

Frequency of Dental X-ray Examinations in a New York County

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SEVERAL studies have been made of the amount of radiation delivered to individual patients during dental X-ray examinations (1-7), and of the frequency with which dentists use X-rays (8-10). Little information is available, however, as to the numbers of such examinations received by the various age and sex groups in the general population. The purpose of the investigation reported here was to obtain this information for an entire county in New York State.

Study Area

Chemung County, N.Y., which includes the city of Elmira and its environs, was selected because of its geographic isolation and other characteristics. These included stability of population, a fluoridated water supply, a well-organized and cooperative dental society, and a ratio of dentists to population similar to that of the remainder of upstate New York. (In 1959-60 in New York State, exclusive of New York City and its surrounding suburban counties of Westchester, Nassau, Suffolk, and Rockland, there was 1 registered dentist per 1,827 persons, and in Chemung County, 1 registered dentist per 1,862 persons.)

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The county had a population, according to the 1960 census, of 98,706, concentrated in Elmira and its suburbs. Light and heavy manufacturing and farming constitute major sources of employment.

Subsampling in Corning, N.Y., the nearest urban area outside the county, revealed that the number of Chemung County residents receiving dental care there was negligible. No other communities with dental facilities are nearby. Consequently, data collection was limited to dental offices in Chemung County. During the study period there were 45 practicing dentists in the county, and the specialties represented included oral surgery and orthodontics.

Methods

Forty-two (93 percent) of the 45 dentists in practice in the county in the spring and summer of 1959 participated in the study. Between mid-July and mid-September 1959 the cooperating dentists began routine submission of data. Each dentist provided the following information for each patient seen between September 14, 1959, and May 15, 1960: name, address, age, sex, date of present and of last visit, and whether or not X-rays were taken during the present visit. When X-rays were taken, the numbers and types of films were also listed. Collection of data was supervised by a graduate nurse who checked for accuracy and completeness. A fixed monthly fee was paid, usually to a secretary or dental assistant immediately responsible for supplying the data. Twelve percent of all visits were made by non-

residents of Chemung County. Data obtained from these visits were not included in the final tabulations except as noted.

All patients who had X-ray examinations during the 3 weeks September 14–October 2, 1959, were followed as a special subgroup throughout the study period to determine whether or not some individuals were receiving substantial numbers of examinations, either in the same office or as a result of changing from one dentist to another.

As appropriate, the data were adjusted to express totals for the 12-month period July 1, 1959–June 30, 1960. This adjustment was made on the basis of the data obtained during the preliminary period from mid-July to mid-September, when the dentists were entering the study. The data were also adjusted, as appropriate, to 100 percent dentist participation.

During the survey an engineer of the New York State Department of Health inspected the X-ray equipment in use by all but one of the participating dentists. This inspection, during September and October 1959, included determination of film speed, filtration, intensity of the primary beam as most commonly used, and field size. Beam intensity was measured with an r-meter. Field size was determined by placing

a calibrated sheet of fluorescent screen at the distance from the X-ray source corresponding to the position of the face in the technique usually used by the dentist. Where indicated, corrective measures were suggested.

Results

During the year beginning July 1, 1959, Chemung County residents made 112,906 dental patient visits. The crude rate of patient visits per capita was 1.14 per year. Of these dental visits, 11,675 (10 percent) involved X-ray examinations (X-ray visits).

The rate of patient visits and the percentage of patient visits which involved X-ray examination varied considerably by age and sex (table 1, fig. 1).

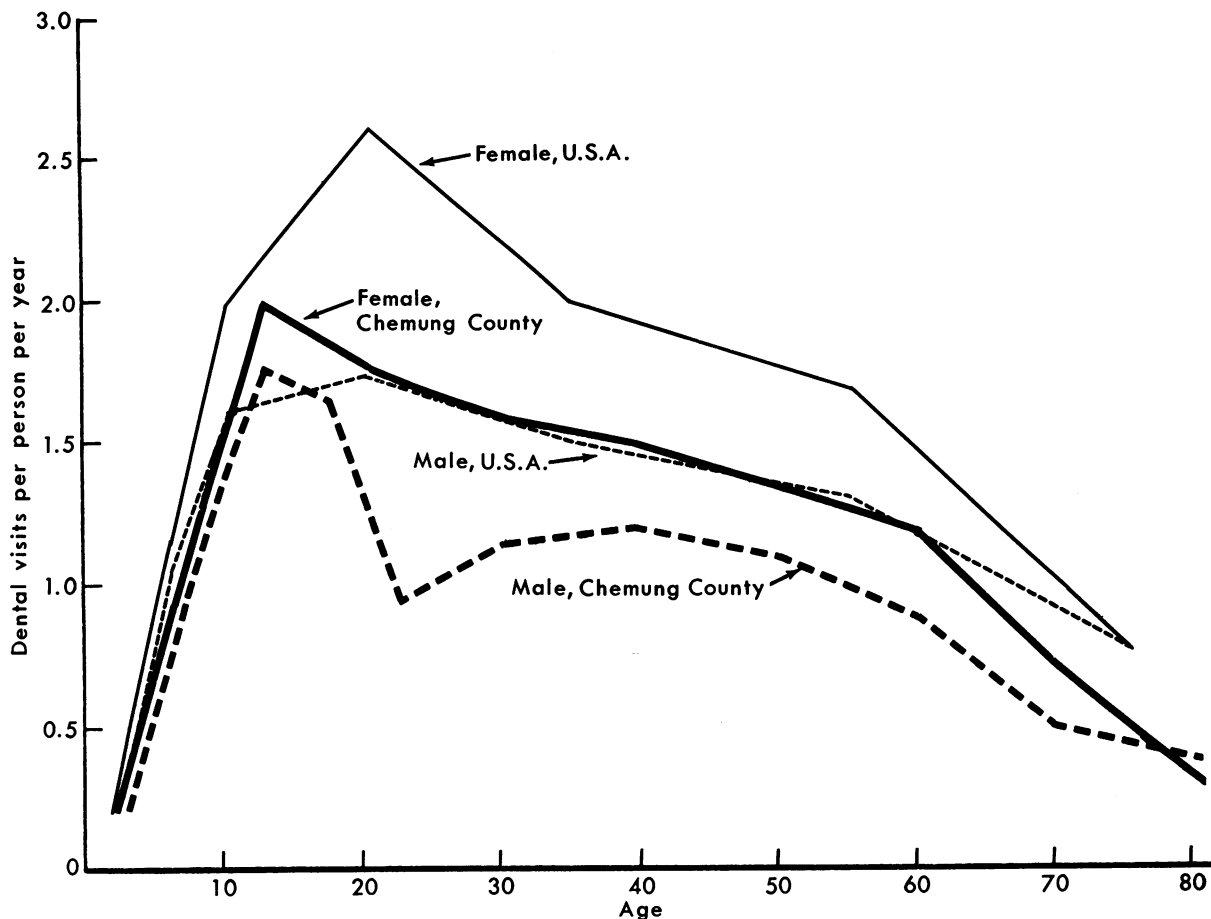
A total of 33,203 X-ray films were taken during the 11,675 X-ray visits, for an overall mean of 2.85 films per X-ray visit. The great majority of these were for periapical (66 percent) or bite-wing (33 percent) examinations (table 2). Cephalometric examinations for orthodontic diagnosis constituted only 0.06 percent of the total films. The majority of these were made on children under 15 years of age (table 3).

A marked association was found between

Table 1. Dental visits and X-ray visits per year, by age and sex, Chemung County, N.Y., 1959–60

Age group (years)	Male						Female					
	Popu- lation	Dental visits		X-ray visits			Popu- lation	Dental visits		X-ray visits		
		Num- ber	Rate per 100 popu- lation	Num- ber	Rate per 100 popu- lation	Per- cent of all visits		Num- ber	Rate per 100 popu- lation	Num- ber	Rate per 100 popu- lation	Per- cent of all visits
Under 5.....	5,685	886	15.6	55	1.0	6.2	5,571	940	16.9	49	0.9	5.2
5-9.....	5,219	5,598	107.3	406	7.8	7.3	5,132	6,001	116.9	411	8.0	6.8
10-14.....	4,748	8,165	172.0	740	15.6	9.1	4,443	8,831	198.8	723	16.3	8.2
15-19.....	3,523	5,754	163.3	674	19.1	11.7	3,672	6,821	185.8	768	20.9	11.3
20-24.....	2,690	2,571	95.6	419	15.6	16.3	2,764	4,671	169.0	740	26.8	15.8
25-34.....	5,867	6,747	115.0	913	15.6	13.5	5,909	9,400	159.1	1,264	21.4	13.4
35-44.....	6,276	7,574	120.7	874	13.9	11.5	6,867	10,343	150.6	1,181	17.2	11.4
45-54.....	5,333	5,848	109.7	583	10.9	10.0	5,540	7,518	135.7	737	13.3	9.8
55-64.....	4,270	3,792	88.8	296	6.9	7.8	4,730	5,740	121.4	423	8.9	7.4
65-74.....	3,004	1,609	53.6	129	4.3	8.0	3,762	2,712	72.1	181	4.8	6.7
75 and over.....	1,358	535	39.4	38	2.8	7.1	2,343	814	34.7	65	2.8	8.0
Not stated.....		13		2		15.4		23		4		17.4
Total.....	47,973	49,092	102.3	5,129	10.7	10.4	50,733	63,814	125.8	6,546	12.9	10.3

Figure 1. Dental visits per person per year, by age and sex, Chemung County, N.Y., 1959-60, and United States, 1957-59



SOURCE: U.S. data from reference 13.

Table 2. Distribution of X-ray examinations by age and type of examination, Chemung County, N.Y., 1959-60¹

Age group (years)	Bitewing	Periapical	Occlusal	Lateral jaw	Cephalometric	Total
Under 5.....	55	57	0	0	0	112
5-9.....	428	981	2	12	30	1,453
10-14.....	919	1,589	14	6	68	2,596
15-19.....	1,204	1,108	6	3	15	2,336
20-24.....	789	1,211	3	9	0	2,012
25-34.....	1,594	2,393	9	14	8	4,018
35-44.....	1,191	2,620	8	17	2	3,838
45-54.....	543	2,024	4	12	1	2,584
55-64.....	167	1,261	1	1	1	1,431
65-74.....	35	538	4	3	0	580
75 and over.....	10	167	0	0	0	177
Not stated.....	0	17	1	0	0	18
Total:						
Number.....	6,935	13,966	52	77	125	21,155
Percent.....	32.8	66.0	0.2	0.4	0.6	100.0

¹ Data for 8-month base period.

Table 3. Distribution of cephalometric examinations¹ by age, Chemung County, N.Y., 1959-60²

Age group (years)	Number of patients, by number of examinations			Total
	1	2	3 or more	
Under 10.....	17	0	2	19
10-14.....	58	5	0	63
15-19.....	6	1	1	8
20 and over.....	6	0	1	7
Total.....	87	6	4	97

¹ Each cephalometric examination corresponds to one exposure.

² Data for 8-month base period.

frequency of X-ray usage and recency of graduation of the dentist. Median patient age also varied with the period in which the dentist graduated. Thus, the median age of patients of dentists graduating before 1940 was 33.4 years, in comparison with 29.8 and 26.0 years for patients of dentists graduating in 1940-49 and 1950-59. Consequently, this patient age difference was taken into account in comparisons of X-ray use by dentists trained in different periods. These age-adjusted percentages revealed that the most recent graduates (1950-59) took X-rays in one out of every five visits,

about twice as often as dentists graduating in 1940-49 and four times as often as the dentists graduating before 1940 (table 4, fig. 2). The average number of films taken during each X-ray examination was also highest among the recent graduates. Forty-two percent of all dental visits during the year were made to dentists in this group.

The subsample comprising all patients X-rayed by the participating dentists during the first 3 weeks of the study included 649 persons. Of these, 84 percent had fewer than five X-ray films taken during the 8 months they were followed. Less than 1 percent, all children, received a total of 20 films or more (table 5). Only two persons in the entire subsample were X-rayed in more than one dental office.

Data obtained on inspection of the 39 X-ray machines used by 41 of the participating dentists are summarized in table 6. High-speed film was being used with 21 (54 percent) of the machines. Twenty-nine (74 percent) of the machines produced a beam larger than the 3 inches maximum diameter recommended by the National Committee on Radiation Protection (11). The average beam diameter of all machines was 4.2 inches, corresponding to a 94 percent excess in area irradiated. In addition, only eight of the machines (21 percent) had been provided with the recommended 2 mm. total aluminum filtration (12) necessary to

Table 4. Frequency of X-ray usage in relation to period in which dentists graduated¹

Age group (years)	Graduated before 1940		Graduated 1940-49		Graduated 1950-59	
	Percent of visits involving X-rays	Number of films per X-ray visit	Percent of visits involving X-rays	Number of films per X-ray visit	Percent of visits involving X-rays	Number of films per X-ray visit
Under 5.....	1.6	2.3	3.4	1.4	23.5	1.7
5-9.....	2.3	2.9	4.9	1.6	22.0	3.4
10-14.....	3.4	1.9	9.1	1.9	17.0	3.7
15-19.....	5.7	2.5	11.7	2.2	18.8	2.8
20-24.....	6.1	2.9	13.1	2.0	43.7	3.0
25-34.....	5.7	2.7	10.1	2.4	33.6	3.2
35-44.....	6.7	2.8	10.6	2.4	19.9	3.4
45-54.....	8.8	2.9	9.3	2.6	11.5	3.6
55-64.....	8.3	2.9	7.5	2.8	7.0	3.6
65-74.....	8.9	2.2	4.5	3.3	7.4	3.6
75 and over.....	6.3	2.4	6.0	2.6	9.9	3.0
Not stated.....	9.1	3.0	28.6	4.0	25.0	7.0
Total.....	5.8	2.7	9.2	2.3	20.4	3.3

¹ Age and sex adjusted using the total patient population.

minimize the quantity of diagnostically useless soft X-radiation reaching the patient.

Partial measurements were made with respect to the air exposure dose of the primary X-ray beam when the machines were used at what their operators regarded as their most common settings for intraoral examinations. There was wide variation among the machines in the intensity of the beam, and hence in the amounts of radiation received by the patients.

In order to check the possibility that the participating dentists had changed their X-ray usage in connection with the survey, they were asked whether or not they had. Six dentists (13 percent) reported increases during the study period; one dentist reported a decrease, and the remainder, no change. In addition, the percentages of patients X-rayed during the first and last months of the study were not significantly different.

Discussion and Conclusions

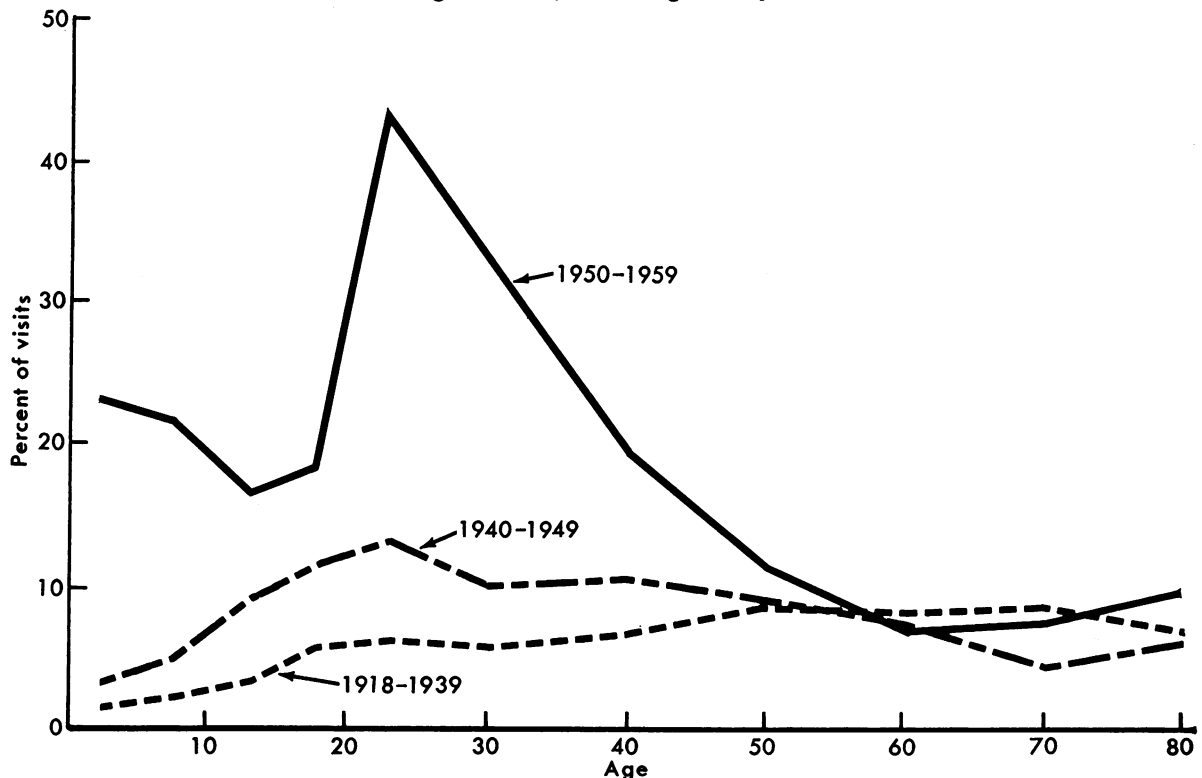
Although many questions remain unanswered regarding the possible contribution of ionizing

radiation to human pathology, it was not the purpose of this study to seek correlations between exposure to X-rays and subsequent development of disease. Rather, the objective was to provide information of use to investigators concerned with the radiation exposure of the population from the standpoint of the frequency of exposures in connection with dental practice. Therefore, emphasis was placed on documentation of age- and sex-specific examination rates, rather than on measurement of amounts of radiation received during these examinations.

Dental visit rates in Chemung County in 1959-60 were somewhat lower than the rates for the entire United States and those for the northeastern United States, reported by the U.S. National Health Survey for 1957-59 (13), but the distributions by age and sex were quite similar (fig. 1).

Visit rates for females were consistently higher than those for males in the same age group except among those 75 years of age and older, where they were approximately equal.

Figure 2. Percentage of dental visits involving X-ray examinations, by patient age and period in which dentists graduated, Chemung County, N.Y., 1959-60



The highest rate for each sex was in the age group 10-19 years.

When X-ray visits were considered in relation to the total county population the highest age-specific rates were in the group 15-19 years for males, and in the group 20-24 years for females. However, among patients of both sexes, those aged 20-24 were most often X-rayed. Although exposure to the gonads during dental X-ray examinations is believed to be small, this preponderance of examinations during the childbearing and earlier years of life is of interest, since any radiation received during this period, from whatever source, may be of genetic significance.

Cephalometric examinations, although constituting only 0.6 percent of all X-ray examinations, are noteworthy because of the high proportion which involved children. The age-specific rates for these examinations, however, were quite low; for example, 4 cephalometric examinations per 1,000 patients of both sexes under age 15.

Because of the shifts in emphasis in dental education which have occurred during recent decades, the association between the period in which the dentist had received his training and the frequency with which he used X-rays was not unexpected. The finding that the dentists most recently trained tended both to use X-rays

more often and to use a greater number of films, on the average, for each examination performed than those trained earlier suggests that there may be an increase in dental X-ray examinations in the coming years. This variation in use is also relevant in comparisons of the dental X-ray experience of various populations.

Only 2 of the 649 patients in the subsample followed for 8 months received X-ray examinations in more than one office during the period. This suggests that the hypothetical problem of some individuals receiving large numbers of dental X-ray examinations as a result of changing from one dentist to another may be negligible, at least for some populations.

Routine full mouth examinations were not common in the area studied. To the contrary, the great majority of patients had fewer than five films taken during the 8-month period. However, four children, three in the same dental office, did have more than 20 X-ray exposures during the period. Considered on a population basis, the radiation dose from these examinations was undoubtedly negligible, but the dose received by these children may have been substantial.

The average number of films taken per week per office, considering only weeks which included 2 or more days worked and including visits by out-of-county residents, was 15.8.

Table 5. Eight-month cumulative X-ray experience of 649 patients first X-rayed in September 1959, Chemung County, N.Y.

Age group (years)	Number of patients having—						Total patients
	1 film	2-4 films	5-9 films	10-14 films	15-19 films	20 or more films	
Under 10.....	18	28	2	2	1	0	51
10-14.....	31	39	4	0	8	1	86
15-19.....	19	41	6	2	3	0	71
20-24.....	18	33	8	3	1	0	63
25-34.....	40	71	6	5	4	0	126
35-44.....	48	62	11	5	1	0	127
45-54.....	23	30	7	5	0	0	65
55-64.....	15	7	3	5	1	0	31
65 and over.....	13	11	3	1	1	0	29
Total:							
Number.....	225	322	50	28	20	4	649
Percent.....	34.6	49.6	7.7	4.3	3.0	0.6	² 99.8

¹ Girl, age 13, had 24 films; boy, age 10, had 25 films; boy, age 12, had 32 films; boy, age 13, had 34 films.

² Difference from 100 is due to rounding.

Table 6. Data obtained from inspection of 39 dental X-ray machines, Chemung County, N.Y., 1959

Characteristic	Number of machines	Per-cent ¹
Relative film speed:		
Fast.....	21	54
Intermediate.....	16	41
Slow.....	2	5
Irradiated field:		
<i>Diameter (in.)</i> <i>Area (sq. in.)</i>		
3.0 or less..... 7.1 or less.....	10	26
3.1-4.4..... 7.5-15.2.....	10	26
4.5-5.9..... 15.9-27.3.....	17	43
6.0 or greater... 28.3 or greater...	2	6
Additional aluminum filtration needed (mm.):		
None.....	8	21
0.1-0.4.....	1	3
0.5-0.9.....	11	29
1.0-1.4.....	6	15
1.5-1.9.....	11	28
2.....	2	5
Primary beam dose (roentgens): ³		
1 or less.....	9	23
1-1.9.....	13	33
2-2.9.....	5	13
3-3.9.....	4	10
4-4.9.....	1	3
5 or more.....	5	13
Not recorded.....	2	5

¹ Differences from 100 in total percentages are due to rounding.

² Both of these machines were manufactured before 1934.

³ At most common setting for intraoral examination.

This is considerably fewer than expected on the basis of information collected elsewhere. For example, the number of films per office per week has been reported as 42 in Oakland, Calif. (8), and 55 in Chicago (9). This indicates that findings from one area cannot be indiscriminately extrapolated to others, and suggests the need for further research in areas of varied characteristics. The age composition and economic level of the population, the types of dental care available, and other characteristics, including fluoride consumption, can all be expected to affect dental X-ray usage in a particular community.

It has been widely reported that dental X-ray equipment is often used without all the safeguards recommended to decrease the amounts of radiation reaching patients and operators

(2, 9, 10, 14). Filtration and collimation have been found inadequate in substantial percentages of installations examined. It has also been shown that the X-ray dose received by the patient can be reduced through the use of fast film. In the county studied 79 percent of the machines did not have the recommended 2 mm. total aluminum filtration at the time of the survey. In addition, collimation of the beams was such that the average area irradiated was 1.9 times the area that would be exposed if the recommended beam diameter of 3 inches or less had been used. High-speed film was in use by only 54 percent of the dentists surveyed. Consequently, although the use of dental X-rays was not excessive in this community, application of recommended precautions would have produced appreciable reductions in population exposure.

Summary

Dental visit and dental X-ray examination rates are reported for the population of Chemung County, N.Y. The highest rates of dental visits were among persons 10-19 years of age. Among patients, those aged 20-24 years were most often X-rayed. Eighty-four percent of patients followed for 8 months had fewer than five films each, but four children had more than 20 films each during the same period.

A marked association was found between the period in which dentists graduated and the frequency with which they used X-rays. Dentists graduating during the decade 1950-59 used X-rays about four times as often as those trained prior to 1940. They also used more films for each examination performed. Median patient age also varied with the period in which dentists graduated.

The majority of dental X-ray machines in use at the time of the study did not meet recommended standards for beam filtration and collimation, and high-speed film was not being used by 46 percent of the dentists surveyed.

Addendum

Subsequent analyses of the data obtained in this study have been concerned with the frequency of X-ray examinations in relation to pregnancy. These were undertaken because of

the frequency of dental X-ray examinations among those of childbearing age and in view of current interest in all sources, however small, of radiation received by the fetus in utero. These analyses showed that there was no significant difference between pregnant patients and other patients in rate of dental visits or X-ray visits or in number of films per X-ray visit. (Pregnancy was determined from examination of vital statistics records of births.)

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Certification in General Preventive Medicine

The American Board of Preventive Medicine has received approval from the American Medical Association to certify physicians in the affiliated specialty of general preventive medicine.

Eligibility requirements are set forth in detail in the "Directory of Approved Internships and Residencies," published as a separate part of the *Journal of the American Medical Association*, September 2, 1961. The first examination is planned for the spring of 1963; subsequent ones will be held annually.

Physicians in full-time teaching, research, or practice in the several fields of preventive medicine may apply, provided they meet the general and special eligibility requirements. Such applicants would include teachers of preventive medicine, epidemiologists, medical administrators, research biologists, maternal and child health specialists, and others.

Information may be obtained by writing to Dr. Tom F. Whyne, Secretary-Treasurer, American Board of Preventive Medicine, Inc., 4219 Chester Avenue, Philadelphia 4, Pa.