesses and no deaths

b. Demographic results are displayed in Table 1 and Figure 1 illustrates the epidemic curve

c. Although the incubation period continued until July 1 no new infections occurred after June 25

d. The incubation period continued until July 1 but no new infections occurred after June 25 nevertheless surveillance continued until July 30

e. Because the incubation period ended July 1 but surveillance continued until July 30

11. Choose the correct pronoun in the following sentences. *(2 points each)*

a. Do you want Bob or I/me/myself to make the call?

b. Just between you and I/me/myself, Jane made an excellent point during the meeting.

c. I attended the play with Jim and she/her.

d. Each of the committee members cast his/her/their/his or her secret ballot.

e. Neither the committee chair nor the members are ready to share his/her/their/his or her final report.

12. Bonus question: **Which is the correct spelling, *acknowledgment* or *acknowledgement*? *(10 extra points)***

Answers

1.

A.	**4**
B.	**7**
C.	**1**
D.	**6**
E.	**2**
F.	**3**
G.	**8**
H.	**5**
I.	**11**
J.	**13**
K.	**10**
L.	**9**
M.	**12**

2. ***Its* is the correct answer because that is the possessive form of the pronoun; *it's* is a contraction of *it is*.** You have probably spotted this common error in messages you have received from colleagues.

3. This sentence is illogical because of the dangling participle, *driving down the highway*. The sentence fails to state who was driving down the highway. *Windows*, which is the noun being modified by the participle, cannot be the driver. The dog also cannot be the driver, unless of course, it is a Walt Disney creation. By the way, a participle is an adjective formed from a verb that is used to modify a noun or pronoun.

4. The correct verb is *was* because the subject is the singular pronoun *none*. Although using *were* feels right because of *players*, the verb should agree in number with the subject, not the object of the preposition. In fairness, I should point out that using plural verbs with *none* has become widespread, and famous authors often do it. Therefore, even if you chose *were*, count this one as correct.

5. In business and scientific writing, *ensure* is usually preferred when the meaning is *to make certain*. *Assure* is used in the sense of *giving comfort*, usually verbally.

Examples: We *ensured* the contract was signed before proceeding. The budget analyst *assured* the branch chief that the numbers were correct.

6. <u>Fewer</u> students attended the financial planning class, and more of them said they had <u>fewer</u> dollars to invest. A simple rule for using *less* and *fewer* correctly is that we use *fewer* if the noun that follows the adjective is plural, and we use *less* if the noun is singular. In this sentence, for example, both *students* and *dollars* are plural. What if, instead of *dollars*, the noun had been *money*? We would have used *less* in that case because *money* is singular. Try using the singular versus plural rule the next time you need to decide between *less* and *fewer*. As with every rule in English grammar, this rule probably has exceptions, but it usually works.

7. During the late <u>1700s</u>, members of <u>King Louis XVI's</u> army helped the Americans in their fight against the British. In the first instance, the number is simply plural, not possessive. In the second instance, the number is singular possessive. Deciding when to use an apostrophe with a number is difficult, perhaps because we see it done incorrectly so often. However, numbers form their plurals and possessives the same as other nouns—We use an apostrophe to indicate possession, and to form the plural, we simply add *s*. (Watch for a similar question on abbreviations and acronyms in a future quiz.)

8. Please tell me what the book is about. Regardless of your answer to this one, give yourself 3 points because it is a trick question. You probably said that the sentence should not end with a preposition. However, although *about* is often used as a preposition, it is an adverb in this sentence. If you are uncomfortable with having an adverb at the end of the sentence, you can revise it to say, for example, "Please tell me about this book." Although this sentence was easy to revise, you will encounter others that become awkward when you try to avoid having an adverb at the end.

9. Mary Smith became <u>director</u> of the <u>Evaluation Division</u> last year and has since reorganized the <u>division</u> teams. When do you capitalize a person's title or the name of an organization? A person's title is only capitalized when used immediately after his or her name (*Mary Smith, Director, Evaluation Division*). Names of organizations are only capitalized when the full formal name of the organization is used (*the Evaluation Division*, but *the division*).

10a. The outbreak resulted in 216 illnesses and no deaths.

This statement is a simple sentence (one independent clause), and the only punctuation that is needed is the period at the end. The compound object of the preposition, *illnesses* and *deaths*, needs no punctuation.

10b. Demographic results are displayed in Table 1, and Figure 1 illustrates the epidemic curve.

A comma is needed to separate these two independent clauses joined by the coordinating conjunction *and*. Notice how easily misread this compound sentence is without the comma separating the two complete thoughts. Is the comma always needed in a compound sentence? The comma is often dropped when one or both clauses are only three or four words. Moreover, works of fiction and popular-interest magazines often do not include commas in compound sentences. This journalistic-type style probably has more to do with saving characters (and thus, space and ink) than grammatical correctness, however.

10c. Although the incubation period continued until July 1, no new infections occurred after June 25.

A comma is needed in this complex sentence to set off the dependent clause (*Although…July 1*) from the independent clause (*no new…June 25*). Dependent clauses, which cannot stand alone, can also be placed in the middle of a sentence or after the independent clause. For example, in the previous sentence, *which cannot stand alone* is a dependent clause. Note that it is set off from the independent clause by two commas because it interrupts the main thought.

10d. The incubation period continued until July 1, but no new infections occurred after June 25; nevertheless, surveillance continued until July 30.

Scientific and business writing often requires that three or more closely related thoughts be expressed in the same sentence. Compound-complex sentences serve this purpose well, but they must be punctuated correctly to be understood clearly. In this example, a comma separates the first two independent clauses, and a semicolon and comma set off the third independent clause. You might have chosen a different way to write and punctuate these three thoughts that is just as correct; therefore, give yourself 2 points.

10e. Because the incubation period ended July 1 but surveillance continued until July 30

I hope you were not fooled by this sentence fragment that is merely a dependent clause. To express a complete thought, it should be rewritten without the adverb *because*, or an independent clause should be added. Examples: **The incubation period ended July 1, but surveillance continued until July 30.** Or, **Because the incubation period ended July 1 but surveillance continued until July 30, investigators concluded that no new cases had occurred.**

11.

a. Me

b. Me

c. Her

d. His or her

e. Their

Speakers and writers frequently choose the wrong pronoun because they are trying too hard to be correct or to use gender-neutral language. For example, the fear of using *me* might keep us from choosing correctly in Questions 11a and 11b; however, when the pronoun is the object of the verb (*want*) or the preposition (*between*), the objective case pronoun is correct (*me*, *him*, *her*, or *them*). The same is true for Question 11c; the object of the preposition *with* should be *her*. In Questions 11a–11c, dropping the other half of the compound object makes choosing the correct pronoun much easier. (We will explore subjective case pronouns another time; they can also be quite tricky.)

Choosing the correct pronouns in Questions 11d and 11e is more difficult because the antecedent (the noun for which the pronoun stands) causes confusion. In Question 11d, *each* is the pronoun's antecedent and it is singular; therefore, a singular pronoun is needed. Moreover, because the committee comprises both men and women presumably, we need both *his* and *her* to be correct. Unfortunately, that construction is awkward. A better sentence might be, **The committee members cast their secret ballots.** Question 11e poses a different problem because it contains a compound subject as the antecedent, one of which is singular and the other plural. Should the pronoun agree in number with the singular antecedent or the plural? Because the plural antecedent is closest to the pronoun, the correct choice is *their*.

How often do you hear newscasters or dramatic actors using the wrong pronoun? Perhaps they also are trying too hard to be correct.

12. Bonus answer: Both *acknowledgment* and *acknowledgement* are correct, depending on whether you are using American English or British English, respectively. For a more intensive test of your spelling knowledge, visit **http://www.businesswriting.com/tests/commonmisspelled.html**.

If you have comments, questions, or particular topics you wish to have addressed, please send your suggestions to C. Kay Smith-Akin, MEd, Health Communication Specialist, at ***crs5@cdc.gov****.*

Special Feature

Report Writing 101

Lillian Antonelli, MS, CTR

If writing reports is not for you, or you just don't know how to start, then the following information should be helpful. As healthcare professionals, we all know that administrators, physicians, and others are always requesting data. Submitting data with no supporting information or explanation is an injustice to all the hard work cancer registrars perform. So what is one to do?

As we were all trained in elementary school, we must support the data we provide by using basic report-writing skills: introduction, body of report, conclusion. How does this work in the medical field? Well, the theory holds true but is taken a step further. The report should consist of the following sections: Abstract, Introduction, Methods, and Results as separately identified sections (body of report), and Discussion (or conclusion). It's helpful to break down what each section may entail prior to starting your report.

Introduction

To spark an interest, the introduction introduces the reader to the reason why the report is being written. Provide background information and explain the scope of the report.

Another important aspect is to clarify key terms that are used throughout the report. Remember, the report may be read by individuals who are not familiar with your terminology and how it is used.

Body of Report

Now it's time to build off of the introduction. Providing documentation to support your introduction is critical. So what does this really mean?

- Describe the steps taken to pursue the data (Methods).
- Describe the findings (Results). An explanation of the results is included in the Discussion section.

Discussion

- Explain and provide comparison information. Information that supports or contradicts should be explored.

Conclusion

The conclusion may be included as part of the discussion, or may have a separate section. Summarize the report and connect all the points that were discussed. You can also provide your own opinion by elaborating on the information that was found.

The conclusion is very important since this is where the reader can be persuaded to agree with your findings.

Referencing

With all the new resources available to perform research, everyone wonders how to reference this material. According to Silvia Rogers' *Mastering Scientific and Medical Writing: A Self-Help Guide*, there are several styles that can be used.

Vancouver Style is noted to be the bibliographic style of choice. References are numbered consecutively in the order mentioned.

Key Points to Remember

Journal Articles

- List the first six authors followed by "et al"
- Omit the month and issue number if it's used throughout the report
- If no author is given, state the title and journal details
- For volumes and issues with supplements, state "suppl" where appropriate

Books

- Note the personal author or editors using last name, first initial, and middle initial
- Provide book name, edition, publisher, and year published
- Note page number, if applicable

Conference Proceedings and Papers

- Note the presenter(s) using last name, first initial, and middle initial
- Document the title of the conference
- Note the location and year of the conference
- Provide the resource where you found the information

Unpublished Items

- Always note if the material was unpublished
- Note the personal author or presenter using last name, first initial, and middle initial
- Document the title of the report
- Note the location
- Note the date the information was presented
- Provide the resource where you found the information

Now that you have the basic tools to develop and produce an amazing report, why don't you try it the next time there is a request? Remember, most requestors have no idea what exactly registrars do or collect, but you can change that. It's your time to shine and produce a report that reflects the quality of work that you strive to maintain.

5-Step Program for Doing More With Less

Michele A. Webb, CTR

It seems that most hospitals these days are telling staff to "do more with less." What seems to be missing from this phrase, however, is the significant burden that it carries for the healthcare professional on the receiving end.

What does "doing more with less" really mean? To many, the statement implies that they are being expected to do more low-quality work with fewer resources. They may feel it is unrealistic to think that the organization is going to be able to maintain the same levels of productivity and quality or service, with fewer people and less money. Nothing in this equation adds up or makes sense. Surely something has to give and that generally means quality. Sound familiar?

Instead of running for cover or reacting defensively, the cancer registrar can use this opportunity to step up as a leader. Do not fall into the automatic excuse mentality of simply demanding "more with less" or slipping into passivity. Leaders quickly determine the top priorities, realign their resources with the organization and its business, and get on with proactively and visibly demonstrating the registry's value. John Battelle, CEO for Standard Media Corporation, said this so well:

"We're now in a cycle of demanded innovations.
When profits are down and there is no money,
you have to innovate to stay in business."

The cancer registrar is a partner in the organization's healthcare business. While the department may not actively collect revenue, it does impact the bottom line. Rapid realignment, innovation, and perhaps even radical change are in order. Here are 5 simple steps to realign the cancer registry operations:

1. Realize that with today's limited budgets, administrators are trying to evaluate whether programs and services are delivering on their promised value. While they are not necessarily looking to eliminate value or benefits, they may be willing to risk cutting programs or services that are not performing optimally. First, identify the cost-saving goals of the organization. Then, take time to review your cancer registry's operations. Identify activities that are not supporting the organization's needs and either eliminate them or quickly implement change to support the new goals.
2. Gather information from other staff, managers, or departments in your organization about what they are doing to cut expenses and maximize value and service. Be willing to implement same or similar changes into the registry's operations.
3. If changes in reporting requirements, staffing, or other operational activities are absolutely necessary, try them on a small scale first rather than launching large, systemic change.
4. Think broadly and creatively. This is the time to step outside your comfort zone and to explore internal partnerships and maximize your resources. Build mutually beneficial relationships in order to develop ideas that improve and enhance registry services.
5. Announce now, implement later. You may stand a better chance of getting administrative support and commitment to a future implementation date. By announcing impending changes early on, you are sending the message that the registry business is still on the move and is aligned with the mission and goals set forth by the organization.

This 5-point plan is not intended to be a "magic wand" that can be waved to solve all of the organization's budget problems. Nor will it bestow upon the cancer registrar special powers of influence or send a genie to grant every wish. What it does provide are a few tools and resources that can be used immediately to realign the registry's operations with a new, streamlined, and cost-effective way of conducting healthcare business.

Looking ahead to 2010 and the many changes that will affect cancer data collection and reporting, the registrar needs to prepare to gently lead his/her organization to implement program change. This will not be an easy task, and it will likely require shifting entire paradigms and how you go about your business. Take time to study the situation and explore every opportunity for reducing cost and maximizing value. Carefully craft the registry's new plan for operations, quality control, and change management well in advance. Deliver your plan succinctly, with confidence, and in a manner that demonstrates your expertise as a cancer registrar, leader, and strategic partner in oncology healthcare.

Michele is the Cancer Registry Manager at Saddleback Memorial Medical Center in Laguna Hills, CA, and an independent consultant and speaker. Send your comments to ***michele@michelewebb.com****.*

The Inquiry and Response System: to Appeal or Not to Appeal

Asa Carter, CTR; Vicki Chiappetta, RHIA, CTR; Anna Delev, CTR; Debbie Etheridge, CTR; Donna Gress, RHIT, CTR; Lisa Landvogt, CTR

To appeal or not to appeal? That is the question many cancer programs ask themselves upon review of their post-survey Performance Report. Ultimately, the decision to appeal is up to the cancer program.

There are two kinds of appeals; one is to appeal a contingency when a program disagrees with the rating for a particular standard, and the second is to appeal a standard to receive a Commendation rating. Often, when an appeal is accepted, the survey outcome status may be upgraded from non-approval to 3-Year with Contingency or to 3-Year with Commendation.

Most importantly, when appealing a contingency or for Commendation, the cancer program must provide supporting documentation that the program was in compliance with that standard at the time of the survey and for the time between surveys. Cancer programs have *45 calendar days* from the date the Performance Report became available on Commission on Cancer (CoC) Datalinks to submit an Appeals cover letter (which should include facility name, FIN, standard, and why that standard is being appealed) and supporting documentation to Vicki Chiappetta at the American College of Surgeons, 633 North Saint Clair Street, Chicago, IL 60611, or via email at **vchiappetta@facs.org**. *(Do not send in appeals and deficiency resolution documentation to the CoC at the same time as these are two different processes.)*

Appeals are processed *once a month* through the Program Review Subcommittee (PRS). As a subcommittee of the Accreditation Committee, the PRS is charged with confirming final survey outcomes, determining appeals outcomes and Outstanding Achievement Award recipients, adjudicating decisions when accreditation recommendations differ between surveyors and CoC staff, and providing guidance on the interpretation of standards. PRS members include representatives from National Cancer Registrars Association, the Association of Cancer Executives, the Association of Oncology Social Work, members of the CoC, and CoC surveyors.

The outcome of the appeal will be released by an email notification that will be sent to the cancer program's contact staff (chair, liaison, administrator, and registrar) informing them of the updated Performance Report. The updated Performance Report will be accessible via the CoC Datalinks Activity Menu, located on the CoC Web site at **https://datalinks.facs.org/ncic_login.cfm**.

Looking back at data from July 2007 to July 2008, 17 different standards were appealed. The most frequent appeals were for Standards 7.2 (registry education), 2.11 (outcomes analysis study), and 3.3 (abstracting timeliness). Standard 7.2 is appealed for both contingency and Commendation due to inconsistent data entered into the SAR (comparison of Standards 3.1 and 7.2) and incomplete data, as all registry staff (CTR and non-CTRs) are not entered for each year as having participated in educational activities.

Standard 2.11 is usually appealed on the basis of documenting national data comparison (with narrative analysis). Standard 3.3 is often appealed because abstracting was caught up at the time of survey, but the surveyor review found less than 90% of abstracts reviewed during the survey show abstracting completed within six months from the date of first contact. All standards are to be in compliance *for all years* between surveys.

Thirty-two facilities submitted a request for appeal during the reporting period; 70% of contingencies that were appealed were accepted and 81% of appeals for Commendations were accepted. Fifty-six percent of the programs who appealed had survey outcomes that were upgraded to 3-Year with Commendation. (Not all programs appealed every contingency.)

So, is it worth it to appeal? Have the cancer committee review minutes for the years between survey, and ask this question: "Is there documentation that supports your program as being in compliance or meeting Commendation criteria for each year?" If so, then an appeal of survey findings is a good idea. Highlight the appropriate areas within the minutes, policies, grids, reports, etc. Make sure to send *all* the appropriate documentation in at one time along with the appeals cover letter within 45 days of receiving the Performance Report.

Appealing standards may be a post-survey option, but the best recommendation is to make sure the cancer committee discusses and evaluates all required standards at least annually with minutes *clearly* documenting the discussion, outcome, and recommendations, as appropriate. (Attachments to the minutes must be documented as being discussed, as well.) Documenting compliance for each standard will make sure your cancer program is perfect "upfront" so an appeal won't be necessary.

*For further follow-up on this article please contact Vicki Chiappetta, RHIA, CTR, Technical Specialist, at **vchiappetta@facs.org** or at (312) 202-5288.*

CORRECT ANSWERS FOR SPRING 2009

Journal of Registry Management **Continuing Education Quiz**

MISCLASSIFICATION OF AMERICAN INDIAN RACE IN STATE CANCER DATA AMONG NON-FEDERALLY RECOGNIZED INDIANS IN NORTH CAROLINA

*(correct answers in **bold**)*

1. Racial or ethnic identification gleaned from which of the following sources is least prone to error:
   a) death certificates
   b) medical records
   c) direct collection from the individual
   d) disease surveillance systems

2. Misclassification increased as the percent blood quantum (a measurement of American Indian ancestry) decreased.
   a) true
   b) false

3. Cancer is the second leading cause of death among American Indians and the leading cause among Alaska Natives.
   a) true
   b) false

4. In North Carolina, the majority of American Indians are:
   a) covered by the Indian Health Service
   b) not associated with federally-recognized tribes
   c) the smallest population of state-recognized and non-federally recognized Indians in the United States
   d) none of the above

5. Female breast, prostate, lung, and colorectal cancers were chosen for this analysis because:
   a) they provide stable incidence rates due to the small number of cases
   b) they provide unstable incidence rates due to the large number of cases
   c) the burden among these 4 sites is the lowest for all racial groups combined
   d) the burden among these 4 sites is the highest for all racial groups combined

6. After correction of race, cancer incidence rates for 1996–2000:
   a) increased 19% for American Indians
   b) were much greater for whites and blacks
   c) reflected higher increase for female breast than for prostate in American Indians
   d) decreased after correction of race

7. American Indians were listed on tribal roles but not classified as such in the NCCCR at a rate of:
   a) 10%
   b) 17.9%
   c) 42%
   d) 95%

8. According to Table 2: *American Indian Misclassification of Race, by Tribe*, the:
   a) Occaneechi Tribe had 468 names on their tribal role
   b) Meherrin Tribe residing in Person County were included in this analysis
   c) Coharie Tribe had a 12.5% misclassification rate
   d) Waccamaw-Siouan Tribe had 17 names on the CCR subset

9. Limitations that should be considered when interpreting the results of this analysis include:
   a) human error in the matching process
   b) the results may overestimate the problem
   c) not all American Indians in the state were represented
   d) all of the above

10. Falsely low reported rates of cancer can lead to:
    a) underfunding of screening, detection, and treatment programs
    b) inaccurate accounting of morbidity and mortality rates for American Indians
    c) both a and b
    d) neither a nor b

Journal of Registry Management Continuing Education Quiz—SUMMER 2009

SURVIVAL AND TIME INTERVAL FROM SURGERY TO START OF CHEMOTHERAPY AMONG COLON CANCER PATIENTS

Quiz Instructions: The multiple choice or true/false quiz below is provided as an alternative method of earning CE credit hours. Refer to the article for the ONE best answer to each question. The questions are based solely on the content of the article. Answer the questions and send the original quiz answer sheet and fee to the NCRA Executive Office before the processing date listed on the answer sheet. Quizzes may not be retaken nor can NCRA staff respond to questions regarding answers. Allow 4–6 weeks for processing following the submission deadline to receive return notification of your completion of the CE process. The CE hour will be dated when it is submitted for grading; that date will determine the CE cycle year.

After reading this article and taking the quiz, the participants will be able to:

- Discuss the research on the effect of the timing of chemotherapy on survival
- Correlate the association of chemotherapy with survival, and the association of initiating treatment within 45 days versus more than 45 days after surgery with survival
- Explain the possible link between the length of time between surgery and chemotherapy treatment and probability of survival

1. Of the 3,006 patients who met the eligibility criteria for this study, those who:
   a) received chemotherapy after surgery were more likely to survive than those who received surgery alone
   b) received chemotherapy within 45 days did not have better survival than those who began treatment later
   c) had stage II colon cancer and received chemotherapy after surgery had significantly lower mortality than those who received surgery alone
   d) all of the above

2. According to this article, colon cancer, one of the most commonly diagnosed cancers in the United States, has:
   a) the highest mortality rate
   b) the lowest mortality rate
   c) declining incidence and mortality rates over the past two decades
   d) increasing incidence and mortality rates over the past two decades

3. This study used data on patients from:
   a) the linked SEER-Medicare database
   b) a population-based sample of stage II colon cancer patients in Western Australia
   c) stage II or stage III colon cancer patients from the Massachusetts Cancer Registry (MCR)
   d) none of the above

4. The subjects in this study included:
   a) Massachusetts residents who were newly diagnosed with colon cancer between January 1, 1997 and December 31, 1999
   b) patients with colon or rectal cancer
   c) patients from the five Veterans Affairs hospitals in Massachusetts
   d) colon cancer patients with any *International Classification of Disease for Oncology, Third Edition (ICD-O-3)* histology code

5. Cases listed in the MCR were excluded if the patient:
   a) was diagnosed with any primary cancer prior to the diagnosis that met the other eligibility criteria
   b) had a survival time of greater than 8 months
   c) started chemotherapy <1 year after their surgery
   d) did not receive radiation therapy in the first year.

6. The primary independent variables of interest in this study are:
   a) age, sex, race/ethnicity, year of diagnosis, stage, and type of hospital (teaching vs. non-teaching)
   b) receipt of chemotherapy following colon cancer surgery and the interval of time between surgery and initiation of adjuvant chemotherapy treatment
   c) survival
   d) covariates

7. In order to be included in the analysis, a case record had to include only the month and year for both colon cancer surgery and first adjuvant chemotherapy, if any.
   a) true
   b) false

8. Of the 3,006 study subjects:
   a) those with stage II disease were more likely to receive chemotherapy
   b) those who did not receive chemotherapy were on average about 10 years younger
   c) 44% of patients with stage III disease received chemotherapy
   d) a total of 945 (31.6%) received chemotherapy after surgery

9. According to Table 1a: *Demographic and Clinical Characteristics of Study Population: All Cases*, the group with the highest survival rate as of December 31, 2003 was the group that received:
   a) radiation therapy within the first year
   b) no chemotherapy
   c) chemotherapy
   d) none of the above

10. This study found that:
    a) chemotherapy treatment after surgery improves the probability of survival for patients with stage II colon cancer
    b) chemotherapy treatment after surgery improves the probability of survival for patients with stage III colon cancer
    c) the time interval between surgery and start of chemotherapy does not affect survival
    d) all of the above

Journal of Registry Management **Continuing Education Quiz** **Answer Sheet**

Please print clearly in black ballpoint pen.

First Name | M.I. | Last Name

Address

Address

City | State/Province | Zip Code/Postal Code

NCRA Membership Number (MUST complete if member fee submitted) | CTR Number

The JRM CE Quiz is also available online at www.creducationcenter.org!

Instructions: Mark your answers clearly by filling in the correct answer, like this ■ not like this ☒. Passing score of 70% entitles one (1) CE clock hour per quiz.

Please use black ballpoint pen.

1	A	B	C	D
2	A	B	C	D
3	A	B	C	D
4	A	B	C	D
5	A	B	C	D
6	A	B	C	D
7	A	B		
8	A	B	C	D
9	A	B	C	D
10	A	B	C	D

Submit the original quiz answer sheet only!
No photocopies will be accepted.

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The *Journal of Registry Management,* official journal of the National Cancer Registrars Association (NCRA), announces a call for original manuscripts on registry methodology or research findings related to the above 5 subjects, and related topics. Contributed manuscripts are peer-reviewed prior to publication.

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7. **Letters to the Editor** are also invited.

Address all manuscripts to: Reda J. Wilson, MPH, RHIT, CTR, Editor-in-Chief, *Journal of Registry Management,* (770) 488-3245, **dfo8@cdc.gov.**

Manuscript submission requirements are given in "Information for Authors" found on the inside back cover of each *Journal* and on the NCRA Web site at **http://www.ncra-usa.org.**

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