Cancer Incidence and Cancer Mortality:
Bethlehem NH and Surrounding Towns
Follow-Up Analysis and Medical Records Review

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Section 1. Cancer Incidence and Mortality

I. INTRODUCTION

In August 2008, during a landfill permit hearing, the New Hampshire Department of Health and Human Services (DHHS), Division of Public Health Services (DPHS), Office of Health Statistics and Data Management (HSDM) began an investigation of a suspected cancer cluster in Bethlehem NH in response to community concerns. The investigation identified 170 cases of primary malignant cancer occurring from 1991 to 2005. A preliminary comparative analysis identified female breast cancer and pancreatic cancer as having elevated incidence in Bethlehem. In light of these findings, DPHS recommended that a more comprehensive investigation be undertaken, to include three main components:

1. **Cancer Incidence Study:** Extension of the original Bethlehem cancer incidence investigation to include the eight towns that share town boundaries with Bethlehem.
2. **Mortality Study:** Extension of the analysis to include mortality data by 24 major cancer types including pancreas and breast, for Bethlehem and the eight surrounding towns.
3. **Medical Records Review:** Review of medical records of all pancreatic and breast cancer patients who were residents of the Town of Bethlehem at the time of diagnosis during the study period. This is an exploratory investigation to address the question of whether elevated Bethlehem cancer rates may be related to identifiable hereditary, behavioral, life-style, environmental, or occupational factors.

This section of the current report addresses the first two components; specifically, whether a cluster of cancer cases, as defined below, is present in Bethlehem. The second section addresses the medical records review.

According to American Cancer Society statistics, cancer is the second leading cause of death in New Hampshire and the United States. Not only will one out of three people develop cancer in their lifetime, but this tragedy will also affect three out of every four families. Consequently, the chance that someone will be acquainted with multiple persons who develop cancer is high and cancers may appear to occur in "clusters." A group of cancer cases is more likely to be a true cluster if it has the following characteristics:

- A large number of cases of one type of cancer diagnosed in a relatively short time period, rather than several different types diagnosed over a long period of time
- A rare type of cancer rather than common types
- A large number of cases diagnosed among individuals in age groups not usually affected by that cancer.

The primary purpose of this investigation is to determine whether such a cluster is present in Bethlehem.

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II. METHODS

Epidemiologic investigations typically focus on any of three phenomena: incidence, prevalence, and mortality. Incidence is the number of new events, such as disease cases, occurring in a defined population during a specified time period. Incidence rates are calculated by dividing the number of new cases during the time period in question by the size of the population (after deducting the number of already existing cases). Prevalence is the number of cases of a given disease or attribute (such as obesity) existing in the population at a specific time. Prevalence rates are computed as the proportion of the population having the disease or attribute at the given time. Mortality refers to any event resulting in death. The present study is concerned with incidence and mortality.

A. Data Sources

The New Hampshire State Cancer Registry (NHSCR) is a population-based surveillance system charged with monitoring cancer incidence in the state since 1986. The Norris Cotton Cancer Center of Dartmouth Medical School, under contract with DHHS, has overall responsibility for the NHSCR. HSDM, through a grant from the US Centers for Disease Control and Prevention (CDC), works to increase the scope of registry information and to assure the quality of the data collected. NHSCR currently collects reports from hospital physician practices, freestanding radiation oncology centers, out-of-state pathology laboratories and other sources as required by NH Administrative Rules. NHSCR also receives reports for NH residents who are diagnosed outside of NH based on exchange agreements with other states. The registry database consists of incident cancer cases only. Information on other risk factors such as health-related behaviors, environmental and occupational exposures, or access to medical care, is not captured in the cancer registry.

Cancer mortality data for the same period was obtained from the New Hampshire Division of Vital Records Administration (DVRA), an agency under the New Hampshire Secretary of State. DVRA collects and maintains records of vital events (birth, death, marriage, and divorce) in accordance with NH Statutes and Administrative Rules from hospitals, funeral directors, and town offices throughout the state. DVRA also obtains data on out-of-state deaths and births of NH residents through information exchange agreements with other states. A cancer death case was defined as an individual member of the study population who died during the evaluation period with cancer as the Underlying Cause of Death. Variables analyzed included town of residence at time of death, underlying cause of death, date of death, age at death, and gender.

Statewide and town population estimates were obtained from the US Census Bureau, the New Hampshire Office of Energy Planning and Management, and the Claritas Corporation.

B. Data Analysis

The study populations included residents of the Town of Bethlehem and of the eight populated towns that share a boundary with it. Statistics for Bethlehem were considered separately from those of the other towns, which were aggregated for analysis into three groups based on their geographic location relative to Bethlehem: North (Carroll, Dalton, and Whitefield), West (Lisbon and Littleton) and South (Franconia, Lincoln, and Sugar Hill). North towns are located in Coos

County; all other study towns are in Grafton County. Most of the area bordering Bethlehem to the east is comprised of unincorporated, unpopulated county subdivisions. According to 2006 US Census estimates, the population of Bethlehem was 2,422 and that of the eight surrounding towns totals 14,433.
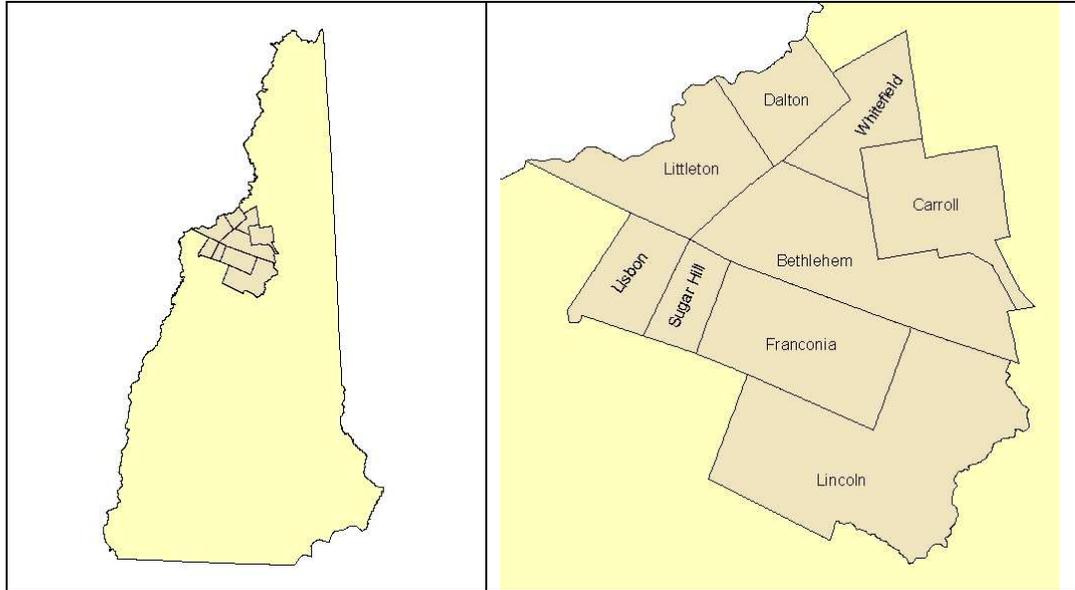

Figure 1. State of New Hampshire (left), towns in study area (right)

Statistics for individual towns were also used for drill-down analysis where necessary and statistically appropriate. Due to confidentiality and legal issues, we are unable to provide maps showing the locations of individual cases, or any other information that could be used to identify them. About one-third of listed addresses in the study area are post office boxes, so residence locations are not known for any of these individual cases.

All cancer statistics for towns and town groupings were compared with those of the state of New Hampshire as a whole. New Hampshire was used for comparisons because the demographics of the study area resemble those of New Hampshire much more closely than the United States (Table 1).

Table 1: Demographic Data

Variable	Bethlehem	NH	U.S.
High school graduate or higher*	88.9%	90.5%	84.5%
Families below poverty level*	7.9%	4.9%	9.6%
Individuals below poverty level*	11.4%	7.6%	13.2%
Male*	50.9%	49.3%	49.3%
Median Age*	39.0	36.7	35.3
White*	97.0%	94.9%	74.3%
Uninsured under 65 all incomes, ages, genders and races**	13.0%	12.3%	13.2%
* U.S. Census Bureau, 2006-2008 American Community Survey ** Data Source: SAHIE//State and County by Demographic and Income Characteristics/2006 ** Grafton County insurance measure used for Bethlehem			

Rates of cancer incidence and mortality were calculated for 24 major cancer types taking into account the age and gender composition of the population. The time period from 1991 to 2005 was selected because it is the most recent for which data were available, and because multiple years of data are needed to provide large enough numbers to yield meaningful statistics for smaller areas such as individual towns. An incident case was defined as an individual member of the study population who was diagnosed with a new primary malignant cancer during the study period. Variables analyzed included town of residence at time of diagnosis, primary cancer type, date of diagnosis, age at diagnosis, and gender.

To identify unusually high or low rates in an area, Standardized Incidence Ratios (SIR) and Standardized Mortality Ratios (SMR) were computed. The former refers to disease rates and the latter refers to death rates. The SIR and SMR are based on the ratio of actual (observed) number of cases in a study population to the number that would be expected to occur if that population had the same age-gender composition as a reference population (in this case, the state of New Hampshire). The term "expected" as used in this study is based only on the characteristics of age and gender and does not take into account other determinants of elevated disease and death rates. For example, if a disease has high incidence among persons over 50 years of age, then a community having a higher than average proportion of its population in this age group will have a higher number of expected cases.

If the observed number of incident cancer cases equals the age-gender expected number, the SIR will equal 1.00; thus this number provides the baseline for comparisons. If more (fewer) observed cases occur than would be expected, then the SIR will be greater than (less than) 1.00. For example, if 11 cancer cases are observed in the study population but 10 cases are expected, then the SIR is computed as 11/10 = 1.10 and the population has 10% more cases than expected. But if nine cases are observed, then the SIR is 9/10 = 0.90, meaning that the population has 10% fewer cases than expected.

Interpreting an SIR or SMR requires caution because the numerator and denominator of a ratio are also important. Two SIRs or SMRs can have equal ratios but represent very different

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scenarios. For example, an SIR of 1.50 could mean 3 cases were observed and 2 were expected (3/2 = 1.50), or it could mean 300 cases were observed and 200 were expected (300/200 = 1.50). In the first instance, only one "excess" cancer case occurred, which could have been due to chance. In the second instance 100 excess cancers occurred, which would not likely have been due to chance alone. This elevated ratio would then be investigated further to determine if it could be linked to any known cause or set of causes.

Since almost all calculated SIRs and SMRs are likely to be either greater than or less than 1.00, it is necessary to distinguish whether the deviation is likely due to either random chance or an elevated (or reduced) incidence rate. This is done by computing a probability-based range of values that is highly likely to contain the "true" underlying rate; this range is called a "confidence interval" (CI). The standard level of confidence is 95 percent; that is, under hypothetical repeated sampling the CI will capture the underlying true value 95 times in 100 samples. For example, suppose that a 95% confidence interval for an SIR ranges from 1.05 to 1.20. This means that given the data and the statistical procedure, we are 95% confident that the "true" rate is somewhere between 5% and 20% higher than expected. Since this interval does not contain the baseline value of 1.00, we say that the rate is "statistically significant at the 5% level" or simply "significant." A confidence interval of 0.95 to 1.10 would be described as "not statistically significant" since it includes the baseline value.

The width of the confidence interval also reflects the stability of the estimate. For example, a narrow confidence interval, such as 1.03 to 1.15, allows a fair level of certainty that the calculated SIR is close to the true SIR for the population. A wide interval like 1.85 to 8.50 instead leaves considerable doubt about the true SIR, which could be much lower or much higher than the calculated SIR. This usually occurs when the sample size or the number of incidents is small. For this reason, statistical significance is generally not assessed when fewer than five cases are observed.

Two cautions must be considered when interpreting a confidence interval. First, while 95 percent represents a high degree of confidence, even if no underlying difference exists a statistically significant difference will be observed by chance in five percent of instances. Second, a difference which is technically nonsignificant could still be important, especially if the null value falls near an endpoint of the interval. For instance, an interval for an SIR of 0.98 to 3.00 would technically be nonsignificant at the 5% level, but the endpoint of 0.98 is close enough to the null value to suggest that an underlying difference may indeed be present.

It is also very important to bear in mind that in this report the term "significant" is used in a technical statistical sense only. It does not in any manner describe, for instance, the impact of disease on an individual, a family, or a community.

III. RESULTS

This section presents results of SIR and SMR analyses of cancer incidence and cancer mortality for residents of Bethlehem and the eight other study towns. Where possible, findings were based on data for each of the 24 major cancer types, although in many instances rates and numbers were suppressed to assure confidentiality and statistical validity.

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Tables 2 and 3 (attached) present statistics by cancer type for the populations of Bethlehem, the other eight study towns, and all nine towns for the years 1991-2005. Statistics for incidence (Table 2) and mortality (Table 3) include the following:

- Observed number of cases (N)
- Expected number of cases based on the NH statewide age-gender rates
- Ratio of observed to expected cases (SIR or SMR)
- 95% confidence intervals (CI) for each SIR or SMR

The SIR of all cancer types combined for residents of Bethlehem towns was 1.09; that is, incidence was 9% higher than expected for the study period. The 95% confidence interval was 0.93 to 1.13. For the surrounding towns, the SIR was 1.06 (CI = 1.00-1.12). Mortality from all cancers was 26% higher than expected (SMR = 1.26, CI = 0.99-1.58) in Bethlehem, with an SMR of 1.04 is the surrounding towns (CI = 0.96-1.14).

The original study of cancer incidence in Bethlehem identified breast cancer and pancreatic cancer as having significantly elevated SIRs. Additional types are identified as "cancers of concern" in the current report if their SIRs or SMRs were significantly elevated for any of the following groups during the study period:

- Total population of the nine study towns
- Male or female population of the nine study towns
- Total population of any of the four town groupings

Leukemia and melanoma were thus identified. Next, 15-year summary rates for the total study population were systematically dissected by 5-year intervals, by gender, by geographic (town) groupings, and by combinations of these factors.

Analysis of SIRs and SMRs by gender revealed three additional cancers of concern. Bladder cancer incidence in the study area was significantly elevated for females (SIR = 1.49; CI = 1.01-2.13) but not for males. The male incidence of non-Hodgkins lymphoma (NHL) in the study area was significantly elevated (SIR = 1.44; CI = 1.02-1.97).

Presented below are the results of descriptive analyses of each cancer of concern identified above: breast, pancreas, leukemia, melanoma, bladder, and NHL. Each section begins with a description of the summary 15-year, nine-town SIR and SMR for the particular cancer type followed by an analysis of rates dissected by 5-year intervals, by gender, by town groupings, and by combinations of the three factors simultaneously.

Breast Cancer

Incidence. The 15-year SIR for the nine towns combined indicated an estimated 13% elevation (N = 222, SIR = 1.13, CI = 0.98-1.28) in the number of breast cancer cases during 1991-2005 (Table 1). This translated into an estimated 25 more breast cancer cases than expected during the 15-year period. The elevation was attributable entirely to the first two five-year periods (1991-

1995 and 1996-2000) primarily in Bethlehem, and secondarily in the South and West town groupings. South was the only group with a significantly elevated breast cancer SIR in the most recent five-year period. The SIR for breast cancer in Bethlehem declined from 1.94 in 1991-1995 and 2.06 in 1996-2000 to 0.71 in 2001-2005.

Mortality. SMRs indicated that death rates from breast cancer for the nine towns combined were at or below state levels throughout the fifteen-year study period (N = 44, SMR = 0.96, CI = 0.70-1.29). None of the 1991-2005 town-group SMRs were significantly elevated. Most of the five-year SMRs were based on too few events to yield meaningful statistics.

Pancreatic Cancer

Incidence. The 15-year pancreas cancer SIR for the nine study towns combined (N= 42, SIR = 1.38, CI = 0.99-1.86) indicated 38% more cases than expected in 1991-2005 and was close enough to statistical significance to warrant further analysis. Bethlehem accounted for six of the twelve excess cases and exhibited the only significantly elevated SIR of the four town groupings. By far most of the elevation in the nine-town SIR was attributable to elevated male cancer incidence in all four town groupings. The only female subpopulation that contributed to the increase was from Bethlehem in 2001-2005.

The trend in five-year pancreas cancer incidence by gender showed that only the male SIR of the middle time period (1996-2000) exhibited a significant elevation (SIR = 2.59). In the most recent five-year period (2001-2005), Bethlehem was the only sub-population to exhibit a significantly elevated SIR of 4.10.

Mortality. Deaths from pancreatic cancer exhibited similar temporal and spatial patterns as incidence during the study period (N = 42, SMR = 1.34, CI = 0.96-1.81). This is to be expected because of the relatively low survival rate and the often-short duration between diagnosis and death from pancreatic cancer. Like incidence, pancreatic cancer mortality exhibited an increase during the 1996-2000 and 2001-2005 periods, primarily among males in all four town groupings but also among Bethlehem females.

Leukemia

Incidence. The significantly elevated 15-year leukemia SIR for the nine study towns combined was 63% higher than expected resulting in an estimated 21 excess cases in 1991-2005 (N = 54, SIR = 1.63, CI = 1.22-2.13). Each of the four town subgroups contributed equally to the excess number of cases during the 15-year period, though none of the subgroups exhibited a significantly elevated SIR. Bethlehem's contribution to the nine-town excess was due much more to males (3.7 excess cases) than to females (0.5 excess cases). The contribution of South towns to the excess was exclusively female (excess N = 6.1), while North and West had relatively equal male and female excess numbers.

The trend in five-year leukemia SIRs for the total population revealed a somewhat greater excess in the two most recent periods (1996-2000 and 2001-2005), but very different patterns by gender. The female SIR was elevated in all three periods and significantly elevated in 1991-1995. (N =

10, SIR = 2.20, CI = 1.05-4.05). The male SIR, on the other hand, was lower than expected in 1991-1995 (SIR = 0.70, CI = 0.19-1.78) followed by a statistically significant three-fold increase in 1996-2000 (SIR = 2.09, CI = 1.11-3.58), then a 59% excess in 2001-2005 (SIR = 1.59, CI = 0.79-2.85). In the most recent five-year period (2001-2005), for both the genders, the nine-town SIR (1.59, CI = 0.96-2.49) approached statistical significance; this was attributable mostly to the significantly elevated SIR of the North towns (SIR = 2.81, CI = 1.21-5.55).

Mortality. The 15-yr leukemia SMR (N = 42, SMR = 1.51, CI = 1.03-2.13) is stable when divided into three separate 5-year SMRs for each town grouping with the exception of the 15-yr South's lower-then-expected SMR of 0.87 (CI = 0.23-2.23). The number of leukemia deaths is too small to yield meaningful statistics of five-year SIRs by gender for town groupings. The 15-yr leukemia SMR (N = 42, SMR = 1.51, CI = 1.03-2.13) is stable when divided into three separate 5-year SMRs for each town grouping with the exception of the 15-yr South's lower-then-expected SIR (0.87, CI = 0.23-2.23). The number of leukemia deaths is too small to yield meaningful statistics of five-year SIRs by gender for town groupings.

Melanoma

Incidence. The 15-year melanoma SIR for the nine study towns combined was significantly higher than expected (N = 73, SIR = 1.29, CI = 1.01-1.63). The elevation was almost entirely attributable to a significant excess for the South towns (SIR = 2.19), which in turn was due to a statistically significant four-fold elevation in the male Melanoma SIR in 1996-2000. In 2001-2005, all four town groups exhibited elevated SIRs of similar magnitude. Bethlehem and West SIRs were significantly elevated in this period, but all four groups made similar contributions to the nine-town excess.

Mortality. There were 12 deaths from melanoma in the 15-year study period (SMR = 1.34, CI = 0.75-2.54). This is too small a number of cases to yield meaningful statistics for sub-populations or 5-year periods. There were no melanoma deaths to Bethlehem residents during this period.

Bladder Cancer

Incidence. For bladder cancer, the nine-town SIR for 1991-2005 was significantly elevated for females (N = 30, SIR = 1.49, CI = 1.01-2.13), while the male rate was lower than expected (N = 51, SIR = 0.92, CI = 0.68-1.20). Bethlehem had the only significantly elevated female SIR for the 15-year period, although the North and West towns contributed a similar number of cases to the elevated nine-town SIR. The excess in female bladder cancer was also attributable almost entirely to a significantly elevated SIR (N = 18, 2.52, CI = 1.49-3.08) in 2001-2005, the most recent 5-year period for which data was available.

Mortality. There were sixteen deaths from bladder cancer in the fifteen year study period. This is too small a number of cases with which to produce meaningful statistics. The overall bladder cancer SMR is virtually the same as expected.

Non-Hodgkins Lymphoma

Incidence. The (non-significant) elevated NHL SIR for both genders combined for the nine study towns in 1991-2005 (N = 63, SIR = 1.22, CI = 0.94-1.56) was entirely attributable to a significant 44% elevation in the male SIR (N = 39, SIR = 1.44, CI = 1.02-1.97). Bethlehem and the NORTH towns exhibited significantly elevated SIRs and accounted for most of the excess number of cases. Only one of the five-year male SIRs for the nine towns combined (1996-2000) was significantly elevated, and accounted for the majority of the excess number. North and South towns exhibited significantly elevated SIRs in 1996-2000, while Bethlehem's 2001-2005 SIR was also significantly greater than expected.

Mortality. The 28 deaths from NHL for the nine-town grouping in 1991-2005 represented an estimated four (4) more deaths than expected according (SMR = 1.15, CI = 0.76-1.16). Neither this SMR nor any for the individual town groupings was elevated by a statistically significant margin.

All Cancers

Incidence. The 15-year all cancer SIR for the nine study towns combined was significantly higher than expected (N = 1459, SIR = 1.07, CI = 1.02-1.13). The elevation was equally spread among all towns and gender groupings. None of the town groups showed any elevated SIRs of similar magnitude in any specific time period.

Mortality. The 15-year SMR from all cancers in the nine towns was nearly statistically significant (N = 621, SMR = 1.05, CI = 0.97-1.14). Mortality followed a pattern similar to incidence; that is, SMR's in all gender groupings, town groupings and time periods were nearly statistically significant and made similar contributions to excess cancer deaths.

Results are summarized in Table 2 (incidence) and Table 3 (mortality). Results highlighted in yellow designate statistical significance; those highlighted in pink are nearly significant.

IV. DISCUSSION

When interpreting the information presented in this report, it is important to keep in mind that cancer is a common disease. Recall that the American Cancer Society has estimated that one out of every three Americans will develop cancer during his or her lifetime. Over the past forty years, the rise in the number of cancer cases has generally reflected the increase in the population, particularly in the older age groups.

Understanding that cancer is not one disease, but a group of diseases, is also very important. Research has identified more than 100 different types of cancer, each with different causative or risk factors. Cancers of a certain tissue type in one organ may also have a number of causes. Cancer may also be caused by one or several factors acting over time. For example, tobacco use has been linked to lung, bladder, and kidney cancers. Other factors related to cancer may include lack of crude fiber in the diet, high fat consumption, alcohol abuse, and reproductive history. Heredity, or family history, is an important risk factor for several cancers. To a lesser extent, some occupational exposures, such as jobs involving contact with asbestos, have been shown to

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be carcinogenic. Environmental contaminants have also been associated with certain types of cancer.

The most commonly diagnosed cancers for adult males are prostate cancer, lung and bronchus cancer, and colorectal cancer. For women, the most common cancer types diagnosed are breast, lung and bronchus, and colorectal. These accounted for 53% of the 170 cases diagnosed in residents of Bethlehem, both male and female, from 1991 through 2005. The cancers determined to be elevated in either Bethlehem or the surrounding towns are pancreatic, female breast, leukemia, bladder, NHL, and melanoma.

Little is known about the causes of pancreatic cancer. Cigarette smoking is the most consistently observed factor. The risk for heavy smokers is two to three times that of non-smokers, but it is unclear whether smoking alone is responsible, or if other unrecognized factors exist to which smokers may more likely be exposed.

Over the course of a lifetime, one in eight women will be diagnosed with breast cancer. A major risk factor is age; most advanced breast cancer cases are found in women over age 50. Women are 100 times more likely to get breast cancer then men. A family history of breast, uterine, ovarian, or colon cancer increases risk for breast cancer. About 20% to 30% of women with breast cancer have a family history of the disease. Women with the BRCA1 or BRCA2 gene have up to an 80% chance of getting breast cancer sometime during their life. Other risk factors include excessive alcohol consumption and use of the synthetic estrogen diethylstilbestrol (DES).

Being male and of older age increases the likelihood of developing NHL. Persons with an impaired immune system are also at risk; this can occur with an autoimmune disease like HIV/AIDS or from taking immunosuppressant medications following an organ transplant. Risk also increases with viral infections like Epstein-Barr virus (EBV). Other risk factors include exposure to *H. pylori* bacteria, agricultural pesticides or fertilizers, solvents and other chemicals, rubber processing, asbestos, and arsenic.

Older, white, and male adults are more likely to be diagnosed with bladder cancer. Risk factors include smoking, and exposure to arsenic and chemicals used in the manufacture of dyes, rubber, leather, textiles and paint products. Smokers who are exposed to toxic chemicals may have an even higher risk. Treatment with the anti-cancer drugs cyclophosphamide (Cytoxan) and ifosfamide (Ifex) also increases the risk.. A family history of hereditary nonpolyposis colorectal cancer (HNPCC), sometimes called Lynch syndrome, can increase risk of cancer in the urinary system, as well as in the colon, uterus, ovaries, and other organs.

Leukemias represent about two percent of all new cancers. Little is known about the responsible factors, both environmental and non-environmental. Only in rare circumstances is an occurrence directly attributable to a specific agent. Large-scale studies of Japanese atomic bomb survivors and of excess exposures to radiation in the United States have shown extraordinarily high rates. Job-related exposure of workers to benzene is also a well-established risk factor, but EPA surveys suggest that the workplace only accounts for a

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small proportion of benzene exposures. While cigarette smoking elevates the risk for leukemia, alcohol consumption data is conflicting. Therapeutic agents such as chemotherapy (alkylating agents) and uncontrolled diagnostic X-rays can also cause leukemia.

Rates of malignant melanoma vary by amount of sun exposure, particularly early in life. Persons less pigmented who burn easily are at greatest risk. Severe sunburn is a known risk factor. Atypical moles appear to be an important precursor to cancer development. In some individuals the risk of these moles is genetically transmitted, which can lead to clusters in families. Hormonal factors play a role in tumor growth, but their role in tumor development is not clear.

The most common risk factors for all cancers of concern are summarized in Table 5.

To gain further insight into risk factors possibly affecting the study area, we also examined data from the Behavioral Risk Factor Surveillance System (BRFSS), an ongoing telephone survey designed to track health conditions and risk behaviors throughout the United States. Since BRFSS does not track specific individuals over time, we cannot draw conclusions about current cancer risk based on past survey results. Rather, BRFSS is a tool for identifying current risk behaviors that might result in future incidence of cancer and other diseases.

Analysis was centered on the Littleton hospital service area (HSA), which includes the study area. The variables examined were as follows:

- General health status, ranging from excellent to poor
- Having had any physical activity in the past 30 days
- Heavy alcohol consumption
- Diabetes
- Having current health insurance
- Overweight and obesity
- Current smoking
- Having had a sigmoidoscopy or colonoscopy (adults aged 50 or older)
- Having had a mammogram in the past two years (women aged 40 and older)
- Whether the level of physical activity meets health recommendations
- Eating fruit or vegetables five or more times per day

Results from the last four variables are based on data covering two years, since those questions are asked in alternating years. All other results are based on four years of data. The data showed that, compared to New Hampshire, adults in the Littleton HSA had significantly higher prevalence of current smoking, significantly lower coverage of health insurance, and a significantly higher proportion reporting having had any physical activity in the past month. These were the only statistically significant differences observed. Results are presented in Table 6.

V. SUMMARY AND CONCLUSIONS

DHHS is sensitive to community concerns about the apparently high number of people diagnosed with cancer who live in areas near the landfill and to the impact, both physical and emotional, on these individuals and their families. In light of this, we have taken the most objective view possible of the situation in Bethlehem. This study is not an etiologic investigation designed to prove that an environmental pollutant can cause cancer; rather, it is a descriptive study designed to provide objective measures of cancer risks of residents of the study area relative to those elsewhere in New Hampshire.

Cancer is an important medical and public health problem. Each year about six new cases are diagnosed in every 1,000 New Hampshire residents and incidence rates increase dramatically with age. In the United States, one adult in three will develop cancer in his or her lifetime. As mentioned earlier, the probability that a particular individual will have multiple acquaintances with cancer is very high. Screening tests in common use today result in the detection of cancer cases that have nothing to do with the factors that cause cancer and would otherwise have gone undetected. Some communities contain a high concentration of individuals who possess related behaviors, such as smoking, or risk factors for cancer. Upon close examination, many perceived cancer "clusters" are not unusual increases, but are related to such factors as local population density, variations in reporting, or chance fluctuations in occurrence. Under these circumstances, it is very easy to develop a perception that cancer rates in one's community are rising.

The most common types of diagnosed cancer, both in New Hampshire and the study area, are colorectal, lung, female breast and prostate. Epidemiologic studies have not shown that the ambient environment contributes to any of these types; either the environment is not a risk factor, or exposures to known carcinogens are below those for which the effects are measurable.

Although some particular cancers were found to have elevated incidence in the study area, their risk factors vary widely. Based on the types of cancer in the area and the incidence rates, we have not found any atypical patterns with respect to gender or diagnoses over time that would suggest any common factor, either environmental or non-environmental, is related to the overall occurrence of cancer in Bethlehem.

Section 2. Medical Records Review

I. INTRODUCTION

A review of medical records was conducted focusing on cases of pancreatic and female breast cancer, both identified as elevated in Bethlehem.

II. METHODS

A total of 220 records of residents of Bethlehem, dating between 1989 and 2007, were reviewed; of these 190 cancer diagnoses occurred during the period corresponding to the incidence and mortality investigation (1991-2005). These included 183 diagnoses within New Hampshire. Information collected included vital status, occupation, personal and family history of cancer and other morbidities, alcohol and tobacco consumption, residential history, family history of cancer, and ethnicity.

III. RESULTS

Of the 183 cases, 66 had died; these included 53 from cancer, 10 from other causes, and three for which no NH death certificate was available. Fifteen had multiple cancers (defined as primary cancer with at least one year between diagnoses).

Nine cases of pancreatic cancer were identified, six of whom died from the disease. Charts were only available for five cases. Of these, it was determined that

- Three had a prior history of other cancers
- Occupational information was available only for three, with no documented history of exposure to carcinogens
- Three were former smokers and one was a nonsmoker
- Three consumed alcohol on an occasional or regular basis; one was a nondrinker
- Complete residential history was available for only three cases; two were Bethlehem residents at time of diagnosis
- Three had a family history of cancer; two did not
- Some evidence suggests that Eastern European descent may be associated with pancreatic cancer; this information was not available

For female breast cancer, 33 cases were identified; eleven died of breast cancer and three from other cancers. Of the 26 for whom charts were available, it was determined that

- Three had a personal history of breast cancer; four of other cancers
- Occupational information was available for 23; no documented history of exposure to carcinogens was found
- Five were current smokers, five were former smokers, and 11 were nonsmokers
- Fifteen, including two former alcoholics, consumed alcohol on an occasional or regular basis; eight were nondrinkers

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- Residential history was incomplete; available information showed that most were residents of Bethlehem, surrounding towns, or elsewhere in NH
- Three had a family history of breast cancer; nine had a history of other cancers in the immediate family

IV. DISCUSSION AND CONCLUSION

A large amount of missing and incomplete information was encountered, due to destruction of medical charts, unavailable charts from outside NH, and unrecorded information. From the available information, it is not possible to suggest a common factor, either environmental or non-environmental, related to the incidence of pancreatic and female breast cancer in Bethlehem.

Section 3. Recommendations

The NH DPHS will update this report on an annual basis, or whenever additional data on cancer incidence and cancer mortality become available. DPHS will also continue to monitor all statistically significant and nearly significant elevated cancers in Bethlehem and the surrounding towns. If warranted, upon receipt of new cancer data, DHHS will do a more in-depth statistical analysis on the number of cases in the affected area and nearby regions. DHHS scientists will also continue to review reports in the medical literature for possible occupational or environmental factors linked to the type of cancers under investigation.

Members of the community should keep themselves informed about toxic substances, human exposure, and public health hazards associated with the environment. As an important public health measure, everyone should also follow prescribed cancer prevention and screening guidelines including regular screenings for breast, cervical and colon cancer.

The following resources are recommended:

For more information on requesting a public health assessment, contact:
Agency for Toxic Substances and Disease Registry (ATSDR)
http://www.atsdr.cdc.gov

US EPA – New England Region
ATSDR Region 1
1 Congress Street
Suite 1100 (HBT)
Boston, MA 02114-2023
(617) 918-1490
Fax (617) 918-1494

NH Department of Environmental Services, Environmental Health Program (ATSDR supported)
http://des.nh.gov/organization/divisions/air/pehb/ehs/ehp/index.htm

NH State Cancer Registry
http://www.dartmouth.edu/-nhscr

National Cancer Institute
http://www.cancer.gov

American Cancer Society
www.cancer.org

Providers can avail themselves of resources such as *Case Studies in Environmental Medicine* (CSEM), available through ATSDR. CSEM is a series of self-paced courses, part of ATSDR's continuing education program, designed to increase primary care providers' knowledge of hazardous substances in the environment and to aid in the evaluation of potentially exposed patients. See the section on resources for access information.

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Providers should work with community members to build a strategy to investigate community concerns further. DHHS, Office of Health Statistics and Data Management is prepared to work in partnership with all communities involved in this study as requested.

BIBLIOGRAPHY AND RESOURCES

Agency for Toxic Substances and Disease Registry Continuing Education
http://www.atsdr.cdc.gov/emes/health_professionals/index.html

Agency for Toxic Substances and Disease Registry Patient Care and Instruction Sheets
http://www.atsdr.cdc.gov/emes/health_professionals/instruction_sheets.html

Breast cancer risk assessment tool, National Cancer Institute
http://www.cancer.gov/bcrisktool

Cancer incidence: Residents of Bethlehem, Grafton County, New Hampshire 1991-2005. New Hampshire Department of Health and Human Services, 2008.
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http://www.cancer.gov/cancertopics/wyntk/leukemia

What you need to know about cancer of the pancreas, National Cancer Institute, 2009
http://www.cancer.gov/cancertopics/wyntk/pancreas

What you need to know about breast cancer, National Cancer Institute, 2009
http://www.cancer.gov/cancertopics/wyntk/breast

What you need to know about bladder cancer, National Cancer Institute, 2009
http://www.cancer.gov/cancertopics/wyntk/bladder

What you need to know about Non-Hodgkin lymphoma, National Cancer Institute, 2009
http://www.cancer.gov/cancertopics/wyntk/non-hodgkin-lymphoma

Table 2. Cancer incidence by type: Residents of Bethlehem and surrounding towns, 1991-2005.

Cancer Type	Bethlehem					Surrounding Towns					All 9 Towns				
	Observed	Expected	SIR	95% CI Lower	95% CI Upper	Observed	Expected	SIR	95% CI Lower	95% CI Upper	Observed	Expected	SIR	95% CI Lower	95% CI Upper
Bladder	12	8.4	1.43	0.74	2.5	69	68.6	1.01	0.78	1.27	81	75.7	1.07	0.85	1.33
Brain & Other CNS	0	0.9	0	na	na	16	16.9	0.94	0.54	1.53	16	19.3	0.83	0.47	1.35
Breast (Female)	33	23.2	1.42	0.98	2	189	175.4	1.08	0.93	1.24	222	197.3	1.13	0.98	1.28
Cervical	2	1.1	1.74	0.2	6.29	9	9.8	0.92	0.42	1.75	11.2	11	0.98	0.49	1.76
Colorectal	18	15.6	1.16	0.68	1.83	143	143.2	1	0.84	1.18	162	159.2	1.02	0.87	1.19
Esophagus	3	2	1.47	0.3	4.3	14	14.6	0.96	0.52	1.61	17	16.3	1.04	0.61	1.67
Hodgkins Disease	3	1	2.95	0.59	8.61	10	6.7	1.5	0.72	2.75	13	7.7	1.69	0.9	2.89
Kidney & Renal Pelvis	2	4.1	0.49	0.05	1.76	28	28.1	0.99	0.66	1.44	30	31.7	0.95	0.64	1.35
Larynx	0	1.2	0	na	na	9	12.2	0.74	0.34	1.4	9	13.6	0.66	0.3	1.25
Leukemia	8	4	2	0.86	3.93	46	29.6	1.55	1.14	2.07	54	33.2	1.63	1.22	2.13
Liver	0	1.2	0	na	na	12	9	1.33	0.69	2.32	12	10.1	1.19	0.61	2.07
Lung & Bronchus	24	20.7	1.16	0.74	1.72	174	176.4	0.99	0.85	1.14	200	196.7	1.02	0.88	1.17
Melanoma of the Skin	7	9.2	0.76	0.3	1.56	65	49.6	1.31	1.01	1.67	73	56.4	1.29	1.01	1.63
Multiple Myeloma	2	1.7	1.16	0.13	4.2	12	13.8	0.87	0.45	1.52	14	15.3	0.92	0.5	1.54
Non-Hodgkins Lymphoma	10	6.4	1.57	0.75	2.88	51	46	1.11	0.83	1.46	63	51.5	1.22	0.94	1.56
Oral Cavity & Pharynx	1	3.5	0.28	0	1.58	33	27.1	1.22	0.84	1.71	34	30.5	1.11	0.77	1.56
Other	10	12.1	0.83	0.4	1.52	87	87	1	0.8	1.23	97	97.1	1	0.81	1.22
Ovary	2	2.2	0.91	0.1	3.27	27	21.3	1.27	0.83	1.84	29	23.9	1.21	0.81	1.74
Pancreas	9	3.2	2.85	1.3	5.42	33	27.3	1.21	0.83	1.69	42	30.5	1.38	0.99	1.86
Prostate	15	23.7	0.63	0.35	1.05	177	179.4	0.99	0.85	1.14	203	194	0.96	0.83	1.1
Stomach	1	1.7	0.6	0.01	3.32	17	15.8	1.08	0.63	1.73	18	17.5	1.03	0.61	1.63
Testis	0	1.1	0	na	na	7	5.9	1.18	0.47	2.43	7	7	1	0.4	2.07
Thyroid	4	2.9	1.37	0.37	3.51	14	13.2	1.06	0.58	1.79	18	15.2	1.18	0.7	1.87
Uterine	4	4.5	0.89	0.24	2.27	39	34.7	1.12	0.8	1.54	43	38.9	1.11	0.8	1.49
TOTAL	170	155.7	1.09	0.93	1.27	1289	1217	1.06	1	1.12	1459	1364.3	1.07	1.02	1.13

Reference population for calculating expected values is the state of New Hampshire.

Surrounding towns are Carroll, Dalton, Franconia, Lisbon, Lincoln, Littleton, Sugar Hill, and Whitefield

Where observed is greater than expected and CI is significant

Where observed is greater than expected and CI is near significance

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Table 3. Cancer mortality by type: Residents of Bethlehem and surrounding towns, 1991-2005.

Cancer Type	Bethlehem					Surrounding Towns					All 9 Towns				
	Observed	Expected	SMR	95% CI Lower	95% CI Upper	Observed	Expected	SMR	95% CI Lower	95% CI Upper	Observed	Expected	SMR	95% CI Lower	95% CI Upper
Bladder	1	1.41	0.71	0.01	3.96	15	14	1.08	0.6	1.78	16	15.5	1.03	0.59	1.67
Brain & Other CNS	0	1.65	0	na	na	10	13	0.79	0.38	1.45	10	14.4	0.69	0.33	1.28
Breast (Female)	6	4.45	1.35	0.49	2.94	38	41	0.92	0.65	1.27	44	45.8	0.96	0.7	1.29
Cervical	2	0.45	4.4	0.49	15.88	6	4	1.71	0.63	3.73	8	4	2.01	0.86	3.96
Colorectal	5	6.1	0.82	0.26	1.91	56	58	0.97	0.74	1.26	55	56.2	0.98	0.74	1.27
Esophagus	1	1.6	0.62	0.01	3.47	19	14	1.37	0.82	2.14	20	15.6	1.28	0.78	1.98
Hodgkins Disease	1	0.19	5.4	0.07	30.04	2	1	1.41	0.16	5.09	3	1.7	1.81	0.36	5.28
Kidney & Renal Pelvis	2	1.23	1.63	0.18	5.89	14	11	1.28	0.7	2.15	16	12	1.33	0.76	2.17
Larynx	0	0.4	0	na	na	4	3	1.15	0.31	2.94	4	4	1.01	0.27	2.59
Leukemia	4	2.09	1.91	0.51	4.89	28	19	1.5	1	2.17	32	21.2	1.51	1.03	2.13
Liver	1	1.18	0.85	0.01	4.72	21	10	2.04	1.26	3.11	22	11.5	1.91	1.19	2.89
Lung & Bronchus	23	17.53	1.31	0.83	1.97	142	138	1.03	0.86	1.21	165	161.7	1.02	0.87	1.19
Melanoma of the Skin	0	0.91	0	na	na	12	7	1.65	0.85	2.89	12	8.2	1.46	0.75	2.54
Multiple Myeloma	1	0.97	1.03	0.01	5.72	13	9	1.46	0.78	2.5	14	10.8	1.3	0.71	2.18
Non-Hodgkins Lymphoma	3	2.4	1.25	0.25	3.66	25	22	1.16	0.75	1.71	28	24.4	1.15	0.76	1.66
Oral Cavity & Pharynx	1	0.99	1.01	0.01	5.62	4	8	0.48	0.13	1.22	5	9.5	0.53	0.17	1.23
Other	8	6.57	1.22	0.52	2.4	45	59	0.76	0.56	1.02	59	75.7	0.78	0.59	1
Ovary	3	1.45	2.07	0.42	6.04	11	13	0.82	0.41	1.46	14	14.9	0.94	0.51	1.57
Pancreas	8	3.09	2.58	1.11	5.09	34	28	1.22	0.84	1.7	42	31.4	1.34	0.96	1.81
Prostate	3	3.29	0.91	0.18	2.66	32	28	1.13	0.77	1.6	35	34.4	1.02	0.71	1.41
Stomach	0	1.11	0	na	na	7	10	0.69	0.28	1.43	7	11.4	0.61	0.25	1.26
Testis	0	0.07	0	na	na	0	0	0	na	na	0	0.5	0	na	na
Thyroid	0	0.11	0	na	na	5	1	4.82	1.55	11.24	5	1.2	4.33	1.4	10.11
Uterine	0	0.48	0	na	na	5	5	1.04	0.34	2.43	5	5.3	0.95	0.31	2.22
Total Cancer Deaths	73	58.89	1.26	0.99	1.58	548	525	1.04	0.96	1.14	621	591.2	1.05	0.97	1.14

Reference population for calculating expected values is the state of New Hampshire.

Surrounding towns are Carroll, Dalton, Franconia, Lisbon, Lincoln, Littleton, Sugar Hill, and Whitefield

Where observed is greater than expected and CI is significant

Where observed is greater than expected and CI is near significance

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Table 4. Risk Factors for Elevated Cancers and Cancers of Concern

CANCER TYPE	GENETIC	BEHAVIORAL	ENVIRONMENTAL
Pancreatic	Age Gender Race Family history Gene changes Diabetes	Smoking Obesity Lack of Exercise Cirrhosis	Occupational (pesticides, dyes)
Female Breast	Gender Age Race Gene mutations Family History Dense Breast Tissue	Alcohol use Obesity Lack of Exercise Diet Birth Control Pills Not Having Children PHT Combined PHT- Estrogen Therapy	Radiation Diethylstilbestrol

Leukemia	Genetic Diseases
	HTLV-I (viral)
	Myelodysplastic
	  Syndrome
			Radiation
			Occupational
			  (certain industries)
			Benzene
			Chemotherapy

Bladder	Age
	Gender
	Race
	Family History
		Smoking	Arsenic
			Radiation
			Chemotherapy
			Occupational
			  (rubber, leather, textiles,
			  paints)

Non-Hodgkins Lymphoma	Age Gender Race Body weight Autoimmune Disease	Diet	Radiation Viral Infections Benzene Pesticides
Melanoma	Age Gender Family History Moles Fair Skin Xeroderma pigmentosum (XP)		UV Light

Note: "Environmental" refers only to physical or chemical agents.
Abbreviations: PHT   Post-menopausal Hormone Therapy
                UV   Ultra violet
                HTLV-I Human T-cell Leukemia Virus I
Source: American Cancer Society

Table 5. Behavior Risk Factor Surveillance System Results

2005 through 2008	New Hampshire		Littleton HSA	
2008	**Percent**	**95% Confidence Interval**	**Percent**	**95% Confidence Interval**
Heavy drinking	5.8	5.4 – 6.2	6.7	3.7 – 9.6
Diabetes	7.2	6.8 – 7.5	7.5	5.3 – 9.8
Any exercise	79.5	78.8 – 80.1	84.3	80.9 – 87.6
Health insurance	89.0	88.4 – 89.5	81.3	76.1 – 86.5
Health status Excellent, very good or good	88.3	87.8 – 88.8	85.7	81.7 – 89.8
Not overweight or obese	38.3	37.5 – 39.1	37.5	32.0 – 43.0
Overweight	37.6	36.8 – 38.4	35.3	30.1 – 40.5
Obese	24.1	23.4 – 24.8	27.2	22.1 – 32.3
Current smoking	19.0	18.3 – 19.6	25.0	19.9 – 30.2
2006 and 2008				
Ever had a sigmoidoscopy or colonoscopy, adults age 50 and older	67.9	66.6 – 69.2	65.7	58.6 – 72.9
Mammogram in past 2 years, women aged 40 and older	81.0	79.9 – 82.2	84.7	78.9 – 90.5
2005 and 2007				
Physical Activity level meets recommendations	54.8	53.7 – 56.0	58.9	50.5 – 67.3
Eat fruit or vegetables 5 or more times per day	71.3	70.3 – 72.3	73.0	66.6 – 79.4

Interpretations:
Several years of NH BRFSS data were combined to assess the prevalence of health risk behaviors among adults residing in the Littleton HSA compared to the NH average.

For the years 2005 through 2008 combined:
- The proportion of adults in the Littleton HSA reporting some type of health care coverage was significantly lower than the NH average.
- The proportion of adults in the Littleton HSA reporting they were current smokers was significantly higher than the NH average.
- The proportion of adults in the Littleton HSA reporting some type of physical activity in the past month was significantly higher than the NH average.
- No significant difference was found in the proportion of adults in the Littleton HSA reporting heavy drinking, diabetes, overweight or obesity or general health status, compared to the NH average.

For the years 2006 and 2008 combined (the most recent data available):
- No significant differences were found in the proportion of adults 50 or over in the Littleton HSA reporting they ever had a sigmoid or colonoscopy.
- No significant differences were found in the proportion of women 40 or older in the Littleton HSA reporting they had a mammogram in the past two years.

For the years 2005 and 2007 combined (the most recent data available):
- The proportion of adults in the Littleton HSA reporting physical activity levels that met recommendations was not significantly different from the NH average.
- The proportion reporting eating fruits or vegetables 5 or more times per day was not significantly different from the NH average.

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