

# MORTALITY PATTERNS OF ARMY CHEMICAL CORPS VIETNAM-ERA VETERANS

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## Introduction

The purpose of this research is to examine the mortality patterns of 5,609 male Vietnam-era veterans who were involved in chemical operations during the Vietnam War. Agent Orange, one of the major herbicidal chemicals sprayed during the Vietnam War for defoliation, has been associated with various negative health outcomes in military personnel<sup>1</sup>. Agent Orange contains a contaminant called dioxin (2,3,7,8 tetrachlorodibenzo-p-dioxin or TCDD) that has been shown to have teratogenic and carcinogenic effects in animals<sup>2,3</sup>. In Vietnam veterans, Agent Orange has been associated with mortality from various diseases and other health issues. TCDD altered immunity-modulating factors in Korean Vietnam veterans and in those who were Agent Orange exposed<sup>4</sup>. An increased frequency of ischemic heart disease was found to be linked to increased levels of exposure to Agent Orange in Korean Vietnam veterans<sup>5</sup>. The likelihood of developing diabetes, heart disease, hypertension, and chronic respiratory disease was significantly higher in Vietnam veterans as compared to non-Vietnam veterans who distributed herbicides for the Army Chemical Corps<sup>6</sup>. A statistically significant excess of digestive disease deaths for Vietnam veterans relative to U.S. men was observed in a preliminary mortality and morbidity follow-up of 894 Army Chemical Corps veterans<sup>7</sup>. Further follow-up performed in 1991 demonstrated significant excess mortality from digestive disorders for Vietnam veterans relative to non-Vietnam Army Chemical Corps veterans<sup>8</sup>. Men with the highest TCDD levels, as determined through adipose tissue analyses, were Vietnam War Army Chemical Corps specialists<sup>9</sup>. Similarly, Vietnam veterans who were involved in spraying herbicides had a statistically significant elevation of 2,3,7,8 TCDD in their serum as compared to non-Vietnam veterans who were not involved in sprayings<sup>10</sup>. In contrast to the previous findings, no overall increase in the risk of prostate cancer in Ranch Hand veterans (unit responsible for the spraying of herbicide in Vietnam) versus a control group (those who served in Southeast Asia but were not involved in herbicide sprayings)<sup>11</sup>, and no increased risk of testicular cancer was observed for most individuals selected from the Agent Orange Registry<sup>12</sup>. Other studies demonstrated similar findings<sup>13,14</sup>. Further research is needed to help clarify the impact of these agents on the health of Vietnam War veterans.

## Materials and methods

This research updated the vital statistics of 5,609 male Vietnam-era veterans through December 31, 2005 who were involved in chemical operations during the Vietnam War. Individuals who served in the Army Chemical Corps are being studied because it was presumed that they would have had a greater likelihood of exposure to Agent Orange as compared to US Army ground troops<sup>8</sup>. Data from individuals designated as alive based on the last mortality update in 1991<sup>8</sup> were matched against data from the Department of Veterans Affairs (DVA) Benefits Identification and Record Locator Subsystem (BIRLS) and Social Security Administration Death Master File (SSDMF) to identify dates of death occurring primarily between January 1, 1992 and December 31, 2005. Data for deceased individuals, determined through the process described above, were submitted to the National Center for Health Statistics (NCHS) in 2007 for conduct of a National Death Index (NDI)-Plus search to determine cause of death. COD were recoded to ICD 9<sup>15</sup> where applicable. Vietnam-service status, based on two cohorts of individuals involved in chemical operations who either served (N=2872) or did not serve in Vietnam (N=2737), was investigated relative to all cause and cause-specific mortality. Observed mortality rates will be compared to expected rates obtained for men in the US general population (adjusted for race, age, and calendar period) for each cohort.

Resultant data were analyzed in aggregate. Person-years at risk of dying were calculated based on when an individual left military service or the date the last US troops left Vietnam (March 28, 1973). Crude mortality rates (# deaths per 10,000 person-years at risk) and crude mortality rate ratios (ratio of the crude mortality rates for the two cohorts) were computed for all causes and for each of the approximately 15 cause-specific mortality categories. Relative risks were adjusted for potential confounders (e.g., race, age at entry into follow-up, rank) and 95% confidence intervals obtained for the resulting point estimates through application of Cox proportional hazards multivariate analysis procedures (PROC PHREG) using SAS system ® software for the mainframe (Version 9.1)<sup>16</sup>. Analyses are still ongoing and preliminary selected findings are presented in the forthcoming tables.

### Results and Discussion:

Vital status by Vietnam-service status is presented in Table 1. There were a total of 948 deaths, which represented approximately 17% of the individuals in the two cohorts resulting from all vital status determinations through December 31, 2005; 624 deaths occurred since the last update in 1991<sup>8</sup>. A total of 593 deaths were for veterans who served in Vietnam. The average length of follow-up was approximately 32 years for the Vietnam and non-Vietnam cohorts with total person-years at risk computed to be 93,316 and 89,852 respectively. The mean age at entry into follow-up was 26.5 years for the Vietnam cohort and 23.6 years for the non-Vietnam cohort (not shown in tables), with the individuals in each of the cohorts being predominantly White. Approximately 50% of each of the groups on average had 2-3 years of active military duty (not shown in tables).

Table 2 presents the observed number of deaths, crude mortality rates, crude mortality rate ratios, and the adjusted relative risks with concomitant 95% confidence intervals for all-cause and various cause-specific mortality categories for the Vietnam and non-Vietnam cohorts. Findings revealed a significant excess in mortality for respiratory system disease for Vietnam veterans relative to non-Vietnam veterans while controlling for all other covariates (adjusted relative risk [ARR] = 3.01, 95% confidence interval [CI] 1.38 – 6.57). This statistically significant finding was not present in the prior update<sup>8</sup>, although mortality from respiratory diseases in that study was shown to be nonsignificantly elevated for Vietnam veterans relative to non-Vietnam veterans. In recent research, herbicide spraying history was significantly associated with chronic respiratory disease<sup>6</sup>. Despite an increased mortality from respiratory diseases for the Vietnam-service cohort in this study, no significant excess in mortality from respiratory system cancers for Vietnam veterans as compared to non-Vietnam veterans was observed. Nonsignificant excess mortality was reported for digestive system disease (and cirrhosis of the liver) in the current analysis. The latter finding is consistent with prior research<sup>8</sup> but not of the same magnitude. After an additional 16 years of follow-up, there are no statistically significant differences in mortality from all causes or all cancers between Army Chemical Corps Vietnam veterans and non-Vietnam veterans.

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**Table 1. Vital status determination through December 31, 2005 of Army Chemical Corps veterans (N=5609) by Vietnam-service status**

Vital status	Vietnam-service status			
	Vietnam (N=2872)		Non-Vietnam (N=2737)	
	Number	%	Number	%
Alive	2279	79.4	2382	87.0
Deceased	593	20.6	355	13.0

**Table 2. Mortality among Army Chemical Corps veterans by Vietnam-service status through December 31, 2005**

Underlying cause	Vietnam-service status						
	Vietnam		Non-Vietnam		Crude rate ratio <sup>b</sup>	Adjusted relative risk <sup>c</sup>	95% confidence interval
	Observed	Crude rate/10 <sup>4</sup> <sup>a</sup>	Observed	Crude rate/10 <sup>4</sup>			
All causes	593	63.55	355	39.51	1.61	1.11	0.97 – 1.28
All cancer	142	15.22	74	8.24	1.85	1.15	0.86 – 1.55
Digestive	33	3.54	19	2.11	1.67	1.05	0.58 – 1.89
Respiratory	60	6.43	26	2.89	2.22	1.28	0.78 – 2.08
Testicular	2	0.21	0	0.00	-----	-----	-----
Skin	5	0.54	4	0.45	1.20	1.29	0.32 – 5.20
Brain	4	0.43	2	0.22	1.93	1.71	0.29 – 10.18
All lymphopoietic	6	0.64	6	0.67	0.96	1.10	0.35 – 3.50
Leukemia	2	0.21	4	0.45	0.54	0.57	0.10 – 3.27
Circulatory system disease	184	19.72	88	9.79	2.01	1.18	0.92 – 1.54
Respiratory system disease	40	4.29	8	0.89	4.81	3.01	1.38 - 6.57 <sup>d</sup>
Digestive system disease	34	3.64	15	1.67	2.18	1.62	0.86 – 3.03
Cirrhosis of liver	19	2.04	9	1.00	2.03	1.67	0.73 – 3.80
All external causes	91	9.75	100	11.13	0.88	0.86	0.64 – 1.16

<sup>a</sup> Crude mortality rate = # deaths per 10<sup>4</sup> person-years at risk.

<sup>b</sup> Ratio of crude mortality rate of Vietnam to non-Vietnam cohorts.

<sup>c</sup> Estimate derived from the proportional hazards multivariate regression model adjusting for race, rank, duration of military service, and age at entry into follow-up.

<sup>d</sup> 95% confidence interval does not include 1.