Table 40. Observed and Expected Deaths by Specific Natural Cause (From Death Certificate) Among Vietnam and Non-Vietnam Veterans and Standardized Mortality Ratios (1965 – 1983)

Cause of death* (ICDA – 8)	Vietnam			Non-Vietnam		
	Observed deaths	Expected + deaths	SMR + + (95% CI)	Observed deaths	Expected deaths	SMR (95% CI)
Infectious diseases (000 – 136)	1	2.3	–	1	2.2	–
Neoplasms (140 – 239)	12	21.0	0.57 (0.30 – 1.00)	14	20.1	0.70 (0.38 – 1.17)
Mental disorders (290 – 315)	5	5.7	0.87 (0.29 – 2.05)	8	5.4	1.49 (0.64 – 2.91)
Diseases of nervous system (320 – 389)	2	4.4	–	1	4.2	–
Diseases of circulatory system (390 – 458)	12	24.8	0.48 (0.25 – 0.85)	21	24.0	0.87 (0.54 – 1.34)
Diseases of respiratory system (460 – 519)	5	6.0	0.84 (0.27 – 1.96)	4	5.7	–
Diseases of digestive system (520 – 577)	6	10.8	0.56 (0.20 – 1.21)	3	10.3	–
Diseases of genito-urinary system (580 – 611)	5	2.0	2.53 (0.82 – 5.79)	1	1.9	–
Congenital anomalies (740 – 759)	1	–	–	1	–	–
Symptoms, signs and ill-defined conditions (780 – 796)	2	6.7	–	1	6.3	–

*Because causes of death are coded to the Eighth Revision of the International Classification of Diseases, the numbers of deaths for certain causes may not agree with the numbers coded according to the Ninth Revision (see Section 4.3.1). Categories not listed had no deaths assigned to them.

+ Expected number based on the mortality rates among U.S. males and standardized for age, calendar year, and race.

+ + SMR = Observed deaths/expected deaths. SMRs are not computed for categories with fewer than five observed deaths.

Table 41. Observed and Expected Numbers of Deaths (From Death Certificate) for Specific External Causes Among Vietnam and Non-Vietnam Veterans and Standardized Mortality Ratios (1965 – 1983)

External cause (ICDA – 8)	Vietnam			Non-Vietnam		
	Observed deaths	Expected* deaths	SMR+ (95% CI)	Observed deaths	Expected deaths	SMR (95% CI)
All accidents (E800–E949)	125	103.8	1.20 (1.00–1.43)	88	98.2	0.90 (0.72–1.1
Motor vehicle accidents (E810–E827)	81	63.2	1.28 (1.02–1.59)	52	59.8	0.87 (0.65–1.1
Other accidents	44	40.6	1.08 (0.79–1.46)	36	38.4	0.94 (0.66–1.3
Suicide (E950–E959)	29	29.3	0.99 (0.66–1.42)	28	27.8	1.01 (0.67–1.4
Homicide and all other external causes (E960–E999)	34	42.3	0.80 (0.55–1.12)	27	40.2	0.67 (0.44–0.9

*Expected number based on the mortality rates among U.S. males and standardized for age, calendar year and race.

+ SMR = Observed deaths/expected deaths.

5. DISCUSSION

The findings described here raise a number of issues related to the interpretation of and conclusions about the postservice mortality experience of Vietnam veterans. Among these are the strengths and limitations of the study, findings from previous studies of Vietnam veterans, and prior investigations of veterans of other wars. These topics are reviewed here, and a number of summary comments are made regarding mortality risks of Vietnam veterans. Some of the concluding remarks are speculative, since available data do not allow further inferences. Other comments represent our best judgment about relationships between mortality and the Vietnam experience, given the totality of data examined.

5.1. STRENGTHS AND LIMITATIONS

This study began with a carefully defined cohort of Vietnam-era soldiers, and various methods were used to ascertain deaths occurring after separation from active duty. Vietnam and non-Vietnam veterans were chosen according to a stringent set of criteria to ensure maximum comparability. A comparison of entry and military-service characteristics for the two groups of veterans has confirmed their general similarity. Adjustment for residual differences in background characteristics between the two groups did not appreciably alter most relative mortality estimates. This indicates that differences in known background characteristics do not account for the observed pattern of relative mortality among Vietnam veterans. However, the possibility exists that other, unmeasured differences between the two cohorts could affect the estimate of the effect of Vietnam service on mortality.

Through the multiple overlapping sources of death ascertainment, virtually all deaths that occurred in the U.S.A. should have been identified, but some that occurred elsewhere may have been missed. Confirmation of death was obtained from copies of official death certificates, which were recovered for all but 2% of the deaths. A distinct advantage of this study is the special attempt to locate all presumably living men for the purpose of conducting health interviews; in most cohort mortality studies these persons are not individually traced. This component of the study provided verification of vital status on 94% of Vietnam veterans and 92% of those serving elsewhere. Furthermore, background and military-service characteristics of those with unconfirmed vital status are similar between the two cohorts, suggesting that mortality rates in these subgroups are not likely to be very different.

We attempted to keep misclassification of cohort status and cause of death to a minimum. After death certificates were coded, the correspondence between the ICD codes and the actual medical statements on the certificates was verified independently by two CDC staff persons. Any discrepancies were resolved with the nosologist. An evaluation of the reproducibility of cause of death coding by the nosologist indicated excellent agreement between the original codes and a sample of blind repeats. To minimize misclassification of cohort status, we verified duty location for all postservice deaths.

A special feature of this study is the special independent medical review of causes of deaths by reference to supplemental medical and legal documents recovered for 97% of deaths for which death certificates were obtained. This process clarified general or vague terms on death certificates, assured that as much information as possible was considered in cause-of-death determinations, and permitted use of similar criteria to determine underlying cause of death for the two cohorts. This was especially valuable for identifying deaths that were alcohol or drug-related. Through the medical review effort many more alcohol-related deaths were found than were derived from death certificates alone and half again as many drug-related deaths. These larger numbers of "cases" produced more reliable risk estimates and the standardization of criteria produced more valid results. Interestingly, the number of

suicide deaths derived from death certificates (n=29) was about the same as from the medical review (n=32) and the adjusted rate ratios based on the two sources are similar in both follow-up periods (RRs=2.54 and 2.47 in the early interval and RRs=0.57 and 0.74 in the later interval).

Any observational study has limitations. Perhaps the most important one here is the restricted sample size and limited number of deaths in this young population for most major cause of death categories, and especially for specific diseases or conditions. With the exception of the relatively common external causes of death, this study could detect, as statistically significant, only substantial elevations in cause-specific death rates. Nevertheless, numbers of deaths from some causes are significant to identify *patterns* of risk that are informative. This is important in interpreting the findings for drug-related deaths, suicide, and homicide.

The extent of underreporting in our data, in particular for deaths which are alcohol- or drug-related, may be substantial. If alcohol- or drug-related deaths were more or less likely to be reported among Vietnam veterans than non-Vietnam veterans, the resulting rate ratios would reflect this reporting bias. In our data, however, only drug-related deaths appeared in excess among Vietnam veterans; if reporting was differential, we might expect both alcohol and drug deaths to be in excess.

A methodologic issue of concern in the analysis of these data was the choice of relevant covariates as possible confounders. In particular, some of the military service variables such as "pay grade at discharge" and "AWOL/confinement time" are measured during or after the military experience and could be affected differentially by it in the two cohorts. If this was the case, adjustment for that covariate could introduce a bias in the RR estimate. Pay grade was retained in the reduced model (e.g., Table 38) since it is a strong determinant of mortality in these data and in prior studies of Army veterans.[17,28] The biggest shift in the relative mortality estimate caused by including a military service covariate in the Cox model, namely pay grade, occurred for suicide.

Another potential limitation of this study is the relatively short time that has elapsed since the Vietnam conflict. If the "Vietnam experience" does place veterans at an increased risk for certain fatal chronic diseases, the time interval between exposure and death may be longer than our current 10-15 years of follow-up. Continued monitoring of mortality in VES participants, therefore, may provide additional insights.

5.2. COMPARISON WITH PREVIOUS MORTALITY STUDIES OF VIETNAM VETERANS

The present findings can be viewed against the results of five previous mortality studies of Vietnam veterans. Four are proportional mortality studies[6-9], which may not be directly comparable to this study because of incompleteness of data and inherent limitations of the analytic method.[29] The fifth, a cohort study of Australian Vietnam veterans, is very similar in design to our study and, thus, is a more appropriate comparison.[10] The U.S. Air Force's "Ranch Hand Study" is not discussed here, since its principal concern is the adverse health effects of herbicide exposure in a unique group of veterans.[5]

Two of the proportional mortality studies were conducted using fairly well-defined populations.[7,8] The results of one included nonsignificant increases in suicide, homicide, accidental poisonings and nonmotor vehicle accidents of transport among Vietnam veterans relative to other Vietnam-era veterans. However, deaths due to MVAs were not elevated.[7] Time since discharge was not considered in that study and this was critical in elucidating the pattern of external cause mortality in our study. In the other study, only deaths from suicide and motor-vehicle accidents were examined, and neither occurred more frequently among Vietnam veterans.[8]

The two other proportional mortality studies were conducted by using deaths occurring among veterans registered for a military service bonus in their respective states[6,9], and it is unclear what bias may have been introduced through this selection process. In one of the studies, a nonsignificant increase in deaths from MVAs among Vietnam veterans was found.[6]

The excess in overall mortality among Australian Vietnam veterans was mainly confined to men who had served in the Engineer Corps, a finding the investigators could not entirely explain.[10] A similar variation in risk is not seen in the present study, although the number of men assigned to Engineer units is relatively small.

The 30% excess of external-cause mortality among Australian Vietnam veterans relative to non-Vietnam veterans is similar to what is seen in our study. Although the Australian investigators do not examine external cause mortality by time since discharge, there is a suggestion of a decline in relative mortality from all causes with increasing time since discharge. Deaths from suicide, homicide, and accidental poisoning also occur more frequently among Australian Vietnam veterans. MVA mortality is not elevated overall, but an excess in the youngest age group is suggested. The authors conclude that although modest, the consistency of the results across several external cause-specific categories may indicate that the association is, in fact, real.

The results of our study are in agreement with those of the Australian study, that is, no association was found between service in Vietnam and mortality due to neoplasms (all types combined). In several of the proportional mortality studies, however, investigators found an increased frequency of deaths from connective-tissue and other soft-tissue cancers among Vietnam veterans.[6,8,9] There are no such deaths in the present study, and only two among Australian Vietnam veterans, but small sample sizes in both studies preclude the detection of increased risks for these rare malignancies. For this reason, these tumors and others are being examined in CDC's Selected Cancers Study.[3]

One surprising finding is the lower mortality rate from cardiovascular disease (CVD) among Vietnam veterans. This result is evident regardless of time since discharge and applies to several major types of circulatory disease. The lower rate might be explained as a by-product of some kind of selection process taking place in the final assignments to Vietnam, which might correlate with cardiovascular fitness established during basic or advanced training. In fact, the SMR results suggest that the CVD deficit may be the result of an unusually high rate in the comparison group. CVD mortality in the non-Vietnam cohort is only slightly below that of the general population, whereas we expected it to be much lower.[25] Various indices of CVD morbidity measured in the other components of the VES may help in elucidating the mortality findings. Contrary to our findings for CVD, Australian Vietnam veterans experienced a significant 90% increase in deaths from such causes.[10] The investigators speculate that this increase may have resulted from health-influencing behaviors, such as cigarette smoking and excess alcohol intake, which Vietnam veterans may have acquired more easily than non-Vietnam veterans because of the stressful environment of the war zone and/or the availability of these substances.

Australian Vietnam veterans have an excess of deaths from alcohol-related natural causes, but no increases in deaths from alcohol-related external causes or any type of drug-related mortality. These findings are contrary to ours and may reflect differences in use of drugs and alcohol by American and Australian troops. In contrast to the reportedly heavy use of illicit drugs by American troops in Vietnam,[30,31] drug use among Australian soldiers was reported to be uncommon, while alcohol use was heavy.[10]

Another point that can be raised here is the relationship between the present findings for drug-related deaths and two factors: (1) the reported heavy use of drugs (especially narco-

ics) among servicemen in Vietnam in the latter part of the conflict (1969-1971)[30,31] and (2) surveys of postservice drug use by veterans in which no association with service in Vietnam or combat exposure was found.[31,32] With respect to the first point, our results do not show a relationship between total mortality or any specific cause of death and discharge from the Army in 1970 or later, a time period that would include men who were in Vietnam in the early 1970s. On the contrary, the overall mortality excess is greatest among Vietnam veterans discharged in the late 1960s, and drug-related deaths are most excessive among Vietnam veterans who were in Vietnam in the late 1960s. Regarding the second point, it would appear that the drug-related findings are at variance with findings in two surveys of drug use among living Vietnam veterans.[31,32] One possibility for the discordant results is response bias on the part of interviewed Vietnam veterans whereby actual drug use is concealed. Admittedly, this would have had to operate in two independent surveys. Another consideration is the time frame for the studies. Since the greatest part of our excess occurs 11 or more years after discharge, it could be a delayed response that affects a susceptible subgroup of Vietnam veterans and is completely masked when use habits are studied in living veterans at earlier points in time. Also, one of the surveys was conducted with veterans returning from Vietnam in late 1971[31], while the drug-related excess in our study was found among those serving in Vietnam during the late 1960's.

5.3. POSSIBLE INTERPRETATIONS AND CONCLUSIONS

The increase in early postdischarge mortality from external causes (i.e., MVA, suicide and homicide) among Vietnam veterans seen in this study has at least three possible explanations:

1) It reflects a peculiarity of the process of selecting men for assignment, whereby those sent to Vietnam tended to have characteristics that placed them at increased risk of dying from external causes shortly after discharge from active duty.
2) It is a result of the psychological and physical stresses associated with military duty in a combat zone, a set of circumstances not unique to the Vietnam conflict.
3) It is a consequence of the uniqueness of the Vietnam conflict, some combination of environment and experience that exerted special effects while men were serving there and/or after their return to an unsupportive and sometimes hostile social climate in the U.S.A.

The first of these possibilities appears doubtful for several reasons. In our data, no important differences were apparent in background characteristics between Vietnam and non-Vietnam veterans (e.g., race, age, aptitude test scores) at the time of entry into the Army. On the other hand, the non-Vietnam group had a *higher* prevalence of nonhonorable discharges, lower pay grades at discharge, and more AWOL or confinement time while in the Army, characteristics that might be associated with risk-taking behavior. Furthermore, if Vietnam veterans tended to have a greater predisposition (by selection) toward traumatic events than non-Vietnam veterans, it might be expected to manifest itself in increased relative mortality from such causes throughout the entire period of observation, rather than being confined to the first few years after discharge, as was observed here. Further doubt about such selective factors is raised by a survey of high-school boys which showed that those who subsequently served in Vietnam were similar to those who served elsewhere in the military with respect to family background, early academic abilities and achievements, and adolescent personality traits.[33]

The second possible explanation has some basis in the light of previous studies of postservice mortality among U.S. veterans who served in other war zones. Increased postdischarge mortality from external causes was observed in two groups of World War II combat veterans and one group of Korean War combat veterans, when compared with the general U.S. male

population, even though older men and officers were included.[34] In contrast, broader cross sections of World War II veterans, including both combat and noncombat groups, showed no difference, or even a slight deficit, in postdischarge traumatic deaths,[25,34] as did non-Vietnam veterans in our study.

The third possible explanation for the present findings, the unique elements of the Vietnam conflict, seems plausible on the surface, since the Vietnam conflict was characterized by a number of special features. Among these were: (1) entry to, and exit from, the war zone in a very compressed time period, with little or no time for adjustment (the "jet-age war" phenomenon); (2) individual replacement after predetermined 12-month tours of duty (associated with reduced morale and cohesiveness within units); (3) fighting an enemy that was hard to distinguish from one's allies; and (4) fighting for "body counts" rather than for territory. On top of this, returning Vietnam veterans encountered an indifferent and sometimes hostile reception at home. This is in direct contrast to the experience of most World War II and Korean War veterans who were sent overseas "for the duration" as members of pre-formed units that trained and stayed together. Warfare was more "conventional", and objectives could be more easily understood. Furthermore, the World War II and Korean veterans returned to a generally more supportive homeland. In spite of these contrasts in military experience, however, the same pattern of excess postservice mortality due to external causes seen in Vietnam veterans is also found among men returning from combat areas in the two previous wars. Thus, increased external cause mortality seen here among Vietnam veterans may be one of the unfortunate sequelae of unusual stresses endured while stationed in a hostile fire zone.

Although this explanation is very suggestive, it should be noted that certain features of our data do not support this conclusion. Namely, Vietnam veterans who were likely to have engaged in combat did not have a higher rate of mortality than Vietnam veterans who were less likely to have done so. We might expect just the opposite if the excess mortality observed here is the result of the psychological and physical stresses associated with military duty in a combat zone. Also, the findings for the World War II and Korean War Army veterans are not particularly enlightening for deaths due to suicide and homicide, because of small number of such deaths and the lack of data on suicide and homicide risks according to time period after discharge. In addition, the influence of factors specific to the Vietnam experience in explaining this early postservice external mortality excess cannot be completely ruled out. Indeed, cross sectional surveys[32,33,35-37] have uncovered a variety of psychosocial and economic problems among Vietnam veterans that may be the precursors for certain types of traumatic deaths, such as suicide.

If the MVA excess among Vietnam veterans is causally related to their experience in a combat zone, it may be consistent with one or more theories of young driver risk-taking behavior.[38] According to these theories, unusual risk-taking on the part of young drivers may be

(1) an outlet for stress, aggression, hostility, or frustration. Could service in Vietnam have created these feelings?

(2) a physiological need for increased arousal that makes some people seek ways of increasing their stimulation. Could service in Vietnam have produced a desire for sensation- or thrill-seeking?

(3) an attempt by some persons to increase the level of perceived driving risk to some higher target level that they find acceptable. Could service in Vietnam have produced an acceptance of increased risk in everyday life?

Whatever the explanation is, factors responsible for the MVA results were operable only in the first few years after discharge. Thus, this may have been the critical period in which those most affected by the Vietnam experience succumbed.

The pattern of drug-related mortality among Vietnam veterans in this study appears different from the pattern of external causes (i.e., MVAs, suicide, homicide). Excess drug-related deaths increase with time since discharge, and certain subgroups of Vietnam veterans seem to be at especially high risk, namely, draftees and those whose job was in tactical operations (i.e., combat-related activities). Examination of risks in relation to the calendar year men were in Vietnam shows the largest excess associated with 1968 and 1969, the years of heaviest combat. Thus, the increased death rates from drug-related causes among Vietnam veterans may be linked to intensity of combat exposure rather than to a general, across-the-board effect of the Vietnam experience.

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APPENDIX A

DETAILED DISTRIBUTIONS OF VETERAN CHARACTERISTICS

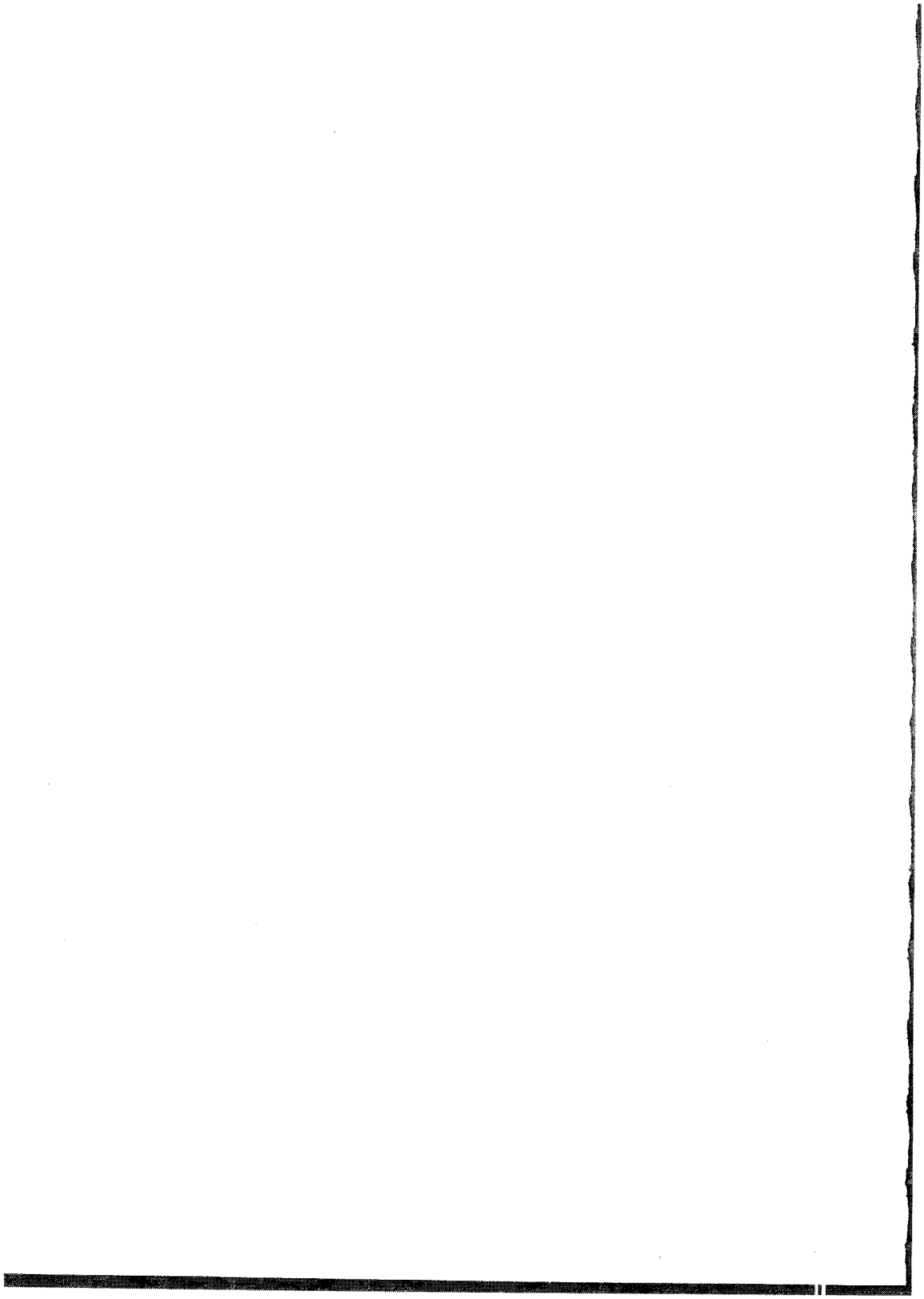


Table A-1. Descriptive Characteristics of Vietnam Experience Study Veterans at Time of Entry Into U.S. Army, by Duty Location

Characteristic	Vietnam		Total Non-Vietnam		Germany/Korea		United States Only	
	No.	%	No.	%	No.	%	No.	%
Total	9324	100.0	8989	100.0	5120	100.0	3869	100.0
Race:								
White	8097	86.8	7776	86.5	4403	86.0	3373	87.2
Black	1156	12.4	1123	12.5	666	13.0	457	11.8
Other	63	0.7	85	0.9	49	1.0	36	0.9
Unknown	8	0.1	5	0.1	2	0.0	3	0.1
			($X^2 = 4.22, p = 0.12$)		($X^2 = 4.62, p = 0.10$)		($X^2 = 3.17, p = 0.21$)	
Place of birth:								
Northeast	1769	19.0	1781	19.8	1006	19.6	775	20.0
Midwest	2827	30.3	2751	30.6	1607	31.4	1144	29.6
South	2205	23.6	2047	22.8	1188	23.2	859	22.2
West	2193	23.5	1988	22.1	1147	22.4	841	21.7
Foreign	312	3.3	393	4.4	160	3.1	233	6.0
Unknown	18	0.2	29	0.3	12	0.2	17	0.4
			($X^2 = 21.28, p < 0.001$)		($X^2 = 7.42, p = 0.19$)		($X^2 = 55.81, p < 0.001$)	

Table A-1. Descriptive Characteristics of Vietnam Experience Study Veterans at Time of Entry Into U.S. Army, by Duty Location—Continued

Characteristic	Vietnam		Total Non-Vietnam		Germany/Korea		United States Only	
	No.	%	No.	%	No.	%	No.	%
Enlistment status:								
Draftee	5943	63.7	5899	65.6	3201	62.5	2698	69.7
Volunteer	3381	36.3	3090	34.4	1919	37.5	1171	30.3
			($X^2 = 7.12, p = 0.01$)		($X^2 = 2.11, p = 0.15$)		($X^2 = 43.49, p < 0.001$)	
Age at entry:								
17	443	4.8	590	6.6	357	7.0	233	6.0
18	979	10.5	748	8.3	465	9.1	283	7.3
19	3459	37.1	1967	33.0	1777	34.7	1190	30.8
20	2200	23.7	2001	22.3	1174	21.9	827	21.4
21 +	2235	24.0	2683	29.9	1347	26.3	1336	34.5
			($X^2 = 134.39, p < 0.001$)		($X^2 = 49.38, p < 0.001$)		($X^2 = 187.80, p < 0.001$)	
Year of entry:								
1965	1112	11.9	1271	14.1	673	13.1	598	15.5
1966	1997	21.4	1925	21.4	1151	22.5	774	20.0
1967	1659	17.8	983	10.4	632	12.3	306	7.9
1968	1953	21.0	1318	14.7	790	15.4	528	13.7
1969	1702	18.3	1357	15.1	729	14.2	628	16.2
1970	650	7.4	1227	13.7	650	12.7	577	14.9
1971	208	2.2	953	10.6	495	9.7	458	11.8
			($X^2 = 995.06, p < 0.001$)		($X^2 = 626.24, p < 0.001$)		($X^2 = 950.91, p < 0.001$)	

Table A-2. Physical and Mental Profile of Vietnam Experience Study Veterans At Time of Entry into U.S. Army, by Duty Location

Characteristic	Vietnam		Total Non-Vietnam		Germany/Korea		United States Only	
	No.	%	No.	%	No.	%	No.	%
Total	9324	100.0	8989	100.0	5120	100.0	3869	100.0
Physical Capacity or Stamina:								
No impairment	9230	99.0	8877	98.8	5053	98.7	3824	98.8
Mild-significant	85	0.9	106	1.2	63	1.2	43	1.1
Unknown	9	0.1	6	0.1	4	0.1	2	0.1
			($X^2 = 3.17, p = 0.06$)		($X^2 = 3.31, p = 0.07$)		($X^2 = 1.13, p = 0.29$)	
Upper Extremities:								
No impairment	9247	99.2	8904	99.1	5073	99.1	3831	99.0
Mild-significant	68	0.7	79	0.9	43	0.8	36	0.9
Unknown	9	0.1	6	0.1	4	0.1	2	0.1
			($X^2 = 1.28, p = 0.26$)		($X^2 = 0.53, p = 0.47$)		($X^2 = 1.41, p = 0.24$)	
Lower Extremities:								
No impairment	9075	97.3	8743	97.3	4982	97.3	3761	97.2
Mild-significant	240	2.6	240	2.7	134	2.6	106	2.7
Unknown	9	0.1	6	0.1	4	0.1	2	0.1
			($X^2 = 0.16, p = 0.69$)		($X^2 = 0.02, p = 0.88$)		($X^2 = 0.29, p = 0.59$)	
Hearing Acuity and Ears:								
No impairment	8794	94.3	8378	93.2	4763	93.0	3615	93.4
Mild-significant	521	5.6	605	6.7	353	6.9	252	6.5
Unknown	9	0.1	6	0.1	4	0.1	2	0.1
			($X^2 = 10.32, p = 0.001$)		($X^2 = 9.91, p = 0.002$)		($X^2 = 4.22, p = 0.04$)	

Table A-2. Physical and Mental Profile of Vietnam Experience Study Veterans At Time of Entry into U.S. Army, by Duty Location—Continued

Characteristic	Vietnam		Total Non-Vietnam		Germany/Korea		United States Only	
	No.	%	No.	%	No.	%	No.	%
Eyes and Visual Acuity:								
No impairment	6934	74.4	6404	71.2	3677	71.8	2727	70.5
Mild-significant	2381	25.5	2579	28.7	1439	28.1	1140	29.5
Unknown	9	0.1	6	0.1	4	0.1	2	0.1
			($X^2 = 22.95, p<0.001$)		($X^2 = 11.18, p<0.001$)		($X^2 = 21.44, p<0.001$)	
Psychiatric Functioning:								
No impairment	9300	99.7	8962	99.7	5105	99.7	3857	99.7
Mild-significant	15	0.2	21	0.2	11	0.2	10	0.3
Unknown	9	0.1	6	0.1	4	0.1	2	0.1
			($X^2 = 1.23, p = 0.27$)		($X^2 = 0.54, p = 0.46$)		($X^2 = 1.37, p = 0.24$)	
Composite Index of Health:								
No impairment	6297	67.5	5712	63.5	3270	63.9	2442	63.1
Mild-significant	2990	32.1	3232	36.0	1823	35.6	1409	36.4
Other than minor	26	0.3	36	0.4	20	0.4	16	0.4
Unknown	11	0.1	9	0.1	7	0.1	2	0.1
			($X^2 = 33.47, p<0.001$)		($X^2 = 20.43, p<0.001$)		($X^2 = 25.13, p<0.001$)	

Table A-3. Mean Scores of Vietnam Experience Study Veterans on Aptitude Tests Given as Part of the Entrance Examination for the U.S. Army, by Duty Location

Aptitude Test	Vietnam			Total Non-Vietnam			Germany/Korea			United States Only		
	No.	Mean	SD	No.	Mean	SD	No.	Mean	SD	No.	Mean	SD
Army Classification Battery:												
Verbal ability	9136	104.4	21.9	8863	106.9	22.1	5067	105.2	22.1	3796	109.0	21.9
				($t = -7.55$, $p<0.001$)			($t = -2.17$, $p = 0.03$)			($t = -11.00$, $p<0.001$)		
Arithmetic reasoning	9135	101.5	21.5	8865	103.8	22.1	5068	102.3	21.8	3797	105.9	22.3
				($t = -7.26$, $p<0.001$)			($t = -2.13$, $p = 0.03$)			($t = -10.6$, $p<0.001$)		
Pattern analysis	9136	101.7	22.5	8864	103.5	22.3	5068	102.8	22.0	3796	104.6	22.7
				($t = -5.42$, $p<0.001$)			($t = -2.66$, $p = 0.008$)			($t = -6.52$, $p<0.001$)		
General information	9117	100.3	18.4	8844	100.8	18.5	5060	100.2	18.3	3784	101.6	18.9
				($t = -1.85$, $p = 0.07$)			($t = 0.30$, $p = 0.77$)			($t = -3.68$, $p<0.001$)		
General technical	9200	103.1	19.9	8914	105.5	20.4	5087	104.0	20.2	3827	107.6	20.6
				($t = -8.08$, $p<0.001$)			($t = -2.52$, $p = 0.01$)			($t = -11.5$, $p<0.001$)		
Armed Forces Qualification Test	9280	50.4	25.5	8950	52.3	26.0	5102	50.8	25.7	3848	54.3	26.3
				($t = -5.06$, $p<0.001$)			($t = -0.97$, $p = 0.03$)			($t = -7.94$, $p<0.001$)		

Table A-4. Military-Service Characteristics of Vietnam Experience Study Veterans, by Duty Location

Characteristic	Vietnam		Total Non-Vietnam		Germany/Korea		United States Only	
	No.	%	No.	%	No.	%	No.	%
Total	9324	100.0	8989	100.0	5120	100.0	3869	100.0
Military Occupational Specialty*:								
Tactical	3196	34.3	2462	27.4	1577	30.8	885	22.9
Missile and fire control electronic maintenance	48	0.5	166	1.6	116	2.3	50	1.3
General electronics maintenance	591	6.3	621	6.9	431	8.4	190	4.9
Precision maintenance	147	1.6	162	1.8	93	1.8	69	1.8
Auxiliary services	441	4.7	333	3.7	199	3.9	134	3.5
Motors	1776	19.1	1223	13.6	761	14.9	462	11.9
Clerical	1763	18.9	1907	21.2	992	19.4	915	23.7
Graphics	106	1.1	170	1.9	82	1.6	88	2.3
General technical	1002	10.8	1579	17.6	685	13.4	894	23.1
Special assignment	254	2.7	366	4.1	184	3.6	182	4.7
			($X^2 = 442.5, p < 0.001$)		($X^2 = 194.6, p < 0.001$)		($X^2 = 616.3, p < 0.001$)	

Table A-4. Military-Service Characteristics of Vietnam Experience Study Veterans, by Duty Location—Continued

Characteristic	Vietnam		Total Non-Vietnam		Germany/Korea		United States Only	
	No.	%	No.	%	No.	%	No.	%
Type of Unit:								
Infantry	2477	26.6	1313	14.6	906	17.7	407	10.5
Engineer	911	9.8	542	6.0	368	7.2	174	4.5
Armor	123	1.3	508	5.7	376	7.3	132	3.4
Cavalry	792	8.5	203	2.3	127	2.5	76	2.0
Artillery	1021	11.0	1462	16.3	1061	20.7	401	10.4
Other	3920	42.0	4926	54.8	2264	44.2	2662	68.8
Unknown	80	0.9	35	0.4	18	0.4	17	0.4
			($X^2 = 1223.2, p<0.001$)		($X^2 = 892.3, p<0.001$)		($X^2 = 1045.2, p<0.001$)	
Number of Months of Active Duty:								
1–12	484	5.1	445	5.0	62	1.2	383	9.9
13–24	6208	66.6	6315	70.3	3560	69.5	2755	71.2
25–36	2632	28.2	1946	21.6	1367	26.7	579	15.0
37+	0	0.0	283	3.1	131	2.6	152	3.9
			($X^2 = 436.0, p<0.001$)		($X^2 = 19.8, p = 0.003$)		($X^2 = 1070.9, p<0.001$)	

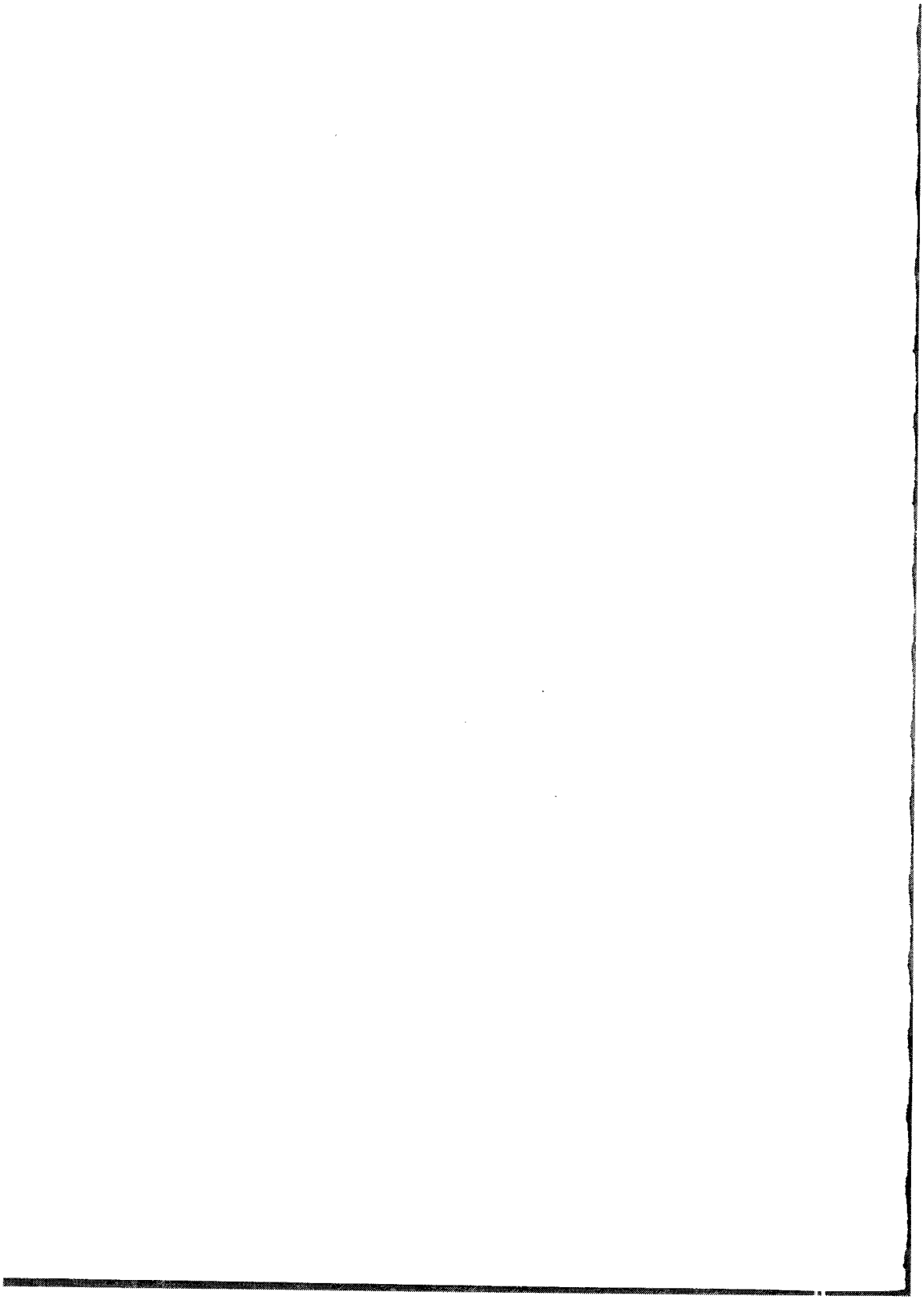
*Job specialty for which the man was trained.

Table A-5. Military Characteristics of Vietnam Experience Study Veterans at Discharge from Active Duty, by Duty Location

Characteristic	Vietnam		Total Non-Vietnam		Germany/Korea		United States Only	
	No.	%	No.	%	No.	%	No.	%
Total	9324	100.0	8989	100.0	5120	100.0	3869	100.0
Ever AWOL or Confinement Time:								
No	8163	87.5	7744	86.2	4668	91.2	3076	79.5
Yes	1081	11.6	1197	13.3	422	8.2	775	20.0
Unknown	80	0.9	48	0.5	30	0.6	18	0.5
			($X^2 = 11.9, p = <0.001$)		($X^2 = 40.5, p<0.001$)		($X^2 = 158.8, p<0.001$)	
Type of Discharge:								
Honorable	9067	97.2	8183	91.0	4866	95.0	3317	85.7
Other	249	2.7	802	8.9	252	4.9	550	14.2
Unknown	8	0.1	4	0.1	2	0.1	2	0.1
			($X^2 = 333.6, p<0.001$)		($X^2 = 51.0, p<0.001$)		($X^2 = 640.8, p<0.001$)	
Pay Grade at Discharge:								
E-1	249	2.7	649	7.2	185	3.6	464	12.0
E-2	212	2.3	499	5.6	180	3.5	319	8.3
E-3	614	6.6	668	7.4	362	7.1	306	7.9
E-4	4608	49.4	4278	47.6	2642	51.6	1636	42.3
E-5	3641	39.1	2895	32.2	1751	34.2	1144	29.6
			($X^2 = 387.7, p<0.001$)		($X^2 = 53.7, p<0.001$)		($X^2 = 786.0, p<0.001$)	

Table A-5. Military Characteristics of Vietnam Experience Study Veterans at Discharge from Active Duty, by Duty Location—Continued

Characteristic	Vietnam		Total Non-Vietnam		Germany/Korea		United States Only	
	No.	%	No.	%	No.	%	No.	%
Age at Discharge:								
<19	11	0.1	172	1.9	68	1.3	104	2.7
19	173	1.9	320	3.6	152	3.0	168	4.3
20	841	9.0	774	8.6	421	8.2	353	9.1
21	3421	36.7	2776	30.9	1704	33.3	1072	27.7
22	2374	25.5	2032	22.6	1268	24.8	764	19.8
23	1094	11.7	1145	12.7	661	12.9	484	12.5
24	632	6.8	755	8.4	378	7.4	377	9.7
25+	778	8.3	1015	11.3	468	9.1	547	14.1
			($X^2 = 319.3, p<0.001$)		($X^2 = 128.5, p<0.001$)		($X^2 = 499.2, p<0.001$)	
Year of Discharge:								
1965–1966	21	0.2	94	1.1	22	0.4	72	1.9
1967–1968	2482	26.6	2787	31.0	1516	29.6	1271	32.9
1969–1970	4011	43.0	2395	26.6	1565	30.6	830	21.5
1971–1972	2571	27.6	2811	31.3	1521	29.7	1290	33.3
1973–1974	234	2.5	856	9.5	488	9.5	368	9.5
1975–1977	5	0.1	46	0.5	8	0.2	38	1.0
			($X^2 = 864.4, p<0.001$)		($X^2 = 483.2, p<0.001$)		($X^2 = 884.9, p<0.001$)	



APPENDIX B

DETAILED EXAMINATION OF ALL-CAUSE MORTALITY BY SELECTED COVARIATES

In this section, we present a detailed examination of factors that might modify the effect of Vietnam service on mortality. Because the increased rate of mortality associated with service in Vietnam appears to be limited to the first 5 years of follow-up, and because covariates potentially can have different effects in different time periods, all covariates are examined with respect to time since discharge.

1. ENTRY CHARACTERISTICS

Race (Table B-1): The effect of Vietnam service on mortality in the early postservice period is slightly higher for whites (RR=1.50) than for persons of races other than white (RR=1.30) but the test for effect modification is not significant. After the first 5 years of follow-up, there is little or no effect of Vietnam service on mortality in whites or in nonwhites.

Region of birth (Table B-2): Although the rate ratios appear to vary somewhat among the various regions of birth, the variation is not statistically significant. In general, regardless of where they were born, Vietnam veterans were more likely to die within the first 5 years after discharge than non-Vietnam veterans. After 5 years, again regardless of region of birth, little increase in the relative rate of mortality among Vietnam veterans is seen.

GT score (Table B-3): Overall, level of performance on the GT test does not appear to modify the effect of Vietnam service on mortality. Although not shown, similar conclusions can be drawn from an examination of the potential modifying effect of the other components of the Army Classification Battery and the Armed Forces Qualification Test.

Physical health profile (Table B-4): In the first 5 years after discharge, the rate ratios associated with service in Vietnam appear to differ somewhat among those with and without physical impairment. Among those with some type of physical impairment, over a twofold increase in the rate of mortality was found for those who served in Vietnam relative to those who had not. In contrast, there is only a 20% increase among veterans with no impairment in functioning. This departure from homogeneity is of borderline significance ($X^2=3.10$, $p = 0.08$). After the initial 5 years, the rate ratios are 1.1 for veterans with no impairment and 0.9 for those with any impairment. Although not shown, the patterns for the individual physical components mirror those seen with the summary measure.

Enlistment status (Table B-5): The rate ratios in the first 5 years after discharge differ somewhat among those who volunteered for military service compared to those who were drafted. Vietnam veterans who were drafted into service were 1.8 times more likely to die in the first five years postservice, but Vietnam veterans who volunteered were only 1.1 times more likely. The test of effect modification is of borderline significance (p=0.09). After the first 5 years, both rate ratios are at or below 1.0, indicating no association between Vietnam service and likelihood of dying in that time period for either volunteers or draftees.

Table B-1. Number of Deaths, Crude Rates/1000 Person-Years, and Rate Ratios, by Cohort Status, Race, and Time Since Discharge (1965 – 1983)

Years since discharge	Race	Vietnam		Non-Vietnam		Rate ratio	95% CI
		No. deaths	Rate/ 1000	No. deaths	Rate/ 1000		
≤5	White	89	2.2	57	1.5	1.50	1.08–2.09
	Nonwhite	21	3.5	16	2.7	1.30	0.68–2.50
6+	White	99	1.4	94	1.4	0.99	0.74–1.3[illegible]
	Nonwhite	37	3.6	33	3.3	1.07	0.67–1.7[illegible]
All years	White	188	1.7	151	1.4	1.18	0.95–1.46
	Nonwhite	58	3.5	49	3.1	1.15	0.78–1.68

Tests for effect modification of race: ≤5 years: $X^2 = 0.15$, $p = 0.70$
6+ years: $X^2 = 0.08$, $p = 0.78$
All years: $X^2 = 0.02$, $p = 0.89$

Table B-2. Number of Deaths, Crude Rates/1000 Person-Years and Rate Ratios, by Cohort Status, Region of Birth, and Time Since Discharge (1965 – 1983)

Years since discharge	Region of birth*	Vietnam		Non-Vietnam		Rate ratio	95% CI
		No. deaths	Rate/ 1000	No. deaths	Rate/ 1000		
≤5	Northeast	16	1.8	15	1.7	1.07	0.53–2.17
	Midwest	37	2.6	23	1.7	1.57	0.93–2.64
	South	25	2.3	16	1.6	1.45	0.78–2.72
	West	32	2.6	19	1.6	1.60	0.91–2.83
6+	Northeast	25	1.6	18	1.2	1.37	0.75–2.51
	Midwest	36	1.5	34	1.5	1.00	0.62–1.59
	South	39	2.0	37	2.1	0.96	0.61–1.50
	West	36	1.7	38	1.9	0.87	0.55–1.38
All years	Northeast	41	1.7	33	1.4	1.23	0.78–1.95
	Midwest	73	1.9	57	1.5	1.22	0.86–1.73
	South	64	2.1	53	1.9	1.11	0.77–1.59
	West	68	2.0	57	1.8	1.11	0.78–1.58

*Foreign places of birth grouped with West category.
Tests for effect modification of region of birth: ≤5 years: $X^2 = 0.91$, $p = 0.82$
6+ years: $X^2 = 1.42$, $p = 0.70$
All years: $X^2 = 0.27$, $p = 0.97$

Table B-3. Number of Deaths, Crude Rates/1000 Person-Years and Rate Ratios, by Cohort Status, General Technical Test (GT) Score, and Time Since Discharge (1965–1983)

Years since discharge	GT score	Vietnam		Non-Vietnam		Rate ratio	95% CI
		No. deaths	Rate/ 1000	No. deaths	Rate/ 1000		
≤5	<100	60	3.0	37	2.1	1.41	0.93–2.12
	100+	48	1.8	35	1.3	1.43	0.92–2.20
6+	<100	73	2.1	68	2.3	0.90	0.64–1.25
	100+	61	1.3	58	1.2	1.07	0.75–1.53
All years	<100	133	2.4	105	2.3	1.07	0.83–1.39
	100+	109	1.5	93	1.2	1.20	0.91–1.58

Tests for effect modification of GT score: ≤ 5 years: $X^2 = 0.004$, $p = 0.95$
6+ years: $X^2 = 0.53$, $p = 0.47$
All years: $X^2 = 0.33$, $p = 0.57$

Table B-4. Number of Deaths, Crude Rates/1000 Person-Years and Rate Ratios, by Cohort Status, Composite Index of Health, and Time Since Discharge (1965–1983)

Years since discharge	Composite index of health	Vietnam		Non-Vietnam		Rate ratio	95% CI
		No. deaths	Rate/ 1000	No. deaths	Rate/ 1000		
≤5	No impairment	69	2.2	52	1.8	1.20	0.84 – 1.73
	Some impairment	41	2.7	21	1.3	2.12	1.25 – 3.59
6+	No impairment	100	1.8	82	1.7	1.08	0.80 – 1.44
	Some impairment	36	1.4	45	1.6	0.85	0.55 – 1.32
All years	No impairment	169	2.0	134	1.7	1.12	0.90 – 1.41
	Some impairment	77	1.9	66	1.5	1.25	0.90 – 1.74

Tests for effect modification of composite index of health: ≤5 years: $X^2 = 3.10$, $p = 0.08$
6+ years: $X^2 = 0.78$, $p = 0.38$
All years: $X^2 = 0.27$, $p = 0.60$

Table B-5. Number of Deaths, Crude Rates/1000 Person-Years and Rate Ratios, by Cohort Status, Enlistment Status and Time Since Discharge (1965–1983)

Years since discharge	Enlistment status	Vietnam No. deaths	Vietnam Rate/ 1000	Non-Vietnam No. deaths	Non-Vietnam Rate/ 1000	Rate ratio	95% CI
≤5	Volunteers	43	2.6	36	2.4	1.09	0.70 – 1.70
	Draftees	67	2.3	37	1.3	1.80	1.21 – 2.69
6+	Volunteers	57	2.1	54	2.3	0.91	0.63 – 1.32
	Draftees	79	1.5	73	1.4	1.06	0.77 – 1.45
All years	Volunteers	100	2.3	90	2.3	0.98	0.74 – 1.30
	Draftees	146	1.8	110	1.3	1.31	1.02 – 1.67

Tests for effect modification of enlistment status: ≤5 years: $X^2 = 2.72$, $p = 0.09$
6+ years: $X^2 = 0.34$, $p = 0.55$
All years: $X^2 = 2.20$, $p = 0.14$

2. MILITARY AND DISCHARGE CHARACTERISTICS

Military occupational speciality (Table B-6): The categorization of MOS into "tactical" and "nontactical" jobs is a rough surrogate for combat exposure; Vietnam veterans assigned a tactical MOS are more likely to have experienced combat than those with nontactical MOSs. In general, service in a tactical MOS does not appear to influence the effect of Vietnam service on likelihood of dying. In the intial follow-up period, service in Vietnam has a slightly greater effect on mortality among those with a nontactical MOS. The opposite pattern is apparent after five years. Neither difference is statistically significant.

Type of unit (Table B-7): In the first 5 years after discharge, the death rate is increased among Vietnam veterans who served in each type of unit except engineering units. The rate ratios are especially high among those in the infantry (RR=2.02) and armor (RR=2.07). The overall test for effect modification is, however, not statistically significant. In addition, Vietnam veterans assigned to engineering units do not appear to be at greater risk of dying than Vietnam veterans in other units. Only 23% of men in engineering units, however, had an MOS that could be classified as an actual engineering occupation. When the analysis was restricted to such veterans, similar results were found.

AWOL or confinement time (Table B-8): In the first five years after discharge the rate ratio associated with service in Vietnam is higher among those who never had AWOL or confinement time than for those who had been AWOL or had served confinement time, but this difference is not statistically significant. After 5 years both rate ratios are close to unity.

Duration of active duty (Table B-9): Vietnam veterans who served less than 12 months of active duty in the Army had an appreciably higher relative death rate than those serving more than 12 months. Although further exploration was not possible because of the small numbers, this departure from homogeneity is not statistically significant.

Age at discharge (Table B-10): The effect of Vietnam service on mortality is somewhat stronger among those who were less than 21 years at the time of discharge than among those 21 years or older. The reverse is true in the later follow-up period. This finding may be the result of chance fluctuation, since the tests for effect modification in both follow-up periods are nonsignificant.

Table B-6. Number of Deaths, Crude Rates/1000 Person-Years and Rate Ratios, by Cohort Status, Military Occupational Specialty (MOS) Category and Time Since Discharge (1965–1983)

Years since discharge	MOS* category	Vietnam No. deaths	Vietnam Rate/1000	Non-Vietnam No. deaths	Non-Vietnam Rate/1000	Rate ratio	95% CI
≤5	Tactical	39	2.4	24	2.0	1.19	0.71–1.97
	Nontactical	71	2.3	49	1.5	1.58	1.10–2.27
6+	Tactical	53	1.8	36	1.8	1.04	0.68–1.53
	Nontactical	83	1.6	91	1.6	0.97	0.72–1.31
All years	Tactical	92	2.1	60	1.9	1.10	0.79–1.52
	Nontactical	154	1.8	140	1.6	1.18	0.94–1.48

*Based on MOS assignment held while on active duty.

Tests for effect modification of MOS: ≤5 years: $X^2 = 0.81$, $p = 0.37$
6+ years: $X^2 = 0.08$, $p = 0.78$
All years: $X^2 = 0.12$, $p = 0.73$

Table B-7. Number of Deaths, Crude Rates/1000 Person-Years and Rate Ratios, by Cohort Status, Type of Unit and Time Since Discharge (1965–1983)

Years since discharge	Type of unit	Vietnam No. deaths	Vietnam Rate/1000	Non-Vietnam No. deaths	Non-Vietnam Rate/1000	Rate ratio	95% CI
≤5	Infantry	38	3.1	10	1.5	2.02	1.01 – 4.06
	Engineer	8	1.8	5	1.9	0.95	0.31 – 2.90
	Armor	2	3.3	4	1.6	2.07	0.38 – 11.3
	Cavalry	13	3.3	2	2.0	1.68	0.38 – 7.43
	Artillery	14	2.8	17	2.3	1.18	0.58 – 2.39
	Other	33	1.7	35	1.4	1.18	0.74 – 1.91
6+	Infantry	37	1.7	20	1.8	0.94	0.55 – 1.63
	Engineer	13	1.6	10	2.2	0.74	0.32 – 1.68
	Armor	2	1.9	7	1.6	1.19	0.25 – 5.74
	Cavalry	15	2.2	3	1.8	1.23	0.36 – 4.26
	Artillery	22	2.4	18	1.4	1.72	0.92 – 3.20
	Other	46	1.3	67	1.6	0.84	0.58 – 1.22
All years	Infantry	75	2.2	30	1.7	1.30	0.85 – 1.98
	Engineer	21	1.7	15	2.1	0.81	0.42 – 1.56
	Armor	4	2.4	11	1.6	1.51	0.48 – 4.75
	Cavalry	28	2.6	5	1.9	1.40	0.54 – 3.64
	Artillery	36	2.5	35	1.8	1.46	0.91 – 2.32
	Other	79	1.5	102	1.5	0.96	0.71 – 1.28

Tests for effect modification of type of unit: ≤5 years: $X^2 = 2.5$, $p = 0.77$
6+ years: $X^2 = 4.5$, $p = 0.48$
All years: $X^2 = 4.2$, $p = 0.52$

Table B-8. Number of Deaths, Crude Rates/1000 Person-Years and Rate Ratios, by Cohort Status, Presence of AWOL or Confinement Time, and Time Since Discharge (1965–1983)

Years since discharge	AWOL or confinement time	Vietnam		Non-Vietnam		Rate ratio	95% CI
		No. deaths	Rate/ 1000	No. deaths	Rate/ 1000		
≤5	Ever	19	3.6	21	3.5	1.00	0.54 – 1.86
	Never	91	2.2	51	1.3	1.70	1.20 – 2.38
6+	Ever	30	3.5	34	3.7	0.92	0.56 – 1.51
	Never	106	1.5	93	1.4	1.06	0.80 – 1.40
All years	Ever	49	3.5	55	3.7	0.95	0.65 – 1.40
	Never	197	1.8	144	1.4	1.28	1.03 – 1.59

Tests for effect modification of AWOL or confinement time: ≤5 years: $X^2 = 2.13$, $p = 0.14$
6+ years: $X^2 = 0.23$, $p = 0.63$
All years: $X^2 = 1.76$, $p = 0.18$

Table B-9. Number of Deaths, Crude Rates/1000 Person-Years and Rate Ratios, by Cohort Status, Duration of Active Duty, and Time Since Discharge (1965–1983)

Years since discharge	Duration of active duty (in months)	Vietnam		Non-Vietnam		Rate ratio	95% CI
		No. deaths	Rate/ 1000	No. deaths	Rate/ 1000		
≤5	<12	2	9.2	3	1.5	6.17	1.03 – 36.86
	12–23	66	2.2	42	1.4	1.59	1.08 – 2.34
	24+	42	2.6	28	2.3	1.16	0.72 – 1.86
6+	<12	1	2.5	6	1.6	1.57	0.19 – 13.07
	12–23	72	1.3	77	1.4	0.92	0.67 – 1.27
	24+	63	2.4	44	2.3	1.04	0.71 – 1.53
All years	<12	3	4.9	9	1.6	3.13	0.85 – 11.54
	12–23	138	1.6	119	1.4	1.15	0.90 – 1.47
	24+	105	2.5	72	2.3	1.08	0.80 – 1.46

Tests for effect modification of duration of active duty: ≤5 years: $X^2 = 3.20$, $p = 0.20$
6+ years: $X^2 = 0.41$, $p = 0.81$
All years: $X^2 = 2.02$, $p = 0.36$

Table B-10. Number of Deaths, Crude Rates/1000 Person-Years and Rate Ratios, by Cohort Status, Age at Discharge and Time Since Discharge (1965–1983)

Years since discharge	Age at discharge	Vietnam No. deaths	Vietnam Rate/ 1000	Non-Vietnam No. deaths	Non-Vietnam Rate/ 1000	Rate ratio	95% CI
≤5	<21	28	5.5	19	3.0	1.83	1.02 – 3.27
	21+	82	2.0	54	1.4	1.41	1.00 – 1.98
6+	<21	15	1.8	27	2.7	0.67	0.36 – 1.26
	21+	121	1.7	100	1.5	1.10	0.84 – 1.43
All years	<21	43	3.2	46	2.8	1.14	0.75 – 1.73
	21+	203	1.8	154	1.5	1.21	0.98 – 1.49

Tests for effect modification of age at discharge: ≤5 years: $X^2 = 0.56$, p = 0.45
6+ years: $X^2 = 2.09$, p = 0.15
All years: $X^2 = 0.06$, p = 0.81

Year of discharge (Table B-11): A modifying effect of borderline significance (p=0.06) is seen for year of discharge during the initial follow-up period. For those discharged before 1970, and who therefore served sometime between 1965 and 1969, the death rate among Vietnam veterans is more than twice that of veterans who did not serve in Vietnam. In contrast, the increase for those discharged in 1970 and after is only 16%. There is no difference in the rate ratios for those discharged before and after 1970 in the 6-plus-year follow-up period, both ratios being about 1.00. The results in the first 5 years after discharge may be due to differences in the characteristics of Vietnam veterans who served before 1970 compared with those who served later. For example, those serving earlier were younger at discharge and more likely to have been drafted than those serving later. When these and other factors are controlled, the excess risk in Vietnam veterans discharged before 1970 is still apparent.

Type of discharge (Table B-12): There is no significant difference in the relative rate of mortality associated with Vietnam service between honorably or nonhonorably discharged veterans in either follow-up interval, although in the initial postservice period, Vietnam veterans with honorable discharges had higher relative mortality than Vietnam veterans with nonhonorable discharges. These estimates, however, are based on small numbers of deaths and, therefore, are unstable.

Pay grade at discharge (Table B-13): In the earlier follow-up interval, all rate ratios are greater than 1.0. Although a lower pay grade is associated with a higher rate of mortality, this effect is seen among both Vietnam and non-Vietnam veterans. Consequently, a test of interaction comparing the relative rates among the five categories in the first 5-year period is not statistically significant. Although there does not appear to be any consistent pattern across categories, the chi-square test indicates a lack of homogeneity among the five pay grade categories in the later and total follow-up period.

Table B-11. Number of Deaths, Crude Rates/1000 Person-Years and Rate Ratios, by Cohort Status, Year of Discharge and Time Since Discharge (1965–1983)

Years since discharge	Year of discharge	Vietnam		Non-Vietnam		Rate ratio	95% CI
		No. deaths	Rate/ 1000	No. deaths	Rate/ 1000		
≤5	Before 1970	55	2.5	24	1.2	2.05	1.27 – 3.32
	1970+	55	2.3	49	2.0	1.16	0.70 – 1.70
6+	Before 1970	62	1.4	60	1.5	0.96	0.67 – 1.36
	1970+	74	2.0	67	2.0	1.06	0.76 – 1.47
All years	Before 1970	117	1.7	84	1.4	1.27	0.96 – 1.69
	1970+	129	2.1	116	2.0	1.21	0.98 – 1.49

Tests for effect modification of year of discharge: ≤5 years: $X^2 = 3.42$, $p = 0.06$
6+ years: $X^2 = 0.16$, $p = 0.69$
All years: $X^2 = 0.62$, $p = 0.43$

Table B-12. Number of Deaths, Crude Rates/1000 Person-Years and Rate Ratios, by Cohort Status, Type of Discharge and Time Since Discharge (1965–1983)

Years since discharge	Type of discharge	Vietnam		Non-Vietnam		Rate ratio	95% CI
		No. deaths	Rate/ 1000	No. deaths	Rate/ 1000		
≤5	Honorable	104	2.3	56	1.4	1.68	1.21 – 2.32
	Other	5	4.1	17	4.3	0.94	0.35 – 2.55
6+	Honorable	128	1.6	102	1.4	1.11	0.86 – 1.45
	Other	8	4.4	25	4.3	1.02	0.46 – 2.25
All years	Honorable	232	1.9	158	1.4	1.31	1.07 – 1.61
	Other	13	4.2	42	4.3	0.99	0.53 – 1.84

Tests for effect modification of type of discharge: ≤5 years: $X^2 = 0.73$, $p = 0.39$
6+ years: $X^2 = 0.08$, $p = 0.78$
All years: $X^2 = 0.56$, $p = 0.45$

Table B-13. Number of Deaths, Crude Rates/1000 Person-Years and Rate Ratios, by Cohort Status, Pay Grade at Discharge and Time Since Discharge (1965–1983)

Years since discharge	Pay grade at discharge	Vietnam		Non-Vietnam			
		No. deaths	Rate/ 1000	No. deaths	Rate/ 1000	Rate ratio	95% CI
≤5	E1	6	4.9	11	3.4	1.42	0.52 – 3.84
	E2	6	5.8	5	2.0	2.86	0.87 – 9.36
	E3	19	6.3	11	3.3	1.89	0.90 – 3.98
	E4	52	2.3	29	1.4	1.67	1.06 – 2.63
	E5	27	1.5	17	1.2	1.26	0.69 – 2.32
6+	E1	5	2.6	24	5.2	0.51	0.20 – 1.34
	E2	12	7.2	7	1.6	4.40	1.73 – 11.17
	E3	16	3.0	16	2.9	1.06	0.53 – 2.12
	E4	68	1.7	50	1.4	1.20	0.84 – 1.73
	E5	35	1.1	30	1.2	0.95	0.58 – 1.54
All years	E1	11	3.5	35	4.5	0.79	0.40 – 1.56
	E2	18	6.6	12	1.8	3.74	1.80 – 7.77
	E3	35	4.2	27	3.0	1.39	0.84 – 2.30
	E4	120	1.9	79	1.4	1.37	1.03 – 1.82
	E5	62	1.2	47	1.2	1.06	0.73 – 1.55

Tests for effect modification of pay grade at discharge:
≤5 years: X^2 = 1.77, p = 0.78
6+ years: X^2 = 12.22, p = 0.02
All years: X^2 = 11.75, p = 0.02

APPENDIX C

DETAILED CHARACTERISTICS OF MEN KILLED IN ACTION

Table C-1. Descriptive Characteristics of Vietnam Veterans, by Vital Status at Discharge from Active Duty

Characteristic	Killed in Action*		Discharged Alive		X^2 + (p-value)
	No.	%	No.	%	
Total	181	100.0	9324	100.0	
Race:					
White	156	86.2	8097	86.8	0.50
Black	23	12.7	1156	12.4	(0.78)
Other	2	1.1	63	0.7	
Unknown	0	0.0	8	0.1	
Place of Birth:					
Northeast	24	13.3	1769	19.0	8.75
Midwest	52	28.7	2827	30.3	(0.07)
South	38	21.0	2205	23.7	
West	57	31.5	2193	23.5	
Other	7	3.9	312	3.3	
Unknown	3	1.7	18	0.2	
Enlistment Status:					
Draftee	117	64.6	5943	63.7	0.06
Volunteer	64	35.4	3381	36.3	(0.80

*Deaths in service from causes other than hostile enemy action are excluded.

+ The chi-square statistic tests the similarity of the distributions of each characteristic between those killed in action and those discharged alive, after the unknown category has been excluded.

Table C-2. Physical Profile of Vietnam Veterans, by Vital Status at Discharge from Active Duty

Characteristic	Killed in Action*		Discharged Alive		X^2+ (p-value)
	No.	%	No.	%	
Total	181	100.0	9324	100.0	
Physical Capacity or Stamina:					
No impairment	181	100.0	9230	99.0	1.67
Mild-significant impairment	0	0.0	85	0.9	(0.20)
Unknown	0	0.0	9	0.1	
Upper Extremities:					
No impairment	181	100.0	9247	99.2	1.33
Mild-significant impairment	0	0.0	68	0.7	(0.25)
Unknown	0	0.0	9	0.1	
Lower Extremities:					
No impairment	180	99.5	9075	97.3	2.94
Mild-significant impairment	1	0.5	240	2.6	(0.09)
Unknown	0	0.0	9	0.1	
Hearing and Ears:					
No impairment	173	95.6	8794	94.3	
Mild-significant impairment	8	4.4	521	5.6	0.47 (0.50)
Unknown	0	0.0	9	0.1	
Eyes and Visual Acuity:					
No impairment	161	89.0	6934	74.4	19.79
Mild-significant impairment	20	11.1	2381	25.5	(<0.001)
Unknown	0	0.0	9	0.1	
Psychological Functioning:					
No impairment	181	100.0	9300	99.7	0.29
Mild-significant impairment	0	0.0	15	0.2	(0.59)
Unknown	0	0.0	9	0.1	
Composite Measure of Physical Health:					
No impairment	153	84.5	6297	67.5	23.44
Minor impairment	28	15.5	2990	32.1	(<0.001)
Other than minor impairment	0	0.0	26	0.3	
Unknown	0	0.0	11	0.1	

*Deaths in service from causes other than hostile enemy action are excluded.

+ The chi-square statistic tests the similarity of the distributions of each characteristic between those killed in action and those discharged alive, after the unknown category has been excluded.

Table C-3. Aptitude Test Scores of Vietnam Veterans, by Vital Status at Discharge from Active Duty

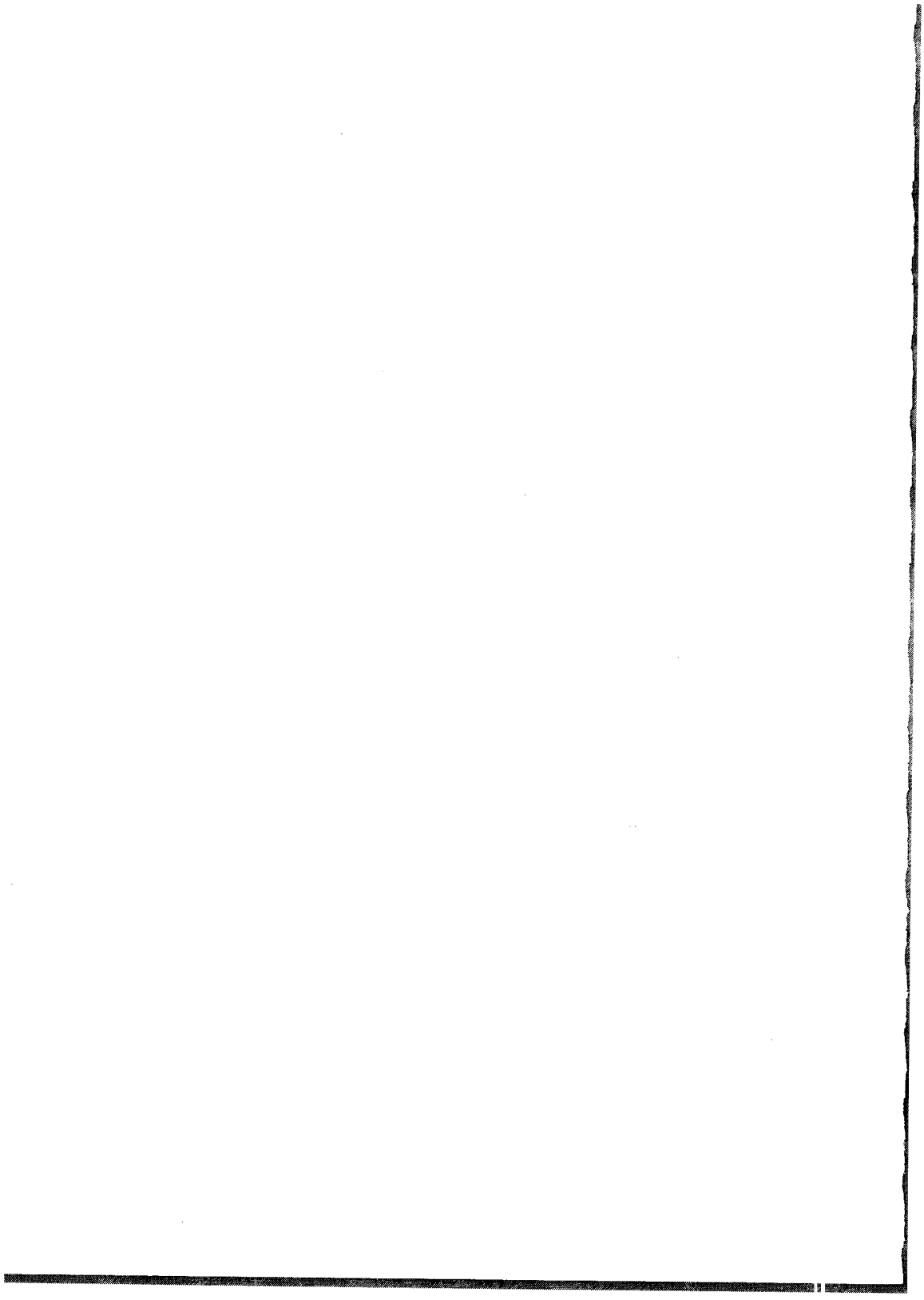
Aptitude Test	Killed in Action*			Discharged Alive			t-statistic + + (p-value)
	No. +	Mean	SD	No. +	Mean	SD	
Army Classification Battery:							
Verbal Ability	177	103.1	22.1	9136	104.4	21.9	0.79 (0.43)
Arithmetic Reasoning	177	100.3	20.1	9135	101.5	21.5	0.71 (0.47)
Pattern Analysis	177	101.7	20.6	9136	101.7	22.5	0.00 (1.00)
General Information	175	99.6	19.6	9117	100.3	18.4	0.48 (0.63)
General Technical	179	101.6	19.5	9200	103.1	19.9	0.98 (0.33)
Armed Forces Qualification Test	180	48.4	26.3	9280	50.4	25.5	1.05 (0.29)

*Deaths in service from causes other than hostile enemy action are excluded.
+ Number of veterans for whom test scores were available.
+ + The t-statistic tests the differences between the mean scores of those killed in action and those discharged alive.

Table C-4. Military Service Characteristics of Vietnam Veterans, by Vital Status at Discharge from Active Duty

Characteristic	Killed in Action*		Discharged Alive		X^2 + (p-value)
	No.	%	No.	%	
Total	181	100.0	9324	100.0	
Military Occupational Specialty:					
Tactical operations	156	86.2	3217	34.5	207.2* (<0.001)
Other and unknown	25	13.8	6107	65.5	
Type of Unit:					
Infantry	127	70.2	2477	26.6	192.5* (<0.001)
Engineer	2	1.1	911	9.8	
Armor	2	1.1	123	1.3	
Cavalry	23	12.7	792	8.5	
Artillery	7	3.9	1021	11.0	
Other	19	10.5	3920	42.0	
Unknown	1	0.6	80	0.9	

*Deaths in service from causes other than hostile enemy action are excluded.
+ The chi-square statistic tests the similarity of the distributions of each characteristic between those killed in action and those discharged alive, after the unknown category has been excluded.



APPENDIX D

MORTALITY FROM MOTOR VEHICLE ACCIDENTS, SUICIDE AND DRUG-RELATED CAUSES BY SELECTED COVARIATES

Table D-1. Number of Deaths Due to Motor Vehicle Accidents (as Determined by Death Certificate) Among Vietnam and Non-Vietnam Veterans and Rate Ratios, by Time Since Discharge and Selected Characteristics (1965 – 1983)

Characteristic	Time Since Discharge					
	≤5 years			6+ years		
	No. deaths	Rate ratio	95% CI	No. deaths	Rate ratio	95% CI
Race:						
White	57	1.92	1.11–3.35	60	1.31	0.78–2.19
Other	9	1.98	0.49–7.91	7	0.38	0.07–1.36
GT score:						
<100	33	2.00	0.95–4.21	35	0.79	0.41–1.53
100+	33	1.82	0.89–3.71	32	1.70	0.83–3.48
Enlistment status:						
Draftee	42	2.22	1.15–4.27	41	1.52	0.81–2.86
Volunteer	24	1.52	0.67–3.48	26	0.74	0.34–1.60
Duty MOS:						
Tactical	28	1.39	0.64–3.01	22	1.08	0.46–2.53
Other	38	2.31	1.16–4.58	45	1.18	0.66–2.13
Age at discharge:						
<21 years	9	1.55	0.42–5.78	13	1.03	0.35–3.07
21+ years	57	2.02	1.16–3.53	54	1.22	0.71–2.10
Year of discharge:						
<1970	37	2.79	1.31–5.90	32	1.54	0.75–3.15
1970+	29	1.26	0.61–2.64	35	0.90	0.47–1.75
Pay grade at discharge:						
E1–E3	17	3.12	1.16–8.43	18	0.63	0.23–1.77
E4–E5	49	1.80	0.99–3.26	49	1.60	0.89–2.89

Table D-2. Number of Deaths Due to Suicide (as Determined by Death Certificate) Among Vietnam and Non-Vietnam Veterans and Rate Ratios, by Time Since Discharge and Selected Characteristics (1965–1983)

Characteristic	Time Since Discharge					
	≤5 years			6+ years		
	No. deaths	Rate ratio*	95% CI	No. deaths	Rate ratio*	95% CI
Race:						
White	22	2.06	0.84–5.05	30	0.62	0.30–1.30
Other	3	–	–	2	–	–
GT score:						
<100	8	–	–	14	0.63	0.22–1.81
100+	17	1.48	0.57–3.91	18	0.65	0.25–1.68
Enlistment status:						
Draftee	14	1.79	0.60–5.35	13	1.14	0.38–3.39
Volunteer	11	1.60	0.47–5.46	19	0.40	0.15–1.05
Duty MOS						
Tactical	5	–	–	9	–	–
Other	20	1.98	0.79–4.97	23	0.80	0.35–1.82
Age at discharge:						
<21 years	4	–	–	10	0.13	0.02–1.06
21+ years	21	2.33	0.90–6.00	22	1.09	0.47–2.52
Year of discharge:						
<1970	9	–	–	16	0.55	0.20–1.53
1970+	16	1.32	0.49–3.56	16	0.74	0.28–2.00
Pay grade at discharge:						
E1–E3	8	–	–	7	–	–
E4–E5	17	2.09	0.74–5.93	25	0.67	0.30–1.48

*RRs are not computed for categories with less than 10 deaths among Vietnam and non-Vietnam veterans combined.

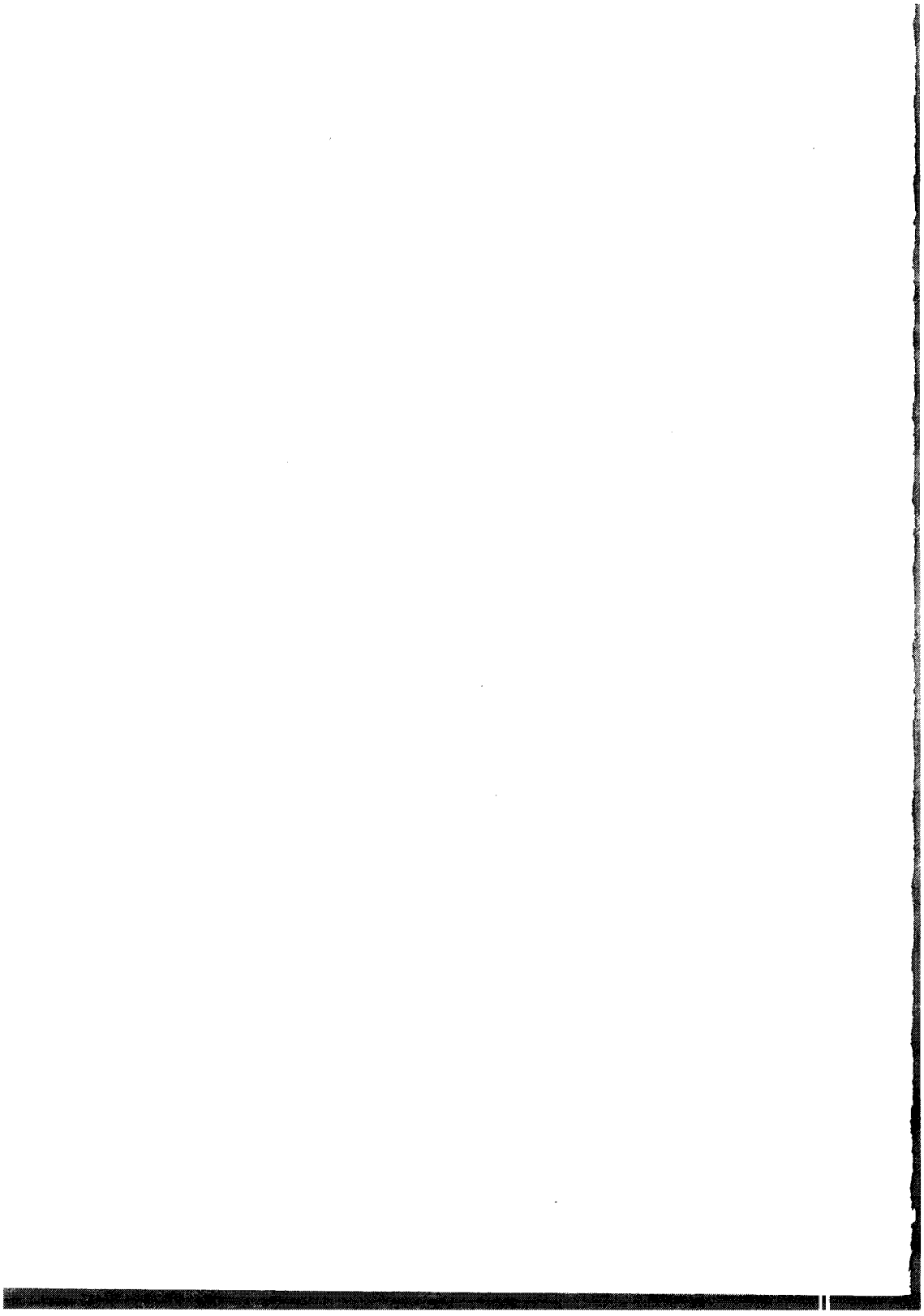
Table D-3. Number of Drug-Associated Deaths (as Determined by Medical Review) Among Vietnam and Non-Vietnam Veterans and Rate Ratios, by Selected Characteristics (1965–1983)

Characteristic	Number of Deaths		Rate ratio*	95% CI
	Vietnam	Non-Vietnam		
Race:				
White	18	10	1.70	0.79–3.63
Other	7	5	1.35	0.43–4.23
GT score:				
<100	13	11	1.00	0.45–2.24
100+	12	4	3.09	1.00–9.57
Enlistment status:				
Draftee	11	1	10.81	1.39–83.79
Volunteer	14	14	0.88	0.42–1.85
Duty MOS:				
Tactical	8	1	–	–
Other	17	14	1.27	0.63–2.53
Age at discharge:				
<21 years	8	10	0.97	0.38–2.47
21+ years	17	5	3.12	1.15–8.43
Year of discharge:				
<1970	5	4	–	–
1970+	20	11	1.79	0.86–3.74
Pay grade at discharge:				
E1–E3	10	11	1.52	0.64–3.57
E4–E5	15	4	3.22	1.07–9.71

*RRs are not computed for categories with less than 10 deaths among Vietnam and non-Vietnam veterans combined.

APPENDIX E

DETAILS OF MEDICAL-REVIEW-PANEL FINDINGS



The following is a description of medical review panel findings for all deaths in which cause of death via medical review differed from cause as determined by death certificate (see Table E-1 and E-2 for the cross-classification of death certificate and medical review cause of death).

1. ***Infectious diseases***. The two deaths attributed to infectious diseases by the death certificates were both classified elsewhere by the panel. In one case, an alcoholic man died as an immediate consequence of an overwhelming infection. The death certificate underlying cause of death was septiciemia due to other gram-negative organisms (ICD-9, 038.4). The panel attributed the fatal infection to impaired host defense mechanisms associated with the decedent's alcoholism and cited alcohol dependence syndrome as the underlying cause of death (ICD-9, 303). In the other case, an intravenous drug abuser with acquired immunodeficiency disorder died as a result of pneumocystis carinii pneumonia. The death certificate diagnosis was pneumocystosis (ICD-9, 136.3), while the panel attributed the death to deficiency of cell-mediated immunity (ICD-9, 279.1).

2. ***Neoplasms***. The panel recategorized 2 of the 25 deaths that had been attributed to neoplasm according to the death certificate (see Table E-3). The panel determined that both deaths were caused by operative misadventures on the basis of hospital records and autopsy findings. In one case, the panel attributed the death to an accidental cut during a surgical operation (ICD-9, E870.0). The cut, to the mesenteric vein, complicated an operation to remove a colon cancer. Further complications led to additional bowel resections. "Short bowel syndrome" developed, and the veteran eventually died as a consequence of severe dehydration and malabsorption. At autospy, no metastatic lesions were detected. In the other case the veteran had previously undergone an operation to remove a bronchial adenoma. During a subsequent operation to repair a bronchopleural fistula, the endotracheal tube was not correctly placed, and he had a cardiac arrest (ICD-9, E876.3). The pathologist who performed the autopsy attributed the death to "respiratory insufficiency" and noted that "the death of this patient is not related to the tumor itself."

The panel cited a neoplasm as the underlying cause of two deaths attributed to nonneoplastic causes according to the death certificates (see Table E-3). One is discussed below in section "16. Other external cause." The panel determined that a pineal gland neoplasm was the cause of death, but the death certificate determination was "head trauma," coded as an accident of unspecified cause. The other death is discussed below in section "5. Circulatory diseases." The panel attributed the death to Burkitt's tumor (ICD-9, 200.2); the death certificate attributed it to "cardiopulmonary arrest" (ICD-9, 427.5).

In 23 cases both the panel and death certificate determinations resulted in deaths being coded as neoplasms, but in 11 the determinations did not agree to the fourth digit of the ICD-9 code (see Table E-3). In each of the 11 cases, the lack of complete agreement can be attributed to statements on the death certificate that lack precision or do not contain available diagnostic information.

The major features of a tumor, according to the ICD-9 classification system, are its anatomic location, whether it is benign or malignant, and whether it is a primary or secondary lesion. The underlying cause of death on three death certificates was "brain tumor," and each was appropriately coded as neoplasm of unspecified nature (ICD-9, 239.6). On the basis of its review of hospital records pertaining to these cases, the panel included the specific cerebral site and the malignant nature of the three tumors in its cause-of-death determinations (see Table E-3). Two other deaths were due to malignant neoplasm, unspecified site (ICD-9, 199.1), according to the death certificates; the panel localized one to the bronchus and lung (ICD-9, 162.9), and the other to the head, neck, and face (ICD-9, 195.0). The panel, on the

Table E-1. Comparison of Death Certificate and Medical Review Panel Results by Major Cause of Death Category*

Death certificate	Medical review panel												
	Infec-tious	Neo-plasm	Endo-crine	Mental Dis.	Ner-vous	Circu-latory	Respir-atory	Diges-tive	Genito-urinary	Muscu-loskel.	Ill-defined	Exter-nal	Total
Infectious Diseases	0	0	1	1	0	0	0	0	0	0	0	0	2
Neoplasms	0	23	0	0	0	0	0	0	0	0	0	2	25
Mental Disorders	0	0	0	4	1	0	1	4	0	0	0	4	14
Nervous System	1	0	0	0	2	0	0	0	0	0	0	0	3
Circulatory System	0	1	0	0	0	27	0	1	1	0	3	1	34
Respiratory System	0	0	0	1	0	1	3	0	1	1	0	2	9
Digestive System	0	0	0	3	0	0	0	4	0	0	0	0	7
Genitourinary	0	0	0	0	0	0	0	1	1	0	0	2	4
Congenital	0	0	0	0	0	1	0	0	0	0	0	1	2
Ill-defined	0	0	0	0	0	0	0	1	0	0	1	0	2
External Causes	0	1	0	7	1	0	0	1	1	0	0	313	324
Total	1	25	1	16	4	29	4	12	4	1	4	325	426

*Categories not shown have no deaths assigned to them.

Table E-2. Comparison of Death Certificate and Medical Review Panel Results for Major External-Cause-of-Death Categories

Death certificate	Medical review panel						
	MVA	Accidental poisoning	Other acc.	Suicide	Homicide	Undetermined	Total
Motor-vehicle accidents (MVA)	127	0	0	2	1	0	130
Accidental poisoning	0	9	1	0	0	2	12
Other accidents	3	0	47	3	0	5	58
Suicide	0	0	0	54	0	0	54
Homicide	0	0	4	0	47	0	51
Undetermined	0	4	1	0	1	2	8
Total	130	13	53	59	49	9	313

Table E-3. Deaths Due to Neoplasms in Which the Death Certificate and Medical Review Panel Determinations Disagree

Case	ICD-9	Death certificate cause	ICD-9	Medical review cause
1	153.6	Malignant neoplasm of ascending colon	E870.0	Accidental cut during surgical operation
2	235.7	Neoplasm of uncertain behavior, respiratory tract	E876.3	Endotracheal tube wrongly placed during anesthesia
3	E928.9	Unspecified accident	237.1	Neoplasm of uncertain behavior of pineal gland
4	427.5	Cardiac arrest	200.2	Burkitt's tumor
5	239.6	Neoplasm of unspecified nature, brain	191.2	Malignant neoplasm of brain, temporal lobe
6	239.6	Neoplasm of unspecified nature, brain	191.2	Malignant neoplasm of brain, unspecified
7	239.6	Neoplasm of unspecified nature, brain	191.1	Malignant neoplasm of brain, frontal lobe
8	199.1	Malignant neoplasm, unspecified site	162.9	Malignant neoplasm of bronchus and lung
9	199.1	Malignant neoplasm unspecified site	195.0	Malignant neoplasm of head, face and neck
10	172.9	Malignant melanoma	172.4	Malignant melanoma of scalp and neck
11	186.9	Malignant neoplasm of testes, unspecified	186.0	Malignant neoplasm of testes, undescended
12	208.9	Leukemia of unspecified cell type	205.0	Acute myeloid leukemia
13	204.0	Acute lymphoid leukemia	200.1	Lymphosarcoma
14	155.2	Malignant neoplasm of liver, unspecified origin	199.1	Malignant neoplasm unspecified site
15	201.9	Hodgkin's disease, unspecified	201.5	Hodgkin's disease nodular sclerosis

basis of medical records, localized a death attributed to malignant melanoma, site unspecified (ICD-9, 172.9) according to the death certificate to the scalp and neck (ICD-9, 172.4). The panel, using hospital records and an autopsy report, described a malignant testicular tumor as affecting an undescended testicle (ICD-9, 186.0), but the affected testicle was not specified as to its descent on the death certificate (ICD-9, 186.9). Another death was due to metastatic carcinoma of unknown primary site, which secondarily involved the liver. The death certificate described the cause of death simply as "liver cancer," which resulted in the appropriate code for malignant neoplasm of the liver, not specified as primary or secondary (ICD-9, 155.2). If the death certificate had mentioned that the "liver cancer" was secondary, then the death would have been coded differently by ICD-9 rules. The panel, on the basis of hospital records and histopathology reports, correctly attributed the death to malignant neoplasm of unspecified primary site (ICD-9, 199.1).

In three cases of malignant neoplasms of lymphatic and hematopoietic tissue, the tumor histology, which was available from medical records, allowed the panel to arrive at more accurate or specific diagnoses than did the original certifiers (see Table E-3). In one instance, "leukemia" was listed as the cause of death on the certificate, and this resulted in the appropriate code for leukemia of unspecified cell type (ICD-9, 208.9). The panel had access to the decedent's hospital record, which documented acute myeloid leukemia (ICD-9, 205.0) on several bone marrow aspirates. In a second case, the underlying cause on the death certificate was "terminal Hodgkin's disease," which was appropriately coded to Hodgkin's disease unspecified (ICD-9, 201.9). Antemortem lymph node biopsy findings allowed the panel to specify the Hodgkin's disease as nodular sclerosis type (ICD-9, 201.5). In the third case, the decedent had a lymphoblastic lymphoma which was subsequently complicated by leukemia. The decedent died in the hospital, and the diagnosis was "lymphoblastic lymphoma with leukemia." The death certificate cause-of-death statement mentions only the lymphoblastic leukemia which was appropriately coded as acute lymphoid leukemia (ICD-9, 204.0). On the basis of the medical record, the panel cited lymphoblastic lymphoma (ICD-9, 200.1) as the underlying cause of death.

3. ***Mental disorders.*** Fourteen deaths were attributed to mental disorders as a result of death certificate findings, and the panel categorized 10 elsewhere (see Table E-4). In one of the cases, the death certificate was improperly completed and the coded cause of death, simple schizophrenia (ICD-9, 295.0), was the first diagnosis in a continuous statement which contained a total of five diagnoses. The last listed cause of death, "episodes of G.I. bleeding," which could not be coded as the underlying cause according to ICD-9 rules, was similar to the panel's determination, hemorrhage of gastrointestinal tract, unspecified (ICD-9, 578.9).

In the remaining nine recategorized cases, death was due to either substance dependence or abuse according to the coded death certificates. In all nine cases the panel's determinations included diagnoses pertaining to misuse of drugs or alcohol, but the diagnostic reasoning or descriptive terms differed significantly from those used on the death certificates. Consequently, the underlying cause of death the panel assigned is categorically different from that assigned on the basis of the death certificate.

The ICD-9 rules governing selection of the underlying cause of death give preference to diagnostic terms that provide the most specificity regarding the site or nature of the fatal condition. For example, alcoholic liver disease (ICD-9, 571.0-571.3) is preferred to alcohol dependence syndrome (ICD-9, 303). In two cases, the panel cited alcoholic liver damage, unspecified (ICD-9, 571.3), whereas the death certificate findings were coded as alcohol dependence syndrome (ICD-9, 303). In another case, the panel cited alcoholic fatty liver (ICD-9, 571.0), whereas the certificate was coded as nondependent abuse of alcohol (ICD-9, 305.0).

Table E-4. Deaths Due to Mental Disorders in Which the Death Certificate and Medical Review Panel Determination Disagree

Case	ICD–9	Death certificate cause	ICD–9	Medical review cause
1	295.0	Simple schizophrenia	578.9	Gastrointestinal tract hemorrhage, unspecified
2	303	Alcohol dependence	571.3	Alcoholic liver damage, unspecified
3	303	Alcohol dependence	571.3	Alcoholic liver damage, unspecified
4	303	Alcohol dependence	348.4	Compression of brain
5	303	Alcohol dependence	481.0	Pneumococcal pneumonia
6	305.0	Nondependent abuse of alcohol	571.0	Alcoholic fatty liver
7	304.6	Other drug dependence	E866.6	Accidental poisoning by glue
8	304.9	Unspecified drug dependence	E858.8	Accidental poisoning by other drugs
9	304.9	Unspecified drug dependence	E858.9	Accidental poisoning by other drugs, unspecified
10	305.9	Nondependent abuse of drugs	E850.0	Accidental poisoning by opiates
11	038.4	Septicemia due to other gram negative organisms	303	Alcohol dependence
12	518.4	Acute edema of lung, unspecified	304.0	Morphine type drug dependence
13	571.1	Acute alcoholic hepatitis	303	Alcohol dependence
14	577.0	Acute pancreatitis	303	Alcohol dependence
15	577.0	Acute pancreatitis	303	Alcohol dependence
16	E850.0	Accidental poisoning by opiates	304.0	Morphine type drug dependence
17	E850.0	Accidental poisoning by opiates	304.0	Morphine type drug dependence
18	E850.8	Accidental poisoning by other analgesics	304.0	Morphine type drug dependence
19	E850.8	Accidental poisoning by other analgesics	304.0	Morphine type drug dependence
20	E853.2	Accidental poisoning by benzodiazepine tranquilizer	305.0	Nondependent abuse of alcohol
21	E858.9	Accidental poisoning by unspecified drugs	304.9	Unspecified drug dependence
22	E980	Poisoning by analgesics, intentionally undetermined	304.0	Morphine type drug dependence

In two additional cases, both coded to alcohol dependence syndrome (ICD-9, 303) on the basis of death certificates, the panel cited alcohol dependence as contributing to death, but specified compression of the brain stem (ICD-9, 348.4) and pneumococcal pneumonia (ICD-9, 481.0) as the underlying causes of death. In the first case, hospital records indicate that the decedent's rapid neurological deterioration was due to a "cerebral abscess/neoplasm or infarction," with no clear causal connection with alcoholism. In the second case, the panel determined that an alcoholic man died as a direct result of pneumococcal pneumonia. In this case the panel was mistaken; the priority placed on alcohol dependence on the death certificate is more reasonable, because the infection that the veteran did not survive was probably secondary to impaired host defense mechanisms associated with alcoholism.

The original death certifiers attributed the other 4 recategorized deaths in the mental disorder category to either drug dependence or drug abuse. The ICD-9 manual defines drug dependence as a "compulsion to take a drug on a continuous or periodic basis in order to experience its psychic effects, and sometimes to avoid the discomfort of its absence." The manual also states that the diagnosis of nondependent abuse of drugs (ICD-9, 305.0-305.9) is only appropriate "when no other diagnosis is possible." A drug abuse code should not be selected as the underlying cause of death if either drug dependence or drug poisoning is a possible cause of death. The panel adhered to the ICD-9 drug-related definitions and diagnostic preferences, which accounts for the recategorization of these 4 deaths.

In 3 deaths attributed to drug dependence on the basis of death certificates, the corresponding panel diagnoses were accidental poisonings, because the panel had no information to document compulsion to use drugs at the time of death. The coded death certificate cause of death in one instance was other drug dependence (ICD-9, 304.6) and in the other two cases it was unspecified drug dependence (ICD-9, 304.9). The corresponding panel determinations were accidental poisoning by glue (ICD-9, E866.6), accidental poisoning by other drugs (ICD-9, E858.8), and accidental poisoning by unspecified drugs (ICD-9, E858.9).

Finally, the original death certifier attributed a death to unspecified nondependent drug abuse (ICD-9, 305.9), but the panel, which adhered to the ICD-9 preference for the accidental poisoning diagnosis, classified it as an accidental poisoning by opiates and narcotics (ICD-9, E850.0).

In addition to the 10 recategorized deaths described above, the panel attributed to mental disorders 12 deaths that were placed in other disease categories on the basis of the death certificates (see Table E-4). These 12 deaths are discussed in detail in the following sections: 1. Infectious diseases, 6. Respiratory diseases, 7. Digestive diseases, 12. Accidental poisonings, and 15. Injury of undetermined intentionality. In most of the 12 cases, both the death certificate and panel diagnoses pertained to misuse of drugs or alcohol, but the specific ICD-9 codes were categorically different.

4. ***Diseases of the nervous system and sense organs.*** The panel disagreed with the original death certifier on one of the three deaths attributed to neurologic disorders. The decedent was a previously healthy man who had overwhelming septicemia and meningitis due to *Haemophilus influenzae*. There was no recognizable primary source of infection and no obvious defect in host-defense mechanisms. The pathologist who performed the autopsy described the primary diagnosis as "overwhelming speticemia and meningitis with *Haemophilus influenzae*, type B." The physician who completed the death certificate cited "Haemophilus influenzae meningitis" as the underlying cause, appropriately coded to ICD-9, 320.0. In view of the absence of a primary source of infection, the panel attributed the death to septicemia due to other gram-negative organisms (ICD-9, 038.4), which placed the death in the infectious disease category.

5. ***Circulatory diseases.*** The panel categorized elsewhere 7 of the 34 deaths coded on the basis of death certificates to circulatory disease. In four, the panel's findings differed from the diagnosis of either cardiac arrest (ICD-9, 427.5) or myocardial infarction (ICD-9, 410) cited on the death certificates. In one case, described briefly in section "2. Neoplasm," the panel determined that Burkitt's tumor (ICD-9, 200.2) was the cause of death. The veteran had had several antemortmem bone marrow biopsies that established the diagnosis of Burkitt's lymphoma. He received two courses of chemotherapy and subsequently died as a direct consequence of an intracerebral hemorrhage. At autopsy, no tumor was found, and the death certifier stated that the death was due to "cardiopulmonary arrest," although she mentioned "probably Burkits' (sic) lymphoma" as a nonunderlying cause of death. The panel attributed the absence of tumor at postmortem examination either to an incomplete dissection or to the effects of chemotherapy. In view of the poor prognosis associated with disseminated Burkitt's lymphoma, the panel cited the neoplasm as the underlying cause of death.

In another death described as "cardiopulmonary arrest" on the death certificate, the panel diagnosis was sudden death within 24 hours of onset of symptoms (ICD-9, 798.2). An emergency room record stated that the decedent had gone to bed complaining of "epigastric discomfort and nausea" and that his mother found him dead 3 hours later. No autopsy was done.

In the case of both recategorized myocardial infarctions (ICD-9, 410.0), the coroners who completed the death certificates stated that the deaths were due to a "heart attack." Both veterans had died at home and in neither instance was an autopsy performed. In each case, the panel based its diagnosis, sudden death within 24 hours of onset of symptoms (ICD-9, 798.2), on the medical history contained in the coroner's records.

The remaining three circulatory disease deaths, for which the panel and death certificate determinations differ, were originally attributed to hypertensive renal disease, not specified as benign or malignant (ICD-9, 403.9); cardiovascular disease, unspecified with mention of arteriosclerosis (ICD-9, 429.2); and compression of the superior vena cava (ICD-9, 459.2). In the first death, the only information available to the panel was an emergency room record indicating that the decedent had a cardiac arrest as a result of chronic renal failure. The record contained no information on the etiology of the kidney disease, so the panel determination was renal failure, unspecified (ICD-9, 586.0), which placed the death in the genitourinary disease category. The original death certifier apparently was aware that the renal disease had been attributed to hypertension, and this causal sequence is indicated on the death record. In the second death, the medical examiner apparently cited "arteriosclerotic heart disease" as the cause of death on the basis of the decedent's past medical history. The panel attributed the death to a hemorrhage of the gastrointestinal tract, unspecified (ICD-9, 578.9). The police records show that the decedent was found at home, with "a great deal of blood on his facial area, and also in the bathroom sink." There was no evidence for a traumatic death. The panel inferred that gastrointestinal hemorrhage was the most likely cause of death on the basis of the medical examiner's report that the decedent was an alcoholic. No autopsy was performed. The third death, which the original death certifier attributed to superior vena cava syndrome, resulted from a crush injury that occurred when the automobile the veteran was repairing fell on his chest. The panel listed struck by falling object (ICD-9, E916) as the cause of death, in accordance with ICD-9 underlying cause selection rules, which give preference to the circumstances that resulted in injury rather than to the anatomic location of the injury.

6. ***Respiratory diseases.*** The panel recategorized 6 of the 9 deaths originally attributed to respiratory disease. In 4 cases, the death certificate findings were bronchopneumonia, organism unspecified (ICD-9, 485). The corresponding panel-determined causes of death were:

glomerulonephritis, not otherwise specified (ICD-9, 583.9), systemic lupus erythematosus (ICD-9, 710.0), passenger on a motorcycle involved in a collision with another motor vehicle (ICD-9, 812.3), and accidental poisoning by other drugs (ICD-9, E858.8). In the first case, the medical record documented that at the time of his death the veteran was receiving hemodialysis for end-stage renal disease due to glomerulonephritis of undetermined etiology. The panel attributed his fatal pneumonia to impaired host defenses associated with severe chronic renal failure. In the second case, the veteran was found on autopsy to have systemic lupus erythematosus with renal and central nervous system involvement, and the panel determined that lupus was responsible for susceptibility to the fatal infection. In the third case, the death certificate was improperly completed and did not reflect the coroner's autopsy-determined cause of death, "accidental-motorcycle fatality." In the fourth case, the decedent was admitted to a hospital following an "overdose with cardiopulmonary arrest." He died 7 days later in the hospital, following a hospital course complicated by pneumonia. The panel attributed the death to poisoning by a mixture of drugs.

In another recategorized respiratory disease death, the death certificate determination was acute edema of the lung, unspecified (ICD-9, 518.4), while the panel diagnosis was morphine-type drug dependence (ICD-9, 304.0). The decedent had many prior hospitalizations for medical problems due to heroin dependency. He was found dead at home, and autopsy findings included evidence of a recent intravenous injection and pulmonary edema. The toxicologic analysis of body fluids showed no evidence of morphine but the panel, on the basis of the medical history and autopsy findings, attributed the death to drug dependence.

In the final recategorized case, the death certificate determination of "hemorrhagic interstitial pneumonitis," appropriately coded as other alveolar and parietoalveolar pneumopathy (ICD-9, 516.8), omitted available diagnostic information. The veteran had received an antemortem diagnosis of Goodpasture's syndrome, a disorder which affects both the kidneys and the lungs, and the diagnosis was confirmed at autospsy. The panel attributed the death to hypersensitivity angiitis (ICD-9, 446.2), an entity classified as a circulatory disease and the correct ICD-9 code for Goodpasture's syndrome.

7. ***Digestive diseases.*** The death certificates attributed seven deaths to digestive diseases, but the panel attributed three of the seven to alcohol dependence syndrome (ICD-9, 303). In the first case, the death certificate citation was "alcoholic hepatitis," appropriately coded to acute alcoholic hepatitis (ICD-9, 571.1). The panel, on the basis of the hospital record and autopsy report, determined that the decedent, at the time of his death, had many complications of alcoholism, but the panel did not attribute the death to a particular alcohol-related disease. The panel listed alcohol dependence syndrome as the underlying cause of death, which placed the case in the mental disorder category. The second and third cases were both coded as acute pancreatitis (ICD-9, 577.0) on the basis of the death certificates, neither one of which mentioned that the decedents were dependent on alcohol. The panel used available medical records to establish that in both cases, pancreatitis was a direct sequel of alcohol dependence, and classified the deaths accordingly.

8. ***Genitourinary diseases.*** The panel, using the available diagnostic information, recategorized three of the four deaths that the original death certifiers had attributed to genitourinary diseases. In one case, the underlying cause on the death certificate was coded as renal failure, unspecified (ICD-9, 586), but the panel's determination was coded as alcoholic cirrhosis of the liver (ICD-9, 571.2). The panel had access to the record of the hospitalization during which the veteran died, and the record indicated that both renal failure and coma were secondary to liver disease. The pathologist who performed the autopsy attributed the death to "cirrhosis of the liver, advanced (history of ethanol use)." The second recategorized death was coded as a urinary tract infection, site unspecified (ICD-9, 599) on the basis of the death

certificate, but the panel diagnosis was late effects of motor vehicle accident (ICD-9, E929.0). The decedent was quadraplegic and incontinent of urine after a motor vehicle accident that occurred 4 years before his death. The panel attributed the immediate cause of death, urinary tract infection, to his traumatic neurologic impairment. The third recategorized death was also coded as a urinary tract infection, site unspecified (ICD-9, 599) on the basis of the death certificate. The certificate did not contain the primary discharge diagnosis listed on the hospital record, "suicidal drug overdose with cardiac and subsequent respiratory arrest." The panel used the medical history of a self-inflicted mixed drug poisoning to describe the death as suicide by other specified drugs (ICD-9, E950.2).

9. ***Congenital anomalies.*** The panel, on the basis of autopsy findings, categorized elsewhere two deaths attributed to congenital disorders on the death certificates. Before death, one veteran had had a diagnosis of and surgical treatment for a congenital cerebral arteriovenous malformation. His death was preceded by rupture of the aneurysm and rapid neurological deterioration. The nosologist coded the underlying cause of death as congenital anomaly of cerebral vessels (ICD-9, 747.8) on the basis of the death certificate statement that the decedent was "status post removal right frontal arteriovenous malformation." The postmortem examination records, which were available to the panel, indicated that the fatal cerebrovascular event began prior to the decedent's operation, and the panel cited the appropriate cause of death, subarachnoid hemorrhage (ICD-9, 430). In the other death, the coded death certificate cause was coarctation of the aorta (ICD-9, 747.1). At autopsy the death was shown to be due to rupture of a surgically implanted aortic graft. The postmortem findings are reflected in the panel's determination of the underlying cause, late complication of aortic graft placement (ICD-9, E878.1).

10. ***Symptoms, signs and ill-defined conditions.*** Autopsy results account for the diagnostic disagreement in one of the two deaths placed in the signs, symptoms and ill-defined conditions category on the basis of the death certificates. The death certificate shows "pending further study" as the underlying cause, which was coded to other unknown and unspecified cause of mortality (ICD-9, 799.9). No revised death certificate was available. The panel based its determination, alcoholic cirrhosis of the liver (ICD-9, 571.2), on the autopsy report.

11. ***Motor vehicle accidents.*** The panel recategorized three motor vehicle traffic deaths. In two instances, the panel assigned the deaths to suicide by crashing of a motor vehicle (ICD-9, E958.5). In one, police records indicated that the veteran repeatedly drove his car into the path of oncoming traffic and made no effort to avoid a collision with an oncoming truck. In the other, police records contained a report of a distress call from the veteran's spouse following a domestic quarrel. The spouse was concerned about his self-destructive intentions. The panel recategorized the third motor vehicle death as a homicide on the basis of a coroner's report. The decedent, a pedestrian, had "confronted" the driver of a motor vehicle immediately before he was struck by the vehicle and dragged for "about six blocks." The death certificate listed "auto-pedestrian" as the underlying cause and "homicide" as the manner of death. The certificate did not contain a statement of intentionality in either the "cause of death" or the "circumstances of injury" sections, and, as a result, the nosologist coded the fatality as a motor vehicle accident, in accordance with the coding practices of the National Center for Health Statistics.

12. ***Accidental poisoning.*** The panel categorized elsewhere 9 of the 18 deaths attributed to accidental poisoning according to the death certificates. In 4 cases of heroin or morphine-type drug poisoning, the panel recategorized the deaths to chronic morphine dependence (ICD-9, 304.0) on the basis of historical and postmortem evidence of drug dependence. In two instances of accidental poisoning by motor vehicle exhaust gas (ICD-9, E868.2), law en-

forcement records were not available, and the panel could not characterize the decedents' intentions. Consequently, the panel's underlying cause of death for both was poisoning by motor vehicle gas, undetermined whether accidentally or purposely inflicted (ICD-9, E982.0). The causes of death on the death certificates in two other accidental poisoning fatalities were "apparent accidental drug overdose" and "intoxication of unknown origin," which the nosologist coded as accidental poisoning by unspecified drugs (ICD-9, E858.9) and accidental poisoning by unspecified substance (ICD-9, 866.9), respectively. In the first case, the panel attributed the death to drug dependence, unspecified (ICD-9, 304.9) on the basis of hospital records. In the second case, an autopsy showed that the decedent aspirated gastric material, a finding that warranted toxicologic investigation, according to the pathologist. No toxicologic results were available to the panel, and it determined that the cause of death was inhalation of food causing obstruction of the respiratory tract (ICD-9, E911).

In the ninth recategorized accidental poisoning, the death certificate cited "synergistic action of alcohol and diazepam" as the underlying cause of death, which was coded as accidental poisoning by benzodiazepine-based tranquilizer (ICD-9, E853.1). The panel had access to the medical history, autopsy results, and toxicologic analysis—all of which indicated that death resulted from aspiration of gastric contents as a consequence of alcohol intoxication (ICD-9, 305.0).

13. ***Suicide.*** The panel categorized all 54 of the suicides listed on the death certificates as suicides. The panel identified an additional six suicides, which are discussed in sections 8. Genitourinary diseases, 11. Motor vehicle accidents, and 16. Other external causes.

14. ***Homicide.*** For 47 homicides, the panel agreed with the categorization based on the death certificates. In four deaths, disagreements between the certificates and panel occurred. In one case, the veteran was shot in the head by a "friend" while the two men were "fooling around." The "friend" was charged with involuntary manslaughter, and the death certificate lists "homicide" as the manner of death. The panel attributed the death to an accident caused by a handgun (ICD-9, 922.0). In three other recategorized deaths, the certificates cite homicide as the underlying cause but do not mention that the decedents were killed by law enforcement agents. Consequently, the death certificate codings, each of which was assault by unspecified firearm (ICD-9, E965.4), differ from the panel's codings, each of which was injury due to legal intervention by firearms (ICD-9, E970.0).

15. ***Injury of undetermined intentionality.*** The panel assigned to other categories 8 of the 10 deaths coded as injuries of undetermined intentionality according to the death certificates. In five deaths, drug poisoning was listed on the certificate as the underlying cause of death and "undetermined" as the manner of death. The panel recategorized all five. It determined that three of the deaths were accidental drug poisonings on the basis of either medical examiner interviews with family and friends, which indicated the absence of suicidal intent, or law enforcement investigations, which documented that recreational drugs were being used at the death scene. The panel recategorized the other two deaths to natural causes. In one case, police records included reports of a scene investigation and an interview with the decedent's brother that provided sufficient evidence for the panel to cite morphine-type drug dependence (ICD-9, 304.0) as the underlying cause of death. In the other case, "acute multiple drug intoxication" was cited as the underlying cause on the death certificate. The panel, on the basis of a review of the hospital record and autopsy findings, attributed the death to renal failure due to acute tubular necrosis (ICD-9, 584.5). There was no historical or laboratory evidence to support a toxic etiology.

In a sixth case, "ethanol poisoning" was cited as the underlying cause on the death certificate, and "undetermined" was listed as the manner of death. The veteran had been drinking

alcohol with two friends, who had been "teasing" him into drinking to excess according to police records. The decedent died at home and was found to have a lethal blood alcohol level. Criminal charges were not filed against the friends, and the panel attributed the death to accidental poisoning by alcoholic beverages (ICD-9, E860.0).

In two other deaths, injury by firearm and injury by fire were listed as causes on the certificate. In the firearm injury death, despite a coroner's jury finding that the victim was shot by his wife, the certificate specifies that the manner of death was "undetermined." The panel attributed the death to assault by an unspecified firearm (ICD-9, E965.4). Similarly, in the fire injury death, the coroner's autopsy report describes the death as an "accident," but the manner was "undetermined" according to the death certificate. In the absence of any evidence to suggest either homicide or suicide, the panel attributed the death to accident caused by smoke and fumes from a conflagration (ICD-9, E890.2).

16. ***Other external causes.*** The panel recategorized 14 of 61 deaths that had been placed in the other external cause group on the basis of death certificate determinations. Of the 14, the panel attributed 11 to the specific external cause categories discussed above and 3 to natural causes.

The panel categorized as suicides three deaths that the original death certifiers had categorized as accidents. In one case, involving a drowning, medical examiner's records describe the decedent as a newlywed in "extreme financial difficulty" who "walked off his job without notice" and was found drowned in a lake 3 days later. The panel inferred self-destructive intent from the victim's life circumstances, and cited suicide by drowning (ICD-9, E954) as the underlying cause of death. In the second case, in which the veteran was crushed by a train, the panel based the diagnosis of suicide on eyewitness accounts that the the decedent "ran out from buses and laid on the tracks in front of (a) train." In the third case, a death from a self-inflicted gunshot wound, the death certificate apparently was not amended after the medical examiner's determination of suicide.

For five other death certificate-determined causes in this category, the panel could not rule out either suicide or homicide, and it placed these deaths in the accident of undetermined intentionality category. Law enforcement records raised the possiblity that two of the five deaths might have been suicides. In one case, a gun hobbyist cleaning a revolver sustained a lethal head injury, and the trajectory of the bullet was consistent with either an intended or unintended injury. In the other case, the fatal self-inflicted gunshot wound occurred immediately after a domestic quarrel that reportedly involved the issue of the paternity of one of the decedent's children. A third death involved an alcohol dependent man who was observed to be lying on the railroad tracks before being crushed by a train. The panel could not rule out suicidal intent and listed the underlying cause of death as injury by lying before moving object, intentionality undetermined (ICD-9, E988.0). In the fourth case, the original death certifier attributed the death to an accident caused by fire. The coroner subsequently reported that he could not rule out "foul play," and the panel cited injury by fire, intentionality undetermined (ICD-9, E988.1) as the underlying cause of death. The fifth case was that of a veteran who drowned, and the panel had no information other than an emergency room report that the decedent was dead on arrival as a result of drowning. The panel could not exclude self-inflicted injury, so it attributed the death to drowning, intentionality undetermined (ICD-9, E984).

The panel considered three other deaths to be motor vehicle accidents. In two, the anatomic sites of the injury, but not the circumstances of injury, were stated on the death certificate. The panel, on the basis of medical records, assigned these two deaths to the motor vehicle accident category. In the third, a fatal accident involving the driver of a "skidder" was

coded to accident caused by lifting machine and appliance (ICD-9, E919.2) on the basis of medical statements in the death certificate. The panel coded it to motor vehicle traffic accident due to loss of control without collision on the highway (ICD-9, E816.0).

As stated earlier, the panel recategorized 3 of these deaths to natural causes. Two had been coded to an accidental fall (ICD-9, E888) on the basis of the death certificates, but the panel, on the basis of medical documentation of antecedent seizure activity, coded them to other categories. In one case, the decedent injured his head during an observed alcohol withdrawal seizure; the panel therefore attributed the death to alcohol dependence syndrome (ICD-9, 303). In the other case, the decedent, known to have epilepsy, sustained a fatal head injury during an observed seizure; the panel therefore diagnosed generalized convulsive epilepsy (ICD-9, 345.1). The third death, attributed to "head trauma" on the death certificate, had been coded to unspecified accident (ICD-9, E928.9). The panel, on the basis of the autopsy report, coded it to pineal gland neoplasm (ICD-9, 237.1). The pathologist who performed the autopsy concluded that the onset of the decedent's head trauma was a coincidence. The post-mortmem examination showed "no signs of traumatic injury to the skull or brain."

APPENDIX F

THE COX REGRESSION MODEL

The Cox proportional hazards regression procedure models the risk of death and, correspondingly, the risk ratio when comparing two cohorts. The model assumes that the risk ratio is constant during the period of follow-up modeled. The model contains an underlying risk function, which may depend on time. This function is assumed to be modified by various covariates under consideration, such as in this study, Vietnam status, age, and race. When there are several groups defined by potential confounders, a stratified analysis can be done to allow different underlying risk functions in the different groups. With a stratified analysis, the proportional hazards assumption (that of a constant risk ratio) must hold in each group (stratum). If the intent is to estimate a common risk ratio over the strata, the risk ratio for the various strata should be similar.

Let: $X_0, X_1, ..., X_P$ be the covariates of interest

$b_0, b_1, ..., b_P$ be unknown regression coefficients, to be estimated.

In particular, let X_0 be 1 if an individual served in Vietnam and 0 otherwise. Then the Cox model estimates the risk ratio for an individual with covariates $X_0, ..., X_P$ relative to one with covariates $Y_0, ..., Y_P$ as log (RR) = $b_0(X_0-Y_0) + ... + b_P(X_P-Y_P)$

The risk ratio for service in Vietnam is estimated as $\exp(b_0)$. The SAS program PHGLM[2] was used to provide estimates of the parameters, their standard errors, and likelihood ratio statistics for tests of hypotheses. The program also computes a statistic to test the proportional hazards assumption[3]. This statistic has a distribution which is approximately that of a standard normal variable.

Table F-1 contains values of the test statistic for the proportional hazards assumption for the simple model with cohort (service in Vietnam) as the only covariate. The values of this statistic for the model including the covariates age, race, GT score, year of discharge, and pay grade at discharge were very similar. The assumption appears reasonable within each time period and stratum, with a departure of marginal significance only for the first five years of follow-up for volunteers with a tactical MOS (Z=2.02, p=.04). The proportional hazards assumption does seem reasonable during this period for the model with the four strata combined (Z=1.35, p=.18). For the remaining period of follow-up, the assumption seems very well satisfied. If there is a modest departure from uniformity in the first time period, the estimate obtained from the model will be an average measure over this interval.

The validity of the proportionality assumption was also checked for the cause-specific analyses. There was substantial evidence for non-proportionality only for deaths due to homicide, according to the clinical review, in the later time period (Z=2.7).

Table F-2 contains the estimates of the regression coefficients for cohort (service in Vietnam) and their standard errors. The standard errors are interpreted as those from a standard normal distribution. There is some variability among strata in the rate ratio for the first five years of follow-up. In particular, the rate ratio is less than 1 for one of the four strata, that of volunteers with a tactical MOS. However, this is the smallest stratum, with less than half the number of men and about half the number of deaths as the next smallest stratum. In addition, this rate ratio is not significantly less than 1, and the difference between the largest and smallest coefficients is not particularly large compared to their standard errors. Therefore, it is reasonable to use the estimate from the stratified model as a summary estimate, regarding it as an average of the effects in the four strata. Relatively small numbers of deaths in many strata makes this homogeneity check unreliable for the cause-specific analyses.

Table F-1. Test Statistics* for Validity of Proportionality Assumption for Cox Regression Model Stratified on Enlistment Status and MOS, by Time Since Discharge

Stratum	Years since discharge		
	≤5 years	6+ years	All years
Tactical			
Draftee	0.5	0.2	−0.9
Volunteer	2.0	−0.4	1.2
Nontactical			
Draftee	−0.1	0.1	−1.4
Volunteer	0.8	−0.1	−1.0
All strata	1.4	−0.1	−1.4

*Test statistic has approximately a standard normal distribution. Results shown are for a model that includes place of service but no covariates.

Table F-2. Uniformity of Vietnam Effect Over Strata for Cox Regression Models Stratified on Enlistment Status and MOS, by Time Since Discharge (All-Cause Mortality)

Stratum	Years since discharge					
	≤5 years		6+ years		All years	
	Beta	SE	*Beta*	SE	*Beta*	SE
Vietnam service only:						
Tactical						
Draftee	0.77	0.36	0.16	0.27	0.40	0.22
Volunteer	−0.22	0.42	0.29	0.40	0.05	0.29
Nontactical						
Draftee	0.48	0.25	−0.03	0.21	0.17	0.16
Volunteer	0.23	0.27	−0.22	0.22	0.04	0.17
All strata	0.37	0.15	−0.02	0.12	0.14	0.10
Vietnam service plus covariates:*						
Tactical						
Draftee	0.86	0.37	0.25	0.28	0.49	0.22
Volunteer	−0.39	0.45	0.10	0.42	−0.13	0.31
Nontactical						
Draftee	0.49	0.26	0.00	0.21	0.20	0.16
Volunteer	0.47	0.28	−0.13	0.23	0.11	0.18
All strata	0.45	0.16	0.03	0.13	0.20	0.10

*Covariates include age at discharge, race, General Technical test score, year of discharge and pay grade.

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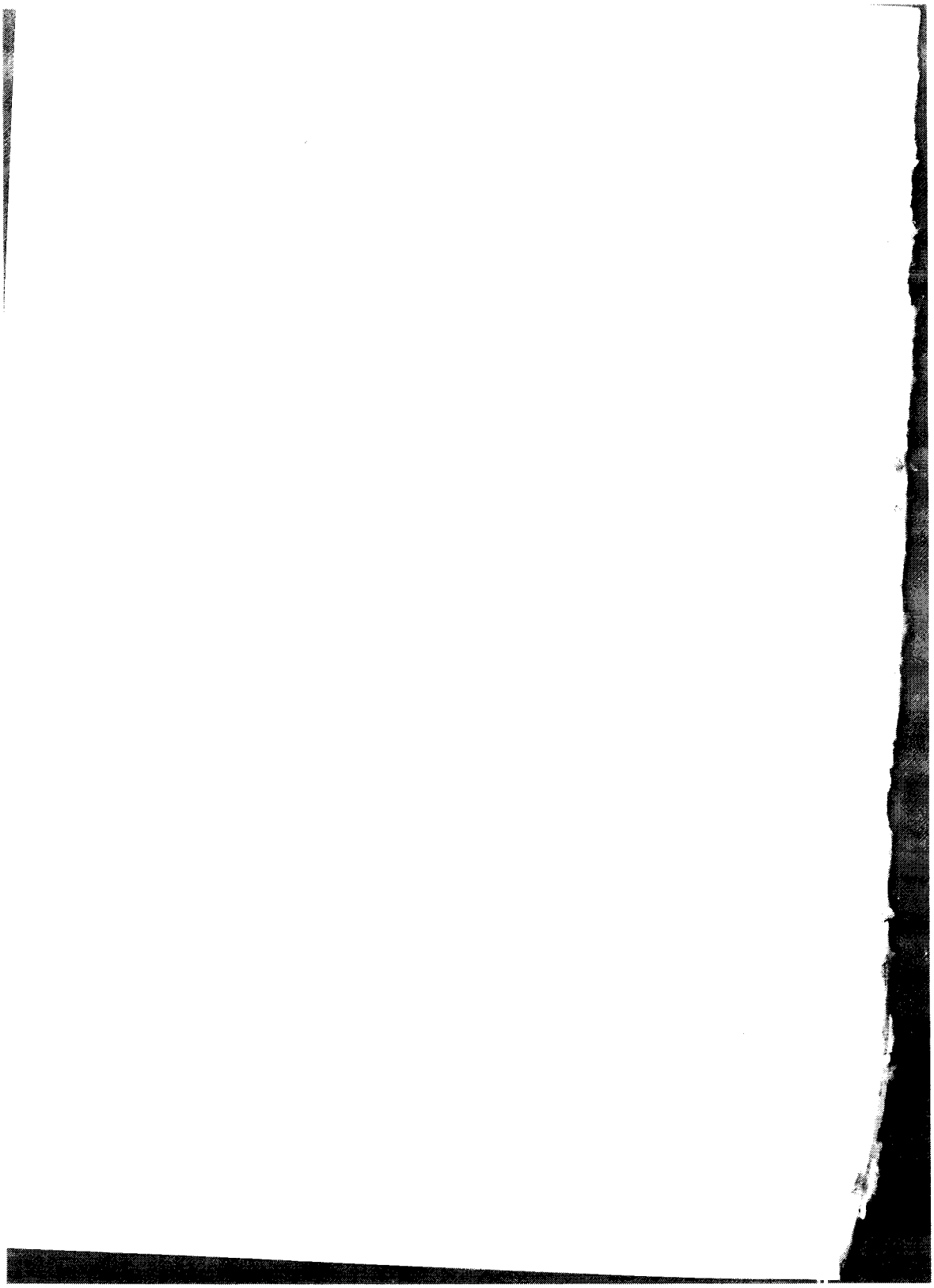
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