Colorado Department of Public Health and Environment

May 2010

Report Summary:

UPDATE OF CANCER INCIDENCE IN NORTHEAST DENVER RESIDENTS LIVING IN THE VICINITY OF THE ROCKY MOUNTAIN ARSENAL 1997-2005 DATA REVIEW

INTRODUCTION

This summary presents the findings of a cancer surveillance study performed by the Colorado Department of Public Health and Environment (CDPHE) for communities surrounding the Rocky Mountain Arsenal (RMA) in southern Adams County, Colorado.

Cancer surveillance is one of the community health activities conducted by the CDPHE as part of the Rocky Mountain Arsenal Medical Monitoring Program. The cancer surveillance program was one of the recommendations made to the department by the Rocky Mountain Arsenal Medical Monitoring Advisory Group.

This data review is the third report compiled as part of the RMA Medical Monitoring Program. An earlier report, *Analysis of Diagnosed vs. Expected Cancer Cases for the Northeast Denver Metropolitan Area in the Vicinity of the Rocky Mountain Arsenal, 1979-1996*, published in January 2003, analyzed cancer data from 1979-1996 to establish baseline rates of cancer incidence prior to the start of RMA soil remediation activities in 1997. A second report of cancer incidence for the period 1997-2000, the initial post-baseline analysis, was published in October 2003.

The current study evaluates the same cancer types and geographic area assessed in the October 2003 report, using a consistent study design and adding five more years of surveillance data to encompass the time period of 1997-2005. The objective of the current study was to analyze cancer incidence around the RMA for significant changes during and after RMA soil remediation, and to investigate increased or unexplained rates of cancer.

More than 18,000 new cases of cancer are registered annually in Colorado, and on average, approximately one in three Coloradans will develop cancer in their lifetime. Current and past studies conducted to assess cancer outcome in communities around the RMA look at disease frequency at the group level. Such cancer surveillance studies allow public health officials to investigate whether cancer is occurring in numbers that are significantly higher than background rates. There are recognized limitations to these types of studies, however, including lack of data on important individual risk factors, such as exposure to carcinogens in the workplace or indoor or outdoor ambient air, and length of residence at the address recorded in the cancer registry records. An additional limitation is that it is not possible to control for the influence of common carcinogenic exposure such as traffic-related exposure to benzene or other industrial influences within a given study boundary. In addition, assignment to a broad geographic area, such as a census tract, must be used to indicate individual exposure status. While a variety of exposures may contribute to the overall individual and population risk of some of the cancers reported, these factor cannot be accounted for or fully assessed with this type of study.

For the current study, very large population growth was identified as a potentially significant factor that adds to the uncertainty of the study findings, because up-to-date U.S. Census data, with important demographic detail such as age structure of the study population, will not be available until the 2010 Census for areas that have grown very rapidly since the last study was released.

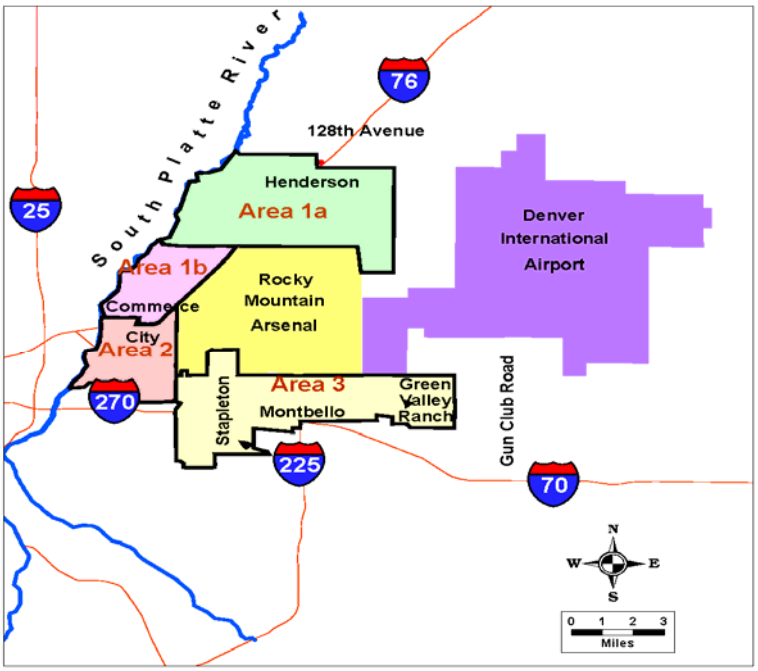
STUDY DESIGN

The current study used cancer surveillance data available from the Colorado Central Cancer Registry (CCCR) for 1997-2005. All cancers diagnosed in Colorado are reported to the Cancer Registry with the exception of non-melanoma skin cancers.

The study boundary was composed of three distinct areas (Areas 1 through 3), based on the geography first described in the 1993 report *Cancer Incidence in the Northeastern Denver Metro Area: Report of the Ad Hoc Panel* (CDPHE 1993). In the present investigation, as in the earlier reports, Area 1 was further subdivided into Areas 1a, 1b, and Area 1 Combined, to better track cancer incidence in this region of rapid population growth (*see map, Figure* 1).

Cancer occurrence was evaluated for both overall cancer outcome (all cancer types combined) and for 30 distinct types of cancer. Using cancer rates for the greater Denver metropolitan area (outside of the study area) as a standard for comparison, the estimated number of expected cases was compared to the number of diagnosed cases reported to the registry. When statistically elevated ratios of diagnosed-to-expected cases were observed, other data recorded in the Cancer Registry abstract were reviewed to help characterize potential risk factors such as smoking history, potential chemical exposure in the workplace or family history of cancer. Additional demographic detail (cancer outcome by age group, gender, race/ethnicity) also was provided, along with specific information about the cell type of the tumor.

FIGURE 1. Study Area Map



DISCUSSION OF STUDY RESULTS

The study shows that cancer incidence was not statistically elevated in both genders for any of the three geographic areas studied. For nine of the 30 individual types of cancer studied (lung, colorectal, stomach, small intestine, nasopharynx, bladder, larynx, leukemia and extrahepatic bile duct/gallbladder), the number of diagnosed cases exceeded the statistical range for the expected number of cases in one gender only. These elevations were not consistent across location, gender, race or time. In addition, fewer cases occurred for several types of cancer (female breast, prostate, lymphoma, melanoma and multiple myeloma) than would be expected due to statistical variation alone.

No obvious patterns or trends in cancer occurrence were identified. Statistically high numbers of cancers reported in previous studies for some individual cancer types (lung, pancreas, lymphoma and brain) did not persist in the current study, with the exception of lung cancer. Past surveys have identified higher smoking rates in the study area than is typical for the rest of the Denver metropolitan area. Review of case abstract data for the current study confirmed that most individuals diagnosed with lung cancer in Areas 1 and 2 were smokers.

For the current study, a statistically high number of colorectal cancers were reported in males, and in males and females combined, in Area 1b and Combined Area 1. Case counts were not statistically high in females alone or in Area 1b. An elevation in colorectal cancer was not seen in earlier studies. Eight of the 58 colorectal cancers reported in the current study (14 percent) were diagnosed among just four individuals, each with double primary tumors during this time period. This is about twice the percentage of multiple tumors diagnosed among colorectal cancer cases in the rest of the Denver metropolitan area. These four additional cancers were sufficient to increase the risk ratio for colorectal cancer above statistical significance. Colorectal cancer for cases in Area 1 was diagnosed at an earlier stage of disease than was typical for the comparison population, possibly indicating earlier screening in this population. For Areas 2 and 3, colorectal cancer ratios were within expected limits.

A statistical elevation in other biliary tract cancer was reported for Area 1, with five of six cases diagnosed in Area 1a residents. Four of the six cases were cancer of the gallbladder, which has been reported in peer-reviewed studies to be strongly related to the presence of gallstones, a condition linked with obesity. Past surveys of northeast Denver residents indicate there may be some unquantifiable impact from higher rates of obesity reported in the study area boundary than in the comparison population. Elevations of gallbladder and other biliary tract cancer have not been seen in any of the previous time periods studied. Increased risk of developing these types of cancer also has been linked to certain chemical exposures in workers, and to smoking for individuals with other underlying inflammatory disease.

In addition to the statistically high number of lung cancers reported above, other findings in Area 2 included a statistically elevated number of cancer of the larynx in females and leukemia and stomach cancer in males. Both leukemia and stomach cancer were observed to be statistically high in previous studies, but the findings were not consistent across gender or geographic area. Among the male leukemia cases identified during the 1997-2005 time period, only Hispanics had a statistically higher number of cases than expected. Five of the seven male leukemia cases with occupational information available in the case abstract were truck drivers, all with acute myeloid leukemia (AML), a type of leukemia associated with occupational exposure to benzene from diesel exhaust. All of the individual types of cancers in Area 2 that occurred in statistically high numbers have a known association with smoking, with a particularly strong risk for cancer of the larynx. Three of four females with cancer of the larynx were listed in the cancer abstract as smokers.

Bladder cancer occurred at statistically higher than expected numbers in Area 1b and Area 3; however this finding was not consistent across genders, with elevations occurring in males in Area 1b and in females in Area 3. In Area 1b, all of the bladder cancer cases occurred in males, with most cases occurring in white non-Hispanic males age 65 years and older. For Area 3, case counts were statistically elevated for females and males and females combined, with males contributing 20 cases, compared to about 14 expected. Case counts

also were statistically high for the 35-44 age group, but this finding is based on only six cases. Smoking was identified as a contributing factor in 80 percent of the bladder cancer cases identified, including four of the six cases in the 35-44 age group.

Area 3 was the only study area reported to have a statistically high number of cases for the area overall, for all cancers combined (risk ratio of 1.09, with 863 cases compared to about 794 expected). The ratio for males alone was not statistically high for all cancers combined. Two individual types of cancer, cancer of the small intestine and nasopharynx, were statistically high in males, and in males and females combined, with males accounting for all but one case for each of these cancer types. Both of these types of cancer are relatively rare and have not been linked to smoking. The elevation among female cancers was comprised of a number of ratios of different cancer types that were somewhat higher than the expected number, with only bladder cancer having a statistically high ratio. Of the other cancer types that occurred in higher than expected numbers in females, counts for all but one type (lung cancer) were well within expected statistical variation. Lung cancer had a ratio of 1.36 (44 cases compared to about 32 cases expected), which was one case short of being statistically higher than expected, and was sufficient alone to force the statistically high ratio for all cancers combined for females. In other words, excluding lung cancers, all other cancers combined for females in Area 3 were within expected statistical limits.

Smoking is an important contributing risk factor for many of the cancer sites where a statistically elevated risk ratio was identified (lung, bladder, larynx, colorectal, leukemia, stomach). For several other cancer types reported in statistically high numbers, but which are not recognized as being smoking-related (i.e., gallbladder/ other biliary, nasopharynx and small intestine), the results are based on a very small number of cases for each site. This greatly limits the ability to make firm conclusions about the significance of these findings.

This study identified very large population growth from 2000-2005, particularly in Area 1 and Area 3, which showed increases of 32 percent and 113 percent, respectively. This rapid population shift adds considerable uncertainty to the interpretation of this study. The best methods available were applied at the time this study was done to calculate expected cancer rates, however, detailed age-, gender- and race/ethnicity-specific estimates were not available for all study areas. Age adjustment is particularly critical for any investigation of cancer outcomes, because cancer is largely a disease of older adults, particularly for certain types of cancers, with about 77 percent of all cancers being diagnosed in individuals aged 55 and older. Area 2 population change was not substantial, but change in demographic composition from in- and out-migration since the 2000 Census was conducted is an unknown effect, leading to uncertainty in the precision of the age, gender and race composition in this area. Results based on a very small number of cases may be particularly susceptible to observed fluctuation in population. It will not be possible to fully evaluate this methodological issue until the 2010 U.S. Census population data are available.

CONCLUSIONS

Statistical elevations in cancer incidence identified in the current study varied across location, gender, race and time. Cancer incidence was not statistically elevated in both genders for any of the three geographic areas studied. A finding of statistically high ratios of cancer in only one gender is generally considered an inconsistency when investigating environmental exposures, making it less likely that cancer outcomes were caused by a common environmental agent in the ambient environment.

For the current study, statistical elevations were reported for multiple types of cancers, without one type predominating. A common environmental cause would be more likely when several cases of the same type of cancer occur and that type of cancer is not common in the general population.

Cancer outcomes from the current study were also compared to previous data reviews, including the October 2003 post-remediation study, and no obvious patterns or historical trends were identified.
Smoking is recognized by the American Cancer Society and other health agencies as an important contributing risk factor for many of the cancer types that occurred in statistically high numbers in this study (lung, bladder,

larynx, colorectal, leukemia, and stomach). Smoking rates in the study population that exceed state rates have been identified through surveys of north Denver residents in the past. Additional review of individual case-level medical records confirmed a higher rate of smoking in individuals diagnosed with several types of smoking-related cancers than was typical in the comparison population. The possibility of some interaction effect from exposure to other risk co-factors, such as exposure to carcinogens in an occupational setting or other chemical exposures indoors or in the outdoor ambient environment, cannot be ruled out by this analysis, but any such effect would likely be small compared to the smoking effect for these cancer types.

Review of other available case information (smoking history, alcohol use, occupation, predisposing genetic factors and family history of cancer) identified other obvious risk factors that partially explain the slight to moderate increased risk reported in this study for a variety of cancer types. Identification of contributing risk factors at the individual case level cannot be fully assessed with this study, but the presence of known risk factors further weakens the likelihood of a common environmental exposure.

An important source of uncertainty for this study was the very large and rapid population growth that has occurred in the vicinity of the RMA, particularly from 2000-2005. Such dynamic, but currently uncharacterized, demographic fluctuations introduce uncertainty into some of the statistical analyses performed in this study because adjustments for gender, race, and especially age are critical for any investigation of cancer outcomes. This is particularly true for cancers that occur in small numbers, such as nasopharynx, other biliary tract and small intestine. It will not be possible to fully evaluate this methodological issue until the 2010 U.S. Census population data are available.

In this study, many statistical tests were carried out and it is expected that some of them would be statistically high or low by chance alone. Tumor rates are quite variable in small populations and rarely match the overall average rate for a larger area, such as the state or the greater Denver metropolitan area. For any given time period, some subpopulations have rates above the overall rate and others have rates below the overall rate, so that even when there is an excess of cancer cases reported, this may be completely consistent with the expected random variation. For this reason, it is important to evaluate statistically elevated findings within the broader context of overall patterns and consistency over location, time, demographic characteristics and cancer type.

The time period of this study was selected to coincide with soil cleanup activities at the RMA. Cancer cases diagnosed from 1997-2005 are not likely to be related to RMA cleanup activities because focused air monitoring conducted during cleanup has not shown ongoing or substantial off-site release that would cause significant exposure to surrounding communities for RMA chemicals.

RECOMMENDED FOLLOW UP ACTIVITIES

1. Produce an addendum to the current study when the 2010 U.S. Census population data become available, to improve estimates of study area population counts, and age, race/ethnicity and gender distributions. Compile the updated surveillance report using the last complete year of cancer data available from the state Cancer Registry at the time the 2010 census population data are released.

2. Post the addendum to the current study on the state RMA web page, for consideration during the five-year site review process.

3. Communicate the findings of this report to the Comprehensive Cancer Control Section at the state health department, local health departments serving the study area and affected neighborhood groups, to provide risk prevention information and to improve cancer control strategies in the northeast Denver metropolitan area, e.g. obesity prevention and, particularly smoking cessation.

Contact Information

You may obtain copies of the full technical report online at:

http//www.cdphe.state.co.us/rma/index.htm

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Glossary

Cancer – A large group of diseases where there is uncontrolled growth and spread of abnormal cells in the body. A tumor starts in one organ, but may then travel to other parts of the body. The location where the tumor starts and types of cells involved gives the cancer its name, such as lung, colon or squamous cell skin cancer. There is no single cause of cancer and cancers that start in different organs often have different causes. The growth of cancer depends on many different types of risk factors, such as family history, underlying health, diet and the environment. There are many different types of cancer and each is viewed as a separate disease with individual risk factors.

Risk factors – Aspects of personal behavior or life-style, an environmental exposure, or an inborn or inherited characteristic whose presence, based on scientific and medical evidence, is associated with an increased likelihood that a disease or a cancer will develop at a later time.

Statistically elevated, also "**statistically significant elevation**" – Refers to a ratio of diagnosed-to-expected cancers in this study that has been tested with a mathematical formula to determine if the result falls within a range of values that would likely occur due to chance or random statistical variation over time. It is common for many health studies to calculate this range of ratio values, which is called a 95 percent confidence interval (95% CI). When the lower bound of the confidence interval for a particular ratio exceeds the value of 1, the finding is called statistically elevated, or statistically significant, because the statistical test indicates there is less than a 5 percent chance that the finding is due to expected statistical variation.