DEPARTMENT OF HEALTH AND HUMAN SERVICES

Public Health Service

National Institute for Occupational Safety and Health
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Dear Ms. McCarthy:

On March 9, 2010, the National Institute for Occupational Safety and Health (NIOSH) received your request for a health hazard evaluation (HHE) among employees of the Transportation Security Administration (TSA) at the Boston Logan International Airport (BLIA). The request concerned a possible excess of cancer among employees and concern about radiation exposure from baggage scanning machines. You reported that approximately 25 of approximately 1100 employees had been diagnosed with a variety of cancers. I spoke to the Designated Occupational Safety and Health Official for BLIA; the Director of the Office of Safety, Health, and the Environment for TSA; and you. I received a list of employees diagnosed with cancer, including date of diagnosis, date of employment, type of cancer, age, and smoking status. Fifteen employees were diagnosed with cancer since 2005. The average age at diagnosis was 52 (range: 30–62). Five employees had breast cancer, two had lung cancer (both smokers), two had prostate cancer, and one each had melanoma, basal cell carcinoma of the skin, ovarian cancer, colon cancer, cervical cancer, and stomach cancer. This letter summarizes my findings and gives you information addressing the employees' concerns.

Background

Radiation

The term "radiation" is commonly used to refer to ionizing radiation, which is energy that is able to ionize atoms or molecules of the substance in which the energy is absorbed. This causes chemical changes which damage tissues and the body's biological structural materials. Ionizing radiation can cause many types of cancer. The thyroid gland and the bone marrow are the most sensitive to radiation, and the bladder, kidney, and ovary are the least sensitive [American Cancer Society 2006a]. Humans can be exposed to three kinds of ionizing radiation, (1) natural background radiation from cosmic rays and the soil; (2) nonmedical synthetic radiation from weapons testing and workplaces; and (3) medical radiation from x-rays and other medical tests [American Cancer Society 2006a].

Transportation Security Administration and Baggage Screening

On November 19, 2001, because of the need for increased air transportation security, Congress enacted the Aviation and Transportation Security Act (ATSA). Under ATSA, the responsibility for inspecting persons and property carried by aircraft operators and foreign air carriers was transferred to a newly formed agency, the TSA. This rulemaking transferred the Federal Aviation Administration (FAA) rules governing civil aviation security to TSA. Prior to TSA, carry-on baggage and checked baggage screening at airports had been privately contracted. With the creation of TSA, these jobs were placed within the federal civil service system (at most airports), and baggage screeners were required to have additional background security evaluation, training, and testing. Since its establishment, TSA has federalized security employees at over 400 commercial service airports throughout the United States and its territories to screen carry-on and checked baggage. Carry-on baggage of airport travelers is examined by TSA baggage screeners using Threat Image Protection Ready X-ray (TRX) systems located at passenger check points. TSA baggage screeners use Explosive Detection System (EDS) equipment to x-ray checked passenger baggage.

Between 2003 and 2004, NIOSH conducted radiation exposure surveys for TSA baggage screeners at 12 airports, including BLIA [Achutan and Mueller 2008]. All 12 airports received a basic characterization that consisted of an observational survey, a review of airport-specific screening operations, and an inspection of x-ray generating equipment. A second phase involved monitoring the radiation exposure received by TSA baggage screeners at six airports, including BLIA, over a 6-month period. Overall, the radiation doses for TSA baggage screeners were low. The median estimated 12-month cumulative occupational whole body dose during the period of observation was zero at four of six airports. BLIA was one of two airports with a non-zero median estimated 12-month cumulative dose (0.4 millirem [mrem] each for whole body and wrist). Carry-on baggage screeners at BLIA had significantly higher radiation exposures than the checked baggage screeners. One explanation could be that checked baggage screeners at BLIA were located in a control room that was not near any radiation source (e.g., the EDS machines). This likely contributed to their radiation exposures being lower than those for the BLIA carry-on screeners who worked near TRX baggage screening machines and were potentially exposed to low-level radiation emissions.

Breast Cancer

An estimated 192,370 cases of invasive breast cancer were diagnosed in women in the United States in 2009, making it the most common cancer in women in the United States [American Cancer Society 2010]. Although epidemiologic studies have identified some factors that appear to be related to increased risk for breast cancer, much remains unknown about the causes of breast cancer. Well-established risk factors include family history of breast cancer, biopsy-confirmed atypical hyperplasia, early menarche (first menstrual period), late menopause, post-menopausal hormone replacement therapy, not having children or having the first child after 30, alcohol consumption, overweight or obesity (especially after menopause), never breastfeeding a child, low physical activity levels, and higher levels of education and socioeconomic status [American Cancer Society 2010]. Breast cancer is not known to be associated with environmental or occupational exposures other than high doses of ionizing radiation [Goldberg and Labrèche 1996; Weiderpass et al. 1999; Carmichael et al. 2003]. The risk is highest if exposure occurs during childhood and is negligible after age 40. Several studies have found teachers and other professional and managerial employees to have an increased risk for developing breast cancer [Rubin et al. 1993; King et al. 1994; Pollán and Gustavsson 1999; Bernstein et al. 2002; Snedeker 2006; MacArthur et al. 2007] but others have not [Coogan et al. 1996; Calle et al. 1998; Petralia et al. 1999]. No causative workplace exposures have been identified for these occupations, and it is postulated that the possible increase in risk is a result of non-occupational risk factors such as parity (number of times a woman has given birth), maternal age at first birth, contraceptive use, diet, and physical activity [Threlfall et al. 1985; Snedeker 2006; MacArthur et al. 2007]. Women with higher educational status are also more likely to have mammograms, thus increasing detection of breast cancer. A recent study compared the incidence of invasive breast cancer among women who were screened once between ages 50 and 64 to women screened three times between ages 50 and 64. Distribution of known risk factors was similar between the two groups, but the rate of invasive breast cancer was 22% lower in the group screened only once, suggesting that some breast cancers regress without treatment [Zahl et al. 2008]. Another study examined the incidence of breast cancer among women for 7 years before and 7 years after the full implementation of a mammography screening program [Jørgensen and Gøtzsche 2009]. The researchers determined that one third of cancers were overdiagnosed, meaning that they would not have caused symptoms or death.

Prostate Cancer

Prostate cancer is the most commonly diagnosed cancer among men in the United States, with 192,280 cases diagnosed in 2009 [American Cancer Society 2009a]. The main risk factor is increasing age; blacks are at higher risk. No occupational or environmental risk factors for prostate cancer are known. Exposure to certain substances, such as polycyclic aromatic hydrocarbons, pesticides, and cadmium have been suspected to increase the risk for prostate cancer, but study results conflict [Verougstraete et al. 2003; Boers et al. 2005; Sahmoun et al. 2005; Van Maele-Fabry et al. 2006; Huff et al. 2007; Mink et al. 2008].

Lung Cancer

Lung cancer is the most common cause of cancer death in both men and women. An estimated 219,440 new cases of lung cancer were diagnosed in 2009 [American Cancer Society 2009a]. The most significant risk factor for lung cancer is cigarette smoking, which accounts for 90% of cases in men and 80% in women [Ettinger 2008]. A lifelong nonsmoker has a relative risk ratio of 1 of getting lung cancer. Cigarette smokers of less than 0.5 packs per day, between 0.5 and 1 pack per day, 1 to 2 packs per day, and more than 2 packs per day have relative risk ratios of 15, 17, 42, and 64, respectively [Ettinger 2008]. The risk for former smokers depends on how long ago they quit smoking. It takes about 30 years to bring the risk ratio down to 1.5 to 2.0 [Ettinger 2008]. Radon is the most common cause of lung cancer in nonsmokers, and second most common cause of lung cancer overall, accounting for over 20,000 cases of lung cancer annually in the United States. Almost 3,000 of these cases occur in people who have never smoked [EPA 2010]. Secondhand smoke is the third most common cause of lung cancer in the United States, with more than 3,000 cases annually [EPA 2010; American Cancer Society 2008b]. Known occupational causes of lung cancer include asbestos, arsenic, chromium, nickel, cadmium, coke oven emissions, tars, and soot [American Cancer Society 2006b].

Cancer Clusters

Because of the concerns among the BLIA TSA employees about cancer, it is helpful to review some general information about cancer, and the approach we take in determining whether cancers have any relationship to the workplace.

Cancer is a group of different diseases that have the same feature, the uncontrolled growth and spread of abnormal cells. Each different type of cancer may have its own set of causes. Cancer is common in the United States. One of every four deaths in the United States is from cancer. Among adults, cancer is more frequent among men than women, and is more frequent with increasing age. Many factors play a role in the development of cancer. The importance of these factors is different for different types of cancer. Most cancers are caused by a combination of several factors. Some of the factors include: (a) personal characteristics such as age, sex, and race, (b) family history of cancer, (c) diet, (d) personal habits such as cigarette smoking and alcohol consumption, (e) the presence of certain medical conditions, (f) exposure to cancer-causing agents in the environment, and (g) exposure to cancer-causing agents in the workplace. In many cases, these factors may act together or in sequence to cause cancer. Although some causes of some types of cancer are known, we do not know everything about the causes of cancer.

Cancers often appear to occur in clusters, which scientists define as an unusual concentration of cancer cases in a defined area or time [CDC 1990]. A cluster also occurs when the cancers are found among workers of a different age or sex group than is usual. The cases of cancer may have a common cause or may be the coincidental occurrence of unrelated causes. The number of cases may seem high, particularly among the small group of people who have something in common with the cases, such as working in the same building. Although the occurrence of a disease may be random, diseases often are not distributed randomly in the population, and clusters of disease may arise by chance alone [Metz and McGuinness 1997]. In many workplaces the number of cases is small. This makes it difficult for us to detect whether the cases have a common cause, especially when there are no apparent cancer-causing exposures. It is common for the borders of the perceived cluster to be drawn around where the cases of cancer are located, instead of defining the population and geographic area first. This often leads to the inaccurate belief that the rate of cancer is high. This is referred to as the "Texas sharpshooter effect" because the Texas sharpshooter shoots at the barn and then draws his bull's eye around the bullet hole.

When cancer in a workplace is described, it is important to learn whether the type of cancer is a primary cancer or a metastasis (spread of the primary cancer into other organs). Only primary cancers are used to investigate a cancer cluster. To assess whether the cancers among employees could be related to occupational exposures, we consider the number of cancer cases, the types of cancer, the likelihood of exposures to potential cancer-causing agents, and the timing of the diagnosis of cancer in relation to the exposure. These issues are discussed below as they relate to the request.

Do more BLIA TSA workers have more cancer than people who do not work in the TSA?

Because cancer is a common disease, cancer may be found among people at any workplace. In the United States, one in two men and one in three women will develop cancer over the course of their lifetimes. These numbers do not include basal or squamous cell skin cancers, which are very common (over 1 million diagnosed annually), or any in-situ carcinomas other than bladder. (In-situ refers to cancer that has not yet spread beyond where it began; it is considered a precursor form of cancer.) If these were included, rates would be even higher. When several cases of cancer occur in a workplace they may be part of a true cluster when the number is greater than we expect compared to other groups of people similar with regard to age, sex, and race. Disease or tumor rates, however, are highly variable in small populations and rarely match the overall rate for a larger area, such as the state, so that for any given time period some populations have rates above the overall rate and other have rates below the overall rate. So, even when there is an excess, this may be completely consistent with the expected random variability. In addition, calculations like this make many assumptions, which may not be appropriate for every workplace. Comparing rates without adjusting for age, sex, or other population characteristics assumes that such characteristics are the same in the workplace as in the larger population, which may not be true. However, 15-25 cases of cancer over 9 years among approximately 1100 employees are not an excess of cancer.

Is there an unusual distribution of types of cancer?

Cancer clusters thought to be related to a workplace exposure usually consist of the same types of cancer. When several cases of the same type of cancer occur and that type is not common in the general population, it is more likely that an occupational exposure is involved. When the cluster consists of multiple types of cancer, without one type predominating, then an occupational cause of the cluster is less likely. There were a variety of cancers reported among TSA employees, and they were among the most common types diagnosed in the United States. No cases of thyroid cancer or leukemia were reported (the thyroid and bone marrow are the most radiosensitive organs).

Is there exposure to a specific chemical or physical agent known or suspected of causing cancer occurring?

The relationship between some agents and certain cancers has been well established. For other agents and cancers, there is a suspicion but the evidence is not definitive. When a known or suspected cancer-causing agent is present and the types of cancer occurring have been linked with these exposures in other settings, we are more likely to make the connection between cancer and a workplace exposure. The NIOSH report on radiation exposures at BLIA noted a median dose of 0.4 mrem, which is far below the dose limits for the general public. The average amount of radiation a person living in the United States is exposed to is 360 mrem, the majority of which is from radon [Idaho State University 2008]. Guidelines for occupational and public exposure to radiation are outlined in the table below.

Occupational and Public Radiation Dose Limits[a]	DOE[b]	NRC[c]	OSHA[d]	NCRP[e,f] (1993)	ICRP[g] (1991)
Occupational					
Whole body (deterministic)[h]	5,000 mrem per year	5,000 mrem per year	1,250 mrem per quarter for the whole body (head and trunk; active blood-forming organs or gonads)	5,000 mrem per year	2,000 mrem per year average over 5 years (10,000 mrem in 5 years), not to exceed 5,000 mrem in any single year
Lens of eye	15,000 mrem per year	15,000 mrem per year	1,250 mrem per quarter	15,000 mrem per year	15,000 mrem per year
Hands, forearms; feet and ankles	50,000 mrem per year	50,000 mrem per year	18,750 mrem per quarter	50,000 mrem per year	50,000 mrem per year
Skin	50,000 mrem per year	50,000 mrem per year	7,500 mrem per quarter	50,000 mrem per year	50,000 mrem per year
Embryo-fetus of pregnant worker[i]	500 mrem per gestation period	500 mrem per gestation period	No limit established	50 mrem per month over gestation period	200 mrem per gestation period
Cumulative	No limit established	No limit established	5,000 (N-18) mrem N=age (y)	1000 mrem x age (y)	No limit established
Public					
Whole body (deterministic)[g]	100 mrem per year for members of the public entering a controlled area	100 mrem per year from licensed operation; *or* 2 mrem per hour from any unrestricted area	No limit established	100 mrem for continuous exposure *and* 500 mrem for infrequent exposure	Annual average over 5 years not to exceed 100 mrem
Lens of eye, skin, and extremities[j]	No limit established	No limit established	No limit established	5000 mrem	1,500 mrem to lens of eye *and* 5,000 mrem to skin, hands, and feet
Negligible Individual Dose	No limit established	No limit established	No limit established	1 mrem annual effective dose per source of practice	No limit established

a. The dose limits are reported in the conventional units (mrem) to be consistent with the U.S. regulations.
b. The Department of Energy.
c. The Nuclear Regulatory Commission (NRC) states that if members of the public are continuously present in an unrestricted area, the dose from external sources cannot exceed 0.002 rem in an hour and 0.05 rem in a year.
d. OSHA occupational dose limits are reported in terms of dose equivalent per calendar quarter and apply only to individuals who work in a restricted area. Restricted area means any area that is controlled by the employer for purposes of protecting individuals from exposure to radiation or radioactive materials. Minors are restricted to 10% of the limits shown.
e. National Council on Radiation Protection.
f. NCRP 116 also states "new facilities and the introduction of new practices should be designed to limit annual effective doses to workers to a fraction of the 1,000 mrem/year implied by the lifetime dose limit."
g. International Commission on Radiological Protection.
h. Occupational and public deterministic dose limits (except OSHA) are reported in terms of annual effective dose (E); the cumulative dose limit is a cumulative effective dose limit. The effective dose ($E=w_R H_T$) is intended to provide a means for handling nonuniform irradiation situations. The tissue-weighting factor (w_T) takes into account the relative detriment to each organ and tissue including the different mortality and morbidity risks from cancer. In other words, the risks for all stochastic effects will be the same whether the whole body is irradiated uniformly or not.
i. Embryo-fetus dose limit is an equivalent dose (H_T) limit in a month once pregnancy is known. The equivalent dose limit is based on an average absorbed dose in the tissue or organ (D_T) and weighted by the radiation weighting factor (w_R) for radiation impinging on the body ($H_T=w_R D_T$).
j. Lens of eye, skin, and extremity dose limit is an annual equivalent dose limit.

Has enough time passed since exposure began?

The time between first exposure to a cancer-causing agent and clinical recognition of the disease is called the latency period. Latency periods vary by cancer type, but usually are a minimum of 10-12 years [Rugo 2004]. For example, it can take up to 30 years after exposure to asbestos for mesothelioma to develop. Because of this, past exposures are more relevant than current exposures as potential causes of cancers occurring in workers today. There was an average of 5 years from date of employment to diagnosis of cancer among the 15 employees reported with cancer (range: 3-7 years). Most importantly, since I did not find an excess of cancer and or any significant hazardous exposures, latency is not a factor.

Conclusions and Recommendations

Based on several pieces of evidence noted in this report, we believe that it is unlikely that the cancers reported are associated with exposures from the TSA baggage screening machines at BLIA. We found that the number of employees with cancer was not above the expected rates overall, and the specific types of cancer diagnosed among TSA employees are varied and among the most common in the general population. Moreover, while the work inherently involves being in the area where ionizing radiation from the x-ray machines is present, the doses to TSA employees are not at the levels to be a health concern. In fact, when we compare the doses to the natural background radiation we all experience in our daily lives, the doses recorded are negligible. Based upon the commonality of cancer in the United States, TSA employees will continue to be diagnosed with cancer of all types, especially as the workforce ages.

Although cancers among the employees and their families are not likely due to their work, employees may have concerns about their own risk for cancer. Therefore, I recommend that you take this opportunity to encourage employees to learn about the following:

- Known cancer risk factors
- Measures they can take to reduce their risk for preventable cancers
- Availability of cancer screening programs for certain types of cancer

The American Cancer Society posts information about cancer on its website, www.cancer.org. For general information, click on "All about cancer" under "Patients, Family, & Friends." For information about a specific type of cancer, click on "Choose a cancer topic," select a type of cancer, then click "Go." Additionally, NIOSH posts information about occupational cancer and cancer cluster evaluations on its website at http://www.cdc.gov/niosh/topics/cancer/.

Employees can take an active role in changing personal risk factors that are associated with certain types of cancer. In fact, the American Cancer Society estimates over 60% of cancer deaths in the United States in 2009 were preventable [American Cancer Society 2009b]. In 2009, tobacco use alone caused an estimated 169,000 cancer deaths. It is well known that tobacco use is the single largest preventable cause of disease and increases the risk of 13 cancers: lung, mouth, nasal cavities, larynx, pharynx, esophagus, stomach, liver, pancreas, kidney, bladder, uterine cervix, and myeloid leukemia. High alcohol consumption, a diet low in fruits and vegetables, physical inactivity, overweight, and obesity are other modifiable personal risk factors that increase the risk of certain cancers. In fact, approximately one third of all cancer deaths in 2009 were related to poor nutrition, physical inactivity, and a high body mass index (BMI, a relationship between weight and height associated with body fat and health risk). Abundant scientific evidence shows that higher levels of BMI are associated with an increased risk of 15 types of cancer: esophagus, stomach, colorectal, liver, gallbladder, pancreas, prostate, kidney, non-Hodgkin lymphoma, multiple myeloma, leukemia, breast, uterus, cervix, and ovary.

Another significant way for employees to prevent morbidity and mortality from cancer is to get cancer screening tests recommended for persons of their age and/or gender (i.e., colonoscopies for colon cancer screening). Employees need to discuss available cancer screening programs with their primary care physicians. This can lead to earlier detection of cancers and earlier treatment, which may increase the chances of curing the disease.

I hope this information is helpful to you. This letter closes this HHE. A copy of this letter is being provided to the Occupational Safety and Health Administration Region 1 Office and the Massachusetts Department of Public Health. I encourage you to share this letter with concerned employees and their dependents. Thank you for your cooperation with this evaluation.

Sincerely yours,

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