

# X-ray Protective Clothing Asset Management and Quality Control Management Practice

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## Abstract

**This study aims to optimize the management of X-ray protective clothing and quality control testing program in hospitals by combining fixed asset information management methods to improve management quality and work efficiency. By comparing and contrasting a variety of asset labeling management methods, the preferred method is to post the asset two-dimensional code on the storage cabinet one by one, and by comparing and contrasting a variety of quality control testing methods such as digital gastrointestinal machine, CT, DSA, etc., the preferred method is to select the scanning-based testing method of the digital gastrointestinal machine and to formulate the end-of-life standard of the protective clothing. The results show that this study can significantly improve the degree of management refinement, realize the long-term effective correspondence of assets, and effectively improve the efficiency of quality control testing and information management level of X-ray protective clothing.**

## Keywords

**X-ray Protective Clothing; Lead Clothing; Quality Control Testing; Asset Management; Asset Labeling.**

## 1. Introduction

In 2023, China's National Healthcare Commission revised the Catalogue of Large Medical Equipment Configuration Permit Management, reducing the categories included in the management of large medical equipment from the original 10 categories to six, with Category A reduced from four to two and Category B reduced from six to four. So far, digital subtraction angiography detection system (DSA) and 64 rows and above CT below RMB 30 million no longer need configuration license, PET/MR is adjusted from Category A to Category B, which further promotes the popularization and increase of radiological equipment in hospitals, and at the same time, there are more requirements for radiological protection work.

In order to protect the health of the general public and healthcare workers, especially interventional surgery patients and healthcare workers who have been in a radiation environment for a long time[1,2], in accordance with the requirements of radiation protection, hospitals are equipped with a large number of X-ray protective suits, including protective clothing, protective hats, protective scarf, protective aprons, protective glasses and so on. However, due to the relatively low value of protective clothing, the attached information labels are easily damaged, and the hospital's unified asset labels are difficult to affix effectively, making management difficult. In addition, long-term use can lead to invisible cracks or holes in the lead protection, posing a safety hazard.

However, there is no uniform specification for the periodic quality control testing of X-ray protective clothing in the country. In 2020, the State issued the "Radiological Diagnosis Radiation Protection Requirements" (GBZ130-2020) deleting the requirement of the normal

service life of personal protective materials and supplies in the old version[3], and changing to the requirement that the medical institutions should check at least once a year on their own, and replace them in a timely manner according to the actual conditions of use. The X-ray protective clothing of interventional departments is frequently used, folded and wrinkled many times, and the internal part is easy to be broken and damaged, and the service life is obviously shortened, and some of the protective clothing needs to be scrapped and renewed in 2-3 years[4]. Therefore, the service life of X-ray protective clothing in different departments varies greatly, which brings great challenges to the hospital's fine management.

Usually, hospitals manage X-ray protective clothing based on low value consumables codes, without referring to fixed asset management methods. For example, using marker pens to label codes and paper registration information on protective clothing, and some protective clothing used by dedicated personnel are also labeled with the doctor's name. With the continuous improvement of the hospital's fine management level, it turns out that more and more large hospitals gradually establish the asset ledger of X-ray protective clothing, and continuously improve the management of X-ray protective clothing. Usually X-ray protective clothing ledger information contains the name, specifications, brand manufacturers, date of use, date of production and so on.

In addition, the "Radiological Diagnosis Radiation Protection Requirements" (GBZ130-2020) clearly requires that the quality control inspection of X-ray protective clothing be carried out at least once a year, but for the detection of protective clothing, there is no clear and specific way and requirements, nor is there a clear standard for end-of-life identification. In order to effectively ensure the safe use of X-ray protective clothing, this study is a comparative study of the management of X-ray protective clothing and testing programs, with the aim of establishing a safe and efficient management program, realizing the use of X-ray protective clothing and the quality control of fine management, reducing the cost of management manpower, strengthening the management of assets through information technology, and truly realizing the accounts in line with. Ensuring the safe and standardized use is also a kind of humanistic care for medical personnel, guarding the life and health of clinical medical and related personnel.

## **2. Management Program Improvement Study**

### **2.1. Management Program Improvement Methodology**

When establishing the informationized ledger of X-ray protective clothing, many difficulties were found, including inaccurate information in the ledger, incomplete information of some brand labels, and even blurred or detached labels were found. In order to effectively solve the above problems, this study transforms the management mode of newly purchased X-ray protective clothing from low-value consumables to fixed assets management mode, and comprehensively strengthens the whole life cycle management of X-ray protective clothing, including procurement, acceptance, use, quality control, and scrapping. At the same time, through the verification of inventory records, request for original factory information, etc., try to improve the original X-ray protective clothing ledger information.

Especially in the new acquisition of X-ray protective clothing acceptance access, with reference to fixed asset management to refine the acceptance process, the supplier is required to provide complete acceptance information, asset information, acceptance through the establishment of the ledger information, and then delivered to the department to use. The end-of-life of protective clothing also refers to fixed asset management, and after technical appraisal by engineers and write-off processing, it will be scrapped to ensure that the account is consistent with the goods. In addition, this study combines the informationized ledger and quality control management to effectively strengthen the quality control and expiration date management of

X-ray protective clothing, incorporating the quality control information and expiration date of X-ray protective clothing into the asset platform management, and uploading the quality control records of X-ray protective clothing into the system, so that real-time online scanning code can be used to view the quality control records.

At present, hospitals basically use asset labels (including asset two-dimensional code) to realize the management of fixed asset identification and inventory, but X-ray protective clothing is not easy to post asset labels, which requires frequent scrubbing, cleaning and disinfecting, and the posted asset labels may be fuzzy, broken, etc[5]. When inventory and quality control management, X-ray protective clothing and asset ledgers often fail to achieve long-term effective one-to-one correspondence. In order to realize the convenient management of asset labels, this study has launched a comparative procurement method to investigate the following options:

Option 1: Marker pen to mark the code, the code will be uniformly written in the fixed position of the protective clothing, and the number will be registered to the information technology ledger, the QR code and the corresponding number of information will be sent to the department to share the management of the use of the department according to the code to find the QR code of the asset and then scanning the registration and view the corresponding information.

Option 2: Attach the asset tag, stick and fix the QR code of the asset tag containing the equipment information on the protective clothing.

Option 3: Laser Printed Asset Labels, print QR code information to protective clothing with laser printing.

Option 4: Chip implantation, where a chip containing information about the device is implanted into the protective suit.

Option 5: Storage cabinets with asset labels affixed, multi-tiered flat stainless steel metal cabinets that can be used to store protective clothing and affix asset label QR codes.

## **2.2. Results and Discussion of the Implementation of Management Program Improvements**

In the past four years, we have continued to strengthen the whole life cycle management of X-ray protective clothing with reference to the fixed asset management method, and the information and data of the new protective clothing have been perfected and put into use after the acceptance and registration of the accounts have been completed, so as to effectively realize the matching of the accounts with the goods and significantly improve the accurate management of the quality control and expiry date. The results of the comparison of asset labeling management programs are as follows:

Option 1, marking pen marking code is the simplest management method, the advantage is low investment, easy to realize, the disadvantage is to understand the information related to protective clothing need to be checked through the asset ledger, management time cost is high, easy to produce errors and omissions.

Option 2, paste the asset label to achieve information management, asset QR code itself also shows the asset name, number, brand, factory number and other information, you can also scan the code to view the quality control period of validity and other related information, but the asset QR code and X-ray protective clothing must be one-to-one correspondence, and then stapled or glued to fix the asset label. Due to the regular cleaning and disinfection of X-ray protective clothing, an additional waterproof membrane must be applied to the outer layer of the QR code. However, after running for about half a year, it was found that the labels often fell off.

Option 3, by laser printing, the asset code is fixed on the protective clothing, test use for a period of time, and found that after many times of cleaning and disinfection, the QR code appears to be worn out and can not be scanned.

Program 4, chip production information imported, and waterproof seal implantation, pre-production time is longer, installation and fixation also takes a long time, after the completion of the information query up to the need for supporting equipment to read, the cost is higher, and can not directly view the asset tag itself comes with the asset name, number, brand, factory number, and other information, after research and discussion was not used.

Program 5, Purchase multi-tiered metal flat drawer cabinets, with each cabinet capable of holding 10 sets of protective clothing, cabinet door posted asset labels and users, to achieve protective clothing, users and storage cabinets one-to-one correspondence, asset labels are not easy to damage, basically lifelong without replacement, the information to view direct, two-dimensional code intuitively presented, rapid scanning code is very convenient, in the department with the cooperation of the department, regular training of department staff, strengthened the use of personnel With the cooperation of the department, regular training is provided to the staff of the department, which strengthens the management of the users, and one-to-one correspondence is achieved in accessing and returning, and at the same time meets the requirements of clinical use and refined management.



**Figure 1.** Cabinet storage and labeling of assets

**Table 1.** Comparison of Programs

programmatic	costs	Label fixation time	Label persistence evaluation	maintenance difficulty	Level of difficulty in viewing information after informatization
1 Marker marking code	No cost	30 seconds	Medium duration	low	Unable to view
2 Asset tagging	low cost	Five minutes.	prone to peeling off	high	Difficulty level 2
3 Laser printed asset labels	moderate cost	Three minutes.	prone to blurring	high	Difficulty level 1
4 Chip implantation	moderate cost	Long, incalculable	longer duration	high	Difficulty level 3
5 Posting asset labels on cabinets	moderate cost	30 seconds	longer duration	low	Difficulty level 0

After testing and using, it is found that Program 5 has the advantages of low cost, low management time cost, long duration (almost not damaged after adding protective film), low management labor cost, convenient checking and quick updating. Moreover, the cabinet door will be labeled with the doctor's name, so that each doctor is involved in the management of X-ray protective clothing, to achieve the one-to-one management of special cabinets for special people, clinical users and management-related personnel can scan the code at any time to check the quality control and maintenance of X-ray protective clothing and asset information.

### 3. Quality Control Testing Program Improvements

#### 3.1. Methods for Improving Quality Control Testing Programs

Our hospital has established a specification for biannual quality testing based on the use of X-ray protective clothing. The methods of inspection include visual inspection, touch inspection and image inspection under X-ray[6]. Visual inspection and touch inspection is mainly through the observation of the appearance and touch the surface of the protective clothing, to check whether there is damage to the protective clothing, X-ray image detection, is through the X diagnostic equipment exposure to see through the protective clothing internal protective shielding role of the protective material whether there is damage to the protective material, that is, the use of radiological equipment scanning and imaging to judge[7]. In order to further understand the advantages and disadvantages of various methods, we compared and studied the advantages and disadvantages of digital gastrointestinal machine, CT equipment and DSA equipment in the quality control inspection of protective clothing.

In addition, in the national regulations and standards, the end-of-life standard for protective clothing has not been clearly proposed, so there is an urgent need to establish a set of end-of-life standards. Referring to the domestic standards for lead protective clothing "Protective Clothing X-Ray Protective Clothing" (GB16757-2016), "Medical Diagnostic X-Ray Protective Apparatus: Determination of Material Attenuation Properties" (YY/T0292.1-2020), "Medical Diagnostic X-Ray Protective Apparatus: Protective Clothing and Gonadal Protective Apparatus" (YY0318-2000)[8] as well as related literature[9,10] and other hospital scrapping standards[11,12], combined with the high frequency of use of X-ray protective clothing in our hospital, we have developed a very strict set of scrapping standards for protective clothing, when the detection of protective clothing cracks  $\geq 1\text{cm}$  or damaged area  $\geq 150\text{mm}^2$  (used in the reproductive region of the protective equipment cracks  $\geq 0.2\text{cm}$  or damaged area  $\geq 5\text{mm}^2$ ) or wrapping cloth is seriously damaged so that the internal shielding material leakage  $\geq 8\text{cm}^2$ , must be scrapped.

#### 3.2. Results and Discussion of the QC Testing Program

The advantages and disadvantages of digital gastrointestinal machines, CT equipment, and DSA equipment for protective clothing quality control testing, as tested and practiced, are as follows: Method 1 uses CT for quality control testing. The CT bed scanning range is 0 mm to 1830 mm, which is a large scanning range, but a full bed scan takes approximately 56.2 seconds, with a maximum scanning area of approximately 0.8 square meters, resulting in low efficiency. The advantage is that the scanned images are of high quality and include cross-sectional images. Using CT testing to inspect two pieces each of protective suits, aprons, and neck gaiters, the total time required-including positioning time, scanning time, and post-scan image review-is approximately 18 minutes, averaging 3 minutes per item.



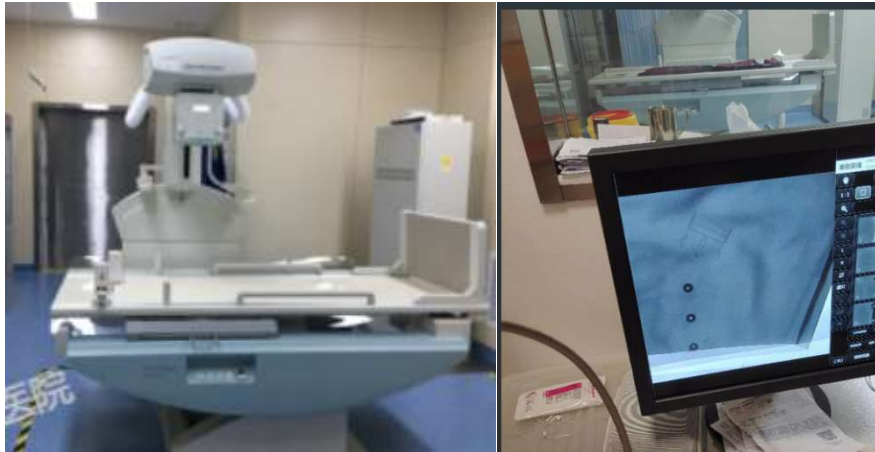
**Figure 2.** CT machine detection

Method 2 uses DSA for quality control testing. The DSA flat-panel detector measures 399mm × 299mm, has a limited scanning range, and operates at a slower bed movement speed. Adjusting the scanning position takes time, and different positions must be set for protective suits of varying sizes. Additionally, the DSA room is equipped with an automatic sliding door in the operating room, which further increases the time required for personnel to enter and exit. Using DSA to test protective suits, aprons, and neck covers (two pieces each), the total time required for positioning, scanning, and reviewing images after scanning completion is approximately 15 minutes, averaging 2.5 minutes per piece.



**Figure 3.** DSA machine detection

Mode 3 using digital gastrointestinal quality control testing, digital gastrointestinal fluoroscopy range of 17 \* 14CM, and has a rectangular large bed plate, scanning range of up and down 133CM, left and right scanning range of 22CM, an area of about 0.3 square meters, the fluoroscopy scanning speed is fast, scanning the whole bed in just more than 10 seconds, and can be controlled by a remote lever handle, fast and easy to move the plate and the bulb tube, the handle is very convenient, flat The large bed plate is very easy to spread the protective clothing, some of the larger protective clothing without the second position, test test protective clothing, aprons,scarf, each of the two pieces of time, position time, scanning time, plus scanning time after the completion of the check image time, a total of about 12 minutes, an average of 2 minutes a piece.



**Figure 4.** Digital gastrointestinal machine test

There is little difference between the images produced by digital gastrointestinal machines and DSA equipment. However, the DSA equipment has a slower field of view movement, requiring adjustments to the X-ray tube and flat panel angles to scan most positions on the bed. Additionally, DSA equipment is used for extended periods daily in clinical departments, making it more difficult to schedule protective clothing quality control inspections. In contrast, digital gastrointestinal equipment is used less frequently, especially after regular working hours or during lunch breaks, making it easier to coordinate and find available time slots for protective clothing quality control testing. Using CT for testing can obtain cross-sectional images, providing higher-quality images. However, there is no established system or method for evaluating protective clothing cross-sectional images, and the scanning time is longer, resulting in higher time costs. Ultimately, analysis is still based on images obtained through horizontal plane scanning, without substantial improvement. It is recommended to use digital gastrointestinal equipment as the primary protective clothing quality control testing device.

Last year, our hospital's Longwan Branch conducted X-ray inspections on 145 pieces of protective clothing (including protective suits, protective caps, protective neck gaiters, and protective aprons). Due to the need to transport and return protective clothing from different departments, the process took approximately 10 hours. Each piece of protective clothing required approximately 4 minutes for X-ray inspection and examination. The number of unqualified protective clothing was found to be 4, pass rate of 97.2%, unqualified protective clothing is as follows: 1) one of the protective clothing fracture length of about 3CM; 2) one of the protective clothing outer skin large areas of damage; 3) one of the protective clothing fracture length of about 2.1CM; 4) one of the protective cap fracture length of about 1.6CM, are up to the standard of obsolescence to be scrapped and synchronized with the write-off processing.

Highly efficient testing program saves the time cost of medical device managers in hospitals. For the test results, the early are used in the paper record archiving method records, such as Figure 4. now with the informationization of the asset ledger, the development of a new function, you can scan the QR code to view the protective clothing testing time and results, as shown in Figure 5, to achieve a random query to effectively strengthen the quality control of the validity of the management, but also to facilitate the supervision of the clinical use of the department. At the same time to strengthen the refinement of management, but also let increase the reliability of the results. And the quality control test image will be uploaded through the PCAS information image system to stay on file, realizing the informationization archive management[13].

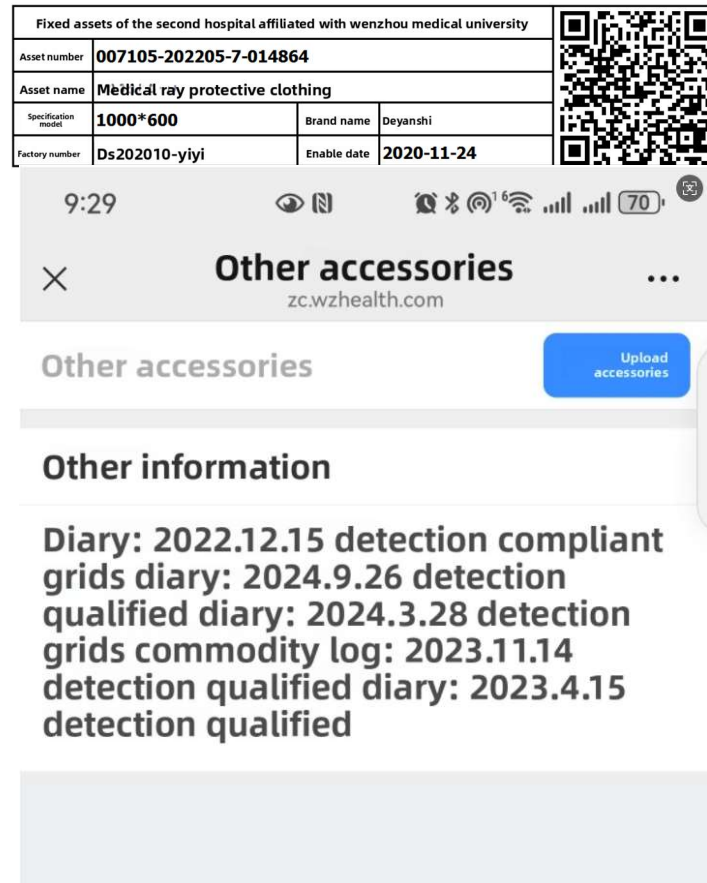


Figure 5. Scanning code to check records

## 4. Conclusion

Continuously improving and perfecting the management and quality control testing of X-ray protective clothing, with reference to the fixed asset management model, we have realized the high-quality management of the whole life cycle of X-ray protective clothing, such as admission and acceptance, the establishment of the ledger, the registration of the use of quality control information, and the scrapping and cancellation of accounts. Through the program of posting asset labels in special cabinets for special people, it reduces the difficulty of management, achieves one-to-one correspondence between protective clothing, users and storage cabinets, realizes long-term and effective correspondence of assets, improves the level of informatization, and scans the code at any time to view the information of protective clothing and quality control and testing records. After the comparative study, the digital gastrointestinal machine was selected as the best choice for efficient testing of protective clothing, and the test results were uploaded to the PACS system, deepening the study of testing and evaluation mechanism, formulating the end-of-life standard, and strictly enforcing it. To ensure the safe and effective use of X-ray protective clothing in the clinic, and to better protect the lives and health of clinical medical care and medical-related personnel.

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