Journal of Dental Sciences 19 (2024) 1854–1858

Available online at www.sciencedirect.com

ScienceDirect

journal homepage: www.e-jds.com

Perspective article

The development of operating license for the medical radiation technologists and their dental radiation work in Taiwan

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Received 5 May 2024

KEYWORDS
Dental radiation work;
Dental radiology;
Radiation protection;
Medical radiation technologists;
Dentists

While Wilhelm Conrad Roentgen discovered X-ray at the end of 1895, soon after that Otto Walkhoff, a German dentist, used X-ray to take the radiographs of his teeth for the first time with the help of Fritz Giesel at the beginning of 1896. Interestingly, when the world's first X-ray radiograph of human teeth was born, the world's first person assisting a dentist in performing dental radiation work

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https://doi.org/10.1016/j.jds.2024.05.009

Table 1 The important events related to radiology equipment operating license for the medical radiation technologists (MRTs) and their dental radiation work in Taiwan.

Time	Events
1955.05.31	Due to the purpose for the international collaboration for atomic energy use in peace, the Atomic Energy Council (AEC) was established within the central government. The work of the AEC was handled by the Science Education Committee of the Ministry of Education in those days.
1965	In the early days, the cultivating of medical radiation manpower was through hospital training classes or master-apprentice teaching. The Yuanpei Junior College of Medical Technology (restructured into a university in 2005) started the formal school education for cultivating medical radiation manpower.
1968.04.27	The Taiwan Society of Radiological Technologists (TWSRT) was established. It is an academic group mainly composed of medical radiation practitioners.
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 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 (such as the management of medical radiation practitioners) was also included.
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 regulations determined that the competent authority for medical radiation practitioners was the AEC, and covered the examination regulations for the medical radiation technologists (MRTs) and medical radiation technicians. It should be noted that the MRTs refer to those who have a college degree or above in radiology, while medical radiation technicians refer to those who have only a high school degree in radiology or no degree. However, there was a criterion of the training and working experience in radiation for those who take the medical radiation technician examination. The relevant regulations regarding applying for an operating license are as follows: 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) MRTs and medical radiation technicians. Any MRT and medical radiation technician passing the examination and obtaining the operating license could engage in various radiation-related businesses under the guidance of a physician or a dentist who has the operating license. In addition, the aforementioned operating licenses are issued by the AEC in conjunction with the DH.
1973.09.05	The AEC and the DH jointly promulgated the Regulations for Medical Radiation Practitioners Qualification Review Committee. One of the tasks of this committee is the accreditation review of the training and working experience in radiation for those who take the medical radiation technician examination.
1976.03.08	The rules for the medical radiation technician special examination were released, and the qualifications for the special examination were given to those who had no relevant academic qualifications but had actually engaged in medical radiation work for three years.
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. In addition, the rules stipulated that the aforementioned special examinations would be only held 3 times.
1978.03	Since the examination regulations for the MRTs passing in 1973, for another five years of struggle, the qualification examination for the MRTs was held for the first time in 1978. The examination was divided into three groups of (1) radiology diagnosis equipment, (2) radiology treatment equipment, and (3) using radioactive isotopes.
1979	The Department of Dentistry of National Taiwan University Hospital (NTUH) established a dedicated dental radiology room, which was managed by the Division of Oral Diagnosis at that time. It may be the earliest dental radiology unit of a general hospital in Taiwan. There were 6 dental X-ray machines in the dental radiology room, 4 for the periapical radiographs and 2 for the panoramic and cephalometric radiographs, as well as one automatic film developing machine and one traditional hand-wash film processing box in the independent darkroom within the dental radiology room. At that time, the dental radiology-related equipment was very comprehensive and advanced.
1980.09	The Department of Dentistry of NTUH employed a full-time MRT, who was responsible for dental X-ray photography in the dental radiology room. He may be the earliest hospital MRT who specializes in dental radiology.
1986.01.24	The Professionals and Technologists Examinations Act was enacted and announced. This was the beginning of the legalization of the professional and technical certificate examination system in Taiwan.

(*continued on next page*)

Table 1 (*continued*)

Time	Events
1986.05.02	The Examination Yuan promulgated the Professionals and Technologists Examinations Act Enforcement Rules. The eligibility of professional and technical personnel to perform professional services should be determined by the examination in accordance with the aforementioned Act, while the MRTs and medical radiation technicians were also included for the time.
1987.05.04	The Examination Yuan and the Executive Yuan jointly promulgated the Regulations Governing the Qualification Examination for Medical Personnel, while the MRTs and medical radiation technicians were also included in the regulations. This was the first time that the MRTs and medical radiation technicians were included in the regulations as medical personnel. At that time, the examination was still divided into three groups.
1994	Since the Professionals and Technologists Examinations Act passing in 1986, for another eight years of struggle, the Senior Examination for the MRTs was held for the first time in 1994. This examination was not divided into categories, and those passing the examination could apply for any of the three operating licenses from the AEC.
2000.02.03	The Medical Radiation Technologists (MRTs) Act was enacted and promulgated. The career of the MRTs and medical radiation technicians began to have an independent legal system for management, and its competent authority was the DH. When they practice, the MRTs or medical radiation technicians should join the local association for the MRTs or association for medical radiation technicians. Except for self-paid examinations at the medical care radiological clinics, to carry out general radiography for diagnostic radiology and nuclear medical in-vitro examination, the MRT should follow an examination order issued by a physician, while to carry out dental radiography for diagnostic radiology, the MRT should follow an examination order issued by a dentist. The MRTs who have obtained a practice license issued by the local municipal or county (city) competent authority are not required to apply for the training certificate or relevant operation license in relation to ionizing radiation as stipulated by relevant laws and regulations. Furthermore, the standards for establishment of a medical care radiological clinic should be determined by the central competent authority upon consultation with the AEC and other related agencies.
2000.06.25	The Taiwan Academy of Oral and Maxillofacial Radiology (TAOMR) was established, and the participants included dentists, MRTs and radiological science experts.
2000.12.30	The Examination Yuan promulgated the Regulations of Professionals and Technologists Senior and Junior Examinations for Medical Personnel. The MRTs were included in the regulation, but the medical radiation technicians were not included.
2001.03.28	The DH formulated and promulgated the Standards for Establishment of a Medical Care Radiological Clinic. Then, the medical care radiological clinics specializing in dental imaging were gradually established.
2002.01.30	The Ionizing Radiation Protection Act was enacted and promulgated. It was a new legal source of radiation protection.
2005	The Ministry of Examination entrusted the Taiwan Association of Medical Radiation Technologists to formulate the Minimum Core Subject Standards for Graduates of the Department of Medical Imaging and Radiation Sciences Taking the MRT National Examination. In clinical internship course, the general X-ray photography of medical imaging technology included dental photography. This was the earliest provision for medical radiation internship to include dental photography.
2012.01.01	In the internship certification standards of the senior examinations for the MRTs applicable to graduates after January 1, 2012, the radiological diagnostic internship included dental photography. This was the earliest official provision for medical radiation internship to include dental photography.
2013.07.23	The DH, the competent authority for the MRTs, was restructured into the Ministry of Health and Welfare.
2021	The first dental hospital was established with complete dental specialties, including a dedicated dental imaging department and its dedicated MRTs. It was the earliest dental radiology department of a dental hospital in Taiwan.
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.

might also be the first person who completed the operating procedure of the dental X-ray machine. Although the X-ray technology has been widely used in the dental diagnosis all over the world, and the first commercially available X-ray machine for dental and jawbone disease diagnosis was manufactured by the current German company Siemens in 1905, the professional development of medical radiation technologists (MRTs) and their dental radiation work have received less attention in the history of dentistry.[1,2]

The Taiwan Government Taipei Hospital might begin using dental X-ray machines in the 1910s. By the 1930s, the local dental clinics in Taiwan might generally have dental X-ray machines for their dental practice. The development of dental radiology in Taiwan began 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 established the Atomic Energy Council (AEC) which was responsible 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. At that time, the dental X-ray equipment was almost essential in all dental institutions, indicating that the MRTs should also have a role in dental radiation work. Therefore, a special system of operating license for the MRTs and their dental radiation work in Taiwan were developed. This article used the document analysis method to explore the connotation of this special development and its historical context.

In this article, we collected the documents related to the descriptions of atomic energy safety supervision, the regulations of medical radiology equipment operating license for the MRTs, and the information related to their dental radiation work as much as possible and screened the important events to delineate the special development of operating license for the MRTs and to excavate its historical context, as shown in Table 1.

Due to the purpose for the international collaboration for atomic energy use in peace, the postwar Taiwan government established the AEC within the central government in 1955, opening a new era in Taiwan's atomic energy management. In the early days, the cultivating of medical radiation manpower was through hospital training classes or master-apprentice teaching. In order to promulgate the medical sciences and their nuclear applications to train more radiographers for health services and associated industries, the Yuanpei Junior College of Medical Technology (restructured into a university in 2005) established the Department of Radiological Technology in 1965 to start the formal school education for cultivating medical radiation manpower. An academic group, the Taiwan Society of Radiological Technologists (TWSRT) was established in 1968 to promote the professional development of the MRTs.

Then, the Atomic Energy Law was formulated in 1968 as the legal source of radiation protection to specify the AEC as 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. In addition, the safety supervision for medical ionizing radiation was also included under the AEC. Since the Regulations for Medical Ionizing Radiation promulgated in 1973, which covered the safety supervision for medical radiation protection, the management of medical radiation practitioners under the AEC and their examination regulations, the development of the MRTs and their professional reached a new milestone. For all medical radiation-related practitioners, there are three kinds of the operating licenses for (1) radiology diagnosis equipment, (2) radiology treatment equipment, and (3) using radioactive isotopes. Any MRT and medical radiation technician with the operating license could engage in various radiation-related businesses under the guidance of a physician or a dentist who has the operating license. Furthermore, the above provisions were transferred to the Enforcement Rules of the Atomic Energy Law.

Since the examination regulations for the MRTs passing in 1973, for another five years of struggle, the qualification examination for the MRTs with the aforementioned three groups was held for the first time in 1978. Finally, this year we ushered in the first batch of the qualified and licensed MRTs. Immediately afterwards, the Department of Dentistry of National Taiwan University Hospital (NTUH) established a dedicated dental radiology room with comprehensive and advanced dental radiology-related equipment, showing the earliest dental radiology unit of a general hospital in Taiwan. Subsequently, a full-time MRT was employed by the NTUH in 1980. He was responsible for dental X-ray photography in the dental radiology room, acting as the earliest hospital MRT who specialized in dental radiation work.

In 1987, the MRTs and medical radiation technicians were defined as medical personnel (or medical staff) for the first time, since an examination method for medical personnel included them. Then, the Senior Examination for the MRTs without grouping was held for the first time in 1994. Those passing the examination could apply for any of the three operating licenses from the AEC. Since the Medical Radiation Technologists (MRTs) Act was enacted and promulgated in 2000, which was the independent legal system for the MRTs management, the professionalism and subjectivity of the MTRs reached another new milestone. The DH (restructured into the Ministry of Health and Welfare in 2013) became the competent authority of the MRTs. The MRTs should join the local association for the MRTs before they practice. They can also operate a medical care radiological clinic for their practice with higher independence and autonomy. The MRTs with a practice license are no longer required to apply for the training certificate or relevant operation license in relation to ionizing radiation as stipulated by relevant laws and regulations. However, they still have to comply with the ionizing radiation protection related regulatory system.

In 2000, the Taiwan Academy of Oral and Maxillofacial Radiology (TAOMR) was established by some dentists and MRTs, indicating that the importance of the common field (known as dental radiology) of dentistry and medical radiation was gradually noticed. Moreover, in 2000, the latest version of the examination regulations for medical personnel retained the MRTs rather than the medical radiation technicians. Since the Standards for the Establishment of a Medical Care Radiological Clinic were formulated and promulgated in 2001, the medical care radiological clinics specializing in dental imaging were gradually established. The minimum requirements for the clinical internship course of medical radiation students started to

include dental photography in 2005, showing that the learning content of dental radiology was gradually gaining attention in the medical radiation education system. Finally, in 2021, the first dental hospital was established with complete dental specialties, including a dedicated dental imaging department and its dedicated MRTs, showing the earliest dental radiology department in a dental hospital in Taiwan.

In short, the development of medical radiation professionalism in Taiwan can be summarized as follows: (1) The cultivating of medical radiation manpower has gradually transformed from multiple methods (including hospital training classes, master-apprentice teaching, and formal school education) to a single model of school education. (2) The professional characteristic of medical radiation practitioners has changed from medical radiation workers under the radiation protection management framework to medical personnel under the health professional management framework. (3) The management model of the operating license of the medical radiation has changed from multiple operating licenses to a single practice license. (4) The government management system has gradually increased the academic professional requirements of the MRTs, and the professionalism and subjectivity of the MRTs in their practice are likely to increase accordingly. (5) The importance of dental radiology in the field of medical radiation has been gradually increasing.

The radiation exposure risk of dental radiation workers is much lower than that of other medical radiation workers (such as the diagnostic radiology, nuclear medicine, radiotherapy, and all other applications), and dental radiation work is a kind of very safe medical radiation work.[4] However, the MRTs are mostly engaged in diagnostic radiology, and are rarely engaged in dental radiology.[4,5] In addition, there are still few related training or courses of dental radiology in our medical radiology education system.[6,7] We consider that it is important to introduce innovative courses related to dental radiology for radiological technology students. By this way, it in turn can provide a new practice direction for the MRTs, and expand their potential participation in the field of dental radiation work.[8,9]

Declaration of competing interest

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

Acknowledgments

None.

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