

Dental radiology: focus for the eighties

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It is a distinct pleasure for me to partake in this program sponsored by the Section on Oral Radiology of the American Association of Dental Schools. This occasion presents, in my judgment, an outstanding opportunity to provide dental faculty responsible for teaching radiology with an insight into the widening focus that is being placed at the national level on the need to control use of ionizing radiation. From this perspective, it is my intent to attempt to offer some foresight into the expanding influence and role that the Commission on Dental Accreditation is exerting in dealing not only with these complex and interrelated issues, but also in dealing with its constituency, the dental educational community.

There is little doubt that considerable public attention and sentiment have converged, in recent years, upon concern over low-level ionizing radiation emitted from man-made sources, its environmental impact generally, and its potential adverse biologic effects on humans particularly. From an historical perspective, impetus for the mounting societal awareness and anxiety over ionizing radiation and its effects was triggered by the tragic aftermath of the atomic bomb devastation of Hiroshima and Nagasaki during World War II. Similarly, the new knowledge that has come to light relative to the consequences of fallout emanating from atomic weapons' testing in Nevada in the 1950's and early 1960's has intensified debate and discussion in the public arena. Unquestionably, national furor was heightened by the 1979 nuclear power plant accident at Three Mile Island in Pennsylvania. Concomitantly, public interest and inquiry began to divert attention and focus on the alleged unnecessary exposure of humans to ionizing radiation from controllable medical and dental X-ray sources. It has been estimated that exposure from such sources accounts for some 90% of the annual population dose in the United States.¹ Likewise, it has been postulated that almost one-third of this total radiation exposure is unnecessary.² These data, however, appear to be based on informed opinion rather than established fact. In view of the nation-wide perceptions, there is little

reason to wonder why the United States Congress and several state legislatures began to ask very pointed questions about alleged over-use, misuse, and abuse in use of ionizing radiation by the health professions.

Federal Initiatives and Proposed Legislation

At the federal level, a number of steps have been taken in the executive and legislative branches of government to cope with the full spectrum of national concerns about radiation and its hazards. In February 1980, a Presidential Executive Order signaled a series of initiatives to deal with radiation as an issue of public policy.³ Specifically, Executive Order Number 12194 called for the establishment of the U.S. Radiation Policy Council (RPC) to articulate and to coordinate the formulation and implementation of national radiation protection policies. The RPC is comprised of policy-level representatives from 13 governmental departments or agencies.

In the Congress, Senator Glenn of Ohio introduced, in October 1979, Bill S.1938, the Federal Radiation Protection Management Act of 1979. This legislation was proposed to reorganize, by Congressional mandate, the responsibilities for this nation's radiation protection activities. Its fundamental tenets were to ensure the highest practical protection against harmful radiation exposure, and to coordinate federal programs in radiation research and regulation. Although public hearings were held, no Senate action was taken on the Glenn proposal. Similarly, in March 1980, Representative John Wydler of New York introduced Bill H.R.6745, the Radiation Control Act of 1980. Essentially, this Bill, if enacted, would place major Federal Government responsibilities for radiation control, from both nuclear and non-nuclear sources, within the purview of the Environmental Protection Agency (EPA). It would require the EPA to make continuing comparisons of the risks and effects of radiation from different sources and to assure that both the Congress and the public are kept apprised of these risks and effects.

Five separate Bills, directly affecting the accrediting and licensing or credentialing processes, have also been introduced in both houses of the United States' Ninety-Sixth Congress. In essence, the proposed Bills are quite similar in that they would establish federal criteria and guidelines for use in accrediting programs relating to the education of users of X-ray equipment. The proposed legislation would also establish federal standards for licensure or credentialing of health care personnel who use equipment that emits ionizing radiation. In dentistry, these requirements would apply exclusively to dental auxiliary education and dental auxiliary personnel, but not to dental education or dentists.

It seems predictable that members of Congress will continue to promote such legislation, and that such legislative activities will escalate in this decade. In light of this activity, it is incumbent upon the dental profession and the educational community to resolve existing problems concerning the use of ionizing radiation in dentistry. If the profession is to remain in the public trust as an advocate and protector of patient health, it cannot do otherwise. Notwithstanding, this philosophic principle will certainly foster, for the first time, direct federal intervention into the professional accrediting and licensing or credentialing processes.

Dentistry's Position in Congressional Hearings

During the past 20 months, the American Dental Association (ADA), the American Association of Dental Schools (AADS) and the American Dental Hygienists' Association testified on three separate occasions before U.S. Congressional committees in both houses on proposed radiation legislation. While the three associations agree with the intent of the legislation, they disagree with the mechanisms suggested for correcting the perceived problems because of the prospects of the Federal Government getting involved in matters of education, and more specifically, into the accrediting, licensing and credentialing processes. Further, it is the position of the respective organizations that, as one of the major health professions, the dental profession is not only entrusted with the responsibility but also has the obligation of safeguarding and protecting the well-being of the public it serves. Federal regulation or legislation should not be the necessary motivating force for the educational community or the profession to protect the safety and health of the public.

During the testimony, the following arguments concerning the dental profession's responsibility for control of ionizing radiation were advanced.

1) The ADA has policies regarding radiation equipment and radiation safety for practice. Specific policies also clearly stipulate the need to use professional judgment in determining the number and

frequency of radiographic examinations in order to secure necessary diagnostic information.⁴

2) Ionizing radiation is used exclusively for diagnostic and research purposes in dentistry and, unlike medicine, is not used for therapeutic reasons.

3) Significant improvements have been made to reduce ionizing radiation delivered to patients through use of X-ray equipment manufactured under federal guidelines and standards, tomographic equipment, filtration, collimation, open end cones, electronic timers, lead aprons and thyroid protective collars, film holding and cone positioning devices, faster speed image receptors, and rare earth screens.

4) The whole body bone marrow dose from dental X-ray sources is very small.⁵

5) Dental auxiliaries using radiographic equipment function at the direction and under the supervision of dentists.

6) The AADS has adopted strong policies concerning the teaching of radiology and use of ionizing radiation in dental, dental auxiliary and dental specialty education.⁶

7) The Section on Oral Radiology of AADS, in cooperation with the American Academy of Dental Radiology, has developed recently revised model curricular guidelines in radiology for use as guides by educational institutions.⁷

8) Dental radiology is an integral component of all dental and dental auxiliary curriculums.

9) The activities of the Commission on Dental Accreditation have been intensified in evaluating qualifications of faculty, instruction in radiology, the clinical practices regarding the control and monitoring of use of sources emitting ionizing radiation, X-ray equipment and radiography and support facilities, and patient records.^{8,9}

The Need for Radiographic Examinations and Selection Criteria

Exposure to ionizing radiation is known to be potentially harmful, as well as beneficial to humans. Beyond question, the use of radiographic examinations in dentistry for diagnostic and treatment planning purposes is indispensable and the need for diagnostic radiography is undisputable. However, in recognizing the value of dental radiographic examinations, subjecting patients to ionizing radiation for diagnostic purposes must only be made after a complete review and evaluation of the dental, oral and general medical health of the patient, and only subsequent to a thorough clinical examination. Concurrently, a critical assessment must be made of the benefit that the patients will derive from radiographic examinations versus the potential risk to their health. Such an evaluation should include the history of previous exposures

to ionizing radiation for dental, medical or therapeutic purposes.

The ultimate determination to use or not use diagnostic radiography must be based on the nature and extent of the diagnostic information required for providing high quality oral health care and must be consistent with good and acceptable clinical practices. In making such professional judgments, the underlying assumption is that every exposure carries some potential risk, but that risk is impossible to quantify. The only rational basis for determining the need, the extent, or the frequency of radiographic examinations must be sound and logical professional judgment. The judgment must include a determination of the minimum amount of radiation exposure that will produce the optimal diagnostic information with maximal radiographic quality. Under any circumstances, the determination of need for or the extent of a radiographic examination ought never be based on an arbitrarily established or prescribed length of time. Rather, the need for or the extent of a radiographic examination ought to be based on selection criteria and the findings of the clinical examination.

The paramount public concern is overutilization of ionizing radiation by the health professions. Overutilization suggests both unnecessary and excessive exposure. In its broadest context, overutilization may consist of excessive radiation per radiographic exposure, excessive radiographs per examination, and excessive number of examinations per patient.

Excessive radiation per radiograph

The patient receives more radiation than necessary if the area or volume being exposed is greater than the size of the image receptor. X-ray beams are to be appropriately collimated, preferably with rectangular collimators. Every effort must be made to limit the area of the body being exposed to ionizing radiation to the size of the image receptor. Inadequate filtration, slow speed image receptors and screens, outmoded, antiquated and poorly functioning equipment, and poor technique can result in unnecessary radiation to the patient. Also, a patient receives needless radiation if the exposure time is increased in order to decrease the developing time. Emphasis must be placed on minimizing the exposure time and maximizing the developing time with a view to obtaining optimal diagnostic yield.

Excessive radiographs per examination

The number of radiographic exposures required for a radiographic examination must be determined for each patient following a thorough clinical examination, subsequent to a complete assessment of the patient's dental, oral and general health histories has been made, and only after the risk to benefit ratio has been considered. If a prior radiographic examination is available and suitable, it may suffice. Panoramic or

tomographic radiographs must never be used as a screening examination when they are not expected to add new information, when they are judged to be of doubtful diagnostic importance, or when they are supplemented by or taken in conjunction with a full-mouth radiographic examination. Such radiographs are, as are any other type(s) of radiographic examination(s), totally unjustified when they are taken prior to a clinical examination and when they are not based on the findings of that examination. Such radiographs are only justified when there is reasonable expectation of gaining information essential or useful to diagnosis or treatment and when they supplant, rather than supplement, full-mouth radiographic examinations.

Poor equipment and poor technique not only result in more radiation to the patient, but excessive repeat radiographs may be taken per examination because of erratic performance of equipment or operator. The frequency of repeat radiographs must be kept to an absolute minimum. Otherwise, repeat radiographs result in an excessive number of radiographs being exposed per examination.

Considerable variability exists in the number of radiographs employed in a full-mouth radiographic series. Such examinations may consist of anywhere from 14 to 20 exposures. More standardization could and should exist. The retake rate in a full-mouth radiographic examination, due to exposure errors, must be kept to a minimum and patients must never be subjected to repeat exposures solely for the purpose of students demonstrating technical proficiency or for the purpose of producing radiographs that are technically perfect.

Excessive examinations per patient

Time must never be used as the criterion for determining whether a radiographic examination is ordered. Radiographs must never be ordered routinely using a set time interval, such as regular patient recall visits, as the criterion for ordering such examinations. Automatic and systematic use of radiographic examinations without prior consideration of the patient's history or clinical signs or symptoms is unjustified. Excessive radiographic examinations per patient may result when such examinations are performed routinely as part of an initial examination of new patients, or a patient recall examination, when patients are subjected to radiographic screening examinations prior to an initial clinical examination, when the need for other specific types of radiographic examinations is not yet determined, or when they are used primarily for evaluating acceptability of patients for clinical teaching.

Other reasons for excessive examinations per patient exist.

- 1) Undue dependence: Dependence upon repeat radiographs to follow treatment in endodontics,

periodontics, pedodontics, orthodontics and oral surgery, rather than following the clinical course of treatment based upon that patient's response to that treatment cannot be condoned or justified.

2) Defensive practice: Malpractice suits that characterize the present era are clearly contributing to the number of radiographic examinations performed. Many in the profession are unwilling to treat oral and dental problems in the absence of every possible safeguard and reasonable guarantee that nothing has been missed.

3) Post-treatment radiographs: Some third-party insurance carriers require submission of post-treatment radiographs to monitor and verify reimbursement claims for treatment. The ADA has recognized that such practices expose patients to unnecessary radiation and, therefore, does not condone such practices. Likewise, post-treatment radiographs to check restorative procedures routinely are unjustified. Such post-treatment radiographs are also too frequently required as part of the procedures followed during state and regional clinical licensing examinations.

The Commission on Dental Accreditation's Role

During the past several years, the Commission on Dental Accreditation has, on several occasions, officially notified all educational programs falling within its accreditation purview that intensified efforts will be made during accreditation site visits to evaluate the instruction, training and clinical experiences that students receive in radiology. Specific emphasis is placed on ensuring that students are adequately educated and competently trained in all aspects of radiology. The continuum of clinical and educational experiences must prepare students to be judicious in the use of ionizing radiation and must teach students to use sound and reasoned professional judgment in ordering or securing radiographs. Additionally, the Commission's site visit committees devote time to reviewing and evaluating the effectiveness of institutional guidelines, policies and procedures, as well as clinical practices related to controlling and monitoring use of ionizing radiation. The Commission expects that such guidelines, policies, and procedures will be in compliance with the 1970 National Council on Radiation Protection and Measurement (NCRP) Handbook 35 on Dental X-ray Protection,¹⁰ the ADA recommendations on radiation hygiene and practice in dentistry,¹¹⁻¹⁵ and state radiation control regulations. Further, such guidelines should parallel the policies stipulated in the parent university and health science center radiation regulations. Consideration is also given to assessing the educational background and qualifications of radiology faculty.

A review of the Commission's expectations concerning radiology in educational institutions follows. This review should truly "focus" dental radiology for the next decade.

Course content

As a matter of policy, the Commission does not dictate or stipulate course content in any curricular area, including radiology. However, during site visits attention is directed to assessing the scope and depth of instruction and the extent to which the radiology curriculum covers topics enumerated in the *AADS Guidelines for Predoctoral Teaching Programs in Dental Radiology*. But it should be emphasized that in so doing, implementation of the *AADS radiology Guidelines* is not mandated for accreditation purposes.

The principal goals of the radiology curriculum should be to ensure that: 1) students have the fundamental background knowledge related to and an understanding of radiation physics; radiation hygiene, safety and protection, and control of its use; image receptors, image production and imaging technologies; and factors influencing radiographic quality, including image processing; 2) students possess technical skills and demonstrated clinical competency in intraoral and extraoral radiography, including panoramic methods and curved surface laminography; 3) students have knowledge about and demonstrate competence in the interpretation of radiographs; and 4) students use clinical judgment in ordering or securing radiographic examinations. Attention is also directed at reviewing the processes used in evaluating all components of the radiology curriculum. In this regard, the site visit team reviews the depth and scope of examinations; preclinical and clinical evaluation instruments; the predetermined selection criteria used in ordering or authorizing radiographic examinations; the criteria used by faculty to evaluate radiographic quality; the proficiency standards used for evaluating preclinical and clinical skills and practice; and the clinical requirements and accomplishments of students in radiography.

It should be pointed out that a recent survey reported that textbooks in many disciplines contain information about use of radiographic examinations that is in conflict with the Bureau of Radiological Health's and ADA's position on use and frequency of use of diagnostic radiation.¹⁶ Such misinformation obviously underscores the magnitude of the problems facing dental education. It is not enough for radiology faculty to teach currently accepted concepts of diagnostic radiography. Indeed, radiology faculty need to reverse decades-old practices that are still contained in standard textbooks and that continue to be taught by faculty in a number of clinical disciplines.

Time devoted to teaching radiology

Although the Commission does not prescribe or

mandate the number of curricular clock hours of instruction in any subject area, the report, *Dental Education in the United States — 1976*,¹⁷ indicated that 59 of the nation's 60 dental schools (One school had not admitted its first class at the time of the study) provided from 19 to 278 clock hours of instruction in radiography. (The institution reporting 19 instructional hours was a new school having only its charter class matriculated when the survey was conducted.) The mean number of hours of radiology instruction reported was 88.0 hours; the median was 70.0 hours. In addition, the report noted that supplemental instruction in radiology, specifically radiographic interpretation, frequently is provided by a number of other clinical disciplines; yet, this component of the educational continuum is not specifically identified as instructional time in radiology.

It is important to emphasize that in the section of the 1976 curriculum study report dealing with changes in curricular emphasis, during the decade between 1966 and 1976, almost one-half of the 59 fully operational dental schools reported an increased emphasis in all areas of instruction in dental radiology. Radiation safety and protection, and interpretation of radiographs were specifically identified as the two areas that had received the greatest increase in attention. About one-third of the schools reported that the number of clock hours devoted specifically to radiology instruction had been increased.

The 1980 survey of dental radiology¹⁸ showed that instructional hours in radiology have increased since the 1976 curriculum study was conducted. The data indicate that instructional hours range from 32 to 178 clock hours. The mean number of instructional hours was 91, and the median was 84 hours. It was noted again that additional instruction in radiology, and more specifically radiographic interpretation, was provided by other clinical disciplines, particularly oral diagnosis.

The Commission has adopted the position that there is no correct number of clock hours of instruction for any subject area because clock hours are not a true indicator of the depth and scope or quality of instruction. Quality of instruction is, in large measure, affected by the qualifications of faculty who provide that instruction and by faculty to student ratios. For these reasons, the Commission evaluates the quality of radiology instruction based on available resources and course content, and in such, an overall evaluation time allocated to radiology is considered.

Sequencing of the subject in the curriculum

Instruction in radiology should be properly sequenced in the curriculum. Pertinent and appropriate course content, preclinical and clinical technical skills and experiences, and instruction in radiographic inter-

pretation should be provided at the most appropriate times in the educational continuum. The sequencing of radiology instruction should be such that it will be most meaningful and useful to students in providing care to patients.

Faculty — numbers and qualifications

There should be an adequate number of formally trained radiology faculty to meet the needs of the institution's educational, service, and research programs. It is generally acknowledged that the number of dental faculty with formal training in radiology is relatively small. Ninety-five percent of the respondents of the 1980 survey of dental radiology expressed the view that, nationally, there is an inadequate number of trained faculty in radiology. Further, 65% of the respondents indicated that there are insufficient numbers of formally trained radiology faculty in their respective institutions.¹⁸

The Commission defines formal education in a specific discipline as an educational sequence, usually of at least two years duration, devoted primarily to and with emphasis on that discipline. Therefore, formally trained dental radiology faculty would not include those who are self-taught, those who received radiology instruction through continuing education, or those who obtained limited radiology instruction as part of a training program in another discipline such as oral pathology, oral medicine, or oral diagnosis.

In recognizing that the number of formally trained radiology faculty is limited, the Commission believes that a concerted effort must be made to correct the deficiency. To achieve this end, the Commission has requested that the American Fund for Dental Health (AFDH) give high priority in its Dental Teacher Training Fellowship Program to faculty development in dental radiology and to earmark such traineeships. The Commission requested and received the concurrence of the AADS relative to the need to develop such targeted AFDH support. AFDH will consider this request in the near future. Because the resources of the AFDH are limited however, efforts should also be made to expand fellowship programs financed through other foundation support or through other granting agencies. Unfortunately, the availability of federal funds for teacher fellowships appears rather limited at the present time.

Currently, there are five institutions in the United States that offer programs in dental radiology. Interest has been expressed by at least two other dental schools in establishing such programs.

To deal with the immediate need, the Commission is of the opinion that schools having formally trained radiology faculty should develop special short-term, but full-time, programs to educate faculty who currently are responsible for teaching radiology. Such programs could be of five to six months duration. To

achieve this end, radiology faculty currently in the workforce should be encouraged to apply for sabbatical leaves so that they could spend time not only advancing their expertise, but also in conducting research in radiology at other institutions. In so doing, the more immediate needs for better trained radiology faculty can be realized.

It is the contention of many that the foremost reason for the lack of formally trained radiology faculty is that radiology is not recognized by the dental profession as a specialty. Since 1958, when requirements for recognition of dental specialties were first developed and approved by the ADA House of Delegates, the criteria for recognizing special areas of dental practice have not been changed. Currently, there are eight areas in dentistry that have attained specialty status. The Council on Dental Education will, in response to recommendations contained in the report of the Task Force on Advanced Dental Education,¹⁹ conduct an indepth study of specialties and specialization and will reassess the dental profession's criteria for recognizing dental specialties. Its outcome is mere speculation at this point. However, trends toward further specialization generally connote greater fragmentation in delivery of care. It is the judgment of many that dentistry will, as from its origin, remain a profession of general practitioners who assume ongoing and total responsibility for the general oral health care of patients, and that, unlike medicine, dentistry is not likely to become a specialty-dominated profession.

Technical support personnel

Efforts are made by the Commission to assess the adequacy of the number and the educational backgrounds and experiences of radiological technical support personnel available for carrying out service functions. Technical personnel are not to be employed in lieu of trained faculty. Rather, faculty coverage should be provided for instructional purposes at all times. Radiological technicians and trained dental auxiliaries should function in a supportive role and should not serve chiefly to provide instruction.

Radiography facilities

All teaching and clinical facilities, including intramural, satellite radiology facilities located in clinical departments other than the radiology clinic, and extramural clinical facilities are to be constructed and designed to afford optimal protection to faculty, students, patients and staff. Operatories should be easily accessible, but totally enclosed, and ordinarily the walls should be lead-lined. Construction of operatories in all intramural and extramural facilities must be such that the operator of the X-ray equipment will be protected at all times while maintaining visual contact with the patient during the radiographic exposure.

Operatories should not, under any circumstances, be part of a thoroughfare. All X-ray facilities and equipment within the school, as well as those located in extramural facilities, should be within the purview of and under the supervision and authority of the radiology faculty. Monitoring of all facilities should be included in the institution's radiology quality assurance program; and all facilities should be in compliance with federal, state, local, and where applicable, university or health sciences center radiation safety regulations.

Darkrooms should provide ample space for processing and drying of radiographs. Appropriate safelights should be provided. An appropriately designed and appropriately equipped and lighted radiographic viewing facility should also be provided. Background illumination in the viewing facility should be adjustable. Magnifying instruments should be available for interpreting radiographs.

Equipment for teaching radiology

Dental X-ray equipment purchased after 1974 is certified to meet federal and ADA specifications. X-ray equipment purchased prior to 1974 must be updated to comply with current federal standards. It is expected that all X-ray equipment will meet the recommendations of the National Council on Radiation Protection and Measurements, the performance standards of the Bureau of Radiological Health that were issued in 1974, and Specification No. 26 published by the ADA in 1974.²⁰

X-ray equipment is to be inspected to ensure that performance standards are maintained. Such inspections are to be conducted by state, local, or university or health science center radiation officers or by a competent health physicist at regular and periodic intervals. Ordinarily, all equipment is to be calibrated annually, including that located in satellite clinical departments and extramural clinics. Such inspection reports are to be maintained in departmental files. The dose rate for each machine must be determined and posted. Kilo-voltage, milliamperage and exposure times should be posted in a conspicuous location near the control panel for reference purposes.

The equipment is to be located in adequate size and enclosed operatories that permit the full range of necessary movement of equipment and operator. Only open-ended position-indicating devices, preferably those that incorporate a metal cylindrical collimator or rectangular collimator, are to be utilized. Lead aprons and cervical collars are to be used. Aprons are to be hung to prevent bending when not in use.

The darkroom facility must be clean, light-tight, and properly equipped with safelights, counterspace and drying facilities. Processing procedures recommended by manufacturers should be posted in a conspicuous location.

Guidelines and policies for exposure — selection criteria

The Commission expects educational institutions to have established policies and guidelines regarding the monitoring, and the controlling of the use of ionizing radiation for teaching and research purposes. The primary goal of such institution-wide policies and guidelines must be aimed at ensuring safe and effective use of ionizing radiation and, thereby, minimizing any potential risk from adverse biologic effects to patients, students, faculty and staff. The Commission intends that such institutional policies and guidelines will not be restricted to dental students, but will encompass the dental auxiliary and dental specialty programs and students, as well. The Commission assumes that dental radiology faculty will have not only the responsibility but also the authority from the dental and clinical administrations for developing, implementing, monitoring, controlling, and enforcing radiation policies throughout the institution. Such responsibility and authority must not be limited or confined to the teaching and service activities that take place in the radiology clinic.

Radiology faculty should develop selection criteria that are to be used in determining the type(s) of radiographic examination(s) required and the number of exposures judged necessary. In making such determinations, the diagnostic yield must be judged to exceed the possible risk to the patient. Efforts must be made to secure prior suitable radiographic examinations. Radiographic examinations are not to be ordered for screening purposes, and only essential radiographic examinations may be ordered after: a review of the oral, dental and medical histories; an evaluation of the general health of the patient and a complete clinical examination; and the ordering of radiographic examinations must be based on the findings of the clinical examination. All radiographic examinations are to be authorized by dentists only, because their prescription must be based on the total oral health needs of the patient. Supplemental radiographs required during patient treatment are to be authorized only when judged as being essential for the patient's welfare and only when considered necessary for good clinical practice. Post-treatment radiographs for restorative procedures result in needless radiation exposure to the patient and such a radiographic examination must not be used to document acceptability of treatment procedures.

All radiographic exposures, including all repeat radiographic exposures, are to be recorded sequentially in an easily identifiable area in the patient's record. The faculty is expected to have clearly established policies regarding repeat exposures. The institution's policy must clearly delineate the number of repeat ex-

posures permitted on a full-mouth radiographic survey. Further, patients are not to be subjected to repeat radiographic exposures only for the purpose of students demonstrating technical competence. Repeat radiographs are not to be retaken for the sole purpose of having technically acceptable or perfect radiographs, providing the areas are covered at diagnostically acceptable levels on other radiographs. It is expected that faculty supervision will be provided during repeat exposures.

Clear policy is to be established that precludes routine use of radiographic examinations on a time schedule basis. For example, full-mouth radiographic surveys should not be obtained every one, two or three years or bitewing radiographic examinations every six months or every year. History, assessment of the patient's general health, clinical examination and professional judgment are the key factors in determining the need for or extent of any radiographic examination.

Students and staff are not to be exposed to ionizing radiation for either teaching or training purposes primarily. Phantoms are to be used exclusively for such purposes. It is expected that students and staff will demonstrate an appropriate level of technical competence on phantoms prior to clinical assignment. If persons are being exposed to ionizing radiation for other than diagnostic purposes, written informed consent must be secured and only after receiving approval of the Human Subjects Protection Committee and the university's or health science center's Radiation Safety Committee.

Guidelines and policies for monitoring

The Commission expects to find an institution-wide, ongoing program related to monitoring equipment, darkrooms, processing solutions, and use of ionizing radiation. The monitoring program on use of diagnostic radiography should include all clinical disciplines and should ensure against the unnecessary use of ionizing radiation in any clinic or any program, including auxiliary and specialty programs. The monitoring program should encompass satellite radiology facilities and extramural facilities as well. The monitoring program must also include operators of X-ray equipment. Film badges are to be worn by all operators of X-ray equipment, including faculty and technical support staff. Reports of results are to be maintained in departmental files.

Quality assurance program

Quality assurance is a rapidly evolving trend in the health professions generally. However, its specific application to dental radiology is somewhat elusive. Quality assurance encompasses the gamut of reproducible and reliable systems necessary for the production of quality radiographic images through continuous monitoring. The purpose of a quality assurance program is to improve continually and consistently

overall radiographic quality, and, at the same time, to minimize the ionizing radiation to which patients and operators of X-ray equipment are exposed.

A quality assurance program requires well-developed administrative policies and procedures that control use of ionizing radiation. Moreover, it also must provide for quality control mechanisms and techniques to monitor the various components of the total X-ray system. The parameters of that system should include the performance of the X-ray generator and other component parts of the X-ray equipment, including the X-ray control, tube housing assembly, tube head stability, beam-limiting devices and other supporting structures. Accompanying components, such as image receptors, image processing systems, darkrooms and their integrity and viewing apparatus and environment, should also be considered as an integral part of the entire quality assurance system.

The quality assurance program should include an ongoing assessment of the quality of all radiographic services provided intramurally and extramurally. Quality assessment of radiographic examinations made prior, during or after treatment in other clinical disciplines, such as oral and maxillofacial surgery, endodontics, orthodontics, pedodontics and periodontics should be included also.

Radiology faculty should provide in-service education programs for faculty in other clinical departments on a periodic and ongoing basis. All clinical faculty, including those in extramural programs and affiliated hospitals, should have an understanding of, and appreciation for, current concepts and concerns about ionizing radiation in view of their wide diversity of backgrounds, education, and perspectives. It is important that such faculty be apprised of the proper use of techniques in diagnostic radiography so that they may reinforce, rather than provide conflicting information about the safe and effective use of radiographic examinations.

It has been argued that dictating an accepted standard of practice regarding use of diagnostic radiology to other clinical faculty or departments is tantamount to infringement on academic rights and privileges. Yet let it be clear that the issue is not academic freedom; rather the issue is protection of the public.

Dr. Santangelo is assistant secretary, Council on Dental Education and Commission on Dental Accreditation, American Dental Association. Presented to the Section on Oral Radiology, American Association of Dental Schools, Chicago, Illinois, 15 March 1981.

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References

1. U.S. Dept. of H.E.W. The Report of the Interagency Task Force on the Health Effects of Ionizing Radiation, Washington, D.C.: U.S. Dept. of H.E.W., 1979.
2. U.S. House of Representatives, Committee on Interstate and Foreign Commerce, Subcommittee on Oversight and Investigations Unnecessary Exposure to Radiation from Medical and Dental X-rays, Serial No. 96-46, Washington, D.C.: U.S. Government Printing Office, 1979.
3. Radiation Policy Council, Executive Order 12194 of February 21, 1980. Federal Register. 45(38): February 25, 1980, pp 12209-12210.
4. American Dental Association. Transactions, 1972. Chicago: 1972, p 95.
5. White, S.C. and Rose, T.C. Absorbed bone marrow dose in certain dental radiographic techniques. JADA 98:553-58, 1979.
6. American Association of Dental Schools Proc. Amer. Assn. Dent. Schools. 1980. J Dent Ed 44:404, 415, 419, 424-26, July 1980.
7. American Association of Dental Schools Curricular guidelines for oral radiology. J Dent Ed 44:674, November 1980.
8. Santangelo, M. V. Communication to Deans of Dental Schools. December 13, 1979.
9. Santangelo, M. S. Communication to Deans of Dental Schools. May 15, 1980.
10. National Council on Radiation Protection and Measurements. Dental X-ray Protection, NCRP Report No. 35, Bethesda, Md. (reprinted 1972).
11. American Dental Association Council on Dental Materials and Devices. Radiation Hygiene and Practice in Dentistry. I. JADA 74:1032, 1967.
12. American Dental Association Council on Dental Materials and Devices. Radiation Hygiene and Practice in Dentistry. II. JADA 75:1197, 1967.
13. American Dental Association Council on Dental Materials and Devices. Radiation Hygiene and Practice in Dentistry. III. JADA 76:115, 1968.
14. American Dental Association Council on Dental Materials and Devices. Radiation Hygiene and Practice in Dentistry. IV. JADA 76:363, 1968.
15. American Dental Association Council on Dental Materials and Devices. Radiation Hygiene and Practice in Dentistry. V. JADA 76:602, 1968.
16. Mills, L. F. A Survey of Required Dental School Textbooks. Draft Report dated March 2, 1981. Department of Health & Human Services, Food & Drug Administration, Bureau of Radiological Health.
17. American Dental Association. Dental Education in the United States — 1976. Chicago:1977.
18. American Dental Association Commission on Dental Accreditation. Report on Radiology Instruction and Use of Ionizing Radiation in United States Dental Schools — 1980.
19. American Association of Dental Schools. Advanced Dental Education: Recommendations for the 80's. Draft Report dated June 1981. Washington, D.C.: 1980.
20. American Dental Association Council on Dental Materials and Devices. New American Dental Association Specification No. 26 for Dental X-ray Equipment. JADA 89:386, 1974.