PCDDs, PCDFs, AND PCBs IN THE PARTICIPANTS OF THE AIR FORCE HEALTH STUDY IN 2002

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Introduction

The Air Force Health Study (AFHS) was a 20-year prospective study examining the health, mortality and reproductive outcomes in US Air Force veterans of Operation Ranch Hand, the unit responsible for the aerial spraying of herbicides, including 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD)-contaminated Agent Orange and other herbicides, in Vietnam from 1962 to 1971. Included as referents were the comparison Air Force veterans who flew or serviced transport aircraft in Southeast Asia (SEA) during the same time period and did not spray herbicides. They were matched on age, race and military occupation to Ranch Hand veterans. All veterans were male and 94% were white.[1] The study protocol with the Air Force concluded in October 2006, and upon the recommendation of a committee of the National Academy of Sciences on the Disposition of the AFHS, the study datasets, medical records, and samples collected since 1982 are being transferred to a Medical Follow-up Agency[2]. Consents for the transfer are in the process of being obtained from the veterans, and the response rate is high (personal communication, JNR). This paper pertains to the project which began before the original study protocol ended and is aimed at finalizing and completing the exposure assessment of this unique cohort by measuring four main classes of organochlorine compounds used to calculate total dioxin TEQs - polychlorinated dibenzo-p-dioxins (PCDDs), polychlorinated dibenzofurans (PCDFs), coplanar or non-ortho-substituted polychlorinated biphenyls (cPCBs) and mono-ortho-substituted polychlorinated biphenyls (mPCBs), as well as other ortho-substituted polychlorinated biphenyls and organochlorine pesticides in all 1,950 veterans who provided blood samples at the last AFHS physical examination in 2002. We presented preliminary results from a random sample of 800 of these veterans at the last years meeting in Oslo, Norway. The size of the cohort, length of follow up and the detail of the information collected makes it an invaluable source of data and is compared to national reference range estimates obtained under the National Health and Nutrition Examination Survey (NHANES) program at the Centers for Disease Control and Prevention (CDC). Measurements for these compounds from both the AFHS and the NHANES were made by the same dioxin laboratory at the National Center for Environmental Health (NCEH) at the CDC.

Materials and Methods

Samples from the 1,950 Comparison and Ranch Hand veterans who attended the 2002 physical examination were analyzed between 2004 and 2007. Measurements from 106 Comparison veterans without a previous valid TCDD measurement were made in 2004[3], samples from a randomly selected four hundred Ranch Hands and 400 Comparison veterans were analyzed in 2005-2006[4], and the remaining 1,044 samples are currently being analyzed.

The organochlorine compounds in serum from all 1,950 Comparison and Ranch Hand veterans were measured by high-resolution gas chromathography/isotope-dilution high-resolution mass spectrometry (HRGC/ID-HRMS) in the dioxin laboratory at the Centers for Disease Control and Prevention.[5, 6] Seven PCDDs, 10 PCDFs, 4 cPCBs (#81, 77, 126, and 169) and 6 mPCBs (#118, 105, 167, 156, 157, and 189) were measured. An additional 30 ortho-substituted PCB congeners and 13 organochlorine pesticides were also measured. The 1997 and 2005 World Health Organization's Toxic Equivalency Factors (WHO-TEF) were used to report PCDDs, PCDFs, and PCBs Toxic Equivalents (TEQs). For levels measured below the limit of detection, the limit of detection for the congener divided by the square root of 2 was substituted.

Results and Discussion

Our previous results seemed to support the original assumption in the AFHS that background exposures to dioxin like compounds in Ranch Hands and Comparisons would be similar and that the difference in the total TEQs could be attributed to the difference in occupational exposure to TCDD contaminated herbicides sprayed by Ranch Hands in Vietnam. This difference was still evident in the sample of 800 veterans over 30 years after the end of exposure, particularly in younger, higher herbicide exposed Ranch Hand veterans.[4] We expect the current result to support that conclusion when the analysis of over 1,000 additional samples is completed.

Results have pointed out some interesting comparisons with the NHANES data. As we can examine similar age groups in the Ranch Hand cohort as in NHANES, and the control group was a fairly good representation of the white male population in the USA, these comparisons provide valuable information on background exposure levels and ranges. The percent contributions to the total mean TEQ for the Ranch Hands were 57% PCDDs, 21% mPCBs, 14% PCDFs, and 8% for cPCBs; and 47% PCDDs, 27% mPCBs, 15% PCDFs, and 11% for cPCBs for Comparisons.[3, 4]

In the 60+ age group, 90th percentile TEQ levels found in Comparison veterans or in Ranch Hands were 43% and 27% lower than 90th percentile TEQ reference range for the 60+ age group for the US population, which in retrospect, was unexpected. The original assumption that it was reflecting lower average age in Air Force veterans in this age group may not be entirely correct as the age difference between AFHS and NHANES samples seem to be small in this age group, not exceeding 2 years of median age.[4]

The AFHS cohort is not a random sample of US population, and the number of veterans living in individual states almost certainly does not correspond to population weights used in NHANES. The veterans included in the AFHS lived in most of the states in the USA and many had a military career that required frequent relocations within the US and these veterans may, therefore, be representative of the US background exposures. For this reason, we consider this an important group to compare with NHANES and much lower levels in the higher age groups reported earlier should be reexamined.

Even with these results we will not be able to reconstruct the Ranch Hand veterans' organochlorine exposures at the end of their tours of duty in Vietnam. But to address the question as to whether other organochlorines, besides TCDD may have contributed to any of the adverse health effects observed in this study, we will be able to provide some additional information that may help to further investigate potential associations.

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References

1. Wolfe WH, Michalek JE, Miner JC, Rahe A, Silva J, Thomas WF, Grubbs WD, Lustik MB, Karrison TG, Roegner RH. *JAMA* 1990; 264(14):1824.
2. National Academy of Sciences Committee on the Disposition of the Air Force Health Study. Washington DC. February 3, 2006, 274p.
3. Pavuk M, Patterson DG Jr, Turner WE, Needham LL, Ketchum NS. *Chemosphere* 2007; 68(1): 62.
4. Pavuk M, Patterson DG Jr, Turner WE, Ketchum NS, Needham LL. PCDDs, PCDFs, PCBs, and organochlorine pesticides in 800 US Air Force veterans in 2002. *Organohalogen Comp* 68, 2006.
5. Patterson D.G. Jr., Hampton L., Lapeza C.R. Jr et al. *Anal Chem* 1987; 59: 2000.
6. Turner W., DiPietro Lapeza C., Green V., Gill J., and Patterson D.G. Jr. *Organohalogen Comp* 1997; 31: 26.