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The Potential Risks of Radiofrequency Interference in a Typical Hospital and Analytical laboratory Instruments

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Abstract
The electromagnetic interference (EMI) is dangerous for our daily lives. It produces vital electronic failures. These problems are due to bad shielding materials for electronic systems. The main objective of this article is to raise the awareness of EMI and its consequences on critical functions of hospitals medical electronic systems. In this article, the general aspects of this topic are introduced. Case histories about EMI in hospitals and analytical laboratory Instruments are presented. It was suggested that the extensive use of modern electronic devices in hospitals and analytical laboratories with an increasingly scattered electromagnetic environment (EMI) should be carefully reconsidered and thoroughly retested.

Keywords: Electromagnetic Interference (EMI), Electronic System Failures, EMI Case History, Hospital Instruments, Analytical laboratory Instruments

Introduction

Electromagnetic interference (EMI) occurs when electromagnetic energy from one or more sources, such as radio waves emitted by portable radios and cellular telephones, interferes with the normal operation of another device. Other natural sources that can produce electromagnetic interference are lightning and solar storms [1]. On the other hand, man-made EMI can be produced from magnetic resonance imagers, high-power radio frequency sources, microwave and electrical sources, it can also come from malfunctioning or improperly designed consumer devices [1].

However, electromagnetic interference in medical devices can be linked to patient injury, or, in worst-case scenarios, even cause death. The EMI in the ambient or the system is capable of interrupting the operation of active medical devices and can cause serious injury to patients [2]. Fig 1 shows the typical medical facilities in hospitals. Hospitals and medical facilities house hundreds of medical devices that require specific EMI / RFI shielding. These devices include magnetic resonance imaging (MRI), computed tomography (CT), electromyography (EMG) and others that rely on shielding to function properly in their intended environment [3].

Fig 1: Typical medical facilities in hospitals [3].

EMI Case History

Recent studies have shown that radio frequency interference (RFI) is a somewhat neglected safety issue in determining and investigating performance characteristics of clinical laboratory, medical, industrial, and other critical instruments. Interest in this vital topic, which is directly related to human life, has increased because there are no documented cases of radio frequency interference leading to incorrect laboratory and diagnostic results. For example, a team of experts [4] investigated an unexpected failure of a blood analyzer that resulted in incorrect white blood cell counts. The failure of the equipment was initially suspected, but the temporal association with increased power output from a nearby antenna led the experts to investigate RFI by increasing the power output from an antenna located approximately 1.3 m from the analyzer to ensure sufficient signal for emergency communications in the building. Fig 2, shows the relationship of the analyzer to two antennas in the laboratory room.

The interference from the antenna resulted in abnormal side scattering and an abnormal white blood cell count. When the antenna was turned off, the device returned to normal operating conditions. The experts concluded that RFI was the root cause of the incorrect white blood cell count in the blood analyzer. The experts have suggested that RFI should be on the list of possible interference mechanisms when clinical and analytical laboratory instruments generate inconsistent or unreliable results [4].

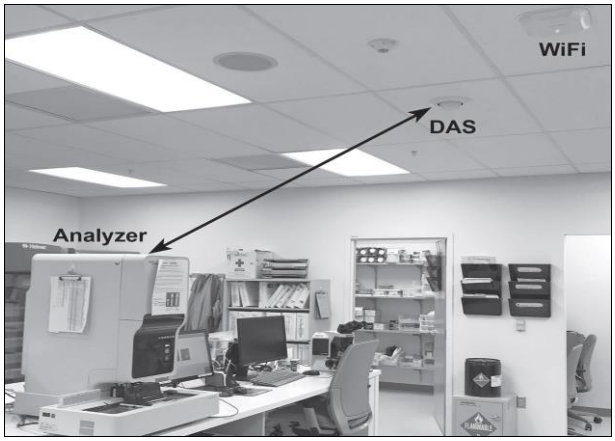
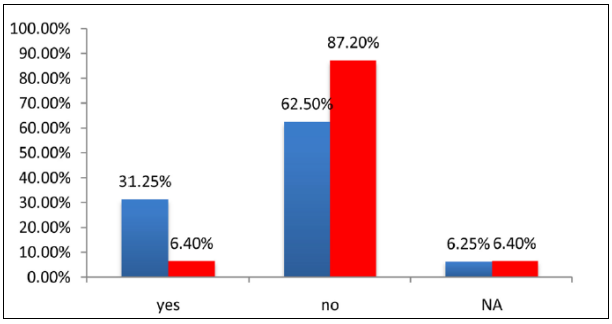


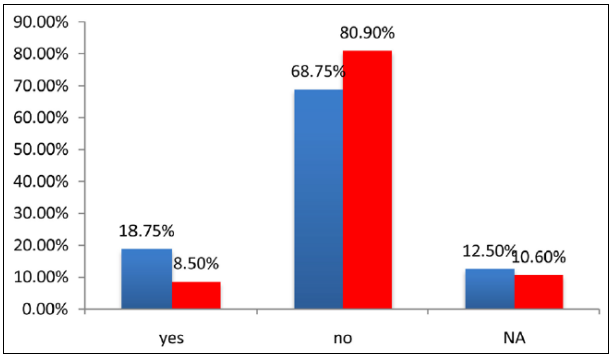
Fig 2: Shows the two-headed arrow between the distributed antenna system (DAS) antenna and the upper right side of the instrument measures approximately 1.3m. [4]

The increase of electromagnetic fields sources in susceptible environments, such as hospitals, clinical and analytical laboratories has led to researchers around the world to quantify the potential risk of electromagnetic interference on medical equipment. Therefore, in order to reduce risks in this equipment, it is very important to know the electromagnetic field environment in different departments of large hospitals and clinics [5]. It was also suggested that, it is very important to assess the electric and magnetic field level in the rooms of a hospital before installing a medical equipment to ensure proper operation and prevent future problems [5].

Other studies on the effects of radiation from electronic equipment in hospitals were performed in Argentinean, Colombian and Spanish hospitals [6]. The work consisted of two parts: a survey to determine the hospital personnel's knowledge of the electromagnetic interferences and a technical part which taking in part measurements levels of radiated electrical and magnetic fields in several hospitals due to the presence of electromagnetic interferences, such as the use of mobile phones [6]. As reported by [6], that more than fifty hospitals were studied in these three countries, considering the following aspects: the hospital personnel's awareness of the electromagnetic interference problem, origin of the interference, whether the hospitals have performed previous studies of this type and the failures that have appeared in medical equipment and computers due to electromagnetic interference [6]. However, the main objective of these studied were aimed to determine the awareness of medical personnel regarding the problem of interference in the performance of the medical equipment and to see if any security measures are taken to avoid the problem of electromagnetic interference [6]. Figure…. Shows the result of the survey for the Spanish hospitals is shown in blue, and the result of the survey for the Argentinian hospitals is shown in red.



(a)



(b)

Fig 3: (a) Hospitals with personnel familiarized with electromagnetic interference problems. **(b)** Hospitals with information about the emission levels of the medical devices [6].

As can be seen from Fig 3, that there is a lack of awareness regarding the electromagnetic interference problem in both countries. In addition the survey has found that between a one-quarter and one-third of the hospitals have suffered equipment damage due to interferences or unknown causes. Also, in most hospitals, precaution measurements have not been taken. Therefore, it was suggested by the survey study that the electromagnetic interference problem is an issue that should be analyzed because there are lives at stake if these measurements are not taken.

Mobile phone interference with medical equipment

The impacts of electromagnetic interference (EMI) are extended also to mobile phones. The amount of electromagnetic radiation (EMR) emitted is low, and is

governed by the inverse square law (exponential decay of radiation with distance from the emitting object). However, the most important point emerged from this survey is to focus on the electromagnetic radiation that mobile phones produce and the safe distance they should be used from medical equipment that may be susceptible to EMR. Results of survey have shown that most clinically relevant EMI occurred when mobile phones were used within 1m of medical equipment [7]. However, it was concluded from this study that hospital construction needs to take into account EMR from different areas within the hospital, as well as external sources, to limit interference with medical equipment and recommend some type of restriction of mobile phone use in hospitals, with use greater than 1m from equipment and restrictions in clinical areas being the most common [7].

Electromagnetic interference with Deep brain stimulation

There are also other influencing factors due to the interference of electromagnetic waves through deep brain stimulation (DBS) therapy as a treatment option in treating patients suffering from various movement disorders and other neurological diseases and in the field of treating psychological disorders. One can easily anticipate the possibility of devastating consequences if therapeutic efficacy is compromised or lost due to electromagnetic interference. Device malfunction due to EMI both intentional and unintentional become an important topic for advanced research [8]. This requires a more comprehensive and up-to-date description to improve the design and development of deep brain stimulation devices that lead to positive patient outcomes. By addressing the knowledge gap, this represents one of the first steps required towards improving the design, implementation, effectiveness and safety of deep brain stimulation systems with respect to electromagnetic interference [8].

Electromagnetic Interference with Medical Devices

Electromagnetic interference (EMI) occurs when electromagnetic energy from one or more sources, such as radio waves emitted by portable radios and cellular telephones, interferes with the normal operation of another device. EMI can come from many sources, since most devices with electronic components can emit electromagnetic energy. Such interference has reportedly caused motorized wheelchairs to move unexpectedly, patient breathing monitors to return false readings, and pacemakers to temporarily malfunction [9]. The increasing use of existing wireless technology, the introduction of new communications services using frequencies and transmission methods not used before, the growth in medical electronics, and the increasing use of sensitive medical devices outside hospital settings all increase the potential for interference among existing electronic equipment, including medical devices [9]. Because of concerns raised by reports of EM1, many centers have conducted laboratory tests on the susceptibility of these devices to electromagnetic transmissions. The studies found that the devices in question could be susceptible to some types of EM1. As a result, some hospitals have recently restricted the use of cellular telephones as a precaution against EMI with medical devices and have led FDA to take regulatory actions, including changes in labeling and in the design of the devices [9].

Electromagnetic Interference with Emergency Medical Service Helicopter Operations

In recent years there have been several incidents with helicopters where magnetic resonance imagers (MRIs) have interfered with the operation of magnetic sensors such as compasses and directional gyroscopes [10]. The fringe magnetic field can cause the magnetic sensors to give aberrant readings [10]. It is likely that all pilots operating in the air ambulance industry will encounter interference from an MRI. These occurrences have taken place at hospital heliports within about 153m of the magnet. In one case the compass reading was 160 degrees off from the earth's magnetic north pole [10]. Reported documents about the effects and hazard with operating helicopters in an MRI fringe field have led to recommendations for safe helicopter operations in and around MRIs [10]. By comparison, the magnetic field strength of the earth is approximately 0.2 G to 0.5 G. This is the magnetic field sensed by an aircraft compass system. Typically a 5 G level is considered safe for human activity without a warning notice. Unfortunately, a magnetic field strength of 5 G will seriously affect the operation of magnetic sensors such as a compass. (A 0.005 G level will cause a compass error of less than 2 degrees [10]). In addition, it was recommended that persons with pacemakers or other implanted electromagnetic devices should be denied entry into a magnetic field strong enough to cause these devices to malfunction. This requires the use of warning signs restricting access to areas where the magnetic field strength exceeds 5G. Magnetic field strength for safe exposure of unwarned personnel is 5G.This level should never be exceeded [10].

Conclusion

It can be concluded that the consequences of EM1 on electrical and electronic systems are serious and of ever growing concern because of their direct connections to our daily lives and activities. The extensive use of modern electronic devices in an increasingly scattered electromagnetic environment (EMI) should be carefully reconsidered and thoroughly retested. Finally, it is of extreme importance of having up-to-date EMI guidelines, standards, and test procedures, so that a minimization of electromagnetic interference can be achieved.

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