BLADDER CANCER AND EMPLOYMENT IN THE PITTSFIELD MASSACHUSETTS AREA II:

A Follow-up Survey of Bladder Cancer Cases

Conducted by:

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and

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Division of Occupational Hygiene

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SUMMARY

In February 1988, the Massachusetts Department of Public Health (DPH) reported excess bladder cancer among Pittsfield males and among city area males who had worked at the General Electric Company (GE) in Pittsfield. The current follow-up case survey was undertaken by DPH, together with the Massachusetts Department of Labor and Industries (DL&I), in order to generate leads about specific occupational exposures which might account for the increased bladder cancer incidence.

Interviews were conducted with 97 Health Service Sub-Area (HSA) 1.1* males diagnosed with bladder cancer between 1982-86 or with their next-of-kin. Lifetime work histories, as well as information about smoking, residence and exposure to known or suspect occupational bladder carcinogens was obtained. The major findings are:

- Employment in industries which have been found in previous epidemiological studies to have increased bladder cancer risks, such as textile, leather and rubber, did not appear to account for the excess bladder cancer incidence among Pittsfield males.
- With the exception of GE, no single company ever employed more than two of the Pittsfield cases. A total of 54% (52 cases) of the interviewed bladder cancer cases had worked at GE for at least six months. It is not known whether this proportion

* Health Service Sub-Area 1.1 includes all of Berkshire County, as well as the towns of Monroe and Middlefield, which are part of Franklin and Hampden Counties, respectively.

is higher than the proportion of present or past GE workers among Pittsfield area men.

- Several of the GE cases reported occupational exposure to materials potentially containing bladder carcinogens, including: 1) an epoxy containing MBOCA, an aromatic amine curing agent which is a suspect human bladder carcinogen; and 2) dyes used in the plastics division. It is not known whether these dyes contained aromatic amines known to cause bladder cancer in humans.
- A number of the GE cases reported exposure to cutting fluids and to transformer oils. These findings are inconclusive. There is limited evidence of an association between bladder cancer and cutting fluids in the epidemiological literature. There is no previous evidence of an association between bladder cancer and transformer oils.
- Twelve HSA 1.1 cases reported exposure to dyes or freshly dyed materials in the textile, leather, paper and printing industries. It is not known whether these dyes contained aromatic amines known to cause bladder cancer. Only one of these cases was a Pittsfield resident. While dye exposures in these industries do not appear to account for the excess of bladder cancer among Pittsfield males, they may have contributed to bladder cancer incidence in the remainder of HSA 1.1.

This survey was not intended as an etiologic study and provides no evidence of a causal association between bladder cancer and occupational exposures among GE workers or HSA 1.1

residents at large. Employment information reported by cases has, however, generated several leads about possible occupational risk factors for bladder cancer in the Pittsfield area. On the basis of the survey findings, DPH and DL&I make the following recommendations:

1. GE should identify all materials containing MBOCA or other aromatic amine curing agents, all aromatic amine dyes, and all other materials containing known or suspect bladder carcinogens, which are being used currently or have been used in the past. For each material, the following information should be determined: 1) product name; 2) chemical composition; 3) information on its use, including locations, time periods, and processes; 4) any available exposure measurements and industrial hygiene evaluations pertaining to the material; and 5) employees exposed directly and indirectly. This information should be made available to the local union (International Union of Electrical Workers, Local 255), DPH, and DL&I.

2. If it is found that some GE workers may be at high risk of bladder cancer due to exposure to known or suspect bladder carcinogens, these current employees or former workers should be informed and a bladder cancer screening program should be developed. Any screening program for these potentially high risk workers should be developed by GE in collaboration with the union and the local medical community. Screening protocols should be reviewed by experts from the National Institute for Occupational Safety and Health.

3. DPH shall provide HSA 1.1 physicians with information regarding both occupational and non-occupational risk factors for bladder cancer. In addition, DPH shall make available to physicians educational material on bladder cancer which they may distribute to their patients.

4. Residents of HSA 1.1 who have worked or are currently working with potential bladder carcinogens, most notably those exposed to dyes or freshly dyed materials in the textile, paper, leather or printing industries, should consult their physicians regarding these and other risk factors. Recently passed state and federal Right-to-Know laws give workers legal access to information about materials they work with. Workers concerned about current occupational exposures should obtain information about potential hazards from their employers.

5. Early detection of bladder cancer may reduce subsequent morbidity and mortality. The major symptom of bladder cancer is blood in the urine. This symptom may also be caused by other medical conditions, such as infection. Anyone who finds blood in their urine is advised to see a physician immediately.

INTRODUCTION

Routine analysis of Massachusetts Cancer Registry (MCR) data for 1982-1985 revealed an excess incidence of bladder cancer among male residents of Pittsfield.[1] Bladder cancer was not elevated among Pittsfield females.

Further analysis, using the limited occupational information reported to the MCR, suggested that this excess may be related to employment at the General Electric Company (GE) in Pittsfield.[2] Male residents of the Health Service Sub-Area (HSA 1.1)* in which Pittsfield is located who reported GE as their usual employer had a statistically significant excess (two-fold) of bladder cancer compared to the rest of the state. The risk was further elevated (four-fold) in those aged 55-64 years, which is younger than the average age at diagnosis of bladder cancer in the general population (68 years), suggestive of a possible occupational etiology.[3] Similar findings were observed controlling for cigarette smoking and residence in Pittsfield. No other type of cancer was elevated among reported GE workers.

GE is the largest employer in the area and has three industrial divisions: transformer, ordnance, and plastics. It was not possible on the basis of the occupational information contained in MCR reports to distinguish between individuals employed in the three divisions or to determine whether they had

* Health Service Sub-Area 1.1 includes all of Berkshire County as well as the towns of Monroe and Middlefield which are part of Franklin and Hampden Counties, respectively.

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occupational exposures in common.

As follow-up, the Massachusetts Departments of Public Health (DPH) and Labor and Industries (DL&I) initially proposed a study linking the cancer cases with GE employment records to obtain and compare detailed work histories. However, this proposal was abandoned for several reasons. These included: the confidential nature of both MCR and company employment records; reports by the company that complete work histories were not available for all workers; and the complexity of dealing with records maintained by three corporate divisions.

In the present follow-up survey, interviews were conducted with male HSA 1.1 bladder cancer cases or their next-of-kin to obtain detailed work histories, as well as smoking and residential information. The purpose of this case series survey was to generate hypotheses about specific occupational exposures which might have contributed to the bladder cancer excess among Pittsfield males or among city area GE workers. This information will be used to determine the advisability of further epidemiologic study and other follow-up activities, such as bladder cancer screening.

There is evidence that early detection of bladder cancer may reduce resulting morbidity and mortality, and screening tests to detect bladder cancer in its early stages are available.[3] The possibility of bladder cancer screening of GE workers was raised in response to the findings of the initial report. Screening, however, is not advisable unless a well-defined high risk group

can be targeted.[4] Information about occupational exposures collected from cases in the present survey will be used to determine whether a specific group of workers, potentially at high risk of developing bladder cancer, can be identified for screening.

It should be emphasized that this survey was intended to generate hypotheses about plausible occupational risk factors for bladder cancer, and is not an etiological study designed to identify causal associations between bladder cancer and occupational exposures.

RISK FACTORS FOR BLADDER CANCER

Occupational:

Bladder cancer is one of the most well-established occupational cancers. It has been estimated that approximately 20% of bladder cancer in males may be due to occupational exposures.[3] Findings regarding occupational risk factors for bladder cancer are summarized below.

1. Dye Manufacturing and Use

Several aromatic amines used as intermediates in dye manufacturing, most notably benzidine and 2-naphthylamine, are well-established as potent human bladder carcinogens. Dyes containing other aromatic amines which are structurally similar to benzidine may also be bladder carcinogens, since these chemicals are metabolized to benzidine in the body.[3]

Workers manufacturing aromatic amine dyes have been known to be at increased risk of bladder cancer since 1895.[5,6] Excess bladder cancer has also been consistently noted in the textile, leather and chemical industries, where exposure to aromatic amine dyes is believed to be responsible. Benzidine-based dyes are also used in the paper industry.[7] Several studies have shown small excesses (not statistically significant) among paper manufacturing workers.[8,9,10,11]

2. Rubber and Electric Cable Manufacturing

Workers in the rubber industry have consistently been shown to be at increased risk of bladder cancer. Antioxidants containing aromatic a[illegible] to retard perishing of the rubber, are the suspected caus[illegible]s.[12] Excess bladder cancer observed [illegible] electric cable workers may also be due to exposure to antioxidants used for rubber insulation of cables.[13]

3. Curing Agents for Resins

4,4'-Methylene-bis-2-chloroaniline (MBOCA), an aromatic amine used as a curing agent for polyurethanes and epoxy resins,[14] is a suspect human bladder carcinogen. Although manufacture of MBOCA in the U.S. ceased in 1979, it is still used in production. MBOCA is structurally similar to benzidine and has similar potency to induce bladder tumors in beagle dogs,[15] the species considered to be the best animal model for humans. The only human evidence to date is based on several case reports of bladder tumors in workers exposed to MBOCA during its production.[16] It is not known whether exposure to MBOCA in curing processes may also increase risk.

Another aromatic amine curing agent, 4,4'-Methylene-dianiline (MDA), is also a suspect bladder carcinogen. It is primarily used to produce polyurethane foams and is also used as a curing agent for epoxy resins in the production of wire-coating enamels.[17] MDA is structurally similar to benzidine and has been found in one study to produce bladder tumors in rats and mice.[18]

Workers potentially exposed to MDA in helicopter manufacturing were found to have excess bladder cancer in one study.[19]

4. Cutting Fluids

There is some evidence that exposure to cutting fluids may increase the risk of bladder cancer. Excess bladder cancer has been observed among machinists or workers exposed to specific types of cutting fluids in a number of epidemiological studies with risk estimates ranging from 1.5 to 5.0.[20,21]

Several carcinogenic substances found in cutting fluids have been suggested as potential causal agents.[22] Polyaromatic hydrocarbons (PAHs) and nitrosamines, both animal carcinogens, can form when the oils are subjected to high temperatures during some machining operations. Chlorinated paraffins, which are added to many insoluble oils as pressure agents, cause cancer in animals. Certain aromatic amine compounds added as antioxidants may also be carcinogenic.

5. Other occupations or industries

A number of other occupational groups have been shown to have excess bladder cancer, although the causal agents have not been identified. Excesses have been observed consistently in several of these occupations, including: cooks and kitchen workers, printers, painters, and truck drivers.[3]

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Non-occupational:

The only well-established non-occupational risk factor for bladder cancer is cigarette smoking. Bladder cancer occurs approximately [illegible] times more often among cigarette smokers than non-smokers.[4] It is estimated that as much as 40% of bladder cancer may be attributed to cigarette smoking.[23] There is some evidence that the combination of occupational exposures and cigarette smoking may have a synergistic effect.[24]

Suspect non-occupational risk factors for bladder cancer include the use of the pain killer phenacetin and several cancer therapeutic agents. Previous bladder infections and pelvic irradiation may also increase risk. The consumption of coffee and artificial sweeteners have been associated with bladder cancer, but recent studies have not supported these associations.[23] There is suggestive evidence from several studies that there may be an association between drinking chlorinated water and bladder cancer.[25] There has also been one study which suggested that nitrates and nitrites found in non-public water sources may also increase the risk of bladder cancer.[26]

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METHODS

Cases:

All male bladder cancer cases (International Classification of Diseases for Oncology[27] [ICD-O] code 188, except 188.7) reported to the MCR who were diagnosed in Massachusetts between January 1, 1982 and December 31, 1986, and who were residents of HSA 1.1 at diagnosis, were eligible for participation in this survey. HSA 1.1 was chosen as the area of analysis in order to include cases who may have worked at GE but lived outside of the city. Vital status of the cases at the time of survey was determined by searching the Massachusetts Death Certificate files for 1982-1988 and by contact with the diagnosing physicians. Permission to contact the living cases was requested from their physicians. For cases who had died, next-of-kin to be interviewed were identified from the death certificates.

Plant Observation:

In response to the findings of the initial report, the DL&I conducted a walk-through of selected buildings at the current GE facility in Pittsfield. Information obtained from the walk-through and from discussions with GE management and local union representatives was used to help develop questions specific to GE for incorporation in the interview questionnaire.

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Interviews:

Letters describing the survey were sent to cases or their next-of-kin. These letters were followed by telephone calls to request participation. Interviews with cases were conducted in-person; however, if this was inconvenient, telephone interviews were carried out. All next-of-kin were interviewed by telephone. In several instances where direct interviews were not feasible, mailed questionnaires were used. Interviews were carried out by occupational health specialists from the DL&I and DPH using a structured questionnaire.

The interviewers collected occupational, smoking and residential histories, and occupational exposure information. The occupational history included the following information about all jobs held for at least six months: employer, type of industry, department, job title, years of employment, duties, and materials handled. Additional information on division and building was requested for GE workers because of the three different industrial divisions and many locations of employment within the Pittsfield facility.

Participants were also asked specifically about their occupational exposure to the following known or suspect bladder carcinogens and materials or processes potentially involving bladder carcinogens.

Known or suspect bladder carcinogens:

- MBOCA
- MDA
- dyes containing 2-naphthylamine or benzidine

Materials potentially containing known or suspect bladder carcinogens:

- resins, epoxies, plastics, enamels, polyurethanes, and plastic or epoxy coated paper and wire
- dyes, not specified

Processes potentially involving exposure to bladder carcinogens:

- handling of dyed materials
- working in the rubber industry or producing rubber-coated products
- machining with or other use of cutting oils

History of occupational exposure to transformer oils was also obtained. Transformer oils containing polychlorinated biphenyls (PCBs) were used extensively at GE, and public concern has been expressed about potential health effects of PCB exposure among GE workers and the Pittsfield community at large. To date, there is no human or animal evidence of an association between bladder cancer and PCB exposure.[28]

Smoking information collected was limited to cigarettes only and included years smoked and the average amount smoked. The

residential history recorded all places and years of residence since 1940.

For some of the cases, similar interviews obtaining occupational, smoking, and residential information had already been conducted in 1987 by the Environmental Health Institute (EHI) as part of a previous case-control study of bladder cancer in Pittsfield.[29] Of these cases, 15 agreed to have EHI release this information to DPH, in order to avoid duplication of effort. These patients were contacted to review the information and to obtain more detailed information on exposures to occupational bladder carcinogens.

Occupational Classification:

In order to evaluate whether the cases had similar occupational exposures, they were grouped in the following ways: 1) by reported exposure to known or suspect bladder carcinogens and materials or processes potentially involving bladder carcinogens; 2) by occupation and industry title; and 3) by employer. Job information was examined in detail for cases who reported similar exposures, or who had the same occupation, industry, or employer.

Prior to the analysis by occupation and industry titles, nine high risk groups were identified based on reports in the literature of excess bladder cancer in these groups. These included 1) jobs where specific etiologic agents are fairly well-established: cable manufacturers, dye users, and leather,

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printing, and textile workers; and 2) jobs for which etiologic agents are unknown but which have consistently been shown to be at increased risk: cooks and kitchen workers, painters, and truck drivers.[3] Paper industry workers were added as a tenth high risk group because of the documented use of benzidine-based dyes in this industry.[7]

Latency, as used in this report, is defined as the length of time, measured in years, between first reported exposure or first employment in a specific job and date of diagnosis of bladder cancer. It is necessary to consider latency in evaluating if a particular exposure is potentially related to bladder cancer; an exposure can only be regarded as a possible cause of bladder cancer if sufficient time has passed between first exposure and onset of cancer. Previously reported latency periods for occupational bladder cancer range from four to over 40 years with a mean of approximately 20 years.[3]

Residence:

The primary purpose of this survey was to generate hypotheses about possible occupational risk factors for bladder cancer in the Pittsfield area. However, in order to explore the possibility of an environmental cause of the Pittsfield bladder cancer excess, the distribution of cases by area of residence within the city was examined using two methods.

First, the usual Pittsfield address (address of longest duration) for the period 10-40 years prior to diagnosis for each

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case (estimated as the most relevant latency period) was plotted on a map to look for patterns of clustering within the city.

Second, street addresses at the time of diagnosis were plotted for the Pittsfield bladder cancer cases and all Pittsfield male colorectal cancer cases reported to the MCR during the same time period. The purpose of this mapping was to examine whether the bladder cancer cases were more likely than other cancer cases to have lived in a specific area of the city.

RESULTS

The MCR received 129 reports of bladder cancer diagnosed in Massachusetts between 1982-1986 among male residents of HSA 1.1. At the time of interview, 78 were living and 51 were deceased. A total of 111 cases or next-of-kin were located and contacted. Of these, three were too sick to be interviewed, and 14 refused to participate. Ninety-four individuals (60 cases, 34 next-of-kin) were interviewed by our staff and information was available for five additional cases (2 cases, 3 next-of-kin) interviewed by EHI. Two interviews were determined to be unusable. Valid interview information was available for 97 cases, yielding a participation rate of 75%.

The age at diagnosis for all interviewed cases ranged from 37 to 92 years, with a mean of 68.3 years. Ninety-seven percent of the cases were diagnosed with transitional cell carcinoma, which is consistent with national cancer statistics.[30] Forty-five percent of the cases were Pittsfield residents at diagnosis. Cases for whom interview information was not available were similar to those interviewed with respect to age, residence at diagnosis, and histology.

Cigarette Smoking:

Of the 97 cases interviewed, 55% were former smokers, 35% were current smokers, and 10% were non-smokers. More than half of those who had been reported as non-smokers in the MCR were

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actually former smokers according to the interviews. This is consistent with previous findings that many individuals reported as non-smokers in the MCR are really former smokers.

The proportion of cases who ever smoked (90%) is higher than that for the general population (60%),[31] but is consistent with that observed among other groups diagnosed with bladder cancer.[32,33,34]

Reported Occupational Exposures:

The number of cases reporting occupational exposure to known or suspect bladder carcinogens and materials or processes potentially involving bladder carcinogens is presented in Table 1. Individuals who reported more than one exposure are counted in each category. All but three of the cases, as noted in the table, were current or former smokers. With few exceptions, next-of-kin could not provide any detailed information about occupational exposures; thus, specific exposure information is missing for approximately a third of the 97 cases.

Known or Suspect Bladder Carcinogens

One person reported exposure to MBOCA, a suspect human bladder carcinogen, which he used as a hardener in a two-part epoxy system in the transformer industry. No one reported working with MDA or dyes specified as benzidine-based.

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Materials Potentially Containing Known or Suspect Bladder Carcinogens

A total of eight cases reported exposure to resins potentially containing MBOCA or MDA as curing agents. Five had worked in the transformer industry and three in plastics. All reported being exposed on a regular basis to epoxies, plastics or resins. Six additional cases, not included in the table, had used epoxies periodically for repair work in various industries such as construction and auto repair. It is unlikely that the quick drying epoxies typically used for these purposes would contain MBOCA or MDA [Personal communication: Robert Herrick, NIOSH].

Four cases reported use of dyes. Three had worked in the plastics industry adding dyes to plastics compounds (2) or mixing inks for painting on plastics (1). One had worked in the textile printing industry mixing colors for dyes. Cases did not provide any information about the chemical composition of the dyes or the types used.

Processes Potentially Involving Exposure to Bladder Carcinogens

Ten additional cases reported exposure to dyed materials in the textile (3), textile printing (2), paper (4), or printing (1) industry. Also, one of the plastics workers who used dyes, described above, reported exposure to dyed materials in two other jobs in the textile and leather industries. All of these jobs entailed possible exposure to dyes or dye mists through contact with printing inks or recently dyed yarns, cloth, paper, or

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leather.

No cases reported working in the rubber industry or in producing rubber coated products.

Twenty-three cases reported exposure to cutting fluids. Sixteen had used these fluids for machining parts in the: transformer (7), ordnance (2), textile machinery (2), toolmaking (1), instruments (1), electronics (1), railroad (1), and aircraft (1) industries. Five had used them for cutting and threading pipes in the plumbing (2), hardware supply (2), or electrical (1) industry. One optometrist reported use of cutting fluids for a lens grinding machine.

Of the 37 cases who reported exposure to at least one potential bladder carcinogen, 13 were Pittsfield residents at diagnosis. Nine of these 13 reported that they had been exposed to the materials or processes in question while working for GE. (Exposures reported by GE workers are discussed further in a subsequent section). The remaining four Pittsfield cases who reported exposure included: one paper worker exposed to dyed materials, and three workers exposed to cutting fluids in various industries.

Transformer Oils

Seventeen cases reported occupational exposure to transformer oils. They had all worked in the transformer division at GE. This is discussed in detail in a subsequent section.

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Occupation and Industry:

The distribution of cases who worked in occupations or industries considered to be at increased risk of bladder cancer is presented in Table 2. Individuals who worked in more than one high risk job are counted in each category.

There were three cooks or kitchen workers, four dye users (described previously under exposure to dyes), three leather workers (one described previously under exposure to dyed materials), two painters, one printing worker (described previously under exposure to dyed materials), 13 textile workers (8 described previously under exposure to dyes or dyed materials), and five truck drivers. The two additional leather workers were: a shoe manufacturer who made soles and a hide toggler. The five additional textile workers who did not report exposure to dyes or dyed materials worked in jobs where dye exposure was unlikely (for example, cotton carding machine operator).

There were no more than three cases who were Pittsfield residents at diagnosis in any of the high risk job categories. As shown in Table 3, the Pittsfield cases were no more likely than non-Pittsfield cases to have ever worked in high risk jobs. Pittsfield cases actually appeared less likely to have worked in high risk jobs, but this difference was not statistically significant.

Of the 32 cases who worked in at least one high risk job, 47% were less than 65 years old at diagnosis, compared to 28% of those who did not report high risk employment. This finding is

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consistent with reports in the literature that individuals with occupationally-related bladder cancer tend to be younger at diagnosis.[3]

Employers:

A review of the occupational histories revealed three employers for which more than three cases reported ever working. These included: GE in Pittsfield (49 cases), Sprague Electric in North Adams (8 cases), and Arnold Printworks in Adams (4 cases). The Sprague workers, none of whom had ever lived in Pittsfield, all had different jobs and no consistent pattern in reported exposures or years of employment at Sprague was observed. One was a toolmaker who used cutting fluids and one was a millwright who reported limited use of epoxies. Two of the Arnold Printworks workers reported exposure to dyes (dye mixer) or dyed materials (calender operator). The other two were a janitor who cleaned the offices and a shipping clerk with no reported exposures. None of the four were Pittsfield residents. Arnold Printworks is no longer in existence.

General Electric Company:

Because of the finding in the initial report of a potential excess of bladder cancer among GE workers, job information was further examined for those cases ever employed by GE. A total of 49 (51%) of the interviewed cases reported working for GE for at least 6 months. An additional three cases (3%) had worked at GE

while employed by another entity: a union plumber, an electrician, and a Navy cost inspector. Of these 52 "GE cases", 39 had worked there for at least two years during the period 10-40 years prior to diagnosis. The remaining 13 cases had worked at GE in the 1920's, 30's, or early 40's. None had entered employment at GE within 10 years prior to diagnosis.

The age at diagnosis of the 52 GE cases ranged from 37 to 82 years with a median of 67 years. These cases were slightly younger than the non-GE cases but this difference was not statistically significant. As shown in Table 4, the GE and non-GE cases were similar with respect to smoking status at diagnosis.

Of the interviewed cases who had lived in Pittsfield at diagnosis, 70% had at some time worked at GE. It is not known whether this proportion is higher than what would be seen in the Pittsfield community at large, given that GE is the largest employer in the area. Also, it is possible that cases who worked at GE were more likely than non-GE cases to participate in the interviews which would overestimate the proportion of Pittsfield cases who were GE workers; however, this could not be determined in the present survey.

The GE cases were grouped by 1) division (transformers, plastics, and ordnance); 2) building; and 3) job title. The distribution of GE cases by division is presented in Table 5. The majority of the cases worked in transformers, as would be expected, since historically this has been the largest of the

three divisions. From 1960 through 1970, the transformer division employed approximately 81% (8,900) of all Pittsfield GE workers, whereas the ordnance and plastics divisions employed approx[illegible] 000) and 1% (100) respectively [Personal communication: [illegible]ne, GE].

There have be[illegible] buildings at the GE Pittsfield facility, the first of [illegible] built in 1901. Over the years, industrial processes carri[illegible] the buildings have changed and some buildings have been [illegible]n. Transformer workers reported working in 30 differe[illegible]ings, ordnance workers in three buildings, and plastics workers in three buildings. Job titles for cases reporting working in buildings in which there were five or more cases are presented in Table 6. No notable clustering of job titles within buildings was observed.

There are hundreds of different job titles used at GE and these have also changed over time. The 52 GE workers reported working in 91 different jobs which fell into 57 different job titles. The only jobs which had more than three cases were welder (4) and machinist (10).

The distribution of GE cases by reported exposures is presented in Table 7. Individuals who reported more than one exposure are counted in each category, with one exception: the MBOCA exposed case reported use of several epoxies, one of which contained MBOCA, but he is only listed once under MBOCA to avoid confusion. As stated earlier, next-of-kin, for the most part, could not provide details about specific exposures. Therefore,

the actual numbers of exposed cases are probably underestimated.

One worker reported use of a two-part epoxy system containing MBOCA. He reported using this epoxy in two different buildings in the transformer division in the early 1970's for two years, and indicated that he had dermal contact with the epoxy product. An additional case, who was 37 years old at diagnosis, reported that he had worked in one of these buildings during the same time period and also used a two-part epoxy system, but did not know if it contained MBOCA. Three other GE cases reported use of epoxies but did not report working in either of these buildings during those years. Only one other GE case did report having worked in these buildings during this time period, but he did not report epoxy use.

It is notable that the latency period for the individual who reported exposure to MBOCA (13 years) and for three of the other four workers who reported exposure to epoxies (14-16 years) is consistent with latencies recently reported for bladder cancer cases exposed to MBOCA in a MBOCA production plant (8, 11, and 16 years).[16]

It is not known to what extent or in what buildings products containing MBOCA may have been used at GE. The use of MBOCA in GE's ordnance division was mentioned by a GE representative during DL&I's industrial hygiene walk-through of the facility. Both he and the MBOCA exposed case reported that the company discontinued use of MBOCA.

Two GE cases reported exposure to dyes while working in the

plastics division, prior to 1968: a banbury operator and a mold maker. Whether these were aromatic amine dyes was not known. These two workers were also exposed to resins, as was one additional case. The extent to which dyes were used at GE is not known.

Twelve GE cases reported exposure to cutting fluids while working at the company. Seventeen GE cases reported exposure to transformer oils while working as: transformer assemblers (4) or testers (2), maintenance workers (2), electricians (2), a machinist (1), a serviceman (1), a coil taper (1), a welder (1), a plumber (1), a transposing machine operator (1), and a pyranol mixer (1). It cannot be determined from the present survey whether bladder cancer cases are more likely than other GE workers to have been exposed to cutting fluids or transformer oils. Since both of these products were used widely in the production processes at GE, it is likely that a substantial proportion of all GE workers were exposed to these substances.

The occupational histories of GE workers were examined to determine whether they had held high risk jobs before or after their employment at GE. Of the 52 GE cases, 16 had worked in high risk occupations as: cooks (3), leather workers (2), a painter (1), paper manufacturing workers (3), textile workers (6), and a truck driver (1). Four of these textile workers reported exposure to dyed materials. It is possible that occupational exposures outside of GE contributed to bladder cancer incidence in the population defined as ever GE workers.

Residence:

Of the cases interviewed, 56 (59%) lived in Pittsfield at some time prior to diagnosis. In order to determine whether there was any clustering of cases within Pittsfield, the usual Pittsfield address during the period 10-40 years prior to diagnosis for each case (as determined from the interview data) was plotted on a map. There did not appear to be any unusual clustering of cases by area of the city.

Street addresses at the time of diagnosis were plotted for the 58 bladder and 106 colorectal cancer cases reported to the MCR among male Pittsfield residents. The bladder cancer cases were no more likely than the colorectal cases to have lived in a specific quadrant of the city.

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DISCUSSION

In this case survey, we obtained work histories from HSA 1.1 male bladder cancer cases or their next-of-kin in order to generate hypotheses about possible occupational risk factors for bladder cancer among Pittsfield males and among city area GE workers. Not all cases were interviewed and specific exposure information was incomplete, especially that provided by next-of-kin. Therefore, it is likely that the number of cases exposed to potential bladder carcinogens or having worked in high risk job categories is underestimated.

On the basis of the available information, no single known or suspect occupational bladder carcinogen was identified as a plausible explanation for the excess risks of bladder cancer observed previously. The data do suggest, however, that several different occupational exposures may have contributed to the bladder cancer incidence in the area.

Several Pittsfield cases had worked in jobs which have previously been shown to increase the risk of bladder cancer, including textile and leather workers. However, Pittsfield residents were no more likely than non-Pittsfield residents to have worked in these high risk jobs. While exposures in these jobs may have contributed to bladder cancer incidence among HSA 1.1 residents, these exposures alone do not appear to account for the excess in Pittsfield.

The textile industry stands out as the high risk industry in

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which the largest number of cases (13) reported having worked. This finding is inconclusive because the textile industry was once a predominant industry in the area, and it is very likely that a substantial proportion of the population at large had at some point worked in the textile mills. However, excess bladder cancer has been previously observed among textile workers, and it is very possible that exposures to dyes or freshly dyed materials in the textile industry contributed to bladder cancer incidence in the HSA 1.1 population. It should be noted that only two of the Pittsfield cases reported having worked in the textile industry; thus, exposures in the textile industry alone could not account for the increased incidence of bladder cancer among Pittsfield residents.

The large number of cases who worked for GE draws attention to this company. However, since GE is the largest employer in the Pittsfield area, the finding that 54% of the interviewed cases had worked for GE cannot be interpreted without knowing what proportion of the community at large has ever worked for the company.*** There was no notable clustering of workers by GE buildings or job titles; it is unlikely that any more detailed analysis by job titles and buildings would be fruitful without specific exposure information.

The exposures reported by GE workers, however, did generate two hypotheses about possible occupational risk factors for

*** However, based on available MCR occupational data, more HSA 1.1 bladder cancer cases reported their employment to be GE (40%) than did cases diagnosed with cancer of other sites (18-32%).

bladder cancer at GE. These include exposure to MBOCA in the transformer division and exposure to dyes in the plastics division. Additional information about exposures to curing agents and dyes containing aromatic amines at GE is necessary to determine the extent to which these agents may have contributed to bladder cancer incidence in the GE population.

The comparatively large number of GE cases who were exposed to cutting fluids and transformer oils at GE is difficult to interpret given the widespread use of these substances at the company. Previous evidence in the literature of an association between cutting fluids and bladder cancer is inconclusive. There has been no evidence of an association between bladder cancer and transformer oils observed in either animals or humans. Further in-depth epidemiologic study would be necessary to determine whether the bladder cancer cases were more likely to have been exposed to cutting fluids and transformer oils than were other GE workers.

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RECOMMENDATIONS

This survey was not intended as an etiologic study and provides no evidence of a causal association between bladder cancer and occupational exposures among GE workers or HSA 1.1 residents at large. Employment information reported by cases has, however, generated several leads about possible occupational risk factors for bladder cancer in the Pittsfield area. On the basis of the survey findings, DPH and DL&I make the following recommendations:

1. GE should identify all materials containing MB DA or other aromatic amine curing agents, all aromatic amine dyes, and all other materials containing known or suspect bladder carcinogens, which are being used currently or have been used in the past. For each material, the following information should be determined: 1) product name; 2) chemical composition; 3) information on its use, including locations, time periods, and processes; 4) any available exposure measurements and industrial hygiene evaluations pertaining to the material; and 5) employees exposed directly and indirectly. This information should be made available to the local union (International Union of Electrical Workers, Local 255), DPH, and DL&I.

2. If it is found that some GE workers may be at high risk of bladder cancer due to exposure to known or suspect bladder carcinogens, these current or former workers should be informed and a bladder cancer screening program should be developed. Any

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screening program for these potentially high risk workers should be developed by GE in collaboration with the union and the local medical community. Screening protocols should be reviewed by experts from the National Institute for Occupational Safety and Health.

3. DPH shall provide HSA 1.1 physicians with information regarding both occupational and non-occupational risk factors for bladder cancer. In addition, DPH shall make available to physicians educational material on bladder cancer which they may distribute to their patients.

4. Residents of HSA 1.1 who have worked or are currently working with potential bladder carcinogens, most notably those exposed to dyes or freshly dyed materials in the textile, paper, leather or printing industries, should consult their physicians regarding these and other risk factors. Recently passed state and federal Right-to-Know laws give workers legal access to information about materials they work with. Workers concerned about current occupational exposures should obtain information about potential hazards from their employers.

5. Early detection of bladder cancer may reduce subsequent morbidity and mortality. The major symptom of bladder cancer is blood in the urine. This symptom may also be caused by other medical conditions, such as infection. Anyone who finds blood in their urine is advised to see a physician immediately.

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TABLE 1

Bladder Cancer Cases with Reported Exposure to Known or Suspect Bladder Carcinogens or Materials/Processes Potentially Involving Bladder Carcinogens

Reported Exposure	Industry of Exposure	Number of Cases (Pitts. at Dx)		Mean Latency (range)
Known or Suspect Bladder Carcinogens				
MBOCA	Transformer		1	13
MDA	—	0		—
2-Naphthylamine or Benzidine-based dyes	—	0	—	—
Materials Potentially Containing Known or Suspect Bladder Carcinogens				
Resins: epoxy, phenol formaldehyde, other plastic	Transformer	5	4	25
	Plastics	3	1	(14-43)
Dyes, not specified	Plastics	3	1	31
	Textile printing	1	0	(17-47)
Processes Potentially Involving Exposure to Bladder Carcinogens				
Handling dyed materials	Silk mill	1	0	40
	Woolen mill	1	0	(18-53)
	Textile mill	1	0	
	Textile printing	2	0	
	Paper	4	1	
	Printing	1	0	
	Thread mill, and leather tannery	1	0	
Rubber industry, producing rubber-coated products	—	0	—	—
Machining with, other use of cutting oils	Aircraft	1	0	40
	Textile machine	2	0	(14-60)
	Railroad	1	0	
	Hardware store	2	1	
	Transformers	7 [b]	5	
	Ordnance	2	1	
	Instruments	1 [b]	1	
	Electrical	1	0	
	Plumbing, heating	2 [b]	1	
	Electronics	1	0	
	Unknown	1	0	
	Toolmaking	1	0	
	Optometry	1	0	

[a] Estimated as the number of years between date of first reported exposure or employment and date of diagnosis.

[b] One case in each of these industries was a non-smoker; all other cases were former current smokers at diagnosis.

TABLE 2

Frequency of Bladdder Cancer Cases Ever Working in High Risk Occupations/Industries[a]

Occupation/Industry	Number of Cases Total	(Pitts. at Dx)	Mean Latency[b] (range)
Cooks and kitchen workers	3	(2)	45 (37-51)
Dye users	4	(1)	31 (17-47)
Leather workers	3	(1)	33 (9-47)
Painters[c]	2	(2)	45
Paper manufacturing workers	9	(3)	39 (18-61)
Printing industry	1	(0)	38
Textile workers	13	(2)	47 (36-62)
Truck drivers	5	(2)	35 (6-49)

[a] All cases in high risk industries were current or former smokers.

[b] Estimated as the number of years between date of first employment in this high risk job and date of diagnosis; mean is for total number of cases.

[c] Latency information was missing for one painter.

TABLE 3

Distribution of Bladder Cancer Cases by Residence at Diagnosis and Employment in High Risk Occupations/Industries

	Number of Cases (Percent)	
	Pittsfield	Rest of HSA 1.1
Ever High Ri	[illegible]	21 (40%)
Never High Risk	[illegible] (75%)	32 (60%)
To[illegible]	44 (100%)	53 (100%)

difference not statistically significant (X^2=2.3; p=0.13)

TABLE 4

Distribution of Bladder Cancer Cases by Smoking Status at Diagnosis and Employment at General Electric

Smoking Status	Number of Cases (Percent)	
	Ever GE	Non-GE
Never	6 (11%)	4 (9%)
Former	27 (52%)	26 (58%)
Current	19 (37%)	15 (33%)
Total	52 (100%)	45 (100%)

difference (ever vs. never smoked) not statistically significant (X^2=0.18; p=0.67)

TABLE 5

Distribution of Bladder Cancer Cases who Ever Worked at General Electric, by Division

Division	Number of Cases (Percent) Employed by GE	Stationed at GE
Transformers Only	28 (57%)	-
Ordnance Only	6 (12%)	1
Plastics Only	1 (2%)	-
Transformers & Ordnance	4 (8%)	-
Transformers & Plastics	3 (6%)	-
Ordnance & Plastics	0	-
Transformers, Plastics, & Ordnance	1 (2%)	2
Unknown	6 (12%)	-
Total	49 (100%)	3
Total Ever in Transformers	36 (73%)	2
Total Ever in Ordnance	11 (22%)	3
Total Ever in Plastics	5 (10%)	2

TABLE 6

Frequency of Bladder Cancer Cases who Ever Worked at General Electric, by Building (Limited to Buildings with 5 or more cases)[a]

Building Number	Total Number of Cases	Job Title (# cases)
4	5	tester (2) pressman fabricator, welding production coordinator
12	7	finisher/pyranol mixer production coordinator shipping laborer cost accountant electrician tester methods
24	6	welder (3) serviceman tester clamp assembler/tapping operator
26	8	welder (2) shipping clerk janitor toolmaker apprentice set-up, repairman moveman clamp assembler/tapping operator
33	5	welder (2) wire winder crane operator clamp assembler/tapping operator
42	5	packer toolmaker apprentice welder cost accountant foreman
100	7	assembler, repairer (2) crane operator electrician safety engineer tester methods

TABLE 6 (continued)

Frequency of Bladder Cancer Cases who Ever Worked at General Electric, by Building (Limited to Buildings with 5 or more cases)[a]

Building Number	Total Number of Cases	Job Title
OP1	5	engineer
		set-up and repairman
		electrician
		precision grinder
		crane operator
OP2	5	engineer
		logistician
		set-up and repairman
		electrician
		crane operator

[a] Individuals who worked more than one building are counted in each.

TABLE 7

Bladder Cancer Cases Who Ever Worked at General Electric, According to Reported Exposures

Reported Exposure	Division[a]	Years Worked	Latency (years)	Age At Diagnosis	Pittsfield at Dx
MBOCA	T	1970-72	13	61	Y
Epoxies	T	1969-78	16	69	N
	T	1972-86	14	56	Y
	T	1947-83	36	58	Y
	T	1968-83	15	37	Y
			Mean 20	55	
Resins	P	1959-60	25	57	Y
	P	1949-83	35	58	N
	P	1940-68	43	69	N
			Mean 34	61	
Dyes, not specified	P	1959-60	25	57	Y
	P	1948-68	35	69	N
			Mean 30	63	
Cutting oils	T,O	1941-69	42	79	Y
	T	1972-86	14	56	Y
	T	1940-75	44	67	Y
	T	1938-46[b]	47	70	Y
	All	1950-85	35	61	N
	T	1940-42	42	63	N
	U	1940	42	79	N
	O	1949-50	37	66	N
	O	1941-83	41	61	N
	T	1940-42	42	61	N
	T	1949-53,60-64	33	59	Y
	T	1940-81	43	61	Y
			Mean 39	65	
Transformer oils	T	1972-86	14	70	Y
	T	1940-75	44	67	Y
	T	1949-50	35	57	Y
	T	1937-38[b]	48	70	Y
	T	1964-74	18	71	Y
	T	1968-69	17	61	N
	T	1946-58	38	65	Y
	T	1922-31	60	76	Y
	T	1955-58	27	63	N
	T	1936-73	50	73	N
	T	1951-77	31	63	Y
	T	1959-82	23	51	Y
	T	1953-67	33	80	N
	T	1947-83	36	58	Y
	T	1950's	32	61	N
	T	1951	32	67	N
	T	1968-83	15	37	Y
			Mean 33	64	

[a] T=transformer; O=ordnance; P=plastics; All=all divisions; U=unknown

[b] These two cases were nonsmokers; all other cases were smokers.

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