Brief Communication

Bladder Cancer Risk among Laundry Workers, Dry Cleaners, and Others in Chemically-Related Occupations

Elaine M. Smith, Ph.D.; Elizabeth R. Miller, M.S.; Robert F. Woolson, Ph.D.; and Carl K. Brown, M.S.

Many studies have shown that occupational chemical exposures have a role in the development of cancers in the lower urinary tract.[1-4] A number of occupations, such as those of printers, typesetters, refinery workers, rubber product makers, chemical workers, and painters, have been associated with increased risk of bladder cancer. Laundry workers and dry cleaners are exposed to some of the same chemicals — e.g., trichloroethylene, tetrachloroethylene, carbon tetrachloride, 1,2-dichloroethane, ethylene glycol ethers, and benzene (as a chemical contaminant). Although solvents and chlorinated hydrocarbons to which dry cleaners are exposed are not known human bladder carcinogens, a number of these are known carcinogens of the kidney and liver.[2,5,6] Despite these potential carcinogenic risks, Chapman et al[1] found a larger than expected proportion of male controls who had been laundry and dry cleaners, and Blair et al[2] found a nearly significant decreased proportionate mortality ratio among this occupational group ($p = .08$).

This study examined bladder cancer risk among individuals employed as laundry workers and dry cleaners and in other occupations and industries with similar chemical exposures and compared it with that of workers in occupations or industries that did not expose them to these chemicals.

Methods

Cases and controls resided in the nine National Cancer Institute (NCI) SEER (Surveillance, Epidemiology, and End Results) population-based areas and in the state of New Jersey, and population-based controls had participated in the NCI National Bladder Cancer Study (NBCS) conducted in 1978. Subjects were between 21 and 84 years of age and cases had newly diagnosed, histologically confirmed transitional or squamous cell carcinoma of the urinary bladder, including papillomas not otherwise specified as benign. Controls in the NBCS were frequency matched for age and sex. Subjects were interviewed face-to-face with a structured questionnaire regarding a history of use of artificial sweeteners, cigarette smoking, coffee consumption, occupation, and diseases. Further details of the population and methods have been published previously.[7,8]

Individuals included in this study were categorized in one of three exposure groups: (1) the exposed group, which included those who had ever worked in a laundry or dry cleaning occupation as operatives for at least six months (N = 103), (2) the chemically related exposure group, which included those who either worked in other occupations or industries that might expose them to similar chemicals or indicated exposure to chemicals found in the laundry and dry cleaning business (N = 5,776); and (3) the unexposed group, which was composed of those not included in groups 1 or 2 (i.e., did not work in suspected occupations and industries) or indicating exposure to suspected substances (N = 1,869). Examples of suspected chemical exposures were specified organic solvents, chlorinated compounds, and ethers. Occupation and industry codes were based on the U.S. Bureau of Census classification.[9]

Logistic regression was used to model for the effects of the occupational exposure variable and duration of exposure, comparing the exposed with the unexposed (categorized as having zero duration) and controlling for the other variables in the model.[10] The chemically related exposure group was excluded from these analyses because it lacked a comparable duration of occupational exposure. Duration of exposure among laundry workers and dry cleaners was assessed by number of years in that occupation.

Sex, race, education, age in 1978, coffee consumption, and cigarette smoking were examined to evaluate con-

From the Department of Preventive Medicine (Drs. Smith and Woolson), The University of Iowa (Ms. Miller and Mr. Brown), Iowa City.

Address correspondence to Department of Preventive Medicine, 2800 Steindler Bldg., The University of Iowa, Iowa City, IA 52242 (Dr. Smith).

Table 1 — Relative Risk* of Bladder Cancer Associated With Occupational Exposure and Smoking Status				
Smoking Category	Laundry and Dry Cleaners†		Chemically Related Exposure Group†	
	RR	(Confidence Interval)	RR	(Confidence Interval)
Nonsmoker‡	1.31	(0.85-2.03)	1.11	(0.99-1.25)
Former smoker§	2.99	(1.80-4.97)	2.01	(1.69-2.40)
Current smoker§	3.94	(2.39-6.51)	3.12	(2.62-3.71)

* Adjusted for age and sex
† Referent: unexposed nonsmoker group
‡ never smoker
§ former or current smoker of <20/day, ≥20<40/day, ≥40 cigarettes/day

founding or interaction effects on disease status in the logistic regression model. Because the relative risk (RR) associated with artificial sweeteners was shown to be not significant in the NBCS nor in several other studies, this substance was not controlled in the final models.[7,11-13] Relative risk and approximate 95% confidence intervals were calculated and all *p* values for logistic regression were two tailed.[10]

Results

Table 1 summarizes results of logistic modeling for risk of bladder cancer for the exposed and chemically-related exposed groups compared with the unexposed nonsmoker group, controlling for the significant confounders age and sex. Little excess risk was found to be associated with either occupational exposure category, based on the RRs in the exposed or chemically-related exposed nonsmoker categories. No significant interaction between occupation and other potential risks was found.

In the final logistic model (Table 2), duration of occupational exposure among laundry workers and dry cleaners also was not a significant risk factor for bladder cancer. The parameters that remained in the model were age, sex, former smoker, and current smoker. A variety of age and duration levels was modeled for both sexes and three smoking categories. The models shown are for ages 50 and 60, with durations of 0, 10, and 20 years; RRs are quite similar for other age and duration models not shown. Risk of disease increased significantly in association with smoking, with little effect from age and none from occupational exposure. Using 50-year-old male nonsmokers with 0 years of exposure duration as the referent, no significant increase in risk was found among 60-year-old male

Table 2 — Logistic Model: Relative Risk of Bladder Cancer by Age, Sex, Smoking Status, and Duration in Occupation					
Smoking Category	Age	Males		Females	
		RR	(Confidence Interval)	RR	(Confidence Interval)
Duration: 0 yr					
Nonsmoker*	50‡	1.00	(.77-1.30)	1.38	(1.18- 1.62)
Former smoker†		2.28	(1.58-3.30)	3.16	(2.33- 4.26)
Current smoker†		3.00	(2.10-4.30)	4.15	(3.10- 5.56)
	60‡				
Nonsmoker		1.12	(0.91-1.40)	1.55	(1.45- 1.67)
Former smoker		2.57	(1.83-3.61)	3.56	(2.72- 4.65)
Current smoker		3.39	(2.43-4.71)	4.68	(3.62- 6.05)
Duration: 10 yr					
Nonsmoker	50‡	1.05	(0.63-1.76)	1.45	(0.91- 2.32)
Former smoker		2.40	(1.35-4.27)	3.32	(1.94- 5.67)
Current smoker		3.16	(1.79-5.59)	4.36	(2.57- 7.42)
Duration: 20 yr					
Nonsmoker	60§	1.11	(0.44-2.75)	1.53	(0.63- 3.71)
Former smoker		2.52	(0.98-6.52)	3.49	(1.38- 8.80)
Current smoker		3.32	(1.29-8.55)	4.59	(1.82-11.54)

* Never smoked
† Former or current smoker of <20/day, ≥20<40/day, ≥40 cigarettes/day
‡ Referent: male, age 50, zero year's duration, nonsmoker
§ Referent: male, age 60, zero year's duration, nonsmoker

nonsmokers with 10 years of occupational exposures; however, a significant increase was found among females. Using 60-year-old male nonsmokers with 0 years of exposure duration as the standard, no increased risk of bladder cancer was observed for males or females with 20 years of exposure in the laundry and dry cleaning business. Risk increased across smoking categories, from nonsmoker, to former smoker, to current smoker and was higher for women than for men.

Discussion

The chemicals to which laundry workers and dry cleaners are exposed do not appear to increase the risk of bladder cancer. Likewise, these substances, which are also used in other occupations or industries, as represented by the chemically related exposure group, do not appear to increase the probability of disease. It is possible that insufficient dose, duration, or latency accounts for the findings, even if workers are exposed to bladder carcinogens in these occupations. The two previous epidemiologic studies of laundry workers and dry cleaners did not report power.[1,2] Unlike this study, neither was a large, population-based study of incident cases and matched controls with detailed personal interviews. Because of concern regarding the number of available exposed cases (E/D), we determined the power $(1-\beta)$ of our study, given observed sample sizes of cases, N(D), and controls, $N(\overline{D})$, and the proportion of exposed subjects without disease, $p(E/\overline{D})$, among males with a median age greater than 69, stratifying by three smoking categories and assuming a "real" RR = 2. We found a 40% chance of rejecting the null hypothesis $p(E/D) = p(E/\overline{D})$ among nonsmokers and former smokers and a 20% chance among the current smokers. Thus, although we are encouraged by the lack of increased incidence of bladder cancer among laundry workers and dry cleaners demonstrated by the NBCS data for a large population, confirmation of our findings by a well-designed study of a large exposed population would be valuable.

Acknowledgment

Robert N. Hoover, M.D., and Patricia Hartge, Sc.D., designed and conducted the initial study from which these data were derived (NBCS). The following people provided helpful suggestions: Clyde Berry, Ph.D.; Keith Long, Ph.D.; James Merchant, M.D., Dr. P.H.; and Donald Morgan, M.D., Ph.D., Environmental Health Section, Preventive Medicine and Environmental Health, University of Iowa, Iowa City.

References

1. Chapman JW, Connolly JG, Rosenbaum L: Occupational bladder cancer: A case-control study, in Connolly JG, (Ed.): Carcinoma of the Bladder. New York: Raven Press, 1981, pp, 45-54.
2. Blair A, Decoufle P, Grauman D: Causes of death among laundry and dry cleaning workers. *Am J Public Health* **69**:508–511, 1979.
3. Cole P, Hoover R, Friedell GH: Occupation and cancer of the lower urinary tract. *Cancer* **29**:1250–1260, 1972.
4. Miller AB: The etiology of bladder cancer from the epidemiologic viewpoint. *Cancer Res* **37**:2939–2942, 1977.
5. Levy BS, Wegman DH (Eds.): Occupational Health. Boston: Little Brown & Co., 1983.
6. Craft BF: Solvents and related compounds, in Rom WN (Ed.) Environment and Occupational Medicine. Boston: Little Brown & Co., 1983, pp 511–533.
7. Hoover RN, Strasser PH: Artificial sweeteners and human bladder cancer: Preliminary results. *Lancet* **1**:837–840, 1980.
8. Hartge P, Cahill JI, West D, et al: Design and methods in a multicenter case-control interview study. *Am J Public Health* **74**:52–56, 1984.
9. 1970 Census of Population Alphabetical Index of Industries and Occupations. Washington, D.C.: U.S. Bureau of the Census, 1971.
10. Schlesselman JJ: Case-Control Studies: Design, Conduct, Analysis. New York: Oxford University Press, 1982.
11. Howe GR, Burch JP, Miller AB, et al: Tobacco use, coffee, various nutrients, and bladder cancer. *JNCI* **64**:701–713, 1980.
12. Kessler II, Clark JP: Saccharin, cyclamate, and human bladder cancer: No evidence of an association. *JAMA* **240**:349–355, 1978.
13. Morrison AS, Buring JE: Artificial sweeteners and cancer of the lower urinary tract. *N Engl J Med* **302**:537–541, 1980.

Nutrient and Poison of Life

From the perspective of the living organisms on earth before the appearance of oxygen, oxygen was an appalling pollutant. Until then the life forms were anaerobic; they had evolved in the absence of air in a methane-rich atmosphere, and with oxygen they died or retreated to deep and airless crevices forever. According to contemporary theory, one of the most momentous events in Precambrian evolution was the development of mutants with systems that could metabolize oxygen, and later produce oxygen themselves by means of the process of photosynthesis. From such mutants did man ultimately emerge.

Scientists are becoming increasingly aware that oxygen is poisonous to man. Since man cannot live without oxygen, he must endure its destructive effects. Oxygen is a "sink" or receptor for the electrons in the body, and as it is metabolized, it causes severe toxic reactions: It produces the biologically dangerous superoxide radicals; it produces peroxide in the fat; it damages enzyme functions; it causes breaks in DNA. Despite the body's defense mechanisms, oxygen causes slow poisoning over the years and, ultimately, death. Man has only the choice to die immediately without oxygen, or to die of it eventually.

—From Edith Efron: *The Apocalyptics—Cancer and The Big Lie*. Simon and Schuster, New York, 1984.