# Experiences with Distributed Deployment of Wireless FPD-Equipped Mobile X-Ray Systems

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## 1. Introduction

Oita University Hospital is situated in Hasama-machi, Yufu City, and a short distance southwest of Oita City. Oita Medical University was established in 1976 as one of the so-called "new medical colleges" based on the (then named) Ministry of Education, Science and Culture's plan to increase physician numbers so as to solve the problem of some prefectures in Japan having no medical university. The hospital that is part of the medical faculty of Oita Medical University was opened and starting treating patients in October 1981. The hospital was integrated into Oita University in October 2003 to become Oita University Hospital, and finally became a national university corporation in 2004 **(Fig. 1)**.

Our fundamental guiding principle is to provide "the best patient-centered medical treatment." Our objective is to contribute to the welfare of the local community through the development and provision of highly advanced medical treatments and the cultivation of highly ethical health care providers. The hospital boasts 31 departments, 618 beds, a hospital for advanced medical treatment and technology, a new critical care center building completed in October, 2012, which was the second facility in Kyushu to be designated an advanced critical care center on October 1, 2013.

**Fig. 1** View of Oita University Hospital

## 2. Background to System Introduction

While the general radiography department of Oita University Hospital introduced a flat panel detector (FPD) system for chest radiography and a computed radiography (CR) system for portable radiography in 2000, the digitalization of other systems did not immediately follow. The general radiography and fluoroscopy department finally completed its transition to full digitalization (FPD and CR) in 2006, with the radiology department reaching full digitalization and film-less operation (with partial film use remaining). At the same time, an FPD-compatible mobile X-ray system (Sirius Star Mobile (CXDI-50G), Hitachi Medical) was also introduced. However, the Sirius system used a heavy and non-wireless FPD where the cables were inconvenient for practical use and the system could not be used to its full potential.

In 2012, we updated the general radiography systems to make all general radiography systems FPD-compatible. Apart from some exceptions, all radiography examinations are now performed with FPDs.

We introduced 5 of Shimadzu's wireless FPD-equipped MobileDaRt Evolution (wireless FPD: Canon) units as mobile X-ray systems (4 of 14" × 17" CXDI-70C FPDs, and 1 compact CXDI-80C FPD). The systems were deployed and utilized in the radiology department's general radiology room (for ward rounds), the advanced critical care center (outpatient ward and in-patient ward), operating room, and ICU.

These mobile X-ray systems were used for a total of 14,516 radiography examinations in 2012 (6,717 cases on in-patient wards, 2,597 cases in operating room, 3,502 cases in the ICU, and 928 outpatient and 772 in-patient cases in the critical care center).

The following report describes how these systems are used and our experiences with using these systems at Oita University Hospital.

## 3. Characteristics of the Wireless FPD-Equipped (CXDI-70C and CXDI-80C) MobileDaRt Evolution and Our Experiences of Using It

### 3.1 Deployment and Application

One system was placed in the radiology department's general radiology room for use on in-patient ward

rounds that included CXDI-70C and CXDI-80C FPDs. Routine radiography in in-patient wards is performed from the afternoon onwards by a single staff member. One dedicated system is allocated to the ICU where the personnel in charge performs radiography on the following morning (between 07:00 and 08:00). Both the system allocated to in-patient ward rounds and to the ICU are available for use in emergencies. One dedicated system is allocated to the operating room, where the personnel in charge with a PHS performs radiography. One system is deployed to the outpatient ward and one system to the in-patient ward of the advanced critical care center. When an air ambulance arrives at the rooftop helipad, the elevator is only used for transporting patients between the helipad to the outpatient ward. This means a mobile system cannot be moved between the outpatient ward and the in-patient ward. Therefore, 1 system is deployed to the outpatient ward and 1 system to the in-patient ward of the critical care center to enable rapid response in emergencies.

The 5 MobileDaRt Evolution systems are each deployed to different locations and each utilized for a particular purpose. Systems deployed to the operating room, ICU, and advanced critical care center can be used to perform quick radiography at any time without having to bring the mobile X-ray systems from the radiology department. Images can also be checked immediately after radiography, and referenced by other staffs by transmitting the images to PACS through wireless LAN. This capability provides excellent mobility and convenience, substantially improving throughput and working efficiencies (Fig. 2).

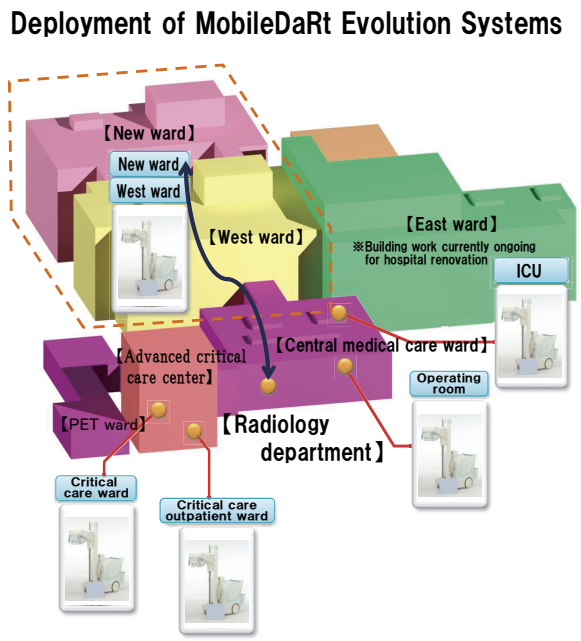


Fig. 2 MobileDaRt Evolution Systems Deployed Each for Dedicated Use

### 3.2 Workflow Comparison (Between Previous System <CR> and MobileDaRt Evolution <FPD>)

Since medical safety is checked based on the use of paper request forms, there has been no change in the workflow of preparations prior to radiography. MobileDaRt Evolution makes the conveyance of cassettes unnecessary, and images can now be checked immediately and transmitted to PACS. Rapid response is now possible for performing emergency tasks, and the removal of barcode reading and IP processing after radiography improves throughput as well as the efficiency and speed of radiography tasks.

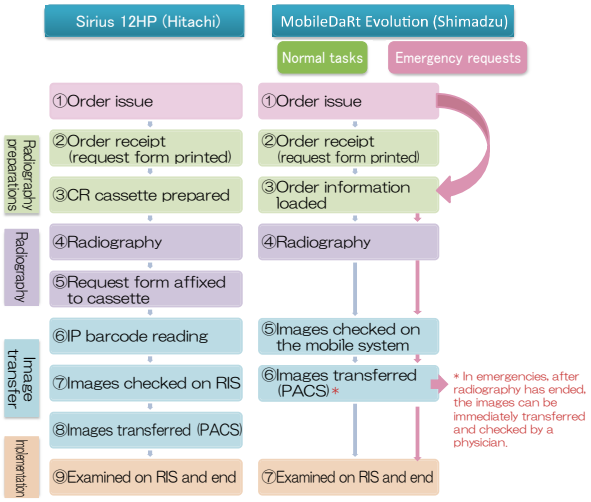


Table 1 Workflows

### 3.3 Operability

Compared with the Sirius 12HP (pantographic arm type), the MobileDaRt Evolution system is about 120 mm deeper, 10 mm wider, and the column for the telescopic arm is large in diameter. Because of this, the system seems larger first-hand than its dimensions indicated, but in real terms the system moves very smoothly, and the tube arm, collimator, and angle adjustment are very simple and easy to manipulate. Furthermore, since movement speeds are adjustable (acceleration, maximum speed, and rotational speed), speed settings can be altered according to location of use, which is convenient.

The low-column model introduced to Oita University Hospital has a column height of 1,780 mm, and when there is insufficient distance to the patient for radiography due to bed height, using the MobileDaRt Evolution requires the bed height to be adjusted.

### 3.4 Merits of the Wireless FPD-Equipped MobileDaRt Evolution

**1) There is no restriction in the number of cases that can be covered and number of images that can be obtained during a single round of a ward.**

It is no longer necessary to carry the number of cassettes required for radiography. The previous

system had a storage capacity of 12 CR cassettes, and ward round radiography examinations required multiple trips between the radiology department and wards over the course of a single day.

**2) System and tube operation is easy.**

(1) The system sounds an alarm when it touches something or bumps into something during movement, calling attention to the problem.

(2) Manipulating the tube is easy using the telescopic arm.

(3) Being wireless, the FPD cassette can be positioned easily from either side of the bed.

Fig. 3 Advanced Critical Care Center Ward

(4) Convenient inch mover buttons
Fine forward and backward adjustments to the position of the system can be conveniently made when performing positioning form the tube side (Fig. 4).

Fig. 4 Inch Mover Buttons

(5) An exposure button in two locations: on the front and rear of the system
A front exposure button is very convenient when a patient must be observed or assisted during radiography.

**3) Images can be viewed, checked, and processed immediately after radiography.**

(1) Images can be checked immediately after radiography (in approx. 3 seconds).
This is very useful in cases of emergency, such as when checking images after providing treatment in the operating room or advanced critical care center. Repeated radiography can also be performed immediately if positioning was incorrect for a previous radiography (Fig. 5).

(2) In the event of a request for radiography of multiple sites, such as the chest and abdomen, images can be taken successively without changing cassettes.

(3) Since images can be transferred to PACS through wireless LAN, other departments are able to quickly view images. The frequency standard used to transmit from the FPD to the mobile system is IEEE 802.11n, and from the mobile system to the internal network is IEEE 802.11n. While the FPD can use 5 GHz or 2.4 GHz frequency bands, 5 GHz is used at Oita University Hospital. The secure encryption method used for transmissions is WPA2-AES.

(4) Emergency or additional radiography can be performed by loading from an HIS order without the order being received on the RIS. (Execution input is performed on RIS.)

(5) Previously taken images can be referenced.

Fig. 5 Checking Images in the Operating Room Immediately After Performing Radiography

### 3.5 Areas That Deserve Improvement

(1) Time required for system startup (DR system) (approx. 3 min 20 sec)

(2) Transmission errors can occur depending on the signal quality (when the system is moving, etc.).

(3) Using the dedicated grid holder (handle unit) makes it difficult to determine the center of the grid during positioning, which makes centering the X-ray beam difficult.

(4) The FPD is heavy compared to a CR cassette (CR: 2 kg, FPD: 3.4 kg).

(5) The battery pack is a consumable product (must be replaced once every 2 years).
(6) Images on the display screen are difficult to see without the operator having to lean forward.
It would be useful if the display screen was placed at more of an angle, or if the screen could be tilted to make viewing easier.
(7) When there is an additional order, only the order can be confirmed but the details of the order, such as the examination objectives, comments, etc. cannot be confirmed. (Countermeasures for this concern are currently under review.)

### 3.6 Problems and Solutions at Oita University Hospital

1) The FPD (CXDI-80C) does not fit into the incubator cassette tray.

Three incubators are used at Oita University Hospital: Drager Caleo, ATOM Incui, and ATOM V-2100G. Because the FPD is larger than the conventional CR cassette, it cannot be inserted into the ATOM V-2100G incubator (previous model).
We removed the cassette tray that came with the incubator and installed a new, specially designed cassette tray.


Fig. 6 ATOM V-2100G FPD Cassette Tray

Fig. 7 Radiography in the NICU

2) The dedicated handle unit (dedicated grid + grid frame) is heavy. The location of the center of the grid is also difficult to determine due to the presence of the carrying handle, which makes FPD positioning difficult.

When the dedicated handle unit is used, it makes the total weight of FPD heavy (6.1 kg, Fig. 8), and difficult to set in place. Consequently, a fitted grid cover (integrated unit) was ordered especially for purpose. Using the fitted grid cover made matching the position of the center of the X-ray beam and the center of the grid easier, and lightened the total weight (4.5 kg, Fig. 9).

Fig. 8 Dedicated Handle Unit
It includes a carrying handle, which makes the FPD heavy and makes determining the center of the grid difficult.

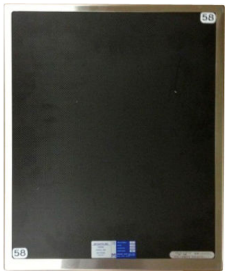

Fig. 9 Fitted Grid Cover Ordered Especially for Purpose

When the specially-designed grid cover was attached to the FPD, it covered the power button on the FPD cassette.
A hole was opened in the side of the grid cover so that the FPD cassette power switch could be turned ON/OFF without removing the cover, and so that the indicator lamp could be seen (Fig. 10).

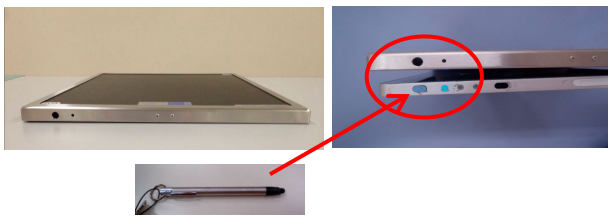

Fig. 10

3) When there is an additional order, the details of the order, such as examination objectives and comments, cannot be confirmed. A computer was made permanently available for use with the mobile X-ray system to allow for confirming order details.
4) Other design changes
A holder was attached to the main unit to attach an alcohol gel bottle to be used for infection prevention (Fig. 11).

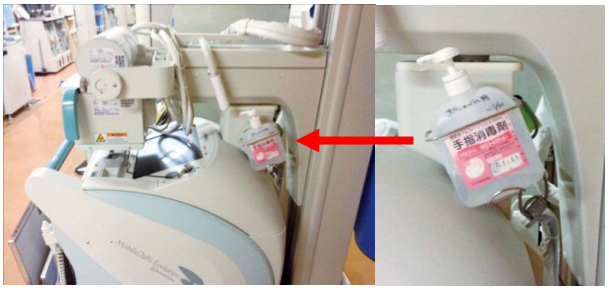

Fig. 11

## 4. Summary

The MobileDaRt Evolution is equipped with the wireless FPD in a way that fully utilizes the practical benefits of a wireless FPD. In our facility, we have experienced first-hand the many

conveniences afforded by MobileDaRt Evolution that have been profiled in existing reports[1)–3)].

Using a wireless FPD-equipped MobileDaRt Evolution has allowed us to concentrate on radiography examination, without the need to worry about numbers of images to be taken or number of radiography cases. The ability to view images immediately after radiography speeds up tasks such as determining how to proceed after catheter insertion, and the ability to immediately repeat radiography due to patient movement and in other situations greatly reduces the burden on the personnel performing radiography during ward rounds, which is a particularly notable advantage. The wireless FPD-equipped MobileDaRt Evolution has afforded Oita University Hospital an improvement in workflow for the hospital's X-ray technologists that could be described as revolutionary in terms of how radiography is performed on ward rounds, in the critical care center, and in the operating room.

A smaller and lighter wireless FPD also seems to have been developed and introduced to the product lineup[4)], which will improve the convenience of using this system even further.

Oita University Hospital uses 5 wireless FPD-equipped MobileDaRt Evolution systems for various duties, and deploys them throughout the hospital for dedicated radiography use in multiple departments. We consider this an efficient application of these systems that takes advantages of the merits of the wireless FPD system. We anticipate the amount of radiography examination performed in our advanced critical care center to increase in the future, and intend to continue to utilize the benefits and convenience afforded by the MobileDaRt Evolution systems.

**References**

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