A STUDY OF PATIENTS IN CANCER-RELATED DRGs

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ABSTRACT

The DRGs representing lymphoma, leukemia, and other cancer-related diseases contain wide variations in patient severity of illness and use of hospital resources. We examined case mix and financial data for 4,390 cases in 40 cancer-related DRGs from 15 hospitals. After we adjusted charges to costs and standardized all data to fiscal year 1983, 40 cancer-related DRGs explained 15.2% of the variation in cost per case, while 4 Severity of Illness groups explained 16.7%, 12 Severity of Illness and procedure-adjusted groups explained 38.6%, 143 Severity-adjusted DRGs explained 44.9%, and 255 Severity/procedure-adjusted DRGs explained 58.4%. The average variation in cost per case explained by Severity/procedure levels within an individual DRG was 36.5% for all data and was 24.6% when cost and length of stay outlier cases were removed. We study differences in Severity of Illness distributions in hospitals with and without cancer centers and discuss the impact of these differences on equity of prospective payment.

The problem of variation in severity of illness of patients within DRGs is well recognized,[1-5] but the impact of this variation on hospitals with specialty cancer services has not previously been examined in detail. This research was undertaken to determine the variation of severity of illness in 40 cancer-related DRGs and the impact of this variation on hospitals with and without cancer centers.

METHODS

We examined data from 15 hospitals and 40 DRGs whose titles indicate the presence of cancer. The 15 hospitals, located across the United States in urban settings, were already collecting Severity of Illness data before this study. There were 10 teaching hospitals and 5 community hospitals, all of which collected Severity of Illness data at the same time they coded discharge abstracts or performed discharge utilization reviews. The four-level Severity of Illness Index used in this study has been described in detail elsewhere;[6] the Severity levels one through four reflect increasing levels of patient severity of illness. We adjusted charges to costs using cost-to-charge ratios from each institution's Medicare cost report, and further adjusted for differences in wage rates, depreciation, interest, and the indirect cost of medical education using HCFA's standard methodology.[7] All the cost data were standardized to FY83.[1]

Dr. Susan Horn researches cancer DRGs and Severity of Illness

The data sets from the 15 hospitals included 4,390 cancer cases scored into Severity levels 1 through 4. There were other cancer cases scored into Severity level 0 along with one of three special cases codes:

G = patients admitted for administration or monitoring of any chemical therapy, radiation therapy, or dialysis;

P = patients admitted or treated under established medical regimens that have predetermined treatments, resource consumption, and lengths of stay; and

B = patients admitted for diagnostic workup, evaluation, or observation.

No Severity level is assigned to these patients because not all dimensions of the Severity criteria could be determined

from the medical record. The cases in Severity level 0 were not included in our homogeneity analyses.

We compared the amount of variability in hospital inpatient cost per case predicted by:

40 Cancer-related DRGs;

Four Severity of Illness groups;

Four Severity of Illness groups adjusted for three types of operating procedures: none, moderate, and major operating room procedures (a total of 12 groups);(1)

Severity of Illness within DRGs (a total of 143 groups); and

Severity of Illness and procedure groups within DRGs (a total of 255 groups).

These analyses were performed for all patients scored into Severity levels 1 through 4, as well as for the patients within individual DRGs; analyses were performed both with and without HCFA-defined outliers. Two statistical measures of homogeneity of resource use were used: reduction in variance and coefficient of variation.[2] To study the differences in the distribution of Severity of Illness in various hospitals, we examined three hospitals with a cancer center and three hospitals with large numbers of cases in the cancer-related DRGs but without a cancer center.

RESULTS

Analyses of Predictive Ability

We used two statistical measures to examine the heterogeneity of resource use in the total data set of 4,390 cancer-related cases that had been scored into Severity of Illness levels one through four: reduction in variance and weighted average coefficient of variation. The reduction in variance statistic

$$RIV = \frac{TSSQ - TWGSSQ}{TSSQ}$$

TABLE 1

Homogeneity Statistics for Cost Data
DRGs Alone and Severity and Procedure Groups
Within Cancer DRGs
All Data N = 4,390, Severity Levels 1 through 4

DRG	N	RIV For Sev/Pr in DRG	CV for DRG	Wtd. C.V. for Sev/Pr in DRG
10	119	23%	8%	71%
11	98	17	74	57
64	89	25	145	73
82	624	15	107	82
172	184	19	106	77
173	50	43	106	72
199	33	58	61	41
203	143	13	183	90
239	234	25	109	70
257	95	34	71	46
258	93	26	46	40
259	45	62	85	44
260	38	26	52	46
274	103	30	120	73
275	16	19	70	61
303	113	44	54	43
344	23	78	44	28
346	72	26	97	69
347	14	87	75	33
353	150	63	68	34
357	24	71	63	39
363	163	69	109	65
366	172	40	129	81
367	76	59	100	66
400	161	53	162	56
401	54	70	129	64
402	53	46	79	53
403	526	44	134	97
404	190	43	141	87
405	140	75	151	63
406	46	66	80	45
407	37	50	54	44
408	47	36	96	65
409	23	31	104	100
410	128	05	137	110
411	36	73	78	48
412	34	19	61	53
413	113	28	98	67
414	32	58	102	54
465	5	0	31	31
Weighted Average		36.5%	110.8%	71.6%

enabled us to determine how much of the variation in cost per case in the entire data set was explained by each case mix grouping system. In this formula, TSSQ is the total sum of squares and TWGSSQ is the total within-group sum of squares. The coefficient of variation is the standard deviation divided by the mean.

The 40 cancer-related DRGs predicted 15.2% of the variation in cost per case; alternatively, four Severity of Illness groups alone predicted 16.7% of the variation, 12 Severity and procedure-adjusted groups predicted 38.6%, 143 Severity-adjusted DRGs predicted 44.9%, and 255 Severity and procedure-adjusted DRGs predicted 58.4% (Figure 1). The weighted coefficients of variation (weighted by sample size) for our study data were 110.8% for DRGs alone, 104.0% for four Severity groups, 94.3% for 12 Severity and procedure-adjusted groups, 75.2% for 143 Severity-adjusted DRGs, and 71.8% for 255 Severity and procedure-adjusted DRGs. Thus, by both statistical measures, we found that Severity information added much to the explanatory power of DRGs.

We also examined the heterogeneity of resource use within each of the 40 DRGs. These results are shown in Table 1. The amount of variation explained (RIV) by Severity/procedure levels within a DRG ranged from 0% in DRG 465 to 87% in DRG 347. The weighted average variation explained by Severity/procedure levels within the 40 DRGs is 36.5%. It should be noted that this is the amount of variation in cost per case explained by Severity/procedure levels *over and above* that already explained by the DRGs.

The coefficient of variation statistics for individual DRGs are also shown in Table 1. They range from 31% in DRG 465 to 183% in DRG 203, and the weighted average coefficient of variation for the 40 DRGs is 110.8%. Thus, on the average, the standard deviation of cost data within a cancer-related DRG is about 111% of the mean. When the DRGs are subdivided by Severity/procedure levels, the coefficients of variation of the Severity/procedure-adjusted DRG groups range from 28% in DRG 344 to 110% in DRG 410; the weighted

TABLE 2

Homogeneity Statistics for Cost Data
DRGs Alone and Severity and Procedure Groups
Within Cancer DRGs
HCFA Charge and LOS Outliers Removed
N = 3,772, Severity Levels 1 through 4

DRG	N	RIV for Sev/Pr in DRG	CV for DRG	Wtd. CV for Sev/Pr in DRG
10	110	34%	78%	59%
11	96	19	64	51
64	83	21	78	67
82	574	16	78	72
172	168	10	76	71
173	46	50	87	67
199	28	36	47	42
203	132	21	86	71
239	217	30	78	67
257	88	21	49	44
258	93	24	67	60
259	42	47	58	44
260	38	15	58	56
274	89	14	72	66
275	16	20	79	65
303	74	26	39	37
344	18	26	40	38
346	69	21	82	71
347	14	75	71	37
353	118	34	45	36
357	22	68	61	41
363	150	30	75	66
366	159	16	87	72
367	74	25	88	75
400	117	26	50	41
401	39	30	67	58
402	49	42	70	50
403	351	23	80	67
404	155	24	75	62
405	90	31	70	58
406	37	31	53	47
407	36	63	50	35
408	43	37	65	51
409	16	21	81	68
410	120	8	62	61
411	29	80	98	53
412	33	16	51	44
413	103	25	71	59
414	31	56	69	50
465	5	0	44	44
Weighted Average		24.6%	71.8%	61.4%

average coefficient of variation is 71.6%. On the average, the standard deviation of cost data within severity/procedure-adjusted groups within a cancer-related DRG is about 72% of the mean. Thus, the coefficient of variation statistic also indicates that Severity/procedure-adjusted DRGs explain more of the variation in cost per case than DRGs alone.

In our study data, 14.1% of the cases scored into Severity levels 1 through 4 were cost or LOS (length of stay) outliers according to the Health Care Financing Administration's definitions. [7] We removed these outlier cases and repeated the analyses. The results are shown in Table 2. With outliers removed, the weighted average variation in cost data explained by Severity/procedure levels within individual cancer DRGs is 24.6%. Thus, Severity/procedure levels explain a great deal of variation in cost per case even after outliers are removed.

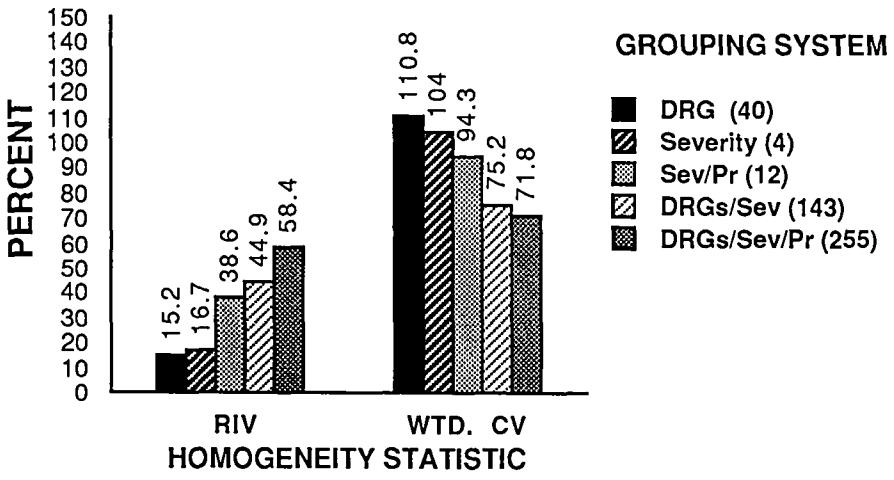
There can be great financial impact from Severity of Illness heterogeneity within DRGs. For example, there were 161 Severity-rated patients in DRG 400 in our combined hospital data set; their costs by Severity of Illness level and procedure type are shown in Figure 2 and Table 3. Hospitals that treat proportionately more of the *more* severely ill patients could be greatly under-paid, while hospitals that treat proportionately more of the *less* severely ill patients could be greatly over-paid. Dividing these patients into Severity of Illness levels and type of operating room procedure explains 53% of the variation in cost per case in this DRG; the weighted average CV for the 8 DRG/Severity/ Procedure groups is 56% compared with 162% for the DRG as a whole.

Analyses of the Distribution of Severity of Illness

In order to compare distributions of Severity levels across hospitals, we chose 3 of the study hospitals with cancer centers and 3 without cancer centers. We had additional data from these hospitals from fiscal quarters beyond those used in the homogeneity study (and for which we did not have the transformation factors needed to convert charges to costs). Using six to twelve months of data from three hospitals with a cancer

FIGURE 1

ABILITY OF FIVE CASE MIX SYSTEMS TO EXPLAIN VARIATION IN COST PER CASE FOR PATIENTS IN CANCER-RELATED DRGs



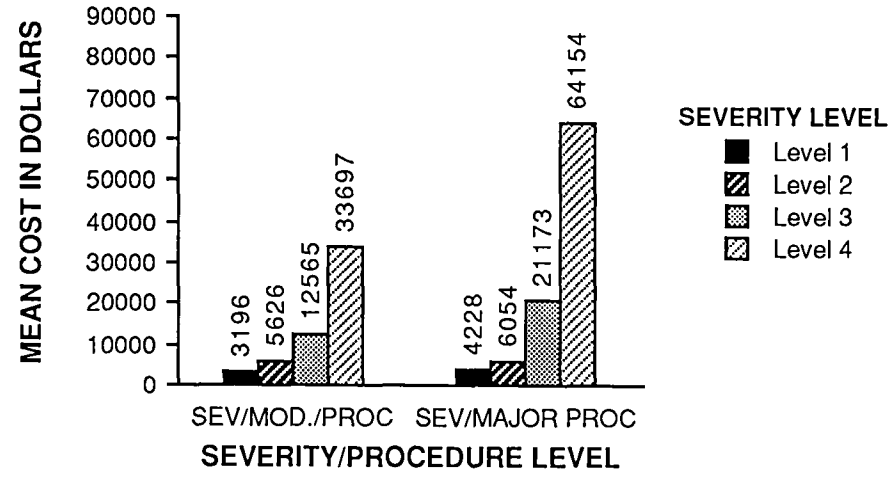
The ability of five case mix systems to explain the variation in cost per case for patients in cancer-related DRGs is illustrated in Figure 1. Twelve groups using Severity levels and procedure types explain more than twice as much of the variation as DRGs alone; Severity and procedure-adjusted DRGs explain four times as much variation as DRGs alone.

FIGURE 2

DRG 400 - LYMPHOMA OR LEUKEMIA, MAJOR O.R. PROCEDURE

COST PER CASE BY SEVERITY LEVEL AND PROCEDURE TYPE

Minimum Cost = $678 Maximum Cost = $146,029



Cost per case by Severity level and procedure type for patients in DRG 400 - Lymphoma or leukemia with major O.R. procedure is illustrated in Figure 2. Cost per case increases dramatically as Severity of Illness increases and major operating room procedures are performed.

center and six months of data from each of three hospitals without a cancer center, we tabulated the Severity of Illness distributions for each institution for Severity levels 0 to 4 and death. The distributions, shown in Table 4, are significantly different (chi square test, $p < .001$). When LOS and cost outliers were removed, the distributions remained significantly different ($p < .001$). Overall, the cancer centers treated proportionately fewer Severity level 1 patients (less severely ill) and proportionately more Severity level 3 and 4 patients (more severely ill) than did the non-cancer centers. Figure 3 shows these distributions combined for cancer and non-cancer centers.

Differences in Severity of Illness distributions for several individual DRGs (for which the cell sizes were large enough for meaningful analysis) are shown in Tables 5-7. Most of the patients in DRG 257 are in Severity levels 1 and 2, but the three cancer centers treated proportionately fewer Severity level 1 patients and proportionately more Severity level 2 patients than the three non-cancer centers ($p < .006$, with and without outliers). The cancer centers treated proportionately more Severity level 3 and 4 patients in DRG 403 than did the non-cancer centers ($p < .006$, with and without outliers).

Patients were scored into Severity of Illness levels 1 through 4 in our study data base only if they received treatment to which they were expected to respond during the hospitalization. If not, the patient was scored into Severity level 0 and a special cases code was assigned. For DRG 410, the cancer centers treated proportionately more level 1 to 4 patients than the non-cancer centers ($p < .01$, with and without outliers). Thus, the cancer centers treated proportionately more DRG 410 patients who received more than just chemotherapy or protocol treatment than did the non-cancer centers.

SUMMARY

There is a great deal of variation in cost per case for patients classified into the 40 cancer-related DRGs. DRGs explained about 15% of the variation in cost per case data in our data set. The explanatory power increased to 58.4%

TABLE 3
DRG 400 -- Lymphoma or Leukemia with Major O.R. Procedure
Cost per Case by Severity Level and Procedure Type
Minimum Cost = $678; Maximum Cost = $146,029

	N	Mean Cost	CV
OVERALL	161	$10,574	162%
Severity, with moderate procedure			
1	22	$ 3,196	46%
2	25	5,626	59
3	10	12,565	62
4	9	33,697	52
Severity, with major procedure			
1	24	$ 4,228	50%
2	52	6,054	51
3	14	21,173	76
4	5	64,154	96

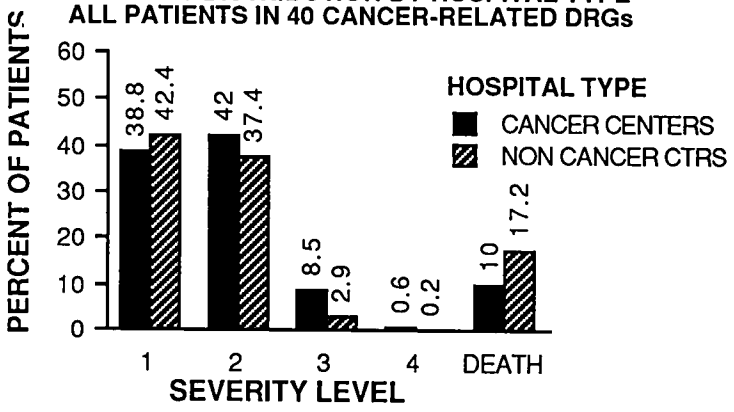
OVERALL RIV = 53% WTD. CV = 56%

TABLE 4
Severity Distribution by Hospital
All Patients in 40 Cancer DRGs

	SEVERITY LEVEL												
HOSPITAL	0		1		2		3		4		DEATH		TOTAL
C1	674	30%	571	25%	777	34%	97	4%	5	.2%	149	7%	2,273
C2	448	38%	219	18%	285	24%	121	10%	13	1%	101	9%	1,187
C3	642	42%	469	30%	301	19%	59	4%	2	.1%	76	5%	1,549
NONC1	55	15%	135	38%	103	29%	9	2%	1	.3%	56	16%	359
NONC2	60	25%	65	27%	77	32%	4	2%	0		35	14%	241
NONC3	82	38%	62	29%	51	24%	5	2%	0		15	7%	215

Chi squared test
All data, $p < .001$; Outliers removed, $p < .001$
C# = Cancer Center Hospital
NONC# = Non Cancer Center Hospital

FIGURE 3
SUMMARY
SEVERITY DISTRIBUTION BY HOSPITAL TYPE
ALL PATIENTS IN 40 CANCER-RELATED DRGs



Overall Severity of Illness distributions for all patients in 40 cancer-related DRGs in hospitals with (C1, C2, and C3) and without (NONC1, NONC2, and NONC3) cancer centers. Significantly more of the patients are at Severity levels 2 through 4 in the cancer centers.

when DRGs were subdivided by Severity of Illness and procedure type. Within individual DRGs, Severity of Illness levels explain an average of 36.5% of the variability in cost per case for all data, and 24.6% of this variability when outlier patients are removed.

The observed heterogeneity of Severity of Illness within DRGs could have great financial impact, since not all hospitals' cancer patients exhibit the same distribution of Severity of Illness. As the data in Tables 4 through 7 and Figure 3 indicate, the hospitals with cancer centers treated proportionately more of the more severely ill patients than did the non-cancer centers. This is not surprising, since cancer centers are intended to treat patients with advanced stages of malignancy, as well as to receive transfers from non-cancer center facilities. However, prospective payment based on fixed DRG payments could be very inequitable to these and other institutions that attract the more severely ill patients. Prospective payment programs should identify costs directly attributed to patients' severity of illness; the long-term consequences of not doing so could include closure of specialty treatment centers, refusal to admit certain patients, or reduction in quality of care.

To facilitate widespread collection of Severity of Illness data, we have developed a Computerized Severity Index (CSI) based on an expanded ICD-9-CM codebook that incorporates Severity of Illness criteria. This new codebook utilizes a 6-digit system: the first 5 digits are the same as the disease condition labels in the current ICD-9-CM codebook; the 6th digit (1 to 4) tells how severe each disease is based on objective signs and symptoms, laboratory values, radiology findings, etc. These criteria are similar to those now taught to and used by raters scoring Severity of Illness as described in this article, and they have been documented exhaustively in the new codebook.[9]

The new 6-digit codebook is the basis of an expanded discharge abstract data set including principal and secondary diagnoses labelled in 6-digit codes (these correspond to the first three dimensions of Stage, Complications, and Interactions in the manual Severity of Illness Index.) A computer algorithm is applied to the

TABLE 5

Severity Distribution by Hospital
DRG 257, Total Mastectomy for Malignancy, Age > 69 and/or C.C.

	SEVERITY LEVEL									
HOSPITAL	1		2		3		4		DEATH	TOTAL
C1	16	64%	09	36%	0		0		0	25
C2	12	38%	19	59%	1	3%	0		0	32
C3	11	61%	06	33%	1	6%	0		0	18
NONC1	15	94%	01	06%	0		0		0	16
NONC2	4	100%	00	00%	0		0		0	4
NONC3	10	91%	01	09%	0		0		0	11

C# = Cancer Center Hospital
NONC# = Non Cancer Center Hospital
Chi square test
All data, $p < .01$
Outliers removed, $p < .01$

TABLE 6

Severity Distribution by Hospital
DRG 403, Lymphoma or Leukemia, Age > 69 and/or C.C.

	SEVERITY LEVEL										
HOSPITAL	1		2		3		4		DEATH		TOTAL
C1	43	17%	128	50%	31	12%	4	2%	50	20%	256
C2	7	6%	29	27%	44	38%	3	3%	30	27%	113
C3	5	16%	10	32%	7	23%	0		9	29%	31
NONC1	17	40%	12	29%	1	2%	0		12	29%	42
NONC2	7	37%	8	42%	1	5%	0		3	16%	19
NONC3	0		2	67%	0		0		1	33%	3

C# = Cancer Center Hospital
NONC# = Non Cancer Center Hospital
Chi square test
All data, $p < .001$
Outliers removed, $p < .006$

TABLE 7

Severity Distribution by Hospital
DRG 410, Chemotherapy

	SEVERITY LEVEL													
HOSPITAL	0		1		2		3		4		DEATH		TOTAL	
C1	215	81%	13	5%	29	11%	3	1%	0		5		265	
C2	416	89%	23	5%	26	6%	2	1%	1		0		468	
C3	203	81%	30	12%	19	8%	0		0		0		252	
NONC1	45	94%	1	2%	2	4%	0		0		0		48	
NONC2	11	100%	0		0		0		0		0		11	
NONC3	79	91%	5	6%	3	3%	0		0		0		87	

C# = Cancer Center Hospital
NONC# = Non Cancer Center Hospital
Severity Level 0 = Chemo or radiation therapy only
Chi square test
All data, $p < .005$
Outliers removed, $p < .01$

elements of this expanded discharge abstract data set to produce the overall computerized severity level. Thus, the CSI can be used in the future on a national basis to study the implications of the prospective payment system on cancer centers.

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THE LEADING ONCOLOGY DRGs

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Beginning in 1983, the Health Care Financing Administration (HCFA) began reimbursing hospitals for Medicare patients using a system based upon diagnostic related groups (DRGs). The 468 DRGs had been developed at Yale University and were designed to measure resource consumption by specific diagnoses and procedures grouped within body systems.

While most illnesses fall within only a few DRGs, oncology is a conspicuous exception to this rule. Because cancer cuts across body systems, it has been estimated that oncology diagnoses fall into at least a hundred DRGs with substantial concentrations of cancer discharges in at least half of these. While many of the oncology-related DRGs are specific to cancer, other DRGs, particularly those with operative procedures, are split between cancer and non-cancer diagnoses.

This article represents a descriptive attempt to determine those diagnostic-related groups (DRGs) which are most important for oncology. Knowledge of which DRGs these are is an important component of hospital decision-making, particularly for those hospitals with active cancer programs or with substantial numbers of Medicare recipients. Since the most resource intensive oncology discharges are not necessarily the most common ones, oncology DRGs are examined in this article both by absolute number of oncology discharges and by total billed charges for discharges with an oncology diagnosis. Major teaching hospitals are compared to community hospitals and the under 65 population compared to the Medicare population.

The data to be discussed here are from the Massachusetts Rate Setting Commission for Fiscal Year 1983. In 1983, Massachusetts was one of four states which had a waiver from reimbursement under the DRG system. This analysis thus represents an opportunity to examine the actual makeup of the oncology DRGs before they were used for reimbursement purposes.

The Rate Setting Commission data set contains the uniform hospital discharge data set (UHDDS) for all patient discharges from all general hospitals in Massachusetts. The DRG, the total billed charges, and the identification of each hospital are also included in the data. The entire data set is in the public domain.

METHODOLOGY

In order to qualify as an oncology DRG for purposes of this analysis, the DRG was required to have at least 25 percent of its discharges with a primary diagnosis of cancer. In practical terms, this was defined using ICD-9-CM codes 140.0-208.9 except for 173.0-173.9 (skin cancer). In addition, V10.0-V10.99 (history of cancer) and V58.1 (chemotherapy as reason for admission)