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Perspective article

# A special system of radiology diagnosis equipment operating license for the dentists and its development history in Taiwan

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Since Wilhelm Conrad Roentgen discovered X-ray at the end of 1895, and Otto Walkhoff, a German dentist, used X-ray to take radiographs of his teeth for the first time at the beginning of 1896, the X-ray technology has been widely used in dental and medical diagnosis all over the world. Subsequently, the X-ray equipment became the most advantageous diagnostic tool in dentistry and medicine. In addition, the first X-ray machine for dental and jawbone disease diagnosis was manufactured by the current German company Siemens in 1905. Thus, the field of dental radiology has existed for more than 120 years.[1,2] The article "the value of X-ray in the diagnosis of dental diseases (with photobook)" was published in the Journal of the Formosan Medical Association by the Taiwan Government Taipei Hospital in 1913. This may be the earliest academic publication on the application of dental X-ray images for diagnosis of dental diseases in Taiwan. It means that the development of dental radiology in Taiwan started as early as the Japanese colonial period (1895—1945), and its development is almost synchronized with the world.[3]

After the World War II, there was internationally a profound reflection on the peaceful use of atomic energy. The postwar Taiwan government also followed this trend and established the Atomic Energy Council (AEC) within the central government to take charge of the development of atomic energy technology and safety supervision related to the peaceful use of atomic energy, including the safety supervision of medical ionizing radiation in dentistry. As a result, a special system of radiology diagnosis equipment operating license for the dentists was developed. This article used the document analysis method to explore the connotation of this special system and the historical context of its development.

In this article, we collected the documents related to the descriptions of atomic energy safety supervision and the regulations of medical radiology equipment operating license for the clinicians as much as possible and screened the important events to delineate the special system of radiology diagnosis equipment operating license for the dentists and to excavate its development history, as shown in Table 1.

The postwar Taiwan government established the AEC within the central government in 1955 in accordance with the spirit of the United Nations (UN) "International Collaboration for Atomic Energy Use in Peace", opening a new era in Taiwan's atomic energy management. In 1968, the Atomic Energy Law was formulated as the legal source of radiation protection. It was specified that the AEC became a department established within the central government in accordance with the law, responsible for the development of atomic energy technology and the safety supervision involving in the peaceful use of atomic energy, while the safety supervision for medical ionizing radiation was also included. In 1970, the Safety Standards for Protection against Ionizing Radiation were approved, which were the earliest explicit specifications on radiation protection.

In 1973, the AEC and the Department of Health (DH) jointly promulgated the Regulations for Medical Ionizing Radiation, which were the earliest explicit specifications on medical radiation protection control. Regarding the medical radiology equipment operating behavior of the

**Table 1** The important events related to radiology diagnosis equipment operating license for the dentists in Taiwan.

| Time | Events |
|---|---|
| 1955.05.31 | The 9th Regular Session of the United Nations (UN) General Conference reviewed the "International Collaboration for Atomic Energy Use in Peace" proposed by the US government. In Taiwan, subsequently, the Ministry of Foreign Affairs recommended in December 1945 to the Executive Yuan to establish an atomic energy research institution and participate in the International Atomic Energy Agency (IAEA) General Conference. According to the Executive Yuan Organization Law Article 14 "to handle specific matters, the Executive Yuan may establish various committees within the Executive Yuan", the "Organizational Regulations of the Atomic Energy Council (AEC) of the Executive Yuan" was drafted by the Ministry of Education. Then, it was revised and approved by the Executive Yuan. On May 31, 1955, it was promulgated to establish the AEC. The work of the AEC was handled by the Science Education Committee of the Ministry of Education in those days. |
| 1968.05.09 | The Atomic Energy Law was formulated as the legal source of radiation protection. It was specified that the AEC became a department established within the central government in accordance with the law, responsible for the development of atomic energy technology and the safety supervision involving in the peaceful use of atomic energy, while the safety supervision for medical ionizing radiation was also included. |
| 1970.07.29 | The Safety Standards for Protection against Ionizing Radiation were approved. They were the earliest explicit specifications on the radiation protection. |
| 1970.12.03 | The Organization Act of the AEC was enacted and announced, and the AEC became an agency established in accordance with the organizational law. |
| 1973.02.26 | The AEC and the Department of Health (DH) jointly promulgated the Regulations for Medical Ionizing Radiation. It was the earliest explicit specifications on medical radiation protection control, and the detailed medical ionizing radiation safety regulations were attached. The relevant regulations regarding applying for an operating |

**Table 1** (*continued*)

| Time | Events |
|---|---|
| | license are as follows:<br>The operating licenses of medical radioactive materials and medical ionizing radiation installations are divided into the operating licenses of (1) radiology diagnosis equipment, (2) radiology treatment equipment, and (3) using radioactive isotopes. Moreover, the licenses are issued in three capacities for (1) physicians, (2) dentists, and (3) medical radiation technologists and technicians. Any physician or dentist, applying for an operating license, should have received a medical ionizing radiation protection training, and this operating license is issued by the AEC in conjunction with the DH. In addition, the aforementioned medical ionizing radiation protection training should be sponsored by the AEC in accompanying with the DH. |
| 1976.12.07 | The AEC promulgated the Enforcement Rules of the Atomic Energy Law, while the above provisions were transferred to the Enforcement Rules of the Atomic Energy Law. |
| 1991.07.10 | The second version of the Safety Standards for Protection against Ionizing Radiation was revised and released. |
| 1995.01.26 | The AEC specifically regulated the implementation procedure for the ionizing radiation protection workshop. A 23-h training course was required for the ionizing radiation protection. |
| 1995.07.08 | The AEC clearly defined the application procedure for medical ionizing radiation operating licenses. The license types and application qualifications were the same as before. |
| 2002.01.30 | The Ionizing Radiation Protection Act was enacted and promulgated. It was a new legal source of radiation protection. The relevant regulations regarding for the training of personnel for handling radioactive materials or operating equipment capable of producing ionizing radiation are as follows: The personnel to handle radioactive materials or operate equipment capable of producing ionizing radiation should receive training specified by the Competent Authority, and obtain radiation safety certificates or licenses. However, the training may be used in lieu of certificates or licenses when handling radioactive materials below a specific activity level or operating equipment capable of |

(*continued on next page*)

**Table 1** (*continued*)

| Time | Events |
|---|---|
| | producing ionizing radiation below a specific energy level. Furthermore, the specific level of activity or energy should be laid down by the Competent Authority. |
| 2002.12.25 | The AEC promulgated the Enforcement Rules for the Ionizing Radiation Protection Act. |
| 2002.12.25 | The AEC promulgated the Administrative Regulations for Operators of Radioactive Material or Equipment Capable of Producing Ionizing Radiation. For the specific radioactivity or specific energy levels stipulated in the Ionizing Radiation Protection Act, they are as follows:<br>(1) Sealed radioactive materials defined in Category IV and Category V.<br>(2) Radioactive material that forms a component of an instrument or a manufactured product and that has a radioactivity less than 1000 times that of the exemption level and the surface dose rate at an accessible distance of 5 cm is 5 μSv/h.<br>(3) Radioactive materials besides those mentioned in the preceding two subparagraphs with a radioactive level of 100 times that of the exemption level.<br>(4) For equipment capable of producing ionizing radiation, the nominal voltage is 150 kV or the particle energy is 150 keV.<br>(5) Cabinet or baggage inspection X-ray machine, ion implanter, electron beam welding machine or static eliminator, the surface dose rate at an accessible distance of 5 cm is 5 μSv/h.<br>(6) Other material or equipment as designated by the Competent Authority. |
| 2002.12.25 | The AEC promulgated the Administrative Regulations for Business Related to Radiation Protection Service. The relevant regulations regarding the courses and hours for the training of personnel for handling radioactive materials or operating equipment capable of producing ionizing radiation are as follows:<br>(1) Radiation safety certificate:<br>The implementation period of this training should not exceed one month, and the total number of |

(*continued on next page*)

**Table 1** (*continued*)

| Time | Events |
|---|---|
| | course hours should not be less than 36 h. The course names and course hours are as follows: basic radiation (at least 6 h), radiation measurement and dose (at least 6 h), radiation protection (at least 7 h), radiation application and protection (at least 6 h), ionizing radiation protection regulations (at least 8 h), and radiation protection internship or apprenticeship (at least 3 h).<br>(2) Replace radiation safety certificate with radiation protection training: The implementation period of this training should not exceed one month, and the total number of course hours should not be less than 18 h. The course names and course hours are as follows: basic radiation (at least 4 h), radiation protection (at least 3 h), radiation application and protection (at least 3 h), ionizing radiation protection regulations (at least 5 h), and radiation protection internship or apprenticeship (at least 3 h). |
| 2003.01.30 | The third version of the Safety Standards for Protection against Ionizing Radiation was revised and released. |
| 2005.12.30 | The fourth version of the Safety Standards for Protection against Ionizing Radiation was revised and released. |
| 2023.06.21 | The Nuclear Safety Commission (NSC) Organization Act was enacted and announced. |
| 2023.09.27 | The AEC was restructured into the NSC, which continued to be responsible for the safety control of atomic energy such as nuclear energy, radiation and radioactive materials, as well as the safety supervision of medical ionizing radiation. |

clinicians, it has officially entered the era of government management.

The operating licenses of medical radioactive materials and medical ionizing radiation installations are divided into the operating licenses of (1) radiology diagnosis equipment, (2) radiology treatment equipment, and (3) using radioactive isotopes. Moreover, the licenses are issued in three capacities for (1) physicians, (2) dentists, and (3) medical radiation technologists and technicians. For the dentists, however, there was only the operating license of radiology diagnosis equipment. Any physician or dentist, applying for an operating license, should have received a medical ionizing radiation protection training, and this operating license is issued by the AEC in conjunction with the DH. In addition, the aforementioned medical ionizing radiation protection training should be sponsored by the AEC in accompanying with the DH. However, the above provisions were transferred to the Enforcement Rules of the Atomic Energy Law promulgated in 1976.

From 1973 to 2002, the above license management model lasted for nearly 30 years. Only in 1995, the implementation procedure for the ionizing radiation protection workshop was specifically regulated and a 23-h training course was required, as well as the application procedure for medical ionizing radiation operating licenses was clearly defined.

In 2002, the Ionizing Radiation Protection Act was enacted and promulgated, which became a new legal source of radiation protection. A series of related sub-laws were enacted and promulgated in the same year. The new system simplified regulations regarding the supervision for the medical radiology equipment operating behavior, consistent for both medical and non-medical uses. The personnel or radiation works (of course including dentists) to handle radioactive materials or operate ionizing radiation installations with the specific radioactivity or specific energy levels should receive a 36-h radiation protection training specified by the Competent Authority, and obtain radiation safety certificates. In addition, the personnel to handle or operate those below the specific levels could receive an 18-h radiation protection training in lieu of certificates. Thereby, since the nominal voltage of dental X-ray equipment, even cone-beam computed tomography (CBCT), is less than 150 kV, the dentists only need the 18-h training to be qualified to use the above-mentioned dental X-ray equipment. Finally, due to government organizational adjustments, the AEC was restructured into the Nuclear Safety Commission (NSC) in 2023, but the above license management model has not changed.

In Taiwan, the government currently adopts a low-involvement model in the management of dental X-ray diagnosis equipment operating license for the dentists. When a dentist completes the 18-h government-recognized radiation protection training, he or she is legally qualified to operate dental X-ray equipment for life. Almost every dental student completes this 18-h radiation protection training before and after he or she graduates, so that he or she is qualified to operate dental X-ray equipment immediately after practicing. Although the ionizing radiation protection related regulatory system stipulates that radiation workers must receive a 3-h radiation protection continuing education course every year, this requirement does not apply to the dentists. However, in addition to radiation protection training, for the dentists, dental radiology also includes professional training in dental radiology technology and dental radiology pathology and diagnosis.

The significance of this article is to outline the current landscape of the special system of radiology diagnosis equipment operating license for the dentists and its development history in Taiwan, indicating that dental radiology should be an interdisciplinary professional specialty that covers not only ionizing radiation protection, but also medial radiation technology and oral pathology. Therefore, it seems crucial to strengthen the training of dental radiology in the undergraduate dental curricula. With the improvement of dental radiography technology and its extensive use in dental procedures, such as CBCT,

we cannot limit our thinking about the ionizing radiation protection to just obtaining qualifications for radiology equipment operation. On the contrary, we should consider the feasibility of adding dental radiology (including radiation protection, dental radiology technology, and dental radiology pathology and diagnosis) to the dentist continuing education in the future.[4,5]

## Declaration of competing interest

The authors have no conflicts of interest relevant to this article.

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