Evaluation of contaminated drinking water and male breast cancer at Marine Corps Base Camp Lejeune, North Carolina: A case control study

Perri Ruckart, MPH

Community Assistance Panel Meeting
December 4, 2015
Tampa, Florida

U.S. Department of Health and Human Services
Agency for Toxic Substances and Disease Registry

Study Overview

- **Purpose: To evaluate whether residential exposure to contaminated drinking water at Camp Lejeune increased the risk of male breast cancer**
  - Used cases ascertained through the Department of Veterans Affairs Central Cancer Registry (VACCR)

- **Included male Marines born before 1/1/69 who were diagnosed with or treated for cancer at a VA medical facility from 1/1/95-5/5/13 and had information on tour dates and locations**
  - Excluded Marines born after 1/1/69 as they were not old enough to serve during the period of contamination at Camp Lejeune

Study Population

- **VACCR identified 78 cases of male breast cancer**
- **400 controls in the final sample**
  - Cancers of the bone, mesothelioma, and skin
- **Located 444 (93%) of 478 personnel files**
  - Files were unavailable for 7 (9%) cases and 27(7%) controls
- **71 cases and 373 controls included in study**
  - Controls: 270 (72%) skin cancers, 67 (18%) mesotheliomas of the pleura, 32 (9%) bone cancers, and 4 (1%) mesotheliomas of the peritoneum

Exposure Assessment

- **Due to lack of exposure information, ATSDR used extensive water modeling to reconstruct residential exposures before 1987**
  - Other drinking water studies did not have monthly estimates of residential contaminant levels
- **Used information abstracted from personnel records, base family housing records, information on where units were barracked and water modeling results**

Data Analysis

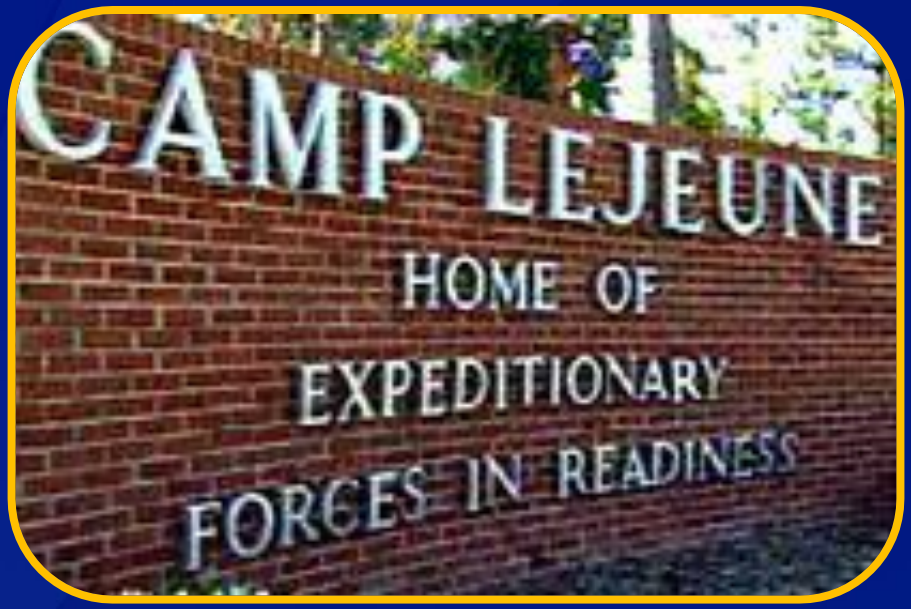
- **Calculated odds ratios (ORs) and 95% confidence intervals (CIs)**
- **Two criteria used to assess associations**
  - size of the estimate
  - exposure-response relationship
- **Exploratory analyses evaluated if exposures to drinking water contaminants at Camp Lejeune were associated with earlier age at onset for male breast cancer**

Conclusions and Key Results

- **Study results suggested possible associations between exposure to PCE, DCE, and vinyl chloride at Camp Lejeune and male breast cancer (ORs ranged from 1.19-1.50)**
  - Results accounted for age at diagnosis, race, and service in Vietnam
  - Results were based on small numbers of cases with high exposure
  - For PCE, risk increased slightly with increasing levels of exposure
- **Exposures to TCE, PCE, DCE and vinyl chloride were also observed to possibly accelerate the onset of male breast cancer (HRs ranged from 1.41-2.72)**
- **The study did not find evidence suggesting associations between male breast cancer and exposures to benzene**

Study Limitations

- Small numbers of exposed cases resulting in wide CIs
- Excluded 7 cases with no information about where they were stationed
- Only about 25% of veterans used VA health care facilities so cases were likely underestimated
- Did not conduct interviews to obtain more details about residential history or on-base activities
- Unmeasured confounding



For more information please contact Agency for Toxic Substances and Disease Registry

4770 Buford Highway NE, Chamblee, GA 30341
Telephone: 1-800-CDC-INFO (232-4636)/TTY: 1-888-232-6348
E-mail form: www.cdc.gov/info
Web: http://www.atsdr.cdc.gov

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

ATSDR
U.S. Department of Health and Human Services
Agency for Toxic Substances and Disease Registry

Background

Hadnot Point (HP) Distribution System

- **Began operations in 1943**
- **Contaminated primarily with trichloroethylene (TCE) from leaking underground storage tanks, industrial area spills, and waste disposal sites**
  - Vinyl chloride and 1,2-dichloroethylene (DCE) present due to degradation of TCE
  - Other major contaminants included tetrachloroethylene (PCE) and benzene
- **Maximum TCE level = 1,400 ppb**

Tarawa Terrace (TT) Distribution System

- Began operations in 1952
- Contaminated primarily with PCE from solvent waste disposal from an off site dry cleaner
- Major supply well was 900 feet from dry cleaner's septic tank
- Maximum PCE level = 215 ppb

Contamination of HP and TT Drinking Water Supplies

- Water from contaminated and uncontaminated wells mixed at treatment plants before delivery to residences
- Contamination levels in drinking water distribution systems varied depending on wells being used at a particular time
- Most contaminated wells in HP and TT systems were shut down by February 1985

Holcomb Boulevard (HB) Distribution System

- Supplied by HP system prior to June 1972
- Beginning June 1972, HB system was supplied by uncontaminated wells
- Contaminated water from HP supplemented HB system during dry weather conditions in spring/summer
- HP also supplied water to HB during 1/27/85-2/7/85 when HB system was shut down for repairs

Data Collection

- **Data obtained from the National Personnel Record Center (NPRC) military personnel files to identify Marines stationed at Camp Lejeune before 1986**

- **NPRC located 444 (93%) of 478 requested files**
  - Files were unavailable for 7 (9%) cases and 27(7%) controls
  - Files for 1 control contained very limited information

- **71 cases and 373 controls included in study**
  - Controls: 270 (72%) skin cancers, 67 (18%) mesotheliomas of the pleura, 32 (9%) bone cancers, and 4 (1%) mesotheliomas of the peritoneum

Data Collection

- **Extensive review and data abstraction for each NPRC file**
  - Personal identifying information, tour(s) of active and reserve duty, rank(s), military occupational specialty (MOS), service in Vietnam
  - For those at Camp Lejeune: station assignment, deployments, marital status, and dependent status
- **Obtained information on potential risk factors from NPRC, VACCR, and the VA's Patient Treatment File (PTF)**

Assumptions Made to Determine Residence

- **Unmarried enlisted Marines resided in barracks**
- **Unmarried officers resided in bachelors officers' quarters (BOQs) in the area where their units were barracked**
- **Married Marines usually resided either in off-base housing or in base family housing**
  - If names of married Marines were not found in family housing records and spouse's address was not in/near Jacksonville, we assumed they were barracked with their unit

Assigning Exposure

- Exposure period was earliest start date of tour at Camp Lejeune and continued until Marine left or 12/31/85, whichever was earlier
- Accounted for Marines who had > 1 tour at Camp Lejeune and who may have left the base and come back
- Tours not at Camp Lejeune assigned as unexposed

Exposure Categories

- Tours at Camp Lejeune were categorized as unexposed if Marine resided off-base or at a residence with uncontaminated drinking water
- Used estimated average monthly contaminant concentrations in the drinking water system serving Marine's residence(s) at Camp Lejeune to determine average and cumulative exposure to contaminants

Data Analysis

- **Calculated odds ratios (ORs) to compare the odds of male breast cancer among the exposure variables**
- **95% confidence intervals (CIs) were calculated**
- **Evaluated risk factors**
  - age of diagnosis, race/ethnicity, educational level of parents, rank, service in Vietnam, alcoholism, obesity, diabetes, gynecomastia, thyroid disorder, endocrine disease, cholelithiasis, diseases of the male genital organs, orchitis/epididymitis, osteoporosis, fractures, liver disease, EMF exposure, and solvent exposure

Exploratory Analyses

- **Used proportional hazards methods to evaluate whether being stationed at Camp Lejeune and cumulative exposures to drinking water contaminants were associated with earlier age at onset for male breast cancer**
  - age at diagnosis, as a continuous variable, was the response variable in the proportional hazards model

Comparing Ever/Never Stationed at Camp Lejeune

- **Unadjusted OR = 1.45 (0.86-2.44)**
- **Adjusted OR = 1.14 (95% CI: 0.65-1.98)**
  - adjusted for age at diagnosis, race, and service in Vietnam
- **Adjusted OR = 0.89 (95% CI: 0.38-1.93) for duration ≥ 38 weeks in a residence receiving contaminated drinking water at Camp Lejeune**

Adjusted ORs for High Cumulative Exposure

Cumulative exposure	Cases #(%)	Controls #(%)	aOR* (95% CI)
High PCE	2 (2.8)	8 (2.2)	1.20 (0.16-5.89)
High DCE	3 (4.2)	8 (2.2)	1.50 (0.30-6.11)
High vinyl chloride	2 (2.8)	8 (2.2)	1.19 (0.16-5.89)

*adjusted for age at diagnosis, race, and service in Vietnam

Possible Confounding by Diabetes and Gynecomastia

- Data on diabetes and gynecomastia missing for 13% of controls and 7% of cases
- For those with data, possible separate confounding by diabetes and gynecomastia observed
- Used multiple imputation procedure to impute missing values
- Results for models that included imputed values of diabetes and gynecomastia were similar to models that did not include these variables

Exploratory Analyses of Age at Onset of Male Breast Cancer

Exposure	Cases #, %	Controls #, %	HR (95% CI)
Ever stationed at Camp Lejeune	30 (42.3)	125 (33.5)	1.51 (0.78-2.95)
High cumulative PCE	2 (2.8)	8 (2.2)	2.08 (0.31-14.00)
High cumulative TCE	12 (16.9)	57 (15.3)	1.41 (0.58-3.46)
High cumulative DCE	3 (4.2)	8 (2.2)	2.72 (0.52-14.18)
High cumulative vinyl chloride	2 (2.8)	8 (2.2)	2.14 (0.31-14.81)