TECHNICAL REPORT

Cancer concern among residents of a neighborhood in Mountain View, California: Report on cancer incidence from the Greater Bay Area Cancer Registry

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Executive summary

- At the request of a citizen, the Greater Bay Area Cancer Registry (GBACR), operated by the Cancer Prevention Institute of California (CPIC), has reviewed the incidence of trichloroethylene (TCE)-associated cancers occurring in a neighborhood in Mountain View, Santa Clara County, California.
- The neighborhood of concern was in the Middlefield-Ellis-Whisman Superfund study area near the Moffett Naval Air Station in Mountain View. Since TCE was the primary exposure of concern, we focused our assessment on three cancer types that have been associated with this exposure based on published research: non-Hodgkin's lymphoma and cancers of the liver, and kidney.
- We compared the number of cancer cases reported to our cancer registry among residents of the census tracts with the average number expected among residents based on the rates reported for the surrounding region (Santa Clara, Santa Cruz, San Benito, Monterey counties).
- There was no significant difference between the Mountain View neighborhood and the larger region in cancers of the liver or kidney.
- There was a statistically significant elevation for non-Hodgkin lymphoma during one period evaluated (1996-2005), although it appears that no statistically significant elevation existed prior to this time (1988-1995) or in the most recent period (2006-2010).
- This evaluation included only existing cancer registry data, which cannot speak to specific exposures incurred by residents of this neighborhood.

Introduction

The GBACR at CPIC has examined the incidence of TCE-associated cancers in a neighborhood within Mountain View. The neighborhood of concern is located within the Middlefield-Ellis-Whisman (MEW) Superfund study site. Concern was expressed regarding a possible increase in cancer incidence due to exposure to TCE, a chemical substance used as an industrial cleaning and degreasing agent and found for several years in the soil and groundwater of the neighborhood. The GBACR's investigation followed the guidelines set forth in the California Cancer Registry publication "Guidelines to address citizen concerns about cancers in their communities" (available upon request).

Methods

The GBACR collects and manages information on all persons diagnosed with cancer in a nine-county region of California. These data are obtained according to state law from physicians, hospitals, and other cancer treatment facilities, which are required by the state to report all cancer cases to the registry. Cancer data in the Santa Clara Region (Monterey, San Benito, Santa Clara and Santa Cruz counties) are considered complete from 1988-2009. As information is received from many facilities and must be consolidated and quality-confirmed, there is a lag time for cancer registry data to be deemed complete for a given year. As such, cancer registry data are currently considered complete through the year 2009; data for 2010 diagnoses are approximately 95 percent complete. As understanding cancer occurrence requires accurate counts of both the number of cancer cases and the numbers of persons living in a region (e.g. population at risk), our ability to assess cancer occurrence in areas smaller than counties depends on the availability of accurate population counts. These detailed population counts are only collected as part of the US Census every ten years. In this report, we examined cancer occurrence for the 8-year time interval around the census year 1990 (1988 to 1995), and the 10-year time interval around the census year 2000 (1996 to 2005). Although we did not have the information needed to assess cancer occurrence in the years around the most recent US Census (2010) we evaluated cancer occurrence for the most recent 5-year time interval (2006-2010) for which cancer data are available.

To determine the number of cases diagnosed among residents of a certain geographic area, the GBACR collects information on cancer patients upon diagnosis, including his/her address. However, the data are limited to the address at the time of diagnosis and do not contain information on residential history. Since the development of cancer is a multi-step process and there is assumed to be a long time between the initiation of the carcinogenic process and a clinically diagnosable cancer, some former MEW neighborhood residents will have been diagnosed with cancer after moving out of the area, and some residents will have been diagnosed shortly after moving into the area. However, if there were a major increase in cancer among residents who have lived in the MEW neighborhood for a long period of time, it is likely to be seen in this type of investigation.

The citizen identified the area of concern as the residential neighborhood in the Middlefield-Ellis-Whisman study area near Moffett Naval Air Station in Mountain View, an area bordered by Whisman Road, Middlefield Road, Ellis Street, and Highway 101. This neighborhood is closest to census tracts 5091.08, 5901.09, and 5092.01 in the 2000 and 2010 US Censuses and census tracts 5091.04 and 5092.01 in the 1990 US Census. The difference in census tract numbers between the 1990 and 2000/2010 US Censuses is due to the split of census tract 5091.04 after the 1990 US Census into two distinct census tracts 5091.08 and 5091.09 in the 2000 and 2010 US Censuses.

The number of new cancer cases reported in residents of these tracts from 1988 to 2010 were tabulated from the GBACR data. To determine if cancer occurrence has been unusual in the neighborhood of interest, we compared the number of cancer cases that occurred among residents of those census tracts (the observed number), with the number that would be expected to occur if the residents had the same pattern of cancer occurrence as the entire four-county Santa Clara Region. As socioeconomic status is well documented to be associated with cancer occurrence, this four-county region was selected as the comparison region because it is comparable in socioeconomic status to the neighborhood of concern. All three census tracts in the MEW neighborhood were of relatively high socioeconomic status, which is similar to the socioeconomic status of the four-county Santa Clara reference region. To protect the confidentiality of patients according to cancer reporting standards, if the observed number is fewer than 5 cases, we report "<5" as opposed to the actual number. Determining the expected number requires information on detailed population characteristics of the census tract (i.e., the number of persons by gender, race/ethnicity, and five-year age-group).

To reasonably estimate the expected number of cancer cases, average annual incidence rates were calculated using cancer registry data from 1988-1995 and 1996-2005 and Census population estimates for the years 1990 and 2000, respectively. The Santa Clara Region was used as the region for comparison. These average annual incidence rates were applied to the number of residents in the neighborhood of concern according to the 1990 and 2000 Census population estimates to generate the expected cancer case counts per year. The expected counts per year were in turn multiplied by eight and ten, respectively, assuming that the expected rates were constant over each year throughout the 8- and 10-year periods of time. Similarly, to estimate the expected number of cancer cases occurring between 2006 and 2010, the expected numbers of cases were based on average annual incidence rates computed from cancer registry data from 2006-2009 (since cancer incidence data are not considered fully complete for 2010) and Census population estimates for the Santa Clara Region for 2010. This average annual incidence rate was applied to the number of residents in the neighborhood of concern according to the 2010 Census population to generate the expected cancer case counts per year; which in turn were multiplied by five, assuming that the expected rates were constant over each year throughout the 5-year period of time 2006-2010.

The expected and observed numbers can be compared directly using the Standardized Incidence Ratio. A Standardized Incidence Ratio of 1 indicates that the number of observed cases equals the number expected; a Standardized Incidence Ratio greater than 1 means more cases were observed than expected; and a Standardized Incidence Ratio less than 1 means fewer cases were observed than expected. Together with the Standardized Incidence Ratio, we can use the 99 percent confidence intervals to test if the difference between the observed and expected numbers is statistically significant. Due to statistical limitations of using small area data, a 99 percent confidence interval is used to minimize the false positive error. If the 99 percent confidence interval for the

Standardized Incidence Ratio includes 1.0, then any difference between the observed and expected number is considered to be not statistically significant and may have been due to chance sampling fluctuation.

Our report focuses on three cancer sites suggested in the scientific literature to be associated with TCE, the exposure of concern specifically expressed by the citizen requesting the analysis. The recently published systematic and quantitative review by Scott and Jinot (enclosed) identifies three specific types of cancer: non-Hodgkin lymphoma, and invasive cancers of the liver and kidney, for which there is evidence of an association with TCE exposure. To be concordant with the literature, we classified non-Hodgkin lymphomas as one category; we classified liver cancers as cancers of the liver, gallbladder, intrahepatic, and extrahepatic bile ducts; we classified kidney cancers as cancers of the kidney and renal pelvis. It should be noted that the category of non-Hodgkin lymphoma includes a wide range of related blood cancers that vary with respect to pathologic, clinical, and epidemiologic features. We did not address other cancer types (e.g., colon, lung, breast) for which the medical literature evidences no association with TCE exposure.

Results

In 1990, there were 11,733 people counted in census tracts 5091.04 and 5092.01. In 2000, there were 12,510 people counted in census tracts 5091.08, 5091.09, and 5092.01. In 2010, there were 13,230 people counted in census tracts 5091.08, 5091.09, and 5092.01. Census data indicate that the residents in the neighborhood of interest had an older age distribution in 2010 compared to 1990.

Liver and Kidney Cancer

Table 1 shows for 1988 to 1995, 1996 to 2005, and 2006 to 2010 the estimate of cancer cases observed and expected to be diagnosed in the census tracts of concern, as well as the Standardized Incidence Ratios for non-Hodgkin lymphoma, liver, and kidney cancer, along with the 99% confidence intervals. The observed occurrence of cancers of the liver and kidney were not significantly higher in the neighborhood than expected given the rates in the rest of the region for any time period examined, and therefore, we conclude that there is no excess of liver or kidney cancer during the period 1988 to 1995, 1996 to 2005, and 2006-2010 in the neighborhood of concern. Further analysis revealed no significant elevations in liver and kidney cancer among children under age 15 years living in the neighborhood of interest.

Non-Hodgkin Lymphoma

For non-Hodgkin lymphoma from 1988 to 1995, 12 cases were observed and 9 were expected. This Standardized Incidence Ratio has a confidence interval that includes 1.0, leading us to conclude that there was no statistically significant difference between the observed and expected numbers of non-Hodgkin lymphoma diagnosed between

1988 and 1995. From 1996 to 2005, 31 cases of non-Hodgkin lymphoma were observed, and 17 were expected, resulting in a statistically significant Standardized Incidence Ratio increase of 1.8 (99 percent confidence interval=1.1-2.8). From 2006 to 2010, 14 cases of non-Hodgkin lymphoma were observed and 10 were expected. This Standardized Incidence Ratio has a confidence interval that includes 1.0, leading us to conclude that there was no statistically significant difference between the observed and expected numbers of non-Hodgkin lymphoma diagnosed between 2006 and 2009 (Table 1).

Further analysis on a larger period of time revealed that 57 cases of non-Hodgkin lymphoma were diagnosed in these three census tracts from 1988 to 2010, but the case counts fluctuated from year to year, and seemed to be centered around selected years – 1998 to 2001 and 2008 to 2009, while case counts were relatively lower in the other years (Table 2). Of the 57 cases, 22 of these occurred from 1998 to 2002; thus, the numbers of cases in the years prior to 1998 and following 2002 suggested that numbers were lower than the 1998 to 2002 period. No cases of non-Hodgkin lymphoma were diagnosed in the neighborhood of interest for the calendar years 1989, 1995, 1997, 2007, and 2010. The increased rate of non-Hodgkin lymphoma was not driven by one of the census tracts and thus, we refer to the three census tracts collectively as the neighborhood of interest. Caution should be taken when comparing these case counts over time, since: 1) generally, we expect the numbers of cases to increase over time simply due to growth in the population in these tracts (note: the population within this neighborhood has increased by about 13 percent from 1990 to 2010); and 2) 1990, 2000, and 2010 Census population estimates indicate that this neighborhood is an aging population, and increased age increases the expected rate of non-Hodgkin lymphoma. There were no significant elevations in non-Hodgkin lymphoma among children under age 15 years living in the neighborhood of interest.

It is important to note that non-Hodgkin lymphoma is a group of related yet heterogeneous diseases with differing characteristics and causes. Some of the risk factors include human immunodeficiency virus (HIV) and other viruses, conditions that weaken the immune system, and some occupational exposures to herbicides and other chemicals. We did not have sufficient numbers of any particular subtype to carry out detailed analyses of particular lymphoma subtypes.

Limitations

It is also important to note that although the Standardized Incidence Ratio for non-Hodgkin lymphoma is significantly increased for one of the three time periods examined, it is based on small numbers and any difference may be due to random fluctuations rather than a true excess of non-Hodgkin lymphoma, even with a 99 percent confidence interval. The number of cancer cases in an area, like any other event, may be high simply by chance, especially when working with small numbers within a small geographic area. For example, there are 7000 census tracts in California. Even using a

99 percent confidence level, at any given time 30 census tracts could have an apparent statistically significant increase in a particular type of cancer, even without any differences in the cancer risk.

There are several limitations related to the use of cancer registry data for carrying out these kinds of assessments. As previously noted, we do not have information on duration of residence, or risk factor information on residents. Therefore, cancer registry data cannot be used to establish a causal relationship between a particular exposure and cancer occurrence. Any observed patterns may be due to demographic and/or risk factor contributions other than environmental contaminants. Additionally, the timeframe between exposure to a carcinogen and onset of disease can be years, even decades, and attempting to link the elevated incidence rate in a given time period to a specific cause or exposure is not possible with these data. Since we are only able to define neighborhoods using census tract definitions, it is possible that boundaries of the three selected census tracts do not accurately capture the intended neighborhood, or exposure.

Conclusions

Our assessment did not find an increased occurrence of liver cancers and kidney cancers in this area of Mountain View during the time periods that could be assessed. The cancer incidence rates in the surrounding Santa Clara Region were used as comparison values.

However, we did detect a statistically significant increase in the diagnoses of non-Hodgkin lymphoma, a cancer thought to be related to high TCE exposure, among residents of this neighborhood during one particular time period assessed, 1996 to 2005. A statistically significant elevation was not detected before this time (1988 to 1995), or after this time (2006 to 2010). Thus, there is a lack of evidence of a consistent or current elevation in non-Hodgkin lymphoma occurrence in this neighborhood. It is important to note that cancer registry data cannot be used to establish a causal relationship between a particular exposure and cancer occurrence. Additionally, rates of these relatively rare cancers are generally unstable in such a relatively small population.

Still, in light of the elevated Standardized Incidence Ratio for one of the three time periods examined, we will continue to monitor the area and update this analysis when more current cancer registry data become available. The Santa Clara County Health Officer has been notified of these results.

Table 1. Incidence of cancer in Mountain View CA neighborhood†, 1988 to 1995, 1996 to 2005, and 2006 to 2010

	1988-1995				1996-2005				2006-2010‡			
	Observed	Expected *	SIR §	99% CI •	Observed	Expected *	SIR §	99% CI •	Observed	Expected *	SIR §	99% CI •
Non-Hodgkin Lymphoma	12	9	1.3	(0.5-2.6)	31	17	1.8	(1.1-2.8)	14	10	1.4	(0.6-2.8)
Kidney cancer°	5	4	1.2	(0.3-3.4)	10	8	1.3	(0.5-2.8)	6	6	0.9	(0.2-2.4)
Liver cancer°	<5	<5	0.8	(0.1-2.8)	8	9	0.9	(0.3-2.1)	5	7	0.7	(0.2-2.1)

† 1988 to 1995: Census Tracts 5092.01 and 5091.04 (1990 US Census); 1996 to 2005 Census Tracts: 5092.01, 5091.08 and 5091.09 (2000 US Census); 2006 to 2010 Census Tracts: 5092.01, 5091.08 and 5091.09 (2010 US Census).

‡ 2010 data is approximately 95% complete, with about 12% of cases not yet geocoded to a residential census tract

* Rounded value. Expected rates were obtained from the Santa Clara region (Monterey, San Benito, Santa Clara and Santa Cruz counties)

§ SIR = Standardized Incidence Ratio = Observed number of cases/Expected number of cases. The exact value of the number of expected cases is used in computing the SIR.

• If the 99% confidence interval (CI) for the SIR contains 1, then any difference between the observed and expected number is not statistically significant.

°Kidney cancer includes cancers of the kidney and renal pelvis; Liver cancer includes cancers of the liver, gallbladder, intrahepatic, and extrahepatic bile ducts

Table 2. Case counts of non-Hodgkin Lymphoma in Mountain View CA neighborhood†, 1988-2010•

Year of diagnosis*	Observed
1988-1989	<5
1990-1991	<5
1992-1993	5
1994-1995	<5
1996-1997	<5
1998-1999	10
2000-2001	8
2002-2003	6
2004-2005	6
2006-2007	5
2008-2009	9
2010‡	<5

† Census Tracts 5092.01 and 5091.04 (1990 US Census); Census Tracts: 5092.01, 5091.08 and 5091.09 (2000 and 2010 US Censuses).
‡ Data for 2010 diagnoses are approximately 95% complete, with about 12% of cases not yet geocoded to a residential census tract
•Caution should be taken when comparing case counts over time, since 1) the population in this neighborhood is growing; and 2) this neighborhood is an aging population; both of which (1&2) increase the expected rate of non-Hodgkin Lymphoma.
*Zero cases of non-Hodgkin Lymphoma were diagnosed in the neighborhood of interest for the years 1989, 1995, 1997, 2007, and 2010.