AMI COHORT—LONG AND SHORT TERM MORTALITY RESULTS

Comparison of Mortality in VA Patients with AMI1

National Trends in Mortality in VA Patients with AMI

National trends in mortality over time. There was a trend towards decreased adjusted mortality over the period FY 1994 to 1999 (Figure C1)[2]. Analyses at fixed time points after the AMI confirmed this trend towards decreased mortality, although the trends were not statistically significant (Table C1).

Table C1
Adjusted Mortality in VA Patients with an AMI, all cohort years

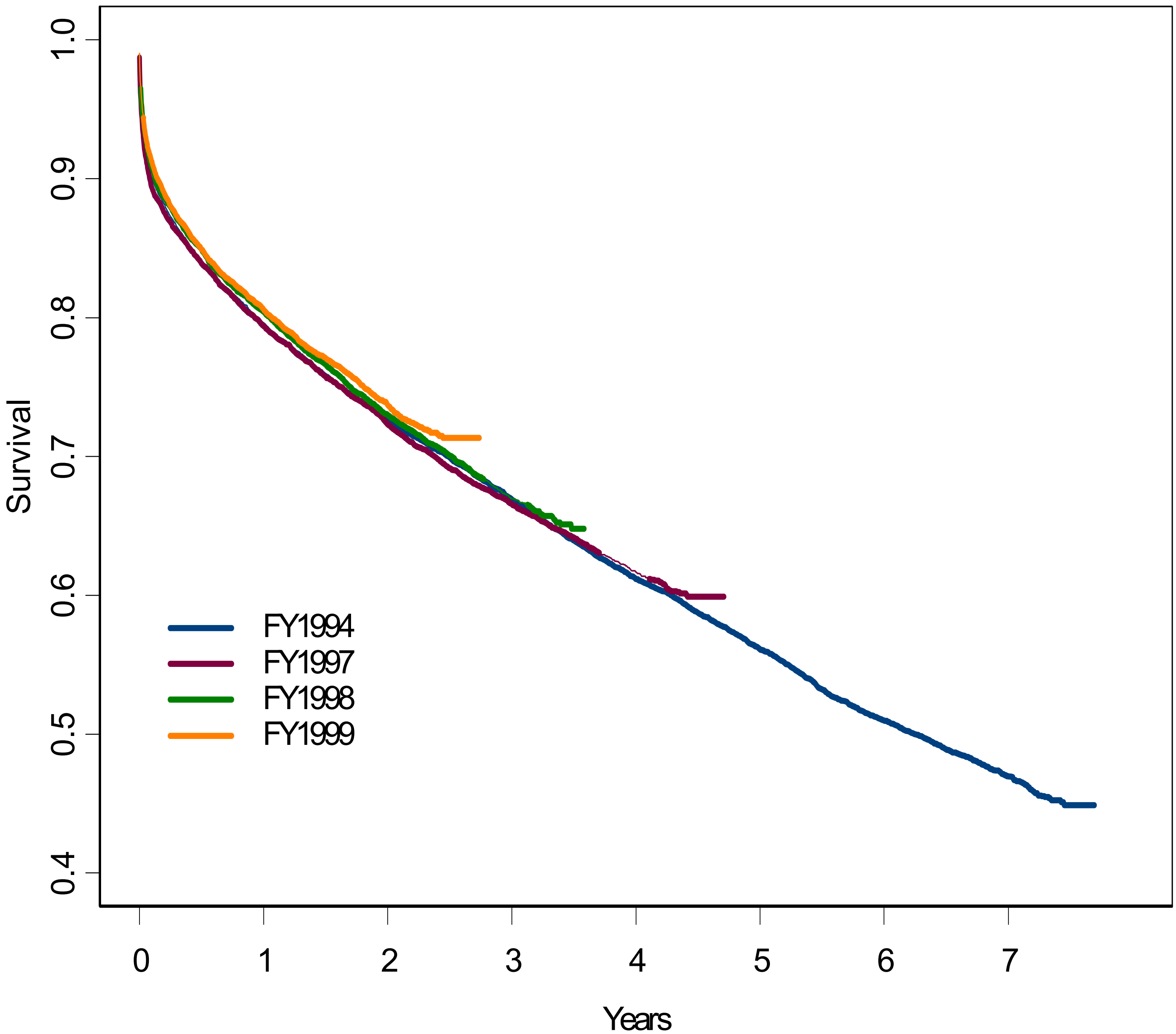
	Cohort				Statistically[a] Significant Trend?
	FY 1994 (n=8677)	FY 1997 (n=8135)	FY 1998 (n=8353)	FY 1999 (n=8664)	
30 Day Mortality (%)	10.6	10.0	9.8	9.7	N
1 Year Mortality (%)	21.9	21.1	20.9	20.7	N
2 Year Mortality (%)	28.6	28.5	27.4	NA	N
3 Year Mortality (%)	34.5	34.1	NA	NA	N
6 Year Mortality (%)	50.8	NA	NA	NA	NA

[a] at the 10% level

[1] All of the data presented in this section represent *adjusted* values to account for possible differences in disease severity across cohort years, VISNs and demographic subgroups. However, in Tables AC1 and AC2 of the appendix, unadjusted values are presented for completeness.

[2] Because of our concerns that differences across cohorts would not be constant over the years of follow-up, violating the proportional hazard assumption required for Cox regression models, we relied on hierarchical logistic regression models fit to binary measures of mortality at fixed time points after AMI to test for differences in mortality across cohort years.

Figure C1
Adjusted Survival in VA Patients following an AMI
FY 1994-1999



<u>Adjusted mortality by demographic subgroup</u>. Adjusted mortality was higher among male veterans compared to females, particularly 2 to 4 years following the AMI (Figure C2)[3]. When data were pooled across all cohorts (FY 1994, 1997-1999), we found that male veterans had significantly[4] higher adjusted mortality rates at 2 and 3 years following their AMI compared to similar females (Table C2). There were also differences in adjusted mortality across racial groups (Table C2 and Figure C3)[5]. African Americans had significantly[6] lower adjusted mortality at both 30 days and 1 year, but as indicated in the section on utilization, they were significantly less likely to receive catheterization, PCI or CABG within 30 days following admission. Thus, if there is a benefit from these procedures over the long term, the surgical operative mortality may prevent seeing such benefit over the short term (i.e., 30 days and 1 year following admission) for non African Americans. When we pooled cohorts for which long-term mortality data were available we found no significant differences in adjusted mortality between African Americans and white veterans at 2, 3 or 6 years post-AMI. The adjusted survival curves for African Americans and white veterans cross between 3 and 4 years (Figure C3), after which white veterans have lower mortality than did African Americans (although the differences at 6 years were not statistically significant (Table C2)). There were no significant differences in short- or long-term mortality between Hispanic and white veterans.

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[3] Because of our concerns that differences across demographic subgroups would not be constant over the years of follow-up, violating the proportional hazard assumption required for Cox regression models, we relied on the hierarchical logistic regression models fit to binary measures of mortality at fixed time points after AMI to test for differences in mortality across demographic subgroups.

[4] These differences were statically significant at 10% level but not at 5% level.

[5] Race data were not available for approximately 2 to 4% of the veterans in each cohort and there were a small number of veterans representing other racial groups. We included these patients in the regression models, but because of difficulty in the interpretation of results for patients with missing race data and small numbers of patients in other racial categories, we only present comparisons of white, African American, and Hispanic patients.

[6] Differences at 1 year were statistically significant at 10% but not at a 5% level; differences at 30 days were statistically significant at a 5% level.

Figure C2
Adjusted Survival in VA Patients following an AMI
FY 1994-1999

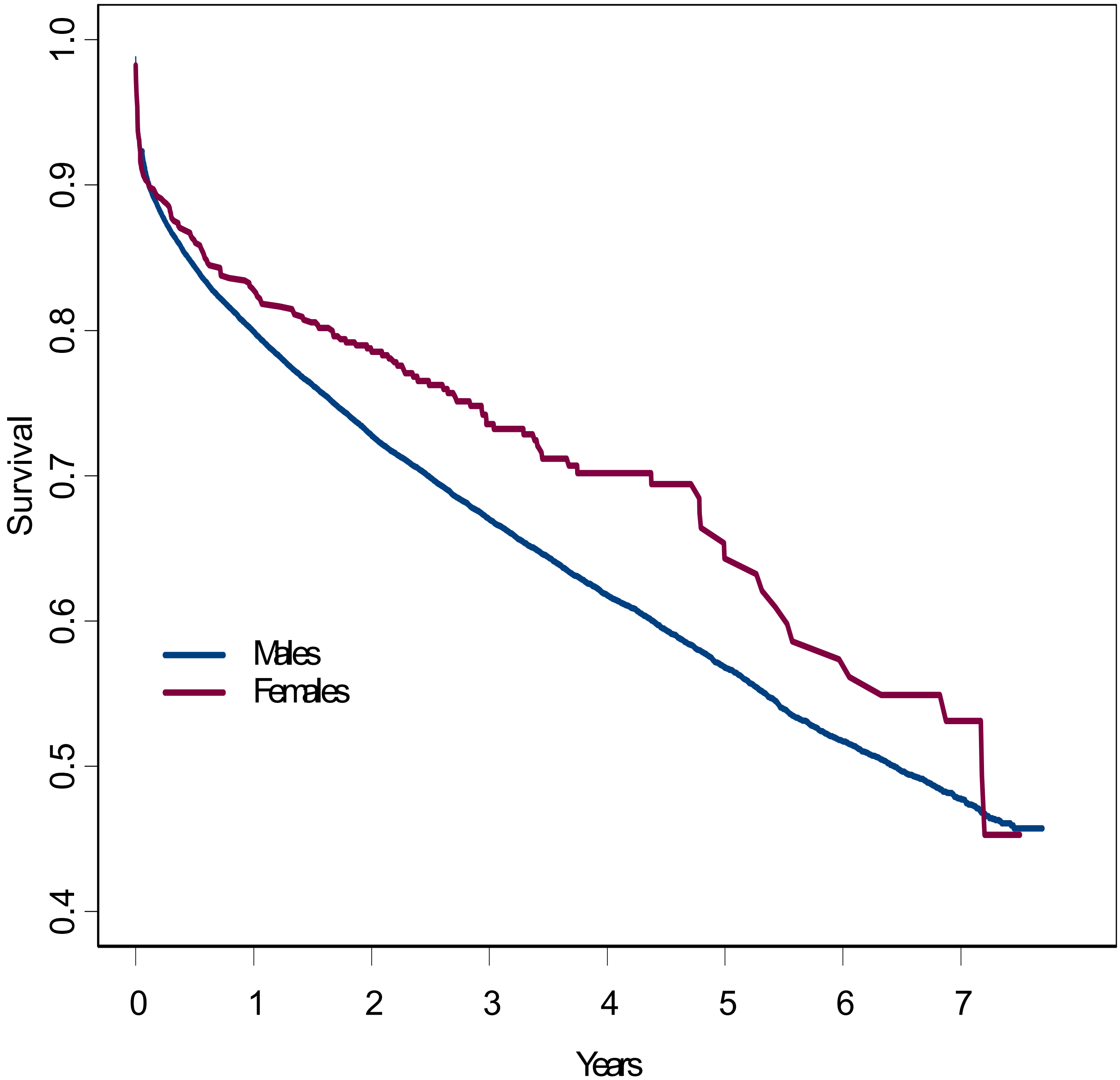


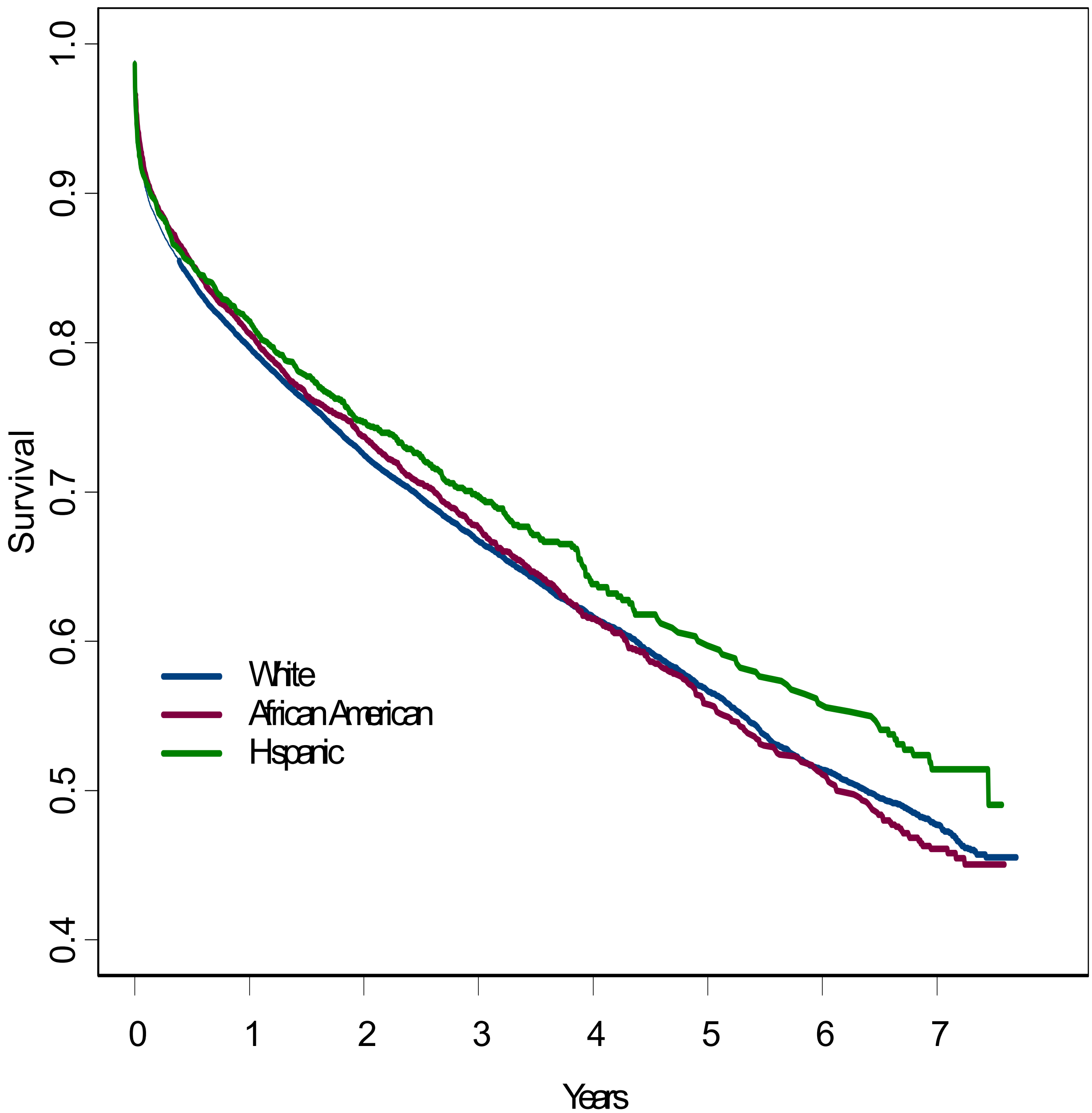
Table C2
Adjusted Odds-Ratios Comparing Mortality in Demographic Subgroups
(Combining data across cohorts)

	Males compared to Females	African Americans compared to Whites	Hispanics compared to Whites
30 Day Mortality			
Odds ratio (94, 97-99 cohorts)	0.92	**0.86**	1.00
90% CI	(0.73, 1.16)	**(0.78, 0.94)**	(0.85, 1.16)
1 year Mortality			
Odds ratio (94, 97-99 cohorts)	1.16	**0.91**[a]	0.89
90% CI	(0.93, 1.44)	**(0.84, 0.99)**	(0.78, 1.02)
2 year Mortality			
Odds ratio (94, 97-98 cohorts)	**1.29**[a]	0.94	0.89
90% CI	**(1.03, 1.60)**	(0.87, 1.02)	(0.78, 1.02)
3 year Mortality			
Odds ratio (94 & 97 cohorts)	**1.30**[a]	0.94	0.90
90% CI	**(1.01, 1.69)**	(0.85, 1.02)	(0.77, 1.04)
6 year Mortality			
Odds ratio (94 cohort)	1.05	1.02	0.90
90% CI	(0.72, 1.52)	(0.89, 1.17)	(0.74, 1.09)

[a] Not significant at 5% level

Bolded numbers represent significant differences at a 10% level

Figure C3
Adjusted Survival in VA Patients following an AMI
FY 1994-1999



Variation in Mortality in VA Patients with AMI Across Networks

There was some variation across networks (VISNs) in adjusted mortality (Table C3). For example, the mortality rates at 30 days after AMI differed by 7 percentage points—from a low of 6% in VISN 22 to a high of 13% in VISN 2. There were fewer differences across VISNs in adjusted 6-year mortality. However, our power to detect differences in six-year mortality across VISNs was limited by the available sample sizes, since these results are based on a single cohort of patients from FY 1994. Specific data on mortality at fixed time points are described next.

Table C3
Variation in Adjusted Mortality in VA Patients with an AMI Across VISNs

	National Average (%)	Lowest VISN		Highest VISN		Difference (%)
		VISN	Mortality (%)	VISN	Mortality (%)	
30 Day Mortality (%) (FY 1999)	9.7	**22**	**6.3**	**2**	**13.1**	6.8
1 Year Mortality (%) (FY 1999)	20.7	**20**	**16.7**	3	24.3	7.6
2 Year Mortality (%) (FY 1998)	27.4	**19**	**23.3**	**9**	**32.4**	9.1
3 Year Mortality (%) (FY 1997)	34.1	**13**	**29.2**	**18**	**39.6**	10.4
6 Year Mortality (%) (FY 1994)	50.8	5	49.5	14	51.8	2.3

Bolded numbers represent VISNs with significantly lower or higher mortality than the national average at a 10% level.

Thirty-day and 1-year mortality rates. The 30-day adjusted mortality rates in the FY 1994, 1997, 1998 and 1999 cohorts were 10.6% (90% CI=[7.1, 14.9]), 10.0% [8.4, 11.7], 9.8% [8.6, 11.0], and 9.7% [8.6, 10.8], respectively. In FY 1999, VISNs 2, 7 and 16 had higher 30-day mortality and VISNs 6 and 22 had lower 30-day mortality compared to the national average (Figure C4a). Over the period FY 1994 to 1999, there was a non-significant negative trend in national thirty-day mortality rates (p-value for linear trend >0.10). The 30-day mortality rate decreased significantly over this time period in VISNs 11 and 22 (Figure C4b)[7]. The rate did not increase over this time period in any VISN.

The 1-year adjusted mortality rates in the FY 1994, 1997, 1998 and 1999 cohorts were 21.9% (90% CI=[15.3, 29.5]), 21.1% [18.1, 24.4], 20.9% [18.8, 23.1], and 20.7% [18.9, 22.5], respectively. In FY 1999, VISN 20 had lower adjusted 1-year mortality compared to average; no VISN had higher than average 1-year mortality (Figure C5a). Over the period FY 1994 to 1999, there was a non-significant negative trend in national 1-year mortality rates (p-value for linear trend >0.10). One-year mortality rates decreased over this time period in VISNs 11 and 17 (Figure C5b)[8]. The rate did not increase over this time period in any VISN.

[7] The Appendix shows by VISN time trends from FY 1994 to 1999. (Appendix-Figure AC1)

[8] The Appendix shows by VISN time trends from FY 1994 to 1999. (Appendix-Figure AC2)

Figure C4a

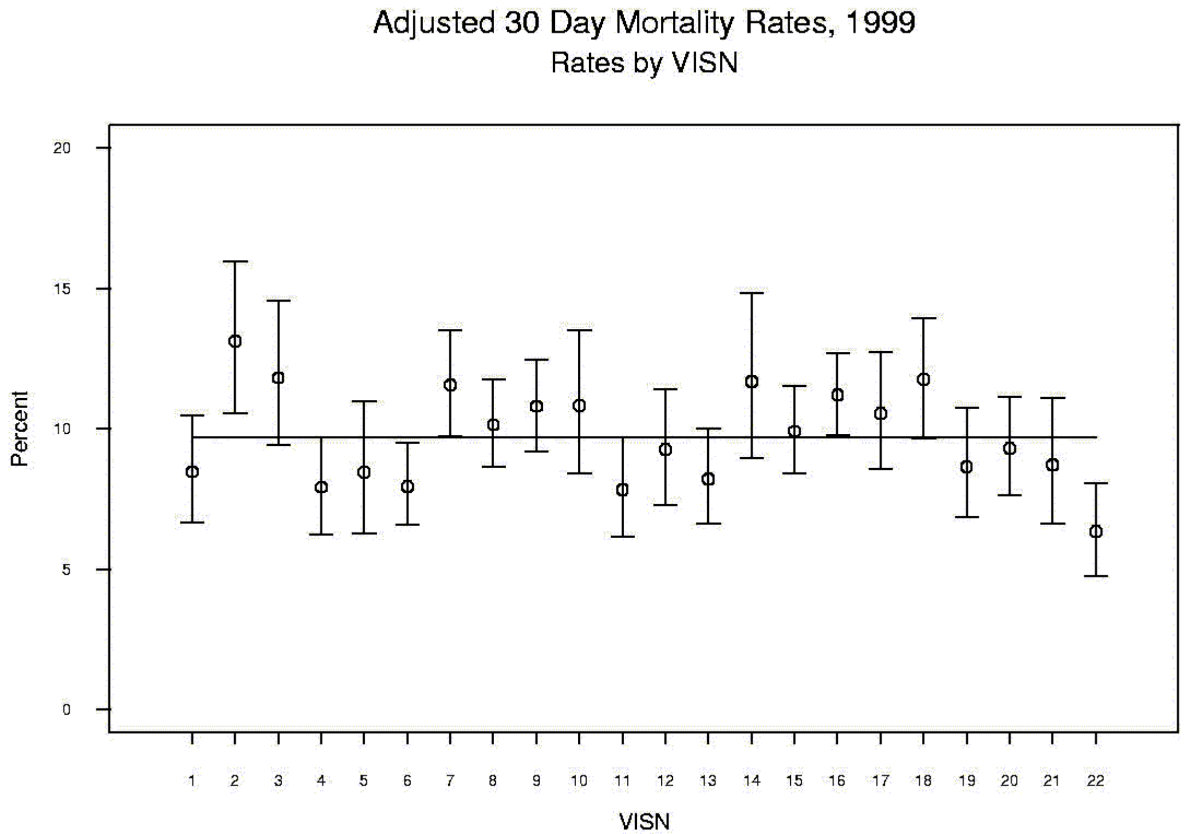


Figure C4b

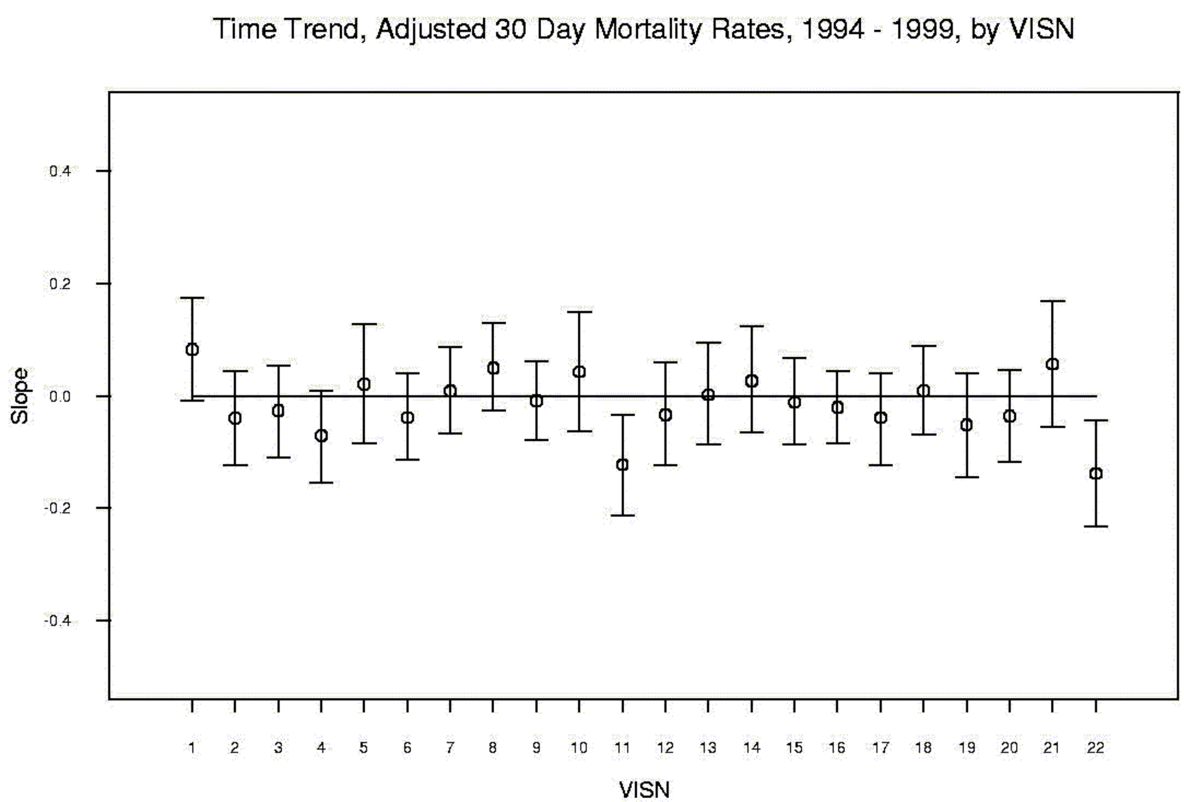


Figure C5a

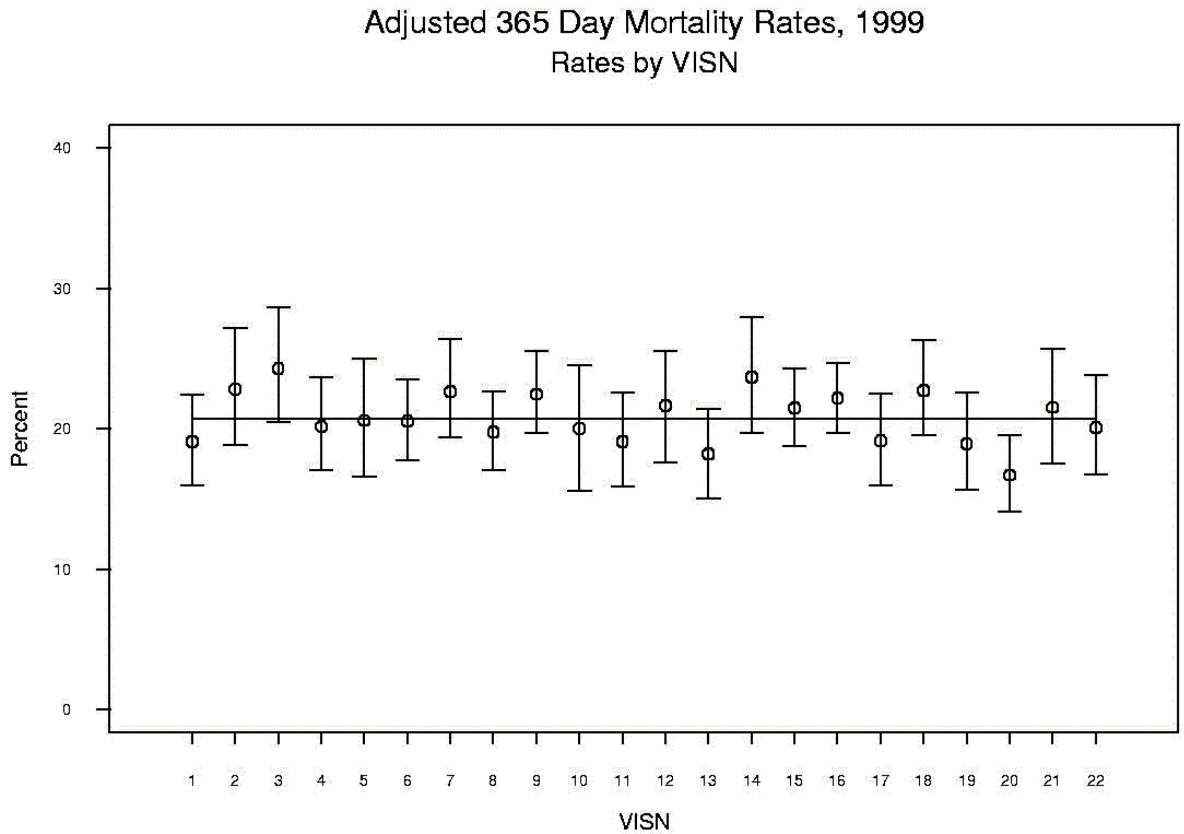
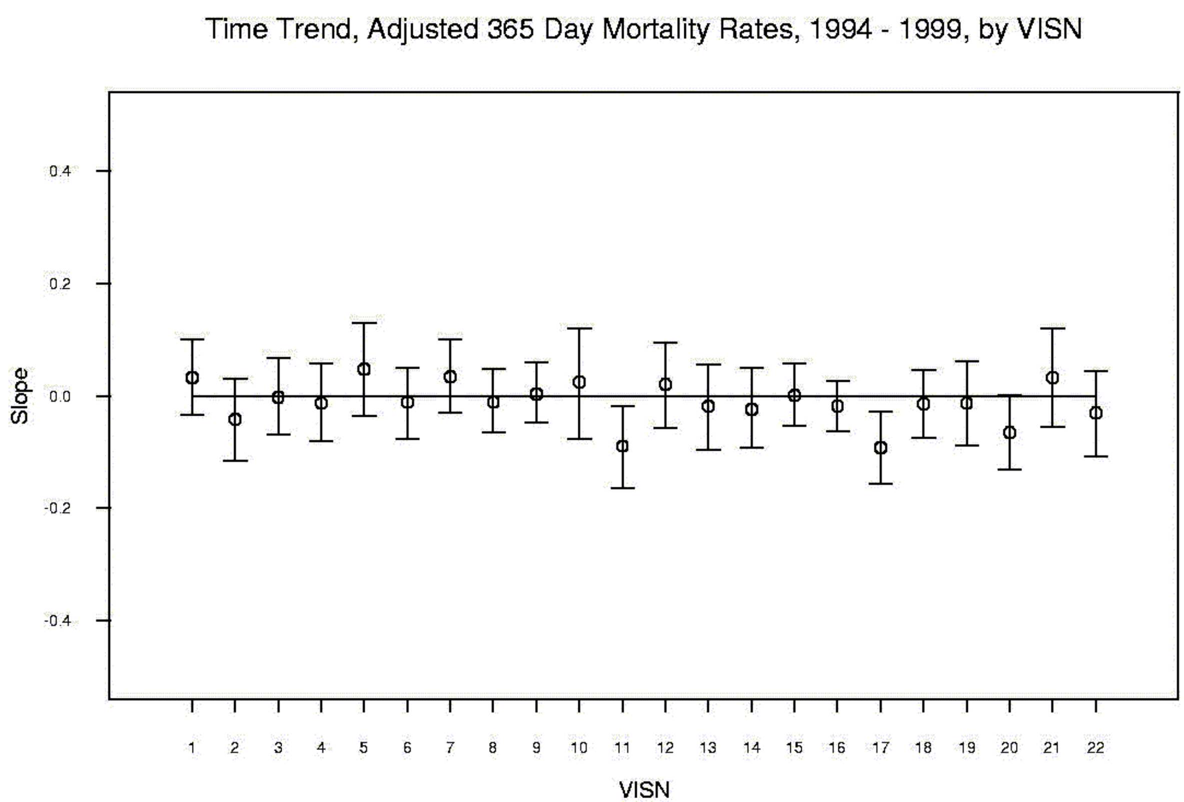


Figure C5b



Two-year and longer mortality rates. The adjusted two-year mortality rates in the FY 1994, 1997 and 1998 cohorts were 28.6% [26.5, 30.8], 28.5% [26.2, 30.8], and 27.4% [25.2, 29.5], respectively, the adjusted three-year mortality rates in the FY 1994 and 1997 cohorts were 34.5% [32.1, 36.9] and 34.1% [31.7, 36.7] respectively, and the adjusted six-year mortality rate in the FY 1994 cohort was 50.8% [49.6, 52.0]. There were no differences in adjusted 6-year mortality rates across networks (Figure C6a). However, our power to detect differences in long-term mortality across VISNs was limited by the available sample sizes, especially for 6-year mortality since these results are based on a single cohort of patients from FY 1994. There were few consistent patterns across networks in 2 and 3-year mortality rates (Figure C6b-C6f). In FY 1997, VISNs 1 and 13 had lower 3-year mortality and VISN 18 had higher 3-year mortality compared to the national average (Figure C6b). In FY 1994, VISNs 5 and 19 had lower 3-year mortality compared to the national average (Figure C6c). In FY 1998, VISNs 9 and 16 had higher 2-year mortality and VISN 19 had lower 2-year mortality compared to average (Figure C6d). In FY 1997, VISN 1 had lower and VISN 18 had higher 2-year mortality compared to average (Figure C6e). Finally in FY 1994, VISN 5 had lower 2-year mortality compared to national average (Figure C6f).

Figure C6a

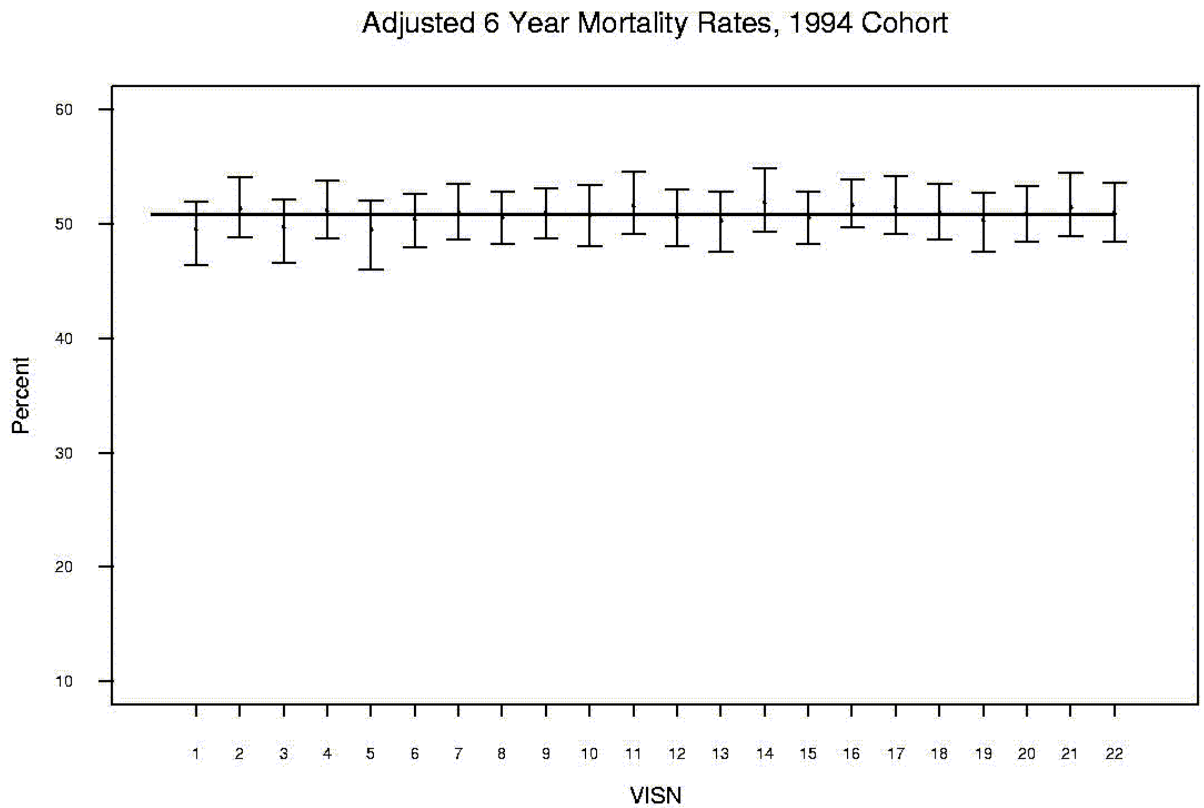


Figure C6b

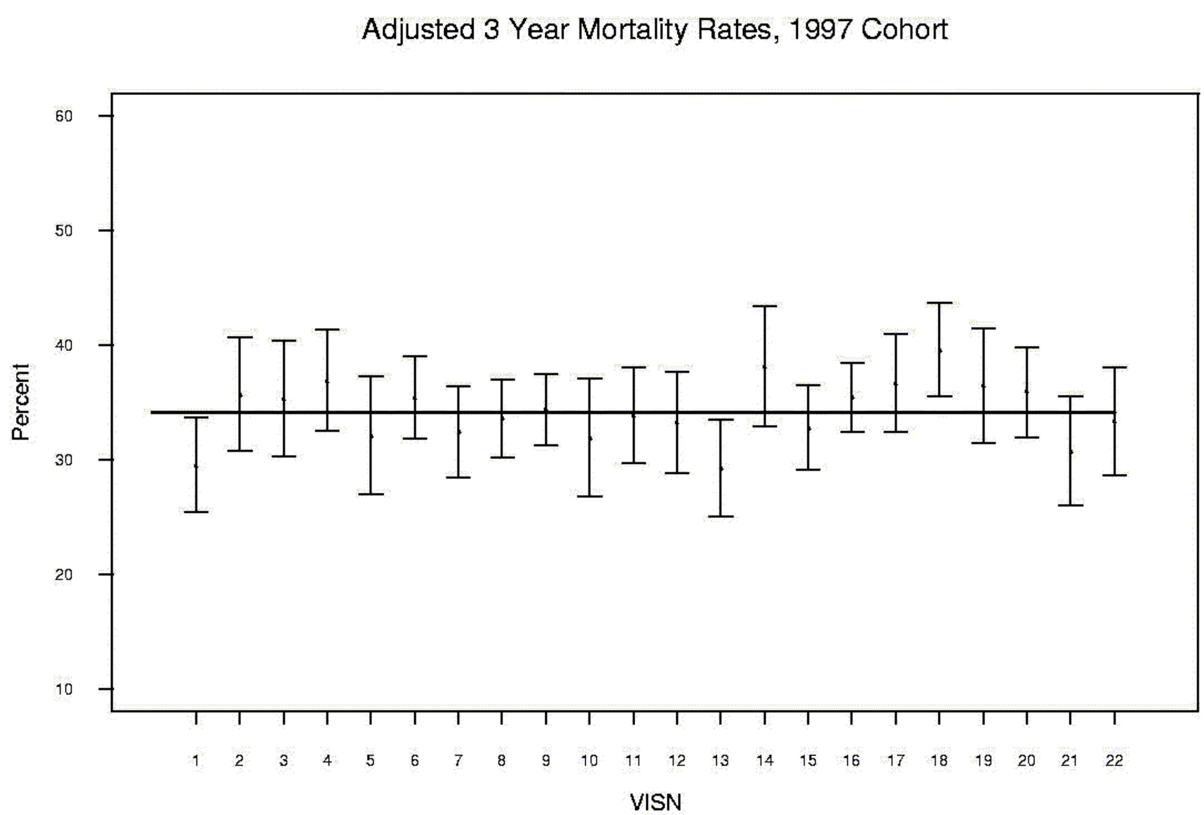


Figure C6c

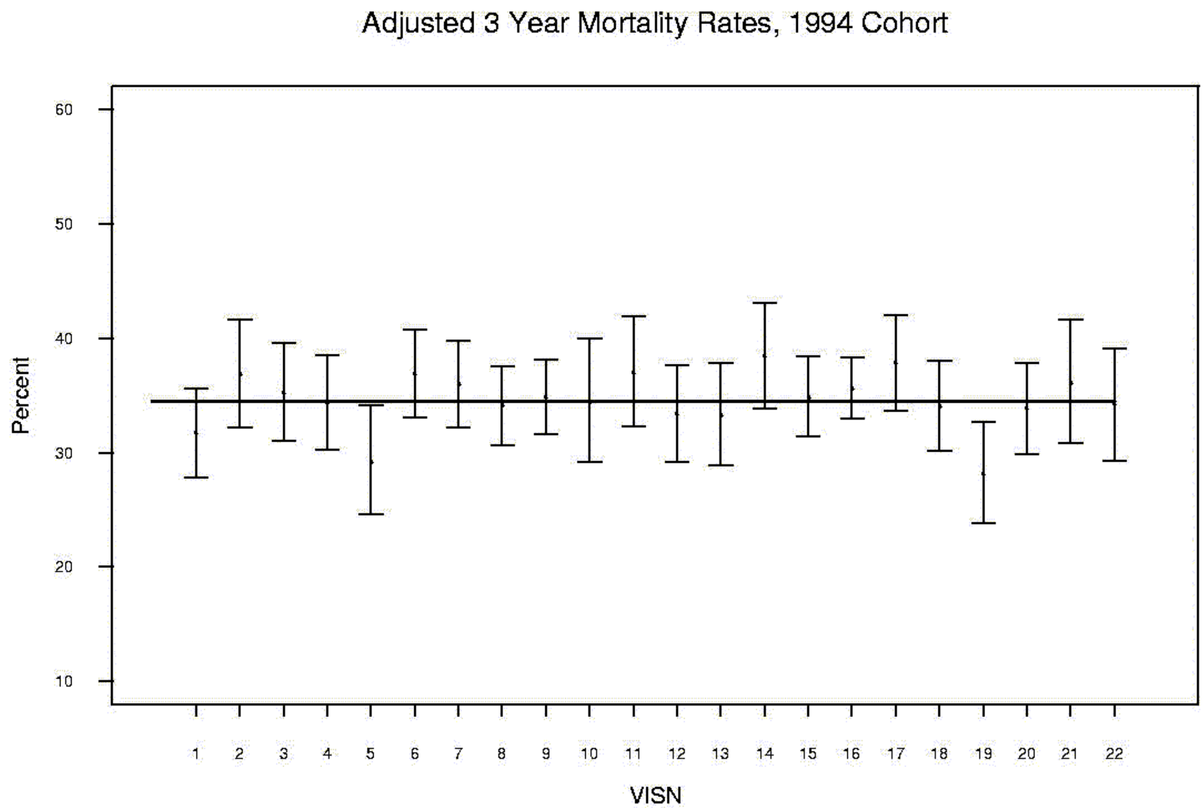


Figure C6d

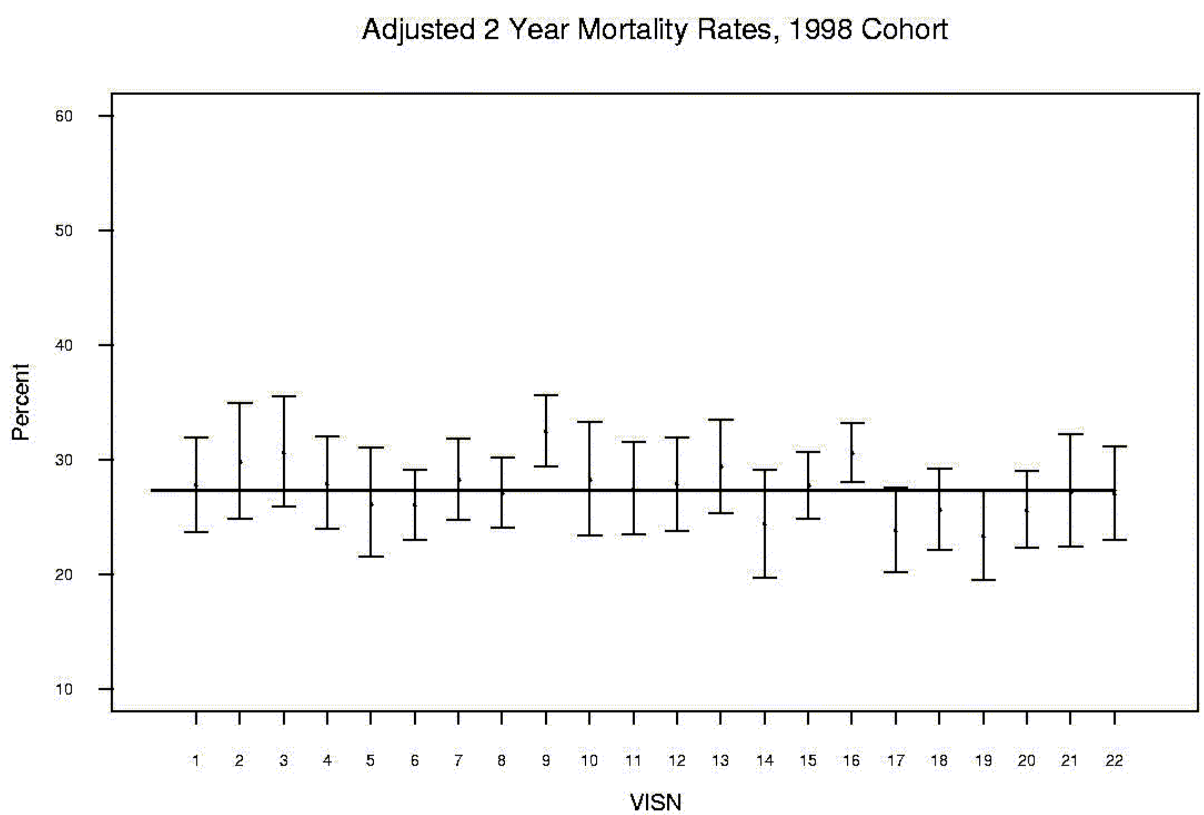


Figure C6e

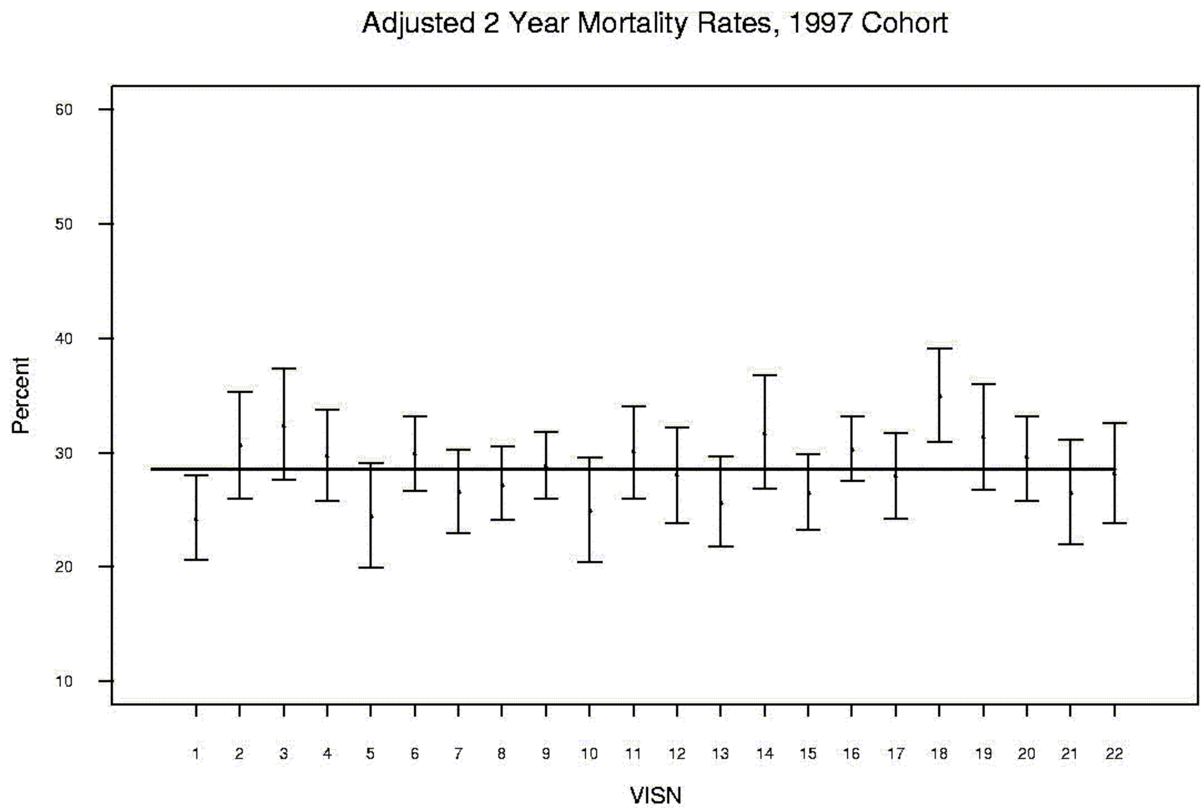
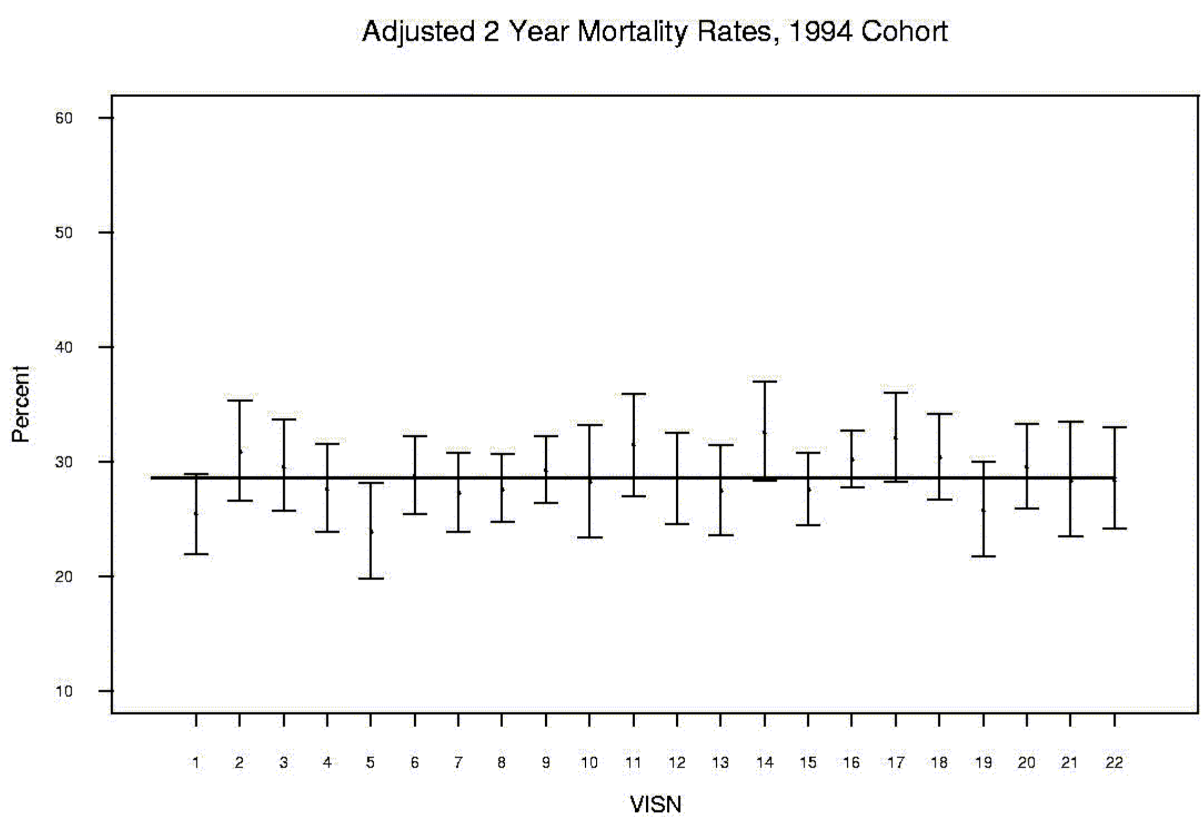


Figure C6f



Comparison of Mortality Rates for VA-Medicare Matched Cohorts

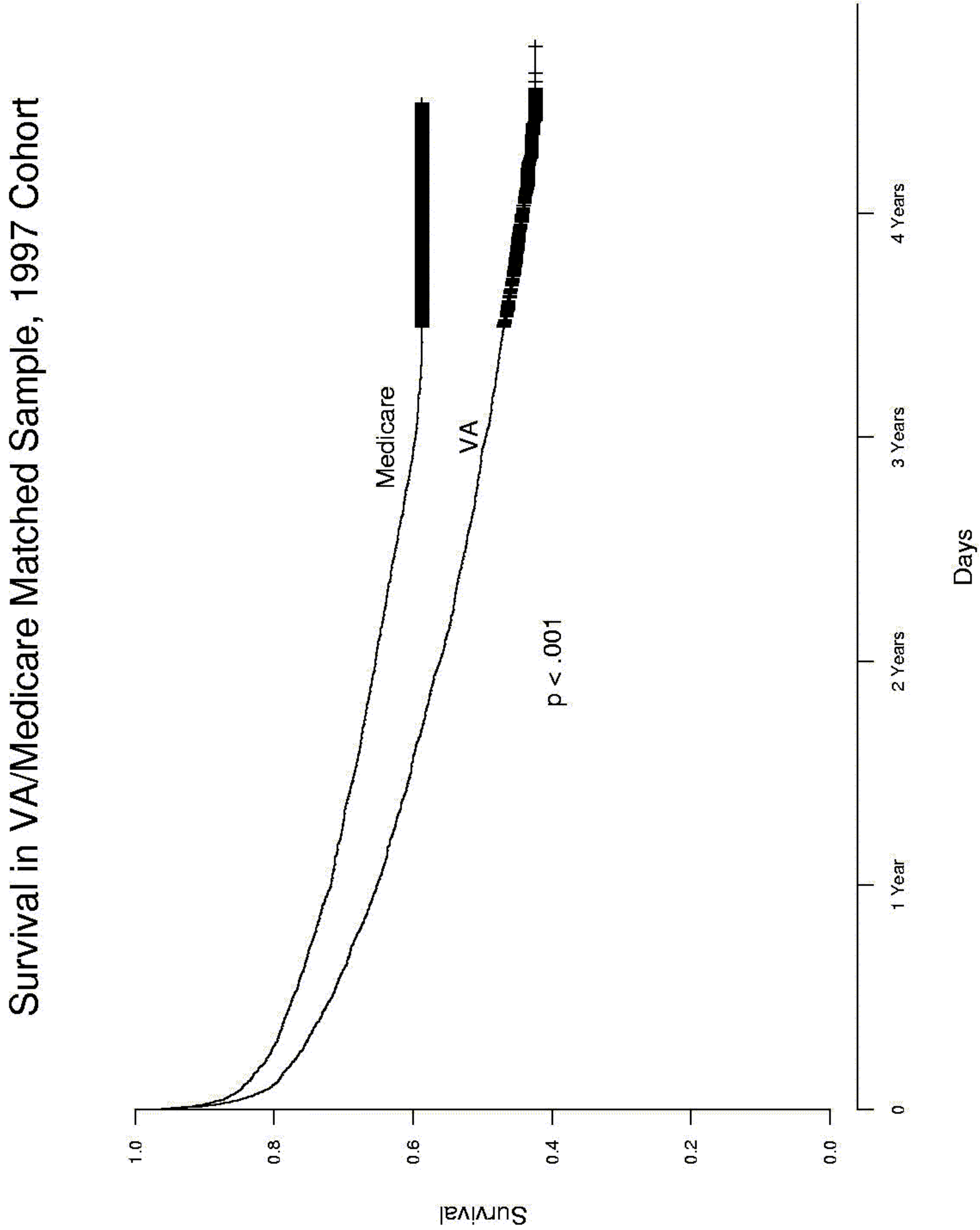
National Trends in Mortality in the Matched Cohorts

We provide *un*adjusted mortality data for the VA and Medicare cohorts in Table C4. The higher mortality for Medicare compared to the VA patients at 30 days in FY 1998 and 1999 was also observed by Petersen et al. for data from calendar year 1994-1995 [Petersen, 2000]. Adjusted analyses using the matched samples demonstrated statistically significant (p-value <0.001) differences in mortality between elderly (age ≥ 65) male VA and male Medicare patients in FY 1997, 1998 and 1999 matched cohorts (Figures C7a-C7c). Analyses at fixed-time points since admission, demonstrated lower mortality among Medicare patients at 30 days and 1 year post-AMI in the FY 1997, 1998 and 1999 cohorts, at 2 years post-AMI in the FY 1997 and 1998 cohorts and at 3 years post-AMI in the FY 1997 cohort (Table C5).

Table C4
Unadjusted Mortality: Males age 65 and older, 1997-1999

	FY 1997		FY 1998		FY 1999	
	VA	Medicare	VA	Medicare	VA	Medicare
N	4451	137095	4674	135137	4924	133630
30 day mortality (%)	17.8	16.8	16.0	16.8	15.5	17.0
1 year mortality (%)	34.2	30.2	33.6	31.3	33.8	30.7
2 year mortality (%)	43.5	37.7	43.3	38.3	NA	NA
3 year mortality (%)	49.9	43.3	NA	NA	NA	NA

Figure C7a



Survival in VA/Medicare Matched Sample, 1997 Cohort
Medicare
VA
p < .001
Survival
1.0
0.8
0.6
0.4
0.2
0.0
Days
0
1 Year
2 Years
3 Years
4 Years

Figure C7b

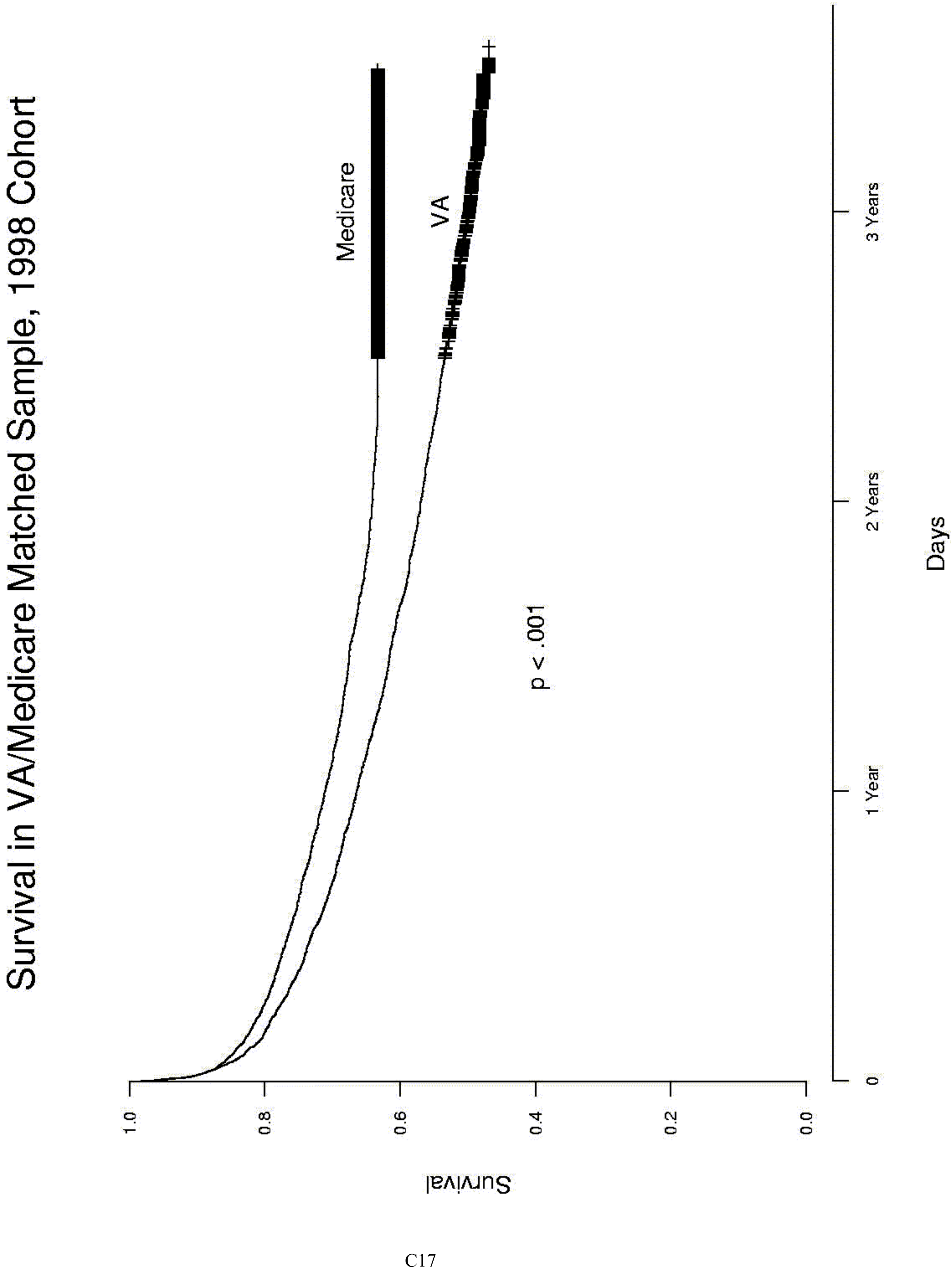

Survival in VA/Medicare Matched Sample, 1998 Cohort
Medicare
VA
p < .001
Survival
1.0
0.8
0.6
0.4
0.2
0.0
0
1 Year
2 Years
3 Years
Days

Figure C7c

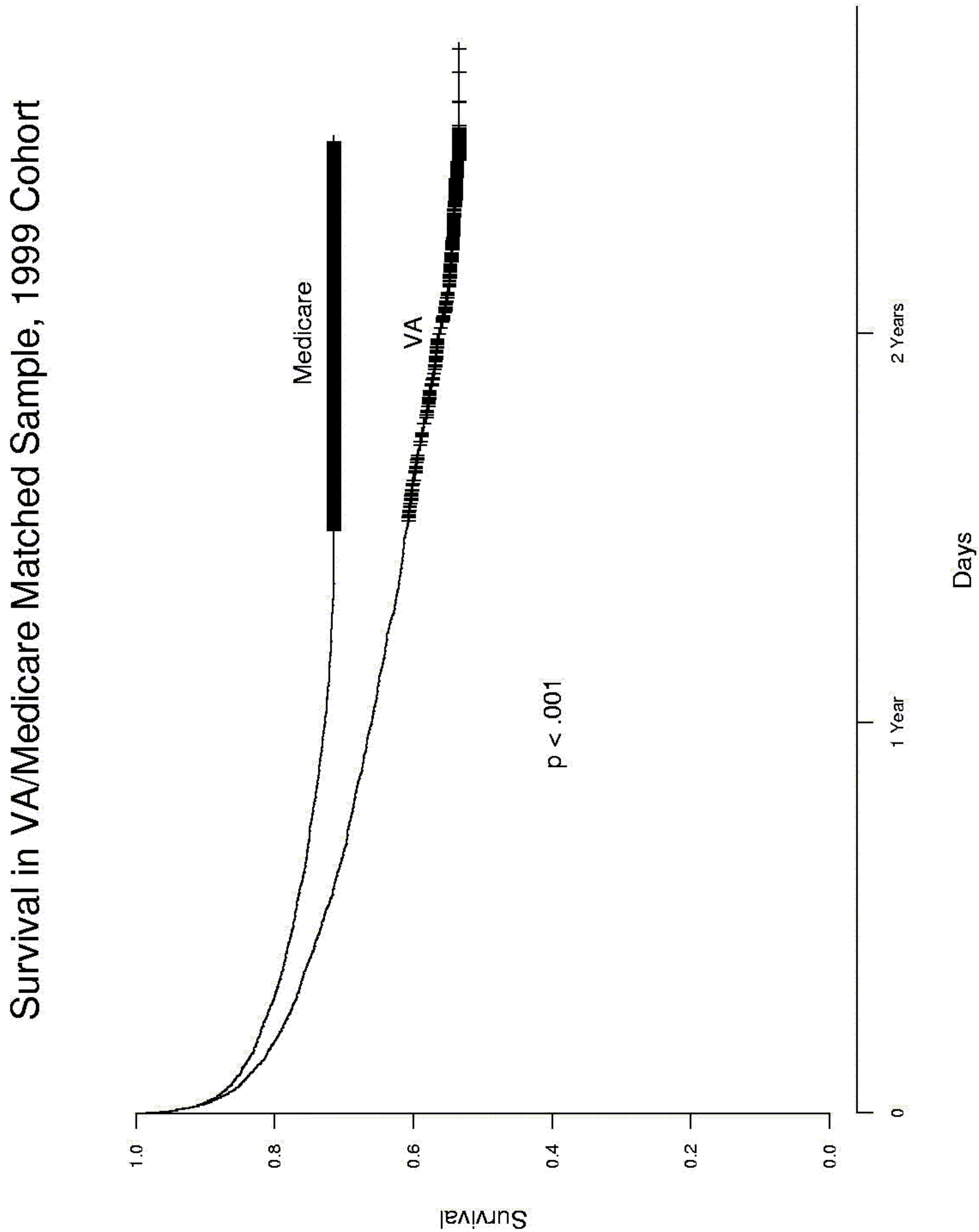

Survival in VA/Medicare Matched Sample, 1999 Cohort
Medicare
VA
p < .001
Survival
1.0
0.8
0.6
0.4
0.2
0.0
0
1 Year
2 Years
Days

Table C5
Adjusted Mortality in Matched Cohorts: Males age 65 and older, 1997-1999

	FY 1997			FY 1998			FY 1999		
	VA (n=3992)	MED (n=3992)	p-value	VA (n=4277)	MED (n=4277)	p-value	VA (n=4502)	MED (n=4502)	p-value
30 day mortality	**18.4**	**14.9**	**<.001**	**16.3**	**14.6**	**.039**	**15.5**	**14.1**	**0.062**
1 year mortality	**34.8**	**28.2**	**<.001**	**33.6**	**28.9**	**<.001**	**35.0**	**29.3**	**0.002**
2 year mortality	**43.9**	**34.6**	**<.001**	**43.0**	**35.9**	**<.001**	NA	NA	
3 year mortality	**50.4**	**40.3**	**<.001**	NA	NA		NA	NA	

Bolded numbers represent significant differences at 10% level

Because even after matching there were several clinical variables in which patients in the VA sector had higher rates of comorbid disease than did those in the Medicare sector (see Tables A5-A7), we estimated adjusted 30-day, 1-year, 2-year and 3-year mortality using logistic regression models fit to the matched samples to control for these residual differences. These results are reported in Table C6. Adjustment for residual differences in comorbidities in the matched samples resulted in smaller differences in mortality and did eliminate the differences in 30-day mortality between VA and Medicare patients in FY 1998. However, differences at 1-year and beyond remained statistically significant in all three cohort years.

Table C6
Regression-Adjusted[a] Mortality in Matched Cohorts: Males age 65 and older, 1997-1999

	FY 1997			FY 1998			FY 1999		
	VA (n=3992)	MED (n=3992)	p-value	VA (n=4277)	MED (n=4277)	p-value	VA (n=4502)	MED (n=4502)	p-value
30 day mortality	**18.3**	**15.0**	**0.003**	15.4	15.5	0.87	**15.5**	**14.1**	**0.066**
1 year mortality	**34.6**	**28.3**	**<.001**	**32.7**	**29.7**	**0.009**	**35.3**	**29.1**	**0.001**
2 year mortality	**43.9**	**34.6**	**<.001**	**42.0**	**36.8**	**<.001**	NA	NA	
3 year mortality	**50.2**	**40.5**	**<.001**	NA	NA		NA	NA	

[a] Adjusted for age, race, median household income in zip code of residence, percentage of residents in zip code that are African American, percentage of residents in zip code that are Hispanic, distance to admitting hospital and a set of clinical variables based on primary and secondary diagnoses codes from inpatient encounters from the index admission as well as from the prior year (see Tables A5-A7).

Bolded numbers represent significant differences at 10% level

After 30 days, unadjusted mortality was higher among elderly VA patients compared to Medicare patients (Table C4), although the differences were smaller than those found in the matched sample (Tables C5 and C6). Because most (approximately 90%) of the elderly VA patients remain in the matched samples, these differences between unadjusted and adjusted mortality rates largely reflect the selection of the subset of patients from the Medicare general population with characteristics similar to VA patients (see Tables A5-A7). Medicare patients in the matched samples differed from patients in the general Medicare population according to three important characteristics. First, because patients treated for AMI in the VHA were younger than the Medicare AMI population, Medicare patients in the matched samples were younger, leading to reductions in mortality in the matched sample of Medicare patients compared to the general population of Medicare patients. Second, VA patients traveled, on average, twice as far to their admitting hospital as did Medicare patients. If distance is a valid proxy for unmeasured aspects of severity, the VA patients may have had less severe infarctions (see sensitivity analysis in Tables AC5 and AC6 on this point). Consequently, we selected Medicare patients for the matched sample who also traveled farther distances to their admitting hospital. This also led to decreased mortality in the matched Medicare sample. However, veterans treated for AMI in the VHA were more likely to have comorbid illness compared to the Medicare AMI population. The propensity score methodology that we employed to create the matched samples thus led to the selection of Medicare patients with higher rates of comorbid disease than in the general Medicare population. In contrast to age and distance, the selection of patients with higher rates of comorbid disease led to increased mortality (within age and distance groups) among Medicare patients in the matched samples compared to the general population of Medicare patients. Overall, however, mortality was lower for Medicare patients in the matched sample compared to the general population of Medicare patients (Tables C4 and C5-C6), suggesting greater influence of age and distance compared to comorbid disease.

Within VISN Comparisons Between Elderly VA and Medicare Patients

Within service networks (VISNs), mortality rates for elderly VA patients were generally higher than for matched Medicare patients, although often these differences were not statistically significant (Figures C8-C11). However, in FY 1999 1-year mortality was significantly higher for VA patients compared to matched Medicare patients in VISNs 2, 7, 8, 9, 10 and 20 (Figure C9). Moreover, 3-year mortality was higher for VA patients compared to matched Medicare patients in VISNs 4, 6, 16, 18, 19, 20, and 22 in FY 1997 (the only cohort with 3-year follow-up data). There was no VISN in which VA patients had significantly lower mortality rates at any time point compared to matched Medicare patients.

Figure C8

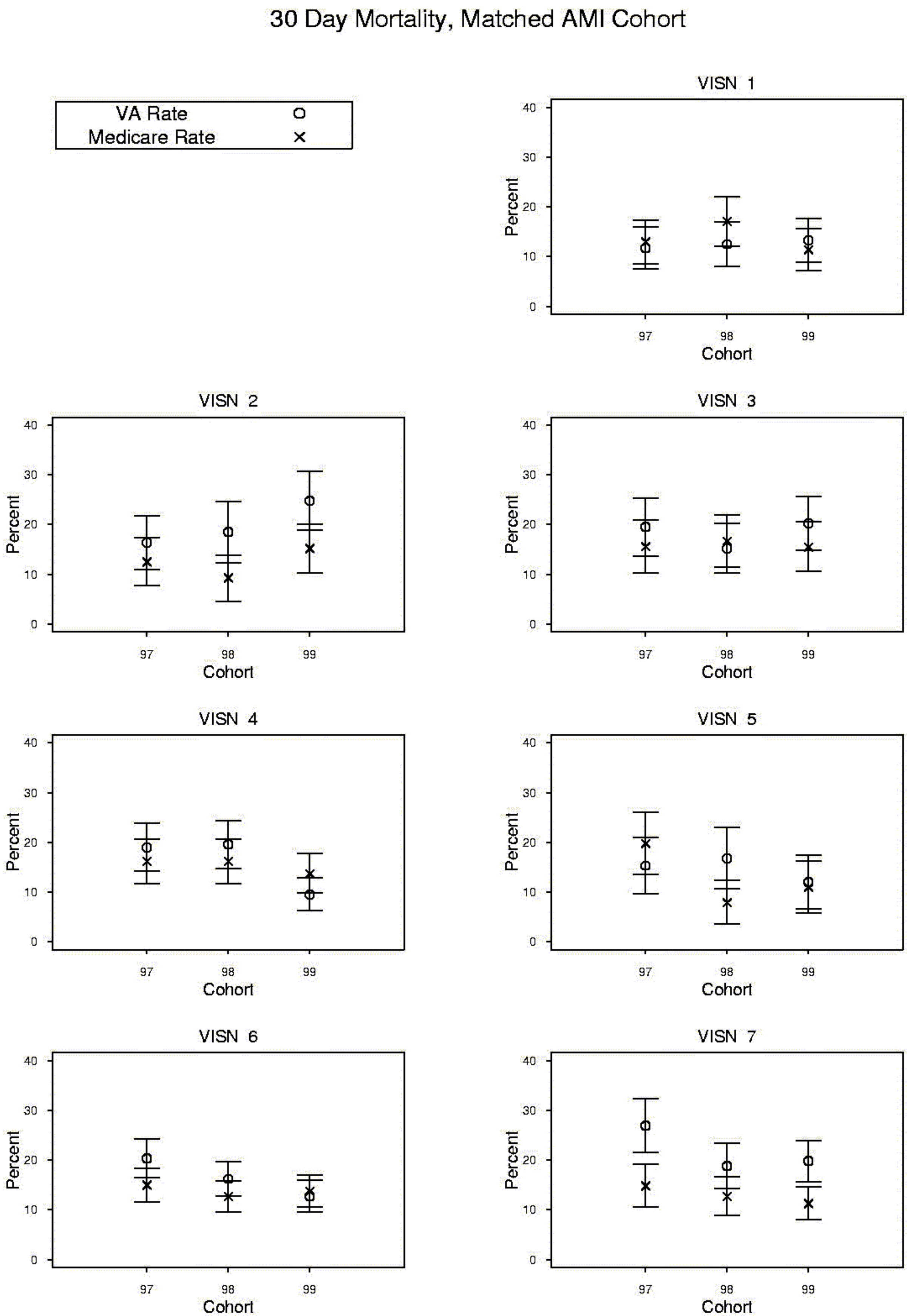

30 Day Mortality, Matched AMI Cohort
VA Rate
Medicare Rate
VISN 1
VISN 2
VISN 3
VISN 4
VISN 5
VISN 6
VISN 7
Percent
Cohort
97
98
99
0
10
20
30
40

Figure C8

30 Day Mortality, Matched AMI Cohort

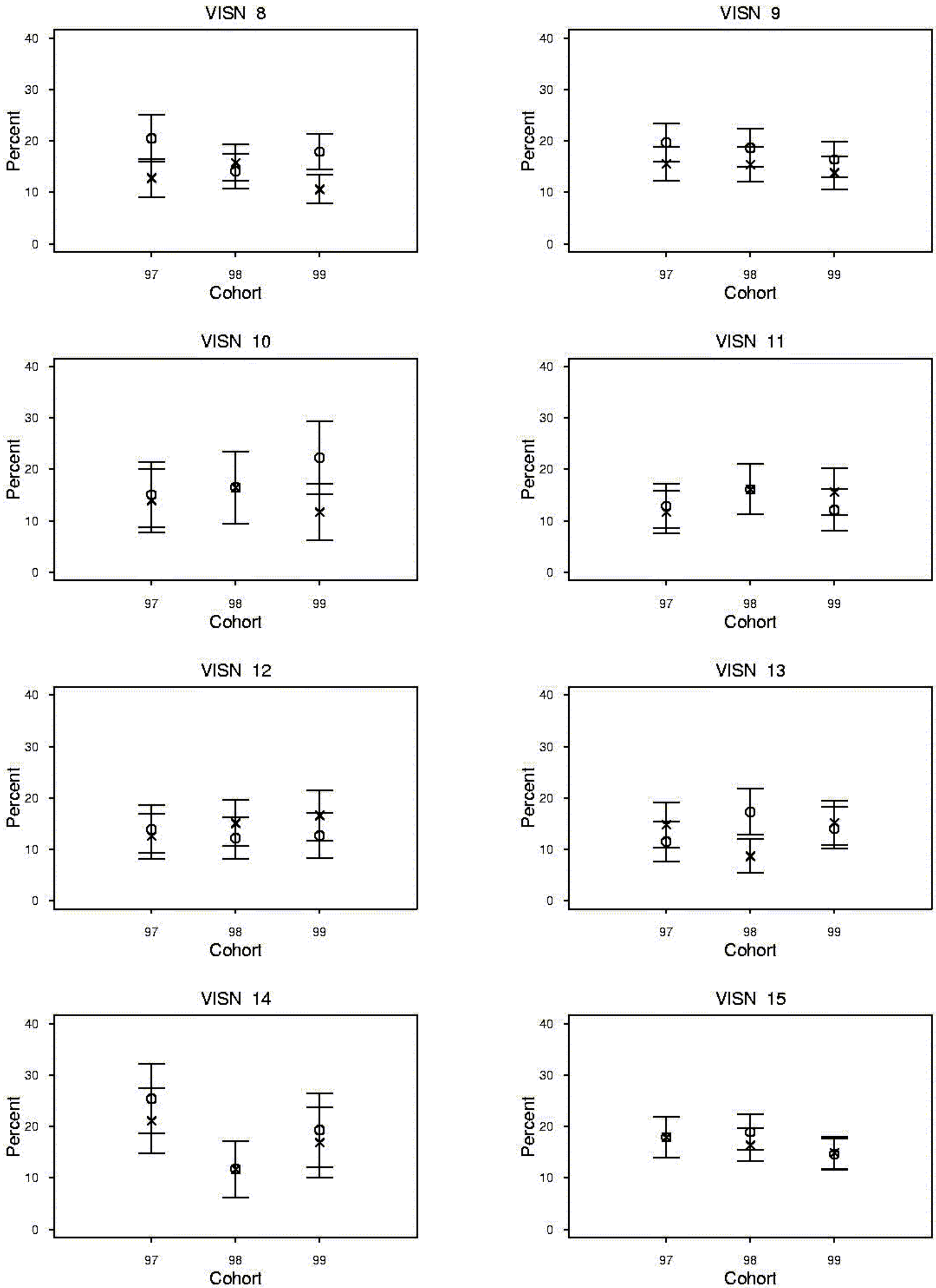


Figure C8

30 Day Mortality, Matched AMI Cohort

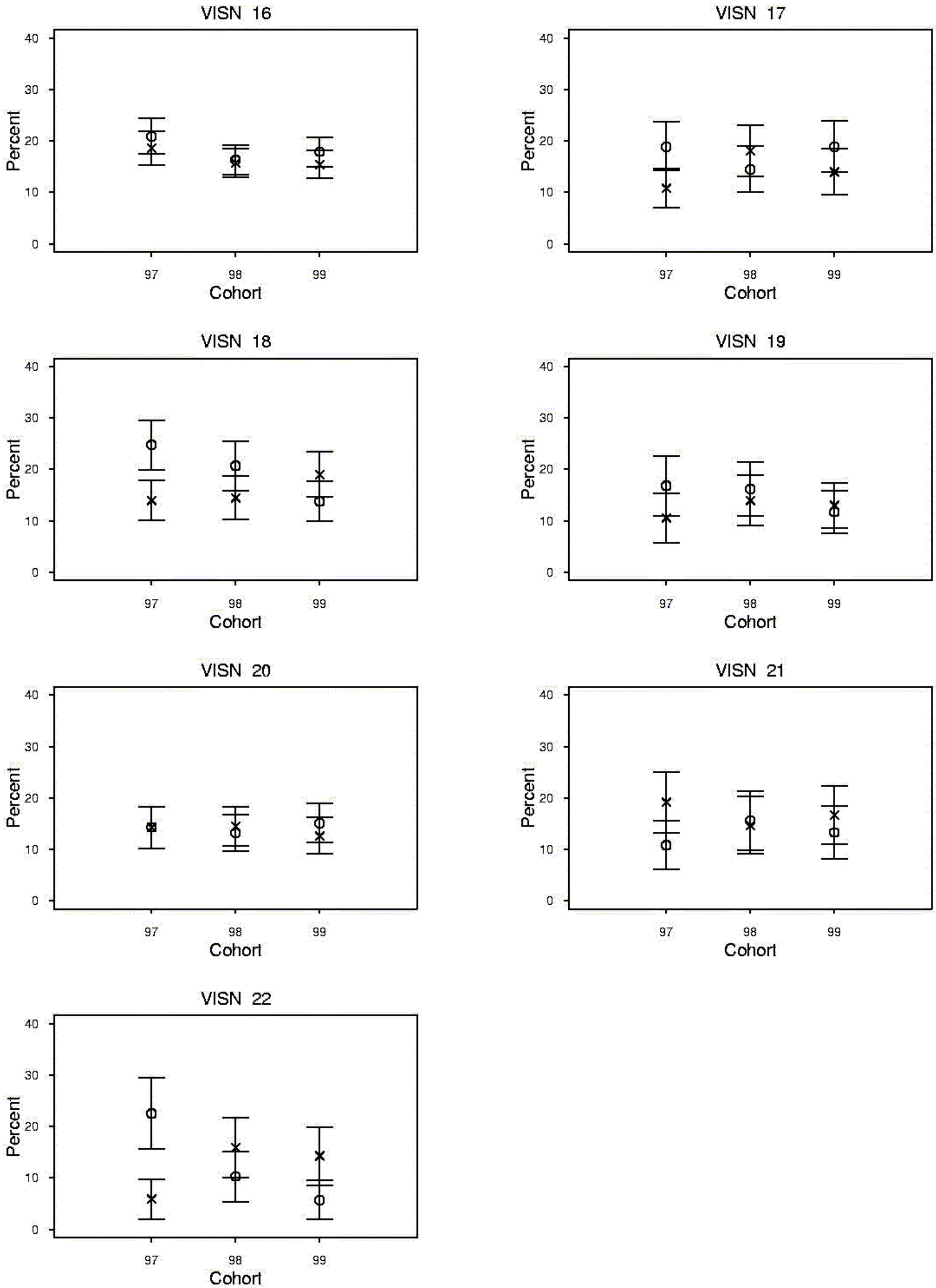


Figure C9

365 Day Mortality, Matched AMI Cohort

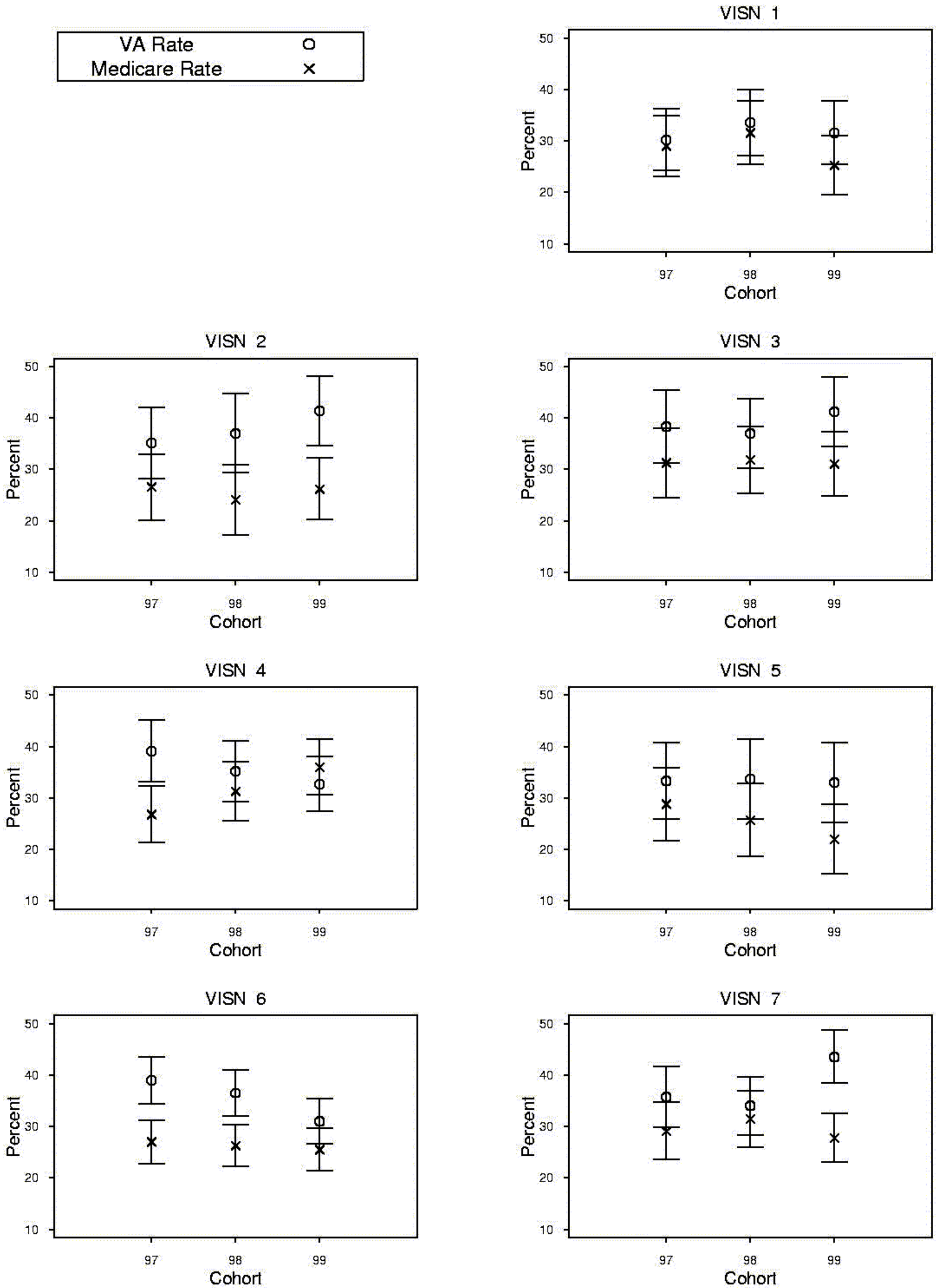


Figure C9

365 Day Mortality, Matched AMI Cohort

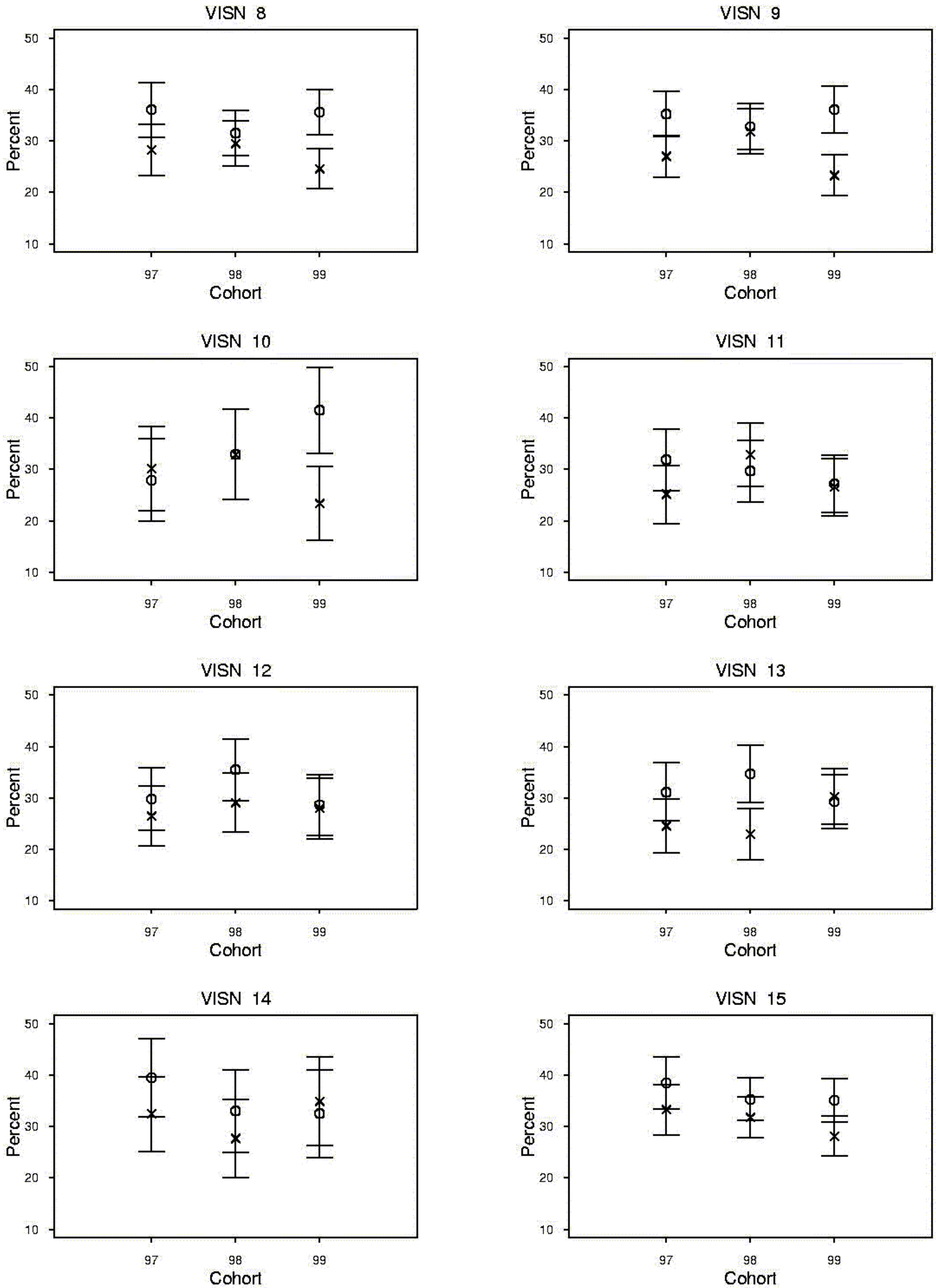


Figure C9

365 Day Mortality, Matched AMI Cohort

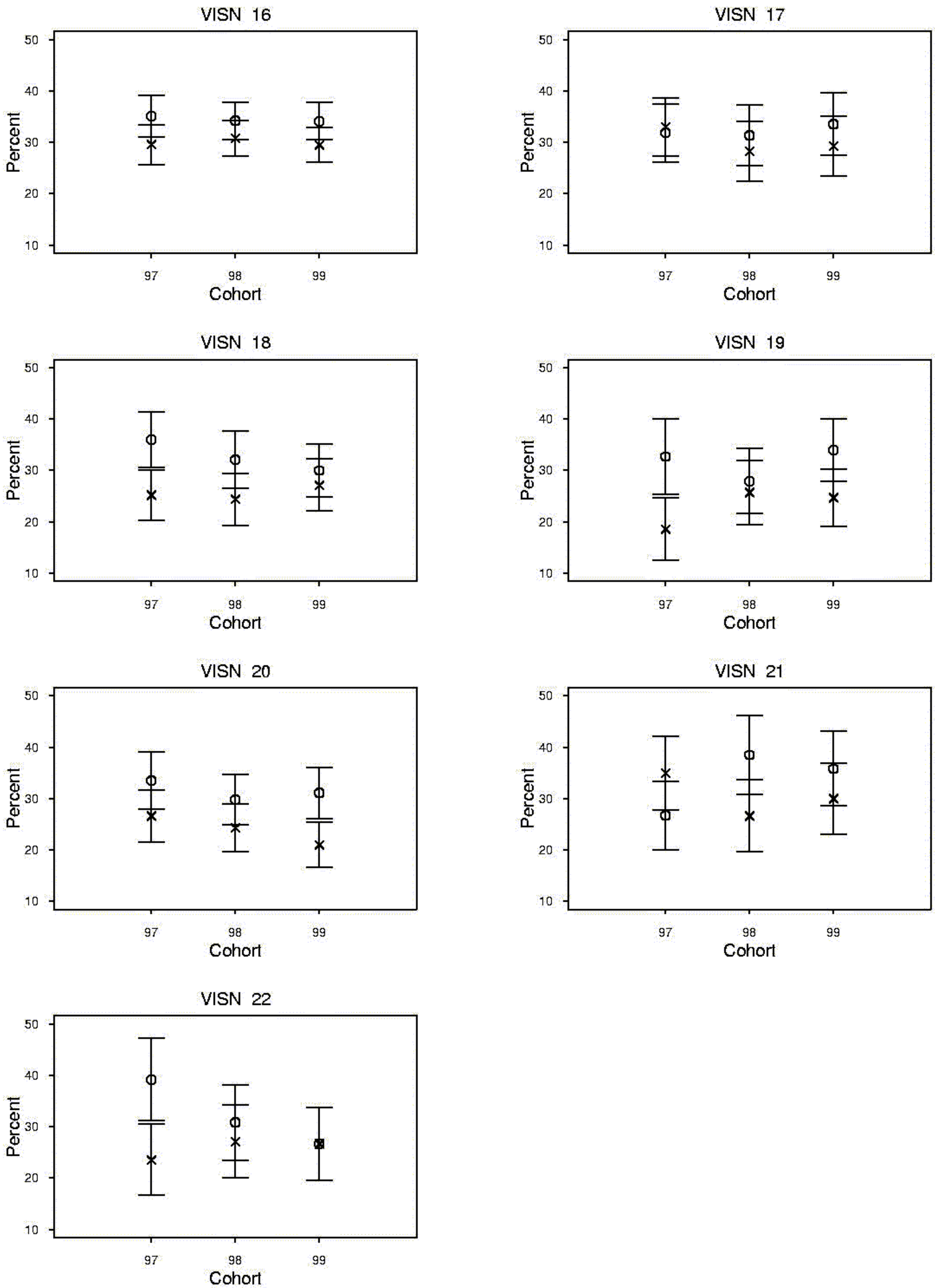


Figure C10

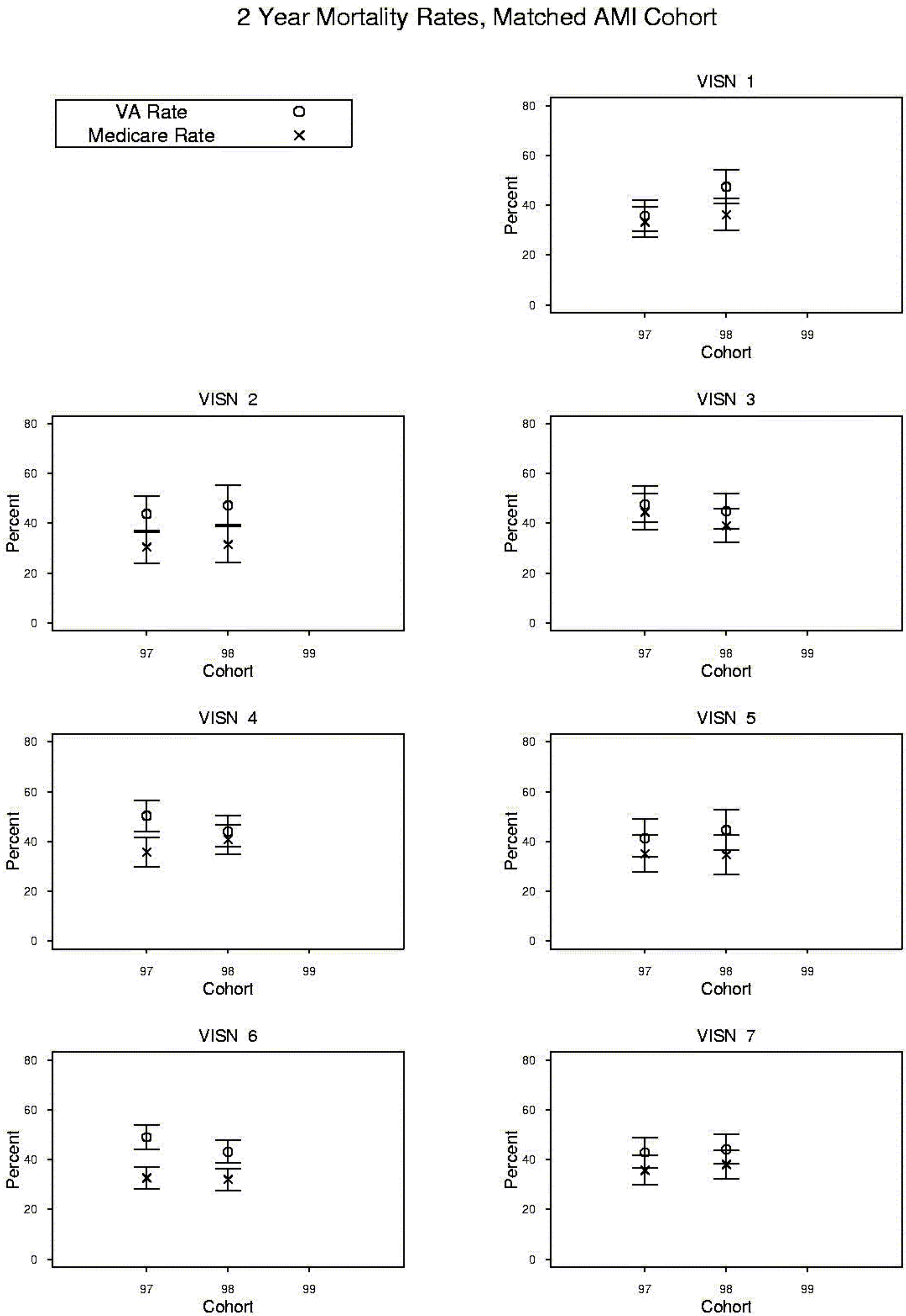
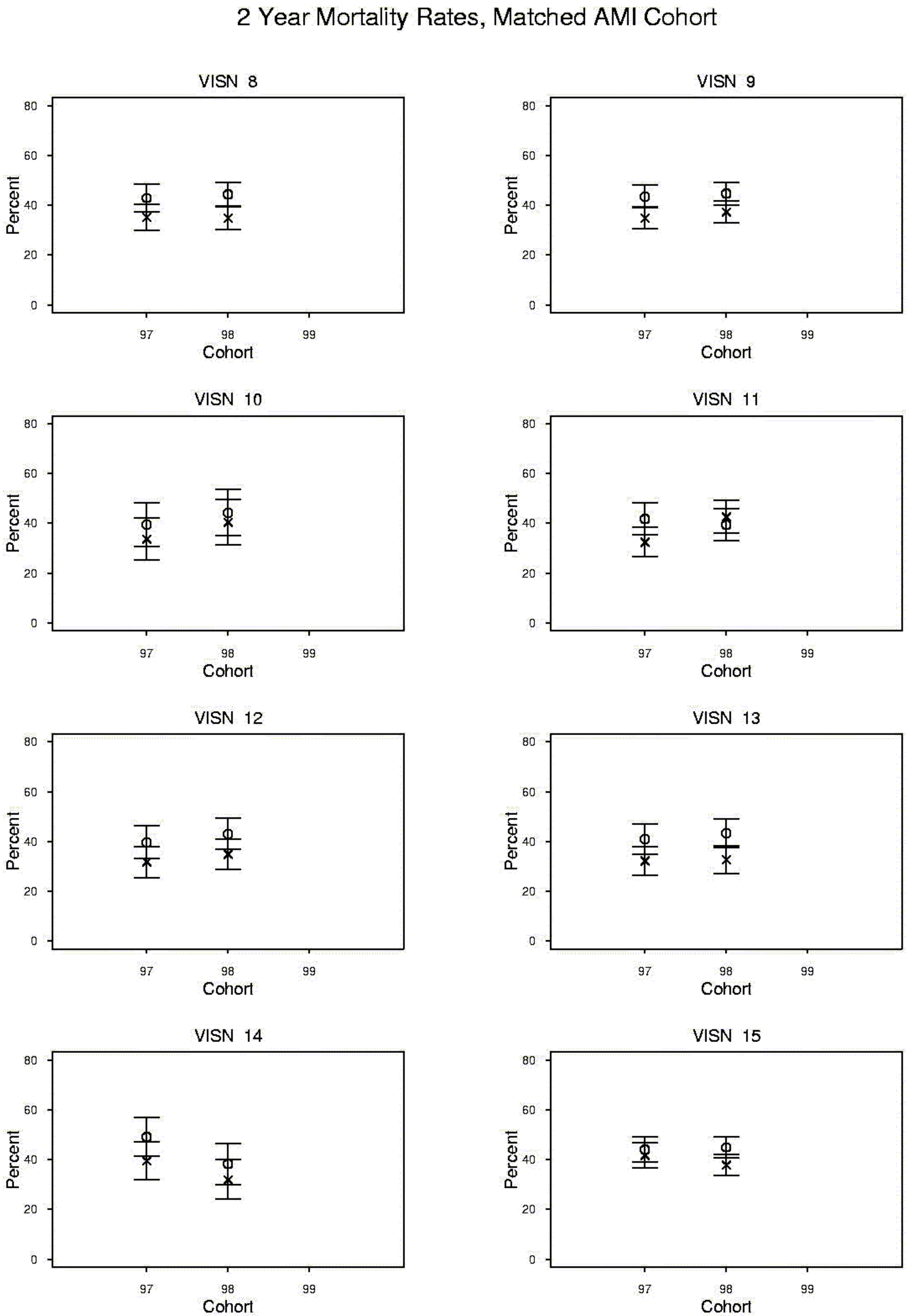

2 Year Mortality Rates, Matched AMI Cohort
VA Rate
Medicare Rate
VISN 1
VISN 2
VISN 3
VISN 4
VISN 5
VISN 6
VISN 7
Percent
Cohort
0
20
40
60
80
97
98
99

Figure C10


2 Year Mortality Rates, Matched AMI Cohort
VISN 8
VISN 9
VISN 10
VISN 11
VISN 12
VISN 13
VISN 14
VISN 15
Percent
Cohort
0
20
40
60
80
97
98
99

Program Evaluation of Cardiac Care Programs in the VHA

Figure C10

2 Year Mortality Rates, Matched AMI Cohort

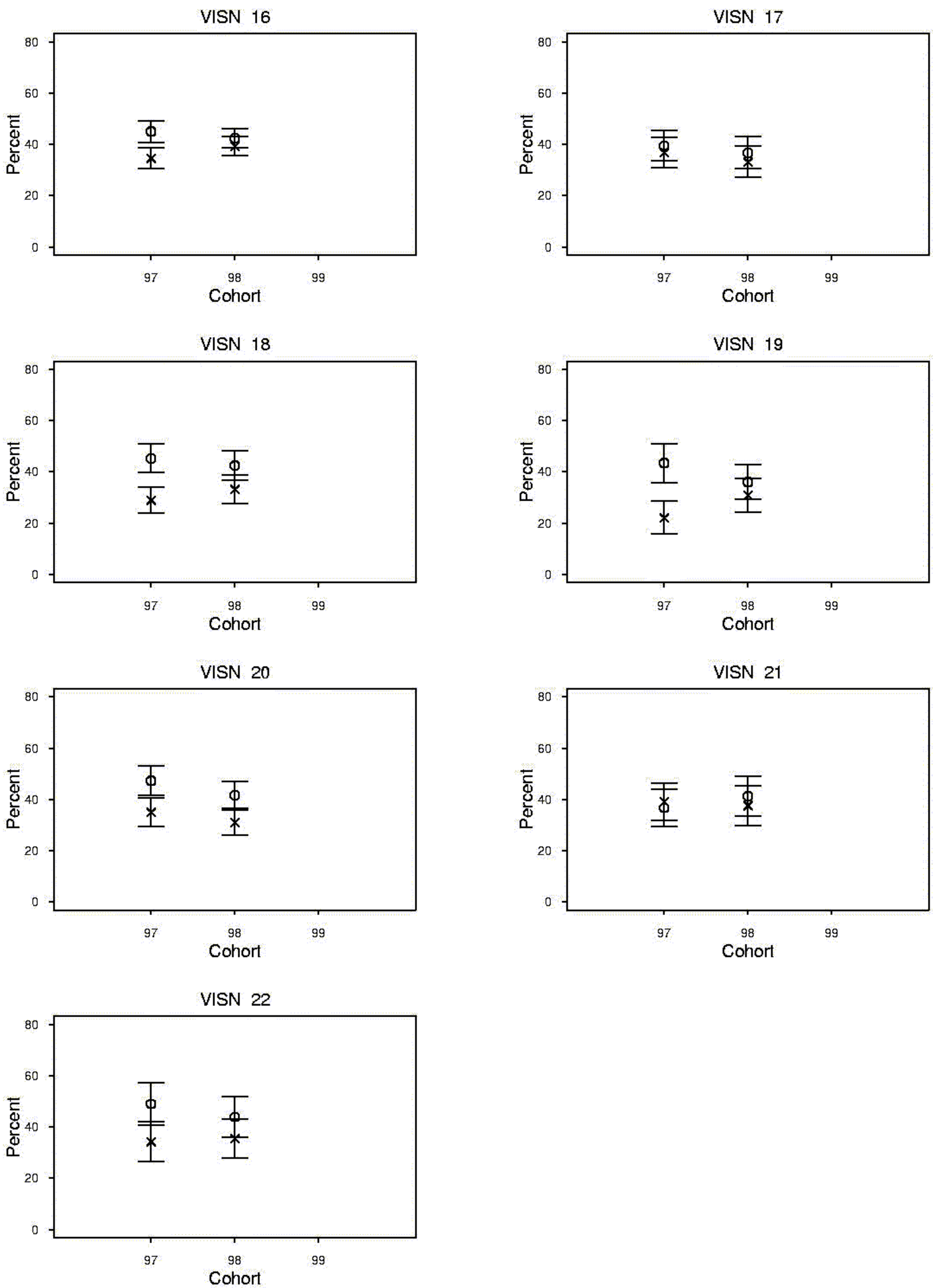


Figure C11

3 Year Mortality Rates, Matched AMI Cohort

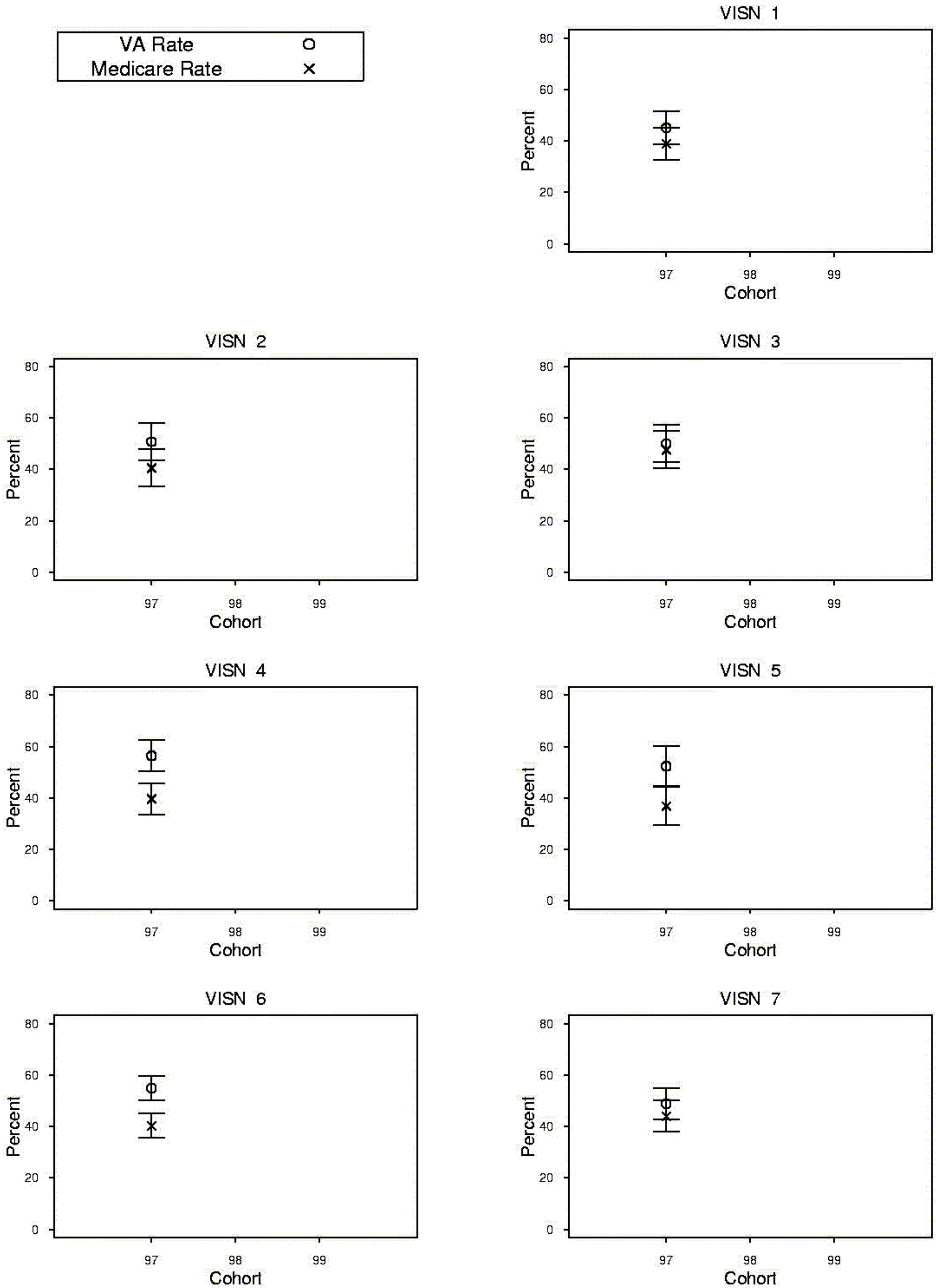


Figure C11

3 Year Mortality Rates, Matched AMI Cohort

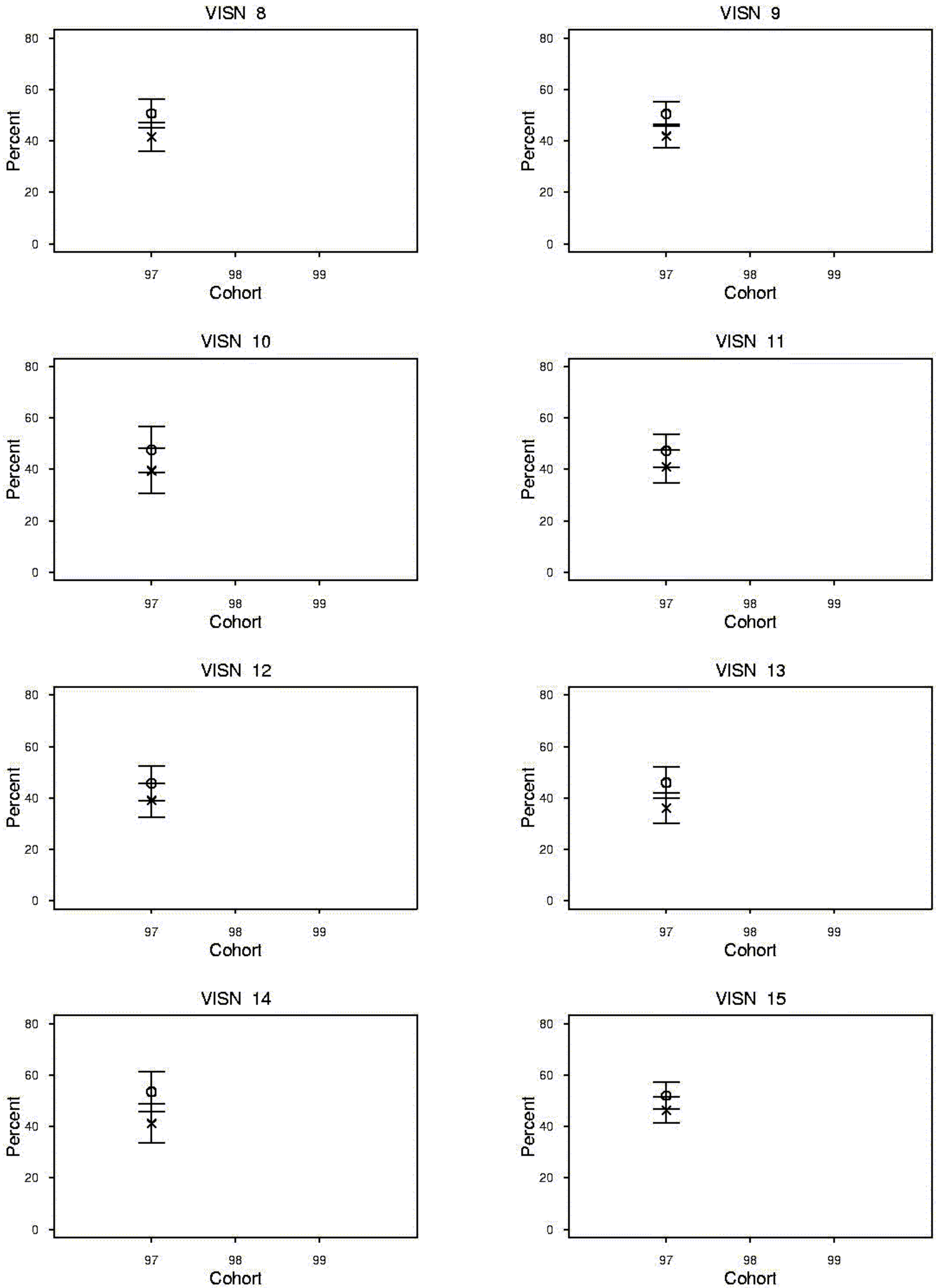
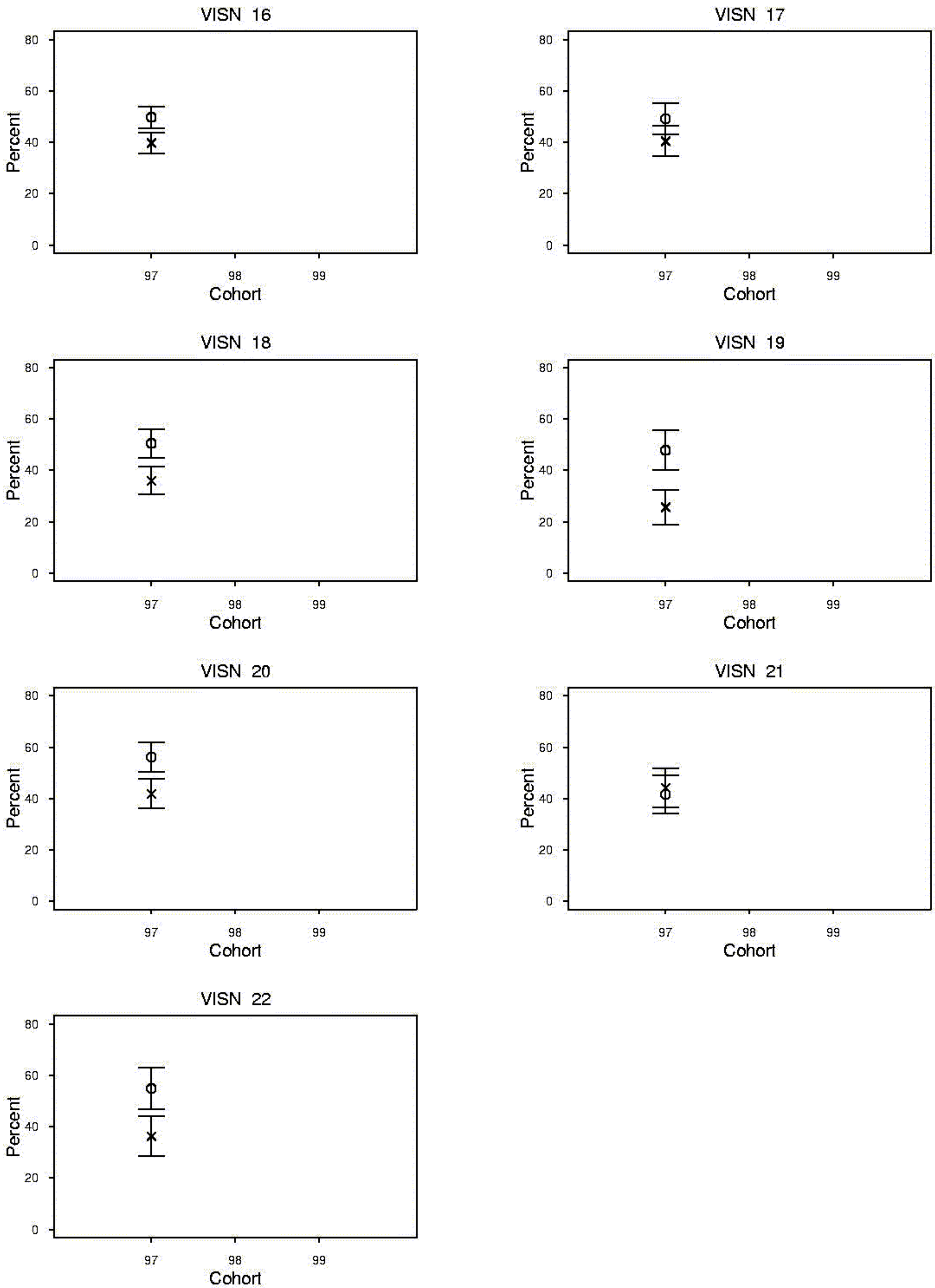


Figure C11

3 Year Mortality Rates, Matched AMI Cohort



Robustness of Conclusions

We performed several tests of the robustness of our conclusions to potential biases in our approach. The large and statistically significant differences in mortality among veterans treated for AMI in the VHA compared to similar patients treated under Medicare estimated in our primary analyses were generally very robust to these tests.

Biased ascertainment of vital mortality. Because we performed an NDI match on the patients in the VA cohort with uncertain vital statistics (approximately 15% of all VA patients could not be matched to BIRLS), and we did not perform a NDI match on Medicare patients with uncertain vital status data (those we could not match to the enrollment files – approximately 2%), we repeated analyses comparing mortality in the two sectors excluding the deaths of VA patients identified through the NDI match. Tables AC3-AC4 report adjusted mortality results excluding the deaths in the VA cohort identified from the NDI match. Conclusions regarding the differences in mortality between VA and Medicare patients were insensitive to the inclusion of deaths obtained with the NDI match.

Inadequate adjustment for comorbidity and disease severity. In an ideal study, important clinical information about the severity of the myocardial infarction would have been available to adequately adjust potential differences between VA and Medicare patients, as well as for comparisons of subgroups within the VA cohorts. In numerous studies, the major risk factors for short-term mortality following acute coronary syndromes have been shown to relate mainly to specific clinical, hemodynamic and angiographic characteristics of patients such as the presence of ST elevation, left ventricular ejection fraction, hypotension and coronary anatomy. None of these important variables, however, were available for the present analyses. For this reason, we employed a proxy measure, in this case distance from the admitting facility. Because VA patients traveled, on average, twice as far to their admitting hospital as did Medicare patients, and therefore, may have had less severe infarctions because they were able to travel farther, we selected Medicare patients for the matched sample who also traveled farther distances to their admitting hospital. While patients who travel longer distances to their admitting hospital may have experienced less severe infarctions, there are several important limitations in this approach. First, distance to admitting hospital is only a proxy for unobserved components of disease severity. The relationship between distance traveled to the admitting hospital and unmeasured severity or acuity of disease may be different for VA and Medicare patients. Specifically, for financial and other reasons, VA patients may strongly prefer to be admitted to VA hospitals, and therefore would be willing to travel farther in the face of symptoms that would have led a Medicare patient to the nearest hospital. We thus tested the robustness of our conclusions to this important assumption by removing distance as matching criteria. Our conclusions were robust to the use of distance as a proxy for disease severity. The exclusion of distance led to a small reduction in most of the differences in mortality between the two sectors and completely eliminated the differences in 30-day mortality in the FY 1999 cohort. However, even without matching on distance we observed large and statistically significant differences in 1-year through 3-year mortality between the two systems (Table C7).

Table C7
Regression-Adjusted[a] Mortality in Matched Cohorts: Males age 65 and older, 1997-1999 – Without Matching on Distance

	FY 1997			FY 1998			FY 1999		
	VA (n=2383)	MED (n=2383)	p-value	VA (n=4677)	MED (n=4677)	p-value	VA (n=4881)	MED (n=4881)	p-value
30 day mortality	**18.0**	**14.9**	**< 0.001**	**16.0**	**14.8**	**0.08**	15.6	14.8	0.29
1 year mortality	**33.9**	**27.9**	**< 0.001**	**33.6**	**28.5**	**< 0.001**	**34.8**	**30.4**	**0.01**
2 year mortality	**43.4**	**36.2**	**< 0.001**	**43.2**	**34.9**	**< 0.001**	NA	NA	
3 year mortality	**49.7**	**42.2**	**< 0.001**	NA	NA		NA	NA	

[a] Adjusted for age, race, median household income in zip code of residence, percentage of residents in zip code that are African American, percentage of residents in zip code that are Hispanic, distance to admitting hospital and a set of clinical variables based on primary and secondary diagnoses codes from inpatient encounters from the index admission as well as from the prior year (see Tables A5-A7).

Bolded numbers represent significant differences at 10% level

Initially we planned to use information on comorbidities obtained from *both* inpatient data as well as outpatient data for the year prior to the index admission. However, outpatient data from the VA were not available for the FY 1994 and 1997 cohorts. For consistency, we wanted to use the same risk adjustment approach for all years within the VA and Medicare cohorts. In order to determine the impact of using comorbidities obtained from inpatient data only, we compared adjusted utilization rates, length of stay, mortality and readmission rates for the FY 1999 VA and Medicare cohorts using inpatient data only and both inpatient and outpatient data. Including diagnoses from outpatient encounters dramatically increased our estimates of the prevalence of comorbid disease (Table AC5). However, as the prevalence increased in both sectors, our estimates of the differences in utilization and outcomes between VA and Medicare patients did not change compared to those estimated by matching patients on comorbidities coded in inpatient encounters only (Table AC6).

If comorbid conditions for veterans are of greater severity than those for patients in the Medicare system (e.g., higher grade of CHF), then we would expect that such individuals would die at a younger age. If so, older veterans would be more comparable in prevalence and severity of comorbid disease than would younger veterans, and we would expect decreased differences in mortality between the VA and Medicare populations as age increases. We report differences in 30-day and 1-year mortality between VA and Medicare patients by 5-year age groups in Tables AC7 and AC8. These tables demonstrated that differences in 30-day mortality were concentrated among patients in their seventies, while differences in 1-year mortality persist up until age 80. Similar mortality between VA and Medicare patients in the over 80 age groups may be due to the fact that these patients are more similar in terms of unobserved confounding characteristics compared to the younger patients or that treatment patterns in the two systems are more similar for the most elderly patients. We report the percent of patients who received a revascularization procedure within 30 days of the AMI by age groups in Table AC9. These results suggest that unmeasured differences between patients in the two sectors might be contributing to the differences we observed.

As a final analysis of the potential bias due to unobserved differences between the patients treated in the VA and Medicare, we estimated differences in mortality between Medicare and VA patients at various time intervals following their AMI (Table AC10). For example, an additional 3.0% of VA patients died between 30 days and 1 year compared to similar Medicare patients in FY 1997. And, an additional 3.0% of VA patients died between 1 year and 2 years compared to similar Medicare patients in FY 1997. These additional deaths suggest that unobserved differences in disease severity during the index admission likely do not explain the significant differences in death rates between the two systems. This approach does not address issues related to unmeasured differences in severity after discharge.

<u>Bias due to unmeasured covariates</u>. We performed a sensitivity analysis to evaluate whether four unmeasured potential confounders and their combination might explain mortality

differences between the two sectors (Table C8). Adjusting for differences in disease severity on admission observed in a previous study with detailed data from medical records (Petersen, Normand et al. 2000), we were able to explain only a small amount of the differences observed. For example, for one-year mortality for the FY 1999 cohort (right hand column, Table C8), if the patients in our study had the same prevalence of cardiac arrest as seen in the Petersen cohort, then adjusting for this difference would have decreased the observed odds-ratio of mortality among VA patients compared to Medicare patients from 1.39 to 1.38 (or a 2.5% decrease) – thus cardiac arrest could explain 2.5% of the observed differences between the two systems. Similarly, consideration of low systolic blood pressure on admission would have led to a further decrease of 8.1% in the observed differences. College education and smoking[9] led to decreases of 5.7% and 17.8% respectively. We estimate that in combination, these four confounders could explain approximately 20% to 50% of the observed differences in 1- 2- and 3-year mortality.

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[9] Although the overall impact of smoking is likely to be negative, it is not clear that our inability to include smoking status in our analyses would have a major impact on our findings. First, a non-trivial proportion of patients quit smoking after experiencing an AMI. Data suggest that the risk of bad outcomes is similar for those who quit smoking and for non-smokers by about 3 years post-MI (Rea, T. D., S. Heckbert, et al. (2002). "Smoking status and risk for recurrent coronary events after myocardial infaction." Annals of Internal Medicine **137**: 494-500.

Second, several studies have documented what is called the "smokers' paradox", where smokers actually have lower mortality rates following AMI than non-smokers over the short term (For example see: Gourlay SG, Rundle AC, Barron HV. Nicotine and Tobacco Research 2002; 101-107). Evidence supporting the "smokers' paradox" over the long term is equivocal (For example see: Rea TD, Heckbert SR, Kaplan RC, et al. Smoking status and risk for recurrent coronary events after myocardial infraction. Annals of Internal Medicine 2001;137:494-500.; Kelly TL, Gilpin E, Ahnve S, Henning H, Ross J Jr**.** Smoking status at the time of acute myocardial infarction and subsequent prognosis. Am Heart J. 1985; 110:535-41.; Mølstad P**.** First myocardial infarction in smokers. Eur Heart J. 1991;12:753-9. Barbash GI, Reiner J, White HD, Wilcox RG, Armstrong PW, Sadowski Z, et al. Evaluation of paradoxic beneficial effects of smoking in patients receiving thrombolytic therapy for acute myocardial infarction: mechanism of the "smoker's paradox" from the GUSTO-I trial, with angiographic insights. Global Utilization of Streptokinase and Tissue-Plasminogen Activator for Occluded Coronary Arteries. J Am Coll Cardiol. 1995;26:1222-9.; Maggioni AP, Piantadosi F, Tognoni G, Santoro E, Franzosi MG. Smoking is not a protective factor for patients with acute myocardial infarction: the viewpoint of the GISSI-2 Study. G Ital Cardiol. 1998;28:970-8.; Jørgensen, Køber L, Ottesen MM, Torp-Pedersen C, Videbaek J, Kjøller E. The prognostic importance of smoking status at the time of acute myocardial infarction in 6676 patients. TRACE Study Group. J Cardiovasc Risk. 1999;6: 23-7.; 88-8406, 1988.; Gottlieb S, Boyko V, Zahger D, Balkin J, Hod H, Pelled B, et al. Smoking and prognosis after acute myocardial infarction in the thrombolytic era (Israeli Thrombolytic National Survey). J Am Coll Cardiol. 1996;28:1506-13. ; Ishihara M, Sato H, Tateishi H, Kawagoe T, Shimatani Y, Kurisu S, et al. Clinical implications of cigarette smoking in acute myocardial infarction: acute angiographic findings and long-term prognosis. Am Heart J. 1997;134:955-60.)

Table C8

Sensitivity Analyses: Effect of Additional Adjustment for Unobserved Variables

Variable	Prevalence in VA patients	Prevalence in Medicare patients	Effect on Mortality (Relative risk)	Estimated decrease in observed odds-ratio of mortality among VA patients compared to Medicare patients					
				FY 1997			FY 1998		FY 1999
				1 year	2 Year	3 year	1 Year	2 year	1 Year
Cardiac Arrest	5%[d]	4.5%[d]	2.5[c]	**2.4%**	**1.9%**	**1.8%**	**4.7%**	**3.1%**	**2.5%**
Systolic BP < 100	10%[d]	7.5%[d]	2.0[c]	**8.0%**	**6.0%**	**6.0%**	**15.3%**	**10.0%**	**8.1%**
College Education	16%[e]	20%[e]	0.6[a]	**5.6%**	**4.3%**	**4.2%**	**10.8%**	**7.0%**	**5.7%**
Smoking	21%[e]	10%[e]	1.5[b]	**17.5%**	**13.3%**	**13.2%**	**33.5%**	**21.9%**	**17.8%**
Total Effect				**27.4%**	**20.8%**	**20.7%**	52.5%	**34.3%**	**27.9%**

[a] (Hardarson, Gardarsdottir et al. 2001)
[b] (Rea, Heckbert et al. 2002)
[c] (Krumholz, Chen et al. 1999)
[d] (Petersen, Normand et al. 2000)
[e] Estimated from the 1997, 1998 and 1999 NHIS

Bolded numbers indicate differences in mortality that remain statistically significant (at 10% level) after controlling for unobserved factors.

Notes on Other Studies Comparing VA and Medicare Patients

The difference in adjusted mortality rates for VA and Medicare patients in the matched sample is striking and appears to contradict other results that describe mortality differences between VA and non-VA patients [Petersen, 2000]. We discuss below the potential reasons for the discrepancy between our results and those recently published by Petersen et al. [Petersen, 2000].

Petersen et al. used regression models and a propensity score approach similar to ours to compare adjusted mortality in the two groups[10]. In contrast to our results, they found no significant differences in mortality at 30 days and 1 year between VA and Medicare patients. Our study differs from theirs in several important respects.

- First, we studied different samples of patients. Petersen et al. studied 29,249 male Medicare patients discharged from 1,530 non-VHA hospitals located in one of seven states and a national sample of 2,486 veterans discharged from 81 VHA hospitals in 1994 and 1995. In contrast, we studied a national census of male veterans aged 65 and older and male Medicare beneficiaries treated in 1997 through 1999. Differences in both the years studied and in the restriction to the seven states could lead to different results. For example, we reanalyzed our data and looked at only Medicare patients treated in the seven states studied by Petersen et al. and found a slightly increased mortality rate among these patients compared to the national sample of Medicare patients (Table AC11).
- Second, we employed additional sources of mortality data for the VA cohort. Specifically, we obtained mortality data from the BIRLS, PTF and National Death Index as well as from the Medicare enrollment files for veterans eligible for Medicare, while Petersen et al. relied on mortality data from the BIRLS and the PTF. Including these additional sources of data led to increased mortality in the VA cohorts in our study (Table AC12). Unpublished data from Petersen and Wright support this finding. For example,

[10] *Unadjusted* data from Petersen et al. are shown below.

VARIABLE	30-DAY MORTALITY	1-YEAR MORTALITY
Death — no. (%)		
Medicare patients	5291 (18.1)	9306 (31.8)
VHA patients	429 (17.3)	784 (31.5)

they found that the sensitivity of BIRLS was 92.6% for veterans (≥ 65 years of age) hospitalized in VA hospitals, but the sensitivity was lower for veterans who were initially hospitalized under Medicare financing (79.3%). The overall sensitivity of BIRLS alone (without regard to whether the index hospital was in the VA or Medicare systems) was 83.0% at 30 days.

- Finally, we used a different set of risk adjustment variables. Petersen et al. abstracted clinical data directly from medical records, allowing them to include measures of disease severity upon admission and were able to obtain, among other things, information on ST elevation or depression, blood pressure levels and the presence or absence of continued pain after admission. In particular, they found that VA patients were more likely to have ST elevation and systolic blood pressure <100 mm Hg compared to Medicare beneficiaries although they were less likely to have continued chest pain after arrival. Our data came only from administrative records and thus our information on comorbid conditions and disease severity was limited to this source. Because we could not adjust for measures of disease severity on admission, our comparisons may overstate differences in mortality between VA and Medicare patients. However, in addition to controlling for these clinical factors, we studied two others as well. We found that veterans were more likely to live in socio-economically disadvantaged areas (Tables A5-A7) and traveled farther to their admitting hospital. Unlike Petersen et al., we included both a set of socioeconomic variables and distance between the patient's residence and admitting hospital in our propensity score model. The socioeconomic variables were measured using U.S. Census variables (for example, median household income, percent of population with a college degree, etc.; see Tables A5-A7 for a complete list) linked to the zip code of the patients' residence. Assuming that lower socioeconomic status is associated with worse outcomes, matching on the socioeconomic variables would lead to smaller differences between Medicare and VA patients, while matching on distance led to larger differences, although as noted above, distance may be a highly imperfect proxy for severity of illness in the context of a VA-Medicare comparison. Finally, Petersen et al. adjust for characteristics of the admitting hospital, in particular teaching status and the availability of invasive cardiac services.

Factors Leading to Mortality Differences

We observed large and statistically significant differences in mortality among veterans treated for AMI in the VHA compared to similar patients treated under Medicare. Two main factors could explain these differences. First, unobserved differences in patients' severity of illness, socioeconomic status, social support, health behaviors or adherence to therapy may persist, even after matching patients closely on numerous observed characteristics. In sensitivity analyses, controlling for unobserved variables related to both sector of care and mortality explained between 2% to 40% of the observed differences in 1- 2- and 3-year mortality. Except for in fiscal year 1998, we found statistically significant differences between the two systems at 1 year and beyond even after controlling for four potential confounders.

A second possible explanation is that differences in quality of care received in the two systems led to differences in patient outcomes. This study was unable to directly measure quality of care in the two systems. However, we did find that patients treated under Medicare were significantly more likely to undergo revascularization procedures and be treated in high volume facilities, both of which have been associated with lower mortality in previous studies.

The impact of revascularization procedures on mortality in patients with coronary artery disease have been studied extensively with randomized clinical trials and observational studies. These studies have consistently demonstrated reduced mortality in patients undergoing CABG or PCI procedures compared to patients receiving medical therapy. For example, Heidenreich and McClellan (Heidenreich and McClellan 2001) estimated that the receipt of either nonprimary angioplasty and bypass surgery following an AMI reduced the odds of 30-day mortality by 15%. Given the 10 percentage point difference we observed in the use of CABG in the 30 days following AMI between the two systems, this would result in a 0.2 percentage point difference in 30-day mortality. Similarly the differences we observed in the use of PCI are estimated to lead to 0.3 percentage point differences in 30-day mortality. This combined difference of 0.5 percentage points explains 16% to 37% of the differences in 30-day mortality we observed in the FY 1997 and 1999 cohorts. Other researchers have recently estimated that the receipt of early revascularization (within 14 days of an AMI) reduces the likelihood of mortality between 14 days and 1 year by 50% (Stenestrand and Wallentin 2002). The differences in the use of revascularization procedures between the two systems could thus result in a 2 percentage point difference in mortality between 30 days and 1 year (or 37% to 68% of the differences we observed across the 3 cohort years). Admission to facilities that treat larger numbers of AMI patients has also been associated with decreased mortality. For example, Thiemann et al. (Thiemann, Coresh et al. 1999) estimated that patients admitted to hospitals in the lowest quartile of the distribution of AMI volume were 10 percent more likely to die within 1 year compared to patients admitted to the highest volume facilities. We found that elderly VA patients were much less likely to be admitted to high volume hospitals (25% compared to 45% in FY 1999). This difference could lead to a 0.5% point difference in 1-year mortality between the two systems (7% of the 6.2 percentage point difference in FY 1999).

It is likely that a combination of the factors described above explains part, but not all of the estimated differences in mortality between the two sectors. Other factors that could explain some of the differences include differences in the use of effective medical therapies (although previous research suggests that patients treated in a VHA facility are more likely to receive effective medical therapies compared to similar Medicare patients), differences in access to specialty care, and continued differences in the use of invasive cardiac services beyond the index event. It is also likely VA patients generally suffer a greater burden of chronic disease that contribute to a higher rate of ongoing mortality. Further study is clearly warranted to better understand these results.

Limitations

The results from this study should be viewed in light of several important limitations. First, this study and others have demonstrated that elderly veterans treated for AMI in the VHA tend to be sicker than patients treated in the private sector and we had only administrative data to measure and adjust for these differences. Thus unobserved differences in the severity of the cardiac disease or in prevalence and severity of comorbid conditions may explain some or all of the observed differences in mortality. However, our comorbidity measures included administrative data from inpatient events in the year prior to admission, improving on risk adjustment methods that consider only the index admission and we obtained similar results when we also included diagnoses from outpatient encounters during the year prior to admission when these data were available. Second, priority in access to care in the VHA is determined by disability associated with military service and/or economic disadvantage, and thus veterans treated in the VA are economically disadvantaged and often disabled compared to patients treated in the private sector. We attempted to control for these differences by matching patients according to several variables describing the socioeconomic conditions in the zip code of the patients' residence. While we observed that patients treated in the VA were more likely to live in areas with lower levels of education and income these measures surely overstate the true education and income of the individual veterans and thus this adjustment is imperfect. Controlling for unobserved variables, such as patients' education, in sensitivity analyses reduced but did not eliminate the statistically significant difference in mortality associated with treatment in the VA; the mortality difference might have been diminished further if more extensive and accurate measures of disease severity and socioeconomic status had been available.

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