RAD

MobileDaRt Evolution MX8 Version Brought Substantial Change to our Radiography Workflow

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1. Introduction

Toho University Ohashi Medical Center was established in 1964 in Ohashi, Meguro-ku of Tokyo as the second hospital affiliated with Toho University. During its subsequent development and reconstruction, the hospital has undertaken its role as a university hospital while also providing medical care for the local community of the southwestern ward medical region of Tokyo (comprising Meguro-ku, Setagaya-ku, and Shibuya-ku) as a designated secondary emergency care hospital. The hospital building aged substantially and lost much of its ability to resist earthquakes over the 50-year period since first opening, and on June 20, 2018, the hospital was reopened on a new, adjacent site, where it is currently located and boasts a seven-story building, 319 hospital beds, and 24 clinical departments **(Fig. 1)**. The new hospital site was designed according to the concept of "a hospital surrounded by water and green," and is surrounded by numerous trees, water features that make use of changes in elevation such as waterfalls, fountains and ponds, and a park. The new site has more than doubled the site area of the former hospital, increasing both the size of the building and the amount of floor space. By contrast, the number of hospital beds was reduced by 120 to 130 beds compared to the old location, to a total of 319 beds. This increased the floor space allocated to each

bed to provide a more relaxed environment for the patient. Building on the underlying idea of "medical care provision with a kind and gentle heart," in its new location the hospital has placed a strong focus on coordinating with local medical institutions, and worked hard to provide better patient-focused medical care as a city emergency hospital.

2. Background of Adoption

Toho University Ohashi Medical Center introduced a Hospital Information System (HIS) and Radiology Information System (RIS) in 2001, moved to filmless radiography in 2009, and introduced electronic medical records in 2011.

In the old hospital building, mobile (ward round) radiography was performed with three mobile X-ray systems, including a MobileArt system (Shimadzu). Computed radiography (CR) was used in all X-ray systems, including mobile X-ray systems, though the hospital did start to use a flat panel detector (single detector, 14 by 17 inch) for mobile radiography. The flat panel detector (FPD) was used by attaching a digital radiography (DR) console to the mobile X-ray system. As the old hospital building lacked a wireless LAN environment, and wired LAN ports were only installed in the Department of Radiology, order information and images could only be received and sent by physically removing the laptop PC from the mobile X-ray system. The difference in image quality between CR images and FPD images also lead to the FPD being mainly used for radiography of bones in the operating room. Nevertheless, the FPD allowed us to view images on-site after radiography, which increased work efficiency and was much appreciated by physicians. However, RIS terminals for mobile radiography and the cables used to connect to PACS were only present in general radiography rooms, which necessitated traffic between the bedside and the general radiography room whenever an emergency order was submitted. The DR console monitor for viewing images was also just 12.1 inches, which made it difficult to determine

Fig.1 External Hospital View

implant status or confirm a catheter tip position without magnifying the image.

Alongside the transfer to a new hospital site, the decision was made to obtain DR systems and convert all X-ray systems to FPDs, including all mobile X-ray systems. Equipment for the new hospital building was chosen on the assumption that DR systems would be mounted on X-ray systems, and the hospital environment was re-evaluated for mobile radiography, and the following requests concerning the in-hospital environment and related matters were conceived. To minimize movement of mobile X-ray systems, include a storage space with power outlet and wired LAN port on-site where mobile radiography rounds occur. To reduce system transportation times and increase the throughput of radiological technologists, and thereby improve work efficiency, install a wireless LAN environment on-site where radiography rounds occur to allow receipt of order information and direct transfer of acquired images. Demands for the X-ray systems were as follows: (1) The ability to perform radiography while the X-ray system is a good distance from the patient's bed, and an X-ray tube with a wide angle of adjustment to accommodate positioning in any situation. (2) A system that can be operated safely even by radiological technologists of smaller stature, that allows good visibility both in front of and under the system. (3) A monitor that allows easy viewing of acquired images. (4) The ability to connect to RIS and PACS through a wireless LAN. In accordance with these demands, an initial decision was made to obtain all DR systems from FUJIFILM, and to acquire five mobile X-ray systems equipped with FUJIFILM DR systems. Considering the specific features of each manufacturer and the characteristics of the hospital environment, this initial plan to procure equipment of a single manufacturer and model was altered, and three different system models were obtained from three different manufacturers. Of these systems, two were Shimadzu's MobileDaRt Evolution MX8 Version **(Fig. 2)**.

Fig.2 MobileDaRt Evolution MX8 Version

3. Environment and Operation

The hospital is located in a seven-story building with an emergency unit, an operating room, and an intensive care unit (ICU, HCU, and SCU) on the third floor, and general wards located on the fourth through seventh floors. A single X-ray system was allocated to each of the emergency unit, the operating room, and the intensive care unit, another system was assigned to floors four and five, and another to floors six and seven. A storage area was also created for each system with a power outlet and wired LAN port. IBM was chosen to supply the ordering system and electronic medical records, FUJIFILM to supply PACS, and INFOCOM to supply the RIS and image quality assurance system. A wireless LAN environment was also installed in the hospital, allowing for wireless receipt of order information and wireless transmission of images.

At first, the two MobileDaRt Evolution MX8 Version systems were allocated to general wards, but currently these systems are allocated to the emergency unit and the intensive care unit. There, they are equipped with a 14 × 17 inch FPD. Our operational workflow is as follows. (1) Check order information on an RIS terminal in the general radiography control room, and accept the order. (2) Collect a spare battery pack and FPD unit, which are stored separate to the mobile X-ray system, and take them to the X-ray system storage space. (3) Turn on the X-ray system, transport it to where radiography will be performed, and receive order information over wireless LAN from the RIS. (4) Select the relevant patient from the list displayed on the MobileDaRt Evolution MX8 Version monitor, confirm the patient's name, then use the barcode reader to verify identity by reading the patient's wrist band. After reconfirming the order information, radiography commences. (5) Once radiography has ended, the images are checked, then sent automatically to the image quality assurance system over wireless LAN. (6) The person in charge of image quality assurance checks the images, then sends them to the image storage server.

4. Experience Using MobileDaRt Evolution MX8 Version

4.1 External Design and Maneuverability

The MobileDaRt Evolution MX8 Version system does not have the somewhat oppressive, boxy look of previous X-ray systems, but instead has a gentler, rounded design. The system appears bulky due to this rounded design, but is actually just 56 cm wide and can easily be maneuvered into small hospital

rooms. The system also does not vibrate and is silent during transportation, so we no longer worry about noises made by the mobile X-ray system when transporting it through hospital wards at night.

4.2 Telescopic Support Column

A major feature of MobileDaRt Evolution MX8 Version is its telescopic X-ray tube support column. The MobileArt system previously used in the old hospital building was equipped with a 178 cm height column, which impeded vision in front of the system and necessitated caution when transporting the system. When retracted for transportation, the top of the MobileDaRt Evolution MX8 Version telescopic support column is just 127 cm high, and the top of the X-ray tube is just 124 cm high. This gives radiological technologists who are small in stature a good view in front of the system, making transportation easier. This design feature has been particularly well-received by our female radiological technologists. The stowed height of the system is around 20 to 30 cm lower than other three models **(Fig. 3)**. During radiography, the tube focal distance from the floor can be set between 68 cm and 202.5 cm. Hospital beds have tended to increase in height in recent years, and when using MobileArt in the operating room in the old hospital building, a 14 × 17 inch irradiation field was only just usable with the X-ray tube adjusted to its maximum focal distance from the floor, a situation that required caution during abdominal radiography. With the new systems, a maximum focal distance of more than 200 cm provides us distance to spare during positioning.

Fig.3-1 During Transportation

Fig.3-2 Visibility in Front of System

4.3 Monitor

Another major feature of MobileDaRt Evolution MX8 Version is its 19 inch touch panel monitor **(Fig. 4)**. As mentioned earlier, the DR console used in the old hospital building was equipped with a 12.1 inch touch panel monitor, which could only display small

images and often required image magnification to pass judgment. Control buttons also appeared small on the monitor and were not particularly easy to operate. However, a larger monitor now allows for images to be checked without the need for image magnification, and the increased control button size also makes them easier to operate, thereby improving work efficiency. The monitor used on MobileDaRt Evolution MX8 Version is also much larger and easier to use than the other three models of mobile X-ray system used in the new hospital building.

Fig.4 19-Inch Touch Panel Monitor

4.4 DR System Startup Time

When the new hospital building was first opened, MobileDaRt Evolution MX8 Version systems were allocated for use on general wards, but are now being used in the emergency unit and the intensive care unit. This change was made based on the two-minute startup time of the DR system, which is shorter than the other models of mobile X-ray system. In the emergency unit and the intensive care unit, where radiography is often performed in emergency situations and shorter radiography times are preferred, a long startup time can be a major source of stress on site. We hope that startup times can be even shorter in the future.

4.5 Collimator

When positioning for radiography, the main unit is placed at the patient's bedside. The only arm lock release buttons on the MobileArt system used in the old hospital building were located on the collimator control handle. In small hospital rooms with limited bedside space, this single button location caused difficulty for radiological technologists who were smaller in stature when positioning the collimator in front of the patient. However, MobileDaRt Evolution MX8 Version has "All Free" buttons on the upper part of the handle but also on the lower part of the handle **(Fig. 5)**, the middle part of the arm **(Fig. 6)**, and the catch area **(Fig. 7)**. These buttons enable

Fig.5 Lower Handle Button

Fig.6 Arm Central Button

Fig.7 Catch Area Button

one-step positioning all for support column rotation, arm extension, and X-ray tube elevation, and provide the operator with controls on the support column side of the system as well as on the collimator side. Elevation of the X-ray tube is now also controlled from a lower location on the system, which makes control easier.

4.6 Image Processing

On transitioning to FPDs, we also chose to obtain the Virtual Grid option. Virtual Grid is image processing software that improves image contrast that was reduced due to scattered X-rays. Virtual Grid is only currently used for chest and abdominal radiography, but this optional software eliminates the labor associated with attaching/removing physical X-ray grids, and also the right and left differences in image density caused by misalignment of physical grids. Virtual Grid also allows the X-ray dose to be reduced by 30 to 40 % compared to CR radiography. Also it is capable of frequency enhancement processing to help identify catheter tips and check for gauze and other forgotten implements.

4.7 Product Options

At one time, patient misidentification became a problem in the old hospital building. To resolve this problem, in addition to checking patient identification orally, the hospital introduced a system of patient verification. Obtaining oral verification from the patient themselves can often be a challenge during mobile radiography, so a visual system of confirmation was implemented using wrist band barcodes. The new mobile X-ray systems strengthen this verification system, and incorporate wrist band barcode verification into the DR system. Barcode readers have also been made wireless **(Fig. 8)**, which reduces the number of wires and makes the equipment easier to use. This feature is also extremely important from the viewpoint of ensuring medical safety.

Fig.8 Barcode Reader

5. Summary

With the transfer to a new hospital building, all mobile X-ray systems were converted from CR to FPD systems. Just six months have passed since obtaining MobileDaRt Evolution MX8 Version, work throughput has already increased substantially compared to the old hospital building. We no longer need to carry X-ray cassettes back and forth through the hospital. The patient verification system of wristbands and barcode readers also strengthens our measures against patient misidentification and helps to improve medical safety. The MobileDaRt Evolution MX8 Version system includes a variety of thoughtful design details, including the larger display monitor and control buttons, which improve ease of use and have been well-received among department staff. MobileDaRt Evolution MX8 Version was clearly designed from the perspective of the radiological technologist who operates the system, and this perspective has created a system that is also beneficial for patients. We hope Shimadzu will continue to listen to the opinions of us, and will be able to develop X-ray systems that are even safer, easier to operate, and better for the patient.