Our Experience Using the MobileDaRt Evolution

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1. Introduction

Mihara Memorial Hospital (Fig. 1) is located in Isezaki, a city in the eastern part of Gunma prefecture. The hospital serves not only Maebashi city and the Tomo district of Gunma, but because it is near the southern border of Gunma prefecture, it also serves northwestern parts of Saitama prefecture as well (Fig. 2). The hospital was established in 1964 to provide comprehensive treatment for cerebrovascular disorders, ranging from acute treatment, physical therapy, home rehabilitation, and in-home medical care. As a hospital specializing in strokes, our primary departments consist of neurology, neurosurgery, orthopedic surgery, and physical therapy. With a total of 189 beds, we treat not only cerebral infarctions, cerebral hemorrhages, brain tumors, and head traumas, but also more difficult neurological cases, such as Parkinson's disease and spinocerebellar degeneration as well.
Though the hospital was expanded and remodeled several times since it originally opened, the hospital was newly rebuilt in 2000 to accommodate infrastructure work. Four years later, an electronic medical record and ordering system was installed to achieve a completely filmless hospital. To support an early diagnosis, early treatment approach to brain disease, the diagnostic imaging section, department of medical examination support, is equipped with state-of-the-art medical equipment, such as 3T-MRI and 320-slice CT systems, and is staffed to enable performing examinations at any time, 24 hours a day, 365 days a year. Furthermore, a scheduling system is provided to make such sophisticated equipment available to neighboring medical facilities as well.

Fig. 1

Fig. 2

2. Background of Introducing MobileDaRt Evolution

In the second half of fiscal 2010, our CR and general radiography systems (including a mobile X-ray unit) were becoming older, so we started considering which new systems to introduce during fiscal 2011. Clearly the trend in general radiography was moving away from CR systems and toward FPD systems, so we thought that if we were going to get rid of our CR systems in the near future anyway, then it may be the right timing to consider an FPD type mobile X-ray system. However, we were ambivalent because we had heard that they were expensive, heavy, and troublesome to keep them plugged in. Of course, since we were planning to purchase the system at the same time as a general radiography system, we were hoping to reduce the cost by purchasing them both from the same manufacturer.
We were already using an MU125M mobile X-ray system from Shimadzu and some of our hospital personnel had seen Shimadzu's latest MobileDaRt Evolution mobile X-ray system at a medical conference and raved about how easy it was to operate and how instantaneously images appeared, so when Shimadzu introduced a wireless version of the MobileDaRt Evolution in the spring of 2011, we finally reached a purchase decision.

3. Instrument Specifications

Compared to the MU125M model we had been using, the maximum tube voltage was increased from 125 kV to 133 kV. A maximum tube current of 400 mA (at 80 kV) provides 320 mAs of time-integrated current capacity, which is double the level we had before, and the maximum frequency is now 60 kHz. This performance is

comparable to stationary X-ray systems **(see Table 1 and Fig. 3)**.
The FPD unit is a Canon CXDI-70C wireless model, which provides higher resolution and sensitivity than any previous models in the CXDI series. Also, the wireless capability (IEEE 802.11n) ensures an efficient workflow. The FPD is the same size as an ISO 40900 film cassette (350 × 426 mm), has a sensor pixel pitch of 125 μm, and utilizes high-sensitivity CsI (cesium iodide) fluorescent substance **(see Table 2 and Fig. 4)**.
The X-ray tube support design has been changed from a telescoping pantographic configuration to a telescoping arm. This makes positioning the tube much easier in confined spaces, such as next to beds in small rooms.

Parameter	MU125M	MobileDaRt Evolution
Output Method	Resonant Inverter	Resonant Inverter
Max. Frequency	30 kHz	60 kHz
Max. Output	32 kW (25 kW/0.1 sec)	32 kW (20 ms)
Tube Voltage	40 to 125 kV	40 to 133 kV
mAs Value	0.5 to 125 mAs	0.32 to 320 mAs
Effective Focus Dimension	0.8 mm	0.7 or 1.3 mm (switchable)
X-Ray Tube Support	Telescopic and pantographic	Telescopic arm
Travel	2-handle, 2-motor drive	2-motor drive with stepless transmission
Travel Speed	Forward 4 km/h and reverse 2 km/h	5 km/h
Climbing Ability	Max. 7 degrees	Max. 7 degrees
Dimensions	W57 × H140 × L123 cm	W58 × H178 × L122 cm
Weight	390 kg	420 kg

Table 1 MobileDaRt Evolution Key Specifications

Fig. 3 MobileDaRt Evolution

Pixel Pitch	125 μm
Fluorescent Substance	CsI (cesium iodide)
Effective Exposure Range	350 × 426 mm
Grayscale Levels	4096 shades
Wireless Protocol	IEEE 802.11n (2.4 GHz)
Power Supply Rating	9 to 12 V DC and 0.92 A
Dimensions	Approx. 384 × 460 × 15 mm
Weight	3.4 kg (including battery)

Table 2 Key CXDI-70C Wireless Specifications

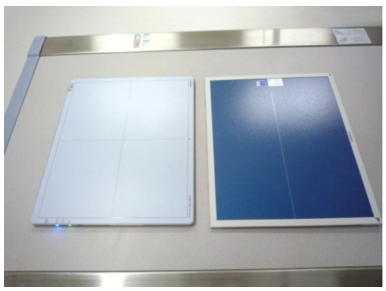

Fig. 4 Left: CXDI-70C
Right: Grid Frame

4. Our Experience Using the New System

In general radiography, the method of creating X-ray images has evolved from an era of using a combination of film and automatic developer, to using a CR system with laser imager, and now to an FPD with an image viewer. Until only a short time ago, no one imaged such an amazing environment would exist, where images acquired with an FPD in the radiography room could be viewed within three seconds and images sent from the X-ray system could be viewed via a viewer by any medical worker in the hospital within 10 seconds. The same applies to images acquired using the mobile X-ray system as well. Everyone remembers how discouraging it was to scurry around from ward to ward to acquire one exposure at a time, return to the radiography room to develop the images, and then find out the radiographs were too dark or too light (though that mostly stopped after we introduced the CR system) or that the area being examined did not appear in the image, so that we had to go acquire another exposure. I'm sure any technologist at the time would have loved this mobile X-ray system, which allows viewing images within only a few seconds after exposure. Because the position of IVH (intravenous hyperalimentation) and stomach tubes can be verified immediately on the spot, it allows repositioning them immediately as well, so doctors and nurses have been very pleased **(Fig. 5)**.

Fig. 5 Operation Panel

The main unit is about 30 kg heavier than before, but it handles easily and moves faster. In fact, it handles so well, it makes one question whether the unit really weighs 420 kg. The telescopic arm

allows moving the tube at the bedside extremely smoothly and makes it very easy to position. The FPD size is 14 × 17 inches and feels slightly heavier than a conventional CR cassette, but can be handled easily due to it being wireless.
In our hospital, the system is always kept in the diagnostic imaging section on the first floor and the MWM (Modality Worklist Management) system sends patient information to the system via a wireless network. Then the unit is taken to respective hospital wards to acquire exposures. After acquiring exposures, the system is taken back to the diagnostic imaging section and images are sent to the PACS via the wireless network. The wireless network access point is installed above the center of the control room ceiling in the diagnostic imaging section **(Fig. 6)**.

Fig. 6

However, whereas the previous mobile X-ray system allowed simply switching the power ON and going immediately to a patient ward when a radiography request was received, the new system requires waiting about three minutes for the DR system CXDI control software NE to boot up. Though this could potentially cause a delay in initial response for emergency radiography if starting with the system power completely OFF, but it is not a problem if the system is in frequent use, such that it is started up in advance like a stationary system. However, it would be better if the DR system startup and shutdown times were shorter.
In addition, forgetting to check the system battery charge status could prevent acquiring exposures. If the battery charge is low, X-rays cannot be emitted, even if the unit is plugged in to a power outlet. The system is designed with overcharge protection, so it can be kept charged by leaving it plugged in to a power outlet, but it is important to note that the battery only charges when the key switch is in the OFF position.
In contrast, if the battery for the CXDI-70C wireless FPD unit is depleted, it can be replaced with a spare to continue acquiring exposures. Furthermore, FPD battery consumption can be reduced by installing an FPD on the specialized handle unit **(Fig. 7)** and connecting it to the main unit via a sensor cable **(Fig. 8)** to change from wireless operation to wired operation.
Just as with normal general radiography systems, all radiography protocols include a selected exposure area. Consequently, manually specifying an exposure area, rather than using the area specified in information from the MWM server, may require extra work to find the desired exposure area and also specify the exposure orientation.

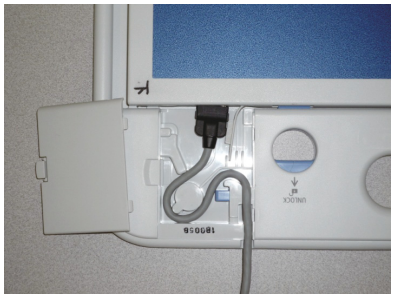

Fig. 7

Fig. 8

5. Summary

The fully wireless system is dramatically more convenient for loading patient information, acquiring radiography images, and transferring images. More than anything, the fact that acquired images can be viewed immediately is extremely appreciated not only by the radiology technologists using the system, but also by the doctors and nurses as well. Considering the workflow involved in using DR systems, the work processes involved in mobile radiography could definitely change in the future, compared to the way they have been performed until now. Due to the somewhat higher price, I assume many facilities have given up introducing such a system. However, if one considers what's best for the patient, I hope there will be even more effort by manufacturers to introduce such wonderful and high performance systems at many more facilities.