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Occupational Awareness of Quality Assurance Program to Lead Aprons Used by Cardiologists: Defect Analysis and Dose Measurement

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LAW ET AL.: Occupational Awareness of Quality Assurance Program to Lead Aprons Used by Cardiologists: Defect Analysis and Dose Measurement. By visual inspection and fluoroscopic examination lead aprons, the procedures of a quality assurance program to ensure occupational safety can be accurately performed in a cardiology unit with in-house fluoroscopic apparatus by trained radiation personnel. (*J HK Coll Cardiol* 2014;22:35-37)

Cardiologist, lead apron, occupational dose, quality assurance

摘要

通過外觀檢查和螢光檢測鉛保護衣，以確保職業操作安全的品質保證程式可以在具備螢光檢測儀器設備的心臟病單元病房內，由訓練有素的放射科人員準確地執行。

關鍵詞：心臟病學專家、鉛保護衣、職業劑量、品質保證

Introduction

Cardiologists are among the most intensive users of radiation fluoroscopy in the medical profession. While occupational protection in catheterization laboratory is important, lead aprons are used for staff protective apparel against ionizing radiation.¹ An accurate and reliable quality assurance (QA) program is recommended to maintain a high level of good practice.² In order to promote a practical QA program for lead aprons in cardiology units in Hong Kong, results are presented on defect analysis and dose measurement

for a batch of lead aprons used by a group of cardiologists. The program can be extended to perform acceptance test to new lead aprons, from which lead equivalent thickness deficiency is occasionally detected. Therefore the important steps to start up a regular QA program with associated resource are introduced. We also share our experience to upcycle defective lead aprons into clinical use to make the QA program environmental friendly.

Methodology

Twenty-six lead aprons, estimated age between 3 years and 8 years old since their first use, were assigned into different groups by their shapes (vest, skirt and standard). We followed the annual QA program in our institute,³ based on which apron with defect dimension $\geq 3 \text{ mm}^2$ or the length of a fault line $\geq 2 \text{ cm}$ would be regarded as failure and then removed from

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occupational protection against ionization radiation. Any visible defects, namely holes, cracks and tears, were firstly evaluated and documented. The aprons were then screened under X-ray fluoroscopy and sizes of defect were measured.

A defective skirt apron, with crack length and opening of about 12 cm wide, was chosen to measure the radiation dose received at the defective site as if this defective apron was used during interventional procedure. A pelvis phantom, to simulate the lower body of a cardiologist, was draped with this defective apron. By placing three direct readout bleeper type pocket dosimeters (Vertec, United Kingdom) at different regions (defective, semi-defective and no-defect) underneath the lead apron, radiation dose to the pelvis phantom was measured to simulate a cardiologist performing interventional procedure. As we would compare between the dose underneath the defective sites and that underneath properly shielded area of the apron, the phantom draped with the defective apron was placed on the X-ray tube side with routine fluoroscopy irradiation.

Results

Five aprons (19%) were visually observed to have different sizes of holes and/or tears associated with fabric material of adhesive magic tape design.

One lead apron of skirt (4%) was observed to have a crack with largest portion at about 12 cm width observed under fluoroscopic screening. However there was no visual defect on the fabric material for this skirt.

The radiation doses, as received by the cardiologist performing interventional procedure with the use of the defective apron, were measured with the dosimeters underneath the defective, semi-defective and no-defect regions. The measured doses were 18 $\mu\text{Sv}/\text{min}$ and 12 $\mu\text{Sv}/\text{min}$ underneath the defective and semi-defective region respectively and underneath the no-defective region of 1 $\mu\text{Sv}/\text{min}$. It implied that the regions with defective and semi-defective protection would receive more than 10 times higher radiation exposure than that of well protected region.

By visual inspection of this batch of aprons, it was common to have exterior damages on the surface

of the fabric material. Torn fabrics were found at the vicinity of the magic tapes. It was believed that the textiles of the lead aprons could not withstand long-term tearing which might cause holes and tears. By vigorously repeated pulling type force of the aprons, holes and tears on the aprons were increasingly formed in size. However defects within the lead lining enclosed by the fabric material were difficult to detect visually but could be examined with readily available X-ray fluoroscopy method because of the high spatial resolution for the fluoroscopic machine to detect defects localization and size determination.

Discussion

In order to set up a long term tracking system for the aprons, it is essential to have a systematic management system and to train up operators for the use of fluoroscopic machine. Information of the age since its first use of aprons, date of previous QA test and other updated status are usually not clearly labeled and documented, all of which were experienced in the batch of lead aprons as presented here. This situation is more obvious when new aprons are regularly purchased for replacement to be used along with those existing ones, in addition to the situation of not easy to access to privately owned lead aprons. A complete management system with documentation for lead aprons is important. There should be a person responsible for the management of the lead aprons with reference to some international criteria for rejecting defective aprons after the QA testing.⁴

Trained operators in radiation machine play an important role in the QA program. They should be familiar with the fluoroscopy machine and have the license to operate the radiation apparatus. If there are defects on the lead aprons, operators should be experienced to report the size and location. It is believed that radiographers from radiology unit fulfill the above requirements. They have much experience in using the radiation machine including those in cardiology units. The QA service of using fluoroscopic machine can be arranged when the facility is not for patient service and the radiographers still remain on duty in catheterization laboratory.

Conclusion

Despite regular check for existing lead aprons, it is equally important to have the same program on new aprons. From our experience, it cannot assume that new lead aprons are perfect enough for radiation protection. Not only tiny defects on lead aprons are found, but also deficiency in the lead equivalence is occasionally observed in new aprons. Wearing a defective or insufficient lead equivalence lead apron violates the code of practice in hospitals.⁵ Therefore, lead equivalent test is essential before the occupational use of new aprons. Physicist team in hospital is with experience and knowledge in this area and in our institute, new apron acceptance test is performed by physicist. Experience can be shared to centres without the support of physicist.

The defective lead aprons should be disposed in a proper way as the lead lining is composed of rubber layers uniformly mixed with lead powder, both of which are materials not friendly to our environmental disposal. There are some programs in the radiology unit in our institute studying the upcycle process for defective lead aprons, in which the usable portions are cut into different sizes of blankets to be clinically used as radiation shielding during radiological imaging. An example of this is to cover nuclear medicine patient pelvis region with such blanket in order to reduce the radiation exposure to staff during positioning the patient undergoing imaging. Cardiology unit is suggested to work with the radiology unit to upcycle the defective aprons.

A defective lead apron may cause unnecessary occupational exposure because of inappropriate protection. Occupational dose would be accumulated when defective aprons are regularly used. Therefore, QA program for lead aprons should be established in cardiology unit with available in-house equipment and expertise to assure occupational safety. It is recommended that the integrity of all new protective aprons be verified upon receipt as well as at yearly intervals. Upcycle of defective aprons is also suggested.

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