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AN UPDATE OF EPIDEMIOLOGIC STUDIES OF PLUTONIUM WORKERS

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ABSTRACT

Retrospective and prospective epidemiologic studies are being conducted as part of a national survey of plutonium workers at four Department of Energy facilities (Los Alamos, NM; Rocky Flats, CO; Mound Laboratory, OH; and Savannah River, SC). A preliminary analysis of mortality was done for all white males who have worked at the Rocky Flats Plant during the period 1952 to 1979. The 452 observed deaths were significantly fewer than the 831 expected for all causes. The 107 deaths due to all malignant neoplasms were also significantly fewer than the 167 expected from these diseases. Expected deaths were derived from age and calendar-specific death rates for U. S. white males. Deaths reported for benign and unspecified neoplasms numbered eight versus an expected two, a significant elevation. These tumors, all intracranial, are the subject of a case-control study to be reported later. Subdividing the cohort on the basis of plutonium exposures and external radiation exposures results in similar overall findings. The benign and unspecified neoplasms, however, were not significantly high in the plutonium-exposed group.

INTRODUCTION

Significant quantities of plutonium first became available in 1944 and 1945 with development of the atomic bomb. Over the past 35 years, approximately 15,000 individuals have worked with plutonium for the Department of Energy and its predecessor agencies. About 5,000 of these employees have positive body burdens as measured by plutonium in urine. This paper briefly describes our past efforts and future plans for epidemiologic followup of these workers and presents preliminary results of analyses of mortality for workers at the Rocky Flats Plant.

History of Two Studies of Plutonium-Exposed Workers

In 1952, Louis Hempelmann and the late Wright Langham selected a group of 26 Manhattan Project workers who were heavily exposed to plutonium in 1944-45 for clinical follow-up. Their estimated systemic burden ranged from 7 to 230 nanocuries (nCi). In comparison to the so-called "lifetime" permissible body burden of 40 nCi for occupational exposures, 11 of these individuals have body burdens in excess of 40 nCi, and 21 persons demonstrate body burdens in excess of 20 nCi. At this time, the average age for the group is just over 60 with 24 of the 26 individuals still alive. The number of these individuals remaining alive is higher than expected based on mortality rates for U.S. white males. After 32 years of followup no evidence of adverse health affects was found(Vo 79). Clinical re-evaluations are currently in progress.

An important limitation of the Manhattan Project worker study is the small number of subjects. In 1973-74 an effort was made to identify all workers at Los Alamos who had estimated plutonium

depositions of 10 nCi or more. Health physics records were used to select study subjects as of January 1, 1974. A total of 241 subjects were identified, of which 224 were males and 17 were females. All subjects still living were located and contacted. Death certificates were obtained for the deceased. The study had 100% follow-up through June 1976. Mortality patterns for this group have been reported (Vo 78, Vo 80). The observed mortality of these workers was compared with the expected number of deaths based on mortality rates for United States white males, according to the method of Monson (Mo 74). Excess mortality was not observed for any cause in this group. Total cancer, lung cancer, and cardiovascular mortality was less than expected. No bone or liver cancers were discovered. Since lung, bone and liver are primary organ sites for plutonium deposition (IC 73), these specific cancers are of particular interest.

Although this group consists of about one-third of the workers in the United States with plutonium depositions of 25% or more of the "maximum permissible body burden" value, this study is limited also by the small number of subjects.

In order to increase the number of subjects being followed, and the power of the analysis, a national study of all workers exposed to plutonium was needed. Efforts on this study began in 1976. The general plan of the study is summarized briefly.

NATIONWIDE STUDY OF PLUTONIUM WORKERS

The purpose of the nationwide study is to evaluate the health and mortality experience of workers who have been or are potentially exposed to plutonium and other transuranic elements in the United States. The majority of these exposures have occurred within facilities operated under contract for the Department of Energy and its predecessor agencies, the Atomic Energy Commission and the Energy Research and Development Administration. These facilities include: Los Alamos National Laboratory, the Rocky Flats Plant, Mound Laboratories, and the Savannah River Plant. A small number of workers were exposed to plutonium also at Hanford and Oak Ridge. The overall project is designed to evaluate the lifetime health experience of these workers by studying mortality and disease incidence.

Mortality Studies

Standardized mortality ratios for neoplasms and other major causes of death are being or will be calculated for workers at each of these facilities. Comparisons will be made with National and State death rates initially. Internal comparisons will be based upon deaths among plutonium exposed workers and death rates of the unexposed. Nested case-control studies based on death certificate information will be conducted for causes of death that occur more frequently than expected or are of special interest.

Unfortunately, mortality studies are characterized by disadvantages as well as advantages. The advantages are that they can be conducted quickly and less expensively in comparison to incidence studies, and death certificate data are collected in uniform fashion

throughout the United States. The disadvantages are that mortality studies are not sensitive to the occurence of non-fatal diseases, and that information on important confounding variables, such as smoking, medical x-ray exposures, and non-radiation occupational exposures are generally not available.

Incidence Studies

Presently there is no national source of disease incidence data within the United States. Consequently, this information must be obtained by directly contacting study subjects, seeking their cooperation and obtaining information regarding their illness history.

The major advantage of incidence studies is that they are sensitive to the occurence of diseases that are not highly fatal and enable obtaining information on covariates directly from study subjects.

All workers with positive plutonium body burdens and a sample of unexposed workers will be identified, traced and interviewed in order to develop incidence rates for specific diseases. Data will be collected on important risk factors such as tobacco and alcohol use, medical x-ray exposures, occupational exposures to chemicals and radiation, and major illnesses. This approach will allow us to calculate incidence rates for diseases of interest and also to investigate inter-relationships between exposures to plutonium, other radionuclides, external radiation, chemically hazardous substances, and other risk factors. Individuals in the study cohorts will then be interviewed at periodic intervals to update their health status, and to obtain additional data.

As in the mortality effort, nested case control studies will also be conducted when incidence rates for specified diseases are found to be elevated. These studies will focus on important covariates that may contribute to site-specific cancer incidence.

PRELIMINARY MORTALITY STUDY OF ROCKY FLATS WORKERS

Study activities at the different locations are in various stages of completion. Data on Rocky Flats workers have been sufficiently collected and analyzed to present some initial results. These preliminary analyses include an investigation of mortality of white males who worked at Rocky Flats compared to U.S. white males, and are presented as an illustration of our mortality study efforts.

Description of the Rocky Flats Plant

Since the start of its operations in 1952, the Rocky Flats Plant, located near Golden, Colorado, has been involved mainly in the production of components that are used in the construction of nuclear weapons. Major plant activities include the manufacture and assembly of items containing plutonium, beryllium, uranium and other metals, recovery of plutonium, and americium separation as well as weapons research and development (DOE 80)

Methods

The purpose of this investigation is to evaluate the general hypothesis that workers at the Rocky Flats Plant experience greater mortality than would be expected based on U. S. death rates. Should more deaths than expected be discovered, additional investigations would be conducted to determine whether these excesses are related to occupational exposures obtained at the plant. We are especially

interested in investigating causes of death such as deaths from bone, liver, and lung cancers, that have been demonstrated by animal experiments to be caused by exposures to plutonium. We are also interested in causes of death that have been linked to external radiation exposures, such as leukemia.

As a first step in the investigation, employment lists of current and former workers at the Rocky Flats Plant were compiled with the cooperation of Rocky Flats officials. Health physics records were also used in developing this list. The study files are now as complete as available from these sources. The resultant roster has been cross-checked with a sequential badge listing for the purpose of validating the cohort, and was twice submitted to the Social Security Administration (Re 81) for a search of vital status. A task that still remains is to validate the study cohort by means of an external source such as through Social Security forms 941A (Ma 79).

Dosimetry data have been obtained from Rocky Flats health physics records. Measurements of external radiation exposures from film and thermoluminescent dosimeters (TLD) are given in terms of total penetrating doses received as of employment termination date or end of the study. Measures for internal emitters are based upon urine assays conducted for plutonium and americium, and in-vivo counts. In this report, cumulative internal exposures are expressed in microcurie days for plutonium. Systemic body burdens are calculated according to Langham's equation (La 50). The cumulative value in microcurie days is the sum of the products of the estimated systemic burden and the

number of days that burden has been present. The values were taken from the Rocky Flats health physics records.

Demographic and work history data from personnel records have been coded into machine readable form. All of the data were edited for internal consistency. A 10% recoding of the data was done as a quality control check. An upper limit of 2% coding error was considered acceptable and was achieved.

Death certificates were obtained for workers identified as deceased by the Social Security Administration. These deaths were then verified as being part of the Rocky Flats work force and were double coded to the 8th revision of the ICDA by qualified nosologists. This information was merged with other data into an analytic file. The person years at risk, expected numbers of deaths, and indirect adjustments for age were calculated according to procedures developed by Monson (Mo 74). Those persons who were lost to follow-up[1] were considered to be alive at the end of the study. A random sample of those individuals is being traced in order to ascertain their status and to estimate the effect on study outcomes of those lost to follow-up. To date, 1% of the unknowns that have been successfully traced have been identified as dead.

[1]Lost to follow-up refers to individuals for whom the Social Security Administration was unable to determine vital status because there was no record of action on the individual's account for at least 2 years, there was a discrepancy in either name or social security number or they had no record of the individual in their files.

Results

For the purposes of this report, only results pertaining to white males, who comprise more than 75% of the conort, are reported. Table 1 describes the vital status of this cohort. A total of 7112 white males were identified as having been employed between the beginning of plant operations in 1952 and the end of the study date, December 1979. Death certificates for 452 deaths have been obtained.

As evident from Table 1, the work force is still relatively young. The average age upon entry into the cohort is only 33, the mean age as of the end of the study date is 48, and the average age at death for those who have died is 58.

At this time, our main interest is in those health effects, particularly cancer, that have been demonstrated or are alleged to be associated with radiation exposure. Table 2 presents standardized mortality ratios (SMR's = observed deaths - expected deaths X 100) for all causes of death, all neoplasms and selected types of cancers. Observed numbers consist of deaths that occurred among white males in this cohort from 1952 through 1979. Expected numbers of deaths are based upon age and calendar specific mortality rates for white males in the U.S. population. Standardized mortality ratios were calculated using the Monson program (Mo 74) and are reported along with 95% approximate confidence intervals.

Significantly fewer deaths than expected were observed for all causes of death, all malignant neoplasms, cancers of the digestive organs and peritoneum, cancers of the respiratory system, and cancers of the lung. Data for cancer of the pancreas were suggestive of a

deficit of mortality due to this cause ($p=0.076$)[+], but was not significantly less than expected. Only benign and unspecified neoplasms demonstrated a significant excess of observed to expected deaths. Examination of individual death certificates for this group reveals one pituitary adenoma, one acoustic neuroma and six unspecified brain tumors. Expected numbers of deaths from other cancers were not significantly different than expected.

Plutonium Exposed and Unexposed Workers

Investigation of the total cohort of white male workers is useful for considering mortality irrespective of specific exposures. However, our major interest is in mortality among workers who have been exposed to radiation. Since special interest lies in the potential effects of plutonium, an internal emitter with a long effective half-life, separate SMR's were computed for workers with more than one microcurie day exposure to plutonium and for those equal to or less than one microcurie day. For the purposes of this report, these limits of exposure have been arbitrarily used to define plutonium exposed and unexposed workers.

If plutonium exerts an effect at the level and length of exposure for this cohort, one would expect elevated SMR's for plutonium exposed workers. Of special interest are organ sites where plutonium is deposited and/or stored, such as the bone, liver, lung and lymphatic system (IC 72); potential intake organs, such as the respiratory and digestive systems; or systems sensitive to ionizing radiation, such as

+ Exact Miettinen p-value (Po 79)

the hematopoietic system. Table 3 lists the data for plutonium exposed workers. It is interesting to note that no cases of bone cancer were observed, and that deaths due to cancers of the respiratory system and lung are significantly less frequent than expected. Likewise, SMR's for all causes of deaths and all malignant neoplasms are also significantly low. Among plutonium exposed workers, there were two deaths due to benign and unspecified neoplasms, which was not significantly more than expected (p=0.24). Other cancer deaths did not differ significantly from their predicted number.

It is also interesting to consider the SMR's calculated for the plutonium unexposed cohort. These are listed on Table 4. Again significantly fewer deaths than expected are observed for all causes of death and all malignant neoplasms. Data for cancers of the respiratory system, lung and digestive system are suggestive of less than expected mortality. Significantly more deaths than expected were again observed for benign and unspecified neoplasms, based on six observed deaths and 1.6 expected (p=0.008). Deaths due to cancers of the brain and other central nervous system, while not significantly more than expected, were suggestive of an excess (p=0.098). All other causes of death were not significantly different than expected.

External Radiation Exposed and Unexposed Workers

Approximately 75% of the white males who have ever worked at the Rocky Flats facility have been exposed to more than 100 mrem of penetrating external radiation (X-rays, gammas and neutrons combined). Since external exposures are also a matter of concern,

white male workers were dichotomized on the basis of external exposures into those with total cumulative exposure greater than 100 mrem and those less than or equal to 100mrem .

The data on workers who were exposed to more than 100 mrem external radiation are listed in Table 5. Deaths due to all causes, all malignant neoplasms, cancers of the respiratory system and lung are significantly fewer than expected. Comparisons for cancers of the digestive system, pancreas, and lymphopoietic system are suggestive of less deaths than expected. The SMR for benign and unspecified neoplasms is significantly elevated. Mortality from other causes does not differ from that expected.

Data on the unexposed cohort, shown in Table 6, is limited and, in general is not significantly different than expected. The one exception was for the category, all causes, where there were significantly fewer deaths.

DISCUSSION

We have investigated the hypothesis that workers at the Rocky Flats plant demonstrate greater than expected mortality for selected causes of death. The preliminary results show consistently fewer deaths than expected for all causes of death, all malignant neoplasms, cancers of the respiratory system, digestive system and lung. The only cause of death that appears significantly higher than expected is a composite classification of benign and unspecified neoplasms. These findings hold when the white male cohort is dichotomized according to plutonium exposure or according to external radiation exposure. It is noteworthy that elevated numbers of deaths were not found in the

plutonium exposed cohort for those organ sites of greatest concern based on radiobiological research on animals and on the distribution of plutonium in man. Furthermore, health endpoints usually associated with external forms of radiation also were not elevated. Thus, our preliminary results suggest that with the exception of benign and unspecified neoplasms, there is no evidence of increased mortality compared to United States white males. The finding for benign and unspecified neoplasms must be considered in light of the lack of similar evidence from investigations of populations exposed to much higher, acute whole body doses of ionizing radiation such as atom bomb survivors studies. Further study of this finding is being pursued by means of a case control study.

Limitations and Solutions

It is appropriate to specify the limitations of these results. First, this investigation suffers from the problem that is usually encountered when occupational cohorts are compared with the United States population. Such comparisons often result in low SIR's because individuals in the work force are healthier than the general population. This is often referred to as "the healthy worker effect". The obvious solution is to generate expected numbers of deaths with rates from another industrial cohort or an unexposed subcohort. An alternative solution is to compare directly exposed and unexposed subcohorts within the study population itself. The latter approach will be undertaken as part of additional analyses for the studies on plutonium workers.

It is interesting to note that mortality ratios obtained in this investigation are lower than those found in many studies of industrial workers. This may result from unusual selection procedures that were present in the formation of this cohort. Factors such as preplacement physical examinations and the security clearance procedure may contribute to an excessive healthy worker effect. Furthermore, the healthy worker effect is more pronounced at younger ages, thus the observed number of deaths in this cohort should be less than expected based upon the U.S. white male population (Ga 76). It has been shown (Mc 75) that young industrial cohorts demonstrate SMR's well below unity and approach unity as they age. The low SMR's for the Rocky Flats cohort are likely due to the young age and perhaps relatively low exposure to occupational hazards. For instance, the SMR of 54 for all causes reported in Table 2, is similar to the SMR of 58 reported by McMichael for workers in the communications industry (Mc 75). The lack of hazardous work conditions and the similarity in age distribution between these cohorts may explain the marked departure of their SMR's from unity. A small downward bias also exists because no adjustment was made for the few probable deaths in the lost-to-follow-up group.

Another limitation in this study concerns the relatively short period of follow-up. Most solid tumors require 20 to 30 or more years from exposure to the development of clinically evident disease. Continued observation of this cohort is required before one is confident that the neoplasms of interest should have become evident.

A number of important risk variables have not been addressed in this study. Such factors as smoking, other occupational exposures and medical x-rays need to be taken into account. It is planned that these variables will be considered during future investigations of disease incidence.

A limitation of the present effort that requires mention is the lack of external validation of the cohort. Although a sequential badge listing has been employed to verify the study population, an outside source, such as SSA 941A forms should also be used. We are currently in the process of obtaining these documents.

The small number of observed cases that are available for analysis suggest that caution be exercised when interpreting these findings. Estimates based upon small numbers are subject to considerable variability which limits the conclusions that may be made. In this study, the number of observed cases is sufficiently large to overcome this problem only for all causes of death, all malignant neoplasms, and cancers of the digestive system, respiratory system, and lung.

Finally, additional analyses are planned that will include several refinements that are considered desirable. A cut-off date at the end of 1978 will be used because we are not sure that the 1979 data is complete. For persons in the last to follow-up category, the person years at risk will include only the time for which vital status is known. More detailed exposure data is also being collected and verified, and will permit additional analyses to be completed on possible dose response relationships. None of these refinements are

thought to be significant in changing basic conclusions, but will improve the analysis.

There have been allegations (Jo 80) that elevated rates for cancers of the central nervous system are present among Rocky Flats workers. In this study, the standardized mortality ratios for specified central nervous system cancers do not appear excessive, although the small numbers of these cancers result in highly variable estimates. However, there are an additional 6 cases of unspecified brain tumors present in the unspecified neoplasms. Unspecified refers to the fact that the death certificate information does not contain a specific tumor type or histologic classification. As a result, these death certificates were coded by independent nosologists as unspecified brain tumors. Special interest in cancers of the central nervous system at this facility has stimulated us to initiate a case control study of intracranial tumors. That investigation is designed to compare exposures among cases with intracranial tumors with those of control subjects who do not have cancer or central nervous system disease. This effort is well underway and will be reported separately.

Conclusion

Workers at the Rocky Flats Plant near Denver, Colorado from 1952 through 1979 are the subject of this preliminary mortality study. Vital status was determined on 7112 white males. The method of follow-up was through searches of vital status conducted by the Social Security Administration. Additional means of follow-up are also being pursued. Causes of 456 deaths were determined by death certificates and compared with expected deaths, based on age and calendar-specific

U.S. white male mortality rates. Significantly increased mortality ratios were not observed for all causes of death or for all malignant neoplasms. Subdividing the study cohort based on external radiation exposure into those above and below 100 mrem, did not show noticeable increases in standardized mortality ratios for the exposed subcohorts. Based upon plutonium depositions, the cohort was dichotomized into those exposed to more than and less than 1 microcurie-day, and the results do not suggest increased mortality among those with higher plutonium depositions. Our preliminary investigations do show a significant excess for benign and unspecified neoplasms for the total white male cohort. The causes of death in this category are from both benign and malignant tumors of the nervous system. This excess is not significant in the plutonium exposed cohort, but remains significant for the external radiation exposed cohort. Further investigation of this finding is being conducted.

Acknowledgment

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Table 1

Vital Status as of December, 1979 For White Males Ever Employed in Calendar Years 1952 Thru 1979

Total Cohort	7112
Death Certificates Obtained	452
Lost to Follow-Up	627
Mean Age at Entry	33
Mean Year of Entry	1964
Mean Age at Death	58
Mean Age of Cohort as of December 1979	48
Total Person Years of Follow Up	110,111

TABLE 2

MORTALITY FROM SELECTED CAUSES OF DEATH
FOR TOTAL WHITE MALE COHORT (N=7112)

Cause	ICD No.	Observed Number	Expected Number	SMR	95% Confidence Interval for SMR
All Causes	(1-998)	452	831.53	54	49-60
All Malignant Neoplasms	(140-209)	107	167.07	64	52-77
Cancer of Digestive Organs & Peritoneum	(150-159)	28	42.61	66	44-95
Cancer of Liver	(155,156)	3	2.70	111	22-325
Cancer of Pancreas	(157)	4	8.99	45	12-114
Cancer of Respiratory System	(160-163)	35	60.55	58	40-80
Cancer of Lung	(162,163)	33	57.38	58	40-81
Cancer of Bone	(196)	0	.89	--	-----
Cancer of Brain and Other Central Nervous System	(191,192)	8	6.50	123	53-243
Cancer of Thyroid	(193)	1	.34	292	4-1627
All Lymphopoietic Cancers	(200-209)	13	18.20	71	38-122
Leukemia & Aleukemia	(204-207)	6	6.89	87	32-189
Benign and Unspecified Neoplasms	(210-239)	8	2.41	332	143-653

TABLE 3

MORTALITY FROM SELECTED CAUSES OF DEATH
FOR WORKERS EXPOSED TO >1 μCi DAY

Cause	ICD No. (1-998)	Observed Number	Cumulative Exposure >1 μCi Day (N=2130) Expected Number	SMR	95% Confidence Interval for SMR
All Causes		98	259.45	38	31-46
All Malignant Neoplasms	(140-209)	20	52.59	41	23-59
Cancer of Digestive Organs and Peritoneum	(150-159)	8	12.97	62	27-122
Cancer of Liver	(155,156)	1	.79	127	2-705
Cancer of Pancreas	(157)	0	2.80	---	------
Cancer of Respiratory System	(160-163)	4	19.60	20	5-52
Cancer of Lung	(162,163)	4	18.19	22	6-55
Cancer of Bone	(196)	0	.28	---	------
Cancer of Brain and Other Central Nervous System	(191,192)	0	2.24	---	------
Cancer of Thyroid	(193)	0	.11	---	------
All Lymphopoietic Cancers	(200-209)	4	5.86	68	18-175
Leukemia & Aleukemia	(204-207)	1	2.16	46	1-257
Benign and Unspecified Neoplasms	(210-239)	2	.80	251	28-907

TABLE 4

MORTALITY FROM SELECTED CAUSES OF DEATH
FOR WORKERS EXPOSED TO ≤1 μCi DAY

Cause	Cumulative Exposure ≤1 μCi Day (N=4982) Observed Number	Expected Number	SMR	95% Confidence Interval for SMR
All Causes	354	572.09	62	56-69
All Malignant Neoplasms	87	114.48	76	61-94
Cancer of Digestive Organs and Peritoneum	20	29.64	67	41-104
Cancer of Liver	2	1.91	105	12-379
Cancer of Pancreas	4	6.19	65	17-165
Cancer of Respiratory System	31	40.95	76	51-107
Cancer of Lung	29	38.80	75	50-107
Cancer of Bone	0	.61	--	------
Cancer of Brain and Other Central Nervous System	8	4.26	188	81-370
Cancer of Thyroid	1	.23	428	6-2382
All Lymphopoietic Cancers	9	12.33	73	33-139
Leukemia & Aleukemia	5	4.73	106	34-247
Benign and Unspecified Neoplasms	6	1.62	371	136-808

TABLE 5

MORTALITY FROM SELECTED CAUSES OF DEATH
FOR WORKERS EXPOSED TO >100 mrem

Cause	ICD No. (I-998)	Total Penetrating Dose >100 mrem (N=5228) Observed Number	Expected Number	SMR	95% Confidence Interval for SMR
All Causes		313	644.53	49	43-54
All Malignant Neoplasms	(140-209)	76	130.18	58	46-73
Cancer of Digestive Organs and Peritoneum	(150-159)	22	32.98	67	42-101
Cancer of Liver	(155,156)	3	2.07	145	29-424
Cancer of Pancreas	(157)	3	6.99	43	9-125
Cancer of Respiratory System	(160-163)	27	47.55	57	37-83
Cancer of Lung	(162,163)	26	45.07	58	38-85
Cancer of Bone	(196)	0	.69	---	-----
Cancer of Brain and Other Central Nervous System	(191,192)	6	5.14	117	43-254
Cancer of Thyroid	(193)	0	.27	---	-----
All Lymphopoietic Cancers	(200-209)	8	14.19	56	24-111
Leukemia & Aleukemia	(204-207)	4	5.34	75	20-192
Benign and Unspecified Neoplasms	(210-239)	7	1.89	371	149-764

TABLE 6

MORTALITY FROM SELECTED CAUSES OF DEATH
FOR WORKERS EXPOSED TO ≤100 mrem

Cause	Total Penetrating Dose ≤100 mrem (N=1884) Observed Number	Expected Number	SMR	95% Confidence Interval for SMR
All Causes	139	187.00	74	62-88
All Malignant Neoplasms	31	36.89	84	57-119
Cancer of Digestive Organs and Peritoneum	6	9.64	62	23-136
Cancer of Liver	0	.63	---	------
Cancer of Pancreas	1	1.99	50	1-279
Cancer of Respiratory System	8	13.06	62	26-121
Cancer of Lung	7	12.31	57	23-117
Cancer of Bone	0	-----	---	------
Cancer of Brain and Other Central Nervous System	2	1.36	147	16-530
Cancer of Thyroid	1	.08	1317	17-7325
All Lymphopoietic Cancers	5	4.01	125	40-291
Leukemia & Aleukemia	2	1.55	129	14-465
Benign and Unspecified Neoplasms	1	.53	190	2-1059