INTRODUCTION:

A recent policy change of the Department of Veterans Affairs (VA) regarding the sharing of VA cancer data has resulted in incomplete reporting on VA hospital cases (VACs) in some central cancer registries for the 2005 data year. The purpose of this chapter is to quantify the missing number of VA cases in the SEER registries and provide adjustments of new case counts assuming 2005 VA data followed the same patterns as prior years. The undercounts were used to generate VA adjustment factors for 2005 age-specific incidence rates and/or age-adjusted incidence rates for SEER-9 and SEER-17 regions.

MATERIAL AND METHODS:

All but four of the SEER registries provided VA and non-VA case counts for the years 2000-2005. The data were stratified by year of diagnosis, gender, primary cancer site, and 5-year age groups. VA counts were provided in tabular format with no patient identifiers. The four SEER registries that did not provide this information did not have issues with reporting from VA hospitals for 2005. The Louisiana registry submitted VAC counts, but Louisiana was excluded from our analysis since population displacement following Hurricane Katrina confounded the effects of underreporting of VACs for Louisiana in 2005.

For each registry, the VAC proportion of all patients was estimated by year of diagnosis (2000- 2005), and by gender. Since some registries had a reduction in VAC reporting in the last quarter of 2004, an average based on 2000-2003 proportions was used as a baseline for comparison with 2005. Differences between 2005 proportions and the 2000-2003 average proportions were used to estimate the overall cancer underreporting in the SEER program. To do this, we calculated the number of cases that should be added to the denominator (2005 total case counts) and numerator (2005 VAC case counts) so that the 2005 proportion of VACs was consistent with the 2000-2003 average. We estimated the missing number of VACs for each of 19 age groups and these were added to the observed counts to obtain VA-adjusted case counts for all SEER regions (excluding Louisiana) in 2005. These VA-adjusted case counts by age were used to generate 2005 VA-adjusted rates. A ratio between VA-adjusted rate and overall incidence rate yielded a VA-adjustment factor for each age-strata that can be used to adjust for 2005 underreporting in other situations. Similarly, the age-adjusted rates were used to calculate overall VA-age-adjusted factors. VA-adjustments were produced based on non-delay adjusted counts.

Results show that, due to the underreporting of the VACs, the overall cancer burden was underestimated by 1.6% for males and 0.05% for females for 2005. We examined the 10 leading cancer sites among all male VACs (females were a small fraction: less than 1%). Table 1 shows an estimate of the percent of missing cases by

cancer site and adjustment factors for 2005 age-adjusted rates for all SEER regions (excluding Louisiana).

Table 1. Estimated Proportion of Missing Cancer Cases for 2005, and VA-adjustment factor for Age-Adjusted Rate.

Rank based on counts	Cancer Site	Estimated Missing Cases (%) 2005†	VA Adjustment Factor for 2005 Age-Adjusted Rate¶
	All Sites Combined	1.6%	1.015
1	Prostate	1.4%	1.012
2	Lung and Bronchus	2.4%	1.023
3	Colorectal	1.5%	1.016
4	Urinary Bladder	1.0%	1.011
5	Head and Neck	2.4%	1.027
6	Melanomas - Skin	0.4%	1.005
7	Kidney and Renal Pelvis	2.0%	1.020
8	Leukemia	1.5%	1.015
9	NHL - Nodal	1.3%	1.013
10	Liver	2.5%	1.024

Based on information for Atlanta, Connecticut, Iowa, New Mexico, San Francisco, Utah, San Jose-Monterey, Los Angeles, Rural Georgia, Greater California, Kentucky, New Jersey and projected to SEER-17 (excluding Louisiana).
† Difference between average proportion based on 2000-2003 and 2005.
¶ Adjustment factors are generated for SEER-17 (excluding Louisiana) registry.

Table 1 shows that the proportion of missing cases varies by cancer site: the percent missing ranges from 2.5% for liver to 0.4% for melanomas of the skin.

ESTIMATING MISSING MALE VACS

We estimated the impact of missing male VACs for 2005 diagnosis year for the leading 10 cancer sites. Adjustments were estimated for both SEER-9 and SEER-17 regions and for age-adjusted as well as age-specific rates in 2005 to adjust for VA underreporting. Registries that were included to estimate missing case counts for SEER 9 are: Atlanta, Connecticut, Iowa, New Mexico, San-Francisco, and Utah, and for SEER-17 are: above plus Los Angeles, Rural Georgia, San-Jose, Greater California, Kentucky, and New Jersey. Separate adjustment factors were generated based on white and black male VACs. For white VACs, we calculated adjustment factors for age-adjusted rates

among the three leading cancer sites and all cancer sites combined for SEER-9 and SEER-17 regions. For black VACs, adjustment factors for age-adjusted rates were calculated for SEER-17 among the three leading cancer sites and all cancer sites combined. However, SEER-9 adjustment factors were only generated for all cancer sites combined by race. The numbers were too small to produce reliable adjustment factors for age-specific rates by race.

To calculate missing number of cases for male VACs, by cancer site, the following steps are performed:

Step 1:

The proportion of males VACs for each of the 19 age groups was determined for each year of diagnosis from 2000 through 2005. An average of the proportion for the years 2000, 2001, 2002 and 2003 was then calculated, denoted as **p.** This value, **p**, was subtracted from the 2005 proportion. Assuming a steady state, if there were missing male VACs in 2005, the proportion of 2005 male VACS would be smaller than the average proportion for 2000-2003, i.e., **p**. In that case, the difference between the mean of the prior years and 2005 proportion would be negative for age groups with missing cases. If there was a positive difference between **p** and the 2005 proportion for a given age group, we assumed that that age group had no underreporting for 2005 (i.e., zero missing cases).

Step 2:

A formula was derived to estimate missing male VACs cases for 2005. We need to determine how many VACs should be added to the 2005 total VAC counts so that the 2005 proportion stays consistent with the 2000-2003 average (**p**). Mathematically the formula can be written as follows:

$$\mathbf{p} = (\text{Count}_{\text{VA 2005}} + X) / (\text{Count}_{\text{Total 2005}} + X) \qquad (\text{equation 1})$$

or alternatively,

$$\mathbf{p} = (\text{Count}_{\text{VA 2005}} + X) / (\text{Count}_{\text{VA 2005}} + \text{Count}_{\text{NON-VA 2005}} + X) = \quad (\text{equation 2})$$

where X is the missing number of male VACs in 2005. Using equation 2, we can solve for X: $X = [\ (\mathbf{p}/(1-\mathbf{p})^* \text{Count}_{\text{NON-VA 2005}}) - \text{Count}_{\text{VA 2005}}\ ]$. This calculation is performed for each of the 19 age groups.

Assumptions we are making when estimating missing cases:
a) Proportion of male VACs remains constant 2000 onward
b) Previous male VACs have the same amount of delay as the Non-VACS.

ADJUSTING 2005 TOTAL CASE COUNT USING ESTIMATED MISSING MALE VACS:

The missing number of cases for each age group was used to adjust the 2005 total case count by adding back these missing cases.   In this way, rate correction factors were determined for each of the 19 age groups for the SEER-9 and SEER-17 registries, where the correction factor equals to the expected count divided by observed count. These cancer-site specific correction factors can be applied to age-specific rates or counts obtained from a SEER*stat run to adjust for underreporting of VACs in 2005.

Results

Correction factors for SEER-9 and SEER-17 age-adjusted rates are shown in Table 2. Table 3 shows the correction factors for all sites combined by race. Table 4 shows the effect of the VA undercount correction factors on long term trends. Table 5 provides the age-specific correction factors for all cancer sites combined for males. Tables 6-15 provide the age-specific correction factors for males for the top 10 cancer sites: head and neck (Table 6), liver (Table 7), prostate (Table 8), colon and rectum (Table 9), lung and bronchus (Table 10), melanoma (Table 11), urinary bladder (Table 12), kidney and renal pelvis (Table 13), non-Hodgkin lymphoma (Table 14), and leukemia (Table 15),

**Table 2: Correction Factors for 2005 Age-Adjusted Rates
All Races Combined, Males Only**

Primary Cancer Site	Correction Factor	
	SEER-9	SEER-17*
All Cancers Combined	0.60%	1.51%
Head and Neck	1.28%	2.68%
Colorectal	0.50%	1.60%
Liver	0.82%	2.42%
Lung and Bronchus	1.41%	2.33%
Melanomas - Skin	0.36%	0.51%
Prostate	0.26%	1.18%
Urinary Bladder	0.56%	1.09%
Kidney and Renal Pelvis	0.90%	1.97%
NHL - Nodal	0.78%	1.28%
Leukemia	0.66%	1.52%

*Louisiana is excluded from SEER-17

Table 3: Correction Factors for 2005 Age-Adjusted Rates By Race, Males Only

Primary Cancer Site	White		Black	
	SEER-9	SEER-17*	SEER-9^	SEER-17*
All Cancer Combined	0.93%	1.24%	4.22%	3.52%
Prostate	0.70%	1.00%		3.25%
Lung and Bronchus	1.37%	1.75%		5.63%
Colorectal	0.83%	1.36%		2.96%

*Louisiana is excluded from SEER-17

^ The site-specific numbers were too small for blacks in SEER 9 to estimate a correction factor

Table 4: Comparison of Long-term Incidence Trends with and without VA-Adjustment(a) on 2005 Delay-Adjusted Incidence Rate in SEER-9 for Males & Selected Cancer Sites.
Joinpoint analyses for 1975-2005(b)

Cancer site	Race	Joinpoint Trend 1 Year Range	Joinpoint Trend 1 APC(c)	Joinpoint Trend 2 Year Range	Joinpoint Trend 2 APC(c)	Joinpoint Trend 3 Year Range	Joinpoint Trend 3 APC(c)	Joinpoint Trend 4 Year Range	Joinpoint Trend 4 APC(c)	Joinpoint Trend 5 Year Range	Joinpoint Trend 5 APC(c)
All sites, Delay-adjusted	All	1975-1989	1.3*	1989-1992	5.2*	1992-1995	-4.8*	1995-2001	0.3	2001-2005	-1.8*
All sites, Delay- & VA-adjusted(d)	All	1975-1989	1.3*	1989-1992	5.2*	1992-1995	-4.8*	1995-2001	0.3	2001-2005	-1.7*
All sites, Delay-adjusted	White	1975-1989	1.4*	1989-1992	5.0*	1992-1995	-5.0*	1995-2001	0.6	2001-2005	-1.6*
All sites, Delay- & VA-adjusted(d)	White	1975-1989	1.4*	1989-1992	5.0*	1992-1995	-5.0*	1995-2001	0.6	2001-2005	-1.5*
All sites, Delay-adjusted	Black	1975-1981	2.8*	1981-1989	0.7	1989-1992	6.8*	1992-2005	-1.7*		
All sites, Delay- & VA-adjusted(d)	Black	1975-1981	2.8*	1981-1989	0.6*	1989-1992	7.6*	1992-1995	-2.9	1995-2005	-1.3*
Oral cavity and pharynx, Delay-adjusted	All	1975-2005	-1.2*								
Oral cavity and pharynx, Delay- & VA -adjusted	All	1975-2005	-1.2*								
Colon and rectum, Delay-adjusted	All	1975-1985	1.1*	1985-1991	-1.2*	1991-1995	-3.1*	1995-1998	1.9	1998-2005	-2.8*
Colon and rectum, Delay- & VA-adjusted	All	1975-1985	1.1*	1985-1991	-1.2*	1991-1995	-3.1*	1995-1998	1.9	1998-2005	-2.8*
Liver and intrahepatic bile duct, Delay-adjusted	All	1975-2005	3.6*								
Liver and intrahepatic bile duct, Delay- & VA-adjusted	All	1975-2005	3.6*								
Lung and bronchus, Delay-adjusted	All	1975-1982	1.5*	1982-1991	-0.5	1991-2005	-1.8*				
Lung and bronchus, Delay- & VA-adjusted(d)	All	1975-1982	1.5*	1982-1991	-0.5	1991-2005	-1.7*				
Melanoma of the skin, Delay-adjusted	All	1975-1985	5.4*	1985-2000	3.4*	2000-2003	-0.2	2003-2005	7.7*		
Melanoma of the skin, Delay- & VA-adjusted(d)	All	1975-1985	5.4*	1985-2000	3.4*	2000-2003	-0.2	2003-2005	7.9*		
Prostate, Delay-adjusted	All	1975-1988	2.6*	1988-1992	16.5*	1992-1995	-11.5*	1995-2001	2.1*	2001-2005	-4.4*
Prostate, Delay- & VA-adjusted(d)	All	1975-1988	2.6*	1988-1992	16.5*	1992-1995	-11.5*	1995-2001	2.1*	2001-2005	-4.3*
Urinary bladder, Delay-adjusted	All	1975-1986	0.9*	1986-2005	0.0						
Urinary bladder, Delay- & VA-adjusted	All	1975-1986	0.9*	1986-2005	0.0						
Kidney and renal pelvis, Delay-adjusted	All	1975-2005	1.8*								
Kidney and renal pelvis, Delay- & VA-adjusted	All	1975-2005	1.8*								
Non-Hodgkin lymphoma, Delay-adjusted	All	1975-1991	4.2*	1991-2005	0.4*						
Non-Hodgkin lymphoma, Delay- & VA-adjusted	All	1975-1991	4.2*	1991-2005	0.4*						
Leukemia, Delay-adjusted	All	1975-2005	0.1								
Leukemia, Delay- & VA-adjusted	All	1975-2005	0.1								

Footnotes to Table 4

SEER = Surveillance, Epidemiology, and End Results; APC = annual percent change; NOS = not otherwise specified.

Source: SEER 9 areas covering about 10% of the U.S. population (Connecticut, Hawaii, Iowa, Utah, and New Mexico, and the metropolitan areas of San Francisco, Detroit, Atlanta, and Seattle-Puget Sound).

(a) VA-adjustment was generated for SEER-9 regions.

(b) Joinpoint analyses with up to four joinpoints are based on rates per 100,000 persons and were age-adjusted to the 2000 U.S. standard population (19 age groups - Census p25-1130). Joinpoint (JP) Regression Program, Version 3.3.1. April 2008, National Cancer Institute.

(c) APC is based on rates that were age-adjusted to the 2000 U.S. standard population (19 age groups - Census p25-1130).

(d) At least one of the APCs changed based on correcting the 2005 rate for VA undercount.

(*) APC is statistically significantly different from zero (two-sided P<0.05).

Table 5: Correction Factors for 2005 Age-Specific Rates, All Cancer Sites Combined, Males Only, All Races

Age at Diagnosis	Correction Factor	
	SEER-9	SEER-17*
00 years	0.00%	0.00%
01-04 years	0.00%	0.00%
05-09 years	0.00%	0.00%
10-14 years	0.00%	0.00%
15-19 years	0.00%	0.00%
20-24 years	0.15%	0.24%
25-29 years	0.60%	0.44%
30-34 years	0.11%	0.23%
35-39 years	0.00%	0.12%
40-44 years	0.56%	0.64%
45-49 years	0.27%	1.05%
50-54 years	1.85%	2.70%
55-59 years	0.00%	0.90%
60-64 years	0.00%	1.32%
65-69 years	1.32%	2.06%
70-74 years	0.45%	1.51%
75-84 years	0.66%	1.51%
85+ years	0.00%	0.26%

*Louisiana is excluded from SEER-17

Table 6: Correction Factors for 2005 Age-Specific Rates, Cancer of the Head and Neck, Males Only, All Races

Age at Diagnosis	Correction Factor	
	SEER-9	SEER-17
00 years	0.00%	0.00%
01-04 years	0.00%	0.00%
05-09 years	0.00%	0.00%
10-14 years	0.00%	0.00%
15-19 years	0.00%	0.00%
20-24 years	0.00%	1.54%
25-29 years	0.00%	0.00%
30-34 years	0.00%	0.00%
35-39 years	0.00%	0.27%
40-44 years	0.68%	1.86%
45-49 years	1.40%	2.71%
50-54 years	2.89%	5.05%
55-59 years	0.00%	1.20%
60-64 years	0.00%	2.25%
65-69 years	2.65%	3.50%
70-74 years	0.00%	2.24%
75-84 years	0.00%	0.90%
85+ years	0.00%	0.00%

*Louisiana is excluded from SEER-17

Table 7: Correction Factors for 2005 Age-Specific Rates, Cancer of the Liver, Males Only, All Races

Age at Diagnosis	Correction Factor	
	SEER-9	SEER-17
00 years	0.00%	0.00%
01-04 years	0.00%	0.00%
05-09 years	0.00%	0.00%
10-14 years	0.00%	0.00%
15-19 years	0.00%	0.00%
20-24 years	0.00%	0.00%
25-29 years	0.00%	0.00%
30-34 years	0.00%	0.00%
35-39 years	0.00%	0.00%
40-44 years	1.07%	0.00%
45-49 years	0.22%	1.74%
50-54 years	0.00%	3.13%
55-59 years	0.52%	2.56%
60-64 years	0.00%	2.34%
65-69 years	1.24%	3.77%
70-74 years	0.64%	1.55%
75-84 years	2.52%	2.63%
85+ years	0.54%	1.87%

*Louisiana is excluded from SEER-17

Table 8: Correction Factors for 2005 Age-Specific Rates, Cancer of the Prostate, Males Only, All Races

	Correction Factor	
Age at Diagnosis	**SEER-9**	**SEER-17**
00 years	0.00%	0.00%
01-04 years	0.00%	0.00%
05-09 years	0.00%	0.00%
10-14 years	0.00%	0.00%
15-19 years	0.00%	0.00%
20-24 years	0.00%	0.00%
25-29 years	0.00%	0.00%
30-34 years	0.00%	0.00%
35-39 years	0.00%	1.31%
40-44 years	0.00%	0.00%
45-49 years	0.00%	0.05%
50-54 years	1.49%	2.06%
55-59 years	0.00%	0.39%
60-64 years	0.00%	1.07%
65-69 years	0.89%	1.91%
70-74 years	0.00%	1.12%
75-84 years	0.43%	1.43%
85+ years	0.00%	0.08%

*Louisiana is excluded from SEER-17

Table 9: Correction Factor for 2005 Age-Specific Rates, Cancers of the Colon and Rectum, Males Only, All Races

Age at Diagnosis	Correction Factor	
	SEER-9	SEER-17
00 years	0.00%	0.00%
01-04 years	0.00%	0.00%
05-09 years	0.00%	0.00%
10-14 years	0.00%	0.00%
15-19 years	0.00%	0.00%
20-24 years	0.00%	1.26%
25-29 years	1.00%	0.48%
30-34 years	0.62%	0.43%
35-39 years	0.26%	0.00%
40-44 years	0.00%	0.00%
45-49 years	0.03%	0.57%
50-54 years	1.42%	2.34%
55-59 years	0.67%	1.61%
60-64 years	0.00%	0.89%
65-69 years	1.23%	1.85%
70-74 years	0.39%	1.56%
75-84 years	0.00%	1.39%
85+ years	0.00%	0.10%

*Louisiana is excluded from SEER-17

Table 10: Correction Factors for 2005 Age-Specific Rates, Cancers of the Lung and Bronchus, Males Only, All Races

Age at Diagnosis	Correction Factor	
	SEER-9	**SEER-17**
00 years	0.00%	0.00%
01-04 years	0.00%	0.00%
05-09 years	0.00%	0.00%
10-14 years	0.00%	0.00%
15-19 years	0.00%	0.00%
20-24 years	0.00%	0.00%
25-29 years	0.00%	1.82%
30-34 years	0.00%	0.00%
35-39 years	0.00%	0.00%
40-44 years	1.78%	0.75%
45-49 years	0.00%	2.44%
50-54 years	2.77%	3.98%
55-59 years	0.09%	1.45%
60-64 years	0.11%	1.96%
65-69 years	1.91%	2.56%
70-74 years	2.07%	2.44%
75-84 years	1.14%	1.99%
85+ years	0.53%	0.77%

*Louisiana is excluded from SEER-17

Table 11: Correction Factors for 2005 Age-Specific Rates, Melanoma of the Skin, Males Only, All Races

	Correction Factor	
Age at Diagnosis	**SEER-9**	**SEER-17**
00 years	0.00%	0.00%
01-04 years	0.00%	0.00%
05-09 years	0.00%	0.00%
10-14 years	0.00%	0.00%
15-19 years	0.00%	0.00%
20-24 years	0.00%	0.00%
25-29 years	0.85%	0.79%
30-34 years	0.00%	0.00%
35-39 years	0.20%	0.08%
40-44 years	0.15%	0.15%
45-49 years	0.69%	0.75%
50-54 years	0.22%	0.89%
55-59 years	0.32%	0.30%
60-64 years	0.00%	0.40%
65-69 years	1.18%	0.95%
70-74 years	0.12%	0.80%
75-84 years	0.00%	0.11%
85+ years	1.30%	0.54%

*Louisiana is excluded from SEER-17

Table 12: Correction Factors for 2005 Age-Specific Rates, Cancer of the Urinary Bladder, Males Only, All Races

	Correction Factor	
Age at Diagnosis	**SEER-9**	**SEER-17**
00 years	0.00%	0.00%
01-04 years	0.00%	0.00%
05-09 years	0.00%	0.00%
10-14 years	0.00%	0.00%
15-19 years	0.00%	0.00%
20-24 years	0.00%	0.00%
25-29 years	0.00%	0.00%
30-34 years	0.00%	0.00%
35-39 years	0.00%	0.00%
40-44 years	0.43%	0.44%
45-49 years	0.00%	0.66%
50-54 years	2.04%	1.25%
55-59 years	0.00%	0.00%
60-64 years	0.50%	1.28%
65-69 years	2.13%	2.08%
70-74 years	0.00%	0.73%
75-84 years	0.00%	0.95%
85+ years	0.00%	0.11%

*Louisiana is excluded from SEER-17

Table 13: Correction Factors for 2005 Age-Specific Rates, Cancers of the Kidney and Renal Pelvis, Males Only, All Races

	Correction Factor	
Age at Diagnosis	**SEER-9**	**SEER-17**
00 years	0.00%	0.00%
01-04 years	0.00%	0.00%
05-09 years	0.00%	0.00%
10-14 years	0.00%	0.00%
15-19 years	0.00%	0.00%
20-24 years	0.00%	6.00%
25-29 years	0.00%	0.86%
30-34 years	0.00%	0.00%
35-39 years	0.00%	1.33%
40-44 years	0.95%	1.58%
45-49 years	1.31%	1.46%
50-54 years	2.57%	3.27%
55-59 years	0.00%	1.85%
60-64 years	0.00%	1.37%
65-69 years	0.00%	0.89%
70-74 years	2.86%	2.94%
75-84 years	0.90%	2.16%
85+ years	0.00%	0.45%

*Louisiana is excluded from SEER-17

Table 14: Correction Factors for 2005 Age-Specific Rates, Non-Hodgkin Lymphoma - Nodal, Males Only, All Races

Age at Diagnosis	Correction Factor	
	SEER-9	SEER-17
00 years	0.00%	0.00%
01-04 years	0.00%	0.00%
05-09 years	0.00%	0.00%
10-14 years	0.00%	0.00%
15-19 years	0.00%	0.00%
20-24 years	0.00%	0.00%
25-29 years	0.00%	0.00%
30-34 years	0.47%	0.60%
35-39 years	0.00%	0.00%
40-44 years	0.49%	1.11%
45-49 years	0.00%	1.14%
50-54 years	1.14%	2.48%
55-59 years	1.51%	1.49%
60-64 years	0.00%	0.95%
65-69 years	1.19%	1.34%
70-74 years	0.00%	0.44%
75-84 years	1.65%	1.66%
85+ years	0.00%	0.10%

*Louisiana is excluded from SEER-17

Table 15: Correction Factors for 2005 Age-Specific Rates, Leukemia, Males Only, All Races

Age at Diagnosis	Correction Factor	
	SEER-9	SEER-17
00 years	0.00%	0.00%
01-04 years	0.00%	0.00%
05-09 years	0.00%	0.00%
10-14 years	0.00%	0.00%
15-19 years	0.00%	0.00%
20-24 years	0.00%	0.36%
25-29 years	1.74%	0.86%
30-34 years	0.00%	0.00%
35-39 years	0.58%	0.82%
40-44 years	0.00%	0.29%
45-49 years	1.00%	1.24%
50-54 years	3.04%	2.44%
55-59 years	1.73%	2.30%
60-64 years	0.00%	1.43%
65-69 years	0.00%	1.76%
70-74 years	0.00%	1.66%
75-84 years	0.49%	1.33%
85+ years	0.12%	0.95%

*Louisiana is excluded from SEER-17