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# Literature Study on the Utilization of Electromagnetic Waves in the Health Sector

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**ABSTRACT**

The rapid development of natural sciences, especially in developing the concept of physics in the health sector. Its utilization can facilitate the healing of diseases, such as using electromagnetic waves in healing diseases. This study aims to determine the benefits generated from electromagnetic waves that can help and facilitate the handling of diseases in the health sector by using a literature study method that utilizes information retrieval from several journals and trusted sources. Electromagnetic waves can be used in X-rays. Areas of the body that need to be examined through emitted X-rays. Ultrasonogram (USG) is a medical equipment used in tomography to see the fetus's condition and others where all of that is the use of Physics in the Utilization of Electromagnetic Waves which helps the health sector.

## INTRODUCTION

The word radiation is often considered scary and dangerous and interferes with health and safety. Even though there is much radiation around us at home, work, and public places. Radiation is a way of spreading energy from an energy source to its surroundings without needing heat. Some examples are radiation, heat, and radio waves. The different types of electromagnetic waves cover a wide frequency range. Radio waves, television signals, radar rays, invisible light, X-rays, and gamma rays are examples of electromagnetic waves. All these waves travel at the same speed in space, $3 \times 10^8$ m/s. Electromagnetic fields are everywhere; the sun, stars, fire, and storms are natural sources of electromagnetic waves. Electromagnetic sources include nuclear explosions, electrical circuits with vacuum tubes or transistors, microwave diodes, laser radio antennas, and many others. (I.B.Alit Swamardika 2009).

Different magnetic wave frequencies will irradiate the human body. The degree of exposure to electromagnetic waves of different frequencies is highly dependent on technological developments, raising concerns that exposure to these waves could harm human physical health. Possible such interference is electrical sensitivity. Electrical sensitivity is a physiological problem with neurological and emotional signs and symptoms in different symptoms and complaints. Such interference is usually caused by electromagnetic radiation from high power lines, household electronics, offices, and factories. Including mobile phones and microwave ovens, it can cause these complaints. Therefore, it is important to strive for safety and health through radiation protection measures through radiation monitoring services and individual monitoring. This research was conducted to reduce the level of radiation received by humans, both inside and outside the environment, where there are many sources of electromagnetic radiation. (I.B.Alit Swamardika 2009).

One way to determine radiation exposure is to use an electric radiation detection device placed in the hospital treatment room so that nurses know the amount of radiation around the patient so that the patient does not receive too much radiation. (Nur Hudha wijaya,Wisnu Kartika,dan Aulia Resti 2019) Long electromagnetic waves can cause health problems in the population in the study of I.B. Alit, including some symptoms of hypersensitivity known as electric shock, including complaints of headaches and fatigue. Judging from the electric charge, radiation can be divided into ionizing radiation and non-ionizing radiation. Ionizing radiation

includes X-rays, alpha particles (α), beta particles (β), gamma rays (γ), and neutrons. Today, non-ionizing radiation includes radio waves, microwaves, infrared, visible light, and ultraviolet. (Nur Hudha wijaya,Wisnu Kartika,dan Aulia Resti 2019).

Static EMF (0 Hz) is a natural source of electromagnetic radiation, MRI, and industrial electrolysis. Low Frequency (ELF) EMF (0-300Hz). These electromagnetic waves are generated when electricity is passed through wires and when used in electronic devices. The frequency of this wave, when produced by electronic devices, is around 50-60 Hz. EMF medium frequency (300 Hz - 100 kHz). Sources include hands-free machine detectors (Fuadi & Jusli, 2022).

EMF radio frequency (100 kHz – 300 GHz). Sources include television waves, radios, cell phones, and microwave ovens. According to the provisions of the International Atomic Energy Agency, the radiation dose received by radiation workers should not exceed 50 millisieverts per year. The public's radiation doses should not exceed five millisieverts per year. The level of exposure to electromagnetic wave radiation of various frequencies can harm human physical health (Fuadi & Jusli, 2022).

A potential health problem is a hypersensitivity reaction (electric shock). Hypersensitivity (electrical sensitivity) is a health disorder due to exposure to electromagnetic radiation is a physiological disease in which there are neurological symptoms (disorders of the brain and nervous system) and sensitivity to electromagnetic fields. According to Beiser, X-rays have many aspects: A potential health problem is a hypersensitivity reaction (electric shock). Hypersensitivity (electrical sensitivity) is a health disorder due to exposure to electromagnetic radiation is a physiological disease in which there are neurological symptoms (disorders of the brain and nervous system) and sensitivity to electromagnetic fields. There are many aspects of X-rays, according to Beiser:

1. X-rays are electromagnetic waves with wavelengths (0.02-10) Å, including waves outside the visible light region.
2. Like other electromagnetic waves, X-rays can propagate at the speed of light.
3. Lenses or prisms cannot rotate X-rays but can be expanded by crystals.
4. X-rays are also absorbed during the diffusion process in the material, so the penetrating power of X-rays depends on the type of material and its strength (Rudi, 2012).

X-rays are ionizing radiation so that they can create free electrons in matter. In the case of living things, X-rays can damage living cells. If radiation hits the human body, there are two possibilities: it interacts with the human body or passes through it. When they interact, radiation can trigger or excite atoms. Every time the process of ionization and excitation occurs, the radiation loses its energy, which causes an increase in the temperature of the interacting atomic substance, i.e., radiation Energy is lost. In other words, all the radiant energy that enters the body of a living thing will appear as heat from the increased vibration of the parts of atoms and molecules. This is the beginning of chemical changes that harmful organisms can cause (Wardiyati, Adi, & Winatapura, 2018).

Based on the explanation above, it will be explained in terms of electromagnetic waves and their effects on human health, so problems can be raised, such as: what is the effect of electromagnetic radiation on human health. Based on the description above, research is being conducted to evaluate the amount received by humans using thermoluminescence dosimeters. Through this study, it is hoped that the amount of dose received by hospital workers can be known so that they can anticipate what will happen at high dose levels and reduce the negative impact of radiation exposure (Nur Hudha Wijaya, Wisnu Kartika, Aulia Resti 2019)

## METHOD

This study used a literature study method where researchers first read, understood, and reviewed sources. Sources as material that will be used as a reference in writing research. Several journals are used as primary sources, and the journals used as sources are obtained from media and online sites accredited with good predicate journals. Moreover, more than 20 journals are used as secondary sources. This method is used to increase knowledge and understanding of the Utilization of Electromagnetic Waves in the Health Sector by presenting information according to facts or new analysis that is more relevant.

## RESULTS AND DISCUSSION

### A. Electromagnetic radiation

Electromagnetic waves are waves that can also propagate without a medium. Electromagnetic energy propagates in waves with several properties, namely: wavelength, frequency, amplitude, and speed. Amplitude

is the height of the wave, while wavelength is the distance between two wave crests. Frequency is the number of waves that pass through a point in a unit of time. The frequency depends on the speed at which the wave propagates. Since the speed of electromagnetic energy is constant (the speed of light), wavelength and frequency are inversely proportional. The longer the wavelength, the lower the frequency; the shorter the wave, the higher the frequency. All mass in the universe emits or releases electromagnetic energy at different rates. The higher the energy level in the energy source, the shorter the wavelength and the higher the energy frequency produced. Various wave energy characteristics are used in classifying electromagnetic energy (Timor, Andre, & Hazmi, 2016).

Electromagnetic waves are formed by a combination of two fields which are a magnetic field or B and an electric field or E. Electromagnetic waves are obtained from electric charges that oscillate and then experience acceleration or can be called this electric charge which is accelerated to cause electromagnetic waves (Tristanti & Sudarti, 2021).

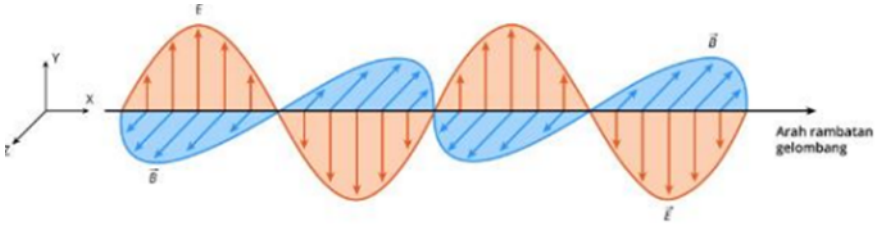



Figure: Electromagnetic waves are formed by electric and magnetic fields perpendicular to each other. Source (Sukarno, n.d.)

According to Maxwell, the speed of electromagnetic waves is:

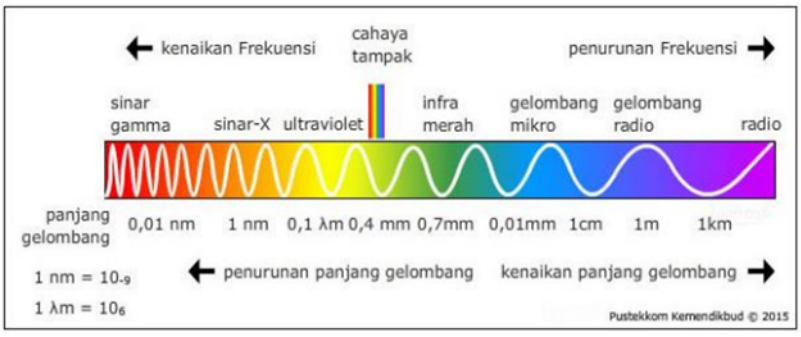
$$v = c = \frac{E}{B} = \frac{1}{\sqrt{\epsilon_0 \, \mu_0}}$$

So that, $c = 3 \times 10^8 m/s$

The electric field is always perpendicular to the magnetic field. The multiplication result between E x B always gives a direction similar to a walking wave. These two fields are always sinusoidally variable and also have the same frequency and phase as each other. According to (Seniari & Baus Widhi Darma, 2020), There are several properties of electromagnetic waves as follows:

a. Can propagate in a vacuum
b. Included in transverse waves
c. May be polarized
d. Can experience reflection
e. May undergo refraction
f. May experience interference
g. May undergo scattering (diffraction)
h. Propagate in a straight direction

The spectrum of electromagnetic clusters includes gamma rays, X-rays, U.V. or ultraviolet light, visible light, infrared light, microwaves, and radio waves.




Source (Sukarno, n.d.)

Meanwhile, the properties of electromagnetic wave radiation are as follows:

1. It is the propagation of vibrations of electric and magnetic fields that are perpendicular to each other in the direction of propagation.
2. Its speed is constant in a vacuum, which is 3×10^8 m/s.

3. Not affected by electric and magnetic fields because it is not
4. It can be reflected, refracted, interference, and polarized.
5. It can propagate in a vacuum or vacuum.
6. Represents a transverse wave.
7. It can act as a particle and has frequency-dependent energy.

Based on the amount of energy produced, electromagnetic wave radiation is divided into ionizing and non-ionizing radiation. Ionizing radiation is radiation with a very high frequency that has the energy to break the bound electrons so that it will create free electrons that collide with each other and release more electrons. Examples of ionizing radiation are X-rays and gamma rays, which are widely used in medicine. Non-ionizing radiation is low-frequency radiation that does not have enough energy to break down bound electrons. Examples of non-ionizing radiation are ultraviolet, infrared, microwaves, and radio waves. Based on their frequency, electromagnetic waves are classified into four levels as follows:

a. Static electromagnetic frequency (0 Hz). Sources included are natural electromagnetics, MRI, and industrial electrolysis.
b. Very low frequency (0 – 300 Hz). These electromagnetic waves are generated when electricity is passed through power lines and by electronic devices when worn.
c. Medium frequency (300 Hz – 100 kHz). Sources included are metal detectors and loudspeakers.
d. Radiofrequency (100 kHz – 300 GHz). Sources included are television waves, radios, mobile phones, and microwave ovens (Iqlima, 2020).

Dangers caused to humans by electromagnetic wave radiation include headaches, insomnia, and liver cell damage. According to The National Radiological Protection Board (NPRB) U.K., U.K., the effects caused by electromagnetic wave radiation are divided into two parts, namely:

1. Physiological effects are effects on the human body systems caused by electromagnetic radiation. It can cause tumor effects, brain cancer, hearing loss, eye problems, reproductive disorders, and nervous system disorders.
2. Psychological effects are side effects of electromagnetic waves on human psychology. Side effects can be caused by stress (Hermawan, Nurbaiti, & Yulianti, 2021).

The following is the use of electromagnetic waves in the health sector :

1. Laser

   LASER is an abbreviation for Light Amplification by Stimulated Emission of Radiation (Nuraeni, Nurfa, Nisa, Azzahra, & Sujarwanto, n.d.). LASER outputs are generally monochromatic and integrated due to light exits from molecules(Young, Freedman, & Ford, 2012). LASER stimulates particles to increase light and release the light of a certain frequency to create a narrow beam of radiation. According to (Kholifudin, 2017), Laser light is an electromagnetic wave exhibiting polarization, reflection, refraction, interference, deviation, diffraction, and dispersion (Biswas, 2023). Low-intensity lasers are already available in the market.

2. Rontgen

   Medical devices that use X-rays to make a diagnosis are known as X-ray machines or X-rays. The area of the body that needs to be examined receives X-rays from the tube. The X-ray beam will capture rays entering the body, producing images of irradiated body parts. X-ray rays are electromagnetic waves with a very short frequency (1Å = 10− 8 cm), so they have a high infiltration power. X-ray beams have many benefits, but using X-rays also impacts potential radiation hazards. As a result, aspects of radiation protection must be considered when using it. To provide a high-quality service, X-ray equipment must be in good condition and maintained so that the X-ray beam matches the collimator light and BAPETEN is less than 2% focal length of the film plane (FFD) (Nanda, 2022).

3. MRI

   According to Kartawiguna, 2015, Magnetic Resonance Imaging (MRI) is a modern medical equipment that produces cross-sectional images of the human body by combining computer technology, high magnetic fields (0.064-7.0 Tesla), and radio waves. Due to non-ionizing radiation, MRI examination has several advantages over other imaging and diagnostic modalities. It is non-invasive, provides high-resolution results on soft tissues, and allows multidirectional imaging of slices in all shapes (transverse, sagittal, coronal, and even oblique) for clearer, more detailed results (Maulida, Susanto, & Murniati, 2019).

4. Ultrasonography (USG)

Ultrasound, more commonly referred to as ultrasound, is a medical equipment used in tomography. The fetus's condition, the development of pregnancy, preparation for childbirth, etc., can all be monitored by ultrasound. In addition, this method is used to find tumors, cardiovascular conditions, and eye defects. Doctors utilize this equipment for ultrasound scanning and the Doppler effect to monitor blood flow through large arteries; doctors monitor the movement and function of the heart.

Ultrasound is a tool used in examinations that utilize ultrasonics (sound waves) released by the transducer. The ultrasonic sound frequency is greater than 20 kHz. This method uses the idea of sound reflection. Sound is a physical phenomenon that moves energy between locations. Large organs will reflect sound when directed into them. Some people have large reflexes, while others have smaller reflections. Images can be generated from this. Because it can see organs in the human body, both stationary and moving, ultrasound is used as a diagnostic tool with high frequency (Mappaware et al., 2020).

(Source: www.google.com )

5. Microwave Diathermy

Micro Wave Diathermy is a physical stressor treatment in electromagnetic wave energy with a wavelength of 12.25 cm produced by current at an alternating power frequency of 2450 MHz used in Microwave Diathermy Therapy. But there is also Micro Wave Diathermy (MWD) which uses a wavelength of 69 cm and a frequency of 433.92 MHz. (Abidin & Amin, 2017).

## CONCLUSION

The rapid development of Natural Sciences, especially in developing the concept of physics in the health field. The use of electromagnetic wave radiation presented with technology developed will produce benefits in the world of health, among others, used as a tool to investigate the causes and symptoms in patients / diagnose a disease. It can help confirm the presence or absence of a disease or injury in a patient. Sterilize medical equipment. The urgency in the field of health and its relationship with natural sciences, especially physical sciences, can also have an impact on increasing knowledge and understanding to educators as a completeness of insight into electromagnetic waves.

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