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COMPREHENSIVE STRATEGY TO INCREASE AWARENESS AND COMPLIANCE WITH SAFETY PROCEDURES IN MRI EXAMINATIONS TO REALIZE SAFE AND QUALITY HEALTH SERVICES

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ABSTRACT

Magnetic Resonance Imaging (MRI) is a non-invasive diagnostic method that uses magnetic fields and radio waves to produce detailed images of the body. This procedure provides very significant benefits in the medical world, especially for detecting various health conditions. However, behind the benefits, there are potential safety risks that need to be well understood by medical personnel, patients, and patient companions. Awareness of these safety procedures is crucial to minimize the risk of injury or complications during the inspection. In one of the hospitals, the implementation of safety procedures involves providing comprehensive education to all relevant parties within the scope of MRI examination. This education includes an in-depth explanation of potential hazards, such as the interaction of metal objects with strong magnetic fields, as well as guidance on adhering to safety rules while in the MRI room. Medical personnel are also equipped with training designed to ensure compliance with safety protocols. The results of the study show that the level of awareness of MRI safety procedures still varies in various health facilities. Some facilities with good education and training programs show a higher level of awareness, while others require improvement in this regard. Efforts to raise awareness can be carried out through a combination of various approaches, including structured education, regular training for medical personnel, and the use of modern technology to support safety. With these measures, risks in MRI examinations can be minimized, resulting in a safe and effective examination environment.

Keywords: MRI; MRI Safety; MRI safety protocols: MRI Patient Safety Education

Introduction

MRI has been an important tool in diagnostic imaging since it was introduced to clinical settings two decades ago. MRI is widely considered a safe modality because it does not involve ionizing radiation such as radiography, CT or PET scans. However, there are health concerns and potential hazards in the MR environment, which is defined as an area where the magnetic field strength of the MR system is greater than 5 Gauss (G) or 0.0005 Tesla (T). Potential risks in MRI are associated with three main components of the MR system: static magnetic field, time-varying magnetic field (gradient) and radio frequency field. Some risks come from the patient, such as their implanted medical devices. Other risks posed to patients are due to lack of knowledge about MR safety or negligence by medical staff. As MRIs are increasingly being performed, it is important to raise awareness about MRIs and patient safety. MR-related accidents have been shown to have devastating consequences, such as equipment damage, personal injury, and even death. Therefore, it is crucial that all healthcare professionals involved in MR procedures understand the potential risks and adhere to safety policies to ensure patient safety [1].

Overall, compliance with updated safety policies and guidelines is essential to minimize the risks associated with MRI (MRI and Patient Safety) procedures. MRI safety for healthcare professionals involved in MRI procedures. Although MRI is a non-invasive imaging technique that does not use ionizing radiation, there are potential health risks associated with the MRI environment, including static magnetic fields, magnetic fields that vary over time, and radiofrequency fields.

In handling the examination, it is necessary to be aware and comply with safety protocols to prevent accidents and ensure patient safety in the MRI environment. The study also outlines safety protocols and recommendations for MRI procedures to prevent harm to patients due to RF heating, magnetic fields, and other hazards.

Occupational safety and health (OHS) in the context of MRI examinations involves various efforts to protect patients and medical personnel from potential hazards that may occur during the procedure. Effective implementation of OSH policies and procedures, including training programs on safety procedures and health awareness, is essential for maintaining a safe work environment and minimizing the risk of injury or accident [2.]

Patient education before an MRI examination also plays an important role in improving their understanding of the risks and procedures to follow. Patients who receive education tend to be more compliant in removing metal objects or providing relevant medical history-related information, reducing the likelihood of incidents occurring during the examination [3].

In an effort to increase awareness about safety procedures in MRI examinations, collaboration is needed between medical personnel, patients, and health facility management. The implementation of a positive occupational safety culture, where members of the organization not only comply with OSH rules but also internalize safety as a core value, will create an environment where all parties are active in efforts to prevent accidents and injuries.

MRI personnel must collaborate with local fire safety officers and train them on MRI safety risks. Overall, compliance with updated safety policies and guidelines is essential to minimize the risks associated with MRI procedures.

A. Definisi MRI Safety

Magnetic Resonance Imaging (MRI) is a non-invasive diagnostic imaging modality that utilizes electromagnetic waves. However, the use of MRI needs to have guidelines for its use to ensure patient safety and comfort. In addition, the MRI safety guide also serves to protect radiographers as well as health workers and other medical personnel [4] has three types of electromagnetic fields used, namely static magnetic fields, radiofrequency magnetic fields, and time-varying gradient magnetic fields, each of which has a risk of danger in its use if it does not comply with existing guidelines [5].

One of the subjects who is on duty and responsible for identifying the dangers of

MRI during the examination process is the operator or radiographer who can choose and use the optimal protocol parameters to avoid an increase in the Specific Absorption Rate (SAR), through the operator it is also possible to know the patient's condition during the examination process[6].

According to radiographer [7], MR safety consists of the following;

B. Responsible personnel

There needs to be education for employees who work in radiology installations in MRI services. Those who are responsible and need to evaluate the safety of use are radiographers, radiology specialists, and nurses on duty. In addition, the doctor in charge of the patient and other supporting specialists such as anesthesiologists, pediatricians, and others are in charge of being responsible as long as they are within the scope of the examination room only and are not required to conduct evaluations.

In addition, the operator on duty (Radiographer) must have knowledge and understanding in MRI safety, be responsible for the safety of patients undergoing MRI examinations, and must ensure that the environment around MRI is not anything that can interfere with the magnetization process.

C. Medan Magnet MRI

The static magnetic field is affected by the strength of the magnetic field with the unit Tesla (T). The use of static magnetic meda that interacts with hydrogen in the human body will produce potential electrification and physical effects that include vertigo, nausea, discomfort in the sense of taste.

D. Safety Symbols

The use of symbols in giving signs in the scope of MRI must clearly define a condition so that it is easily accepted by patients and other general public. Here's an example of an MRI safety symbol:

Figure 2. 1 MR Safety Symbol [7]

MR Safe: defined as goods that do not pose a hazard, contain non-conductive, non-metallic, and non-magnetic materials or materials.

MR Conditional: defined as an item with proven safety in the MR environment under specified conditions. At a minimum, it overcomes the conditions of static magnetic fields, active gradient magnetic fields, and radio frequency fields. With additional conditions, including item-specific configurations that may be required.

MR Unsafe: defined as items that are dangerous and have a high risk to patients, medical personnel and anyone in the scope of MRI.

E. Gradient Magnetic Field

The use of magnetic gradients affects the position of the main magnetic field. The magnetic field gradient has biological effects, namely stimulation of muscles and peripheral nerves, implant interactions that result in heat and vibration, acoustic noise due to coil gradients that switch on and off during the examination.

F. Radiofrequency Effects

The use of radiofrequency can have an impact on increased molecular oscillation and increased heat sensation in the patient's body. So there needs to be a SAR limit that can be accepted by patients and image quality. The MRI operator is required to ensure that the airflow during the examination is in good standing and the operator must pay attention to the acceptable temperature limit of the unit.

G. Dangers of Kryogen

Malfunction and maintenance of the kryogen can only be carried out by a trained kryogen supplier. In the event of an emergency condition marked by an alarm on the oxygen monitor indicating low oxygen,

the examination must be stopped immediately and the patient is evacuated.

H. Medical Implant Usage

Active Medical Implants (AIMD) consist of pacemakers, cochlear implants, cochlear programs, hydrocephalusshunts programs, nerve stimulation system implants, and drug infusion implants. The radiology installation is responsible for ensuring that the examination process with the implant user patient can run safely.

I. Pregnancy safety in MRI examination

In pregnant female patients, MRI examinations need to be carried out with full supervision for the safety of the baby and fetus, Some measures to prevent fetal failure are to minimize the use of RF and acoustic noise. Operators are required to choose parameters that are low SAR and pulse sequences that do not make too loud noises.

J. Keamanan Media Kontras MRI

The most commonly used MRI contrast media are gadolinium (GBCAs) which have a risk of Nephrogenic Systemic Fibrosis (NSF). What needs to be done to reduce these risks is to inform the procedure for using GBCAs in a clear and detailed manner to minimize NSF risks by monitoring during the audit process. The use of contrast media in pregnant patients is not recommended unless it is urgently needed with the approval of an obgynist.

K. Safety MRI ImplementationMRI pada Ibu Hamil

MRI examinations in pregnant women should use sequence parameter protocols that are acceptable to both mother and fetus to prioritize safety. According to a survey, 43%-79% of hospitals have made regulations on the use of MRI for pregnant women, this aims to protect the safety of mothers and fetuses [8].

MRI with implants in the body

The use of implants on the body that have metallic components is basically at the level of conditional MR or unsafe MR. So it is necessary to set parameters first before MRI is used for scanning to avoid malfunctions during the examination process. Low RF usage of normal conditions is used for the examination process with the implant user patient [9].

In the case of using cardiac pacemarkers and ICDs, patients can be safely examined for MRI but with conditional notes using parameters from vendors [10].

Thus, this study aims to analyze the level of awareness regarding safety procedures in MRI examinations and identify the factors that affect them. The results of the study are expected to provide strategic recommendations to increase awareness and implementation of safety procedures, so that the quality of health services can be improved and risks related to MRI examinations can be minimized. **Methods**

The quantitative descriptive design method with a survey approach was carried out in hospitals that have MRI modalities in 2024 with a population including medical personnel involved in the scope of examination. Data were collected through open and closed questionnaires, conducting observation interviews. The data analysis uses quantitative and qualitative approaches. This research was conducted with the approval of the Research Ethics Committee at the relevant health institution. All respondents gave informed consent before participating, and the confidentiality of personal data was guaranteed during the research process.

Results and Discussion

The results of the study show that the level of awareness of MRI safety procedures still varies in various health facilities. Hospitals that implement regular training programs show higher levels of compliance with safety protocols. Studies also revealed that incidents caused by metal objects being carried into the MRI room can be reduced by up to 40% after training. In addition, patient education has been shown to be effective in improving their understanding of safety risks and procedures, thereby minimizing the potential for errors such as not removing jewelry or providing incomplete medical information.

Psychological factors, such as anxiety and claustrophobia, are often obstacles in MRI examinations. Research shows that interventions such as counseling, relaxation techniques, or the use of music therapy can reduce anxiety levels by up to 30%. Additionally, modern technologies, such as safer MRI devices and the application of artificial intelligence (AI) for patient monitoring, have improved safety and efficiency. The system enables automated metal detection and more accurate risk analysis, reducing safety risks by up to 20%.

Increasing awareness of MRI safety procedures can be achieved through various strategies. First, regular training for medical personnel is essential to ensure their understanding of risks and ability to respond to emergency situations. Simulation-based training has been shown to improve staff's ability to deal with MRI-related emergencies. Second, structured patient education, such as through brochures, videos, or short counseling sessions, is effective in increasing patient compliance with safety protocols. This approach not only clarifies the procedures to be followed but also creates a sense of security for the patient.

Infrastructure and technology also play an important role in improving safety. The use of MRI devices with modern safety features, such as automatic metal detection, can prevent accidents in the MRI room. Additionally, effective two-way communication between patients and staff during examinations can reduce anxiety while ensuring patient safety. Regular audits and evaluations of safety protocols are also required to ensure that all measures implemented remain relevant and effective.

Psychological support for patients, especially those experiencing claustrophobia or anxiety, should also be a concern. Relaxation techniques, music therapy, or even the use of mild sedatives if needed, can help patients undergo the examination comfortably. Collaboration between patients, medical personnel, and facility providers is essential to creating a safe and trusted environment.

Conclusion

Awareness of safety procedures in MRI examinations is an important aspect to protect patients, medical personnel, and the work environment from potential risks. By implementing appropriate safety measures and increasing education and training, these risks can be minimized. Collaboration between medical personnel, patients, and related parties is the key to creating a safe, comfortable, and efficient examination environment. With a structured and sustainable strategy, risks can be minimized, and the quality of healthcare services can be significantly improved.

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