The relation between oral cancer and smoking is examined in this study. Research on this problem should continue, but there is enough certainty now to warrant efforts to reduce smoking in order to diminish the incidence of oral cancer.

SMOKING AND ORAL CANCER: EPIDEMIOLOGICAL DATA,
EDUCATIONAL RESPONSES

John M. Weir, M.A.; John E. Dunn, Jr., M.D., M.S.P.H., F.A.P.H.A.; and Philip E. Buell, B.A.

The question of the effects of tobacco smoking on the oral tissues has been one of the most perplexing in the research, over the last 20 years, into the effects of smoking on mortality.

In three successive reviews the Public Health Service has steadily increased its assessment of the causal significance of tobacco smoking in the carcinogenesis of oral cancer. The earliest of these reviews, the 1964 Report to the Surgeon-General, concludes that, "although there are suggestions of relationships between cancer of the specific sites of the oral cavity and the several forms of tobacco use, the causal implications cannot at present be stated." 1, p. 205

It was clear that the study of the effects of tobacco upon the oral cavity would require: increased attention to the experimental production of oral cancer, the separation of the oral cancer category (ICD code 140-148) into more specific sites, more detailed information about the smoking practice of subjects, and greater attention to other personal practice variables—e.g., alcohol consumption—which are involved in oral carcinogenesis and tend to covary with smoking practice.

These concerns require detailed attention in the early planning stages of research, and result in increasingly complicated problems of data collection and analysis. While the time since publication of the report has been too short to allow the execution and publication of a large number of new studies, there have been new reports of older data and some reports of newer data which reflect an awareness of the special problems of oral cancer study. Time and space require that this report ignore the literature on the experimental production of oral lesions in laboratory animals, and clinical studies of tobacco’s basic effects on the tissue of the mouth. Instead, concern will be with the recent epidemiological literature on smoking and oral cancer and the presentation of some new prospective study data on smokers’ risk of death due to cancer from specific oral sites.

Recent Oral Cancer Research

Hammond examined three mortality groups: cancer of the larynx, cancer of the esophagus, and cancers of the mouth and pharynx grouped. Calculations for each of the three categories showed higher over-all risks for smokers.

Doll and Hill used these same cate-
gories and found a substantial increase in the risk of heavy smokers in each of the three mortality categories, but only cancer of the esophagus showed a progressive risk increase with increased amounts of smoking. They found the oral-pharyngeal cancer mortality rate to be higher in smokers than in non-smokers, but not higher in cigarette smokers than in pipe and/or cigar smokers. All smokers were classed together by equating one gram of pipe or cigar tobacco to one cigarette. A substantial excess of oral-pharyngeal cancer deaths was found for heavy smokers (25 grams or more per day). The heavy smoker death rate was more than five times as great as the light smoker rate.

Prospective data of Weir and Dunn\(^8\) show an increased cigarette smoker risk of nearly threefold for a single mortality category composed of cancers of the tongue (ICD code 141), floor of the mouth (ICD code 143) and mouth unspecified (ICD code 144). However, their data fail to demonstrate clearly a progressive increase in mortality with an increase in amount smoked. They also report neither gradient nor increased over-all risk in the case of pharyngeal cancer (ICD code 145-148).

But Kahn,\(^7\) working with an eight-year follow-up of Dorn’s data,\(^9\) examined figures for the buccal cavity and pharynx separately and reports a very sharp risk gradient for cancer of the pharynx. In the case of pharyngeal cancer the cigarette smokers had a very high over-all risk (12.34) and a sharply rising gradient from 7.11 for smokers of one to nine cigarettes per day to 19.14 for smokers of 40+ cigarettes each day. Cigarette smokers also showed an over-all increased risk of buccal cavity cancer and a clear, though uneven, gradient of increasing risk with increasing consumption. The over-all relative risk for pipe and for cigar smokers (3.89) was similar in magnitude to that for cigarette smokers of about one pack per day (4.09).

Keller and Terris\(^9\) and Keller\(^10\) reported on 408 oral and pharyngeal cancer cases and 408 controls in New York City Veterans Administration hospitals. These morbidity studies covered one of the largest series reported in recent years. Intake interview data included self-reports on tobacco and alcohol consumption. These data show an independent effect of both heavy smoking (40+ cigarettes per day) and heavy drinking (1.6 ounces of alcohol per day). The excess of heavy smoking was significant for cases of both cancer of the tongue and cancer of the floor of the mouth.

The principal data reviewed in the Report to the Surgeon-General on the death rates of smokers of various types and of nonsmokers came from seven large prospective studies of men.\(^8,11-16\) Data from these seven studies comprised all the large prospective study data available at that time. Two of these seven studies were by the California Department of Public Health and were referred to in the report as the California Occupation Study\(^14\) and the California Legion Study.\(^13\) Numerous reports from both have been published during the past six years. Deaths due to oral-pharyngeal cancers have been analyzed recently and the results are reported in the present paper.

Research Design and Results of Two Prospective Studies

The prospective study of occupational mortality from lung cancer began in 1954 and several reports have been made.\(^6,14,17,18\) Details of the Occupation Study plan may be found in those publications. Briefly, one-page self-administered questionnaires were collected in the period 1954-1957 from members of certain California labor unions. The study population was limited to those

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aged 35 through 64. Their mortality experience was determined by examining California death records.

Person-years of observation at risk was calculated by assigning each month of a man's risk exposure to the appropriate five-year age group. Each man was followed until one of three conditions was met: (a) the man died; (b) the man reached his 70th birthday; or (c) the date for the end of the follow-up (December 31, 1962) was reached before either (a) or (b) occurred.

Depending on date of entry, each man was observed for five to eight years. The average figure for the 68,153 men in the study was 7.08 years of observation. The total person-years of observation for the population was 482,658. A total of 4,706 known deaths occurred.

The Occupation Study data questionnaire was designed to reflect the major interest of the study—occupational history and occupational exposure to various metals, chemicals and dusts. Information on cigarette practice could claim only the minimum questionnaire coverage necessary for control of the smoking variable in occupation data analysis. The questions as asked imposed the following definitions:

Smokers: All men who were either discontinued or continuing regular smokers of cigarettes.
Nonsmokers: All men who never regularly smoked cigarettes for at least one year. This group includes pipe and cigar smokers.

A second prospective study began in 1957. Recent reports were made by Buell and Dunn. The research was designed as an investigation of the effects of air pollution on lung cancer mortality. The California Division of the American Legion membership list comprised the study universe. Mailed questionnaires resulted in a population of 69,868 men aged 25 years or older. The total person-years of observation through 1962 was 336,571 years. There was no upper-age limit either for entry or for follow-up. There were 5,404 deaths observed. Smoker and nonsmoker definitions were the same as in the Occupation Study.

Although both studies emphasized lung cancer, the follow-up procedures made it possible to examine deaths from cancer of the mouth and pharynx. Observed deaths and person-years of observation were distributed by age (five-year groups in the Occupation Study, ten-year groups in the Legion Study) and by smoking amount per day (less than one pack, one pack, more than one pack). Mortality rates were calculated for smokers and nonsmokers, and standardized to a hypothetical standard population with equal numbers in each age-smoking category. The resulting standardized rates were then used in calculations of relative risk.

The relative risks for smokers were calculated for the combination of current and discontinued smokers of cigarettes, measured against a unit-risk class of nonusers of cigarettes which includes those who smoked pipes and/or cigars exclusively, as well as nonusers of tobacco. Given the probable increased risk of oral-pharyngeal cancer for pipe and cigar smokers in the unit-risk class, and the probable reduced risk for discontinued cigarette smokers in the smoker class, the effect of the categorization used can only dilute the magnitude of any observed increase in risk for the smoker class.

Mouth Cancer and Pharyngeal Cancer Compared

Because of the discrepancy between their data on pharyngeal cancer and that of Kahn, Weir and Dunn suggested that "future studies might do well to isolate the pharynx as a single site in their analysis, in order to see if pharyngeal cancer does or does not show the risk that is reflected for the other sites with which it is usually grouped."
Table 1—Oral cancer relative risks* for cigarette smokers of known amount

<table>
<thead>
<tr>
<th>Cancer site (ICD code)</th>
<th>Occupation study</th>
<th>Legion study</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mouth (140-144)</td>
<td>Pharynx (145-148)</td>
</tr>
<tr>
<td>Occupation study</td>
<td>2.13 (21)</td>
<td>0.61 (12)</td>
</tr>
<tr>
<td>Legion study</td>
<td>2.70 (14)</td>
<td>2.08 (12)</td>
</tr>
</tbody>
</table>

* Risk for nonsmokers set to 1.00. Rates used in calculation of relative risks are standardized for age and smoking amount distribution. Number of deaths in each cell appears in parenthesis.

The relative risk difference between mouth and pharyngeal cancer in the Occupation Study data may be seen in Table 1. Smokers have a mouth cancer relative risk greater than their relative risk for pharyngeal cancer. In addition, new figures from the Legion Study are shown which also suggest cancer of the mouth (ICD code 140-144) to be a threat to cigarette smokers that is greater than or equal to, but not less than, the threat of cancer of the pharynx (ICD code 145-148).

Site-Specific Mortality and Morbidity Data

Site-specific analysis within the general category of oral-pharyngeal cancer requires detailed records. It was not convenient to break down further the Legion Study data. However, the individual ICD code was known for each oral cancer death which occurred in the Occupation Study.

There were 21 deaths from oral cancer where smoking amount was known. Twelve of these were malignant neoplasms of the tongue (ICD code 141), two were neoplasms of the parotid gland (ICD code 142), three were neoplasms of the floor of the mouth (ICD code 143), and four were of the mouth unspecified (ICD code 144). There were 12 cancers of the pharynx observed: one of the mesopharynx (ICD code 145), two of the nasopharynx (ICD code 146), one of the hypopharynx (ICD code 147), and eight of the pharynx unspecified (ICD code 148).

This distribution of coded causes differs from that reported by Keller. Part of this difference is due to Keller's exclusion of nonlocalized lesions from consideration. There was no need, then, for the unspecified categories, 144 and 148. However, had he included lesions with extension, there still would have been some likely distributional differences because his was a case-control morbidity study using hospital diagnostic records, while the Occupation Study was a prospective mortality study using death certificates. It is probable that a morbidity study would find a higher percentage of localized cancers of limited extension, and would thereby have less need for general, unspecified codes like 144 and 148, than would a mortality study in which the underlying cause of death was determined near the time of death.

This possibility is supported by the figures in Table 2 where morbidity rates show the pharynx unspecified (ICD code 148) to have a low incidence rate, while its mortality figure is second only to cancer of the tongue (ICD code 141). The sum of all California deaths recorded during 1960, 1961, and 1962 was divided by three to create the first column, "Mean Number of Annual Deaths." The morbidity rates in the second column are based on reports at time of diagnosis (1960-1964) by recording units at all Alameda County, California (Oakland), hospitals.

Even if the unspecified categories are ignored, there are still distributional discrepancies between the occupation data and that of Keller. Nearly 40 percent (160) of his cases were diagnosed as primary cancer of the floor of the mouth, and only a little over 20 per
cent (87) had tongue neoplasms, while the Occupation Study found four times as many deaths from tongue cancers as from floor of mouth cancers. The occupation data agree with reports from a population-based cancer registry\(^2^0\) which indicate, as seen in the second column of Table 2, that the case incidence rate of cancer of the tongue is twice that of floor of the mouth cancer. This ratio also holds for the mortality figures in Table 2. The figure for mean annual deaths from cancer of the tongue was more than twice that for floor of the mouth cancer.

Keller found heavy smoking (40+ cigarettes daily) significant for cases of both tongue cancer and floor of the mouth cancer. Only three Occupation Study cases were floor of mouth cancers. All smoked for more than 20 years; one smoked more than two packs per day, one smoked a pack and a half a day and the third smoked one-half pack each day. This is in keeping with Keller’s findings, but the number of cases is too small to be more than suggestive of support.

However, there were 12 cancers of the tongue, and it was possible to calculate observed rates from which a relative risk could be computed. The result, an over-all smoker’s risk of 5.52, is reported in Table 1. This figure is well over twice that reported for the general category 140-144, and substantiates Keller’s finding that tongue cancer was one of the oral sites most associated with cigarette smoking.

The occupation data indicate that cancer of the tongue is an oral cavity cancer site having a strong fatal association with cigarette smoking. Data on very few additional cases suggests that floor of the mouth cancer may have a similarly strong fatal association with cigarette smoking.

While the data reported here do respond to the need for detailed information about oral cancer, there is still a desperate need for larger prospective studies of morbidity and mortality from oral-pharyngeal cancer which will examine specific sites of primary cancer in relation to detailed histories of personal practices, e.g., tobacco usage, alcohol consumption, oral hygiene and nutrition. In the meantime, it would be useful if other studies which have information available on smoking and oral cancer could be examined in as much detail as possible.

**Smoking Control Efforts in Dentistry**

While research attempts to delineate the exact nature of the relationship of

**Table 2—Oral cancer mortality and morbidity by specific sites**

<table>
<thead>
<tr>
<th>Oral Cancer Site (ICD code)</th>
<th><em>Mean</em> No. of annual deaths, Alameda County, California, 1960-1962</th>
<th><strong>Age-adjusted average annual case incidence rates/100,000 population,</strong> Alameda County, California</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lip (140)</td>
<td>10.33</td>
<td>4.7</td>
</tr>
<tr>
<td>Tongue (141)</td>
<td>106.33</td>
<td>3.6</td>
</tr>
<tr>
<td>Salivary (142)</td>
<td>26.67</td>
<td>0.9</td>
</tr>
<tr>
<td>Floor (143)</td>
<td>42.33</td>
<td>1.6</td>
</tr>
<tr>
<td>Other mouth (144)</td>
<td>50.33</td>
<td>1.5</td>
</tr>
<tr>
<td>Mesopharynx (145)</td>
<td>47.00</td>
<td>1.7</td>
</tr>
<tr>
<td>Nasopharynx (146)</td>
<td>33.00</td>
<td>0.7</td>
</tr>
<tr>
<td>Hypopharynx (147)</td>
<td>25.67</td>
<td>1.2</td>
</tr>
<tr>
<td>Unspecified pharynx (148)</td>
<td>67.00</td>
<td>0.7</td>
</tr>
<tr>
<td><strong>Total (140-148)</strong></td>
<td><strong>408.66</strong></td>
<td><strong>16.6</strong></td>
</tr>
</tbody>
</table>


**Incidence for males, from "Incidence of Cancer in Alameda County, California 1960-1964." (Table 9.) State of California, Department of Public Health."
smoking to oral cancer must continue, there is enough certainty now about its generally described involvement to warrant the initiation of attempts at reducing cigarette smoking in order to reduce the incidence of oral cancer and other conditions.

The dentist has been one of the single most important agents affecting patient attitudes and practices in regard to fluoridation, oral hygiene, and techniques for the prevention of caries and periodontal conditions. It is a natural and logical step to extend the concern of dental health education to include the use of tobacco. The dentist expects health educators, physicians, and others to have a professional interest in any health issue that is both a primary concern of the dental profession and a major factor in the public’s health, e.g., fluoridation. Similarly, it is expected by others that dentistry will be involved in those issues that affect the individual’s total health, even when these issues are primary responsibilities of other professions. This expectation is especially appropriate in the case of smoking. Although the layman may consider the only serious effects of smoking to be lung cancer and coronary heart disease, the dentist knows that its effects on oral health are also severe.

In 1964, based on the steadily increasing evidence of the last 15 years for a link between mortality rates and smoking practice, the House of Delegates of the American Dental Association resolved: “That the members of the American Dental Association be called upon and encouraged to undertake an educational effort to inform their patients of the health hazards of the use of tobacco and, especially with young people, to warn against acquiring the habit of cigarette smoking.”

In 1967 the American Dental Association successfully sought a contract with the National Clearinghouse for Smoking and Health, United States Public Health Service, to find what preventive education practices are employed by dentists with patients and to find more effective ways for professional health authorities to play a maximal role in education. The contract calls for the development of a patient education program designed for use by the practicing dentist.

Discussion of the project’s activity invariably includes the question of why efforts should be concentrated in professional and patient education rather than in public education. Suggestions about mass media programs directed at popular groups, especially children and adolescents, are recurring topics. However, the association’s project is but one part of a much larger effort—and there are other organizations who have more direct contact with and responsibility for these other elements of society. These organizations are also involved in smoking education. The best program—whether it be that of the American Dental Association, the American Heart Association, the American Cancer Society, or some other—cannot be effective in isolation. The child may participate in a program at school on Monday, visit his physician on Tuesday, watch television on Wednesday, see a billboard Thursday, and go to his dentist on Friday. Each of these elements affects the child’s attitudes, perceptions, and behavior; they must work together for good effect. The most effective role for the dentist will be concentrate on the doctor-patient relationship in the dental office. It is there he can contribute most to this concerted national effort.

There is good reason to believe that the dentist has a unique advantage in the contribution he can make—both as a direct and as a reinforcing influence on education. A substantial proportion of patients see their dentists at regular intervals over a long period. The visit is conducive to effective education because the patient is usually in a rela-
tively healthy state, and is, therefore, most psychologically receptive to information and suggestions rendered by a professional health figure.

The Smoking and Health Project offices are in Chicago. The project has subcontracted with two dental schools, the University of Pittsburgh and the University of Nebraska, for the development, evaluation and local distribution of educational materials. For the present, project activity is focused in Nebraska and southwestern Pennsylvania.

The association program is not directed at the public sector. Program concerns are in the areas of professional education and patient education within the context of the doctor-patient relationship. Professional education activity is directed at the effect of smoking on the oral tissues and general health. Information is placed in professional publications. Undergraduate, postgraduate and continuing education programs at the participating dental schools have been developed. A newsletter featuring abstracts of smoking research is published and circulated to all dentists in the experimental areas of Nebraska and southwestern Pennsylvania. These activities are designed to increase the dentist's knowledge about smoking and health so that he will be better qualified to initiate discussion about smoking with his patients.

Patient education materials and techniques are in a developmental stage. They will include: an appropriately worded sign for dental reception areas requesting that patients refrain from smoking, a dentist's guide on how to answer patient questions about smoking, educational pamphlets, filmstrips, and educational slides. All are designed to be used within the dental office utilizing the unique opportunity presented by the doctor-patient relationship.

The concerned dentist should not expect large numbers of his patients to quit smoking because of his educational activity. Smoking is a deep-rooted, highly personal habit that has become a social institution. There are no simple solutions and no single educational manipulation will significantly reduce the problem. But last year one million Americans quit smoking. If each dentist helped only one of his patients to make a similar decision during the coming year, the number who quit smoking would be greater by more than 100,000.

The nation's dentists are accepted as professional health authorities in every community. The information and attitude they reflect with their patients, and their role as general exemplars in and out of the office, are vital links in the chain of continual educational reinforcement about the health hazards of cigarette smoking.

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Call for Scientific Papers—The American Association of Poison Control Centers

Authors are invited to submit original papers for consideration for the scientific program of the twelfth annual meeting of the American Association of Poison Control Centers, at the Palmer House, Chicago, Ill., October 20, in conjunction with the 1969 meeting of the American Academy of Pediatrics. Please submit abstracts or papers to Matilda S. McIntire, M.D., Secretary, AAPCC, Childrens Memorial Hospital, 44th and Dewey Avenue, Omaha, Neb. 68105, no later than August 15, 1969.