

Radiology as a support for examination and treatment in the medical world and its effects: literature review

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ABSTRACT

The installation of a radiology unit is part of the service at the Hospital, which provides professional examination services in the form of images to assist doctors in diagnosing and treating patients. This type of radiodiagnostic radiological examination is the use of ionizing radiation with X-rays for diagnostic purposes. Interventional radiography is an examination with X-rays used to guide therapeutic procedures. Occupational safety in radiology has risks, both directly and indirectly, these risks can occur if it fails and other causes beyond human capabilities. As a result of exposure to radiation substances, it has an impact on a person's body in the form of biological radiation effects on humans which can occur in individuals exposed to radiation (somatic effects) or their offspring (hereditary/genetic effects). The physical effects obtained can be immediate or delayed. Somatic effects are divided into non-stochastic (deterministic) effects and stochastic effects, while genetic effects are all stochastic. Considering the large radiation hazard potential in the use of X-rays, safety is an important factor so as to minimize the risks due to work in radiology installations and the impact of radiation on worker radiation. Radiation protection is very important in controlling these adverse effects, in the form of Pb aprons and radiation shields, room facilities that meet the requirements and X-ray equipment have been carried out according to suitability.

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INTRODUCTION

Service facilities Health is a tool and/or place that is used to organize health service efforts, both promotive, preventive, curative and rehabilitative carried out by the government, local government, and/or the community (Menkes, 2020). Hospitals are also part of the natural resources. health which is very necessary in supporting the implementation of health and safety efforts for its workers(Ngurah Sutapa and Gde Antha, 2014).(Hatta et al., 2018)(Ristiono & Azkha, 2009).

The Radiology Installation is one of the Minimum Service Standards (SPM) as a medical and treatment support unit in hospitals, it is hoped that it can provide the best service for patients, so that it will improve quality and quality. In providing health services there is still a risk of work accidents and work-related diseases, for example the tools in radiology. for example Magnetic

resonance imaging (MRI), Computed Tomography Scanner (CT scan) and others (Daenuri Anwar, 2011) (Hantari Rahmawati & Hartono, 2021).

Radiology is a science that studies the process of making images of human organs using X-ray radiation, has a very important role in the medical field, by utilizing ionizing and non-ionizing radiation. The results of radiographic images are very helpful in diagnosing and treating. (Finzia & Ichwanisa, 2017). Provide diagnostic services in the form of conventional x-ray services, use of Computer Radiography (CR), Mammography, Panoramic, Dental, as well as diagnostic imaging services, namely ultra sonography (USG) and other types of examination. must be managed by professional radiographers. (Hasmawati, 2016).

Radiodiagnostics is a branch of radiology that uses imaging/images to diagnose diseases using ionizing radiation or electromagnetic waves/photons and charged particles, because their energy is able to ionize the media they pass through. In addition to the benefits, it also has a detrimental effect on radiation workers, patients, and the general public who may be exposed to this substance, both internal and external radiation. (Martem et al., 2015) (PERKA BAPETEN, 2010). Workers on duty consist of radiology specialists, qualified experts or medical physicists, radiation protection officers, and radiographers (Bodies & Energy, 2011).

The process of production and/or assembly of X-ray machines in Indonesia has not yet had clear provisions in terms of guaranteeing the quality of the products produced (Nurhikmah, 2022) (Etlidawati & Diyah Yulistika Handayan, 2017). There is still a need for an x-ray radiation safety management system so that workers feel safe and professional (Sari, 2012).

Some diseases detected by radiology are tumors, heart disease, lung disorders, stroke, cancer, disorders that occur in blood vessels, joints, bones, kidneys, liver function, gastrointestinal tract, reproductive tract, lymph nodes, and lymph glands. thyroid. A low energy beam is used to take a photographic image known as a radiograph. High energy X-rays are used to destroy cancer cells (Ermiza, 2022).

Based on the Regulation of the Head of the Nuclear Energy Monitoring Agency No. 8 of 2011 Radiation protection is an action to reduce the effects of radiation that damages body cells in diagnostic radiology, radiotherapy and interventional. And prevent and protect the occurrence of accidents (Ristiono & Azkha, 2009) (Fairusiyah et al., 2016).

Ionizing radiation directly interacts directly with molecules, cells and tissues. At high or low doses it can cause direct DNA damage and generates reactive oxygen species and free radicals, leading to DNA, protein, and lipid damage and membrane damage, leading to apoptosis, necrosis, teratogenesis, or carcinogenesis. As many as 2% of cancers and 15,000 associated deaths each year) are radiation-only exposure to computed tomography alone (Smith et al., 2017).

Every workplace there are still hazards that can threaten the safety or health of workers, both from raw materials, work processes, to products and waste (liquid, solid and gas) produced (Pratiwi et al., 2021). Risk in work can be obtained directly or indirectly beyond human capabilities. Such as the effects of radiation associated with the use of Personal Protective Equipment (PPE), the use of PPE or radiation protection equipment and personal radiation monitoring (Hendra et al., 2011) (Oemiati & Umar, 2021). RI Government Regulation Number 33 of 2007 concerning Safety of Ionizing Radiation and Safety of Radioactive Sources. Every agency that uses ionizing radiation must implement radiation safety. BAPETEN Head Regulation No. 8 of 2011 concerning radiation safety in the use of diagnostic radiology X-ray aircraft and interventions for radiation safety in radiology installations covering management requirements, radiation protection, techniques, safety verification (Oemiati & Umar, 2021).

Hospitals are included in the criteria for workplaces with various potential hazards that can cause health impacts such as potential radiation hazards (Menkes, 2010). Data from the Ministry of Manpower, in the first quarter of 2018 work accidents increased, namely there were 5,318 work accident cases, 87 workers died, 52 workers were disabled and 1,361 workers recovered after undergoing treatment. This data increased compared to the previous year's period (Ridasta, 2020). It

is important to have knowledge about the benefits and effects of exposure to radiation substances and protection efforts to increase the understanding of all citizens (Irsal, 2022). An estimated 5807 cancers diagnosed in the UK in 2010 were the result of exposure to radiation, accounting for 1.8% of cases. (Parkin & Darby, 2011).

Tissue damage from radiation exposure, this condition is called radiation injury, sometimes there are no clinical symptoms and proper examination is required. Effects of ionizing radiation that can cause physical effects on the body or biological or somatic effects, namely effects that have consequences for themselves and their genetics/offspring. Somatic effects are divided into deterministic or direct/non-stochastic effects such as skin and lens injuries, and stochastic or indirect effects. Effects on heredity or genetics include stochastic effects and must be minimized by following work SOPs (Standard Operating Procedures). (Daenuri Anwar, 2011) (Hantari Rahmawati & Hartono, 2021) (Santamareta, 2023).

This study collects writings from research that are very useful to find out the use of radiation in radiology unit installations in diagnosing, healing and treatment can be successful so that it can reduce morbidity and mortality. Besides the extraordinary benefits of ionizing radiation used, it can also cause side effects which are detrimental to exposed patients or workers. Here the author makes a search regarding the tools used in radiology installations that use radiation materials and their physical effects or effects on individuals exposed to these substances. And it is hoped that in the future there will be many studies that can reduce the risk of the physical effects of this radiation.

RESEARCH METHOD

This paper is a literature review that draws from several reliable sources of articles regarding the types of equipment used in radiology unit installations that use radioactive materials and the effects they cause. Sources for conducting this literature review include systematic search studies of computerized databases in the form of research journals and review articles. The author takes an important theme from each article and combines each theme according to the important focus in the article so that the author can make conclusions regarding Radiology as a Supporting Examination and Treatment in the Medical World and its Effects.

RESULTS AND DISCUSSIONS

There are three types of radiology services: 1. Radiodiagnostic services are diagnostics with ionizing radiation (X-rays/electromagnetic waves and charged particles which due to their energy are able to ionize the media they pass through), namely conventional X-ray services, Computed Tomography Scan (CT Scan) and mammography. 2. Diagnostic Imaging, diagnosis using non-ionizing radiation (non-ionizing for diagnosis and/or therapy), namely Magnetic Resonance Imaging (MRI), and ultrasonography (USG). 3. Interventional Radiology: diagnosis and interventional therapy with X-ray radiology equipment (angiography, CT Scan), using ionizing radiation and non-ionizing radiation. Interventional radiology is a radiology specialty that uses the following techniques: X-ray radiography, CT scans, MRI scans, and ultrasound to place wires. (Septiyanti et al., 2020). Chest X-ray is a simple radiological examination that is mostly done in all hospitals compared to other examinations (Yusri, 2015).

X-rays were discovered by Wilhelm Conrad Rontgen in 1895 (Aisah et al., 2021). The nature of X-rays according to Beiser: namely electromagnetic waves with a length of $(0.0210) \text{ \AA}$, so that they include waves outside of visible light. It can propagate like the speed of light, it can't be deflected by lenses or prisms, it can be scattered by crystals. X-rays experience absorption in the transmission process in the material so that their penetrating power depends on the type of material and its energy (Susilo; Rudi; Pratiwi, 2013). Nuclear engineering in radiology installation medicine includes radiotherapy and radiodiagnostics and the dangers are detrimental to humans. X-rays / X-rays are tools for medical diagnosis. X-rays, directed at the body and then penetrate the body, are captured

by the film and form an image of the inside of the body being irradiated (formed due to differences in the intensity of the X-rays on the film after some of the X-rays are absorbed by the body). X-rays that interact with the body are forwarded and scattered (affects the quality of the radiograph / image), which are absorbed (affects the radiation dose received by the patient). The parameters on the device are voltage (kV), tube current (mA) and exposure time (s) (Silvia Ariska, 2022). The absorbed dose of radiation that will be received by the patient can be measured, according to age, weight and height category (Aisah et al., 2021).

Effects due to radiation exposure, namely biological effects are called somatic effects and hereditary or genetic or hereditary effects. Somatic effects consist of non-stochastic or direct or deterministic effects (cell damage/death, due to exposure to high radiation doses or exceeding the threshold dose). Stochastic or indirect effects, while genetic effects are all stochastic. Effects that can be observed clinically are called tissue reactions or deterministic effects. PThere isskin (redness/erythema), eyes (cataracts), lungs, thyroid (thyroids), reproductive organs, hemopoietic disorders, bone marrow, hair disorders, breast cancer, infertility, ovarian disorders, fetal/embryo death or other radiation syndromes if it does not pass no effect arises (Nugraheni et al., 2022) (Bodies & Energy, 2009).

Stochastic / indirect effects when exposed to low doses continuously, regardless of whether high or low doses, do not cause cell damage or cell death but the effect is changes in cell function. Somatic damage (cancer) or genetic damage (hereditary defects). Examples of stochastic effects are leukemia and some neoplasms, cancer, genetic disorders, damage to cellular DNA in sperm and eggs and congenital abnormalities in the offspring of irradiated individuals. With low radiation doses reduce the number of lymphocytes, chromosome storage and cancer risk (Pratiwi et al., 2021) (Monita et al., 2021).

The Dose Limit Value is the largest dose of nuclear energy permitted by BAPETEN which can be received by radiation workers and the public within a certain period of time without genetic and somatic effects (Bodies & Energy, 2009) (Milda Utari et al., 2014).

Discussion

Type of Examination Tool

The hospital is expected to be able to provide maintenance, care for radiology equipment (Amanah & Mustakim, 2020). Diagnostic radiology generally uses ionizing radiation except ultrasound and MRI. Diagnostic Radiology Examination looks inside the body with imaging or pictures, diagnoses, monitors, and screens diseases, namely: 1) Computed Tomography, Ccomputerized Axial Tomography (CT/CAT) scan: see conditions more clearly and accurately. X-ray emitting machine and a special computer, (rotating around the body to get an image of the target organ from various sides.) The image is clear, more detailed. As in the head, spine, heart, stomach, and others, the location of the tumor / cancer, blood vessels blood, muscle abnormalities, fractures to monitor the success of treatment. 2) Fluoroscopy: X-rays are used for diagnosis, treatment procedures, (cardiac catheterization). Real-time moving images or video formats or as organs move. Examine the condition of the organs (such as bones, muscles, heart, kidneys, lungs in detail). 3) MRI (Magnetic Resonance Imaging) and MRA (Magnetic Resonance Angiography) scans. The machine's magnetic field is very strong to create images of the inside of the body (examination of more than one hour). Uses a computer and magnets for more accurate results. To diagnose aneurysms of blood vessels of the brain, abnormalities of the eye and inner ear, stroke, disorders of the bone marrow and internal organs others. 4) Mammography. Using X-rays to examine tumor tissue or breast cancer. 5) Nuclear examinations, such as bone scans, thyroid scans, and cardiac stress tests. Utilizing the gamma camera embedded in the scanner. Previously, the body was injected with a small-scale radioactive liquid, so that the machine captured images and the function of the radioactive substance was to produce an image or picture. Nuclear power emits radioactive waves shot into organs and captured by a computer,

an image appears. Used to examine the structure of bones, thyroid and heart. 6) PET scan (Positron Emission Tomography) Used to view the structure and blood flow to and from organs. Examples of PET Imaging, PET Scan, or PET-CT. The officer inserts a radioactive substance into the vein, the substance flows with the blood, and the doctor sees the internal organs more clearly. 7) Radiography or X-ray: X-rays to describe the bones, chest and abdomen. Similar to fluoroscopy, different image results, fluoroscopy results in video form, x-rays in the form of 2D images. 8) Ultrasound: high-frequency sound waves aimed at the body being examined, the sound waves are then reflected when in contact with solid objects (using a probe, (Oemiati & Umar, 2021)(Monita et al., 2021).

Interventional Radiology minimal incision procedure, to diagnose and treat disease. The image emitted by the tool will help see inside the body without opening up a lot of tissue. Inserting a camera, catheter, cable, or other device into the patient's body and then connecting it to a radiology device, so that an image is obtained. Performed in tissue retrieval operations, installing medical devices without major surgery and only small incisions, such as in heart examinations, cancer, fibroids in uterus, arteries and veins and others. Such as catheter insertion, chemotherapy through arteries, placing rings in blood vessels, and others. (Septiyanti et al., 2020). The risk of interventional radiology is relatively greater compared to diagnostic radiology, especially for those who do it (D. Wulandari et al., 2023) (I. Wulandari et al., 2021).

A study of three hospitals in the cities of Makassar, Sukabumi and Pontianak showed that the radiation dose data received by patients did not exceed the value of the current diagnostic reference level in Indonesia, and the dose received by children was lower than that of adult patients. (Hiswara & Kartikasari, 2015).

Image formation is determined by factors between film types, parameter settings, and film processing. Its penetrating power is affected by the high voltage setting (kV), please carry out a suitability or function test, in order to comply with radiation safety requirements (Bachtiar, 2011). Besides radiographers, the operator's room and corridor must be safe enough from excessive radiation exposure, the farther the distance from the radiation source, the lower or smaller the measured exposure value (Ancila & Hidayanto, 2016).

Radiation protection is an act of protecting patients, workers, members of the public and the environment from radiation hazards. The dose limit (NBD) for radiation workers may not exceed an average of 20 mSv (millisievert) per year for 5 consecutive years and 50 mSv in a given year, while the NBD for members of the public may not exceed 1 mSv in 1 year. Examination of the radiation dose received by workers with a film badge or a Thermoluminescence Dosimeter (TLD) badge, including an X-ray machine suitability test (Hidayatullah, 2017). Radiation protection training, knowledge of the use of nuclear energy and its harmful effects and legislation for safety levels must be known to workers who are frequently exposed (Dianasari & Koesyanto, 2017). Monitor workers act according to safety and health rules, to improve the health status of the working community (Pane & Astuti, 2009) (Ferusge A. BerutuA, 2018).

The number of doses received can be caused by several factors such as length of service, field/type of work, amount of radiation activity handled, frequency of working with radiation, use of radiation protection equipment and so on. (Monita et al., 2021). If it is not controlled for a long time it will accumulate, causing a drastic reduction in the number of lymphocytes. Chromosomal aberrations, as markers of cancer risk (Sopandi & Salami, 2013) (Mayerni, Ahmad, A., Abidin, 2013).

The dose value received by the radiographer and the surrounding community is with a dose limit value of 2.5 μ Sv/hour (Septiyanti et al., 2020). Research in radiology at the Makassar City Hospital, scatter radiation exposure received by radiation workers in the radiology room, namely the radiation dose received by workers with the longest duration of radiation use, was received by operator XIII, which was 0.1769 mSv/h, while the smallest dose value was received by operator XI, which was 0.0593 mSv/h, so the average dose received by the operator is

0.1570mSv/h. So it can be concluded that the parameters of distance and time of the radiation source have a big effect on the dose of radiation exposure, the farther the distance from the source, the smaller the dose received. While the effect of time on exposure to radiation is that the longer the irradiation time, the greater the radiation dose obtained (Yuliamdani et al., 2020) (Hiswara & Kartikasari, 2015).

Physical effects

The hazard effects of radiation are not only for humans but have an impact on every creature that is around animals and plants. Research conducted at RSUP dr. Hasan Sadikin Bandung in four locations, namely the examination room and operator for interventional cardiology, the examination room and operator for fluoroscopy, the operator room for CTScan and radiotherapy. As a bioindicator, cepa plants are placed in each of these action rooms. The effects seen in *A. cepa* plants are the occurrence of mitotic and chromosomal aberrations in these plants (Sopandi & Salami, 2013). In Suwarda's research on the effects of radiation on workers in radiology installations, there was a decrease in lymphocytes by 17% in radiation workers who used radiation sources and 5% in workers who did not use radiation sources. (Monita et al., 2021).

Research on the analysis of risk factors for exposure to X-ray radiation on changes in the number of lymphocytes in radiographers in the city of Palembang shows a significant relationship between exposure to X-ray radiation at variable doses of radiation and workload on changes in the number of lymphocytes in radiographers who experience a decrease in the number of lymphocytes. And it was found that the number of abnormal lymphocytes was 16 people (18.4%) from 87 radiographers who were respondents. (Ernawidiarti et al., 2017).

On research in Gaza Palestine showed health complaints such as headaches experienced by radiation workers. These results are the same as a study conducted (in Egypt in 2013) which found that those who were exposed experienced headaches, fatigue, and dizziness compared to the group that was not exposed. In skin diseases, research found that skin problems were twice as common in workers (Tjiptono, 2015) (Alnahhal et al., 2017).

Research in Iran on radiation workers showed that the levels of platelets and lymphocytes were lower than the group that was not exposed to radiation (Sabagh & Chaparian, 2019). Indonesia has had two cases, the first case in 1998 in a hospital with a LINAC radiation source causing one person to die. The second case occurred in 2000 with a Cs-137 radiation source, in this case there were no fatalities because the source could be returned to its container (Uthami et al., 2010).

Research (R Aryawijayanti, et al 2015) that X-rays affect the total composition of erythrocytes, leukocytes and hemoglobin (studies on mice). The higher the radiation dose, the farther the composition of the blood from normal criteria (Pohan et al., 2022). In this study, due to exposure to periapical x-ray radiation, there was a decrease in fibroblasts in the extraction socket (in Wistar rats). The group that was exposed to x-ray radiation after extraction had a lower average number of fibroblasts compared to the group that was exposed to x-ray radiation from periapical radiographs before tooth extraction. (Salsabila et al., 2020). Research on exposure to panoramic radiographic radiation on saliva can cause changes in saliva, namely in pH, viscosity, volume, buffering fluid, and the condition of dental calcium. (Pitaloka, 2021).

Saliva flow is a defense system for the oral cavity and can reduce the buildup of plaque on the tooth surface, but excessive radiation exposure to saliva will affect the condition of the mouth to become more acidic so that caries occurs. (Sulendra et al., 2013) (Ajani et al., 2019). Salivary glands in the mouth indicate the mouth is normal, there is an effect of radiation on the pH after post-radiotherapy (Patricia, 2008). Found salivary pH before and after panoramic radiography, found a decrease in salivary pH or a decrease in its production (Nurgalih et al., 2019) (Aisah et al., 2021).

Research by Indah and Dinanda (2020) from 40 respondents who were examined from the 2017-2020 period in radiation workers in the same place, radiation workers' leukocyte levels were found to be within normal limits, only 4 people were abnormal, it turned out they had worked more than the hourly dose should cause an increase in leukocytes (Oemiati & Umar, 2021). Research on 39

radiation workers from 2008-2011, found 35 people with leukocyte levels within normal limits and four people were not normal, it turned out that the four radiation workers did not use Personal Protective Equipment (PPE)(Oemiati & Umar, 2021) (Siburian, 2012).

Several studies have studied the effects of radiation, especially the impact of radiation on cancer (stochastic effect). The study of atomic bomb victims, in the study group of the Life Span Study (LSS) the highest cancer risk. Richardson's study, et al, proved a strong relationship between radiation and the incidence of leukemia. Li, et al, and Preston, et al, demonstrated the risk of tumors due to radiation exposure. Preston, et al, considered that increased cancer rates persisted throughout life regardless of age at exposure. Daniels and Schubauer-Berigan evaluate and show that acute exposure increases the risk of cancer greater than long-term exposure. Musa, et al, showed exposure to radiation doses can cause embryonic or fetal death and decreased IQ(Maleachi & Tjakraatmadja, 2018).

Research from 11 patients who underwent radiotherapy up to 20 Gy, and 11 healthy subjects as controls, to see how much DNA damage a fractionated radiation dose of 20 Gy has in patients with various cancers. Research concludes that high doses of radiation can cause DNA damage to peripheral blood lymphocyte cells(Yusuf et al., 2021).

As a result of exposure to ionizing radiation a person may experience adverse effects and have an impact on causing illness on himself or biological effects. Effects radiation to oneself (somatic effects) or to their offspring (hereditary/genetic effects). This effect can occur immediately, can occur in less than a year due to high doses of radiation or exceeding the threshold dose, and indirect or delayed effects, low dose radiation but takes place continuously (does not immediately show the effect.) Somatic effects are divided into non-stochastic (deterministic) effects. namely damage or death of body cells exposed to radiation if the radiation dose received is high or exceeds the threshold dose. Such as in the skin (redness/erythema), eyes (cataracts), lungs, thyroid (thyroids), reproductive organs, and fetus. The severity of this effect is in accordance with the dose received so if it has not been passed it will not have an effect on the body. In order for this non-stochastic effect to occur, a dose limit value for all body tissues is required(Amanah & Mustakim, 2020). This effect can be observed clinically and immediately if the radiation exposure dose exceeds a certain threshold value and is referred to as a tissue reaction or deterministic effect.(Amanah & Mustakim, 2020)(Pratiwi et al., 2021). Stochastic effects or indirect effects occur when the human body is continuously exposed to low doses, causing somatic damage (cancer) or genetic damage (hereditary defects)., not cell death but changes in cell function. If exposure to low doses, can appear cancer (somatic damage) or defects in the offspring (genetic damage)(Hiswara & Kartikasari, 2015)(Amanah & Mustakim, 2020) The stochastic effect can cause disease no matter how large the radiation dose is, so there is no guarantee of a true threshold value that is truly safe. Examples of stochastic effects are leukemia and some neoplasms, cancer, genetic disorders, damage to cellular DNA in sperm and eggs and congenital abnormalities in the offspring of irradiated individuals. . Effects on pregnant women can cause child disability until the death of the fetus(Nugraheni et al., 2022)(Rachma, 2020). Based on UNSCEAR (United Nations Scientific Committee on The Effects of Atomic Radiation) data, 95% of radiation exposure comes from man-made radiation, especially diagnostic activities(Rachma, 2020).

The risks of harm that may occur to radiation workers are deterministic effects and stochastic effects. The effect of X-rays can cause haemopoietic damage (blood disorders) such as: anemia, leukemia, and leukopenia, namely a decrease in the number of leukocytes (below normal <6000/m²). In adult humans, leukocytes can be found around 7,000 cells per microliter of blood(Mayerni, Ahmad, A., Abidin, 2013)(Mayerni et al, 2013). In addition, the deterministic effects that can be caused on the reproductive organs or gonads are sterility or infertility and cause early menopause as a result of hormonal disorders of the reproductive system.(Purba & Sari, 2020)(Dianasari & Koesyanto, 2017). What is meant by low-dose radiation is radiation from 0.25 to 1,000 mSv, the smaller the radiation dose, the less chance of cell damage(Nugraheni et al., 2022). The farther the

distance from the radiation source, the lower the measured dose of radiation exposure (Septiyanti et al., 2020) (Hantari Rahmawati & Hartono, 2021).

The Dose Limit Value (NBD) is the maximum dose permitted by BAPETEN that can be received by radiation workers and members of the public within a certain period of time and without causing significant genetic and somatic effects due to the use of nuclear power. The required Dose Limit value is 20 mSv (BAPETEN, 2011). The International Committee for Radiation Protection (ICRP) defines the dose limit value as a dose received within a certain period of time or a dose that comes from instantaneous intensive irradiation, which provides a negligible possibility for occurrence of serious somatic defects or genetic defects (Akhadi, 2000) (Rachma, 2020).

The protection procedure by examining or checking the apron is carried out by means of visualization tests, touch tests and testing using X-rays on the surface of the apron, so that the apron can really protect workers or the patient's family from radiation hazards. Officers wear protective clothing called lead apron. Testing acceptance of radiation exposure every 12-18 months. Pb apron is a lead apron designed to protect workers' bodies from radiation hazards (Damayanti, 2021) (Kasalak et al., 2021) (Hantari Rahmawati & Hartono, 2021).

Workers are expected to increase their knowledge about X-ray radiation and safe actions while working by participating in training made by the hospital and being able to apply the training while working (Ferusge A. Berutu A, 2018).

In BAPETEN Regulation Number 9 of 2011, an X-ray machine suitability test is carried out, which is a test to ensure that the X-ray machine is in reliable condition, both for diagnostic and interventional activities and complies with statutory regulations (Bodies & Energy, 2011). Health monitoring activities for radiation workers in radiology installations, including medical examinations, counseling, and management of workers exposed to excess radiation exposure. Health monitoring is carried out by doctors and psychologists (PERKA BAPETEN, 2010) (Bodies & Energy, 2011).

CONCLUSION

In the radiology unit installation, the use of ionizing radiation sources is used to improve the quality of health services. To prevent biological effects, namely deterministic effects and stochastic effects, it is necessary to strictly monitor the factors that play a role, such as carrying out testing activities, ensuring that the equipment is in reliable condition, the radiation dose received workers and patients, length of service, field/type of work, amount of radiation activity handled, frequency of work, use of radiation protection equipment and so on. Radiation workers are required to use radiation protection equipment (Permenkes 2020) (Bapeten, no 8 of 2011). All regulations in the installation of radiology units must be complied with in all their activities, as an effort to reduce morbidity and mortality due to the physical effects of radiation substances.

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