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Lead apron leak test at the Padang Reksodiwiryo Army Hospital's radiology installation

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ABSTRACT
A lead apron is a lead apron designed to protect the body from radiation hazards. The lead apron test is carried out once a year to ensure that it can provide optimal protection when in use, it is necessary to test personal protective equipment. Based on observations, the storage and placement of tin aprons is not in accordance with the rules so that it can reduce its function as personal protective equipment. This study aims to determine whether there is a leak in the lead apron, and to find out whether the lead apron is still suitable for use as personal protective equipment (PPE). This type of quantitative research with experimental methods at the Radiology Installation of RST Dr. Reksodiwiryo Padang on March 31, 2022. The sample in this study was 2 lead aprons, each lead apron is divided into four quadrants, namely the upper right side, upper left side, lower right side and lower left side. Each quadrant was tested with a tube voltage of 70 Kv and a current of 16 mAs. Then made observations and compared with the theory of Lambert and Mc Keon. The results of the study found that there was a leak in the Apron A quadrant 3 with an area of 0.75 mm2 and quadrant 4 with an area of 0.67 mm2. On Apron B there is a leak in quadrant 4 with an area of 0.06 mm2. From the results of the study of lead apron leaks in quadrant 3 and quadrant 4, the quadrant area is a critical area which according to Lambert's theory should not exceed 15 mm2 so that the lead apron under study is still suitable for use as personal protective equipment (PPE).

Introduction

Radiation in radiology is useful for helping to diagnose disease, in this case the radiation in question is X-ray radiation. Because X-ray radiation is ionizing radiation, which can harm objects in its path, it can be dangerous. A branch of science or engineering known as radiation safety, or radiation protection as it is more commonly known, studies issues related to human and environmental health with the goal of minimizing the damage brought on by exposure to X-ray radiation. In this case, the goal is to prevent deterministic effects and minimize stochastic effects Possible(Dewilza et al., 2022)

Low-dose radiation exposure is associated with stochastic consequences, which can manifest in the human body as cancer (somatic damage) or hereditary abnormalities (genetic damage). The deterministic effect is connected to large doses of radiation exposure and can be felt or observed by the radiation-exposed person. After irradiation, these symptoms may start to show up right away or after a few weeks. (Yudha, 2023)

Radiation protection measures can be taken to avoid and lessen the effects of radiation. Three concepts must be used to carry out radiation protection efforts: rationale, individual dose limitation, and optimization. To reduce the radiation dose that radiation workers get, the optimization approach known as ALARA (As Low As Resonably Achievable) is used. According to this rule, radiation dangers should be avoided by keeping a safe distance from radiation sources, keeping exposure times short, and wearing personal protection equipment(Sudarsih et al., 2019). PPE (personal protective equipment) is a device that can shield a person's entire body or just a portion of it from potential workplace risks.

Every service provider is required to have radiation protection equipment that complies with applicable rules, per Regulation of the Head of Bapeten No. 65 of 2015(Bapeten, 2015). According to these rules, the protective apron's minimum thickness must be 0.25 mm Pb, and it must be large enough to shield the wearer's body and gonads from direct radiation. According to this thickness is efficient for resisting radiation at 100 kV (Kartikasari et al., 2018)

To prevent internal damage or fracture, it is crucial to maintain personal protective equipment. Gravity will inevitably result in internal fractures and damage to personal protective equipment if maintenance mistakes such stacking, hanging vertically with a hanger, and placing it on the back of chairs are made. When not in use, personal protective equipment should be stored horizontally rather than stacked(Sari et al., 2020). Pb Apron should not be folded or hung during storage or placement because doing so could compromise the item's ability to act as a radiation protective device.

The integrity and physical state of the Lead Apron can be checked once every 12 to 18 months, according to Lead Apron testing. The Lead Apron cannot be used any longer if the damage measures more than 15 mm2 in vital areas and more than 670 mm2 in non-vital areas, or if the damage takes the form of lines or a fault. This test can be performed using a fluoroscopy plane or radiograph with a regular conventional plane. Testing personal protective equipment is required to make sure it can offer the best protection when worn. The Lead Apron cannot be utilized again if it is no longer appropriate(Bapeten, 2015).

There are two lead aprons at Dr. Army Hospital Reksodiwiryo Padang. Given that the Lead Apron at RST Dr. Reksodiwiryo Padang plays a critical role in workplace safety and has not been tested since it was purchased in 2018 and has been in use for three years, testing is absolutely necessary. Although the Lead Apron has passed the test period, which should be performed once every 12 to 18 months, the Lead Apron has never been tested since it was purchased until now. Based on their observations, the researchers are interested in talking more about the issues that arise in the Dr. RST hospital Reksodiwiryo Padang in a study named "Leak Apron Test at the Radiology Installation of RST Dr. Reksodiwiryo Padang”

This investigation's goal was to find out if there was a lead apron leak at RST Dr. Reksodiwiryo Padang's radiology facility. Dr. Reksodiwiryo padang is utilized as personal protective equipment (PPE) to determine whether or not a Lead Apron is appropriate at the RST Radiology Installation.

Method

Quantitative research using experimental techniques is the kind used in scientific writing. On March 31, 2022, this study was carried out at the Radiology Installation of RST Dr. Reksodiwiryo Padang.

In this investigation, sampling was done utilizing a saturated sample using a non-probability sampling method. When every member of the population is used as a sample, defines this as a saturated sample. When the population is not very large, this is frequently done. This technique is also called the census technique. Two Lead Aprons were used as the study's samples. A comparable study employing a population of all aprons and a sample of two was also conducted with the title investigation of the feasibility of aprons at a type C hospital in a radiology installation at the Bekasi regional hospital.(Afifah, 2022)

Results

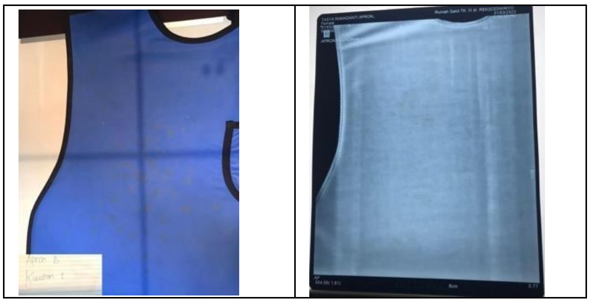
Research has been conducted at the Radiology Installation of Dr. Army Hospital under the title lead apron leak test. Reksodiwiryo Padang in April 2022 with this type of quantitative research using an experimental method and sampling using a non-probability sampling technique using a saturated sample (Martono, n.d.). A saturated sample is a sampling technique if the population is relatively small and the entire population is used as a sample. The following are the Lead Apron Specifications that RST Dr. Reksodiwiryo Padang studied:

Table 1: Lead Apron Specifications at RST Dr. Reksodiwiryo Padang

No	Lead Apron Code	Usage space room	Thicknes	Year of purchase
1	*Apron* A	Radiology	0,35mmPb	2018
2	*Apron* B	Radiology	0,50mmPb	2018

Dr. Reksodiwiryo Padang exposed the predetermined Lead Apron region at the RST Radiology Installation after performing study on Lead Apron there. The Lead Apron part is separated into 4 (four) quadrants: Quadrants 1, 2, 3, and 4. The outcomes shown in the following image are then obtained:

Picture 1 : test result lead apron quadrant 1 Apron A



Picture 2. Test result lead quadrant 1 Apron B

Table 2: test result lead apron RST Dr. Reksodiwiryo Padang

No	Lead Apron	Result Test			
	Code	Q1	Q2	Q3	Q 4
1	*Apron* A	0,99 mm^2	1,08 mm^2	0,75 mm^2	0,67 mm^2
2	*Apron* B	0,06 mm^2	0,09 mm^2	0 mm^2	0,06 mm^2

At RST Dr. Reksodiwiryo Padang, lead apron testing is done by exposing every part of the designated lead apron. This test is performed to find out if the lead apron is leaking or not. According to Dr. Reksodiwiryo Padang's analysis of the 2 (two) lead apron tests conducted at RST, there was a leak and an indentation on the lead apron. Measurements were made with 3 repeaters and the average value was taken to reduce bias and error when measuring

There is a leak and indentations in each of the four quadrants on lead apron A. In contrast, Lead Apron B has leaks in Quadrants 1, 2, and 4, as well as indentations in each of the four quadrants. However, the number of leaks and dents on Lead Apron B is less when compared to Lead Apron A.

Leaks were found in the two Lead Aprons that were tested. All four quadrants of Lead Apron A had leaks. There are multiple small holes-shaped leak sites with a length times a width of 0.99 mm2 in quadrant 1, and there are small holes-shaped leaks with a length times a width of 1.08 mm2 in quadrant 2, respectively. There is a leak in Quadrant 3 in the form of a tiny hole with a leak size equal to an area of 0.75 mm2, and there is a leak in Quadrant 4 in the form of a tiny hole with a leak size equal to an area of 0.67 mm2. In contrast to Lead Apron B, which only has leaks in Quadrants 1, 2, and 4, Quadrant 1 has numerous leak locations in the form of tiny holes with dimensions of length times breadth equal to an area of 0.06 mm2. There is a leak in Quadrant 2 in the form of a small hole that is equivalent to an area of 0.08 mm2, and there is a leak in Quadrant 4 in the form of a small hole that is equivalent to an area of 0.06 mm2.

Lambert (2001) asserts that Lead Apron is still usable if the damaged area, whether from leaks or cracks, is no larger than 670 mm2 (equivalent to a hole with a diameter of 29 mm for non-sensitive areas) and no larger than 15 mm2 (equivalent to a hole with a diameter of 4.3 mm for radiation-sensitive areas).

Table 3: Results test lead apron compared lambert theory

Code	Q	leak area	Leak siza	Standart *Lambert theory*	Result
Apron A	1	Non critical	0,99 mm²	670 mm2	worthy
	2	Non critical	1,08 mm²	670 mm2	Worthy
	3	Critical	0,75 mm²	15 mm2	Worthy
	4	Critical	0,67 mm²	15 mm2	Worthy
Apron B	1	Non critical	0,06 mm²	670 mm2	Worthy
	2	Non critica	0,09 mm²	670 mm2	Worthy
	3	Critical	0,00 mm²	15 mm2	Worthy
	4	Critical	0,06 mm²	15 mm2	worthy

Discussion

Every service provider is required to have radiation protection equipment that complies with applicable requirements, according Bapeten Head Regulation No. 65 of 2015 (Bapeten, 2015). According to these regulations, the protective apron's minimum thickness must be 0.25 mm Pb, and it must be large enough to shield the user's torso and gonads from direct radiation. At 100 kV, this thickness effectively resists radiation (Kartikasari et al., 2018)

To prevent internal damage or fracture, it is crucial to maintain personal protective equipment (Sugiarti et al., 2021). Gravity will inevitably result in internal fractures and damage to personal protective equipment if maintenance mistakes such stacking, hanging vertically with a hanger, and placing it on the back of chairs are made. When not in use, personal protective equipment should be stored horizontally rather than stacked(Sari et al., 2020)

According to the study's findings, lead apron A leaks in each of its four quadrants, with leaks in quadrant 1 measuring 0.99 mm2, quadrant 2 1.08 mm2, quadrant 3 0.75 mm2, and quadrant 4 0.67 mm2. Lead Apron B, on the other hand, exhibits leaks in Quadrants 1, 2, and 4 of 0.06 mm2, 0.09 mm2, and 0.06 mm2, respectively. There is no leak in Quadrant 3 of Lead Apron B. You should still exercise caution when in a radiation field because radiation cannot be detected by the five senses and even a small dose can have an impact. Radiation protection must be used in order to prevent exposure to radiation's negative effects, even though the leakage value is very small and does not exceed the standard.

Providing protection to an individual, a group of individuals, or their progeny against the potential for health harm due to radiation exposure is the subject of the science or technical field known as radiation protection (Damayanti, 2021). This radiation protection's goal is to minimize the incidence of stochastic effects while preventing dangerous deterministic consequences from occurring (Yudha, 2023).

Deterministic effects are those caused by high radiation doses that can be directly felt or seen by those who have been exposed to radiation. These effects can start to show up right away or a few weeks after exposure and can take the shape of a rash or redness. Because reproductive people are sensitive to radiation or have a high sensitivity to radiation, stochastic effects are related to exposure to low doses of radiation and can manifest in the human body as cancer (somatic damage) or even birth defects (genetic damage) (Salmah et al., 2022)

Gonads are the reproductive tissues that create sex cells. In contrast to the testicles and their vessels (vas deferens) in men, the gonads in women include the ovaries and their vessels (oviducts). The gonad organs are radiosensitive and have fast dividing cells, therefore radiation exposure causes damage that cannot be healed (Gault et al., 2019). Due to the high radiation sensitivity of these gonadal organs, extreme care must be taken to ensure that the lead apron does not leak, particularly in the crucial quadrants 3 and 4. Radiation protection measures can be taken to reduce the effects of radiation (Chen et al., 2017)

Three concepts must be used to carry out radiation protection efforts: rationale, individual dose limitation, and optimization. To reduce the radiation dose that radiation workers get, the optimization approach known as ALARA (As Low As Resonably Achievable) is used. The idea is to avoid radiation risks by keeping a safe distance from radiation sources, cutting down on exposure time, and wearing personal protective equipment (Akhadi, 2015)

In a journal article titled "Function Test of Radiation Protective Equipment (Lead Apron) in Hospital Radiology Installations," Kartikasari claims that the lead apron underwent damage in the form of small holes, but that the lead apron was still usable because the leakage value did not go above the required level. Meanwhile, (Atin Nikmawati & Siti Masrochah, 2018), in a journal article titled "evaluation of lead apron performance," claims that the lead apron's indentation is brought on by storage, poor maintenance, and regular use. This is also consistent with this investigation, which discovered leaks on the lead apron in the form of tiny holes and indentations. This was caused by improper lead apron storage.

Calculated increases in doses to the whole body for varying sizes of holes, including special consideration of the effects on effective dose equivalent when the hole is over the testes and thyroid. ALARA standards for cost per personsievert averted are used to establish a rational basis for criteria of acceptance or rejection of lead aprons.(Lambert, Kent; McKeon, 2001) The lead apron examined for this investigation had a number of leaks. The findings demonstrate that the leakage value is extremely low and only manifests as tiny holes, which is within acceptable limits. If the damaged area, such as a leak or crack, does not exceed 670 mm2, which is the equivalent of a hole with a diameter of 29 mm for non-sensitive areas, or 15 mm2, which is the equivalent of a hole with a diameter of 4.3 mm for radiation-sensitive areas, then the lead apron is still suitable for use. The lead apron still functions well as personal protective equipment (PPE) despite having a leak.

Conclusion

Based on the findings of study done at RST Dr. Reksodiwiryo Padang, it can be said that Lead Apron A, namely in the Four Quadrants, and Lead Apron B, specifically in Quadrants 1, 2, and 4, both have leaks. Because they do not exceed the standard according to the apron leak theory, the two Lead Aprons tested are still suitable for use as PPE.

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