RAD

Our Experience with the MobileArt Evolution MX8 Version Mobile X-Ray System

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1. Introduction to Hattori Hospital

Hattori Hospital is located in Miki City, which is in Harima Area and lies close to Kobe City in south-central Hyogo Prefecture. With a population of around 80,000 people, Miki City is known both for a long history of metalworking and for its golf courses, boasting the largest number in West Japan. Since establishing itself in Miki City, Hattori Hospital has built a long history of community medical services as a core hospital in the region.

The hospital opened as Hattori Surgical Clinic in 1967 with just 7 beds, and since 1986 has been expanding its bed numbers and specialist departments. A dialysis clinic was opened in Higashi-Kakogawa in 2007, an MRI machine was installed in 2008, and a rehabilitation unit was opened in 2016. Today, the hospital has 129 general ward beds (including 36 in the rehabilitation unit and 18 integrated community care beds), 50 convalescent ward beds, and 12 medical departments, is a designated emergency hospital, a medical institution for selected diseases, is appointed by Miki City as a medical checkup center, and its department of surgery and many other departments support community health care. Hattori Hospital also uses the Kita-Harima Kizuna Net system to access and share the medical data of consenting patients with neighboring hospitals **(Fig. 1)**.

2. Backdrop to System Procurement and Model Selection

The hospital performs around 500 mobile X-ray examinations each year in its operating rooms and wards. The previous mobile X-ray system used by Hattori Hospital was not made by Shimadzu and first entered into operation in 2004. The hospital chose to replace the system in 2021, after 18 years of use and associated wear and tear. Demonstration units from several manufacturers were put through their paces and the MobileArt Evolution MX8 Version mobile X-ray system stood out as the most promising candidate due to its user-friendliness and superior ease of use. Many of the radiological technologists at Hattori Hospital struggle with operating heavy medical equipment, and the Shimadzu mobile X-ray system features a collapsible column that improves visibility during transport, power-assist functionality for easy driving, and dual motor technology for small turning circles and reduced physical stress for technologists. These features combine with many other aspects of the Shimadzu mobile X-ray system to significantly reduce the burden on hospital technologists. Hattori Hospital also did not have a radiology information system (RIS) at the time, and the Shimadzu MobileArt Evolution MX8 Version mobile X-ray system **(Fig. 2)** was installed, which can be applied to future RIS installations.

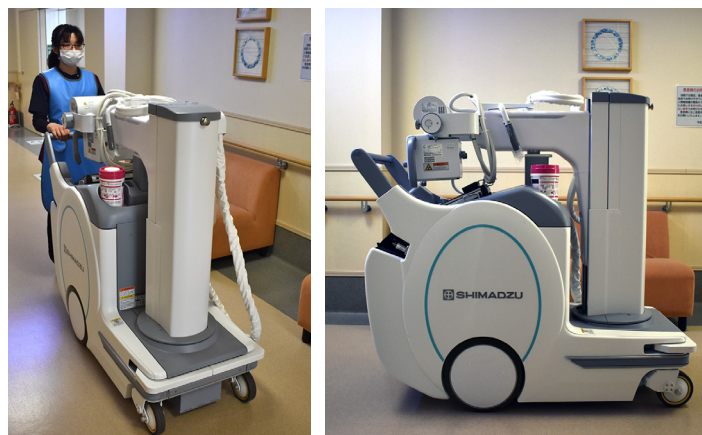**Fig.1** Hattori Hospital

Fig.2 Mobile Art Evolution MX8 Version

3. Imaging Systems and Infrastructure at Hattori Hospital

Hattori Hospital operates an electronic medical records system (hospital information system [HIS]) (updated in February 2022) from Software Service, a PACS and image viewers from Konica Minolta, and FPDs also from Konica Minolta (two 17 × 17 inch, one 14 × 17 inch, and one 10 × 12 inch AeroDR FPDs). The hospital also uses a laptop computer with its mobile X-ray system and its FPDs are shared use with general radiography. A wireless LAN was also installed in the hospital when the HIS was updated, allowing images and radiology orders to be sent and received instantaneously from wards and operating rooms, significantly modifying and improving the workflow.

4. Workflow of Operations using Mobile X-ray System

Most examinations using the mobile X-ray system are performed in wards, operating rooms, and emergency rooms.
(1) A physician submits a radiology order via the HIS.
(2) Patient data is retrieved from the RIS, and the radiographic Information and the patient's location in the hospital where the examination will take place are confirmed.
(3) As the MobileArt Evolution MX8 Version has no built-in DR system, a laptop is loaded onto the Shimadzu mobile X-ray system along with the appropriate FPD and transported to the patient.
(4) Before X-ray exposure, patient data and the radiographic Information are verified once more against the bar code on the patient's wristband.
(5) After X-ray exposure, the images are viewed, image processing is applied, and images are immediately sent to PACS via the hospital wireless LAN.
(6) To prevent patient misidentification, examinations are ended as soon as imaging is complete.

5. Overview of MobileArt Evolution MX8 Version

The MobileArt Evolution MX8 Version is equipped with a collapsible column that is collapsed to a height of 1,270 mm during transport, a 12.5 kW high voltage power unit, an X-ray tube, a collimator, and a range of other optional products. The main cart has a compact design at just 560 mm wide and 1,285 mm high. The collapsible column rotates through a wide angular range, the telescopic arm for the X-ray tube has a maximum horizontal extension of 1,200 mm, and the maximum/minimum tube focal spot height is 2,025 mm/680 mm. The column offers a wide angular range of rotation both clockwise and anticlockwise, rotating through ±270°. The X-ray tube can swing 90° away from the column and 30° towards the column (compared to just 20° towards the column by the previous system), enabling imaging with the patient sitting or lying in small rooms. Pressing one of the "All-Free" buttons on the system gives the technologist free and unweighted control over column rotation, tube arm extension, and vertical adjustment of the X-ray tube. "All-Free" buttons are located on the top and bottom of both collimator handles, the middle of the tube arm, and on top of the cart, allowing technologists to manipulate the column and tube arm both from the collimator and from beside the column. "Inch-Mover" buttons on the collimator also move the cart forward and backward by small increments, giving technologists the ability to make fine adjustments to the irradiation field. Irradiation field adjustment controls and the irradiation field lamp switch are also duplicated on both sides of the collimator. A "soft-touch" bumper on the front of the cart is used to stop the cart upon detection of the slightest obstacle. The storage area is large enough to hold one 17 × 17 inch FPD, one 11 × 14 or 10 × 12 inch FPD, one grid, and numerous other small items, and includes a locking mechanism to prevent FPD theft. A multipurpose tray area measuring 400 × 235 mm on top of the cart serves as a convenient space for the laptop and to stow the collimator during transport. A dose calculator, included as standard, calculates and displays the dose-area product (DAP, μGym^2) after imaging based on the actual tube voltage and tube current time product, which aids in dose management.
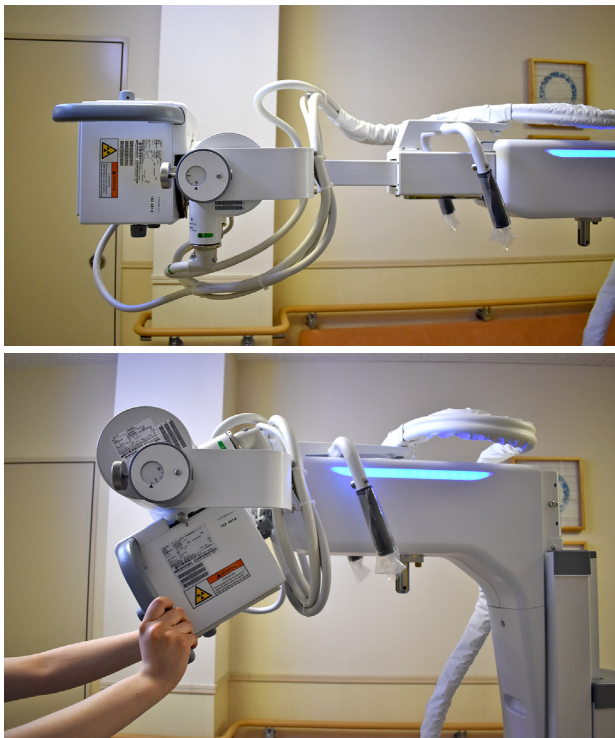
6. Using the MobileArt Evolution MX8 Version

This section describes some aspects of the MobileArt Evolution MX8 Version that stand out as particularly useful during clinical use.

6.1 Wide Range of Column Motion and Trouble-Free Imaging
The impressive extension length of the tube arm and the large vertical and rotational range of motion of the column facilitate imaging in cramped locations or at a distance from the patient when circumstances require it. The column of the previous mobile X-ray system was 1,750 mm high and about 130 mm wide and created a partially obstructed view that required

extra attention during transport. The MobileArt Evolution MX8 Version has a slightly thicker column but an approximately 500 mm lower column height, offering a much-improved view around the system including wiring and other obstacles in front of the cart. The lower column also allows positioning without interference from IV stands and curtain rails. The wide vertical range of motion also eliminates the need to adjust examination bed height, facilitating safer examination with as little unnecessary rearrangement of ventilators, biometric monitors, and other peripheral equipment as possible.

The column rotates through ±270° and the collimator has a large swing angle in both directions, offering a range of motion that facilitates axial positioning and other examinations requiring angling of the X-ray tube, even in cramped spaces (Fig. 3).

Fig.3 Large column rotation (±270°) and collimator swing angle towards and away from column

6.2 Power-Assist Functionality and Dual Motor Technology

Although the MobileArt Evolution MX8 Version weighs 440 kg, power-assist functionality ensures the cart moves smoothly and is not heavy to drive. A dual motor system also allows the cart to turn around the center of its rear axle, making turns easy even in hospital rooms and other confined spaces. These power assistance features are controlled by applying pressure to the control handle, a mechanism that offers responsive and intuitive speed adjustment and turning control.

Hattori Hospital features a number of sloped corridors between its wards that are a legacy of ongoing expansion work since 1967. While the previous mobile X-ray system quickly gained speed on downslopes and was slow and heavy on upslopes, the MobileArt Evolution MX8 Version maintains a maximum speed of around 5 km/hr with minimal input force and drives easily on both flat and sloped floors thanks to its power assistance features.

Dual motor technology also gives the system a very small turning radius, allowing the 560 mm wide unit to be positioned for examinations in corridors and narrow areas just about 700 mm wide, ensuring stable operation of the system even in limited spaces. Its "Inch-Mover" and "All-Free" controls are also very useful for system positioning. The "Inch-Mover" buttons on the collimator move the cart in 1 to 2cm increments, offering technologists a convenient way of making fine adjustments to the cart position (Fig. 4). Power assistance also ensures the cart moves these increments directly forward or backward, helping to prevent contact between the cart and other medical equipment. Multiple "All-Free" buttons are also located in various locations on the system and offer light control over the column and telescopic arm while depressed. When the button is released, the column and telescopic arm are locked. An "All-Free" button is even on the underside of the tube arm within easy reach when the column is fully raised.

Fig.4 "Inch-Mover" Buttons. Incremental control over cart position from the collimator.

6.3 Collimator and Status LEDs

Irradiation field adjustment controls and an irradiation field lamp switch are located on both sides of the collimator, eliminating the need to rotate the collimator when setting the irradiation field. The collimator lamp also illuminates when the system is ready for imaging, which is used to check the irradiation field. The LED lights on the side of the X-ray tube support arm also change color depending on the status of the system and examination, providing an easy-to-understand visual indicator to others in the vicinity.

6.4 Wireless Hand Switch

Hattori Hospital also uses the MobileArt Evolution MX8 Version optional wireless hand switch. The previous mobile X-ray system also came with a wireless hand switch, but signals only reached the system when the hand switch was pointed directly at the signal receiver. Because many of our patients live with severe contractures, upper limbs often overlap lung fields and severe kyphosis is common. Technologists are often required to hold upper limbs away from lung fields and keep patients facing directly toward the X-ray tube during imaging, making it difficult for them to point the old hand switch directly at the receiver. For this reason, technologists often reverted to using a wired hand switch that required frequent repairs due to being used at the limit of its cord length and other general wear and tear. Signals from the MobileArt Evolution MX8 Version wireless hand switch reach the system regardless of where the hand switch is pointed and have a much wider effective range than the old system. Testing by the hospital showed that wireless signals could reach the MobileArt Evolution MX8 Version from about 10 meters away behind the closed door of the fluoroscopy room. The new wireless hand switch has proved so effective that the wired hand switch has not been used since it arrived. The wireless hand switch is also equipped with a loss-prevention alarm that Hattori Hospital has configured to sound when the hand switch is away from its holder for 10 minutes. Other facilities may wish to configure the alarm to sound sooner or later, but this feature is extremely useful and very much recommended for any facility concerned about missing equipment (Fig. 5).

Fig.5 Wireless Hand Switch

6.5 Abundant Storage Space

The storage space in the Shimadzu mobile X-ray system can accommodate grids and 17 × 17 inch FPDs, items that were too large for the old mobile X-ray system (Fig. 6). A multipurpose tray on top of the cart is also large enough to hold a laptop during transport and is a convenient place to carry and fill in irradiation records (Fig. 7). The Shimadzu mobile X-ray system also has numerous spaces to hold small items such as wet tissues and other infection-control products (Fig. 8), and used FPDs can be

Fig.6 Stores One 17 × 17 Inch FPD, One 11 × 14 or 10 × 12 Inch FPD, and One Grid
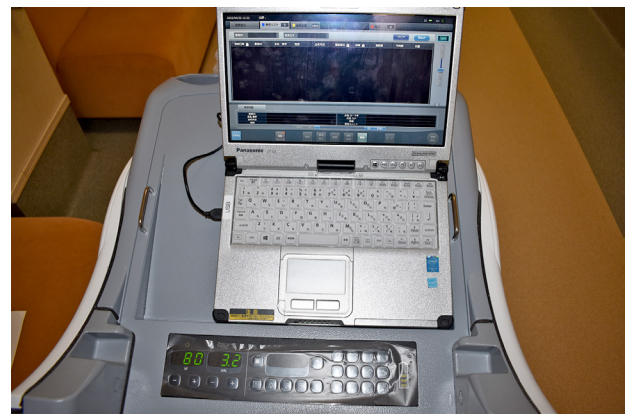

Fig.7 Multipurpose Tray with a Laptop

Fig.8 Small Item Storage on Front of Cart

stood upright in a slit in front of the multipurpose tray for cover removal and cleaning.

6.6 Battery Charging-Related Features

At Hattori Hospital, the old mobile X-ray system normally remained connected to the recharging cable overnight and was disconnected just before the next examination (typically, during the day shift on the following day). There were concerns that leaving the charging cable connected overnight could cause overcharging, but the MobileArt Evolution MX8 Version is equipped with an overcharge prevention feature that reduces the negative effect of extended charging on battery life. This feature is very much appreciated considering how running costs can be affected by battery life (although batteries require replacement after a given duration of use).

The MobileArt Evolution MX8 Version even has an "extra shot" feature that ensures several extra image acquisitions (the exact number depends on the imaging conditions) are still available when the battery becomes depleted during hospital rounds. Although we have yet to use this feature and prefer to avoid circumstances that may call for it, it offers a valuable failsafe.

7. Summary

The Shimadzu MobileArt Evolution MX8 Version mobile X-ray system has enabled Hattori Hospital to convert to digital radiography with comparative ease. Workflows are substantially easier thanks to numerous new features that significantly reduce both physical and technical demands on technologists. The lower column gives technologists a greater field of view, improving the visibility of IV stands and other obstacles for fewer accidents. Power-assist functionality and dual motor technology simplify transporting the system through sloping corridors and significantly reduce the physical demands on technologists during examination, such as when setting up the cart at the bedside. The MobileArt Evolution MX8 Version is more agile and maneuverable than the old system, resulting in a better user experience for both patients and technologists alike. With the MobileArt Evolution MX8 Version, routine imaging work is a more pleasant experience thanks to various thoughtful design considerations that combine to create an excellent mobile X-ray system. Nevertheless, while X-ray systems are becoming more capable and convenient with each passing year, as radiological technologists we must never lose sight of the importance of compassion and understanding in medical care, as well as our responsibility to continue improving our knowledge and expertise. The MobileArt Evolution MX8 Version is designed inside and out for convenience and ease of use, and we hope more people will have the opportunity to share our appreciation for this excellent medical imaging system.