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Flexible deployment of dental radiation equipment in large dental institutions: Taking the department of dentistry of National Taiwan University hospital as an example

KEYWORDS
Dental radiation equipment;
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The Taiwan government Taipei Hospital (the predecessor of National Taiwan University Hospital, NTUH) published an academic paper on the application of dental X-ray images for the diagnosis of dental diseases in the Journal of the Formosan Medical Association in 1913. Thus, at least in the 1910s, Taiwan's dental community started to use the dental X-ray machines clinically. This was less than 10 years after the German company Siemens manufactured the first X-ray machine for the diagnosis of dental and jawbone diseases in 1905.[1] After the World War II, there was internationally a profound reflection on the peaceful use of atomic energy. The postwar Taiwan government 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 management related to the peaceful use of atomic energy. The Regulations for Medical Ionizing Radiation promulgated in 1973 was Taiwan's earliest explicit specifications on the medical radiation protection control. Since then, the safety management of medical radiation equipment, also including dental radiation equipment, has officially entered the era of government management.[2]

In 1979, the Department of Dentistry of NTUH established a dedicated dental radiology room (DRR) managed by the Division of Oral Diagnosis. There were 6 dental X-ray machines in the DRR, 4 for periapical radiographs and 2 for panoramic and cephalometric radiographs, indicating that the earliest independently operating dental radiology unit of a general hospital in Taiwan was born. Moreover, a full-time medical radiation technologist (MRT) employed by the NTUH in 1980 was responsible for dental X-ray photography in the DRR. Since then, the DRR of NTUH had become a radiology unit with the ability to operate independently.[3] Up to date, the Department of Dentistry of NTUH is the dental institution with the largest number and most complete range of dental radiation equipment in Taiwan. The deployment of its dental radiation equipment and the development of its organization are the issues worth exploring in the organizational management of medical radiology. In this study, we used an on-site investigation to explore the deployment of its dental radiation equipment, and interviewed with its current senior MRT to analyze its dental radiology imaging management model.

Based on the on-site investigation and interview, we obtained the results as shown in Fig. 1. In addition to 2

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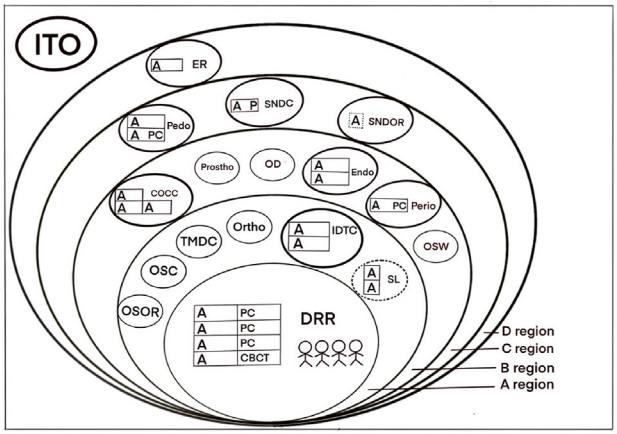
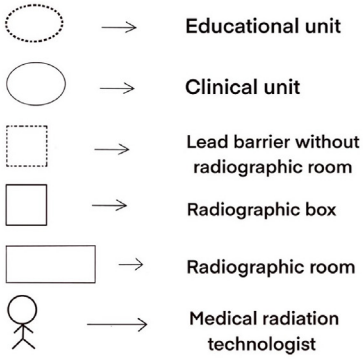


(A)



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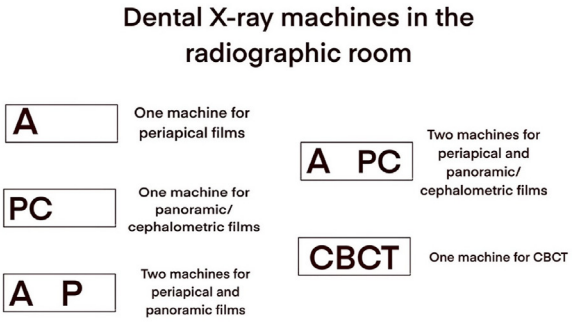

(C)

Figure 1 The flexible deployment of dental radiation equipment and the dental radiology imaging management model in the Department of Dentistry of National Taiwan University Hospital (NTUH)

(A) The schematic diagram presented the parallel management model of geographical centralization and decentralization of dental radiation equipment. There was an independent dental radiology room (DRR), equipped with complete radiation equipment, geographically located in the center of various clinical units of the dental department. Among other scattered clinical units of the dental department in the hospital, some of them were also equipped with dental radiation equipment. The dental clinical units on the outside of the concentric circles indicated that they were geographically far away from the DRR. Moreover, all dental clinical units with dental X-ray machines where dental X-ray images were taken needed to upload the image files to the dental dedicated server in the Information Technology Office (ITO), which was functionally equivalent to a dental image processing center for centralized management. The descriptions of each region of the concentric circles and the units within them were as follows: The A region was the area in the same building as the DRR. The units in this region included Oral Surgery Operation Room (OSOR), Oral Surgery Clinic (OSC), Temporomandibular Joint Disorder Clinic (TMDC), Orthodontics (Ortho), Integrated Diagnostics and Therapeutics Clinic (IDTC), and student laboratory (SL).

The B region was the area of the building adjacent to the DRR. The units in this region included Comprehensive Oral Health Care Clinic (COCC), Prosthodontics (Prostho), Operative Dentistry (OD), Endodontics (Endo), Periodontics (Perio), Oral Surgery Ward (OSW).

The C region was the area of the building that are not adjacent to the DRR. The units in this region included Pedodontics (Pedo), Special Needs Dentistry Clinic (SNDC), and Special Needs Dentistry Operation Room (SNDOR).

The D region was another area far away from the DRR. Only Emergency Room (ER) of dentistry was here

(B) The explanation of symbols in the schematic diagram could be used to understand the distribution of clinical units with radiographic rooms (with dental X-ray machines). Among them, the DRR had a large number of dental radiation equipment and had 4 medical radiation technologists (MRT) to maintain its operations.

(C) A radiographic room was usually equipped with one or two dental X-ray machines, and there were different combinations.

dental X-ray machines for periapical radiographs in the student laboratory belonging to the dental school of National Taiwan University (NTU), the Department of Dentistry of NTUH now managed a total of 24 dental X-ray machines, 17 for periapical radiographs, one for panoramic radiographs, 5 for panoramic/cephalometric radiographs, and one for cone beam computed tomography (CBCT). In terms of geographical deployment, one-third of the dental X-ray machines were concentrated in the DRR with 4 for periapical radiographs, 3 for panoramic/cephalometric radiographs, and one for CBCT. The patients in the outpatient units in the same building as the DRR had their dental images taken directly in the DRR. The Integrated Diagnostics and Therapeutics Clinic (IDTC) in the same building as the DRR had 2 machines for periapical radiographs to meet the immediate needs for their dental procedures. Among the outpatient units in the building adjacent to the DRR, some of them also had machines for periapical radiographs or panoramic/cephalometric radiographs to meet the needs for the outpatient units of this region. Moreover, the patients from this region also could be sent to the DRR to obtain their dental X-ray images. Among the outpatient units far away from the DRR, all of them had their own dental X-ray machines to meet their needs.

Furthermore, in terms of image management according to function, based on the teleradiology model established by the NTUH to complete the comprehensive digitization of medical images, all dental clinical units with dental X-ray machines where the dental images were taken needed to upload their image files to the dental dedicated server in the Information Technology Office (ITO) of NTUH for centralized storage, management, and maintenance. The

DRR had the administrative rights to correct errors in the uploaded files, while all dental clinical units had the operational function of reading dental X-ray images.

Therefore, the management model of dental radiology in the NTUH was an organizational change related to teleradiology. The deployment of its dental radiation equipment was geographically centralized and decentralized in parallel, while the management of its dental information was functionally centralized. The ITO was equivalent to a dental image processing center. Based on the flexible deployment of dental radiation equipment, there was an independent DRR equipped with complete dental radiation equipment to meet the needs of all imaging services in the dental department. Among other scattered clinical units in the hospital, some of them were also equipped with dental radiation equipment to meet the demand for real-time dental imaging services during dental treatment and reduced the risk when moving the patients from one place to the other. This was a parallel management model of geographical centralization and decentralization of dental radiation equipment with the advantages of comprehensiveness and immediacy in providing dental imaging services. On the other hand, with the advancement of information processing and network transmission technology, the dental X-ray imaging services of NTUH had completed the organizational change of teleradiology with comprehensive digital services. All dental X-ray images taken in various dental clinical units were digitally processed, and the image information was uniformly managed and maintained by a dedicated image processing center. This was a functionally centralized model of dental teleradiology with the advantage of effective image management.

Almost all dental procedures require the use of dental radiographs, and almost all dentists have the qualifications and abilities to operate dental radiation equipment.[4] Therefore, large dental institutions are suitable for adopting a centralized and decentralized parallel model for deployment of dental radiation equipment in geography, and using a centralized model for image transmission, storage, and management of teleradiology in function. Organizational changes may be decisive for the future of teleradiology, including dental teleradiology, but it may be wise to plan the changes gradually.[5]

Declaration of competing interest

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

Acknowledgments

None.

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